December 9, 2002

To: Dr. Jim Clark – Administration
Dr. Ron Lacewell – Administration
Dr. Gary Riskowski, P.E. – Administration and faculty
Dr. John Sweeten, P.E. – Administration and faculty
Dr. Brent Auvermann – faculty
Dr. Jacek Koziel – faculty
Dr. David Parker – faculty
Dr. Ron Lacey, P.E. – faculty
Dr. Wayne Greene – faculty
Dr. Bryan Shaw – faculty
Dr. Saqib Mukhtar – faculty

Dear CAAQES Faculty and Administration:

On Thursday morning, December 12, 2002, we will have a closed-door session at the Amarillo Center just prior to the air quality initiative meeting from 8:00 AM until noon. This will be the first meeting of the original faculty of the Center for Agricultural Air Quality Engineering and Science (CAAQES). I am officially appointing all faculty listed above as the initial faculty of the CAAQES. Gary, John, Brent, Jacek, David, Ron, Wayne, Bryan, Saqib, and Calvin are the initial CAAQES Faculty. John and Gary have the added role of serving as administrators at the Texas A&M University Agricultural Research and Extension Center at Amarillo and Head of the Department of Biological and Agricultural Engineering at College Station, respectively. Dr. Riskowski also has an administrative role for the center. The Center Director reports directly to the BAEN Department Head. Dr. Lacewell is our liaison with the administration above Dr. Riskowski. Dr. Clark has an administrative role with West Texas A&M University. Only those listed are to attend this closed-door session. I will chair the session. See the attached agenda. (I took the agenda that Gary sent out (10/17/02) with suggestions from Brent (10/17/02) and modified.) We most likely will not cover all that is on the agenda. We will make a start and continue with e-mail and telephone correspondence.

I have a number of goals for this meeting but one of the goals is for the new CAAQES faculty to ask and discuss all those questions that each of us may have relative to our relationship with the Center. The following are some topics that I think will be addressed under agenda item 1 listed as who, what, when, where, and how?

- Why should I be a member of CAAQES? Is this involvement going to require more of my time? Am I likely to get more funding for my teaching, research and extension activities because I am a member of CAAQES?
- Who will be on the CAAQES Faculty? Dr. Parnell will appoint all CAAQES faculty but how will we decide who should be a CAAQES faculty member? Are we to be CAAQES faculty for life? How do we remove individuals from

the CAAQES faculty. What will be the process for subtracting and adding faculty?
- What will I be required to do as a CAAQES faculty member?
- Periodically the CAAQES Faculty will meet. Where will we meet – Amarillo or CS?

I am including copies of the document that was approved by the Board of Regents for you to have as well as a copy of my letter of acceptance for each of you. I will address how I see us operating in the future. I want you to feel free to express your views (negative or positive) on your role as part of this center. My authority is limited to appointing the Center faculty. I take this authority seriously. I see merit in having a "lean and mean" CAAQES faculty. Our initial CAAQES faculty consists of engineers and one animal scientist.

I view that one of my primary charges is to promote the talents of the CAAQES faculty. In preparation for this meeting, please e-mail me a two-page description of your talents relative to the mission of this Center, prior to next Wednesday if possible.

In addition, I would like your views of what you (and/or your team) has accomplished relative to impact statements. I am looking forward to the challenges we will face and the opportunities that the increased visibility will afford all of us.

Sincerely,

Calvin B. Parnell, Jr., Ph.D., P.E.

Cc: E.A. Hiler

Center for Agricultural Air Quality Engineering and Science
(CAAQES)
(Draft)
Kick-Off Meeting Agenda
Thursday 8:00 – noon
December 12, 2002

1. Vision and Goals:
    a. Who, what, when, where and how?
    b. Develop specific action plan with timeline for next 2 years
    c. Goals for 5 years in the future; new research areas
    d. Future national partnerships
    e. Leveraging current resources for additional future resources
    f. Process to decide which projects and products are included under CAAQES
2. Center Organizational Structure:
    a. Management
    b. Standing committees
    c. External advisory committee
    d. Staffing needs
2. Marketing and visibility:
    a. Logo/theme/letterhead
    b. Web page, power-point slide set, newsletter, brochure, etc.
    c. General public and industry press outlets
    d. Who to keep informed of progress
3. Publications, workshops, and other products:
    a. Refereed journal articles
    b. Extension/general public presentation materials
    c. Sponsored workshops

PROPOSAL

Center for Agricultural Air Quality Engineering and Science (CAAQES)

Texas A&M University (TAMU)
West Texas A&M University (WTAMU)
Texas Agricultural Experiment Station (TAES)
Texas Cooperative Extension (TCE)
April, 2002

PROPOSAL

This proposal seeks to establish a Center for Agricultural Air Quality Engineering and Science (CAAQES) within Texas A&M University, West Texas A&M University, the Texas Agricultural Experiment Station and Texas Cooperative Extension. This Center will be administered through the Department of Biological and Agricultural Engineering at Texas A&M University. The establishment of this Center will allow faculty with specific expertise and interest in air quality to develop quality research and educational programs related to the regulation and abatement of air pollution.

JUSTIFICATION

Agricultural operations are economically and technically challenged to comply with the increasingly stringent state air pollution regulatory demands related to permitting, enforcement, and compliance with the Federal Clean Air Act. Permitting issues include controversy associated with Federal Operating Permits for major and non-major sources involving pollutant emission rates and inventories for concentrated animal feeding operations (CAFOs); cotton gins; grain elevators; feed and oil mills; field operations; and agricultural burning. Enforcement problems are affected by measurement accuracy, use of inaccurate dispersion models, and the lack of accurate emission factors and measurement methodologies. Compliance issues are associated with abatement strategies, cost of compliance, defining and quantifying reductions associated with Best Management Practices (BMPs) and Best Available Control Technologies (BACTs). Compliance with air pollution regulations often results in inappropriate and unfair regulation of agricultural operations. The results of inappropriate regulation are financial stress that threatens the economic viability of rural communities. There is a clear need for science-based research results to address agricultural air quality problems and to provide appropriate regulatory procedures to be used by regulatory agencies.

RESPONSE

The foundation for addressing air quality issues with emphasis in agriculture lies in sound research, demonstration, and evaluation of abatement solutions, technology

transfer, and education. The proposed Center for Agricultural Air Quality Engineering and Science (CAAQES) will seek to respond to these issues by: (1) conducting research to provide science-based, emission factors, abatement strategies, measurement methods, and dispersion modeling procedures for the regulation of air pollutants from agricultural operations; (2) developing extension and fee-based adult education programs to transfer technologies to the public as they are developed; and (3) teaching and developing educational programs to include courses for undergraduate and graduate students at both Texas A&M University (TAMU) and West Texas A&M University (WTAMU) on topics such as air pollution engineering and environmental policy.

System components within the proposed Center (TAMU, TAES, WTAMU and TCE) are independently addressing many of the problems associated with the regulation of air pollution from agricultural operations, technology transfer, and education. Research, education, and extension programs at College Station and Amarillo have organized two "cores of excellence" in air quality research and education with a goal of providing sound science responses to problems related to the regulation and abatement of air pollution. The infrastructure and fiscal support is in place to successfully address critical air quality issues. With this sound science and engineering base, the CAAQES is positioned to compete for larger funding sources to solve air quality problems in Texas and the United States. Faculty members have developed base research, extension, and education programs that are actively addressing particulate matter (PM_{10} and PM_{25}), odor, ammonia, hydrogen sulfide, dispersion modeling, emission factors, emission inventories, monitoring methods and alternative abatement strategies. Based on these program strengths and demonstrated excellence, greater funding and associated collaborations can be developed, expanded, and accelerated through the establishment of a CAAQES.

MISSION AND GOALS

The mission of the CAAQES is to provide the research, technology transfer, and educational programs that will result in appropriate regulation of agricultural operations, rapid adoption of new air pollution abatement technology, as well as increase the number of graduates pursuing careers in environmental air quality fields. The concept of the CAAQES is that faculty will conduct research and develop adult educational programs for technology transfer, and course work for both undergraduates and graduate students. The research results will serve as the science and engineering base for the appropriate regulation of air pollution.

The goals for the CAAQES are to:

- Enhance national and international program visibility;
- Encourage strategic planning;

- Develop, strengthen and expand Agricultural Program expertise and resources;

- Leverage existing A&M System strengths, including interdisciplinary relationships;

- Foster scientific excellence;

- Increase competitive funding;

- Enhance information dissemination; and

- Serve as the source of graduates for careers in environmental air quality.

CENTER OBJECTIVES

The CAAQES will accomplish its goals by addressing a wide range of research, extension, and teaching objectives including, but not limited to, the following:

- Develop particulate matter (PM) data bases that characterize PM emitted by CAFO, field operations, cotton gins, grain elevators, mills, and agricultural burning;
- Improve and refine dispersion modeling technology for particulate matter (PM), hydrogen sulfide (H_2S), ammonia (NH_3), volatile organic compounds (VOC), nitrogen oxides (NO_x), and odor;
- Design and develop economically feasible air pollution (particulate matter and odor) abatement systems;
- Develop accurate emission factors and inventories for odor and gases emitted from agricultural operations;
- Develop improved methods to estimate PM emission rates and emission factors based on scientific understanding of the processes and release mechanisms;
- Determine the relationship between ammonia and secondary $PM_{2.5}$ formation;
- Provide educational programs at WTAMU and TAMU for undergraduate and graduate students that will facilitate careers in air quality engineering and science; and
- Provide training and technology transfer for agricultural producers, scientists, regulatory agencies, and the public.

GOVERNANCE AND ADVISORY STRUCTURE

The Center will be directed by a Director who will report to the Head of the Department of Biological and Agricultural Engineering (BAEN) at Texas A&M University (See Appendix A). The Director will be appointed by the Vice Chancellor/Dean of Agriculture and Life Sciences/Director of TAES/TCE, in consultation with the Head, BAEN and the Dean of the College of Agriculture, Nursing and Natural Sciences at WTAMU. Center Faculty members will be appointed by the Director. Qualifications for Center Faculty will include a professorial appointment; an active teaching, research, or extension program(s) related to air quality; and a desire to be an active, cooperating member of the Center. The department head will have oversight responsibility of Center activities and will serve as a defacto member of the Center faculty. The director may appoint adjunct members of the faculty but these members will not have a vote on Center decisions.

The Center Director and Faculty will be responsible for developing strategic (long-term) research plans and short-term (1-year) work plans to guide research, teaching, and technology transfer efforts. It is anticipated that Center faculty members will gain the following benefits: enhanced interaction among faculty, external clientele, and state and federal regulators; ability to critique and provide constructive analysis of research proposals and manuscripts; access to shared equipment and resources for air quality measurements; enhanced program visibility through targeted publications; and enhanced visibility and administrative leadership for coordination of and response to external funding opportunities.

The CAAQES will appoint an external Advisory Committee composed of representatives from industry, federal, and state agencies. The advisory committee will provide recommendations to focus the research, education, and extension programs; support and assist with funding opportunities; and provide recommendations and assistance in developing partnerships with other universities, industries, state and/or federal agencies, and other disciplines. The Advisory Committee will meet annually or more, depending on the needs of the Center.

FACILITIES AND EXISTING PARTNERSHIPS

The CAAQES will seek to build and expand programs of research, extension, and teaching from a present platform of outstanding facilities located on the Texas A&M University campus and elsewhere through established, active partnerships. The Department of Biological and Agricultural Engineering (BAEN) operates air quality laboratories for particle size distribution analysis, PM sampling and emission factor development, dispersion modeling, electronic odor measurement, ammonia and hydrogen sulfide monitoring, and extensive computer support facilities including software for dispersion modeling, geographical information systems (GIS), geographical positioning systems (GPS), statistical analysis, and signal analysis. The Department has a Memorandum of Agreement with the University of Southern Queensland (Australia). Also, the Texas Agricultural Experiment Station has a Memorandum of Understanding with the Crocker Nuclear Laboratories at the University of California-Davis. Both of these entities have outstanding air quality research capabilities.

The TAMU Agricultural Research and Extension Center at Amarillo/Bushland/Etter (Amarillo AREC) is in the heart of Texas' and the nation's greatest concentration of beef cattle feeding operations, a major swine production area of the state, and a growing dairy production industry. Amarillo AREC faculty developed laboratory facilities for PM monitoring, odorant monitoring and speciation and animal nutrition. They are co-participants in ammonia monitoring capabilities with the United States Department of Agriculture – Agricultural Research Service in Bushland, Texas (USDA-ARS/Bushland), a new gas chromatography/mass spectrometry laboratory in Amarillo, and an olfactometry laboratory at West Texas A&M University in Canyon, Texas (WTAMU/Canyon). Multidisciplinary teams of scientists from WTAMU, Amarillo AREC, USDA-ARS/Bushland, TVMDL (Texas Veterinary Medical Diagnostic Laboratory, Amarillo), Texas Tech University, and New Mexico State University are presently working on several air quality, animal environmental, nutrition and health, and related problems of the cattle feeding industry.

Research, Extension and Education Priorities (See Appendix B.)	**Potential Funding Sources**
Emission Factors Monitoring and Sampling	TAES Air Quality Initiative TAES Animal Waste Initiative
Regulations and Policy	USDA IFAFS
Dispersion Modeling	USDA/ARS Section 224
Receptor Impacts Pollutant Characterization	ARP/ATP Commodity Grants
Process Modeling	Congressional Initiatives
Control Strategies	Industry
Abatement Equipment	State and Federal Agencies

RESOURCES

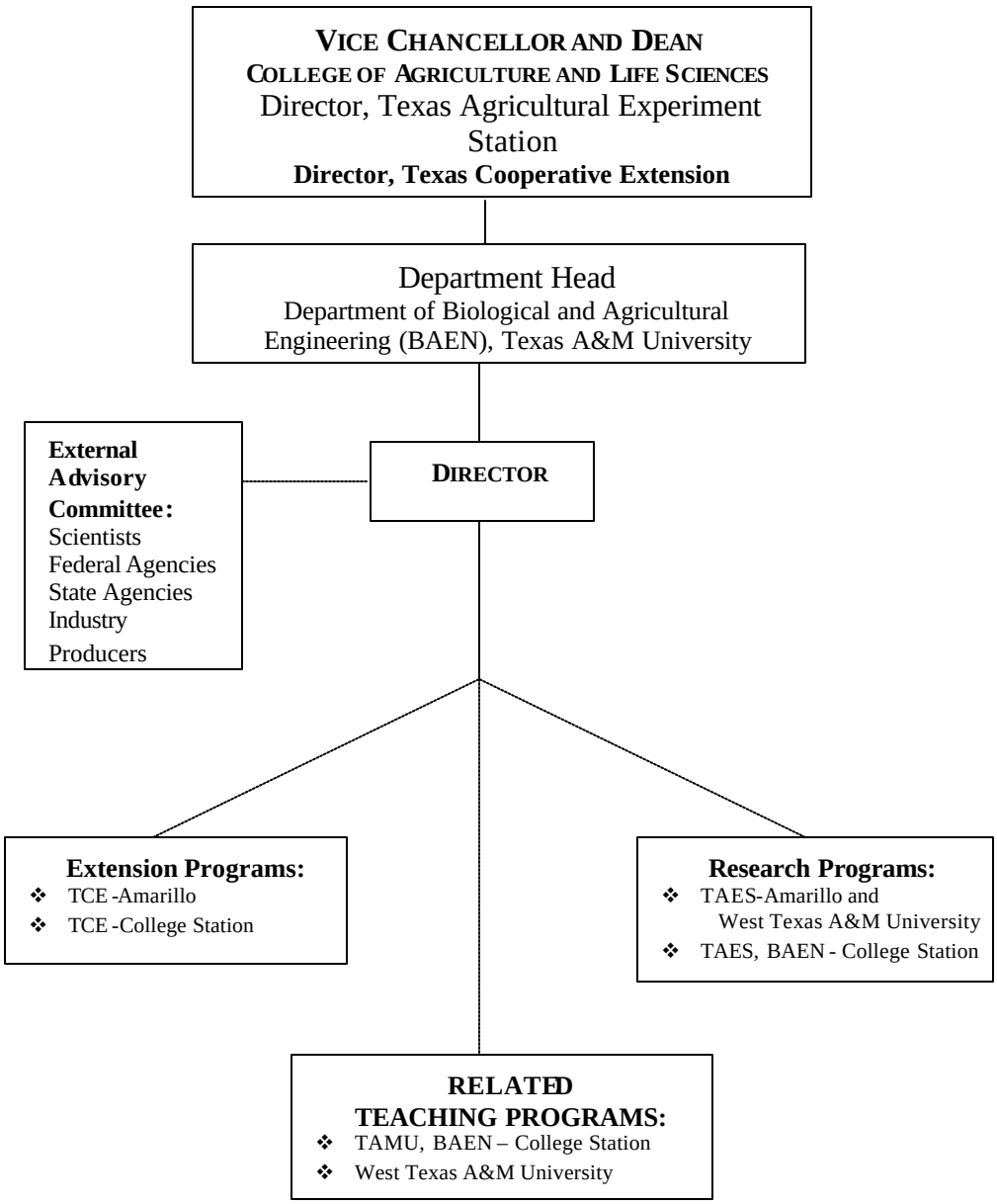
The CAAQES has recently acquired $400,000 per year from new state funds and $640,000 per year from a new Federal Air Quality Initiative that will be available in the Spring of 2002. The potential also exists for the CAAQES to receive funding of $1 million to $5 million per year from USDA, as per the recommendations made by the USDA Agricultural Air Quality Task Force (AAQTF) to the Secretary of Agriculture. Startup funds will be funded through existing sources.

REVIEW

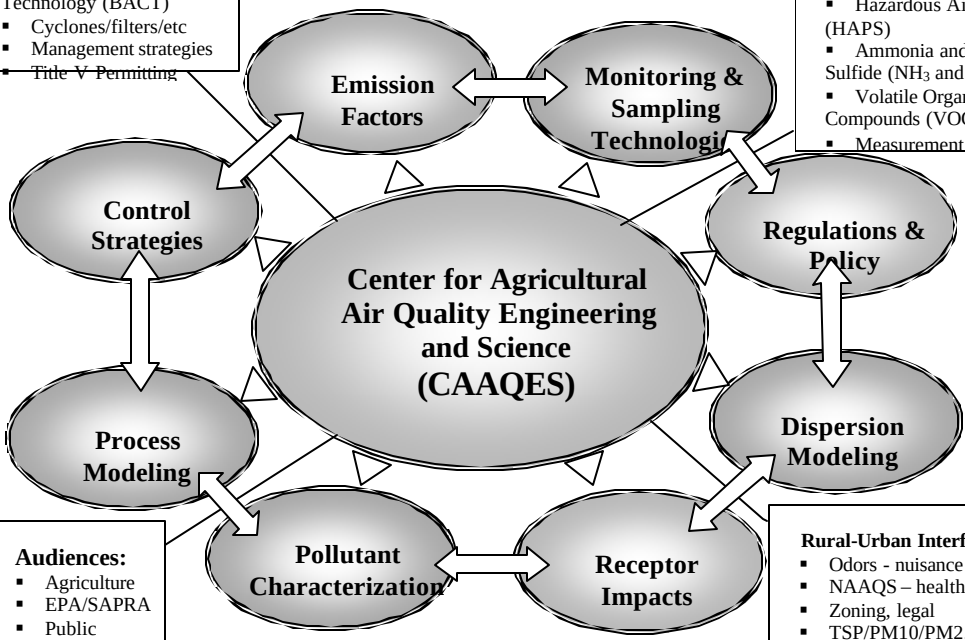
The Center for Agricultural Air Quality Engineering and Science (CAAQES) will provide an annual progress/activity reports to the Vice Chancellor/Dean and the External Advisory Committee. In addition, the CAAQES will undergo an initial review three years following establishment. Thereafter, the Center will be reviewed every five years. Criteria for assessing progress of the CAAQES in achieving its stated objectives will be developed by the Advisory committee and responsible administrators.

Appendix A - Organizational Chart

CENTER FOR AGRICULTURAL AIR QUALITY ENGINEERING AND SCIENCE (CAAQES)



Appendix B - CAAQES Research, Teaching, and Technology Transfer



Economical and Effective Abatement

- Best Management Practices (BMP)
- Best Available Control Technology (BACT)
- Cyclones/filters/etc
- Management strategies
- Title V Permitting

Agricultural Air Pollution

- Odors
- Particulate Matter (TSP/PM_{10} /$PM_{2.5}$)
- National Ambient Air Quality Standards (NAAQS)
- Hazardous Air Pollutants (HAPS)
- Ammonia and Hydrogen Sulfide (NH_3 and H_2S)
- Volatile Organic Compounds (VOC)
- Measurement Accuracy

Audiences:

- Agriculture
- EPA/SAPRA
- Public
- Industry
- Consultants
- Academia

Rural-Urban Interface Issues

- Odors - nuisance
- NAAQS – health effects
- Zoning, legal
- TSP/PM10/PM2.5
- CERCLA

Appendix C – Programs

Air Quality Programs – Amarillo Center

The Texas A&M University Agricultural Research and Extension Center (AREC) at Amarillo/Bushland/Etter is in the heart of the nation's cattle feeding industry, and a rapid growth area for confinement swine and dairy production. Faculty and scientific support staff conduct research and Extension programs that are currently focused on these air quality areas: cattle feedlot odor and dust control (including chemical speciation and kinetics), manure and wastewater management, cattle nutrition and health, energy from biomass, and indoor air quality. Specific Hatch research projects that relate to this comprehensive effort include the following:

- Dr. Brent W. Auvermann, Associate Professor/Environmental Engineer (H# TEX08545) – "Environmental Quality Associated with CAFOs and Intensive Agricultural Production Systems". Dr. Auvermann has a joint research (TAES) and extension (TCE) appointment.
- Dr. Jacek A. Koziel, Assistant Professor/Air Quality Engineering (H# TEX08833) – "Agricultural Air Pollution: Chemical Characterization of Odors". Dr. Koziel has a joint research (TAES) and extension (TCE) appointment
- Dr. L. Wayne Greene, Professor/Beef Cattle Nutrition (H# TEX08703) – "Mineral Nutrition to Improve Beef Cattle Health and Production". Dr. Greene has a joint research (TAES) and teaching (WTAMU) appointment
- Dr. L. Wayne Greene, Professor/Beef Cattle Nutrition (H# TEX08875) – "Improving N Movement through Beef Cattle Feedlots".
- Dr. Norbert K. Chirase, Research Scientist/Beef Cattle Health (H# TEX08324) – "Nutritional and Environmental Stress and Immune Response of Feeder Cattle". Dr. Chirase has a joint research (TAES) and teaching (WTAMU) appointment.
- Dr. Mike Brown, Assistant Professor/Ruminant Nutrition (H# TEX08834) – "Nutrition and Management to Enhance Beef Cattle Productivity and Beef Safety". Dr. Brown has a joint appointment with WTAMU (research & teaching) and TAES (research).
- Dr. John M. Sweeten, Professor and Resident Director (H# TEX08548) – "Feedlot Wastewater Utilization and Odor Control". Dr. Sweeten has a joint research (TAES) and teaching (WTAMU) appointment.

Some of the specific resources that have been developed and are available to this research team include the following: TAES/USDA-ARS Experimental Cattle Feedlot, Bushland, Texas (384 head); Ruminant Nutrition Laboratory; Air Quality Laboratory (odorous gases and particulate); Animal Metabolism Building; air sampling trailers (2); and instrumentation that includes particulate matter (PM) monitors; particle size distribution (PSD) analysis; gas chromatography (2); solid phase microextraction (SMPE) samplers; and atomic absorption unit.

The TAMU-AREC/Amarillo faculty are linked very strongly with counterparts at West Texas A&M University's (WTAMU) Division of Agriculture; USDA-Agricultural Research Service at Bushland; and Texas Veterinary Medical Diagnostic Laboratory

(TVMDL) at Amarillo through the Cooperative Research, Education, and Extension Triangle (CREET). This provides ready access to additional state-of-the-art research facilities at these respective locations including:
(a) WTAMU's 600-head Nance Ranch Feedlot (under the direction of Dr. Mike Brown); and
(b) Olfactometry Laboratory (under the direction of Dr. David Parker). The "CREET team," which includes Texas Agricultural Experiment Station (TAES) and Texas Cooperative Extension (TCE) faculty/staff at AREC-Amarillo, WTAMU, TVMDL, and USDA-ARS/Bushland has helped organize and operate a Consortium for Cattle Feeding and Environmental Sciences (CCFES) that also includes: Texas Cattle Feeders Association (TCFA); Texas Tech University (TTU); and New Mexico State University's (NMSU) Clayton Livestock Center. The CCFES represents approximately 40 scientists focused on cattle feedlot nutrition, health, production, and environmental quality problems and issues of the cattle feeding industry at 5 locations, with 4 experimental feedlots and multiple laboratories to work with. An Industry Advisory Committee of CCFES together with the TCFA Research Committee has established priorities for research and technology transfer. Air quality, including control of feedlot dust (PM), odor, and ammonia, are near the top of the industry priority list.

Some **examples** of current air quality related research and technology transfer programs being led and conducted by TAES and TCE faculty at TAMU-AREC/Amarillo include:

Topic:	Funding Source:
• Water curtain project for cattle feedlot PM reduction (Auvermann)	TCFA
• Evaporative loss of moisture from feedyard surface (Auvermann)	TCFA
• Feedlot nutrition for nitrogen management (Greene)	THECB & USDA-CSREES (IFAFS)
• Feeder cattle stress effects of feedlot dust (Chirase)	--
• Development of breath analysis indicators of feeder cattle stress (Koziel & Chirase)	TCFA
• Arial emissions of swine buildings in Texas Panhandle (Koziel)	USDA-CSREES (IFAFS)
• Cattle feedlot emissions characterization, abatement, and emission factors (Sweeten, Auvermann, Koziel, et al.)	USDA-CSREES (SRG)
• Cattle feedlot manure as a reburn fuel for NO_γ emissions (Sweeten)	USDOE

Air Quality Programs – The Department of Biological and Agricultural Engineering (BAEN) at College Station

The BAEN Department at College Station has developed a national reputation of conducting research that has had an impact on the regulation of pollutants emitted by agricultural operations. Serious problems have been documented where state air pollution regulatory agencies (SAPRAs) and EPA have utilized erroneous data to regulate agriculture. The goal of the BAEN faculty has been to conduct the research that will result in a sound science approach to regulation agricultural air pollutants and the engineering that will have the consequence of appropriate regulation of emissions from agricultural operations. Agricultural operations include the following:

- Concentrated Animal Feeding Operations (CAFOs) – cattle feed yards, dairies, broiler operations, and swine facilities
- Grain elevators, feed mills, oil mills, and cotton gins
- Field operations such as disking, planting, harvesting, etc.
- Agricultural burning

Regulated air pollutants emitted by agricultural operations include the following;

- Particulate matter including total suspended particulate (TSP), PM_{10} - particulate less than a nominal 10 micrometers aerodynamic equivalent diameter (AED) and $PM_{2.5}$ – PM less than a nominal 2.5 micrometers AED.
- Ammonia (NH_3)
- Hydrogen Sulfide (H_2S)

Examples of current research efforts are as follows:

1. **Characterize the performance characteristics of the TEOM continuous PM sampler.**

(This sampler is advertised as a TSP, PM_{10}, and $PM_{2.5}$ sampler). It does not capture PM on a filter as do other gravimetric Federal Reference Method (FRM) samplers but has a sensor that allows for continuous readings of PM. It is being used to estimate downwind emission concentrations of fugitive PM from open-lot CAFOs.

Use of this measurement method is attractive. We have determined that there are serious errors with the FRM PM_{10} and $PM_{2.5}$ samplers when measuring concentrations of PM_{10} and $PM_{2.5}$ from agricultural sources as a consequence of the particle size distribution (Buser, 2001). Typically, PM emitted by any agricultural source has a Mass Median Diameter greater than 10 micrometers (μm). Measurements of PM_{10} with a FRM PM10 sampler can result in a measurement error in excess of 300%. This error is a function of the pre-collector used by the FRM sampler. The TEOM sampler uses the same pre-collector. It is hypothesized that errors will result in the concentration measurements with the TEOM sampler because of the pre-collector.

In addition, it is essential that the results of using any sampler be 24-hour concentrations. The National Ambient Air Quality Standard (NAAQS) for PM_{10} is 150 micrograms per dry standard cubic meter (μg/dscm). How does one convert TEOM measurements into 24-hour concentration measurements? If there is a response time delay, the 24-hour average concentration results can vary significantly. This could significantly affect our efforts to generate PM emission factors from open lot CAFOs using TEOM data.

We have the ideal laboratory system for performing this characterization. The chamber used by Ms. Amber Pargmann (2001) can be used to conduct tests with different PM

while maintaining concentrations constant. It is anticipated that we will test the TEOM under varying conditions using the Coulter Counter and the newly purchased Aerodynamic Particle Sizer (APS) equipment.

2. Develop protocols for PM_{10}, $PM_{2.5}$, TSP, NH_3, and H_2S emission concentration measurements.

This is not a simple task or deliverable. We anticipate working with the staff at Amarillo in conducting two intensive sampling trips in the fall of 2002 and the spring of 2003. Our primary charge will be to conduct the PM sampling. The results of previous work where we conducted field PM sampling (Parnell et al, 1999) will be used to develop the initial sampling protocols used for these trips. The concentration measurement protocols will be improved with the results and evaluations of the initial protocols used for the intensive field sampling trips. A sample of the questions to be addressed in protocol development are as follows:

- Where should the PM samplers be located to obtain the best results? It has been hypothesized that samplers should be located upwind, downwind, and in the pen. The upwind and downwind direction may change during the sampling period because of ambient wind direction changes.
- How often should the filters be changed? We know that the PM emission rate will vary significantly from 1 hour to the next. For example: The TNRCC reported property-line hourly TSP concentrations ranging from over 2000 µg/dscm to less than 100 µg/dscm. (The calculation of the 24-hour PM_{10} average concentrations for this reported data indicated compliance with the PM_{10} NAAQS using the EPA accepted 25% of the TSP is PM_{10}.) Ideally, one would want 1-hour concentrations. However, changing a large number of filters every hour is labor intensive and very costly.

Protocols to measure ammonia (NH_3) and hydrogen sulfide (H_2S) emission concentrations from ground level area sources (GLAS) will be developed using isolation flux chambers (FC) and real-time and laboratory gas monitors. Chambers will be placed at various GLAS components of open-lot CAFO operations (lagoons, stacked manure, free-stall manure alleys etc.) and sweep air (organic-free, ultra-high, pure-grade) will be introduced to the chamber inlet for purging of ambient air and existing contaminants inside the chamber. NH_3 and H_2S concentrations from surface encapsulated by the FC will be measured in the exhaust air from the FC outlet using different methods. Protocols will include description of sampling approach, equipment deployment, materials and supplies needed, FC operation, sampling locations and sample handling.

The concentrations measured from the FC will directly impact the emission rate (flux), emission factor, and subsequently the emissions inventory.

It is anticipated that these protocols will be drafted, evaluated, and changed during the duration of this multi-year project. Each intensive sampling trip will require sampling protocols. As we learn how to improve the accuracy of our concentration measurements, we will change the protocol.

3. Dispersion modeling

Develop improvements to the ISC-ST dispersion model to more accurately predict downwind concentrations of particulate matter. Improvements may include more appropriate use of meteorological data and/or replacement of the Gaussian distribution to

describe the plume in the vertical plane with distribution based on measured plume concentration profile.

Evaluate and compare the performance of dispersion models (ISC-ST, AERMOD, ADMS, and F-TAM) to determine appropriateness of application to agricultural sources. From this evaluation, we will determine how to proceed to improve dispersion models from a sound science standpoint.

4. **Develop the protocol for obtaining emission factors from measured emission concentrations.**

Emission factors are used to develop emissions inventories. They are also used to estimate emission rates in dispersion modeling calculations. For the purposes of this study, an emission factor is directly proportional to the annual average emission rate and is described in units that are characteristic of the operation. For example, the PM10 emission factor for cattle feed yards is 20 pounds per 1000 head per day (lbs/1000hd/d) (Parnell et al, 1999). If it is determined that 21% of the time there is sufficient moisture of the feed yard surface such that zero emissions occur, the emission factor is 16 lbs/1000hd/d. For broiler operations, approximately 5 flocks will be harvested per year. The emission rate will increase from the time that the chicks are very small until just prior to harvesting. It is typical that the houses are vacant for a period of time between flocks. The emission factor must account for the variations in emission rates during the years.

For PM emissions from a GLAS, the determination of the flux is accomplished by back-calculating the flux using the measured concentration and a dispersion model. Several different models have been used. If we assume that the concentrations measurements are accurate, the flux determination is dependent upon the model selected. Researchers have used ISCST3, Box model, and an infinite line source model for determinations of flux and subsequently emission factors. Variations of the box model have also been used with different distributions of concentrations in the box.

For gaseous emissions using Flux Chambers (FC), the determination of flux is dependent upon accurate concentration and flow rate measurements. Flow rate times concentration divided by area covered by the FC yields a flux. It is anticipated that the emission factor will incorporate variations in emission rates (fluxes) throughout the year. The process of accounting for variations of fluxes, converting flux (mass per unit area per unit time) into the appropriate units that incorporate the description of the operation is included in the development of this protocol.

5. Develop a method that will objectively allow for FRM PM_{10} and $PM_{2.5}$ sampler error corrections.

The use of FRM PM_{10} and $PM_{2.5}$ samplers to measure emission concentrations of PM having a particle size distribution that is characterized by a lognormal distribution with a mass median diameter (MMD) larger than 10 µm AED results in significant error. It has been determined that the PM emitted by broiler operations has a MMD equal to 25 µm AED (Redwine and Lacey, 2002). The MMD of cattle feed yard PM emissions is typically 16 µm AED. Most grain dusts have an MMD equal to or greater than 16 µm AED. Buser (2001) demonstrated that the potential exists for measuring a PM_{10} concentration of 300 µg/dscm or more for PM with an MMD equal to 20 µm AED when in fact the true concentration of PM_{10} is 100 µg/dscm. EPA has recognized this as a problem. Several potential corrections have been proposed but no solution has been developed to date. It is imperative that this issue be resolved in the near future in that it impacts the determinations of "emissions" proposed in this work. The following are recent publications describing work conducted by the BAEN Faculty and graduate students:

Buser, M. D.; C. B. Parnell, Jr.; R. E. Lacey, B. W. Shaw; B. W. Auvermann. 2001. Inherent biases of PM_{10} and $PM_{2.5}$ samplers based on the interaction of particle size and sampler performance characteristics. ASAE Paper no. 01-1167. American Society of Agricultural Engineers; St Joseph, Mi.

Pargmann, A. R., C. B Parnell, Jr. and B. W. Shaw. 2001. Performance Characteristics of PM 2.5 Samplers in the Presence of Agricultural Dusts. Paper No. 01-4008, presented at the 2001 ASAE Annual International Meeting in Sacramento, CA, St. Joseph, Mi.

Parnell, C. B., B. W. Shaw, and B. W. Auvermann. 1999. Agricultural Air Quality Fine Particle Project Task 1 Final Report: Livestock – Feedlot PM Emission Factors and Emissions Estimates. Department of Biological and Agricultural Engineering, Texas A&M University, College Station, Tex.

Redwine, J. S., R. E Lacey, S. Mukhtar, and J. B. Carey. 2001. Concentration and emissions of ammonia and particulate matter in tunnel ventilated broiler houses under summer conditions in Texas. Paper No. 01-4095, presented at the 2001 ASAE Annual International Meeting in Sacramento, CA, St. Joseph, Mi. ***(This paper has been accepted for publication in ASAE Transactions)***