OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

MEMORANDUM **April 17, 2007**

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SUBJECT: Evaluation of Permit Application No. **99-104-C (M-4)**
Engine Test Cell Modifications, Buildings 3234 and 3703
Tinker Air Force Base, Oklahoma Co. (≈ Lat. 35.416° N; Long. 97.376° W)

I. INTRODUCTION

Tinker Air Force Base (Tinker) is an existing major facility (SIC Code 9711) with permitted emissions of nitrogen oxides (NO_X), carbon monoxide (CO), and volatile organic compounds (VOCs) exceeding 250 tons per year (tpy) each. Tinker operates 12 engine test cells in which engines are run through a standard profile at various power settings as quality control after performing depot maintenance and prior to deploying engines to the operators at various bases. This permit application is required because modifying (updating) the engine test cells will void the existing "grandfathered" status. In addition, engine testing workload currently being accomplished at other bases is expected to be transferred to Tinker. This realignment will increase Tinker's workload over the recent past, but not to previous levels. The increased number of engines will require some infrastructure change to include equipment such as stands, fixtures, and adapters, modification of the test cells and possibly construction of additional operational testing facilities such as T-9 test cells/stands. Some of this equipment may accompany the transferred workload from other installations. The increased workload may also include one new variant of the F-100 engine, the F-100-229.

These changes require a permit modification and establishing emission limits for inclusion in the Title V operating permit. Part of the upgrade also will include some infrastructure change consisting mainly of replacing electrical lines, plumbing, and fuel system upgrades. Some modification of one or two of the test cells may be required to accommodate the F-100-229.

II. PROJECT DESCRIPTION

Tinker performs routine aircraft engine depot-level maintenance on approximately six different engines. Each engine may have variants required by the unique weapon systems on which similar engines are used. Some engines have several different variants such as the TF-33 with four different models. The test cells are fixed structures in which engines are mounted on stands and either moved into the cells or mounted on equipment in the cells. The engine is then connected to test equipment consisting of fuel supply and controls which include monitoring equipment to assess proper performance. Currently, the software monitoring the equipment is old and requires updating. The software upgrade project known as Pacer Comet 4 is required because the existing computer hardware/software is becoming obsolete and replacement parts are increasingly hard to acquire.

The first proposed action is to remove the existing system, Pacer Comet 3, and replace it with a supportable, state-of-the-art system, Pacer Comet 4. The new system, designed by the 76th software maintenance group at Tinker, consists of computer and data acquisition hardware, instrumentation, and custom-developed software.

The secondary construction aspect of this permit application will include several modifications: replacing/upgrading some electrical and plumbing infrastructure; fuel system supply; and possibly test facilities such as T-9 test stands. The semi-portable engine test stands may be relocated or constructed if the proposed workload is transferred. These emission sources (additional test stands) have been designated as Emission Unit (EU) 4600. Since this has not yet been approved, funded, or timing determined, no firm details are available. It is included in this application to address the emissions, yet streamline the permitting burden for both the facility and the ODEQ. EUs 4403 and 4404 will remain the primary engine test facilities, but the sources such as T-9 test stands (EU 4600) would provide some additional operational flexibility, if constructed. Emission limits discussed later in this application include all three EUs.

III. EQUIPMENT

Tinker operates 12 engine test cells; 8 in Building 3703 and 4 in Building 3234. These are identified in the permit memorandum of Tinker’s Title V permit as “grandfathered” sources, Emission Units 4403 and 4404, respectively. These test cells have been in operation since the 1970s. Engine testing at Tinker has ranged from approximately 350 to 3,000 engines per year. In CY05, Tinker tested approximately 350 engines and now anticipates an increase in future workload due to possible transfer of testing operations from other DoD facilities.

The engines tested will remain the same but may include the F100-229, a variant of the F100. Currently, most of the work expected is associated with existing engines including the F100-220. Excess capacity already exists as the test cells generally operate two shifts plus a few weekends depending on workload. In addition, there are only a finite number of these engines in the Air Force inventory. The new software may reduce the test cell operation time of each engine due to enhanced data acquisition and better analytical capability. The workload as shown in Table 1 following is highly variable depending on the operational utilization of the engines. In a wartime or prolonged contingency operation, aircraft are flown more and thus engine change time is reached much sooner. This results in an increased number of engines requiring depot-level maintenance.

Due to the consolidation of workload throughout the Air Force, additional engine testing may be transferred to Tinker. This workload would consist primarily of those engines which can currently be run with the existing equipment and infrastructure. Similar engines are currently tested elsewhere in the Air Force. Although this may result in additional engines being serviced, that additional work could currently be accommodated at Tinker with test cell modification required only to support the F100-229 engine variant. Depending on the software performance, actual test profiles may reduce engine run time possibly resulting in a decrease in emissions during each test run.

Headquarters Air Force Materiel Command is considering transfer of some intermediate level work which is primary first level maintenance (primarily test and replacement of component parts) to Tinker, a depot-level maintenance facility (highest level maintenance for complex repairs). As previously stated Tinker can perform most of the work in the existing test stands. If the work is transferred to Tinker, the additional support equipment such as stands, fixtures, and adapters may accompany the transfer as that equipment will no longer be needed at the existing locations. Not all field adapters may interface with Tinker's equipment, and therefore Tinker may need to modify or purchase some new equipment.

Additional details on aircraft engine testing and test cells equipment is included in the application as Attachment 1. Also in the application is Attachment 2, an executive summary of aircraft engine emissions testing containing emission factors.

IV. EMISSIONS

Emission calculations were based on emission factors from a study contracted by the Air Force Institute for Environmental, Safety, Occupational Health Risk Analysis (IERA). The report is the product of a 2-year emissions testing program designed to document, characterize, and evaluate emissions from sixteen aircraft engines, two helicopter engines, and two auxiliary power units burning JP-5/8. The final report dated December 1998 lists emissions factors for five criteria pollutants and 10 hazardous air pollutants, e.g., aldehyde/ketones and semi-volatile and volatile organic compounds. Tinker has used these factors to calculate emissions beginning with the CY1998 air emission inventory report. Therefore, emission data referenced in this application is based on the same factors. There is a relatively wide variation in emission factors for each pollutant at each power setting and from engine to engine. Emissions are most representative of testing operations versus number of engines or test runs. Attachment 2 contains the executive summary from that study for referencing specific engine emission factors. A summary of the number of engines tested appears in Table 1. Some of the engines may require running the test profile two or three times to ensure engine serviceability if problems are detected on the initial test. The associated criteria pollutants are summarized in Table 2 for calendar years 1998 - 2005.

Table 1. Summary of Number of Engines Tested

CY	Number of Engines Tested*
97	720
98	650
99	634
00	603
01	495
02	516
03	475
04	406
05	344

* Engines average about two test runs per engine for adjustments.

Table 2. Historical Summary of Criteria Emissions

EU 4403	**Criteria Pollutant Emissions - Tons per Year Reported in AEI**				
B3703	**SO_X**	**NO_X**	**PM_{10}**	**VOC**	**CO**
CY98	15.50	57.03	13.48	50.70	79.80
CY99	0.10	17.58	9.64	90.65	102.19
CY00	4.02	23.29	7.91	63.74	80.54
CY01	2.61	15.95	4.24	35.31	41.15
CY02	3.32	20.33	4.89	41.38	52.83
CY03	5.43	9.25	2.40	18.28	21.65
CY04	4.38	19.57	3.44	21.08	26.11
CY05	3.13	9.85	1.52	8.30	11.00
CY98-05 Average	**4.81**	**21.61**	**5.94**	**41.18**	**51.91**
EU4404	**Criteria Pollutant Emissions - Tons per Year Reported in AEI**				
B3234	**SO_X**	**NO_X**	**PM_{10}**	**VOC**	**CO**
CY98	7.45	28.51	6.74	25.30	39.50
CY99	0.23	96.42	12.15	143.51	118.15
CY00	10.18	101.91	12.34	141.99	116.30
CY01	10.17	102.29	11.66	137.53	112.68
CY02	11.00	96.79	10.94	142.61	114.61
CY03	10.51	98.87	9.90	70.91	97.77
CY04	11.70	91.44	11.91	78.59	102.04
CY05	7.89	61.24	8.28	56.90	76.23
CY98-05 Average	**8.64**	**84.68**	**10.49**	**99.67**	**97.16**

Note: Because of the different engines and variants tested, the emissions are not directly proportional to the number of test cells.

Tinker examined various scenarios and calculated emissions on possible projected workload transfer to Tinker over the next five years. Approximately 1,100 engines could be transferred from existing field and depot-level maintenance facilities. This would restore the workload to the approximate level as in the mid 1990s. Four engines would constitute the total projected increase. These could consist of the following increase in models currently tested: 700 F-100s (F-15 and F-16); 107 TF-33s (B-52); 144 F-101s (B1-B); and 149 F-110s (F-16). In addition, the workload may include approximately 75 F100-229s (F-15 and F-16), a newer model of the F100, not currently tested at Tinker. Emission calculations have been made based on maximum work, i.e., testing at the same level as CY05 plus the entire workload being transferred with two test runs per engine. Although various proposals have been made, the engine mix could vary and Tinker has projected the scenario which would generate the largest emissions increases, i.e., worst case being conservative. Based on the CY05 workload plus the maximum projected increase, emissions are shown in Table 3. Note that although emissions are calculated based on a conservative two runs per engine, the calculations do not account for projected anticipated decreased engine run time per test estimated as high as 25%. This increased efficiency cannot be verified at this time, however, Tinker is confident that some efficiencies will be achieved.

Table 3. Projected Emissions

Pollutant	Total Projected, TPY *
NOx	414.18
CO	277.08
VOC	217.9
SOx	47.94
PM_{10}	40.24

* These emission limits are necessary to accommodate current and projected workload.

Comparing emissions shown in Table 2 with those projected in Table 3, most of the criteria pollutants will increase due to the new engine workload. NO_X has increased the most, and results from fuel NO_X and thermal NO_X. Over 95% of NO_X emissions from jet engines are characterized as thermal NO_X which are generated in the primary combustion zone of the engine. Within this section, localized regions of stoichiometric fuel/air mixture exist, resulting in high flame temperatures and corresponding high generation of NO_X. Because the newer generation of engines operate at higher temperatures, thermal NO_X also has increased significantly over the previous mix of the older generation of jet aircraft engines tested in the cells.

Tinker is requesting permit limits be established based on CY04/05 average emissions plus the increase for the projected engine testing to accommodate varying workloads. OAC 252:100-8-31 defines “Baseline Actual Emissions” as the average rate in tons per year at which the unit actually emitted the pollutant during any consecutive 24-month period selected by the owner or operator within the 10-year period immediately preceding either the date the owner or operator begins actual construction of the project, or the date a complete permit application is received. There has been a gradual decrease in testing operations since the 1970s due to weapon system obsolescence. Although this is well below the 3,000-plus engines tested during earlier periods, the earlier calendar years are more representative of normal operations. By calendar year 2010, Tinker’s engine test workload could increase by about 1,100. The number of engines serviced at the depot is not directly proportional to emissions due to the widely-varying emission factors, test profiles, and specific engines powering different weapon systems.

Each engine has substantially different emission factors. An engine is tested at four (or five power settings if equipped with an afterburner) with discrete emission factors for each power setting for 15 pollutants (5 criteria and 10 HAPs). The projected emissions provide the facility operational flexibility to perform work on other engines as required by the Department of Defense supporting other weapon systems contingent on improved testing efficiency due to data acquisition and analysis enhancements.

Table 4. Project Significant Emissions Increase

Emissions in TPY					
Pollutant	**Total Projected Emissions**	**Average CY04/05 Actuals**	**Project Increase**	**PSD Significance Thresholds**	**PSD Netting Required**
CO	277.08	107.69	169.39	100	Yes
NOx	414.18	91.05	323.13	40	Yes
VOC	217.9	82.44	135.46	40	Yes
PM_{10}	40.24	12.58	27.66	15	Yes
SOx	47.94	13.55	34.39	40	No *

* Netting does not apply since the emission increase of these pollutants are less than their respective PSD significant thresholds.

To determine whether a "significant net emissions increase" will occur requires considering all emission increases and decreases for each pollutant for which the potential emission increase associated with the project (modification) would exceed the respective PSD significance threshold. Emissions netting requires including all changes facility-wide during the contemporaneous period. The Oklahoma rules define contemporaneous as the preceding three years with the increase from a particular change only if it occurs within the three years before the date that the increase from the particular change occurs. Therefore, since these changes will not occur until CY2007, contemporaneous period would include CY 04-06. During CY 04 and 05, no increases or decreases of subject emissions occurred. Therefore, the facility-wide emissions netting summary for the NOx, CO, and VOCs are associated with just two other permitted projects for boilers; both permits resulted in emission increases; the first added two fire-tube boilers in Building 208 (Permit No. 99-104-C (M-2)) and the second was for a water-tube boiler replacement in Building 3001 (Permit No. 99-104-C (M-3)).

Table 5. Contemporaneous Changes

Netting Summary				
Emission Changes CY 04-06 in TPY				
Project	**CO**	**NOx**	**VOC**	**PM_{10}**
B208 – New Boilers	+ 12.98	+ 22.6	+ 0.86	+ 1.46
B3001 – New Boiler	+ 99.5	+ 39.5	+ 4.13	+ 7.14
B3001- Removed Boiler	- 6.1	- 10.1	- 0.3	- 0.30
Net Emission Changes	**+ 106.38**	**+ 52.0**	**+ 4.69**	**+ 8.30**

The net emission increases are then added to the project emission increase to determine net increase over the contemporaneous period and thus determine if PSD review is required. The table below summarizes the net impact.

Table 6. PSD Netting Summary

Emissions (TPY)					
Pollutant	**Project Increase**	**Netting (Contemporaneous Changes)**	**After Netting**	**PSD Significance Thresholds**	**Full PSD Review Required**
CO	169.39	+ 106.38	275.77	100	Yes
NOx	323.13	+ 52.0	375.13	40	Yes
VOC	135.46	+ 4.69	140.15	40	Yes
PM_{10}	27.66	+ 8.3	35.96	15	Yes

Because these changes result in emissions exceeding the PSD thresholds for the pollutants shown in Table 6, a full PSD review is required for each regulated air pollutant that is expected to be emitted from any new facility in "significant" amounts. Section 5 of this permit application addresses PSD permitting considerations.

Testing engines also results in emissions of by-products of combustion which are hazardous air pollutants (HAP). Although previously reported as a HAP, methyl ethyl ketone emissions are not shown below since being delisted as a HAP effective December 13, 2005. HAP emission factors are also included in the referenced emission testing study in Attachment 2. Emissions are relatively small so baseline calculations are not included, however total projected emissions based on worst-case (2 test runs per engine assuming all engine workload materializes without any increased efficiency taken into account) are given in Table 7.

Table 7. HAP Emissions

Engine Test Cells HAP Emissions in TPY (CY10 Projected Worst-Case)				
Pollutant	**CAS Number**	**CY05 Emissions**	**Projected Increase**	**Total Emissions**
Acetaldehyde	75-07-0	0.01198	0.06056	0.07254
Acrolein	107-02-8	0.02902	0.14249	0.17151
Benzene	71-43-2	0.32044	0.78037	1.10081
Ethylbenzene	100-41-4	0.09259	0.21698	0.30957
Formaldehyde	50-0-0	0.81451	1.21276	2.02727
Naphthalene	91-20-3	0.17141	0.38543	0.55684
Styrene	100-42-5	0.69982	0.10060	0.80042
Toluene	108-88-3	0.19607	0.50050	0.69657
Xylenes	1330-20-7	0.21704	0.50474	0.72178
Total HAP		**2.55288**	**3.90443**	**6.45731**

Although HAP emissions are by-products of the engine testing process, limits have not been assigned as there are currently no applicable rules requiring limits on these pollutants. The New Source Review Workshop Manual Table A.4 (Significant Emission Rates of Pollutants Regulated under the Clean Air Act) lists 6 criteria and 20 non-criteria pollutants. Of the 20 non-criteria pollutants, 7 are 'other pollutants' regulated by the Clean Air Act for which significant emission rates have not been promulgated for these pollutants, and any emissions by a new major source or any increase in emissions at an existing major source due to modification, are "significant." Benzene is the only pollutant on that list which is emitted as a result of testing engines. Potential emissions of benzene are 1.1 tons per year. While developing an engine test cell MACT, the EPA failed to identify any cost-effective method for controlling emissions from turbine engine test cells. The MACT, 40 CFR 63, Subpart PPPPP, "Engine Test Facilities," promulgated by the EPA on May 27, 2003, specifically exempts new or reconstructed combustion turbine engines from Subpart PPPPP and Subpart A. There are no federal regulations that apply to these test cells. Emissions of pollutants from the turbine aircraft engine testing operations will continue to be included in the facility's annual air emission inventory report.

Also during the combustion process, approximately 10 percent of the sulfur dioxide (SO_2) could be expected to oxidize to sulfur trioxide (SO_3). SO_3 is hydrophilic and combines with available moisture to form sulfuric acid (H_2SO_4) mist when temperature drops below the acid dew point. For a jet engine test cell, this condition is normally reached only after several minutes and some distance from the plant when the exhaust stream has dispersed and cools. Since potential total sulfur dioxide emissions from testing operations are less than 50 tons per year, based on 10% (5 tons per year) forming SO_3, emissions of sulfuric acid mist will remain well below the 7 tons per year significant threshold.

Requested Limits

Table 8 shows the requested permit limits based on the foregoing discussion.

Table 8. Requested Emission Limits

Pollutant	Emission Limits in TPY
NO_X	414
CO	277
VOC	218
SO_X	48
PM_{10}	40

V. PREVENTION OF SIGNIFICANT DETERIORATION ANALYSIS

Scope of Review

The proposed project will be subject to PSD review. Full PSD review is required for each pollutant emitted above a PSD significance level. Comparison of PSD significance levels to emissions at maximum operation was summarized in Table 6. Oklahoma air quality rules will apply to the project. Pollutants emitted in minor quantities were evaluated for all pollutant-specific rules, regulations, and guidelines.

PSD Review

As shown above, the proposed facility will have potential emissions above the PSD significance levels for NOx, CO, VOC and PM_{10}, and they are reviewed in the following discussion. Full PSD review of emissions consists of the following:

- determination of best available control technology (BACT)
- evaluation of existing air quality and analysis of compliance with National Ambient Air Quality Standards (NAAQS)
- evaluation of PSD increment consumption
- determination of monitoring requirements
- evaluation of source-related impacts on growth, soils, vegetation, visibility
- evaluation of Class I area impact

BACT Review

A BACT analysis is required for all pollutants emitted in PSD-significant quantities. The BACT review follows the "top-down" methodology. Reviewed are the most stringent controls for each applicable pollutant.

BACT Methodology

The "top-down" methodology was followed for the BACT analysis in accordance with EPA guidance in the draft document entitled *New Source Review Workshop Manual* (October 1990). The top-down approach consists of the following five steps:

- **Identify all control technologies**, including inherently lower emitting processes and practices, add-on control equipment, or combination of inherently lower emitting processes and practices and add-on control equipment.

- **Eliminate technically infeasible options.** Eliminate technically infeasible or technically difficult options based on physical, chemical, and engineering principles.

- **Rank remaining control technologies by control effectiveness.** Rank the remaining control options by control effectiveness, expected emission reduction, energy impacts, environmental impacts, and economic impacts.

- **Evaluate most effective controls and document results.** Determine the economic, energy, and environmental impacts of the control technology on a case-by-case basis.

- **Select the BACT.** Select the most effective option not rejected as the BACT.

The source of information used in this BACT analysis includes the following:

Review of the most stringent BACT-PSD control measures for testing of aircraft jet engines in a jet engine test cell approved in the past 10 years by various states, as listed in EPA's Reasonably Available Control Technology (RACT)/BACT/Lowest Achievable Emission Rate (LAER) Clearinghouse (RBLC).

Nitrogen Oxide Emissions and Their Control from Uninstalled Aircraft Engines in Enclosed Test Cell, Joint EPA - U.S. Department of Transportation (DOT) Report, Report No. EPA-453/R-94-068, October 1994.

Regulatory Support Document, Control of Air Pollution from Aircraft and Aircraft Engines, for the Direct Final Rule for aircraft emission standards, U.S. EPA, February 1997.

PSD Analysis for Construction and Operation of Large Engine Environmental Test Facility at Arnold Air Force Base, Arnold Engineering Development Center, Tennessee, August 1995.

NOx Removal in Jet Engine Test Cell Exhaust, Los Alamos National Laboratory, LA-UR-99-3072.

2006 Producer Price Index (PPI) industry data for air purification equipment from the U.S. Department of Labor's Bureau of Labor Statistics at www.bls.gov

BACT for NOx

Identification of Available NOx Control Technologies

Inherently lower emitting processes are not considered further because Tinker only tests the engines in the DoD inventory, therefore, it can neither alter the combustor in the engine nor the combustion characteristics of the engine.

The joint report submitted to the U.S. Congress in October 1994 by the EPA and the DOT entitled "Nitrogen Oxide Emissions and Their Control from Uninstalled Aircraft Engines in Enclosed Test Cell," Report No. EPA-453/R-94-068, October 1994 concludes that there are no existing technologies for control of NOx that have been applied (full scale) to aircraft engine test cells in the United States. The differences in engines, engine tests, engine test cell sizes, and engine types complicate the application of a NOx control system to engine test cells. The preparation and submittal of this study was mandated under Section 233(a) of the Clean Air Act Amendments of 1990.

Potential NOx control technologies for jet engine test cells were obtained from the EPA Report, 453/R-94-068, October 1994, titled “Nitrogen Oxide Emissions and Their Control from Uninstalled Aircraft Engines in Enclosed Test Cell” and the Los Alamos National Laboratory presentation, LA-UR-99-3072, titled “NOx Removal in Jet Engine Test Cell Exhaust.” These technologies are considered post-combustion control methods. Post-combustion control methods address NOx emissions after formation. Combustion control methods that prevent or reduce NOx formation during the combustion process were not available in the literature search. Post-combustion control technologies include:

- Selective Catalytic Reduction (SCR) with Ammonia Injection
- Selective Non-Catalytic Reduction (SNCR)
- Reburn NOx Control Technology
- NOx Sorbent Technology
- Water or Steam Injection
- Non-thermal Plasma Systems
- Direct Atmospheric Exhaust (No Control)

Selective Catalytic Reduction (SCR) with Ammonia Injection
Ammonia is injected to react with NO to form nitrogen and water. The required catalyst temperature is approximately 700°F, though some recent catalysts operate near 500°F. Several catalysts, including platinum and titanium oxide, are available. Proper operation depends on many factors including correct stoichiometric ratio of ammonia to NO, reaction temperature, and condition of catalyst, in addition to the “space velocity,” which is expressed as exhaust gas volumetric flow rate per unit catalyst volume. The NOx reduction efficiency for SCR with ammonia injection has been demonstrated at 80 to 90 percent.

Selective Non-Catalytic Reduction (SNCR)
SNCR uses injection of chemicals such as ammonia or urea to the exhaust gases, for non-catalytic reactions that result in formation of nitrogen and water. Without proper process control, a competing reaction can actually generate NO. The desired reaction for NOx reduction occurs in the temperature range of 1,800°F to 2,000°F. This technology has been demonstrated on utility boilers and other fossil-fuel systems to achieve up to 50 percent NOx removal.

Reburn NOx Control Technology
Natural gas is injected at a region just above the main combustion zone, followed by downstream injection of additional combustion air. The injection of the gas lowers NOx formation in the main combustion zone, where the NOx is reduced by reaction with hydrocarbon fragments formed by the natural gas combustion in fuel-rich conditions.

NOx Sorbent Technology
The exhaust gas passes through a bed of vermiculite impregnated with magnesium oxide. The NOx is adsorbed on the bed and forms magnesium nitrate. When used with a bed of virgin vermiculite upstream of the one containing magnesium oxide, a removal efficiency of 50 to 70 percent has been reported. This technology has not been demonstrated on a full-scale working test cell.

Water or Steam Injection
Water/steam injection is an established NOx control technology for stationary gas turbines. The water or steam injected into the primary combustion zone of a gas turbine engine provides a heat sink, which lowers the flame temperature and thereby reduces thermal NOx formation.

Non-thermal Plasma (NTP) Systems
NTP systems are a type of advanced oxidation and reduction process making use of "cold combustion" via free-radical reactions. Exhaust gases are contacted with electrical energy to create free radicals, which in turn decompose pollutants such as NOx, SO_2, and VOC in the gas phase. The removal efficiency depends on plasma chemistry (free radical yield), reaction chemistry, and applied plasma specific energy. The process is carried out on the exhaust gases without any preheating and has demonstrated removal efficiencies greater than 50 percent in bench-scale and field-pilot demonstration studies. The study (Attachment 3) describes five candidate NTP systems: pulsed corona, dielectric barrier, hybrid NTP reactor-adsorber, plasma-catalytic hybrid, and corona radical shower. In pulsed corona, dielectric barrier, and corona radical shower systems, ammonia or methane can be added to generate radicals that drive reactions leading to the formation of particulates which can be removed using an electrostatic precipitator. The study provides an economic analysis of the cost-effectiveness, which is discussed in the section on evaluation of controls.

Direct Atmospheric Exhaust (No Control)
The engine exhaust mixes with the augmentation/bypass air in the diffuser section, and is emitted to the atmosphere without use of any NOx reduction technology. For the purposes of this BACT analysis, the CO, NOx, and VOC emission factors presented in the Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations, Institute for Environmental, Safety, Occupational Health Risk Analysis (IERA), January 2002, are considered to be the base case for emissions without any control.

Examination of Feasibility of Control Options

The technical feasibility of the control method described above is summarized based on the feasibility analysis given in the EPA-DOT report 453/R-94-068.

Selective Catalytic Reduction
This technology is available in the United States, and is used with stationary gas turbine applications for power plants. However, there are significant differences between exhaust gas characteristics of power plants and those from test cells. The test cell stack gas temperatures are below those required by SCR systems. Also, the stack gas temperature and the NOx emission rates will vary with engine thrust and the augmentation air. The stack gas flow rate and the stack gas temperature vary significantly as the augmentation ratio increases as occurs with turbojet and turbofan engines. The NH_3 injection system must track NOx emission rates, and maintain the proper NOx to NH_3 ratio. The rapid and frequent changes in engine output will place demands on the SCR controller not found in current (non test-cell) installations where SCR technology is used. Improper NOx to NH_3 ratio will result in excess release of either NOx or NH_3.

Selective Non-Catalytic Reduction (SNCR)
Test cell stack gas temperatures are significantly below the 1,800°F to 2,000°F range where SNCR is viable. In addition, a uniform NOx control distribution and an ammonia or urea injection system are required to ensure maximum NOx reduction, and to prevent release of excess NH_3. There is actually a potential for greater NOx production associated with heating of exhaust gases to raise temperature to that required by SNCR. The reheat requirements are a function of test cell operating characteristics which are highly transient and differ by type of engine tested.

Reburn NOx Control Technology
Bench-scale studies of reburning in an oxygen-rich gas such as that from a test cell exhaust have been performed. The respective removal efficiencies for 1,000 parts per million (ppm) and 500 ppm NOx inlet concentrations were reported at 60 and 30 percent. No studies have been conducted at NOx concentration of 100 ppm, which is typical of test cell operation. Assuming removal efficiency of 10 percent for 100 ppm of NOx was based upon the "Study of Nitrogen Oxide Emissions and Their Control From Uninstalled Aircraft Engines in Enclosed Test Cells (EPA-453/R-94-068)." The cost-effectiveness of reburn technology has been estimated to range from $480,000 to $9.4 million per ton of NOx removed for different sized test cells.

NOx Sorbent Technology
This is an emerging technology and has not been demonstrated on a full scale test cell in practice. Until more research and evaluations are performed, the safety and performance issues of this technology cannot be addressed.

Water or Steam Injection
The use of water/steam injection would require temporary engine modifications and would alter the performance characteristics of the engine being tested. Since the engines are tested in a cell to evaluate their performance characteristics, any modifications affecting performance would run counter to the actual reason for testing the engines. In addition, it would result in generating significant quantities of wastewater contaminated with hydrocarbons, requiring treatment.

Non-thermal Plasma Systems
This is an emerging technology, and has only been demonstrated on a field-pilot scale in one test cell in practice. Until more research and evaluations are performed, the safety, operation and performance issues of this technology cannot be addressed.

Direct Atmospheric Exhaust
In the absence of any feasible NOx control technologies currently available, the direct atmospheric exhaust is determined to be BACT.

Ranking of Remaining Options

The EPA-DOT report 453/R-94-068 examines the economic feasibility of the following control options, while eliminating all the other control options evaluated for technical feasibility, except for NPT systems. NPT systems are covered under a Los Alamos National Laboratory study, LA-UR-99-3072, but not in the EPA-DOT report. Based on the available information, the options that are further examined are ranked by their NOx reduction efficiency in Table 9 (Table 2, Attachment 1).

TABLE 9
NOx Reduction Efficiency of Control Options from Literature

Technology	Typical NOx Reduction (percent removal)	Comment
SCR	Up to 80 percent	NOx reduction efficiency as applied to stationary gas turbines
SNCR (Ammonia)	Up to 50 percent	NOx reduction efficiency demonstrated on utility boilers, process heaters and other fossil-fueled systems
NOx Reburn	30 to 60 percent	30 percent at NOx inlet concentration of 500 ppm and 60 percent at NOx inlet concentration of 1,000 ppm
Non-thermal Plasma – Pulsed Corona	56 percent	Field-pilot studies at NOx concentration less than 100 ppm
Non-thermal Plasma – Corona Shower	90 percent	Field-pilot studies at NOx concentration less than 100 ppm
Non-thermal Plasma – Electron Beam	70 percent	Field-pilot studies at NOx concentration less than 100 ppm

Other Control Options from RBLC Clearinghouse Approved BACT

Three determinations were found in the RBLC Clearinghouse search under the SIC codes 3724 and 4581. All the determinations indicate that the BACT was no control.

TABLE 10
RBLC Review of BACT-PSD Control for SIC 3724 and SIC 4581

Facility/ Location	Year Evaluated	Permit Type	Process Name	Primary Fuel/ Throughput	Pollutant	Emission Limit	Notes/Control Method
G. E. Aircraft Engines Peebles, Adams, OH	2006	A	Permitting engine test stand #7 for GE aircraft engine and JSF military engine	Jet fuel, 81,385 lb/hr 12,057 gal/hr			Notes: 12,057 gal/hr worst case in calculations. The test stand is restricted by tons of PM_{10}, VOC, and SO_2 per rolling 12-months, based on the hours of expected operation. However, no restrictions on hours. Maintain records of hours of testing operations and calculated emissions, each rolling month.
					NOx	3113.4 lb/hr; 797.2 tpy per rolling 12 months	Case-by-Case Basis: BACT-PSD Control Method: (N) It was determined that BACT was “No Control”, per RBLC search and other control analysis. Other Applicable: SIP
					CO	850 lb/hr; 164.3 tpy per rolling 12 months	
					SO_2	153.2 lb/hr; 23.2 tpy per rolling 12 months	Case-by-Case Basis: N/A Control Method: (N) Other Applicable: SIP
					PM_{10}	18.2 lb/hr; 2.76 tpy per rolling 12 months	Case-by-Case Basis: N/A Control Method: (N) Other Applicable: SIP
					VOC	33.8 lb/hr; 13 tpy per rolling 12 months	Case-by-Case Basis: N/A Control Method: (N) Other Applicable: SIP
					VE	10% opacity as a 6-minute average	Notes: 10% opacity as a 6-minute average in any 60-minute observation period.
Arnold AFB, Coffee / Franklin, TN	2003	D	Increase in hours of operation for two jet engine cells	Jet fuel: JP-4, -5, -8 90,000 lb/h per cell			Notes: Consists of two jet engine test cells. Only jet fuel JP-4, -5, and -8 may be used.
					CO	1,890 tpy 12-month rolling 1.979 g/BHP-H	Case-by-Case Basis: BACT-PSD Control Method: (N) N/A Compliance Verified: Unknown
					NOx	1,038 tpy 12-month rolling 1.087 g/BHP-H	
					SO_2	114 tpy 12-month rolling 0.119 g/BHP-H	
					VOC	325 tpy 12-month rolling 0.34 g/BHP-H	

TABLE 10
RBLC Review of BACT-PSD Control for SIC 3724 and SIC 4581

Facility/ Location	Year Evaluated	Permit Type	Process Name	Primary Fuel/ Throughput	Pollutant	Emission Limit	Notes/Control Method
					PM	91 tpy 12-month rolling; 0.01 grains/dscf of exhaust gases	
					VE	20% opacity	Case-by-Case Basis: Other; Control Method: (N) None Listed; Compliance Verified: Unknown
G. E. Aircraft Engines, Essex, MA	2002	D	Modify two jet engine test cells for development testing of a new jet engine for the U.S. Navy	JP-4 or JP-5 1031 MMBtu/hr			Notes: Operating modes range from idle through 100 percent power and maximum afterburner. A worst case mix of operating modes calculates to be equivalent to operating continuously at 80 percent. BACT required for SO_2, CO, NOx, and VOC.
					VOC	0.225 g/sec	Case-by-Case Basis: BACT-PSD Control Method: (P) Minimize use of afterburner mode, restriction on the number of hours an engine may operate. Compliance Verified: Unknown
					NOx	0.0229 g/sec	
					CO	2.81 g/sec	
					SO_2	0.607 g/sec	Case-by-Case Basis: BACT-PSD Control Method: (P) Fuel with less than 0.05% sulfur by weight. Minimize use of afterburner mode, restriction on the number of hours an engine may operate. Compliance Verified: Unknown

Permit Type Notes:
A - New/Greenfield Facility
D – Both B (Add new process to existing facility) and C (Modify process at existing facility)

<u>Evaluation of Remaining Options</u>

The remaining technologies are reviewed on a case-by-case basis, taking into consideration economic, energy, and environmental impacts beginning with the top option. If the top option is not selected as BACT, the next most effective control is evaluated.

Selective Catalytic Reduction

The EPA-DOT report 453/R-94-068 provides a cost effectiveness evaluation. Section 3.3 of the EPA-DOT report identifies four model test cells. Of these models, test cell B is used for an F-101 engine having an afterburner, is used in the F-16 Falcon, and is capable of producing a maximum thrust of 15,000 pounds. Model test cell C is used for a J79-GE-10B turbojet engine having an afterburner, used in an F-4 Phantom, and capable of producing a maximum thrust of 17,000 pounds. The cost effectiveness data for model test cells B and C are presented here because the engines tested at Tinker would be of a similar type; however, they are substantially different based on the manufacturer, model, combustor type, thrust, and emission characteristics. The cost effectiveness of SCR is based on a conceptual design of the system, supported with typical costs of SCR when applied to other gas-fired systems.

No determinations were found in the RBLC that required the use of SCR as a control technique for jet engine test cells. The cost effectiveness in the EPA-DOT report was escalated from 1994 to 2007 using the escalation factor based on the Producer Price Index (PPI) obtained from the U. S. Bureau of Labor Statistics (BLS). The cost effectiveness in 2007 cost terms is shown in Table 4 (Section 4.5) of Attachment 1, which ranges from $449,962 to $1,573,086 per ton of NOx removed.

SCR Environmental Impacts

SCR can have accidental ammonia releases during transport, storage, and handling. A search of the available literature indicates that depending upon how well the reagent feed rate is controlled with variable exhaust load and depending upon the optimization of injection location and mixing of reagent with the flue gas, up to 20 ppm of unreacted ammonia could be emitted. Catalyst systems promote partial oxidation of sulfur dioxide in the emission stream to sulfur trioxide, which combines with water to form sulfuric acid. Sulfur trioxide and sulfuric acid react with excess ammonia to form ammonium salts, which would be emitted from the stack, thereby increasing the PM_{10} emissions.

SCR Energy and Operational Impacts

Energy consumption for SCR systems are primarily for 1) the energy needed to store, pretreat and inject the chemical reagent ammonia or ammonia hydroxide, 2) the increased power requirement to overcome the pressure drop across the catalyst bed, and 3) the thermal efficiency loss associated with maintaining the catalyst reactor temperature within the specifications for optimum performance under variable exhaust conditions. Pressure drop across the catalyst bed is of significant concern because it affects the test cell characteristic and would require extensive adjustment and calibration of the test cell and the control module.

Selective Non-Catalytic Reduction

The 1994 cost effectiveness data for model test cells B and C presented in the EPA-DOT report were escalated to 2007 cost terms using the escalation factor based on the PPI obtained from the BLS. The cost effectiveness of SNCR is based on a conceptual design of the system, supported with typical costs of SNCR when applied to other gas-fired systems.

No determinations were found in the RBLC that required the use of SNCR as a control technique for jet engine test cells. The cost effectiveness in 2007 cost terms is shown in Table 4 (Section 4.5) of Attachment 1, which ranges from a negative dollar amount of ($588,194) to ($207,291) per ton of NOx removed.

<u>SNCR Environmental Impacts</u>

SNCR can have accidental ammonia releases during transport, storage, and handling. A search of the available literature indicates that depending upon how well the reagent feed rate is controlled with variable exhaust load and depending upon the optimization of injection location and mixing of reagent with the flue gas, up to 40 ppm of un-reacted ammonia could be emitted from the stack when urea or ammonia-based processes are used. Ammonium salts can be produced when excess reducing agent reacts with exhaust-gas constituents such as sulfur trioxide. These salts, which may include ammonium sulfate and ammonium bisulfate, can pose undesirable consequences such as corrosion or the formation of fine PM.

<u>SNCR Energy Impacts</u>

Energy consumption in the SNCR process is related to pretreatment and injection of ammonia-based reagents and their carrier gas or liquids. Auxiliary power is required to operate reagent feed and circulating pumps. If anhydrous ammonia is used in the SNCR, auxiliary power would be required to operate vaporizers.

Reburn NOx Control Technology

The EPA-DOT report indicates that the cost effectiveness estimates do not reflect any costs beyond those associated with the methane gas consumption. Therefore, the 1994 natural gas cost was escalated to 2006 cost terms using the current natural gas rate obtained from the following Energy Information Administration website:
http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_SOK_m.htm

The EPA-DOT report indicates that the cost effectiveness of Reburn NOx was based on bench scale studies for inlet NOx concentration in the range of 500 to 1,000 ppm. The report further indicates that an optimistic 10 percent reduction in NOx was assumed based on an estimate of mean stack NOx concentrations levels of 100 ppm; actual NOx concentrations could be lower because it depends on the augmentation air flow. The report adds that the assumption of 10 percent NOx reduction has not been proven.

The cost effectiveness in 2006 cost terms ranges from $4,576,000 to $19,630,769 per ton of NOx removed.

Since Reburn NOx control is still an experimental technology, the environmental and energy impacts are not addressed.

Non-thermal Plasma Systems

The cost effectiveness presented in NOx Removal in Jet Engine Test Cell Exhaust, Los Alamos National Laboratory, LA-UR-99-3072, were escalated from the periods of 1997 and 1998 to 2007 using cost escalation factors from PPI. The cost effectiveness in 2007 cost terms ranges from a low of $22,551 to a high of $176,210 per ton of NOx removed. The detailed cost-effectiveness calculations with escalation are included in the BACT analysis.

Summary of Cost Effectiveness and Elimination of Control Options Evaluated

Emissions Control Technologies for NOx

Table 11 summarizes the cost effectiveness for each of the four control technologies evaluated.

TABLE 11
Summary of NOx Control Cost Effectiveness

Control Technology	Test Cell	NOx Emissions (tpy)	NOx Removal Efficiency	NOx Removed (tpy)	Cost Effectiveness ($/ton NOx Removed)	Reason for Elimination of Control Option
SCR	B	15.1	80%	12.08	$449,962	Not cost-effective, in addition to energy and environmental impacts
	C	9.87	80%	7.89	$1,573,086	
SNCR	B	29.4	50%	14.7	($588,194)	Negative cost impact[2]
	C	20.3	50%	10.2	($207,291)	
Reburn NOx	B	5	10%	0.5	$4,576,000	Experimental technology with no application to actual operating engine test cells
	C	2.6	10%	0.26	$19,630,769	
NTP-Pulsed Corona		42.7	56%	23.9	$34,546 [1]	Experimental technology with no application to actual operating engine test cells
NTP-Corona Shower		47.4	90%	42.7	$22,551 [1]	
NTP-Electron Beam		11.9	70%	8.3	$176,210 [1]	

Notes:

The detailed cost-effectiveness calculations with escalation are included in Attachment 1 - BACT analysis.

(1) The cost effectiveness after taking product recovery (in the form of fertilizer) into account is $21,274 for Pulsed Corona, $14,038 for Corona Shower, and $96,031 for Electron Beam.

(2) The negative value in the table for SNCR is the result of the annual tons of NOx per year emitted by the duct burner exceeding the total NOx eliminated by the SNCR controls.

BACT Selection for NOx

The joint report submitted to the US Congress in October 1994 by the EPA and the DOT concludes that there are no existing technologies for control of NOx that have been applied (full scale) to aircraft engine test cells in the United States. The differences in engines, engine tests, engine test cell sizes, and engine types complicate the application of NOx control system to engine test cells.

As indicated in the EPA-DOT report and summarized in Table 11, there are no feasible controls for the control of NOx emissions from engine test cells.

The RBLC determination for GE Aircraft Engines, Essex, Massachusetts, is for modification of jet engine test cells for use in the development testing of a new jet engine for the U.S. Navy. This determination has a NOx control method that requires minimizing the use of afterburner mode and places restriction on the number of hours an engine may operate, without providing operational or hourly limits. This operational or operating hour restriction may be feasible for an engine test cell operated for the development testing of a new engine. However, in the case of the engine test cells at Tinker, the engines are required to go through maintenance testing for the purposes of certifying the safe operation. Any operating limit placed on the engine test cell operation would result in an increased engine maintenance backlog or incomplete testing that may have serious effect on the military operational readiness of the Air Force.

Based on the discussion above, BACT is considered to be no control for NOx and the BACT emission limits are those that are supported through currently available emission factors.

BACT for CO and VOC Control

Identification of Available CO and VOC Emission Control Technologies

A search of the available literature did not identify any technologies for controlling CO and VOC emissions from jet engine test cells. However, the NTP technology indicates that along with NOx removal, VOC reductions also occur during free radical interactions.

Other control strategies required changes to the combustor. By increasing the pressure and temperature in the combustor more energy is available for combustion. This makes for a more complete burning of the fuel-air mixture. A more complete burning means lower production of hydrocarbons as well as carbon monoxide. The maximum temperature and pressure in the combustor are limited by the materials comprising the combustion liner and turbine blades. By using ceramics and routing bypass air around and into the combustor, the upper limit on temperature and pressure can be extended. A high swirl region is also desirable to promote better mixing of fuel molecules among the air molecules to encourage thorough burning.

Combustor changes are not feasible at Tinker AFB because existing engines are tested for maintenance and certification.

Approved BACT for CO and VOC from RBLC Clearinghouse

The RBLC determinations presented in Table 10 indicate that no control methods are available for the control of other pollutants, namely CO and VOC.

The RBLC determination for GE Aircraft Engines, Essex, Massachusetts, has a control method for CO and VOC that requires minimizing the use of afterburner mode and places restriction on the number of hours an engine may operate, without providing operational or hourly limits. This operational or operating hour restriction may be feasible for an engine test cell operated for the development testing of a new engine. However, in the case of the engine test cells at Tinker, the engines are required to go through maintenance testing for the purposes of certifying the safe operation. Any operating limit placed on the engine test cell operation would result in an increased engine maintenance backlog or incomplete testing that may have serious effect on the military operational readiness of the Air Force.

BACT Selection for CO and VOC

Based on the discussion above, BACT is considered to be no control for CO and VOC and the BACT emission limits are those that are supported through currently available emission factors.

BACT Selection for PM Control

Identification of Available PM Control Technologies

Particulate control technologies were obtained from the EPA Report, "*Stationary Source Control Techniques Document for Fine Particulate Matter,*" EPA Contract Number 68-D-98-026, Work Assignment Number 0-08, October 1998, and "*Airborne Particulate Matter: Pollution Prevention and Control,*" Pollution Prevention and Abatement Handbook, World Bank Group, July 1998.

Fuel Substitution

Fuel substitution, or fuel switching, which is typically used as a means of reducing emissions from large utility and industrial boilers, is not an option in the jet engine test cell because the engines are designed to use JP-8.

Process Modification/Optimization

Process modification is also not a feasible option because the engines are only tested to measure the operational characteristics and to certify it for field application. Neither the combustor design nor the combustion zone configuration can be altered in any way to improve combustion efficiency for the engines tested at Tinker. Therefore, the amount of products of incomplete combustion, a component of particulate matter, cannot be reduced.

Although process modification steps such as combustor design or the combustion zone configuration cannot be modified, improvement in operational efficiency, a process optimization technique can be an effective means of reducing PM emissions. By installing the new control software, Tinker anticipates that the engine operation cycle times at various power settings will be limited to just the length of time required to adequately test the operational characteristics. Older control software allow the engine to cycle through different power settings for a longer duration, resulting in higher emissions due to longer engine run times.

Pretreatment

The performance of particulate control devices can often be improved through pretreatment of the gas stream. For PM control devices, pretreatment consists of two categories: 1) precollection and 2) flue gas conditioning. Precollection devices remove large particles from the gas stream, reducing the particulate loading on the primary control device. Flue gas conditioning techniques alter the characteristics of the particles and/or the gas stream to allow the primary control device to function more effectively. Both types of pretreatment can lead to increased collection efficiency and operating life, while reducing operating costs.

Precollection

The vast majority of precollection devices are mechanical collectors. They can be used in combination with other particulate control equipment or as a stand-alone control method depending upon the particulate density in the gas stream and the desired removal efficiency. The five major types of mechanical collectors are settling chambers, elutriators, momentum separators, mechanically aided collectors, and centrifugal separators (cyclones), which are described below.

Settling Chambers
Settling chambers rely on gravitational settling as a collection mechanism. There are two primary types of settling chambers: the expansion chamber and the multiple-tray chamber. In the expansion chamber, the velocity of the gas stream is significantly reduced as the gas expands into a large chamber. The reduction in velocity allows larger particles to settle out of the gas stream. Collection efficiency for PM_{10} is very low, typically less than 10 percent.

Settling chambers would not be useful because the exhaust contains fine particulates in the range of 1 to 10 microns and the exhaust does not have a high particulate density. Settling chambers would also add to the pressure drop, if it is used in conjunction with another particulate control method.

Elutriators
Like settling chambers, elutriators also rely on gravitational settling to collect particles and have similar collection efficiency. An elutriator is made up of one or more vertical tubes or towers in series, where the gas stream passes upward through the tubes. Larger particles whose terminal settling velocity is greater than the upward gas velocity are collected at the bottom of the tube, while smaller particles are carried out of the top of the tube. Elutriators would not be useful because of the same reasons mentioned for the settling chambers.

Momentum Separators
Momentum separators utilize both gravity and inertia to separate particles from the gas stream. Separation is accomplished by forcing the gas flow to sharply change direction within a gravity settling chamber through the use of strategically placed baffles. Because these devices utilize inertia in addition to gravity, momentum separators achieve collection efficiencies approaching 20 percent for PM_{10}.

The collection efficiency of momentum separators is too low and will introduce significant back pressure to the engine test cell; therefore this method is not technically feasible.

Mechanically-aided Separators
Mechanically-aided separators rely on inertia as a separation mechanism. The gas stream is accelerated mechanically, which increases the effectiveness of the inertia separation. As a result, mechanically-aided separators can collect smaller particles than momentum separators. Mechanically-aided separators have higher operating costs as a result of higher pressure drops. Mechanically-aided separators are capable of collection efficiencies approaching 30 percent for PM_{10}.

Although collection efficiency is slightly better than the momentum separators, this type of equipment would not be able to handle the large engine exhaust flow rate ranging from 300,000 to 3,600,000 actual cubic feet per minute (acfm).

Cyclones
While cyclones rely on the same separation mechanism as momentum separators, cyclones are more effective because they have a more complex gas flow pattern. Cyclones use inertia to remove particles from a spinning gas stream, usually conical-shaped chamber. Cyclone collectors can be designed for many applications, and they are typically categorized as high efficiency, conventional, or high throughput. High efficiency cyclones are likely to have the highest pressure drops of the three cyclone types; high throughput cyclones can treat large volumes of gas with a low pressure drop. The cyclones are examined as a stand-alone particulate control option in the next section.

Flue Gas Conditioning

Flue gas conditioning is used to modify the characteristics of the gas stream and particles to enhance particle removal in the primary collection device. Flue gas conditioning is primarily used at coal fired power plants and can be of different types: sulfur trioxide conditioning, ammonia conditioning, ammonium compound (ammonium sulfate and ammonium bisulfate) conditioning, organic amine (triethylamine) conditioning, and alkali conditioning. Usually, flue gas conditioning involves the use of chemicals that are added to the gas stream to improve the fly ash properties and electrical conditions in electrostatic precipitators. Fabric filter and scrubber performance is far less dependent on the chemical composition of the gas and particles, so these devices typically do not employ chemical conditioning for particle removal.

This control method is not suitable for the engine test cells because particulate density of the exhaust is significantly lower than that encountered in coal-fired combustion processes or cement plants.

Exhaust Particulate Control Techniques

In most combustion processes, before flue gas is discharged into the atmosphere, it is often necessary to remove as much of the PM as possible to meet regulatory emission limits. Techniques currently being used for this purpose, either alone or in combination, include:

- Inertial or Impingement (cyclone) Separators
- Electrostatic precipitators (ESPs)
- Fabric filters
- Wet scrubbers

Inertial or Impingement (Cyclone) Separators
Inertial or impingement separators rely on the inertial properties of the particles to separate them from the carrier gas stream and are used for the collection of medium-size and coarse particles. Cyclones are low-cost, low-maintenance centrifugal collectors that are typically used to remove particulates in the size range of 10–100 microns.

For single cyclones, conventional cyclones can remove particles of diameter 10 microns with 85 to 90 percent efficiency, particles of diameter 5 microns with 75 to 85 percent efficiency, and particles of diameter 2.5 microns or less with 60 to 75 percent efficiency. High efficiency single cyclones can remove particles of diameter 5 microns at efficiencies reaching 90 percent, with higher efficiencies achievable for larger particles. High throughput cyclones are only guaranteed to remove particles of diameter greater than 20 microns, although collection of smaller particles does occur to some extent. Multi-cyclones are reported to achieve from 80 to 95 percent efficiency for particles of diameter 5 microns. In some cases, multiple cyclones have been used as primary collection devices.

Electrostatic Precipitators

Electrostatic precipitators (ESPs) remove particles by using an electrostatic field to attract the particles to the electrodes. ESP collection efficiencies for fine particulates and trace emissions of some toxic metals are typically in the order of 99 percent or more of the inlet dust loading. The collection efficiency is dependent on the design, proper operation, and maintenance. ESPs are less sensitive to maximum temperatures than fabric filters are, and they operate with a very low pressure drop. The power requirement for ESPs is similar to that of fabric filters.

Filters and Dust Collectors (Baghouses)

Baghouses collect dust by passing flue gases through a filter media that includes woven fabric, needled felt, plastic, ceramic, and metal. The operating temperature of the baghouse gas influences the choice of fabric. Accumulated particles are removed by mechanical shaking, reversal of the gas flow, or a stream of high-pressure air. Fabric filters are efficient (99.9 percent removal) for both high and low concentrations of particles but are suitable only for dry and free-flowing particles. Their efficiency in removing toxic metals such as arsenic, cadmium, chromium, lead, and nickel is greater than 99 percent.

Wet Scrubbers

Wet scrubbers remove dust particles from the gas stream using a liquid spray. The primary use of wet scrubbers is to remove gaseous emissions, with the added benefit of removing particulates. The dominant means of PM capture in most industrial wet scrubbers is inertial impaction of the PM onto liquid droplets. While all wet scrubbers are similar to some extent, there are several distinct methods of using the scrubbing liquid to achieve particle collection. Wet scrubbers are usually classified according to the method that is used to contact the gas and the liquid. The main types of wet scrubbers include

- Spray chambers
- Packed bed scrubbers
- Venturi scrubbers
- Jet (fume) scrubbers
- Wet impingement scrubbers

The most common scrubber design introduces liquid droplets into a spray chamber, where the liquid mixes with the gas stream and contacts the PM, thereby removing it. Spray chambers are very simple, low-energy wet scrubbers. In these scrubbers, the particulate-laden gas stream is introduced into a chamber where it comes into contact with liquid droplets generated by spray nozzles. Spray chambers can handle larger gas flows with minimal pressure drop and are therefore often used as precoolers.

In a packed-bed scrubber, layers of liquid are used to coat various shapes of packing material that become impaction surfaces for the particle-laden gas.

A venturi scrubber accelerates the gas stream to atomize the scrubbing liquid and to improve gas-liquid contact. In a venturi scrubber, a "throat" section is built into the duct. The venturi throat forces the gas stream to accelerate as the duct narrows and then expands. The scrubbing liquid is sprayed into the gas stream before the gas encounters the venturi throat. As the gas enters the venturi throat, both gas velocity and turbulence increase. The scrubbing liquid is then atomized into small droplets by the turbulence in the throat and droplet-particle interaction is increased. Venturi scrubbers have the advantage of being simple in design, easy to install, and low maintenance. Venturi scrubbers can be designed to allow velocity control by varying the width of the venturi throat. Because of the high interaction between the PM and droplets, venturi scrubbers are capable of high collection efficiencies for small PM. Venturi scrubbers consume large quantities of scrubbing liquid (such as water), electric power, and incur high pressure drops.

Jet or fume scrubbers rely on the kinetic energy of the liquid stream. The typical removal efficiency of a jet or fume scrubber (for particles 10 microns or less) is lower than that of a venturi scrubber.

An impingement plate scrubber is a vertical chamber with plates mounted horizontally inside a hollow shell. Impingement plate scrubbers operate as countercurrent PM collection devices. The scrubbing liquid flows down the tower while the gas stream flows upward. Contact between the liquid and the particle-laden gas occurs on the plates. Impingement plate scrubbers are more suitable for PM collection than packed-bed scrubbers.

Examination of Feasibility of PM Control Options

The technical feasibility of the particulate control methods previously described is summarized in this subsection. The advantages and disadvantages of each control method were obtained from *"Airborne Particulate Matter: Pollution Prevention and Control,"* Pollution Prevention and Abatement Handbook, World Bank Group, July 1998.

Older jet engines do not incorporate technological features such as the reduced emission combustors or advanced fuel injection, which increase combustion efficiency. Combustion efficiency is directly proportional to the pressure ratio developed in the engine. The pressure ratio of older engines ranges from 12 to 15, compared with the pressure ratio range of 20 to 25 of the technologically advanced engines.

Although no data on particle size distribution for jet engine exhaust is available, it should be expected that the particle size distribution for the older engines and the technologically advance engines would be significantly different. The technologically advanced engines, which operate at a higher pressure ratio, are characterized by a higher thermodynamic efficiency and better fuel atomization. These characteristics, combined with better mixing of fuel with the combustion air, results in higher combustion efficiency and lower particulate emissions and smaller particle size. Older engines with their lower pressure ratio regime have a lower degree of atomization and have lower combustion efficiency, which is thought to move the particle size distribution to a higher range. In addition, the low degree of atomization and lower combustion efficiency tends to produce more soot and greater particulate emissions.

The exhaust from the engine test cell is routed through the augmenter tube to a perforated exhaust tube that is enclosed to keep the hot exhaust gases from re-entering the area where the engine is tested. The hot exhaust gases leaving the perforated exhaust tube escape the enclosure through approximately 50 to 60 circular openings that extend outward in the enclosure ceiling. The openings serve as exhaust stacks.

Inertial or Impingement (Cyclone) Separators
The fine-dust-removal efficiency of cyclones is typically below 70 percent, whereas ESPs and baghouses have removal efficiencies of 99.9 percent or more. Cyclones are often used as a primary stage before other PM removal mechanisms.

Advantages
- Low capital cost
- Relative simplicity and few maintenance problems
- Relatively low operating pressure drop of approximately 2 to 6 inches of water column (w.c.)
- Temperature and pressure limitations based only on the materials of construction used
- Dry collection and disposal
- Relatively small space requirements

Disadvantages
- Relatively low overall particulate collection efficiencies, especially for particulate sizes below 10 microns
- Inability to handle tarry or sticky material

The use of cyclones is not feasible because each test cell has approximately 50 to 60 exhaust stacks and each stack would require a cyclone. The cumulative drop in pressure would also adversely affect the performance characteristics of the engine test cell.

Electrostatic Precipitators
Temperature and chemical composition of the dust and gas stream are factors that can influence dust resistivity. Current is conducted through dust by two means: volume conduction and surface conduction. Volume conduction takes place through the material itself and is dependent on the chemical composition of the dust. Surface conduction occurs through the gases or the liquids adsorbed by the particles and is dependent on the chemical composition of the gas stream. Volume resistivity increases with increasing temperatures and is the dominant resistant force at temperatures above approximately 350°F. Surface resistivity decreases as temperature increases and predominates at temperatures below about 250°F. Between 250°F and 350°F, volume and surface resistivity exert a combined effect, with total resistivity highest in this temperature range. Dust resistivity is generally not a factor for wet ESPs.

Advantages

- Collection efficiencies of 99.9 percent or greater for coarse and fine particulates at relatively low energy consumption
- Dry collection and disposal of dust
- Low pressure drop--typically less than 1 inch of w.c.
- Continuous operation with minimum maintenance
- Relatively low operation costs
- Operation capability at high temperatures up to 1,300°F and high pressures up to 150 pounds per square inch or under vacuum

Disadvantages

- High sensitivity to fluctuations in gas stream conditions (flow rates, temperature, particulate and gas composition, and particulate loadings)
- Difficulties with the collection of particles with extremely high or low resistivity
- Relatively large space requirement for installation
- Explosion hazard when dealing with combustible gases or particulates
- Special precautionary requirements for safeguarding personnel from high voltage during ESP maintenance by de-energizing equipment before work commencement
- Production of ozone by the negatively charged electrodes during gas ionization
- Highly trained maintenance personnel required

The jet engine exhaust temperature is in the range of 500°F to 1,500°F and the jet exhaust may be dry or wet depending on whether the water is sprayed to cool the augmenter tube. When the exhaust is dry, the ESP particulate removal efficiency is affected because of the increased volume conduction and surface conduction resistance at high exhaust temperatures. Significant modifications would be required to the existing test cells in order to route the exhaust gases to a battery of ESPs, which would result in significant pressure drop and affect the performance characteristics of the engine test cell. Therefore, ESPs are not feasible for application to jet engine test cell exhaust.

Filters and Dust Collectors (Baghouses)

Although fabric filters are 99.9 percent efficient in removing both high and low concentrations of particles, they are suitable only for dry and free-flowing particles. Other advantages and disadvantages are as follows:

Advantages

- Very high collection efficiency (up to 99.9 percent) for both coarse and fine particulates
- Can accommodate gas stream fluctuations and large changes in inlet dust loadings if filters are cleaned continuously
- Dry recovery of collected material for subsequent processing and disposal
- No corrosion problems
- Low maintenance
- High collection efficiency of submicron smoke and gaseous contaminants through the use of selected fibrous or granular filter aids
- Various configurations and dimensions of filter collectors
- Relatively simple operation

Disadvantages

- Requires costly refractory mineral or metallic fabric at temperatures in excess of 550°F
- Fabric treatment is needed to remove collected dust and reduce seepage of certain dusts
- Explosion and fire hazard of certain dusts in the presence of accidental spark or flame, and fabric fire hazard in case of readily oxidizable dust collection
- Shortened fabric life at elevated temperatures and in the presence of acid or alkaline particulate or gas constituents
- Potential plugging of the fabric due to caking and need for special additives due to moisture condensation or adhesive (tarry) components
- Respiratory protection requirement for fabric replacement
- Pressure-drop requirements are typically in the range 4 to 10 inches of w.c.

If the exhaust contains moisture or water droplets, the fabric will clog and offer very high resistance, which can affect the operation of the engine test cell. In addition, unburned fuel in the exhaust can mix with the cake and create a significant fire hazard. Therefore, baghouses are not suitable for removing particulates from the jet engine exhaust.

Wet Scrubbers

Efficiency of scrubbers that rely on inertial impaction is dependent on the following:

- Particle size – Scrubber efficiency increases as particle size increases; conversely the collection efficiency for small particles (less than 1 micrometer) is expected to be low. The efficiency of scrubbers for small particles can be improved by increasing the relative velocity between the PM and the liquid droplets. This can be accomplished in most scrubbers by increasing the gas stream velocity. The downside of increasing the gas velocity is increased pressure drop, energy demand, and operating costs for the scrubber.
- Particle residence time – Typically, a particle is in the contact zone of a scrubber for only a few seconds. This is sufficient time to collect large particles that are affected by impaction mechanisms. However, since sub-micron particles are most effectively collected by diffusion mechanisms that depend on the random motion of the particles, sufficient time in the contact zone is needed for this mechanism to be effective. Consequently, increasing the gas residence time should also increase the particle/liquid contact time and the collection efficiency for small particles.
- Inlet dust concentration – Collection efficiency for scrubbers has been found to be directly proportional to the inlet dust concentration; efficiency increases with increasing dust loading.

Advantages

- No secondary dust sources
- Relatively small space requirement
- Ability to collect gases as well as “sticky” particulates
- Ability to handle high-temperature, high-humidity gas streams
- Capital cost lower, provided wastewater treatment system is not required
- Insignificant pressure drop concerns for processes where the gas stream is already at high pressure
- High collection efficiency of fine particulates at the expense of pressure drop

Disadvantages

- Potential water disposal/effluent treatment problem
- Corrosion problems (more severe than with dry systems)
- Potentially objectionable steam plume opacity or droplet entrainment
- Higher power requirement due to potentially high pressure drop of approximately 10 inches of w.c.
- Potential problem of solid buildup at the wet-dry interface
- Relatively high maintenance costs

The dust loading per unit volume of jet engine exhaust is much lower than what is encountered from a majority of stationary external combustion sources; therefore, lower scrubber efficiency may be expected. For improved efficiency, the exhaust gas velocity must be increased, which will result in higher pressure drop, which in turn affects the calibration of the engine test cell.

Ranking of PM Control Options

Table 12 ranks the PM control options in the order of their PM removal efficiencies.

Table 12
PM Reduction Efficiency of Control Options from Literature

Technology	Typical NOx Reduction (percent removal)	Comment
Cyclone	70 – 90 percent	For fine dust (particle sizes <5 microns) efficiency is up to 70 percent. Efficiency is higher with larger particle sizes. Suitable for dry exhaust streams only.
ESP	Up to 99.9 percent	Suitable for dry exhaust streams only. Sensitive to fluctuations in gas stream conditions.
Baghouses	Up to 99.9 percent	Suitable for dry exhaust streams only. Explosion and fire hazard of readily oxidizable dust at concentration (~50 g/m^3) in the presence of accidental spark or flame. If caking occurs due to moist gas, very high pressure drop can build up causing exhaust backflow problems.
Wet Scrubbers – Wet Impingement Scrubbers	>95 percent	Efficiency lower than venturi scrubbers especially for particle sizes <1 micron
Wet Scrubbers – Venturi Scrubbers	>95 percent	Increasing the venturi scrubber efficiency requires increased pressure drop which, in turn, increases the energy consumption

Approved BACT for PM from RBLC Clearinghouse

Three determinations were found in the RBLC Clearinghouse search under the SIC codes 3724 and 4581. All three determinations are listed in Table 13, and they indicate that BACT was no control.

TABLE 13
RBLC Review of BACT-PSD PM Control for SIC 3724 and SIC 4581

Facility/ Location	**Year Evaluated**	**Permit Type**	**Process Name**	**Primary Fuel and Throughput**	**Pollutant**	**Emission Limit**	**Notes/Control Method**
G. E. Aircraft Engines Peebles, Adams, OH	2006	A	Permitting engine test stand #7 for GE aircraft engine and JSF military engine	Jet fuel, 81,385 lb/hr 12,057 gal/hr			See Note 1 for G. E. Aircraft Engines Peebles, Adams, OH RBLC Determination
					PM_{10}	18.2 lb/hr; 2.76 tpy per rolling 12 months	Case-by-Case Basis: N/A Control Method: (N) Other Applicable: SIP
					VE	10% opacity as a 6-minute average	Notes: 10% opacity as a 6-minute average in any 60-minute observation period.
Note 1: 12,057 gal/hr worst case in calculations. The test stand is restricted by tons of PM_{10}, VOC, and SO_2 per rolling 12-months, based on the hours of expected operation. However, no restrictions on hours. Maintain records of hours of testing operations and calculated emissions, each rolling month.							
Arnold Air Force Base, Coffee/Franklin, TN	2003	D	Increase in hours of operation for two jet engine cells	Jet fuel: JP-4, -5, -8 90,000 lb/h per cell			See Note 2 for Arnold Air Force Base, Coffee/Franklin, TN RBLC Determination
					PM	91 tpy 12-mo. rolling; 0.01 grains/dscf of exhaust gases	Case-by-Case Basis: Other Control Method: (N) None Listed Compliance Verified: Unknown
					VE	20% opacity	
Note 2: Consists of two jet engine test cells. Only jet fuel JP-4, -5, and -8 may be used.							

TABLE 13 (CONTINUED**)**
RBLC Review of BACT-PSD PM Control for SIC 3724 and SIC 4581

Facility/ Location	**Year Evaluated**	**Permit Type**	**Process Name**	**Primary Fuel and Throughput**	**Pollutant**	**Emission Limit**	**Notes/Control Method**
G. E. Aircraft Engines, Essex, MA	2002	D	Modify 2 jet engine test cells for use in the development testing of a new jet engine for the U.S. Navy	JP-4 or JP-5 1031 MMBtu/hr			See Note 3 for G. E. Aircraft Engines, Essex, MA RBLC Determination
					PM_{10}	None indicated	Not evaluated
Note 3: Operating modes range from idle through 100 percent power and maximum afterburner. A worst case mix of operating modes calculates to be equivalent to operating continuously at 80 percent. BACT required for SO_2, CO, NOx, and VOC.							
Permit Type Notes: A - New/Greenfield Facility D – Both B (Add new process to existing facility) and C (Modify process at existing facility)							

Evaluation of Remaining PM Control Options

Baghouses have been removed from further consideration because of: 1) the explosion and fire hazards of readily oxidizable dust in the presence of accidental spark or flame, and 2) the caking of collected dust due to moist exhaust gas can cause high pressure drop build up, which in turn can cause exhaust backflow problems.

As explained above, none of the PM control options examined are suitable for application to the existing jet engine test cells at Tinker. The next section summarizes the control option efficiency and the reason for elimination of the control options.

Evaluation of Most Effective PM Controls and Cost Effectiveness Summary

Table 14 summarizes the cost effectiveness for each of the PM control technologies identified, although the options examined are found to be not feasible. The detailed cost-effectiveness calculations with escalation are included in the BACT analysis.

TABLE 14
Summary of PM Control Cost Effectiveness

Control Technology	PM Emissions (tpy)	PM Removal Efficiency	PM Removed (tpy)	Cost Effectiveness ($/ton PM Removed)	Reason for Elimination of Control Option
Cyclone	27.7	80%	27.5	$52,786	Not cost-effective. Engine test cell has approximately 50 to 60 stacks. One cyclone per stack would be needed resulting in high pressure drop and significant test cell back pressure.
ESP	27.7	97%	27.4	$356,975	Not cost-effective. Approximately six ESPs would be required to handle a maximum flow rate of 3,600,000 acfm.
Wet Scrubbers – Wet Impingement Scrubbers	27.7	90%	27.5	$43,376	Not cost-effective. Approximately six impingement scrubbers would be required to handle a maximum flow rate of 3,600,000 acfm. Will generate large amounts of wastewater. Would cause significant pressure drop.
Wet Scrubbers – Venturi Scrubbers	27.7	95%	27.4	$60,073	Not cost-effective. Approximately six venture scrubbers would be required to handle a maximum flow rate of 3,600,000 acfm. Will generate large amounts of wastewater. Would cause significant pressure drop.

Notes:
The estimation of cost effectiveness is based on a maximum exhaust flowrate of 3,600,000 acfm and an exhaust particle density (dust loading) of 0.001 grains per standard cubic feet. The flow rate is based on the exhaust mass flow range for engine test cell Models B and C given in Table 3.3 Predicted Emission Characteristics for a Turbojet/Turbofan Model Test Cell; *Nitrogen Oxide Emissions and Their Control from Uninstalled Aircraft Engines in Enclosed Test Cell*," Report No. EPA-453/R-94-068, October 1994.

BACT Selection for Particulate Matter

The RBLC determinations indicate that no control methods are available for the control of PM and PM_{10}. The determination for GE Aircraft Engines Peebles, Adams, Ohio, is for a test stand for a Joint Strike Force (JSF) military engine under development and has a 10 percent opacity limit. The low opacity limit may be feasible for the engine under development because it would incorporate the latest technology for the combustor design, resulting in cleaner burning engines. However, the RBLC determination for Arnold AFB, Coffee/Franklin, Tennessee, has an emission limit of 20 percent opacity.

In the case of the engine test cells at Tinker, engines designed with a combustor technology that is at least 15 to 20 years old would be tested, without any possibility of incorporating changes to the combustor design or operation. Therefore, an opacity limit of 10 percent would not be feasible.

Based on the discussion above, BACT is considered to be no control for PM and the BACT emission limits are those that are supported through currently available emission factors.

VI. AIR QUALITY IMPACTS

The Base is located in Oklahoma County, Oklahoma, which has been designated as attainment or unclassifiable for all criteria pollutants. The project emissions are greater than Prevention of Significant Deterioration (PSD) significant emission rates (SERs) for carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter less than 10 microns in diameter (PM_{10}), and volatile organic compounds (VOCs). The PSD review for this permit action requires an air quality analysis to estimate the ambient impacts of emissions from the project (OAC 252:100-8-35).

Air Quality Modeling Analysis

Modeling Methodology

Two Stage Analysis

This section discusses the modeling methodology used to demonstrate compliance with the NAAQS and PSD Increment for CO, NO_2, and PM_{10}. Based on U.S. EPA modeling guidance, the PSD air quality analysis is conducted in two stages: the significance analysis and the full impact analysis. If the significance analysis indicates the proposed emission increase does not have a significant impact on the air quality, a full impact analysis is not required.

Significance Analysis (Stage One)

The significance analysis determines whether pre-construction monitoring is required, if the Base can forego further analyses, and defines the radius of impact (ROI) within which a full impact analysis (if required) should be conducted. In the significance analysis the annual emission increases from the project are modeled. The maximum modeled ground-level concentrations of CO, NO_2, and PM_{10} are then compared to the corresponding modeling and monitoring significance levels. The U.S. EPA requires that a full impact analysis be conducted if the project emissions result in maximum predicted concentrations exceeding modeling significance levels (MSLs) (*i.e.*, significant impacts). In addition, the permitting agency has the authority to exempt a project from pre-construction monitoring if the concentrations modeled in the significance analysis are less than monitoring *de minimis* concentrations. A significance analysis for CO, NO_2, and PM_{10} was completed to determine if the project emission increase would have a significant impact upon the area surrounding the Base. As shown below, a full impact analysis was not necessary for this proposed emissions increase. The following sections present information regarding the modeling specifics.

Dispersion Model Selection

Dispersion models predict downwind pollutant concentrations by simulating the evolution of the pollutant plume over time and space given data inputs which include the quantity of emissions and the initial conditions (*e.g.*, velocity, flowrate, and temperature) of the stack exhaust to the atmosphere. Building structures that obstruct wind flow near emission points might cause stack discharges to become caught in the turbulent wakes of these structures leading to downwash of the plumes. Wind blowing around a building creates zones of turbulence that are greater than if the building were absent. These effects generally cause higher ground level pollutant concentrations since building downwash inhibits dispersion.

The PSD dispersion modeling analysis for this project was conducted using the latest version of the **A**MS/**E**PA **R**egulatory **M**odel(AERMOD) to estimate maximum ground-level concentrations. AERMOD is a steady-state Gaussian plume model that incorporates planetary boundary layer (PBL) concepts. AERMOD treats dispersion in the PBL, the turbulent air layer next to the earth's surface that is controlled by the surface heating and friction and the overlying stratification, using two different algorithms. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal directions. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function.

Land-Use Analysis

A land-use analysis was conducted using a combination of recent aerial and satellite photographs of the area. Using the Auer typing scheme for land use patterns, it was determined that the adjacent land use is more than 50 percent urban. Therefore, AERMOD was run using the urban options, with an area population of 532,000 and a surface roughness of 0.75 (per ODEQ guidance).

Terrain

For this modeling analysis, elevations were obtained from using Light Detection and Ranging (LiDAR) data obtained under contract by the Base in 2004. LiDAR DEM data was used for the base elevations of on-Base sources and buildings. In addition, the BEEST BaerMap routine (which is equivalent to the AerMap routine, but allows for non USGS DEM data) was run using the LiDAR DEM data as input. A copy of the LiDAR data is included with this application on CD-ROM.

Meteorological Data

The air dispersion modeling is performed using 1986 through 1988 preprocessed meteorological data based on surface observations taken from Oklahoma City, Oklahoma [National Weather Service Station (NWS) station number 13967] with upper air measurements from Oklahoma City, Oklahoma. The 1990 and 1991 preprocessed meteorological data are based on surface observations taken from Oklahoma City, Oklahoma and upper air measurements from Norman, Oklahoma (NWS station number 03948). The met data were processed using the AERMet routine.

Receptor Grids

Ground-level concentrations are calculated for receptors located on four Cartesian grids covering a region that extends 20 km from all edges of the Base fence line. The grids are defined as follows:

1. A Fence Line Grid containing 100 meter-spaced receptors located along the Base fence line.
2. A Fine Grid containing 100 meter-spaced receptors, extending approximately 1.0 km from the fence line, exclusive of the Fence Line Grid.
3. A Medium Grid containing 500 meter-spaced receptors, extending approximately 4 km beyond the Fine grid.

4. A Coarse Grid containing 1,000 meter-spaced receptors, extending approximately 15 km beyond the Medium grid.

Emission Source and Monitor Information

Significance Analysis

The project will result in a combined emission increase of 275.77 tpy of CO, 375.13 tpy of NO_x, and 35.96 tpy of PM_{10} from EUs 4403 and 4404 at the Base. The standards for CO are expressed in terms of 8-hour and 1-hour average concentrations. Therefore, a maximum hourly emission rate for CO was determined assuming that the test cells operate for two 8-hour shifts per day, 5 days per week, 52 weeks per year. The proposed emission increase was divided by 4,160 hours to determine the maximum total hourly emission rate of 132.58 lbs/hour. This maximum hourly emission rate was then apportioned evenly across the twelve total stacks associated with the two test cell EUs. Therefore, 11.05 lbs/hour of CO was modeled from each stack.

The MSL, NAAQS, and PSD Increments for nitrogen oxides are all expressed in terms of NO_2. Although PSD applicability is based on emission of total oxides of nitrogen, the air quality analysis is limited to NO_2. Since the only standard for NO_2 is an annual one, the test cells were assumed to operate continuously, with the 375.13 tpy of NO_x averaged over the entire 8,760 hours. A technique referred to as the Ambient Ratio Method (ARM) is typically used to assess ground-level NO_2 concentrations for a given NO_x emission increase. For the significance analysis the default NO_2/NO_x ratio of 0.75 was used to estimate NO_2 emission rates to be used in the model. Therefore, annual modeled emissions were assumed to be 281.35 tons. The maximum annual emission rate was then apportioned evenly across the twelve total stacks associated with the two test cell EUs. Therefore, 5.35 lbs/hour was modeled from each stack.

The standards for PM_{10} are expressed in terms of a 24-hour and annual average concentrations. Therefore, two maximum hourly emission rates for PM_{10} were utilized in the significance analysis. For the annual averaging period, the test cells were assumed to operate continuously, with the 35.96 tpy of PM_{10} averaged over the entire 8,760 hours, resulting in a maximum annual hourly emission rate of 8.21 lbs/hr. This was apportioned evenly across the twelve total stacks, with 0.68 lbs/hr modeled from each stack. For the 24-hour significance analysis, the test cells were assumed to operate for two 8-hour shifts per day, 5 days per week, 52 weeks per year. The proposed emission increase was divided by 4,160 hours to determine the maximum total hourly emission rate of 17.28 lbs/hour. This maximum hourly emission rate was then apportioned evenly across the twelve total stacks associated with the two test cell EUs. Therefore, 1.44 lbs/hour of PM_{10} was modeled from each stack and the resulting concentrations compared to the 24-hour MSL. Table 15 presents the source parameters modeled in the significance analysis.

Table 15. Source Parameters for the Significance Analysis

Model ID	Source Description	X-UTM (m)	Y-UTM (m)	Elev. (m)	Hgt. (m)	Temp. (K)	Vel. (m/s)	Dia. (m)
4403A	Jet Engine Test Cell	647596.06	3920447.25	387.49	13.72	602.59	50.16	3.41
4403B	Jet Engine Test Cell	647596.06	3920439.00	387.7	13.72	602.59	50.16	3.41
4403C	Jet Engine Test Cell	647596.13	3920429.75	387.86	13.72	602.59	50.16	3.41
4403D	Jet Engine Test Cell	647596.44	3920421.00	388.05	13.72	602.59	50.16	3.41
4403E	Jet Engine Test Cell	647596.94	3920413.00	388.26	13.72	602.59	50.16	3.41
4403F	Jet Engine Test Cell	647596.63	3920404.50	388.45	13.72	602.59	50.16	3.41
4403G	Jet Engine Test Cell	647596.63	3920396.00	388.69	13.72	602.59	50.16	3.41
4403H	Jet Engine Test Cell	647597.60	3920387.50	388.9	13.72	602.59	50.16	3.41
4404A	Jet Engine Test Cell	647460.44	3920354.25	389.57	13.72	602.59	50.16	3.41
4404B	Jet Engine Test Cell	647461.67	3920335.27	389.54	13.72	602.59	50.16	3.41
4404C	Jet Engine Test Cell	647461.19	3920327.25	389.49	13.72	602.59	50.16	3.41
4404D	Jet Engine Test Cell	647461.93	3920308.78	389.68	13.72	602.59	50.16	3.41

Modeling Results

The following sections detail the results of the air quality modeling analyses.

Significance Analysis

In the significance analysis, the proposed emissions increases are modeled and the resulting maximum concentrations are compared to the MSL to determine if a full impact analysis is required. Figures are included in the full air quality analysis report and present the maximum modeled concentrations for each receptor grid and averaging period. The results of the significance analysis are summarized in Table 16 on the following page.

Table 16. Maximum Concentrations Calculated in the Significance Analysis

Pollutant	Receptor Grid	Averaging Period	UTM East (m)	UTM North (m)	Max. Modeled Concentration (μg/m³)	MSL (μg/m³)	Monitoring *de minimis* (μg/m³)
CO	Fence Line	1-hour	648,025	3,920,520	37.42	2,000	n/a
	Fine	1-hour	648,108	3,920,535	41.08	2,000	n/a
	Medium	1-hour	650,608	3,921,935	15.37	2,000	n/a
	Coarse	1-hour	648,108	3,912,435	8.16	2,000	n/a
	Fence Line	8-hour	647,897	3,920,590	20.97	500	575
	Fine	8-hour	647,908	3,920,435	21.24	500	575
	Medium	8-hour	647,608	3,923,935	3.96	500	575
	Coarse	8-hour	648,108	3,928,435	2.87	500	575
NO_2	Fence Line	Annual	647,424	3,922,312	0.32	1	14
	Fine	Annual	647,408	3,922,335	0.31	1	14
	Medium	Annual	647,108	3,923,935	0.12	1	14
	Coarse	Annual	646,108	3,928,435	0.10	1	14
PM_{10}	Fence Line	24-hour	647,897	3,920,290	1.48	5	10
	Fine	24-hour	647,908	3,920,235	1.27	5	10
	Medium	24-hour	647,608	3,923,935	0.22	5	10
	Coarse	24-hour	648,108	3,928,435	0.16	5	10
	Fence Line	Annual	647,424	3,922,312	0.04	1	n/a
	Fine	Annual	647,408	3,922,335	0.04	1	n/a
	Medium	Annual	647,108	3,923,935	0.02	1	n/a
	Coarse	Annual	646,108	3,928,435	0.01	1	n/a

Since modeled concentrations are less than the MSLs, a full impact analysis is not required.

VOC Impact Analysis

The EPA established the primary and secondary ambient air quality standard of 0.08 parts per million parts (ppm) for ozone. The standard is attained when the computed 3-year average of the annual 4th highest daily maximum 8-hour average does not exceed 0.08 ppm. The EPA has not provided guidance to show compliance with the 8-hour ozone standard for individual facilities subject to PSD based on VOC emission increases. EPA has provided guidance to states for modeling using the early action compact (EAC) model to show state-wide compliance. This modeling demonstrated that Oklahoma is in compliance state-wide. The state has the option of running the model after adding large emission sources to the model to indicate continued compliance.

Oklahoma Administrative Code 252:100-8-33(c) [Exemption from monitoring requirements] specifies an exemption threshold for ozone of 100 tpy increase. This project, over a four-year period, has the potential to increase VOC emissions by 140 tons; therefore, triggering the requirement for an impact analysis including the gathering of ambient air quality data. This could include at the discretion of the ODEQ pre-construction or post-construction monitoring. Since the ODEQ has ozone monitors located relatively close to the Base, these monitors should provide adequate data considering the modest potential VOC increase projected over the four-year period.

Table 17 summarizes the latest ODEQ ozone data available as August 23, 2006, from the four ozone monitors located closest to Tinker Air Force Base.

Table 17. ODEQ Ozone Monitor Data (through August 20, 2006)

Monitor Site	Distance to Tinker (miles)	CY03-05 Avg*	CY04-06 Avg*
OKC (Central)	6.6	0.077	0.077
Moore	7.2	0.074	0.075
Choctaw	8.0	0.076	0.076
OKC (North)	14	0.079	0.081

- 0.085 or greater indicates exceedance of the NAAQS.

In addition, the General Motors plant located adjacent to the Base reported VOC emissions as follows: CY03 – 184 tons, CY04 – 118 tons, and CY05 – 172 tons. The average VOC emissions for this three-year period were 158 tons per year. Since the plant has now closed, and considering that its emissions were included in the EAC CY03-05 model; the slight relocation of similar VOC emissions indicates the area should remain in compliance. In view of the level of emission increase, existing monitors and data, this project should not appreciably affect compliance with the NAAQS ozone standard.

Air Quality Monitoring Data

The U.S. EPA's monitoring *de minimis* concentrations establish the levels at which a facility may need to conduct pre-construction ambient air quality monitoring to demonstrate compliance with the NAAQS and PSD Increment. If modeling analyses show that maximum concentrations from a project do not exceed the monitoring *de minimis* concentrations, the permitting authority has discretionary authority to exempt the Base from the pre-construction monitoring requirement. As demonstrated in Table 16, the project does not result in ambient concentrations above the *de minimis* levels; therefore, Tinker AFB requests that the pre-construction monitoring requirement be waived for the project per OAC 252:100-8-33(c). ODEQ hereby waives the requirement.

Class I Area Impact Analysis

The nearest Class I area to the Base is the Wichita Mountain National Wildlife Refuge in Lawton, Oklahoma, which is greater than 100 km from the Base; therefore, a Class I Area Impact Analysis is not required. Also supporting the case that no analysis is needed is the new FLM criteria for excluding a facility from a Class I area visibility analysis, which is the 10D rule. If the emissions from the modification are less than 10 times the distance (in kilometers), no Class I visibility analysis is required. Since Tinker is approximately 137 km from the Refuge, this would mean that the emissions would have to be greater than or equal to 1,370 TPY. Based on that and the low impacts determined based on the previous modeling, this modification would not be subject to a Class I visibility analysis.

<u>Additional Impacts Analysis</u>

An additional impacts analysis considering existing air quality, the quantity of emissions, and the sensitivity of local soils, vegetation, and visibility in the source's impact area was performed for CO, and NO_x (as NO_2), and VOC as part of this PSD application. The following are addressed:

- A growth impact analysis
- Soils and vegetation impact analysis
- A visibility impairment impact analysis

Growth Impact Analysis

The elements of a growth impact analysis include a projection of the associated industrial, commercial and residential growth that will occur in the area due to the proposed emissions increase, including the potential impact upon ambient air due to this growth. No secondary or auxiliary industrial growth is expected as a result of the project. Since there is no significant associated commercial or industrial growth, negligible growth-related air pollution impacts are expected.

Soil And Vegetation Analysis

The effects of gaseous air pollutants on vegetation may be classified into three rather broad categories: acute, chronic, and long-term. Acute effects are those that result from relatively short (less than 1 month) exposures to high concentrations of pollutants. Chronic effects occur when organisms are exposed for months or even years to certain threshold levels of pollutants. Long-term effects include abnormal changes in ecosystems and subtle physiological alterations in organisms. Acute and chronic effects are caused by the gaseous pollutant acting directly on the organism, whereas long-term effects may be indirectly caused by secondary agents such as changes in soil pH.

At the levels of CO that occur in urban air, there are no detrimental effects on materials or plants, however human health may be adversely affected at such levels.[1] The NAAQS are intended to protect the public welfare from the adverse effects of airborne effluents. This protection extends to agricultural soil. The maximum predicted CO pollutant concentrations from the project are below the NAAQS. Therefore, no significant adverse impact on soil and vegetation due to CO emissions is anticipated from the project.

NO_2 may affect vegetation either by direct contact of NO_2 with the leaf surface or by solution in water drops, becoming nitric acid. The secondary NAAQS are intended to protect the public welfare from the adverse effects of airborne effluents. This protection extends to agricultural soil. The maximum predicted NO_2 pollutant concentrations from the project are below the secondary NAAQS. Since the secondary NAAQS protect impact on human welfare, no significant adverse impact on soil and vegetation due to NO_2 emissions is anticipated due to the project.

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[1] Masters, Gilbert M., *Introduction to Environmental Engineering and Science*, (Prentice Hall, NJ), p. 7.6.

PM can be carried over long distances by the wind and settle on the ground. The effects of this deposition can include depleting nutrients in soils, damaging sensitive forests and farm crops, and affecting ecosystem diversity. These effects are generally associated with the removal of large quantities of soils from ecosystems, not with the possible addition of smaller quantities of fine materials. Therefore, no significant impact on soil and vegetation due to PM_{10} emissions is anticipated due to the proposed emissions increase.

Emissions of VOC are precursors to tropospheric ozone. Elevated ground-level ozone concentrations can damage plant life and reduce crop production. VOCs interfere with the ability of plants to produce and store food, making them more susceptible to disease, insects, other pollutants, and harsh weather. No significant impact on soil and vegetation due to VOC emissions is anticipated due to the proposed emissions increase.

Visibility Impact Analysis

The project is not expected to produce any perceptible changes to the visibility impacts in the immediate vicinity to the Base. Certified Method 9 observers have documented visible emissions intermittently while performing readings during engine test runs on some older model aircraft turbine engines depending on the power setting and particular engine. Emissions are localized and soon dissipate. Testing of only one engine model has resulted in opacity readings exceeding the 20% limit. Tinker submits a quarterly emission report of any opacity exceedance, if occurrences are observed.

Additionally, the USEPA VISCREEN model was run using an arbitrary closest distance of 1 kilometer. Tinker performed a Level 1 visibility screening analysis and determined that the modification could potentially impair visibility. Therefore, per USEPA guidance (Workbook for Plume Visual Impact, Revised October 1992), a more rigid Level-2 screening was conducted. The objective of a Level-2 screening is to estimate worst-day plume visual impacts using more site-specific input (in this case meteorological information) than a Level-1 screening. In this instance, the WRPlot View Software, available from Lakes Environmental, was used to determine the average wind speed (5.23 m/sec) and the most frequent stability class (Class D, 55.3% frequency of occurrence) for the Oklahoma City/Norman meteorological data used in the AERMOD analysis. This average wind speed and stability class were used, along with the Level-1 screening parameters for particle-size distribution in the VISCREEN analysis. In addition, maximum hourly emissions were used (180.35 lbs/hour NO_x and 17.29 lbs/hr PM_{10}). Per USEPA guidance, a background visual range of 40 kilometers was used. In addition, since there are no protected integral vistas and dark terrain backgrounds, e.g., mountains are not physically realistic for the area surrounding Tinker Air Force Base, only the “SKY” results are considered. From the summary VISCREEN output (Attachment 3 Appendix B), the maximum delta E and contrast values are below screening levels. Therefore, the more in-depth Level 3 analysis was not warranted, and no appreciable visibility impairment is expected.

VII. OKLAHOMA AIR POLLUTION CONTROL RULES

OAC 252:100-1 (General Provisions) [Applicable]
Subchapter 1 includes definitions but there are no regulatory requirements.

OAC 252:100-3 (Air Quality Standards and Increments) [Applicable]
Subchapter 3 enumerates the primary and secondary ambient air quality standards and the PSD increments. At this time, all of Oklahoma is in "attainment" of these standards.

OAC 252:100-4 (New Source Performance Standards) [Not Applicable to This Project]
Federal regulations in 40 CFR Part 60 are incorporated by reference as they existed on September 1, 2005, except for the following: Subpart A (Sections 60.4, 60.9, 60.10, and 60.16), Subpart B, Subpart C, Subpart Cb, Subpart Cc, Subpart Cd, Subpart Ce, Subpart AAA, Subpart BBBB, Subpart DDDD, Subpart HHHH and Appendix G. NSPS requirements are addressed in the "Federal Regulations" section.

OAC 252:100-5 (Registration, Emission Inventory, and Annual Fees) [Applicable]
The owner or operator of any facility that is a source of air emissions shall submit a complete emission inventory annually on forms obtained from the Air Quality Division. Tinker has and will continue to submit annual air emissions inventory reports and pay appropriate emission fees.

OAC 252:100-8 (Permits for Part 70 Sources) [Applicable]
Part 5 includes the general administrative requirements for part 70 permits. Any planned changes in the operation of the facility which result in emissions not authorized in the permit and which exceed the "Insignificant Activities" or "Trivial Activities" thresholds require prior notification to AQD and may require a permit modification. Insignificant activities mean individual emission units that either are on the list in Appendix I (OAC 252:100) or whose actual calendar year emissions do not exceed the following limits:

- 5 TPY of any one criteria pollutant
- 2 TPY of any one hazardous air pollutant (HAP) or 5 TPY of multiple HAPs or 20% of any threshold less than 10 TPY for single HAP that the EPA may establish by rule

Currently, Tinker is operating under Permit No. 99-104-TV (M-1) issued on October 14, 2005. In addition, the ODEQ has issued two construction permits: one for two small fire-tube boilers in Building 208 and the second for a replacement of a large water-tube boiler in Building 3001. This construction permit is required due to: the engine test cells modification (installation of new computer hardware, software, and instrumentation for data acquisition during testing operations); upgrading of the electric, plumbing, and fuel system infrastructure; enlarging one or two of the existing test cells; possibly constructing additional test stands such as T-9 test units; and maybe some workload increase due to consolidation of engine testing from other installations. This permit establishes emission limits based on past operations plus an increase to accommodate workload variation. Headquarters Air Force Materiel Command is expected to reassign some level I engine maintenance work, basically engine testing after base-level field maintenance, to Tinker.

OAC 252:100-9 (Excess Emission Reporting Requirements) [Applicable]
In the event of any release which results in excess emissions, the owner or operator of such facility shall notify the Air Quality Division as soon as practical during normal office hours and no later than 4:30 pm the next working day following the malfunction or release. Within ten (10) business days further notice shall be tendered in writing containing specific details of the incident.

OAC 252:100-13 (Open Burning) [Applicable]
Open burning of refuse and other combustible material is prohibited except as authorized in the specific examples and under the conditions listed in this subchapter.

OAC 252:100-19 (Particulate Matter) [Not Applicable]
This subchapter specifies allowable particulate matter (PM) emissions rates from new and existing fuel-burning equipment based on rated heat inputs. Fuel-burning unit is defined as any internal combustion engine or gas turbine, or other combustion device used to convert the combustion of fuel to usable energy. Testing of aircraft turbine engines does not meet this definition as they do not produce usable energy. Since the engine test operation does not qualify as a fuel-burning unit nor does it have a quantifiable process rate, this rule does not apply to engine testing.

OAC 252:100-25 (Visible Emissions and Particulates) [Applicable]
No discharge of greater than 20% opacity is allowed except for short-term occurrences which consist of not more than one six-minute period in any consecutive 60 minutes, not to exceed three such periods in any consecutive 24 hours. In no case shall the average of any six-minute period exceed 60% opacity.

OAC 252:100-29 (Fugitive Dust) [Applicable]
No person shall cause or permit the discharge of any visible fugitive dust emissions beyond the property line on which the emissions originate in such a manner as to damage or to interfere with the use of adjacent properties, or cause air quality standards to be exceeded, or interfere with the maintenance of air quality standards. Under normal operating conditions, this facility will not cause a problem in this area, therefore it is not necessary to require specific precautions to be taken.

OAC 252:100-31 (Sulfur Compounds) [Not Applicable]
No person shall cause, suffer, or allow the discharge into the atmosphere of sulfur oxides measured as sulfur dioxide in excess of 0.8 lbs/MMBtu heat input, maximum three-hour average from liquid fuel-burning equipment. JP-5/8, a kerosene-based jet fuel, is estimated to have emission of SOx of approximately 0.13 lbs/MMBtu. Calculations are based on a 1996 survey of refineries producing JP-5/8 found in Table 3.6 of United States Air Force IERA study prepared in 2002. Oklahoma is considered in the East Central United States. The average sulfur content in JP-5/8 was 0.085% average weight percent, the highest sulfur content listed for all regions. This equates to 1.7 pounds per 1,000 lbs of JP-5/8 combusted or ~ 0.09 lbs/MMBtu. Although the rule does not directly address aircraft engine test cells, emissions will be well below the 0.8 lbs/MMBtu. Therefore, burning jet fuel will ensure compliance with this subchapter, even though the engines do not meet the definition of fuel-burning equipment while being tested.

OAC 252:100-33 (Nitrogen Oxides) [Not Applicable]
This subchapter sets limits of NOx emissions from fuel-burning equipment with a rated heat input of 50 MMBtu/hr or more. This subchapter limits NOx emissions to 0.3 lbs/MMBtu for liquid-fired fuel-burning equipment. Turbine engines burn JP-5/8, a kerosene-based jet fuel. In this subchapter fuel-burning equipment affects any fuel-burning equipment installed, altered, replaced or rebuilt after July 1, 1977, resulting in an increase in nitrogen oxide. Subchapter 19 defines fuel-burning unit as any internal combustion engine or gas turbine, or other combustion device used to convert the combustion of fuel to usable energy. Testing of aircraft turbine engines does not meet this definition as they do not produce usable energy during the test mode.

OAC 252:100-35 (Carbon Monoxide) [Not Applicable]
This facility has none of the affected sources: gray iron cupola, blast furnace, basic oxygen furnace, petroleum catalytic cracking unit, or petroleum catalytic reforming unit.

OAC 252:100-37 (Volatile Organic Compounds) [Applicable]
Part 7 requires fuel-burning equipment to be operated and maintained so as to minimize emissions. Temperature and available air must be sufficient to provide essentially complete combustion. Aircraft engines are required to be tested under expected power settings required inflight to ensure safe operation. Emissions from engines vary widely, however the newer engines incorporate better combustion design over the older engines. There is no feasible method of reducing VOC emissions when testing the older generations of aircraft engines.

OAC 252:100-41 (Hazardous Air Pollutants (HAP)) [Part 3 Applicable]
Part 3 addresses hazardous air contaminants. NESHAP, as found in 40 CFR Part 61, are adopted by reference as they existed on September 1, 2005, with the exception of Subparts B, H, I, K, Q, R, T, W and Appendices D and E, all of which address radionuclides. In addition, General Provisions as found in 40 CFR Part 63, Subpart A, and the Maximum Achievable Control Technology (MACT) standards as found in 40 CFR Part 63, Subparts F, G, H, I, L, M, N, O, Q, R, S, T, U, W, X, Y, AA, BB, CC, DD, EE, GG, HH, II, JJ, KK, LL, MM, OO, PP, QQ, RR, SS, TT, UU, VV, WW, XX, YY, CCC, DDD, EEE, GGG, HHH, III, JJJ, LLL, MMM, NNN, OOO, PPP, QQQ, RRR, TTT, UUU, VVV, XXX, AAAA, CCCC, DDDD, EEEE, FFFF, GGGG, HHHH, IIII, JJJJ, KKKK, MMMM, NNNN, OOOO, PPPP, QQQQ, RRRR, SSSS, TTTT, UUUU, VVVV, WWWW, XXXX, YYYY, ZZZZ, AAAAA, BBBBB, CCCCC, EEEEE, FFFFF, GGGGG, HHHHH, IIIII, JJJJJ, KKKKK, LLLLL, MMMMM, NNNNN, PPPPP, QQQQQ, RRRRR, SSSSS and TTTTT are hereby adopted by reference as they existed on September 1, 2005. These standards apply to both existing and new sources of HAP. These requirements are covered in the “Federal Regulations” section.
Part 5 was a **state-only** requirement governing sources of toxic air contaminants that have emissions exceeding a *de minimis* level. However, Part 5 of Subchapter 41 has been superseded by OAC 252:100-42, effective June 15, 2006.

OAC 252:100-42 (Toxic Air Contaminants (TAC)) [Applicable]
Part 5 of OAC 252:100-41 was superseded by this subchapter. Any work practice standard, material substitution, or control equipment required by the Department prior to June 11, 2004, to control a TAC, shall be retained unless a modification is approved by the Director. Since no

Area of Concern (AOC) has been designated anywhere in the state, there are no specific requirements for this facility at this time.

OAC 252:100-43 (Sampling and Testing Methods) [Applicable]
This subchapter provides general requirements for testing, monitoring and recordkeeping and applies to any testing, monitoring or recordkeeping activity conducted at any stationary source. To determine compliance with emissions limitations or standards, the Air Quality Director may require the owner or operator of any source in the state of Oklahoma to install, maintain and operate monitoring equipment or to conduct tests, including stack tests, of the air contaminant source. All required testing must be conducted by methods approved by the Air Quality Director and under the direction of qualified personnel. Emissions and other data required to demonstrate compliance with any federal or state emission limit or standard, or any requirement set forth in a valid permit shall be recorded, maintained, and submitted as required by this subchapter, an applicable rule, or permit requirement. Data from any required testing or monitoring not conducted in accordance with the provisions of this subchapter shall be considered invalid. Nothing shall preclude the use, including the exclusive use, of any credible evidence or information relevant to whether a source would have been in compliance with applicable requirements if the appropriate performance or compliance test or procedure had been performed.

The following Oklahoma Air Pollution Control Rules are not applicable to this facility:

OAC 252:100-7	Minor Sources	not in source category
OAC 252:100-11	Alternative Reduction	not eligible
OAC 252:100-15	Mobile Sources	not in source category
OAC 252:100-23	Cotton Gins	not type of emission unit
OAC 252:100-24	Feed & Grain Facility	not in source category
OAC 252:100-39	Nonattainment Areas	not in a subject area
OAC 252:100-47	Landfills	not in source category

VIII. FEDERAL REGULATIONS

PSD, 40 CFR Part 51 [Applicable]
PSD does apply to this project since some pollutants emission increases exceed the ton per year significance levels which are: NOx 40, CO 100, VOC 40, PM 25, PM_{10} 15 and SO_2 40. This project's emissions have the potential to exceed the significance thresholds for NOx, CO, VOC and PM_{10}.

NSPS, 40 CFR Part 60 [Not Applicable]
There are no subparts in this regulation that apply to turbine engine test cells.

NESHAP, 40 CFR Part 61 [Not Applicable]
There are no emissions of any of the regulated pollutants: arsenic, asbestos, benzene, beryllium, coke oven emissions, mercury, radionuclides, or vinyl chloride except for trace amounts of benzene. Subpart J, Equipment Leaks of Benzene, concerns only process streams that contain more than 10% benzene by weight.

NESHAP, 40 CFR Part 63 [Not Applicable]
Subpart PPPPP. "Engine Test Cells/Stands" applies to existing, new, or reconstructed engine test cells/stands that are located at a major source of HAP. Section 63.9290 states the following: "(b) Existing affected sources do not have to meet the requirements of this subpart and of subpart A of this part.; (d) Any portion of a new or reconstructed affected source located at a major source that meets any of the criteria specified in paragraphs (d)(1) through (4) of this section does not have to meet the requirements of this subpart and of subpart A of this part. (1) Any portion of the affected source used exclusively for testing combustion turbine engines." Tinker test cells are used exclusively for testing aircraft engines, i.e., combustion turbines. Therefore, this regulation is not applicable to this project.

Compliance Assurance Monitoring, 40 CFR Part 64 [Not Applicable]
CAM applies to any pollutant specific emission unit at a major source that is required to obtain a Title V permit, if it meets all of the following criteria.

- It is subject to an emission limit or standard for an applicable regulated air pollutant
- It uses a control device to achieve compliance with the applicable emission limit or standard
- It has potential emissions, prior to the control device, of the applicable regulated air pollutant of 100 TPY.

The engine test cells do not have a control device, thus this CAM regulation does not apply.

Chemical Accident Prevention Provisions, 40 CFR Part 68 [Not Applicable]
This facility does not process or store more than the threshold quantity of any regulated substance. Although significant quantities of various fuels are stored on base, EPA published an exemption for "flammable substances used as fuel" in the Federal Register on March 13, 2000, which applies to the situation at Tinker. More information on this federal program is available at the web site: http://www.epa.gov/ceppo/.

Stratospheric Ozone Protection, 40 CFR Part 82 [Subparts A and F Applicable]
These standards require phase out of Class I & II substances, reductions of emissions of Class I & II substances to the lowest achievable level in all use sectors, and banning use of nonessential products containing ozone-depleting substances (Subparts A & C); control servicing of motor vehicle air conditioners (Subpart B); require Federal agencies to adopt procurement regulations which meet phase out requirements and which maximize the substitution of safe alternatives to Class I and Class II substances (Subpart D); require warning labels on products made with or containing Class I or II substances (Subpart E); maximize the use of recycling and recovery upon disposal (Subpart F); require producers to identify substitutes for ozone-depleting compounds under the Significant New Alternatives Program (Subpart G); and reduce the emissions of halons (Subpart H).
Subpart A identifies ozone-depleting substances and divides them into two classes. Class I controlled substances are divided into seven groups; the chemicals typically used by the manufacturing industry include carbon tetrachloride (Class I, Group IV) and methyl chloroform (Class I, Group V). A complete phase-out of production of Class I substances is required by January 1, 2000 (January 1, 2002, for methyl chloroform). Class II chemicals, which are hydrochlorofluorocarbons (HCFCs), are generally seen as interim substitutes for Class I CFCs.

Class II substances consist of 33 HCFCs. A complete phase-out of Class II substances, scheduled in phases starting by 2002, is required by January 1, 2030.

Since the facility personnel perform service on industrial cooling units, comfort cooling, and motor (fleet) vehicles containing Class I and II refrigerants, the facility is subject to this rule. (see Standard Conditions, Section XX).

IX. COMPLIANCE

Tier Classification and Public Review

This application is classified as a **Tier II** based on a new construction/modification permit for an existing major facility for any facility change not considered minor under OAC 252:100-8-7(e)(1). The permittee has submitted an affidavit that they are not seeking a permit for land use or for any operation upon land owned by others without their knowledge. The affidavit certified that the applicant owns the land.

The applicant published a “Notice of Filing a Tier II Construction Permit Application” in *The Oklahoman*, a daily newspaper in Oklahoma County,on October 20, 2006. The notice indicates the application may be reviewed at the Midwest City Library at 8143 E. Reno, or the ODEQ/AQD main office at 707 N. Robinson in Oklahoma City. The applicant published a “Notice of Draft Permit” in *The Oklahoman* on January 16, 2007, for a 30-day public review. The draft permit was available for review at the same locations listed above. There were no comments from the public. The proposed permit was sent to EPA Region VI for their 45-day review on March 2, 2007. They had no comments.

Fee Paid

A construction permit fee of $1,500 will be submitted by the applicant upon receipt of an invoice.

X. SUMMARY

The applicant has demonstrated the ability to comply with the applicable Air Quality rules and regulations. Ambient air quality standards are not threatened at this site. There are no active Air Quality compliance or enforcement issues concerning this facility. Issuance of the permit is recommended.

PERMIT TO CONSTRUCT
AIR POLLUTION CONTROL FACILIITY
SPECIFIC CONDITIONS

Tinker Air Force Base **Permit No. 99-104-C (M-4)**
Engine Test Cells

The permittee is authorized to modify the engine test cells in Buildings 3234 and 3703 and construct additional test units such as T-9 test stands to accommodate additional engine testing in conformance with the specifications submitted to Air Quality on October 12, 2006. The Evaluation Memorandum dated April 17, 2007, explains the derivation of applicable permit requirements and estimates of emissions; however, it does not contain specific operational standards, or monitoring, reporting, and recordkeeping (MRR) requirements. Commencing construction under this permit constitutes acceptance of, and consent to, the conditions contained herein:

1. Points of emissions and emission limitations are the aircraft turbine engine testing operations consisting of three emission units designated EUs 4403, 4404, and 4600 as follows:
[OAC 252:100-8-6(a)(1)]

Maximum Criteria Pollutant Emissions	
Pollutant	**TPY**
NO_X	414
CO	277
VOC	218
SO_2	48
PM_{10}	40

2. The permittee shall be authorized to operate the engine test cells twenty-four hours per day, every day of the year. [OAC 252:100-8-6(a)(1)]

3. The permittee shall limit fuel combusted to JP-5/8 meeting Department of Defense military specifications. By doing so, no recordkeeping of sulfur content is required.
[OAC 252:100-8-6(a)(1)]

4. The permittee shall keep records of operation as listed below. These records shall be retained on-site for a period of at least five years and shall be made available to regulatory personnel upon request. [OAC 252:100-8-6 (a)(3)(B)]

a. Monthly total number of test runs per engine type.
b. Emission calculations (monthly and 12-month rolling totals).

5. The permittee shall be authorized to construct additional engine test stands subject to the following conditions:

a. The permittee shall notify the ODEQ of the proposed number and location (e.g., building number), prior to beginning construction.
b. The permittee shall notify the ODEQ when each unit becomes operational.
c. Emissions from any additional testing units are limited to aggregated limits in Specific Condition 1 for all jet engine testing operations.
d. Emissions shall be recorded and reported in the annual air emission inventory.

6. Within 180 days of start of operation, the permittee shall apply for a modified Title V operating permit and request that the specific conditions of this construction permit be administratively incorporated into the Title V permit.

TITLE V (PART 70) PERMIT TO OPERATE / CONSTRUCT
STANDARD CONDITIONS
(December 6, 2006)

SECTION I. DUTY TO COMPLY

A. This is a permit to operate / construct this specific facility in accordance with Title V of the federal Clean Air Act (42 U.S.C. 7401, et seq.) and under the authority of the Oklahoma Clean Air Act and the rules promulgated there under. [Oklahoma Clean Air Act, 27A O.S. § 2-5-112]

B. The issuing Authority for the permit is the Air Quality Division (AQD) of the Oklahoma Department of Environmental Quality (DEQ). The permit does not relieve the holder of the obligation to comply with other applicable federal, state, or local statutes, regulations, rules, or ordinances. [Oklahoma Clean Air Act, 27A O.S. § 2-5-112]

C. The permittee shall comply with all conditions of this permit. Any permit noncompliance shall constitute a violation of the Oklahoma Clean Air Act and shall be grounds for enforcement action, for revocation of the approval to operate under the terms of this permit, or for denial of an application to renew this permit. All terms and conditions (excluding state-only requirements) are enforceable by the DEQ, by EPA, and by citizens under section 304 of the Clean Air Act. This permit is valid for operations only at the specific location listed.
[40 CFR §70.6(b), OAC 252:100-8-1.3 and 8-6 (a)(7)(A) and (b)(1)]

D. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of the permit. [OAC 252:100-8-6 (a)(7)(B)]

SECTION II. REPORTING OF DEVIATIONS FROM PERMIT TERMS

A. Any exceedance resulting from emergency conditions and/or posing an imminent and substantial danger to public health, safety, or the environment shall be reported in accordance with Section XIV. [OAC 252:100-8-6 (a)(3)(C)(iii)]

B. Deviations that result in emissions exceeding those allowed in this permit shall be reported consistent with the requirements of OAC 252:100-9, Excess Emission Reporting Requirements.
[OAC 252:100-8-6 (a)(3)(C)(iv)]

C. Oral notifications (fax is also acceptable) shall be made to the AQD central office as soon as the owner or operator of the facility has knowledge of such emissions but no later than 4:30 p.m. the next working day the permittee becomes aware of the exceedance. Within ten (10) working days after the immediate notice is given, the owner operator shall submit a written report describing the extent of the excess emissions and response actions taken by the facility. Every written report submitted under OAC 252:100-8-6 (a)(3)(C)(iii) shall be certified by a responsible official. [OAC 252:100-8-6 (a)(3)(C)(iii)]

SECTION III. MONITORING, TESTING, RECORDKEEPING & REPORTING

A. The permittee shall keep records as specified in this permit. Unless a different retention period or retention conditions are set forth by a specific term in this permit, these records, including monitoring data and necessary support information, shall be retained on-site or at a nearby field office for a period of at least five years from the date of the monitoring sample, measurement, report, or application, and shall be made available for inspection by regulatory personnel upon request. Support information includes all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. Where appropriate, the permit may specify that records may be maintained in computerized form.
[OAC 252:100-8-6 (a)(3)(B)(ii), 8-6 (c)(1), and 8-6 (c)(2)(B)]

B. Records of required monitoring shall include:
(1) the date, place and time of sampling or measurement;
(2) the date or dates analyses were performed;
(3) the company or entity which performed the analyses;
(4) the analytical techniques or methods used;
(5) the results of such analyses; and
(6) the operating conditions as existing at the time of sampling or measurement.
[OAC 252:100-8-6 (a)(3)(B)(i)]

C. No later than 30 days after each six (6) month period, after the date of the issuance of the original Part 70 operating permit, the permittee shall submit to AQD a report of the results of any required monitoring. All instances of deviations from permit requirements since the previous report shall be clearly identified in the report. [OAC 252:100-8-6 (a)(3)(C)(i) and (ii)]

D. If any testing shows emissions in excess of limitations specified in this permit, the owner or operator shall comply with the provisions of Section II of these standard conditions.
[OAC 252:100-8-6 (a)(3)(C)(iii)]

E. In addition to any monitoring, recordkeeping or reporting requirement specified in this permit, monitoring and reporting may be required under the provisions of OAC 252:100-43, Testing, Monitoring, and Recordkeeping, or as required by any provision of the Federal Clean Air Act or Oklahoma Clean Air Act.

F. Submission of quarterly or semi-annual reports required by any applicable requirement that are duplicative of the reporting required in the previous paragraph will satisfy the reporting requirements of the previous paragraph if noted on the submitted report.

G. Every report submitted under OAC 252:100-8-6 and OAC 252:100-43 shall be certified by a responsible official. [OAC 252:100-8-6 (a)(3)(C)(iv)]

H. Any owner or operator subject to the provisions of NSPS shall maintain records of the occurrence and duration of any start-up, shutdown, or malfunction in the operation of an affected facility or any malfunction of the air pollution control equipment. [40 CFR 60.7 (b)]

I. Any owner or operator subject to the provisions of NSPS shall maintain a file of all measurements and other information required by the subpart recorded in a permanent file suitable for inspection. This file shall be retained for at least two years following the date of such measurements, maintenance, and records. [40 CFR 60.7 (d)]

J. The permittee of a facility that is operating subject to a schedule of compliance shall submit to the DEQ a progress report at least semi-annually. The progress reports shall contain dates for achieving the activities, milestones or compliance required in the schedule of compliance and the dates when such activities, milestones or compliance was achieved. The progress reports shall also contain an explanation of why any dates in the schedule of compliance were not or will not be met, and any preventative or corrective measures adopted. [OAC 252:100-8-6 (c)(4)]

K. All testing must be conducted by methods approved by the Division Director under the direction of qualified personnel. All tests shall be made and the results calculated in accordance with standard test procedures. The use of alternative test procedures must be approved by EPA. When a portable analyzer is used to measure emissions it shall be setup, calibrated, and operated in accordance with the manufacturer's instructions and in accordance with a protocol meeting the requirements of the "AQD Portable Analyzer Guidance" document or an equivalent method approved by Air Quality. [40 CFR §70.6(a), 40 CFR §51.212(c)(2), 40 CFR § 70.7(d), 40 CFR §70.7(e)(2), OAC 252:100-8-6 (a)(3)(A)(iv), and OAC 252:100-43]

The reporting of total particulate matter emissions as required in Part 70, PSD, OAC 252:100-19, and Emission Inventory, shall be conducted in accordance with applicable testing or calculation procedures, modified to include back-half condensables, for the concentration of particulate matter less than 10 microns in diameter PM_{10}. NSPS may allow reporting of only particulate matter emissions caught in the filter (obtained using Reference Method 5). [US EPA Publication (September 1994). PM_{10} Emission Inventory Requirements - Final Report. Emission Inventory Branch: RTP, N.C.]; [Federal Register: Volume 55, Number 74, 4/17/90, pp.14246-14249. 40 CFR Part 51: Preparation, Adoption, and Submittal of State Implementation Plans; Methods for Measurement of PM_{10} Emissions from Stationary Sources]; [Letter from Thompson G. Pace, EPA OAQPS to Sean Fitzsimmons, Iowa DNR, March 31, 1994 (regarding PM_{10} Condensables)]

L. The permittee shall submit to the AQD a copy of all reports submitted to the EPA as required by 40 CFR Part 60, 61, and 63, for all equipment constructed or operated under this permit subject to such standards. [OAC 252:100-4-5 and OAC 252:100-41-15]

SECTION IV. COMPLIANCE CERTIFICATIONS

A. No later than 30 days after each anniversary date of the issuance of the original Part 70 operating permit, the permittee shall submit to the AQD, with a copy to the US EPA, Region 6, a certification of compliance with the terms and conditions of this permit and of any other applicable requirements which have become effective since the issuance of this permit. The compliance certification shall also include such other facts as the permitting authority may require to determine the compliance status of the source.

[OAC 252:100-8-6 (c)(5)(A), (C)(v), and (D)]

B. The certification shall describe the operating permit term or condition that is the basis of the certification; the current compliance status; whether compliance was continuous or intermittent; the methods used for determining compliance, currently and over the reporting period; and a statement that the facility will continue to comply with all applicable requirements.
[OAC 252:100-8-6 (c)(5)(C)(i)-(iv)]

C. Any document required to be submitted in accordance with this permit shall be certified as being true, accurate, and complete by a responsible official. This certification shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the certification are true, accurate, and complete.
[OAC 252:100-8-5 (f) and OAC 252:100-8-6 (c)(1)]

D. Any facility reporting noncompliance shall submit a schedule of compliance for emissions units or stationary sources that are not in compliance with all applicable requirements. This schedule shall include a schedule of remedial measures, including an enforceable sequence of actions with milestones, leading to compliance with any applicable requirements for which the emissions unit or stationary source is in noncompliance. This compliance schedule shall resemble and be at least as stringent as that contained in any judicial consent decree or administrative order to which the emissions unit or stationary source is subject. Any such schedule of compliance shall be supplemental to, and shall not sanction noncompliance with, the applicable requirements on which it is based, except that a compliance plan shall not be required for any noncompliance condition which is corrected within 24 hours of discovery.
[OAC 252:100-8-5 (e)(8)(B) and OAC 252:100-8-6 (c)(3)]

SECTION V. REQUIREMENTS THAT BECOME APPLICABLE DURING THE PERMIT TERM

The permittee shall comply with any additional requirements that become effective during the permit term and that are applicable to the facility. Compliance with all new requirements shall be certified in the next annual certification. [OAC 252:100-8-6 (c)(6)]

SECTION VI. PERMIT SHIELD

A. Compliance with the terms and conditions of this permit (including terms and conditions established for alternate operating scenarios, emissions trading, and emissions averaging, but excluding terms and conditions for which the permit shield is expressly prohibited under OAC 252:100-8) shall be deemed compliance with the applicable requirements identified and included in this permit. [OAC 252:100-8-6 (d)(1)]

B. Those requirements that are applicable are listed in the Standard Conditions and the Specific Conditions of this permit. Those requirements that the applicant requested be determined as not applicable are summarized in the Specific Conditions of this permit. [OAC 252:100-8-6 (d)(2)]

SECTION VII. ANNUAL EMISSIONS INVENTORY & FEE PAYMENT

The permittee shall file with the AQD an annual emission inventory and shall pay annual fees based on emissions inventories. The methods used to calculate emissions for inventory purposes shall be based on the best available information accepted by AQD.
[OAC 252:100-5-2.1, -5-2.2, and OAC 252:100-8-6 (a)(8)]

SECTION VIII. TERM OF PERMIT

A. Unless specified otherwise, the term of an operating permit shall be five years from the date of issuance. [OAC 252:100-8-6 (a)(2)(A)]

B. A source's right to operate shall terminate upon the expiration of its permit unless a timely and complete renewal application has been submitted at least 180 days before the date of expiration. [OAC 252:100-8-7.1 (d)(1)]

C. A duly issued construction permit or authorization to construct or modify will terminate and become null and void (unless extended as provided in OAC 252:100-8-1.4(b)) if the construction is not commenced within 18 months after the date the permit or authorization was issued, or if work is suspended for more than 18 months after it is commenced. [OAC 252:100-8-1.4(a)]

D. The recipient of a construction permit shall apply for a permit to operate (or modified operating permit) within 180 days following the first day of operation. [OAC 252:100-8-4(b)(5)]

SECTION IX. SEVERABILITY

The provisions of this permit are severable and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.
[OAC 252:100-8-6 (a)(6)]

SECTION X. PROPERTY RIGHTS

A. This permit does not convey any property rights of any sort, or any exclusive privilege.
[OAC 252:100-8-6 (a)(7)(D)]

B. This permit shall not be considered in any manner affecting the title of the premises upon which the equipment is located and does not release the permittee from any liability for damage to persons or property caused by or resulting from the maintenance or operation of the equipment for which the permit is issued. [OAC 252:100-8-6 (c)(6)]

SECTION XI. DUTY TO PROVIDE INFORMATION

A. The permittee shall furnish to the DEQ, upon receipt of a written request and within sixty (60) days of the request unless the DEQ specifies another time period, any information that the DEQ may request to determine whether cause exists for modifying, reopening, revoking,

reissuing, terminating the permit or to determine compliance with the permit. Upon request, the permittee shall also furnish to the DEQ copies of records required to be kept by the permit.
[OAC 252:100-8-6 (a)(7)(E)]

B. The permittee may make a claim of confidentiality for any information or records submitted pursuant to 27A O.S. 2-5-105(18). Confidential information shall be clearly labeled as such and shall be separable from the main body of the document such as in an attachment.
[OAC 252:100-8-6 (a)(7)(E)]

C. Notification to the AQD of the sale or transfer of ownership of this facility is required and shall be made in writing within 10 days after such date.
[Oklahoma Clean Air Act, 27A O.S. § 2-5-112 (G)]

SECTION XII. REOPENING, MODIFICATION & REVOCATION

A. The permit may be modified, revoked, reopened and reissued, or terminated for cause. Except as provided for minor permit modifications, the filing of a request by the permittee for a permit modification, revocation, reissuance, termination, notification of planned changes, or anticipated noncompliance does not stay any permit condition.
[OAC 252:100-8-6 (a)(7)(C) and OAC 252:100-8-7.2 (b)]

B. The DEQ will reopen and revise or revoke this permit as necessary to remedy deficiencies in the following circumstances: [OAC 252:100-8-7.3 and OAC 252:100-8-7.4(a)(2)]

(1) Additional requirements under the Clean Air Act become applicable to a major source category three or more years prior to the expiration date of this permit. No such reopening is required if the effective date of the requirement is later than the expiration date of this permit.
(2) The DEQ or the EPA determines that this permit contains a material mistake or that the permit must be revised or revoked to assure compliance with the applicable requirements.
(3) The DEQ or the EPA determines that inaccurate information was used in establishing the emission standards, limitations, or other conditions of this permit. The DEQ may revoke and not reissue this permit if it determines that the permittee has submitted false or misleading information to the DEQ.

C. If "grandfathered" status is claimed and granted for any equipment covered by this permit, it shall only apply under the following circumstances: [OAC 252:100-5-1.1]

(1) It only applies to that specific item by serial number or some other permanent identification.
(2) Grandfathered status is lost if the item is significantly modified or if it is relocated outside the boundaries of the facility.

D. To make changes other than (1) those described in Section XVIII (Operational Flexibility), (2) administrative permit amendments, and (3) those not defined as an Insignificant Activity (Section XVI) or Trivial Activity (Section XVII), the permittee shall notify AQD. Such changes may require a permit modification. [OAC 252:100-8-7.2 (b)]

E. Activities that will result in air emissions that exceed the trivial/insignificant levels and that are not specifically approved by this permit are prohibited. [OAC 252:100-8-6 (c)(6)]

SECTION XIII. INSPECTION & ENTRY

A. Upon presentation of credentials and other documents as may be required by law, the permittee shall allow authorized regulatory officials to perform the following (subject to the permittee's right to seek confidential treatment pursuant to 27A O.S. Supp. 1998, § 2-5-105(18) for confidential information submitted to or obtained by the DEQ under this section):
[OAC 252:100-8-6 (c)(2)]

(1) enter upon the permittee's premises during reasonable/normal working hours where a source is located or emissions-related activity is conducted, or where records must be kept under the conditions of the permit;
(2) have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit;
(3) inspect, at reasonable times and using reasonable safety practices, any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under the permit; and
(4) as authorized by the Oklahoma Clean Air Act, sample or monitor at reasonable times substances or parameters for the purpose of assuring compliance with the permit.

SECTION XIV. EMERGENCIES

A. Any emergency and/or exceedance that poses an imminent and substantial danger to public health, safety, or the environment shall be reported to AQD as soon as is practicable; but under no circumstance shall notification be more than 24 hours after the exceedance.
[OAC 252:100-8-6 (a)(3)(C)(iii)(II)]

B. An "emergency" means any situation arising from sudden and reasonably unforeseeable events beyond the control of the source, including acts of God, which situation requires immediate corrective action to restore normal operation, and that causes the source to exceed a technology-based emission limitation under this permit, due to unavoidable increases in emissions attributable to the emergency. [OAC 252:100-8-2]

C. An emergency shall constitute an affirmative defense to an action brought for noncompliance with such technology-based emission limitation if the conditions of paragraph D below are met.
[OAC 252:100-8-6 (e)(1)]

D. The affirmative defense of emergency shall be demonstrated through properly signed, contemporaneous operating logs or other relevant evidence that:
[OAC 252:100-8-6 (e)(2), (a)(3)(C)(iii)(I) and (IV)]

(1) an emergency occurred and the permittee can identify the cause or causes of the emergency;
(2) the permitted facility was at the time being properly operated;
(3) during the period of the emergency the permittee took all reasonable steps to minimize levels of emissions that exceeded the emission standards or other requirements in this permit;
(4) the permittee submitted timely notice of the emergency to AQD, pursuant to the applicable regulations (i.e., for emergencies that pose an "imminent and substantial danger," within 24 hours of the time when emission limitations were exceeded due to the emergency; 4:30 p.m. the next business day for all other emergency exceedances). *See OAC 252:100-8-6(a)(3)(C)(iii)(I) and (II).* This notice shall contain a description of the emergency, the probable cause of the exceedance, any steps taken to mitigate emissions, and corrective actions taken; and
(5) the permittee submitted a follow up written report within 10 working days of first becoming aware of the exceedance.

E. In any enforcement proceeding, the permittee seeking to establish the occurrence of an emergency shall have the burden of proof. [OAC 252:100-8-6 (e)(3)]

SECTION XV. RISK MANAGEMENT PLAN

The permittee, if subject to the provision of Section 112(r) of the Clean Air Act, shall develop and register with the appropriate agency a risk management plan by June 20, 1999, or the applicable effective date. [OAC 252:100-8-6 (a)(4)]

SECTION XVI. INSIGNIFICANT ACTIVITIES

Except as otherwise prohibited or limited by this permit, the permittee is hereby authorized to operate individual emissions units that are either on the list in Appendix I to OAC Title 252, Chapter 100, or whose actual calendar year emissions do not exceed any of the limits below. Any activity to which a State or federal applicable requirement applies is not insignificant even if it meets the criteria below or is included on the insignificant activities list. [OAC 252:100-8-2]

(1) 5 tons per year of any one criteria pollutant.
(2) 2 tons per year for any one hazardous air pollutant (HAP) or 5 tons per year for an aggregate of two or more HAP's, or 20 percent of any threshold less than 10 tons per year for single HAP that the EPA may establish by rule.

SECTION XVII. TRIVIAL ACTIVITIES

Except as otherwise prohibited or limited by this permit, the permittee is hereby authorized to operate any individual or combination of air emissions units that are considered inconsequential and are on the list in Appendix J. Any activity to which a State or federal applicable requirement applies is not trivial even if included on the trivial activities list. [OAC 252:100-8-2]

SECTION XVIII. OPERATIONAL FLEXIBILITY

A. A facility may implement any operating scenario allowed for in its Part 70 permit without the need for any permit revision or any notification to the DEQ (unless specified otherwise in the permit). When an operating scenario is changed, the permittee shall record in a log at the facility the scenario under which it is operating. [OAC 252:100-8-6 (a)(10) and (f)(1)]

B. The permittee may make changes within the facility that:

(1) result in no net emissions increases,
(2) are not modifications under any provision of Title I of the federal Clean Air Act, and
(3) do not cause any hourly or annual permitted emission rate of any existing emissions unit to be exceeded;

provided that the facility provides the EPA and the DEQ with written notification as required below in advance of the proposed changes, which shall be a minimum of 7 days, or 24 hours for emergencies as defined in OAC 252:100-8-6 (e). The permittee, the DEQ, and the EPA shall attach each such notice to their copy of the permit. For each such change, the written notification required above shall include a brief description of the change within the permitted facility, the date on which the change will occur, any change in emissions, and any permit term or condition that is no longer applicable as a result of the change. The permit shield provided by this permit does not apply to any change made pursuant to this subsection.[OAC 252:100-8-6 (f)(2)]

SECTION XIX. OTHER APPLICABLE & STATE-ONLY REQUIREMENTS

A. The following applicable requirements and state-only requirements apply to the facility unless elsewhere covered by a more restrictive requirement:

(1) No person shall cause or permit the discharge of emissions such that National Ambient Air Quality Standards (NAAQS) are exceeded on land outside the permitted facility. [OAC 252:100-3]
(2) Open burning of refuse and other combustible material is prohibited except as authorized in the specific examples and under the conditions listed in the Open Burning Subchapter. [OAC 252:100-13]
(3) No particulate emissions from any fuel-burning equipment with a rated heat input of 10 MMBTUH or less shall exceed 0.6 lb/MMBTU. [OAC 252:100-19]
(4) For all emissions units not subject to an opacity limit promulgated under 40 CFR, Part 60, NSPS, no discharge of greater than 20% opacity is allowed except for short-term occurrences which consist of not more than one six-minute period in any consecutive 60

minutes, not to exceed three such periods in any consecutive 24 hours. In no case shall the average of any six-minute period exceed 60% opacity. [OAC 252:100-25]

(5) No visible fugitive dust emissions shall be discharged beyond the property line on which the emissions originate in such a manner as to damage or to interfere with the use of adjacent properties, or cause air quality standards to be exceeded, or interfere with the maintenance of air quality standards. [OAC 252:100-29]

(6) No sulfur oxide emissions from new gas-fired fuel-burning equipment shall exceed 0.2 lb/MMBTU. No existing source shall exceed the listed ambient air standards for sulfur dioxide. [OAC 252:100-31]

(7) Volatile Organic Compound (VOC) storage tanks built after December28, 1974, and with a capacity of 400 gallons or more storing a liquid with a vapor pressure of 1.5 psia or greater under actual conditions shall be equipped with a permanent submerged fill pipe or with a vapor-recovery system. [OAC 252:100-37-15(b)]

(8) All fuel-burning equipment shall at all times be properly operated and maintained in a manner that will minimize emissions of VOCs. [OAC 252:100-37-36]

SECTION XX. STRATOSPHERIC OZONE PROTECTION

A. The permittee shall comply with the following standards for production and consumption of ozone-depleting substances. [40 CFR 82, Subpart A]

1. Persons producing, importing, or placing an order for production or importation of certain class I and class II substances, HCFC-22, or HCFC-141b shall be subject to the requirements of §82.4.
2. Producers, importers, exporters, purchasers, and persons who transform or destroy certain class I and class II substances, HCFC-22, or HCFC-141b are subject to the recordkeeping requirements at §82.13.
3. Class I substances (listed at Appendix A to Subpart A) include certain CFCs, Halons, HBFCs, carbon tetrachloride, trichloroethane (methyl chloroform), and bromomethane (Methyl Bromide). Class II substances (listed at Appendix B to Subpart A) include HCFCs.

B. If the permittee performs a service on motor (fleet) vehicles when this service involves an ozone-depleting substance refrigerant (or regulated substitute substance) in the motor vehicle air conditioner (MVAC), the permittee is subject to all applicable requirements. Note: The term “motor vehicle” as used in Subpart B does not include a vehicle in which final assembly of the vehicle has not been completed. The term “MVAC” as used in Subpart B does not include the air-tight sealed refrigeration system used as refrigerated cargo, or the system used on passenger buses using HCFC-22 refrigerant. [40 CFR 82, Subpart B]

C. The permittee shall comply with the following standards for recycling and emissions reduction except as provided for MVACs in Subpart B. [40 CFR 82, Subpart F]

(1) Persons opening appliances for maintenance, service, repair, or disposal must comply with the required practices pursuant to § 82.156.

(2) Equipment used during the maintenance, service, repair, or disposal of appliances must

comply with the standards for recycling and recovery equipment pursuant to § 82.158.

(3) Persons performing maintenance, service, repair, or disposal of appliances must be certified by an approved technician certification program pursuant to § 82.161.

(4) Persons disposing of small appliances, MVACs, and MVAC-like appliances must comply with record-keeping requirements pursuant to § 82.166.

(5) Persons owning commercial or industrial process refrigeration equipment must comply with leak repair requirements pursuant to § 82.158.

(6) Owners/operators of appliances normally containing 50 or more pounds of refrigerant must keep records of refrigerant purchased and added to such appliances pursuant to § 82.166.

SECTION XXI. TITLE V APPROVAL LANGUAGE

A. DEQ wishes to reduce the time and work associated with permit review and, wherever it is not inconsistent with Federal requirements, to provide for incorporation of requirements established through construction permitting into the Sources' Title V permit without causing redundant review. Requirements from construction permits may be incorporated into the Title V permit through the administrative amendment process set forth in Oklahoma Administrative Code 252:100-8-7.2(a) only if the following procedures are followed:

(1) The construction permit goes out for a 30-day public notice and comment using the procedures set forth in 40 Code of Federal Regulations (CFR) § 70.7 (h)(1). This public notice shall include notice to the public that this permit is subject to Environmental Protection Agency (EPA) review, EPA objection, and petition to EPA, as provided by 40 CFR § 70.8; that the requirements of the construction permit will be incorporated into the Title V permit through the administrative amendment process; that the public will not receive another opportunity to provide comments when the requirements are incorporated into the Title V permit; and that EPA review, EPA objection, and petitions to EPA will not be available to the public when requirements from the construction permit are incorporated into the Title V permit.

(2) A copy of the construction permit application is sent to EPA, as provided by 40 CFR § 70.8(a)(1).

(3) A copy of the draft construction permit is sent to any affected State, as provided by 40 CFR § 70.8(b).

(4) A copy of the proposed construction permit is sent to EPA for a 45-day review period as provided by 40 CFR § 70.8(a) and (c).

(5) The DEQ complies with 40 CFR § 70.8 (c) upon the written receipt within the 45-day comment period of any EPA objection to the construction permit. The DEQ shall not issue the permit until EPA's objections are resolved to the satisfaction of EPA.

(6) The DEQ complies with 40 CFR § 70.8 (d).

(7) A copy of the final construction permit is sent to EPA as provided by 40 CFR § 70.8 (a).

(8) The DEQ shall not issue the proposed construction permit until any affected State and EPA have had an opportunity to review the proposed permit, as provided by these permit conditions.

(9) Any requirements of the construction permit may be reopened for cause after incorporation into the Title V permit by the administrative amendment process, by DEQ as

provided in OAC 252:100-8-7.3 (a), (b), and (c), and by EPA as provided in 40 CFR § 70.7 (f) and (g).

(10) The DEQ shall not issue the administrative permit amendment if performance tests fail to demonstrate that the source is operating in substantial compliance with all permit requirements.

B. To the extent that these conditions are not followed, the Title V permit must go through the Title V review process.

SECTION XXII. CREDIBLE EVIDENCE

For the purpose of submitting compliance certifications or establishing whether or not a person has violated or is in violation of any provision of the Oklahoma implementation plan, nothing shall preclude the use, including the exclusive use, of any credible evidence or information, relevant to whether a source would have been in compliance with applicable requirements if the appropriate performance or compliance test or procedure had been performed.

[OAC 252:100-43-6]

PERMIT

AIR QUALITY DIVISION
STATE OF OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY
707 N. ROBINSON, SUITE 4100
P.O. BOX 1677
OKLAHOMA CITY, OKLAHOMA 73101-1677

Permit No. 99-104-C (M-4)

Tinker Air Force Base,

having complied with the requirements of the law, is hereby granted permission to construct/modify the Engine Test Cell sources within the boundaries of the Base, in Midwest City, Oklahoma County, Oklahoma,

subject to the Standard Conditions dated December 6, 2006, and Specific Conditions, both attached.

This permit shall expire 18 months from the date of issuance below, except as Authorized under Section VIII of the Standard Conditions.

Director, Air Quality Division **Date**