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Air Emissions Pollution Prevention Special Report

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This report serves as a guidance document for the reduction of stationary source air emissions and minimization of regulatory burdon associated with the Clean Air Act Ammendments of 1990 at U.S. Air Force Installations. The report provides recommended methodologies for reducing both actual and potential emissions and identifies common emission calculation errors that may increase the degree to which an installation is regulated. The report summarizes major air-based pollution prevention opportunities identified during two years of site support visits covering 1998 and 1999. The report contains recommendations for six specific source categories associated with Air Force operations. The six categories include aerospace ground support equipment, boilers, emergency generators, fuel storage/dispensing operations, solvents, and surface coating operations. Also, budgeting (A-106) inputs associated with air emission recommendations are included.

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EXECUTIVE SUMMARY

As pollution prevention (P2) progresses toward comprehensive application in the workplace, opportunities for applying P2 have become more challenging. As such, innovative approaches are necessary to meet the requirements of increasingly stringent air quality regulations. One approach coming to the forefront is air emissions pollution prevention efforts.

The Institute for Environment, Safety, and Occupational Health Risk Analysis (IERA) performed Air-Based Pollution Prevention evaluations at thirty United States Air Force Air Combat Command (ACC), Air Mobility Command (AMC), and Air Force Space Command (AFSPC) installations in FY 98 and FY 99. A compilation of common lessons learned and reduction opportunities identified during these surveys is included here for reference.

The surveys' objectives were to: 1) evaluate existing operations that emit criteria and hazardous air pollutants and identify pollution prevention opportunities; 2) evaluate future plans to ensure that air pollution from new sources is minimized; and 3) provide the Air Quality Manager (AQM) with tools to stay current on developing Air Force and DoD policy and opportunities. Additionally, each installation's most current air emission inventory, which includes both actual and potential emissions, was scrutinized for technical accuracy, confidence in calculation methodology, and assumptions.

This report summarizes the major air-based pollution prevention opportunities we identified over the past two years. We believe the suggested alternatives should prove helpful in prioritizing long term environmental planning, programming, and budgeting needs, ensuring compliance with the Clean Air Act, and building healthy Air Force communities through improved air quality.

SECTION 1.0

SUMMARY OF AIR EMISSIONS/ CALCULATION IMPROVEMENTS

1.1 GENERAL

This portion is a summary of methods that may be used to improve the accuracy of calculating actual and potential to emit (PTE) calculations within the air emissions inventory (AEI). This is done in two ways: 1) Review major source category calculations for accuracy, assumptions, and methodology; and 2) Update calculations or quantify, where possible, the elimination or addition of major emitting processes, new mission requirements, or similar impacts.

A source's potential to emit (PTE) is an essential part of an air emissions inventory. Potential emissions are used to categorize a source as either "major" or "minor" for criteria air pollutants and either "major" or "area" for hazardous air pollutants. Compliance costs vary greatly depending on the source's regulatory status. Under Titles III and V of the 1990 Clean Air Act Amendments, complex and lengthy requirements were established for facilities classified as a "major source," as defined under 40 CFR 63 and 70, respectively. Both Title III and V could conceivably have tremendous economic and operational impacts at U.S. Air Force (USAF) installations. Avoiding major source status can save a facility millions of dollars in manpower costs, equipment modifications, and fees. However, all too often inventories contain overly conservative (and sometimes unrealistic) calculation methods, which result in greatly inflated PTEs and an incorrect classification of the facility as a major source of emissions. This section provides recommended methods for calculating PTE from typical Air Force processes, in a manner that is both realistic and reasonably conservative.

The EPA's definition for potential emissions according to 40 CFR 70.2 is: "*the maximum capacity of a stationary source to emit any air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of a source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation is enforceable by the administration.*" For many emission sources, however, this definition does not lend itself to a clear PTE calculation method. As a result, many sources currently interpret the PTE definition to mean 24 hour a day operation, 365 days a year (or 8,760 hrs/yr). For most of these sources, this is an invalid assumption and results in an overestimation of potential emissions.

To help eliminate some of the confusion associated with PTE, the EPA has addressed the quantification of potential emissions from a few source types. For example, in the case of emergency generators they issued a 6 September 1995 policy memorandum on acceptable limits. More recently, on 14 April 1998, EPA published a policy memorandum which provides PTE guidance on eight different source categories, seven of which may be found at Air Force installations (i.e., gasoline service stations; gasoline bulk plants; boilers; coating sources; printing, publishing, and packaging operations; degreasers using volatile organic solvents; hot mix asphalt plants). Unfortunately, no specific PTE guidance has been issued at this time for any of the other types of sources typically found at Air Force installations.

With few exceptions, most emission sources on an Air Force base are related to maintenance activities and are not proportional to hours of shop operations. Technicians perform the required maintenance for each piece of equipment according to highly regulated and standardized procedures. Technical Orders (TOs) dictate the maintenance procedures for each piece of equipment along designated timelines. Therefore a maintenance shop's workload, and consequently the level of emissions, is determined by the number of items to be maintained and the type of maintenance required and not the number of shop hours. Using this approach, PTE calculation methodologies have been developed for those maintenance processes supporting flightline operations and those supporting the base infrastructure. Some sources are included in both flightline and infrastructure maintenance categories since processes may often overlap. For instance a base may have surface coating operations involving aircraft, vehicles, and buildings. PTE methodologies for flightline maintenance should be used for the surface coating operations done on aircraft, whereas infrastructure maintenance PTE methodologies should be used for vehicle and building surface coating. A few processes on a typical Air Force base (e.g., external combustion sources, gasoline service stations, incinerators, etc.) are not directly related to maintenance activities. Consequently, different PTE methodologies have been developed for these non-maintenance sources.

In addition to employing more realistic calculation methodologies, many sources have been successful in reducing their PTEs by taking enforceable limits on their processes. Limits to potential emissions vary depending on the source. The common criteria for an approved limit are defined by the EPA as "sufficient quality and quantity to ensure accountability." Thus a limit is a definable condition/criteria which a user can record and a regulator can enforce. Some examples of PTE limits include the following:

- Restricting paint usage in surface coating operations (e.g., the limit identifies the maximum gallons of paint that can be used in a paint booth per week or month)
- Restricting the quantity of refuse burned in an incinerator (e.g., the limit identifies a specific maximum weight of refuse that can be burned in an incinerator per month or year)
- Restricting the time an electrical generator can operate (e.g., the limit identifies the maximum hours the generator can operate per month or year)

It's important to remember that all PTE limitations must be federally-enforceable. Federal enforceability ensures the conditions placed to limit a source's potential to emit are enforceable by EPA and citizens as a legal and practical matter. Federal enforceability also provides source owners with assurances that limitations they have obtained from a State or local agency will be recognized by the EPA. In general, federally-enforceable limitations can be established through one of the following programs. [Note - a summary of each of these programs can be found in EPA's 25 January 1995 policy memorandum titled "Options for Limiting the Potential to Emit (PTE) of a Stationary Source Under Section 112 and Title V of the Clean Air Act (Act)"]:

- Title V permits
- Federally enforceable state operating permits (FESOPs)
- Construction permits and General permits
- Limitations established by rules

On 10 July 1998 the EPA published a memorandum titled "Second Extension of January 25, 1995 Potential to Emit Transition Policy and Clarification of Interim Policy" in which they state they are currently engaged in a rulemaking which will further address/clarify federal enforceability issues.

The PTE calculation methods discussed in this section have been developed through detailed analysis of the processes found at Air Force installations and through negotiations with Federal, State, and local regulatory compliance officials. Further, these PTE methods have been used successfully at many installations. Every attempt has been made to quantify realistic potential emissions in a manner consistent with the EPA definition. When using these PTE methodologies it is important to consider the installation's unique situation as well as the requirements of the State or local regulatory agency. Generally, regulatory officials welcome suggestions on how to calculate PTE in a manner other than simply increasing hours of operation to 8,760 hrs/yr. Accordingly, each facility would do well to actively pursue negotiations with their State and local regulators on alternative PTE calculation methods. The PTE methodologies presented here can be used as a starting point for such negotiations.

Potential to Emit (PTE) - - Often, PTE is overestimated by assuming emissions will increase if maintenance shop hours increase to 8,760 hrs/yr (24 hours a day, 7 days a week) as a worst case. A more realistic method for calculating PTE for flightline maintenance activities ties potential emissions to the operational capacity of the base. The ratio of potential operational capacity to actual operations can be used to determine PTE for flightline maintenance activities. To estimate the base's potential operational capacity, a comparison can be made of the actual versus potential flight operations. To determine potential emissions in this manner, it is necessary to compare the actual number of aircraft assigned to the base to the potential number of aircraft that may be assigned to the base without changes in infrastructure. The Director of Operations should have a record of the number of aircraft on the installation and should be able to determine the maximum number of aircraft the installation can support/maintain without changes in infrastructure. The ratio of potential to actual flight operations can then be used as the scaling factor for flightline maintenance sources on the base when determining PTE. As an example, let's assume Base X has a wing with ten KC-135's. The Director of Operations reports that the current infrastructure can support an additional ten aircraft of like type. Therefore, the ratio of potential operational capacity to actual operations in this example is two. This ratio of two can be used as the scaling factor to calculate potential emissions from actual emissions. In this example, potential emissions would be calculated as double actual emissions for flightline maintenance activities. As a final check, however, the PTE calculated from this scaling factor must be compared to the operational capacity of each process. This is to ensure that the PTE does not exceed the operational capacity of any one process. Some sources may already be operating at or near peak capacity. One Air Force base is known to operate their paint spray booth around the clock, five days per week. As such, the scaling factor of two would have to be reduced for this source.

A commonly seen approach - assuming 5% growth per year - is not an accurate representation of changing air emissions for the future. A more accurate method to anticipate future impact on air emissions is assessing proposed mission changes, major operations additions/subtractions, and analysis of past air emissions trends. Given the broadening emphasis on P2 it is feasible air emissions may decrease. A discussion of an alternative methodology for calculating PTE more accurately for Air Force operations is presented below.

The AEI should always be considered a stand-alone document and should always include both actual and PTE for all source categories not exempted from State or Federal permitting requirements. Never discontinue the inclusion of PTEs because a Title V permit is no longer required. It may be necessary to use PTE information in future assessments to prove the installation is operating within current compliance guidelines. Also, sample calculations and methodologies should be included within the body of the AEI and not maintained as a separate document. This simplifies auditing if necessary. Sole use of software, such as AQUIS or I-STEPS, is not recommended because it does not provide a reliable audit trail for calculation verification.

SPECIFIC SOURCE PTE RECOMMENDATIONS

1.2 AEROSPACE GROUND SUPPORT EQUIPMENT (AGSE)

AGSE may be treated as a mobile source in some states. Emissions resulting from mobile sources do not contribute to criteria and HAP major source determinations.

1.3 AIRCRAFT ENGINE TEST FACILITY

Our office is in the process of compiling JP-8 emission factors from a recent comprehensive jet engine testing project. Emissions factors have been calculated for TF39-GE-1C engines (C-5), Factors are provided for both criteria and HAPs. Should you have any questions on this topic, Mr. Mark Wade, DSN 240-4858, is the project manager for this research.

1.4 BOILERS

A realistic PTE operational time should be coordinated with the appropriate CES function and become the basis for determining air emissions. PTEs determined by assuming boilers operate for 8,760 hours per year are conservative. Further, a review of the actual usage for each boiler may reveal significantly altered operation time estimates and affect emission data. A better method would be to directly record the amount of fuel used in the boilers. We encourage discussion with responsible Civil Engineering (CES) parties on techniques for tracking boiler fuel consumption throughout the year. Diligent inventory management will allow for adjustments in reported air emissions based upon the addition or removal of a boiler. The review of the actual usage for each boiler may reveal significantly altered operation time estimates and affect emission data.

Another approach using enforceable limits is to identify low use/backup boilers and attempt to classify them similar to emergency generators, which can utilize a low, 500 hour/year, operation time when calculating PTE s. Dual-fueled boilers also benefit from this approach since a realistic limit can be determined and serve as the basis for the calculated air emissions.

As boilers are upgraded/replaced they should be replaced with as clean burning a fuel as possible. For example, converting from back-up fuel-oil grade #6 (2% sulfur content) to fuel-oil grade #2 (0.5% sulfur content) will reduce SOx by 99.8%.

1.5 DRY CLEANERS

The Army & Air Force Exchange Service (AAFES) operates a retail dry cleaning business on many installations. Potential emissions from this source are based on the potential demand for dry cleaning services. Since most dry cleaning customers are military personnel (or their dependents), the maximum number of military personnel that may be assigned to the base can be used to determine the potential demand for dry cleaning services. The Personnel Employment Section of each base's Military Personnel Flight (MPF) maintains a listing of both the total current number of military personnel assigned and the maximum number authorized. The maximum number of personnel authorized for assignment to the base should not change significantly with an increase in the number of aircraft assigned to the base. Therefore, the ratio of the maximum number of military personnel authorized for the base to the number of personnel currently assigned can be used as the scaling factor in determining PTE. This ratio is multiplied by the actual emissions to get potential emissions.

1.6 EMERGENCY GENERATORS

The prime mover (typically gas turbine or reciprocating engine) is the actual source of the air emissions, not the generator, and should be the basis for determining the emissions. And all portable generators should be excluded from the inventory because they are not considered stationary sources.

Air Force Instruction 32-1063, "Electrical Power Systems," 31 Mar 94, does not specifically require the maintainers of emergency generators to keep records of prime mover horsepower. The prime mover horsepower is usually larger than the generator output. This information is provided with the generator system when purchased and should be filed for future reference. For those generators not having the original operator manuals or brochures, the manufacturer may be contacted for this information. This practice is recommended for improved accuracy in air emission data.

The manufacturer should be contacted to determine source test data for the generators. The source test data can be used instead of AP-42 emissions factors which are typically more conservative.

Another method that could be used for calculating emergency generator emissions when the installation does not track generator fuel usage is as follows:

1. Convert rated kilowatt (kW) output to horsepower (hp).
2. Utilize emission factors in AP-42, Supplement B, section 3.4, (in units of lb/hp*hr).
3. Multiply (1) by (2) to obtain emissions (lb/hr).

1.7 ETHYLENNE OXIDE STERLIZERS

The potential to emit for ethylene oxide sterilizers is based on the potential number of patients and procedures that would require sterilized medical equipment. The maximum number of military personnel that may be assigned to the base will determine the potential number of patients. The Personnel Employment Section of each base's CBPO maintains a listing showing both the total current number of military personnel assigned and the maximum number authorized. The maximum number of personnel authorized for assignment to the base should not change significantly with an increase in the number of aircraft assigned to the base. Therefore, the ratio of the maximum number of military personnel authorized for the base to the number of personnel currently assigned can be used as the scaling factor in determining PTE. This ratio is multiplied by the actual emissions to get potential emissions.

1.8 FUEL DISPENSING

Liquid phase speciation is often used to calculate the HAP content for fuel dispensing. Vapor phase speciation more accurately estimates the emissions from fuel dispensing. Define VPS It is appropriate to use liquid phase speciation to calculate the emissions from fuel spillage but vapor phase speciation should be used for tank filling emissions (See Section 1.15 on Fuel Storage). IERA/RSEQ can provide an air emission inventory guidance document containing calculation methodology, following EPA guidelines, which will allow for a reduction of emissions to more accurate levels. Also, potential emissions may be overestimated for this source. The PTE is often based on the hours of operation being scaled up to 3 shifts per day. This is an invalid assumption since the amount of fuel dispensed is more closely tied to the number of personnel assigned to the base than the hours of operation. A discussion of this can be found in the Section 1.1.

1.9 HAZARDOUS MATERIALS PHARMACY (HAZMART)

It is important to mention the HAZMART since historically the base Supply M-15 report was used to determine chemical usage data. In addition to the M-15 report, the HAZMART now has the Air Force Environmental Management Information System (AF EMIS). As opposed to the supply M-15 report, AF EMIS is able to record chemical constituents and should provide more accurate information from which to base emissions estimates, it is capable to provide the most accurate chemical usage data. Also, the difference between the licensed amount and the actual draw amount recorded in the system is important. Often, shops obtain chemical licenses for quantities they never actually use. AF EMIS will report both the licensed (authorized) and the actual draw amount. The actual draw amount is the quantity that should be used to calculate emissions.

It should be noted that reliance on the Hazardous Material Information System (HMIS) for data-collection based upon a product's material safety data sheet (MSDS) is not recommended. HMIS may not contain the most recent version of a given product formulation and result in the application of incorrect chemicals or chemical percentages being used in various calculations. Further, Title 29 CFR Part 1200, "Hazard Communication," does not require manufacturers to list any hazardous ingredient present in a products formulation if present at concentrations of less than 1% by weight (0.1% for carcinogens). These unlisted ingredients could be a significant contributor to the installation's overall air emissions.

1.10 HEAVY CONSTRUCTION OPERATIONS

Heavy construction operations involve the construction/demolition of buildings and/or roads. These operations can be expected to occur during the year at virtually all Air Force installations. The potential emissions of this source category are based on the maximum amount of demolition, site preparation, and general construction required at the installation. The base's Civil Engineering planners should have a five-year plan for construction projects. As the process owners, they should be able to give a fairly accurate estimate of the maximum potential construction operations in the near future (i.e., in the next 5 years). The ratio of potential to actual construction projects would be multiplied by the actual emissions to get potential emissions.

1.11 INCINERATORS

Two types of incinerators are typically found on Air Force installations; medical (hospital) waste incinerators and classified waste incinerators. Many incinerators are permitted by State or local regulatory agencies. These permits may have prescribed burn limitations. If so, the limits specified in the permit should be used to calculate PTE. If a limit does not exist, potential emissions must be calculated by determining the maximum operational potential for the incinerator. A conservative maximum operational potential of an incinerator is peak capacity (maximum loading) for 85% of the year. This is to take into account down time required for maintenance and inspection. For continuous feed incinerators, the design allows for loading and unloading in a safe manner so that the incinerator can be run continuously, except for down time required for maintenance and inspection. Therefore, the maximum loading rate of the incinerator (in pounds per hour) is multiplied by 8,760 hours and then by 0.85 to obtain the potential amount of waste which can be burned. For batch incinerators, the capacity for the incinerator should be determined per charge cycle. A charge-cycle may include time periods for loading the incinerator, preheating, safety procedures, burning, cooling, and removal of waste. Typically a cycle may last an entire day. Potential emissions should then be based on the number of cycles run in 85% of the total number of hours in a year. For example, if each cycle is 24 hours then there would be 310 cycles per year (0.85 * 365 days/yr). Assuming the maximum amount of waste burned per batch is 100 pounds, the potential amount of waste burned is 31,000 pounds.

1.12 OPEN BURNING ACTIVITIES

This source accounts for the burning at the fire training facility. The emissions from the fire training facility may be considered fugitive. Federal EPA defines fugitive emissions as those emissions that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening. Based on this definition, we believe fire training emissions may be considered fugitive. As such, emissions of criteria pollutants from this source would not need to be included in the AEI. Emissions of HAPs, however, would still need to be included since Title III of the Clean Air Act requires the consideration of fugitive emissions.

Potential emissions for Fire Fighter Training are based on the potential amount of fuel burned during fire training for the year. The potential amount of fuel burned during any given year depends on the potential number of fire fighters trained at the facility and the type of training conducted. The potential number of fire fighters will depend on the fire training policy at each base. Some bases restrict the use of the fire training facility to in-house staff, while others open the facility to off-base agencies.

For those bases that restrict the use of the fire training facility to in-house staff, the potential number of firefighters which may be assigned to the base will determine the amount of training required, the potential amount of fuel burned, and the potential emissions. The Personnel Employments Section of each base's CBPO maintains a listing of both the total current number of personnel assigned and the maximum number authorized for each job classification. The maximum number of personnel authorized for assignment to the base will not change significantly with an increase in the number of aircraft assigned to the base. Therefore, the ratio of the maximum number of firefighters authorized for the base to the number of firefighters currently assigned can be used as the scaling factor in determining PTE. This ratio is multiplied by the actual emissions to get potential emissions.

For those bases that allow off-base agencies to use the fire training facility, a worst case prediction can be determined by communicating with the fire chief on potential increases in the quantity of training. A training plan may be available showing a projected training schedule to allow for coordination between off-base and on-base groups. Usually, a five-year projection is considered adequate. The projected increase in fire training will serve as the scaling factor for this source when determining PTE.

Air Force bases do not typically burn or detonate large quantities of munitions. PTE is determined by identifying the largest quantity of munitions projected to be burned and detonated. A worst case prediction can be determined by contacting the Explosive Ordinance Disposal (EOD) shop to determine the quantity of munitions to be disposed. Often a disposal plan is available which will specify the quantity of munitions targeted for disposal in the upcoming years. Usually, a five-year projection is considered adequate. The projected increase in munitions disposal will serve as the scaling factor for this source when determining PTE.

1.13 SMALL ARMS FIRING RANGE

Potential emissions from small arms firing will be based on the potential number of people requiring training, which in turn is based on the potential number of people who are on mobility and/or who are security police.

Each base Readiness Office will have a listing of the number of people currently assigned to mobility status and should be able to give a prediction of the potential number of personnel which could be assigned to mobility status. Also, the Personnel Employments Section of CBPO maintains a listing of both the total present number of security police assigned and the maximum number authorized. Since security police personnel may also be on mobility status, subtract the security police from the mobility listing to avoid double counting. Next, add the number of people on the mobility listing to the number of security police to obtain the total number of people requiring training. The maximum number of personnel authorized for assignment to the base will not change significantly with an increase in the number of aircraft assigned to the base. Therefore, the ratio of the maximum potential number of people requiring training to the actual number of people currently being trained can be used as the scaling factor in determining PTE for this source. This ratio is multiplied by the actual emissions to get potential emissions.

1.14 SOLVENT TANKS

Many AEI's use emission factors to calculate emissions from solvent tanks; however, this is not always a good approach because emission factors are usually very conservative. A preferred method is to use a mass balance; the following mass balance approach is based on guidance published by the Emission Inventory Improvement Program (EIIP), Air Sources Committee. This program is a joint initiative by EPA and regional/state agencies. The basic approach follows:

Annual Emissions = Annual amount of solvent used – Annual amount of solvent removed for disposal, reclamation or recycling.

It is important to note the annual amount of solvent added to a dip tank does not necessarily equate to the amount of solvent used. For example, 30 gallons of solvent could have been added during the year to a given solvent dip tank. However, to determine the actual amount of solvent used (or lost as air emissions), the amount of solvent disposed, reclaimed, or recycled would have to be subtracted from the amount added. The difference would be the amount lost to air emissions.

Also, differences in the definition of a VOC can provide some emissions savings with solvents. The CAA in 40 CFR 51.100 defines a VOC and provides exempt substances. Should a solvent constituent not meet the definition of VOC or be specifically exempted, it does not contribute toward VOC emissions calculations. Example:

- According to the MSDS, Solvent X is composed of the following ingredients and corresponding weight percents:

  Petroleum Naphtha 37%
  Ethyl Acetate 25%
  Methyl Ethyl Ketone 20%
  Acetone 10%
  Isopropyl Alcohol 8%

The manufacturer may list the VOC content to be 100%; however, their definition does not reflect that in the CAA. You can calculate the weight percent CAA regulated VOC based on the ingredients. A review of the ingredients reveals that they all meet the definition of VOC except acetone which is specifically listed in 40 CFR 51.100 as being exempt from the definition of VOC due to negligible photochemical reactivity. Since Solvent X contains 10% acetone by weight, the weight percent VOC in Solvent X can be assumed to be 90%.

1.15 STORAGE TANKS

Liquid phase speciation is often used to calculate the Hazardous Air Pollutant (HAP) content for fuel storage. However, vapor phase speciation more accurately estimates the emissions from storage tanks. IERA/RSEQ can provide an air emission inventory guidance document containing calculation methodology, following EPA guidelines, which will allow for a reduction of emissions to more accurate levels. Further, the PTE for this source is often based on the maximum flow rate of the pumps. The result is an overestimation of potential emissions. The potential fuel usage can be determined by comparing current operations to the operational capacity of the base. The ratio of current operations to the operational capacity can be determined readily, as discussed in the Section 1.1.

1.16 SURFACE COATINGS

Many AEI's calculate emissions using an average VOC content that may be significantly higher than the paints actually used. It is important to ensure the actual VOC content of the paints are known, especially since many bases are switching to low VOC paints. The hazardous materials pharmacy should be consulted in gathering information, especially the Air Force Environmental Management Information System (AF-EMIS).

Also, the PTE for surface coating based on shop operating hours extending to 8760hr/yr is to conservative. A more accurate method would be to base the PTE on the number of items painted. The reason for this is that painting is a maintenance requirement based on the number of hours of flight operation, or as required. The painters can only paint a given number of aircraft or other equipment based on physical limitations and maintenance requirements, regardless of the number of hours the paint booth is operated. Therefore, the PTE should be calculated by determining the limiting factor, such as the maximum number of aircraft or other equipment which could possibly be painted and the number of gallons of paint needed to paint a given aircraft. See the General PTE Comment in Section 1.1.

Use an accurate transfer efficiency (TE) for particulate and inorganic air emission calculations. TE is the percentage of inorganic HAPs and particulate matter transferred to the surface to be painted by a particular type of paint spray gun. Common TE values range from 50 to 80% and the paint spray gun manufacturer can provide appropriate transfer efficiencies.

Bases have had success in reducing their potential paint booth emissions by following this methodology. Furthermore, a great reduction in potential emissions could also be realized by establishing a Federally Enforceable Limit on the quantity of paint that can be applied. The painters should be able to establish a gallon limit that they can not exceed, thereby reducing the PTE. Additional guidance regarding AEI estimations is under development by IERA/RSEQ and will be available in the near future. Technical questions may be directed to Mr. Bob O'Brien, IERA/RSEQ, DSN 240-4973.

The use of filters will have an impact on particulate and inorganic HAP emissions. The degree of emission reduction will be dependent upon several parameters, including activity level within the facility, paint application equipment and techniques, and the efficiency of the control mechanisms (ventilation system, filtration system). We suggest quantifying the air emissions by considering the following variables:

- Manufacturer's removal efficiency test results for particulates and inorganic HAPs at various aerodynamic diameters (will vary by filter type).
- Operational load for painting facility (the amount of painting and de-painting taking place).
- Particulate size distribution generated (depends largely on the atomization of spray equipment and scraping/sanding mechanism).

Required emission efficiencies specified in 40 CFR 63.745, "Standards: Primer and topcoat application operations," range from 65% to 95% depending upon aerodynamic particle size diameter and its phase (dry or liquid). Use efficiencies of 95% for all paint booth operations. This is a valid estimate if the manufacturer has test data that validates this efficiency for controlling particulate and inorganic HAP emissions.

Impact: The filtration efficiency requirement for aerodynamic particulates (greater than 2 micron (> 2 *u*m) in diameter) is greater than 95% and is applicable to the bulk of particulates generated by surface coating operations. Consultation with the filter manufacturer prior to determining filtration efficiency is recommended for accurate control values.

1.17 WASTEWATER TREATMENT PLANT

Potential emissions from this source are dependent on the maximum potential flow rate through the wastewater treatment facility. A reasonably conservative approach is to base the maximum potential flow rate on the maximum observed daily rate during the previous year. The process owners should select the highest daily flow rate which represents the current process. For instance, if the base population was recently cut in half, a maximum daily flow rate should be selected from the period after the changes occurred. Also keep in mind that daily flow rates observed more than twelve months previous may not be representative of the current process. Once the highest daily flowrate representing the current process is identified, it can be multiplied by 365 to yield a maximum potential flow rate for the year. The maximum potential flow rate should then be divided by the annual flow rate used in determining actual emissions. This ratio can be multiplied by the actual emissions to determine the potential emissions.

1.18 WOOD WORKING

Calculating the PM emissions from woodworking operations can be based on the efficiency of the control device and the amount of sawdust captured/collected. The following procedures are used to perform the calculations.

1. The first step is to calculate the total amount (mass) of airborne sawdust generated by the woodworking equipment by dividing the amount (mass) of sawdust collected by the efficiency of the control device. If the mass of sawdust collected is unknown, it can be estimated by multiplying the volume collected by the density of sawdust. According to Perry's Chemical Engineers' Handbook, the average density of sawdust is approximately 11.5 lb/ft^3.

$$SD_{total} = (SD_{col}) / (eff/100)$$

Where,

SD_{total} = Total amount of saw dust generated by the woodworking equipment (lb/yr)
SD_{col} = Amount of saw dust captured by the control device (lb/yr)
eff = Efficiency of control device (%)

2. The second and final step is to calculate the PM emissions (E_{PM}) by subtracting the amount of sawdust collected from the total amount of airborne sawdust generated.

$$E_{PM} = SD_{total} - SD_{col}$$

The average density of sawdust is 310.5 pounds per cubic yard (lbs/cy). The source is Perry's Chemical Engineer's Handbook, 7th edition (July 1997), McGraw Hill Text; ISBN: 0070498415.

SECTION 2.0

AIRCRAFT GROUND SUPPORT EQUIPMENT

2.1 GENERAL

AGSE are powered (No. 2 diesel fuel, JP-8 or unleaded gasoline) mobile units which provide operating power to aircraft while on the ground. Engine sizes typically vary between 5 and 300 horsepower and provide electrical power, air conditioning, engine starts, heating, hydraulics, and lighting.

2.2 EVALUATION

AGSE is considered by United States Environmental Protection Agency (USEPA) as a mobile source; and emissions resulting from these sources do not contribute to criteria and HAP major source determinations. However, AGSE is a significant source of air pollution.

2.3 OPPORTUNITY ASSESSMENTS

Combustion characteristics affecting pollutant emissions include combustion temperature, oxygen concentration, residence time (at high temperature), air/fuel mixing, burner/combustion chamber geometry, operating conditions (load and engine speed), ignition timing, and humidity. Control technologies for internal combustion engines include combustion modification (control technologies that prevent the formation of the pollutant) and flue gas treatment (control technologies that treat the exhaust gas to remove or destroy the pollutant prior to its release into the atmosphere). Any modifications to AGSE must be approved by the appropriate item manager and incorporated into the governing Technical Order prior to authorizing these modifications by field activities. Currently, fuel delivery modifications such as designing electronic controls and improving fuel injectors to deliver fuel at the best combination of injection pressure, injection timing, and spray location are being evaluated by various USAF activities. Of these modifications, fuel injector modification on the A/M32A-86, which contributes up to 85% of the NOx emissions from AGSE appears to be the most promising. This approach costs approximately $250.00 for a remanufactured fuel injector and is capable of reducing NOx emissions by up to 80%. Governing technical orders will be changed to reflect the fuel injector modification procedure.

2.4 BEST MANAGEMENT PRACTICES

Avoid spilling fuel or allowing evaporation. Preventing spills and over-fills is an easy and effective way for power equipment operators to prevent pollution. Take precautions against spillage when fueling power equipment.

- Use a fuel container size you can handle easily and hold securely so you can pour slowly and smoothly while filling the equipment fuel tank.
- Use a spout or funnel when pouring fuel into the equipment and avoid overfilling or allowing fuel to run over.

- Close the cap or spout and vent hole on the fuel container tightly after filling the fuel tank and after filling the container at the gas pump. Also remember to recap the fuel tank on the equipment.

Maintain equipment. Properly maintained equipment is not only less likely to pollute, but will perform better and last longer. Proper maintenance will become even more important in the future as cleaner engines are developed for power equipment.

- Change oil as indicated in the owner's manual.
- Regularly clean or replace air filters and get periodic tune-ups.

Other practices.

- Minimize actual operating hours if possible.
- Accurately log hours by operating capacity.

2.5 REFERENCES

"Effects of Oxygen Enrichment on NOx Emissions From an Aerospace Ground Equipment 86 Generator," Rothe Development, Incorporated, June 1996;

"Aftertreatment Control Technology for Heavy-Duty Diesels," Southwest Research Institute, October 1992;

"Diesel NOx Catalytic Converter Development: A Review," Southwest Research Institute, July 1996; and

"Emission Control Technology for Stationary Internal Combustion Engines," Manufacturers of Emission Controls Association, October 1995.

SECTION 3.0

BOILERS

3.1 GENERAL

Boilers or external combustion sources include boilers, furnaces, and heaters used for power production and/or heating purposes. Most smaller external combustion units are located at individual buildings on base (e.g., in building mechanical rooms), while larger boilers are usually located at the base heat (or heat/power) plant. As with any combustion source, emissions from external combustion units include the criteria pollutants and a variety of HAPs (both organic and inorganic). The emissions from external combustion units depend on a variety of factors including the type/size of the combustor, firing configuration, fuel type, control devices used, operating capacity, and whether the system is properly operated/maintained. In regards to size, boilers are categorized according to their heat-input capacities. The following size categories are typically used:

Utility Boilers	>100 MMBtu/hr
Industrial Boilers	10 to 100 MMBtu/hr
Commercial/Institutional Boilers	0.3 to < 10 MMBtu/hr
Residential Furnace	<0.3 MMBtu/hr

3.2 OPPORTUNITY ASSESSMENTS

The first pollution prevention opportunity is to expedite installation on low NOx burners at the Central Heating Plants. Secondly, the bases should reevaluate their air emission factors to address reductions as a result of conversion to natural gas and the elimination of any fuel oils. Older/poorly performing boilers/heaters should be replaced with high efficiency low NOx boilers/heaters. For units of 1 MM BTU/HR (or less), high efficiency means a 90% rating (or more), with a maximum NOx concentration in the exhaust of 10 ppm. Due to the high costs involved, this process should take place through attrition. To ensure energy efficient and low emission units are purchased, selection of replacement units should be coordinated with the AQM (see Section 3.2). The second recommendation includes converting from higher fuel-oil grades to lower grades; for example changing from fuel-oil grade #6 (2% sulfur content) to fuel-oil grade #2 (0.5% sulfur content) would reduce SOx emissions by 99.8%.

Existing larger boilers and heaters (2 million Btu/hr and greater) could be retrofitted with O_2 controllers and low NOx burner tips. However, the emission reductions obtained by these technologies on natural gas fired units would be minimal and the capital costs would be in excess of $15,000 per unit.

Reducing the operating time of boilers by lowering the heating demand on the installation will also reduce air emissions. This may be accomplished by educating building managers regarding their responsibility in assisting the Installation Energy Manager in achieving an energy efficient installation. For example:

- Radiators and heating registers in corridors, vestibules, stairwells, and lobbies may be shut off;
- Use thermostats with automatic night setback capabilities;
- Limit after-hours access to reduce heating needs; and
- Ensure existing thermostats are tamper-proof.

Refer to Engineering Technical Letter (ETL) 98-4, "Building Manager Energy Conservation Handbook," HQ AFCESA, undated, for more information.

Additional air quality guidance is being prepared by Mr. Ray Hansen, HQ AFCESA/CESE, DSN 523-6317, commercial (850) 283-6317, or INTERNET hansenr@afcesa.af.mil. He is in the process of coordinating a final draft to ETL 98-2: "Clean Air Act Amendments Requirements for Electric Generators and Power Plant," which contains information on control technologies and selection of properly sized boilers.

The reclassification of backup boilers to "emergency boilers" and administratively limiting these to 500 hours operation annually is another consideration. This option would only be applicable at those facilities with multiple boilers where one boiler is primarily used and the others are used only sparingly. This approach is new so there are few success stories or recorded failures from other DoD installations. This principle should also be applied to the use of backup fuels such as fuel oil at the central heating plant. A federally enforceable limit of fuel could be established if further emissions reductions are required. Emissions from fuel oil combustion are significantly greater than natural gas.

Bases with incinerators may eliminate or reduce their emissions by using shredders to destroy some wastes. There are shredders approved for classified and secret material. Some models include:

- Whittaker Schleicher Conveyer
  Model 1550
- Security Engineered Machinery (800) 225-9293
  Models: 22HDS, 1436, and 1012

3.3 LOW NITROGEN OXIDES (NOX) BURNERS FOR REDUCTION OF NOX EMISSIONS IN INDUSTRIAL BOILERS

Overview: Low NOx burners (LNB) reduce the formation of NOx by staging the combustion process by producing fuel rich and fuel lean zones within the flame. The fuel rich zone is the primary combustion zone and prevents the formation of thermal NOx (formation of NOx caused by high flame temperatures) as a result of low oxygen concentration. The cooler fuel lean zone prevents thermal and fuel NOx (formation of NOx resulting from the oxidation of fuel bound nitrogen). LNBs can reduce NOx emissions by as much as 60 percent.

NOx represents nitric oxide (NO) and nitrogen dioxide (NO2). It is a pollutant that causes many health problems, leads to the formation of ozone and smog, is one of the causes of acid rain (nitric acid), and reduces visibility due to the formation of aerosols. By replacing existing burners with burners designed to reduce the formation of NOx, reductions in NOx emissions of between 20 and 60 percent can be achieved. Department of Defense (DoD) installations have large numbers of small single burner water and fire tube boilers. These units range in size from 0.4 million Btu per hour (MMBtu/hr) to 250 MMBtu/hr, with the majority under 50 MMBtu/hr. Older units are generally exempt from emission control regulations.

Commercial off-the-shelf LNBs are available to control emissions produced in these boilers, however they often require extensive retrofitting and the installation of additional equipment and controls. They normally require very little additional maintenance other than more frequent tip cleaning.

Materials Compatibility: No materials compatibility issues were identified. Any change in boiler configuration or operation should be checked to ensure that no flame impingement or other adverse change in operations occurs.

Safety and Health: No significant changes in safety or health issues should result from the installation and implementation of LNBs. Consult your local industrial health specialist, your local health and safety personnel, and the appropriate material safety data sheet (MSDS) prior to implementing this technology.

Benefits:

- Effectively reduces NOx emissions to meet most Federal, state, and local NOx emissions requirements and regulations;
- Readily available from a large number of vendors;
- Effectively controls thermal NOx.

Disadvantages:

- On package water tube boilers, if the water tubes are run on all four walls, the tubes may have to be bent to allow for the installation of a LNB;
- May require a small amount of flue gas recirculation (FGR) to meet RACT (Reasonably Available Control Technology) or BACT (Best Available Control Technology); and
- Slight reduction of turn down ratio
- Retrofit of LNB requires removal of the existing burner and installation of the LNB.

Economic Analysis: The cost of retrofitting a single boiler with a LNB was estimated at $24,000 (1992 dollars). No operating or maintenance problems have been identified. Note that turndown ratios are often lessened with LNBs. It is important to realize that each boiler has its own unique operating characteristics. Boilers of the same size and same equipment may have different operating requirements and combustion properties, therefore, each boiler should be economically evaluated for LNB on an individual basis.

Economic Analysis Summary
Annual Savings for Low - NOx Burners: $00
Capital Cost for Equipment/Process: $24,000
Payback Period for Investment in Equipment/Process:
Does Not Payback

Vendors: The following is a partial list of companies supplying flue gas recirculation equipment for boilers. This list is not meant to be a complete, other suppliers of this type of equipment may be available.

Coen Company, Inc.
1510 Tanforan Ave.
Woodland, CA 95776
Phone: (916) 661-2128 Fax: (916) 668-2171
Key Contact: Mr. Wayne Wieszczyk

Tampella Power Corporation
2600 Reach Road
P.O. Box 3308
Williamsport, PA 17701-0308
Phone: (717) 326-3361 Fax: (717) 327-3121
Key Contact: Mr. Dick Sechrist

Sources: *Evaluation of Air Pollution Control Technologies for Industrial Boilers, prepared by HSC/YAL, December 1995. Steam: Its Generation and Use, The Babcock & Wilcox Company, 40th edition, 1992. Vendor information from Coen, Inc., Combustion Specialties, Inc., and Tampella Power Corporation. NOx Control Technology Data Source Book, EPA-600/2-91-029, NTIS PB91-217364. Evaluation and Costing of NOx Controls for Existing Utility Boilers, EPA-453/2-92-010.*

3.4 FLUE GAS RECIRCULATION FOR REDUCTION OF NITROGEN OXIDES (NOX) EMISSIONS IN INDUSTRIAL BOILERS

Overview: Flue gas recirculation (FGR) significantly reduces nitrogen oxides (NOx) emissions (up to 60 percent) in industrial boilers by recirculating a portion of the boiler flue gas (up to 20 percent) into the main combustion chamber. This process reduces the peak combustion temperature and lowers the percentage of oxygen in the combustion air/flue gas mixture; thus retarding the formation of NOx caused by high flame temperatures (thermal NOx).

Nitrogen oxides (NOx) emissions are a significant pervasive pollutant that causes a wide variety of diseases, contributes to ozone and smog formation, causes 20 to 30 percent of acid rain, and is the basis for visibility problems because of the formation of aerosols. Thermal NOx is produced from the oxidation of nitrogen (N2) at temperatures above 1500oF. Thermal NOx is the primary source of NOx formation from natural gas and distillate oils because these fuels are generally lower or devoid of nitrogen. Fuel NOx, on the other hand, results from oxidation of nitrogen organically bound in the fuel. Therefore, FGR is not very effective on boilers which use fuels containing large amounts of fuel bound nitrogen.

Department of Defense (DoD) installations have large numbers of single burner water tube and fire tube package boilers that supply steam and hot water to the installation. These boilers range in size from 0.4 million British thermal unit (Btu) per hour (MMBtu/hr) to 250 MMBtu/hr. The majority of these boilers are old, less than 50 MMBtu/hr, package boilers that lack any pollution control devices. This equipment is the major source of nitrogen oxide (NOx) emissions at most military installations.

To modify an existing boiler, ducting must be run from the stack to the boiler air supply fan. Space limitations can make routing new ductwork difficult and costly. More powerful fans, oxygen monitors, and air flow controllers are usually required.

Materials Compatibility: FGR can almost always be used safely and effectively with existing burner hardware. FGR works particularly well with boilers which use clean fuels (e.g., natural gas, kerosene, distillate oils). Any change in boiler configuration or peration should be checked to ensure that no flame impingement or other adverse change in operation occurs.

Safety and Health: No significant changes in safety or health issues should result from the installation and implementation of FGR. Consult your local industrial health specialist, your local health and safety personnel, and the appropriate material safety data sheet (MSDS) prior to implementing this technology.

Benefits:

- Typically costs less to implement than low NOx burners;
- In most situations, would be sufficient to satisfy state NOx RACT (Reasonably Available Control Technology) regulations or other NOx emissions requirements;
- Provides potential for emission reduction credits; and
- Provides potential for increased boiler flexibility.

Disadvantages:

- May cause space limitations for recirculation ducts, fans, and additional air ports;
- May require additional energy to run the recirculation fans;
- Oxygen concentration must remain above 17 percent; and
- Requires additional controls and instruments to control air flow over the desired operating range.

Economic Analysis: The cost attributed to retrofitting one boiler with ductwork, controls, and an uprated fan motor was $20,000 (1992 dollars).
Each boiler has its own unique operating characteristics. Boilers of the same size and same equipment may have different operating requirements and combustion properties. Each boiler should be economically evaluated for FGR on an individual basis.

The $20,000 cost included substantial effort on pre- and post-retrofit testing of NOx emissions and combustion conditions and the purchase and installation of oxygen (O2) and carbon monoxide (CO) instrumentation. Additional operation and maintenance (O&M) costs associated with the system are expected to be minimal. The dampers and the ductwork provided should present no additional operating costs and require only minimal maintenance.

Any instrumentation and controls supplied will require the usual periodic calibration and repair associated with those devices. The annual operating cost for maintenance will probably decreased because of the increased reliability of the new equipment. Implementation of a FGR system is not likely to result in an economic benefit, indeed it is typically very expensive. However, if regulations change or there is a need to obtain NOx reductions, it is among the first alternatives that should be considered as it is often cheaper than many other alternatives.

Economic Analysis Summary
Annual Savings for FGR System: possible increased fuel costs
Capital Cost for Equipment/Process: $20,000
Payback Period for Investment in
Equipment/Process:
Does not payback

Vendors: The following is a partial list of companies supplying flue gas recirculation equipment. This list is not meant to be a complete, other suppliers of this type of equipment may exist.

Gordon-Piatt Energy Group, Inc.
P.O. Box 650
Winfield, Kansas 67156-0650
Phone: (316) 221-4770
Fax: (316) 221-6289
Key Contact: Dan Christenson

Energy Technology Consultants, Inc.
A Division of Woodward-Clyde Consultants
One Northwood Plaza
7600 West Tidwell, Suite 600
Houston, Texas 77040
Phone: (713) 690-0700
Fax: (713) 744-9053
Key Contact: Steve Wood

Sources: *Bayard de Volo, Nick, Energy Technology Consultants, Inc., December 11, 1995 correspondence to John R. Guerra, Brooks Air Force Base, TX.*
Evaluation of Air Pollution Control Technologies for Industrial Boilers, prepared by HSC/YAL, December 1995.
Steam: Its Generation and Use, The Babcock & Wilcox Company, 40th edition, 1992.
NOx Control Technology Data Source Book, EPA-600/2-91-029, NTIS PB91-217364.
Evaluation and Costing of NOx Controls for Existing Utility Boilers, EPA-453/2-92-010.

SECTION 4.0

EMERGENCY GENERATORS

4.1 GENERAL

Basic emission control technologies exist for most sources of air pollution associated with internal combustion engines. However, applying the following technologies to the generators typically found on Air Force bases is probably not cost effective and would not significantly reduce base emissions. This is primarily due to the limited number of hours the generators are operated per year. Typically, one source or type of contaminant can be reduced at the expense of another. For example, timing retard will reduce oxides of nitrogen (NOx) emissions but increase particulate emissions. Further, the selected control technology must be compatible with the intended engine. The majority of generator manufacturers advise against attempting to modify an existing system to reduce air emissions. They claim the decreased operating efficiency of the engine and the cost of the selected control device or technology will offset the benefits from air emission reduction. Generator manufacturers recommend replacing the generators with more modern, clean burning designs through attrition.

However, these alternatives are included for your information and awareness on the technologies being tested and evaluated by various manufacturers. The most cost effective emissions reduction program for this source may be the replacement of aging units with EPA certified engines. EPA certified units cost approximately $1000 to $5000 more than a non-certified engine. They would reduce NOx emissions by 7 to 9 g/hp-hr on diesel fired engines. Low NOx natural gas fired units may also be an option. Low NOx natural gas fired units would lower NOx emissions by 10 to 11 g/hp-hr as compared to diesel engine emissions.

The following agencies were contacted in coming to this conclusion: Southwest Research Institute; Environmental Protection Agency; Electrical Generator Systems Association; PRO-ACT; Air Force Civil Engineer Support Agency; Mr. Dave Elliott, Small Engine Engineer, San Antonio Air Logistics Center; and several generator manufacturers.

Two basic approaches to control air pollutants associated with IC sources are:

- Combustion Modification - Control technologies that prevent the formation of the pollutant. These include fuel modifications.
- Flue Gas Treatment - Control technologies that treat the exhaust gas to remove or destroy the pollutant prior to its release into the atmosphere.

4.2 COMBUSTION MODIFICATIONS

NOx reductions are primarily achieved by retarding the spark, decreasing the inlet temperature, and increasing the A/F ratio.

Air/Fuel (A/F) Adjustment - The A/F adjustment technique inhibits NOx formation by reducing the oxygen available to combine with nitrogen. In rich-burn spark ignition (SI) engines, this can be accomplished by adjusting the A/F ratio toward fuel-rich operation. A low oxygen environment contributes to incomplete combustion, which results in lower combustion temperatures and less NOx formation. The disadvantages associated with A/F adjustment for rich-burn SI engines include incomplete combustion, which can result in increased CO and HC emissions, and decreased combustion efficiency, which, in turn, can result in an increase in the brake-specific fuel consumption (BSFC).

Ignition Timing Retard (IR) - This technique reduces NOx formation by delaying initiation of combustion until later in the power cycle. The delay is achieved by increasing the volume of the combustion chamber and reducing residence time of the combustion products. The levels of NOx reductions vary with each engine. Moderate IR does not appear to significantly increase CO or HC emissions; however, some fuel consumption penalties are associated with this control technique. To sustain NOx reductions, electronic ignition control systems must be used to automatically adjust the timing, thus accommodating changes in engine load or ambient conditions.

Fuel Injection Timing Retard - Ignition in a normally adjusted IC engine is set to occur shortly before the piston reaches its uppermost position (top dead center (TDC)) At TDC, the air or air and fuel mixture is at maximum compression. The timing of the start of injection or of the spark is given in terms of the number of degrees that the crankshaft must still rotate between this event and the arrival of the piston at TDC. Retarding the timing beyond TDC, the point of optimum power and fuel consumption, reduces the rate of NO_x production. Retarding causes more of the combustion to occur later in the cycle, during the expansion stroke, thus lowering peak temperatures, pressures, and residence times. The efficiency loss is identifiable by the increase in fuel flow needed to maintain rated power output. This practice carries with it a fuel consumption penalty of 5 to 8 percent and the potential of excessive smoke. Typical retard values range from 2° to 6° depending on the engine. Beyond these levels, fuel consumption increases rapidly, power drops, and misfiring occurs. Also, TOC, CO, and visible emissions increase, and elevated exhaust temperatures shorten exhaust valves and turbocharger service lives. Increasing the fuel injection rate has been used on some diesel systems to partially mitigate the CO and TOC emissions and fuel consumption effects of retarded injection timing. A high injection rate, however, results in increased mixing of air and fuel and a subsequently hotter flame at the initiation of combustion. Therefore, there is a NO_x trade-off with this modification. Injection timing retard is an applicable control with all IC engine fuels. The reported level of control is in the range of 0.6 to 8.5 percent reduction for each degree of retard. On the average, diesel engines reduce NO_x by 25 percent for 4° of retard and 40 percent for 8° of retard. Fuel usage increases approximately 2 percent at 4° retard, whereas 8° of retard raises fuel usage by about 6 percent.

Combined A/F Adjustment and Ignition Timing Retard- The combination of A/F adjustment and IR can achieve NOx reduction similar to that achieved by A/F adjustment alone, but with additional flexibility in operating characteristics. These include improved fuel consumption response to load changes. The combined control techniques may cause slight increases in CO and HC emissions.

4.3 FLUE GAS TREATMENT

Flue gas treatment can be classified into two basic groups, dry processes and wet processes.

Selective Catalytic Reduction (SCR) - SCR is a dry process that uses ammonia as a reducing agent to convert NOx into nitrogen and water. The ammonia also serves as a catalyst in the presence of oxygen to complete the conversion of CO and unburned hydrocarbons to CO_2 and water. SCR has been used to control NOx emissions from reciprocating engines and has been applied with some success to lean-burn SI engines and to diesel and dual-fired engines. NOx emissions have been reduced between 65 and 95 percent for lean-burn SI engines, and 80 to 90 percent for diesel and dual-fired units. The catalysts for SCR are generally base-metals, such as vanadium pentoxide or zeolite. Special handling and disposal requirements for spent catalysts containing vanadium pentoxide are of concern in some areas where this material is considered hazardous.

SCR Disadvantages - SCR is expensive because of the capital investment required for ammonia storage facilities, the cost of ammonia, and the add-on control equipment. Additional concerns exist regarding catalyst poisoning and fouling of the catalyst and downstream equipment by ammonium bisulfate, a reaction product. Ammonia carryover or "slipping" can occur and, in some cases, can result in a requirement to control ammonia emissions. Some difficulties have also been experienced in controlling ammonia emissions during load changes.

Selective Non-Catalytic Reduction (SNR) - SNR is a dry process that operates without a catalyst. Like SCR, SNR uses ammonia to reduce NOx emissions. However, for CO and HC control, the process relies on high-temperature gas phase reactions instead of using a catalyst. NOx reductions of 35 to 75 percent have been reported with the use of SNR. The SNR process tends to cost less than SCR and eliminates some of the catalyst-related problems. Controlling ammonia injection during upsets and significant changes in load or fuel can affect emissions.

4.4 OTHER MODIFICATIONS

Some manufacturers are designing electronic controls and improving fuel injectors to deliver fuel at the best combination of injection pressure, injection timing and spray location to reduce emissions. These techniques allow the engine to efficiently burn the fuel without causing the temperature spikes that increase NOx emissions.

Air Intake - This involves redesigning turbochargers, aftercoolers, and intake valving to provide optimum pressure, temperature, and routing of the intake air. This is important for managing the physical and chemical processes needed to achieve good air-fuel combustion. Exhaust gas recirculation (mixing some exhaust gas with the intake air) is an established technology on cars that may be effective in heavy-duty diesel engines.

Diesel Fuel Parameters - Employing fuel additives and improving fuel properties such as raising the cetane number, lowering the aromatics content or decreasing sulfur levels can contribute to reduced NOx and PM emissions and may also provide engine manufacturers with greater flexibility to use new emission control technologies.

4.5 PAY BACK PERIOD

Pay back is dependent upon the actual control technology selected and its suitability for use on a given piece of equipment. Typically, the internal combustion engine manufacturer is the best source of this information as they can assess the operational impact of the control technology on engine functioning. Our findings indicate these technologies may not be economical when installed on old, small internal combustion engines. Estimates of costs for emission controls are as follows:

- Oxidation catalysts provide significant reductions in carbon monoxide (CO) (90%) and non-halogenated hydrocarbons (NMHC) (90%) from lean burn engines at a cost of $9-10/brake horsepower (bhp); Particulate matter (PM) emissions are also reduced by more than 25% with no additional cost.

- Non-selective catalytic reduction (NSCR) has been estimated to reduce up to 90% of NOx; however, operating temperature and catalytic coating problems when burning diesel may significantly reduce the quantity of NOx reduction realistically achieved. Cost estimates for this technology range from $10-15/bhp for rich burn engines.

- Selective catalytic reduction (SCR) can be used to reduce more than 90% of NOx emissions from lean burn engines at a cost of $50-125/bhp.

- Lean NOx catalysts have been applied to stationary lean burn IC engines to provide significant reduction in NOx (80%), CO (60%), and NMHC (60%) at a cost of $10-20/bhp.

- Diesel particulate filters (DPF) or trap oxidizers provide considerable potential to eliminate more than 50% or particulate matter emissions from stationary diesel engines at a cost of $30-50/bhp. Catalytic coatings on DPFs add the advantage of reducing CO and HC.

- Ceramic coatings can be used to improve performance, reduce emissions, or allow a trade off in performance and emission levels not possible using solely catalyst technology. Used in conjunction with a catalyst, ceramic coatings have allowed significant reductions in PM and NOx for heavy duty diesels while providing significant performance increases in power and torque. Costs range from $5-15/bhp, but are offset by improved fuel economy.

4.6 BEST MANAGEMENT PRACTICES

Options for reducing emissions from current generators include:

- Minimize the number of generators operating in other than emergency situations.

- Generators dedicated for off base deployments should be identified as such and their PTE emissions should reflect only the emissions required to maintain the unit on base.

- Consider placing Federally enforceable limits on the generators to limit hours of operation.

- Establish baseline performance data against which to evaluate future engine performance.
- Post operating procedures (based upon manufacturer's recommendations) with modifications and supplements to suit specific local conditions and equipment.
- Record system performance during regular operation, inspection, and testing on AF Form 487, Emergency Generator Operating Log (Inspection and Testing).
- Maintain maintenance records to record data during inspections and maintenance that measure equipment condition and wear rates.
- Monitor engine performance data detects gradual changes that signal engine deterioration.

4.7 GENERATOR MANUFACTURER POINTS OF CONTACT

The following generator manufacturer points of contact are provided for your use in the event that you wish to pursue after-market add-on controls or modifications to reduce air emissions.

Cummins, (800) 343-7357

Caterpillar, (800) 321-7332

Cooper Bessemer, (412) 458-3443

John Deere, (309) 765-8000

Katolight, 800) 325-5450

Onan, (804) 589-2415

4.8 REFERENCES

Engineering Technical Letter (ETL) 98-2, "Clean Air Act Amendments Requirements for Electric Generators and Power Plants," Draft.

Air Force Instruction (AFI) 32-1062, "Electrical Power Plants and Generators," May 1994

AFI 32-7040, "Air Quality Compliance," May 1994.

AFI 32-1063, "Electric Power Systems," March 1994.

"Emission Factor Documentation for AP-42 Section 3.3, Gasoline and Diesel Industrial Engines," U.S. Environmental Protection Agency, April 1993.

"Emission Control Technology for Stationary Internal Combustion Engines," Manufacturers of Emission Controls Association, October 1995.

"Emission Control Potential for Heavy-Duty Diesel Engines," U.S. Environmental Protection Agency, June 1996.

SECTION 5.0

FUEL STORAGE AND DISPENSING

5.1 GENERAL

Petroleum, oil, and lubricant (POL) storage includes storage tanks for JP-8, diesel fuel, unleaded motor vehicle fuel (MOGAS), aviation gas (AVGAS), and fuel oil #2. The POL storage and distribution system consists of receiving stations, above and underground storage tanks (AST, UST), underground and aboveground pipelines and pumping and filling systems.

The fuel storage and transfer facilities are a significant source of air emissions. The following information while generic in nature is included for your review. Future tank installation or modifications should include means to mitigate air emissions both from an environmental and product conservation perspective.

5.2 EVALUATION

There are three major types of tanks used to store fuel: fixed roof; internal floating roof; and external floating roof. Optional equipment designs also exist within each major tank type such as seal design, roof fabrication, and fitting closure. Each tank type and equipment option has its own associated emission rate. Generally speaking, fixed roof tanks have the highest emission rates, followed by internal and then, external floating roof tanks.

5.2.1 Fixed Roof Tanks: Working and breathing losses normally incurred from storing fuel in a fixed roof tank can be reduced by installing an internal floating roof with appropriate fitting and a seal system (resilient foam-filled or wiper seals); or installing and using a vapor recovery system (carbon adsorption or refrigerated condensation) or a vapor control system (incineration). The installation of an internal floating roof in a fixed roof tank can reduce emission rates by 69 to 98%. The cost of installing an internal floating roof with liquid-mounted primary seals and secondary seals is approximately $20.00 per linear foot and controlled fittings will add an additional $200.00 (in a newly installed floating roof) to $600.00 for an existing floating roof.

5.2.2 Internal Floating Roof Tanks: Internal floating roof tanks with rim seals emit less VOC per unit of storage than fixed roof tanks, simply because the floating roof precludes direct contact between a large portion of the liquid surface and the atmosphere. The actual effectiveness is dependent upon how well the floating roof can be sealed. The primary source of emission losses are the rim or seal (35%), fitting (35%), and deck seam (18%).
Fitting losses occur through penetrations in an internal floating deck. Penetrations exist to accommodate the various types of fittings required for proper operation. Fitting losses can be controlled with gasketing and sealing techniques, or by substituting a lower-emitting fitting for the same purpose. Costs associated with these modifications range from $200.00 for a newly installed floating roof to $600.00 for existing floating roofs. The following table summarizes the techniques.

EQUIPMENT DESCRIPTIONS

Deck Fitting Type	Uncontrolled	Controlled
Access Hatch	Unbolted, ungasketed or gasketed cover	Bolted, gasketed cover
Automatic Gauge Float Well	Unbolted, ungasketed or gasketed cover	Bolted, gasketed cover
Column Well	Built-up column-sliding cover, ungasketed	Built-up column-sliding cover, gasketed; or Pipe column-flexible fabric sleeve seal for tanks with pipe columns
Ladder Well	Ungasketed sliding cover	Gasketed sliding cover
Sample Pipe or Well	Slotted pipe-sliding cover, ungasketed or gasketed	Sample well with slit fabric seal, 10% open area
Vacuum Breaker	Weighted mechanical actuation, ungasketed	Weighted mechanical actuation, gasketed

Employing liquid-mounted primary seals instead of vapor-mounted seals and/or employing secondary seals in addition to primary seals can reduce Internal floating roof seal losses. All seal systems should be designed, installed, and maintained to minimize the gap between the seals and the tank shell. The cost difference of constructing a liquid-mounted primary seal rather than a vapor-mounted primary seal is $20.00 per linear foot. The installation of secondary seals on existing internal floating roofs is estimated at $26.00 per linear foot. On new installations there is no additional charge for secondary seals.

Deck seam losses are inherent in several floating roof types. Any roof constructed of sheets or panels and bolted is expected to experience deck seam loss. Selecting a welded roof as opposed to a bolted roof eliminates deck seam losses.

5.2.3 External Floating Roof Tanks: Most external floating roof tanks are constructed with welded steel and are equipped with shoe primary seal systems. Since deck seam losses do not occur, emissions result from rim or seal losses (68%) and fitting losses (28%). Fitting losses in external floating roof tanks occur in the same manner as internal floating roof tanks - through the penetrations in the floating roof deck. Gasketing and sealing techniques and substituting a lower emitting fixture type accomplish the same reduction. The cost of controlling fittings in an external floating roof is estimated at $680.00. The following table summarizes the techniques.

EQUIPMENT DESCRIPTIONS

Deck Fitting Type	Uncontrolled	Controlled
Access Hatch	Unbolted, ungasketed or gasketed cover	Bolted, gasketed cover
Gauge Float Well	Unbolted, ungasketed or gasketed cover	Bolted, gasketed cover
Guide Pole/Sample	Unslotted pipe, ungasketed	Unslotted pipe-sliding cover,

Deck Fitting Type	Uncontrolled	Controlled
	cover, ungasketed sliding cover with or without float; or unslotted pipe-sliding cover, ungasketed	gasketed
Sample Well	Weighted mechanical actuation, ungasketed	Weighted mechanical actuation, gasketed
Vacuum Breaker	Weighted mechanical actuation, ungasketed	Weighted mechanical actuation, gasketed
Roof Drain	Open	90% closed
Rim Vent	Weighted mechanical actuation, ungasketed	Weighted mechanical actuation, gasketed

Rim seal losses from external floating roof tanks vary based upon the type of seal system employed. Liquid-mounted seals are more effective than vapor-mounted seals. For example:

Seal System Description	Seal Loss Control Efficiency
Vapor-mounted resilient primary seal only	External floating roof baseline 0%
Vapor-mounted resilient primary seal and secondary seal	66%
Metallic shoe primary seal only	84%
Metallic shoe primary seal with a shoe-mounted wiper seal	95%
Liquid-mounted resilient primary seal only	95%
Metallic shoe primary seal with rim-mounted Secondary seal	99%
Liquid-mounted resilient primary seal with Rim-mounted secondary seal	99%

The retrofit cost of adding secondary seals to an external floating roof is estimated at $54.00 per linear foot.

5.3 FUEL DISPENSING

It is important to specifically mention AAFES gas stations. Often, emissions from the AAFES gas station contribute up to 50% of a base's HAPs. Adding secondary recovery systems to dispensing pumps or using cleaner fuels are the primary pollution prevention controls.

5.3.1 Stage II Vapor Recovery: Stage II vapor recovery is an effective control technology to reduce gasoline vapor emissions which contain volatile organic compounds (VOC) and hazardous air pollutants (HAP). Displaced gasoline vapors from the automobile tanks are collected at the automobile fillpipe and returned to the underground storage tank. There are two basic types of stage II vapor recovery systems: vapor balance; and vacuum assist. The vapor balance system operates on the principle of positive displacement during gasoline transfer operations. Balance systems use pressure created in the vehicle fuel tank by the incoming liquid gasoline and the slight negative pressure created in the storage tank by the departing liquid to transfer the vapors through the combination fuel dispensing/vapor collection nozzle, through the vapor passage, and into the service station underground storage tank. Because a slight pressure is generally created at the nozzle/fillpipe interface, effective operation requires a tight seal be made at the interface during vehicle fuelings to minimize vapor leakage into the atmosphere.

Vacuum assist systems are designed to enhance vapor recovery at the nozzle/fillpipe interface by drawing in vapors using a vacuum. Because of this design, assist systems can recover vapors effectively without a tight seal at the nozzle/fillpipe interface. Various means have been employed to create a vacuum to include a compressor, turbine, blower, or pump to transport the vapors back to the storage tank.

Costs associated with the installation of stage II vapor recovery systems vary considerably based upon the extent of work performed. For example, many service stations incorporate the installation of stage II vapor recovery systems with some other remodeling effort or tank upgrade. Since the cost covers the entire project, the cost of stage II vapor recovery appears to be much higher than it would be if considered separately. Further, the number of pumps, gallons distributed, and recovery credits all compound determining the cost of stage II vapor recovery systems. The following costs serve only to illustrate the relative costs of stage II vapor recovery system components:

- Number and type of nozzles - $240.00
- Hoses - $140-240.00
- Dispenser modifications - $50-60.00
- Vapor processors - $4,000.00
- Other components (such as high-retractor hose assemblies, swivels, hose breakaway fittings, vapor check valves, flow limiters, and hose splitters
- Installation of the above - $535-1,300.00
- Vapor piping - $7-8,000.00
- Trenching and backfilling - $30.00 per foot
- Testing - $670.00

Recovery Credits: The return of saturated vapors to the storage tank during fueling eliminates the inbreathing of fresh air and subsequent evaporation of liquid gasoline. Each gallon of gasoline prevented from evaporating represents a gallon of product available for sale. The earnings generated from this gasoline that would have otherwise have evaporated are counted as recovery credits.

Recovery credits may be calculated as follows (assuming 95% recovery of both displacement and emptying losses):

$$\text{Recovered vapor} = ((1{,}340 \text{ mg/liter})(.95)) + ((120 \text{ mg/liter})(.95)) = 1{,}387 \text{ mg/liter}$$

Example of recovery credit:

1,387 mg/liter x 75,700 liters/month x 1kg/1.0e6mg x liter/0.67kg x 12 mo/year x $0.275/liter = $518/year

5.3.2 Removal from Air Emission Inventory: On 2 August 1996, the EPA published a memorandum titled "Major Source Determinations for Military Installations under the Air Toxics, New Source Review, and Title V Operating Permit Programs of the Clean Air Act." This memo established several policies regarding major source determination at military installations. As mentioned in the 2 Aug 96 memo, military installations include numerous activities that are not normally found at other types of sources. These types of activities include residential housing, schools, day care centers, churches, recreational parks, theaters, shopping centers, grocery stores, BX gas stations, and dry cleaners. These activities are located on military installations for the convenience of military personnel (both active duty and retired), their dependents, and DOD civilian employees working on the base, and they often do not represent essential activities related to the primary military activity(ies) of the base. Therefore, the EPA believes these types of activities may appropriately be considered not to be support facilities to the primary military activities of a base. As such, these activities may be treated as separate sources for all purposes for which an industrial grouping distinction is allowed. Such activities should be separately evaluated for common control, SIC code, and support facility linkages to determine if a major source is present. Many bases have successfully removed their AAFES gas stations from their inventories and do not consider the emissions from this source when determining major source status.

5.4 REFERENCES

"Alternative Control Techniques Document: Volatile Organic Liquid Storage in Floating and Fixed Roof Tanks," Environmental Protection Agency, January 1994.

"Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities," EPA, November 1991.

SECTION 6.0

SOLVENTS

6.1 GENERAL:

During the course of performing surveys, there has been a lot of confusion regarding the term "P-D-680." Federal Specification P-D-680, "Dry Cleaning and Degreasing Solvent," consists of three types of petroleum distillates. It is used for dry cleaning, spot and stain removal, and for degreasing of machine parts in equipment maintenance.

The different types (I, IA, II, IIA, III) are based, in part, upon flash point (the "A" designations refer, in part, to low residue formulations). The flash points for the different types are as follows:

P-D-680 Type	Flash Point
I	100 to 139 degrees F
II	140 to 199 degrees F
III	200 degrees F or greater

Currently, there is no Qualified Product List (QPL) for P-D-680. Therefore, any hydrocarbon solvent meeting the requirements contained in the Specification would be viewed as P-D-680 equivalent without testing (or qualification). Equivalent products include those marketed by under the name Safety Kleen and others.

To reduce confusion OEBQ recommends considering those petroleum hydrocarbon solvents currently in use to be P-D-680. The specific type can be determined by comparing the flash point of the current petroleum hydrocarbon product to those listed above.

PD680-Type 1 – This solvent is often used under the trade name Safety Kleen 105. The use of PD680-Type 1 is discouraged wherever the applicable Technical Orders (T.O.'s) allow the use of PD680-Type 2 or 3 solvents. PD680-Type 3 has a lower vapor pressure that results in lower emissions from degreasing operations and is marketed under many different trade names. According to Federal Specification P-D-680, Section 3, PD680-Type 3 is basically a broad category of hydrocarbon based solvents that have a flashpoint above 200 degrees Fahrenheit. Many bases have used Breakthrough brand solvent with good success. Breakthrough brand solvent can be ordered under the following National Stock Numbers (NSNs): NSN 6850-01-378-0679, five gallon container; NSN 6850-01-378-0698, 15 gallon container; and NSN 6850-01-378-0666, 55 gallon drum. Other bases have switched to citrus type cleaners or aqueous parts washers to replace the use of hydrocarbon based solvents.

6.2 Aqueous Parts Washers - Many shops are able to utilize an aqueous parts washer as a complete alternative to solvent degreasing. For instance, many AGSE, Transportation, and Pneudraulics shops have removed their solvent tanks and use aqueous parts washers exclusively.

This alternative should be employed wherever feasible, if permitted by the T.O. or equipment specifications.

Aqueous jet parts washers clean using a combination of water and detergent. A parts washer is comprised of a cleaning cabinet in which spray nozzles, which are positioned along the interior walls and ceiling, direct heated, high pressure streams of water at the objects to be cleaned. The high pressure water is typically used in conjunction with a detergent and will remove dirt, grime, oil, and grease from the materials being cleaned. Because the detergent solution is biodegradable, the solution may be discharged into the local sewer system if it meets the discharge limitations. However, most of the washers have a purifying/recycling system, whereby the detergent solution is recycled and can be reused. These purifying/recycling systems work by skimming oil from the solution, and removing any sludge waste that has settled to the bottom of the washer. In addition, filters used in the system remove particulate matter, further purifying the solution. These closed-loop systems enable the user to reuse the detergent solution several times before requiring fresh solution.

The detergents used can come in two forms: water soluble liquid concentrate or water-soluble powder. Most contain a rust inhibitor and a lubricant to protect the parts from rust. The detergents are formulated so that they can effectively remove carbon, heavy greases, and other dirt.

The washer units come in a variety of sizes, from a 75-gallon to a 400-gallon capacity. The units are either front-loading or top-loading, depending on the model. Parts are placed in baskets or on shelves, which rotate to expose the parts to the jet washers and the detergent solution. The baskets can be multi-tiered, depending on the size of the washer and the parts being cleaned. Options include rinse and dry modules, where the parts are given a final rinse with fresh water and dried using blasts of heated air.

Because the system uses biodegradable detergents, no hazardous solvents are used. In addition, hazardous wastes will be minimized, reducing disposal costs. However, because paints and metals may collect and form a sludge, hazardous wastes may still be generated, although on a smaller scale.

Aqueous jet parts washers are used throughout the Army, Navy, Marine Corp, and Air Force. Aqueous jet parts washers are used to clean a variety of parts, including aircraft components and engine parts. Closed loop aqueous jet parts washers have been used on-board Navy vessels to clean a variety of parts, including aircraft components.

Economic Analysis: The following cost elements for aqueous jet parts cleaning are compared to 1,1,1-trichloroethane vapor degreasing. Both systems operate 245 days annually. The aqueous jet machine operates 2 hours per day. The TCA vapor degreasing system operates 4 hours per day.

Assumptions:

- Aqueous detergent consumption: 200 lbs
- Aqueous detergent cost: $2/lb
- Annual filter changeouts: 12
- Replacement filter cost: $10/filter
- Labor required for inspection of parts for aqueous system: 600 hrs/year
- Labor required for parts scrubbing, cleaning, and inspection using vapor degreasing: 800 hrs/year
- Maintenance labor equivalent for both systems
- Labor rate: $30/hr
- Aqueous system electricity consumption: 4,800 kw·hr
- Vapor system electricity consumption: 9,500 kw·hr
- Electricity rate: $0.08/kw·hr
- Process water consumption: 5,500 gallons/year
- Process water purchase rate: $0.002/gallon
- Aqueous system sludge disposal cost: $700/year based on two 55-gallon drums
- Laboratory profile analysis of sludge: $1,000/yr
- Sewer discharge cost: $8.24/1000 gallons
- TCA solvent procurement cost: $3,500/yr based on 200 gallons/year consumption of TCA
- Solvent disposal: $1,700/year based on seven 55-gallon drums of spent solvent and soiled rags
- Solvent profile analysis: $2,500/year

Annual Operating Cost Comparison for Aqueous Jet Parts Washer and TCA Vapor Degreasing

Operational Costs:	Aqueous Jet Parts Washer	TCA Vapor Degreasing
Labor	$18,000	$24,000
Material:	$520	$3,500
Electricity:	$380	$760
Water:	$10	$0
Waste Disposal (including any profile analysis):	$1,750	$4,200
Total Operational Costs:	$20,660	$32,460
Net Annual Cost/Benefit:	-$20,660	-$32,460

Convert to an Aqueous Cleaner: The following products are suitable for use in immersion cleaning. They remove grease, oil, shop grime, and dyes from mode metals, including aluminum, copper, and composites.

Manufacturer	Product	NSN	Size	Cost
Brulin Corporation	Formula 815 GD	6850-01-392-8433	5 gal	$94.44
		6850-01-392-8430	55 gal	$733.04
Buckeye International	ShopMaster HP	6850-01-420-2882	5 gal	$74.62
		6850-01-420-2884	55 gal	$660.00
	XL-100	6850-01-420-2887	5 gal	$55.00
	XL-100	6850-01-420-2885	55 gal	$550.00
Harvey Universal	G92015	6850-01-394-2644	5 gal	$39.27
	G92013	6850-01-394-2640	55 gal	$714.06
Inland Technology	Samurai	6850-01-381-4419	5 gal	$175.05
		6850-01-381-4426	55 gal	$1,027.08
	Safety Prep	6850-01-381-5139	5 gal	$185.4
		6850-01-381-5088	55 gal	$1,061.67
Integrated Chemistries	Attack	6850-01-423-1068	5 gal	$45.00
		6850-01-423-1069	55 gal	$467.50
	I.C. Green	6850-01-428-6502	5 gal	$46.00
		6850-01-428-6500	55 gal	$495.00

If flash rust is a concern, then consider:

Manufacturer	Product	NSN	Size	Cost
Finger Lakes Chemicals	1D/4R	6850-01-383-3046	5 gal	$140.91
		6850-01-383-3053	55 gal	$1,298.75
PCI of America	Hurrisafe 9065	6850-01-426-6678	5 gal	$77.00
		6850-01-46-6681	55 gal	$594.00

Replacement cleaners should be coordinated with your installation Bioenvironmental Engineering Flight to ensure all occupational health concerns, if any, are properly addressed prior to use.

Vendors: The following is a list of aqueous jet parts washer vendors. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- Better Engineering Manufacturing, 8361 Town Center Court, Baltimore, Maryland 21236-4964, Phone: (800) 229-3380, Fax: (410) 931-0053
- The Mart Corporation, 2450 Adi Road, Maryland Heights, MO 63043, Phone: (800) 543-MART, Fax: (314) 567-6551,

- PCI of America, 7307 Macarthur Blvd., Suite 215, Bethesda, MD 20816
  Phone: (301) 320-9100, Fax: (301) 3205632

The following product information is being provided for consideration as alternatives to the petroleum-based solvents in use.

Product Name	Impact Concentrated Industrial Degreaser	Bio T Max
Application	Used in high-pressure systems to clean machinery, trucks, road equipment, engine blocks, roofing equipment masonry, building, and maintenance equipment.	Maximum strength degreaser/cleaner effective in dissolving and removing grease, dirt, oil, and similar tough substances. Ideal for use in dip tanks, pressure spray units, and other industrial equipment.
Replaces	TCA, other chlorinated solvents and petroleum distillates.	Chlorinated solvents, mineral spirits, naphtha based products
Method of Use	Wipe and spray	Varied
Chemical Ingredients	Citrus terpenes, coconut diethanolamide, nonionic surfactant, dye	Natural terpene
Safety & Health	Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal	Tar and asphalt, some types of paint	No
Cost	$2,338.96 55-gal drum $167.49 5-gal can $123.08 12/1-quarts/box	$202.56 4/1-gal cans/box $236.64 5-gal can $988.97 55-gal drum
Water Soluble	Yes emulsifier	Dispersible
Disposal	Sanitary system	HW due to low flashpoint
Recycling		Parts washer, filter
VOC	90%	780 g/l
Vapor Pressure	Less than 10 mm Hg	Less than 2 mm Hg
Flashpoint (°F)	130	146
Boiling Point (°F)	335	334
Density (lbs/gal)	7.18	7.17
NSN	6850-01-380-4053 55-gal 6850-01-380-4369 5-gal 6850-01-384-0618 12/1-qt	6850-01-381-3785 4/1-gal 6850-01-381-3930 5-gal 6850-01-381-3944 55-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168
Manufacturer	Allied Enterprises	Golden Technology Co.,

	814 W 45th Street Norfolk, VA 23508-2008 (757) 489-8282	BioChem Systems, Inc. 14452 W 44th Avenue Golden, CO 80403 (800) 777-7870

Product Name	Hurri-Safe Hot Immersion Degreaser	Hurri-Safe HK-188 (Aircraft Exterior Wash)
Application	Used in heated immersion tanks; recirculating in-line wash systems, heated ultrasonic degreasers, steam cleaners, and high-pressure washers.	Used in wipe-on/wipe-off cleaning of aircraft metal parts and surfaces prior to painting, bonding, priming, or using adhesives.
Replaces	TCA, MEK, CFC's, various petroleum solvents	MEK, toluene
Method of Use	Wipe-on/wipe-off	Wipe-on/wipe-off
Chemical Ingredients	2-butoxyehtanol	2-butoxyethanol
Safety & Health	Low toxicity. Skin exposure can cause dryness and irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Contact can cause eye or skin irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal	No	Yes
Cost	$17.00 1-gal $80.00 5-gal $825.00 55-gal drum	$588.55 55-gal drum
Water Soluble	Yes, completely	Yes, completely
Disposal	Sanitary sewer	Sanitary sewer
Recycling Options	Clarifier, OCS can provide a recycling system	Clarifier, OCS can provide a recycling system
VOC	206 g/l	0.05 %
Vapor Pressure	14.2 mm Hg	Non volatile
Flashpoint (°F)	N/A	N/A
Boiling Point (°F)	212	212
Density (lbs/gal)	8.48	8.45
NSN	6850-01-373-5866 5-gal 6850-01-373-5867 55-gal	6850-01-373-5865 55-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168
Manufacturer	OCS Systems	OCS Systems

	429 Madera Street San Gabriel, CA 91778-0370 (818) 458-2471 FAX (818) 458-2437	429 Madera Street San Gabriel, CA 91778-0370 (818) 458-2471 FAX (818) 458-2437

Product Name	Electron 0296-55	Daraclean 282
Application	Non-aqueous; used in electrical maintenance, motors, generators, and general wipe down	Alkaline all-purpose cleaner, multi-metal safe effective between 80-200 degrees Fahrenheit
Method of use		Soaking, agitation, spray
Replaces	TCA, CFC-113	Chlorinated solvent degreasers, 1,1,1-trichloroethane
Chemical Ingredients	Hydro treated light distillate, d-limonene	Glycol ethers
Safety & Health	Dermal and ocular irritation. Excessive inhalation can cause dizziness. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Mild skin, eye, and respiratory irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal		
Cost	$101.04 6-gal $766.38 55-gal	$104.86 5-gal $674.65 55-gal
Water Soluble	No	Yes
Disposal		
Recycling options		
VOC		
Vapor Pressure	0.30 mm Hg @ 68 F	29 mm Hg @ 23 degrees °C
Flashpoint (°F)	147	None to boiling
Boiling Point (°F)	370 - 380	212
Density (lbs/gal)		8.18
NSN	6850-01-375-5553 6-gal 6850-01-375-5555 55-gal	6850-01-364-8328 5-gal 6850-01-364-8329 55-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	W.R. Grace and Co. 55 Hayden Avenue Lexington, MA 02173 (617) 861-6600
Manufacturer	Ecolink Inc. 1481 Rock Mountain Blvd. Stone Mountain, GA 30083 (404) 621-8480	W.R. Grace and Co. 55 Hayden Avenue Lexington, MA 02173 (617) 861-6600

Product Name	MA 102	Hurri-Safe Special Formula Degreaser
Application	Removes heavy soils, grease, and oil from aircraft surfaces, leaves no Residue. Meets or exceeds MIL-C-85570, TY II	Used in cold parts washing for metal cleaning and degreasing; ultrasonic degreasers used at ambient temperatures; wipe on/wipe-off process to remove contaminants from metals prior to painting.
Replaces	Chlorinated solvents	TCA, methyl ethyl ketone, toluene, and various petroleum solvents
Safety & Health	Inhalation can cause mild respiratory irritation. Eye contact can cause slight irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Eye contact can cause slight irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal	No	Yes
Cost	$4.32 16 oz. $111.00 5-gal $598.40 55-gal .	$11.12 1-gal $665.48 55-gal drum $41.90 5-gal
Water Soluble	Yes	Yes
Disposal		Sewer discharge
Recycling Options		Clarifier, OCS can provide a recycling unit
VOC	0.084 g/l	0.05%
Vapor Pressure	N/A	non-volatile
Flashpoint (°F)	more than 200 F	N/A
Boiling Point (°F)	200 F	212
Density (lbs/gal)	8.54	8.45
NSN	6850-01-378-0402 16-oz 6850-01-378-0425 5-gal 6850-01-378-0401 55-gal	6850-01-369-2474 1-gal 6850-01-369-2475 55-gal 6850-01-369-9303 5-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168
Manufacturer	JAD Chemical Inc. P.O. Box 6786 Rancho Palos Verdes, CA 90734 (310) 833-7457 FAX 833-3855	OCS Systems 429 Madera Street San Gabriel, CA 91778-0370 (818) 458-2471 FAX 458-2437

Product	Partsprep	ISO PREP
Application	Penetrates, loosens, removes deposits of carbon, smut, grease, multi-purpose lube oils, and buffing compounds from ball bearings, aluminum, brass, stainless steel, carbon steel, and specialty alloys	Petroleum solvent, removes oil, grease, glues, wax, asphalt, and other deposits.
Replaces	TCA, CFC-113, other halogenated solvents	Chlorinated, fluoridated, or aromatic hydrocarbons
Method of Use		Manual wipe, dip tank
Chemical Ingredients	1-methylpyrrolidone	C12-C13 Paraffinic Hydrocarbons
Safety & Health	If misted at high temperatures can cause nausea and narcotic effects. Dermal exposure can cause redness, swelling, and cracking. Slight ocular irritation. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Low active oral and dermal toxicity. Slight eye irritation. Prolonged skin exposure can cause defatting and dermatitis. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal		No
Cost	$1240.99 55-gal drum $212.38 5-gal can	$210.80 5-gal can
Water Soluble	Yes	No
Disposal		
Recycling Options		Distillation, Inland filtration systems available
VOC		100% volatile
Vapor Pressure	Less than 0.30 mm Hg	Less than 2 mm Hg
Flashpoint (°F)	139	150
Boiling Point (°F)	396	370
Density (lbs/gal)		6.40
NSN	6850-01-383-0780 55-gal 6850-01-383-0833 5-gal	6850-01-378-0706 5-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168
Manufacturer	ISP Bound Brook, NJ 08805 (201) 628-4000	Inland Technology 2612 Pacific Highway East Suite C Tacoma, WA 98424 (206) 922-8932

Product	Partsmaster 140 Solvent	Citra Safe (deodorized)
Application	Parts washer use. Removes oil, grease, glues, inks, asphalt with controlled evaporation, designed to be used with the EDGE TEK Filter System.	Especially made for surface preparation, general cleaning and cleaning prior to sealing.
Replaces	Stoddard solvents/mineral spirits perchloroethylene	1,1,1 Trichloroethane (TCA), MEK, toluene, and blends of MEK and toluene, mineral spirits, thinners, and chlorinated solvents
Method of Use	Parts washer	Manual wipe, dip tank
Chemical Ingredients	C12-C13 Paraffinic Hydrocarbons	D-Limonene
Safety & Health	Low active oral and dermal toxicity. Slight eye irritation. Prolonged skin exposure can cause defatting and dermatitis. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.	Low active oral and dermal toxicity. Slight eye irritation. Prolonged skin exposure can cause defatting and dermatitis. Consult your local Industrial Hygienist, Health and Safety personnel, and MSDS.
Paint Removal	No	No
Cost	$1369.59 55-gal drum	$2,296.00 55-gal drum $384.84 5-gal
Water Soluble	No	No
Disposal Recycling Options	Distillation, Inland filtration systems available	Distillation, Inland filtration systems available
VOC		
Vapor Pressure	Less than 2 mm Hg	Less than 2 mm Hg
Flashpoint (°F)	150	132
Boiling Point (°F)	370	340
Density (lbs/gal)	6.40	6.98
NSN	6850-01-378-0610 55-gal drum	6850-01-381-7081 55-gal drum 6850-01-381-7169 5-gal
POC	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168	Hazardous Technical Information Services (800) 848-4847 DSN 695-5168
Manufacturer	Inland Technology 2612 Pacific Highway East Suite C Tacoma, WA 98424 (206) 922-8932	Inland Technology 2612 Pacific Highway East Suite C Tacoma, WA 98424 (206) 922-8932

6.3 Aerosol Type Cleaners - The use of solvent-based aerosol type cleaners should be discouraged. Aerosol spray cleaners often contain high levels of VOC or SVOC solvents. Where cleaning is not limited by a T.O., citrus and alkaline type cleaners in pump spray bottles could be used. These bottles may filled or refilled by pumping the solution from bulk containers such as 1-, 5-, 30-, or 55-gallon drums. This method is best suited for cleaning solutions, lubricants, and other spray solutions that are available in bulk. The spray bottles are composed of plastic and are compatible with most cleaning solutions and lubricants. They are durable and can last for many refills. Hand pumps are available to pump solutions directly from drums for use in the spray bottles. For solutions that are in pails or buckets, there is a pail adapter to allow the use of the hand pump.

Economic Analysis:
The following cost elements for using refillable pump spray bottles and aerosol cans for lubrication.
Assumptions:

- 55-gallon drum lubricating oil cost: $490
- 16-ounce aerosol can lubricating oil cost: $4.35
- 440 16-ounce aerosol cans equivalent to one 55-gallon drum
- The equivalent of one 55-gallon drum is consumed annually
- Drum pump costs: $20/ea
- Purchase 20 spray bottles at $5/each
- No significant difference in labor

Annual Operating Cost Comparison for
Refillable Spray Bottles and Aerosol Sprays

	Refillable Spray Bottles	Aerosol Sprays
Operational Costs:		
Lubricant costs:	$490	$1,914
Total Operational Costs:	$120	$0
Total Recovered Income:	$0	$0
Net Annual Cost/Benefit:	-$610	-$1,914

Economic Analysis Summary

Annual Savings for Pump Spray Bottles: $1,304

Vendors: The following is a list of drum dispenser pumps and spray bottles vendors. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- McMaster Carr Distributor, 473 Ridge Road Dayton, NJ 08810, Phone: (908) 329-3200, Fax: (908) 329-3772

- Action Pump Company, 170 Chicago Street, Cary, IL 60013, Phone: (847) 516-3636, Fax: (847) 516-0033

- Lab Safety Supply, PO Box 1368, Janesville, WI 53547, Phone: (800) 356-0783, Fax: (800) 543-9910
- VWR Scientific, 16290 Shoemaker Avenue, Cerritos, CA 90701, Phone: (800) 944-1894, Fax: (310) 404-0417

6.4 Enzyme Cleaners – These types of cleaners use enzymes in a water solution to break down the grease and grime on metal parts. Shops at some AF bases have switched to enzyme cleaning as the sole cleaning method. For instance, Transportation, AGSE, and Auto hobby shops have reported excellent results with these types of cleaners.

6.5 Citrus Cleaners – Various shops have reported good cleaning success with citrus-based cleaners such as Citriclean or Voltz II. These cleaners can often be used as replacements for solvent based cleaners, thereby significantly reducing VOC emissions from cleaning operations when a base-wide program is established. The Auto hobby shop at Langley AFB and the Corrosion Control shop at Beale AFB are currently using an enclosed paint gun washer utilizing a citrus based cleaner (manufactured by Herkules). According to Vehicle Management Directorate, Warner-Robins AFB, Georgia, DSN 468-0014, solvents such as Citra Safe and Citrikleen HD are widely accepted and used on Federal installations for cleaning automotive brake assemblies and other grimy components such as engine parts. A search of Federal Logistics Data (Fed Log) and Hazardous Materials Information System (HMIS) for applicable National Stock Numbers (NSNs) and Material Safety Data Sheets (MSDS) for these products revealed:

- Citra Safe solvent contains greater than 95 percent d-limonene and is available under the following NSNs:

  6850-01-378-0575, five gallon container;
  6850-01-378-0616, box of 12 15 oz cans; and
  6850-01-378-0797, 55 gallon drum.

- Citrikleen HD contains D-limonene, ethanolamine, diethanolamine, water, surfactants and a coupling agent and is available under the following NSNs:

  7930-01-339-3425, box of 24 16 oz bottles;
  7930-01-329-7434, six gallon container; and
  7930-01-314-6133, 55 gallon drum.

6.7 References:

"Guide to Cleaner Technologies: Cleaning and Degreasing Process Changes," EPA/625/R-93/017, US EPA, 1994..

"Manual: Pollution Prevention in the Paints and Coatings Industry," EPA/625/R-96/003, US EPA, 1996

Technical Order (T.O.) 4W-1-61, Maintenance and Overhaul Instructions for All Types of Wheel Assemblies.

Military Specification MIL-C-87937, "Cleaning Compounds, Aircraft Exterior Surfaces, Water Dilutable," Types I and II.

Military Specification MIL-C- 29602, "Cleaning Compounds, For Parts Washers and Spray Cabinets."

SECTION 7.0

SURFACE COATING OPERATIONS

7.1 GENERAL

Surface coating operations involve the application of primers and/or topcoats to protect a large range of equipment and surfaces. Most surface coating work is conducted in paint booths. Paint removal operations are conducted either in a media-blasting booth or by hand with sanding equipment. Paint touch-up operations occur in both the booths and in the open. Paint touch-up operations conducted out side the booths may be limited by air pollution regulations.

7.2 FACILITY OR PROCESS EVALUATIONS

Typically, the piece of equipment requiring coating work is first scuff sanded then an epoxy primer is applied followed by a polyurethane topcoat. Generally, VOC compliant paints (420 grams per liter (g/l) VOCs maximum) and primers (340 g/l VOC maximum) are used and are applied with high volume low-pressure (HVLP) paint guns. However, most shops still use a few high VOC paints even though suitable replacements are available. Typically the paint spray booths are equipped with only a single stage particulate filter. Auto hobby shops are notorious for using improper filters in their paint spray booths. The filters often appear to be furnace type filters which do not provide the filtering efficiency needed for painting applications. Also, the Auto hobby shops usually have no restrictions on the types of paints which may be applied in the booth. In other words, low VOC paints are not required.

7.3 OPPORTUNITY ASSESSMENTS

7.3.1 Paints - Bases have begun switching to high solids/low VOC paints during the last three years, but not all paints currently used are considered low VOC. Further emissions reductions can be realized, however, by completing the switch to compliant (e.g., low solvent/high solid) paints/primers. Usually, the Transportation shop has no requirement to use low VOC paints. However, it is recommended that the Transportation shops begin using low VOC paints since they are available. See the Sempen and Automotive Paint Sections below. Also, it is recommended that the Auto hobby shop require customers use low VOC paints.

7.3.2 Paint Booths - As a pollution prevention step, the paint booths could be fitted with carbon filter media for VOC emission reduction Nevertheless, any single stage particulate paint booth filters should be replaced with 2-stage filters for improved capture efficiency and emissions reductions. Also, the Auto hobby paint booth manufacturers should be contacted to determine the proper filters to be used in their paint booth.

The costs associated with the installation of a carbon adsorber system vary widely due to the number of variables involved in controlling the VOC emissions. These include the targeted VOC, ventilation rates, contaminant generation rates, size of facility, etc. Specific VOC carbon adsorber cost factors also include the volumetric flow of the VOC laden gas passing through the carbon beds; inlet and outlet VOC mass loadings of the gas stream; adsorption time; and working capacity of the activated carbon. Fixed-bed versus canister-type adsorbers further affect costs. Direct annual costs such as steam, cooling water, electricity, carbon replacement, labor, and possibly recovery costs must also be determined.

The best source of information for the cost of these controls is the Hazardous Air Pollutant Program (HAP-PRO). The primary purpose of (HAP-PRO) is to assist permit engineers in reviewing applications for control of air toxics. HAP-PRO calculates the capital and annual costs for up to six different volatile organic compounds (VOCs) and three particulate control devices, including selected engineering parameters. Calculations used by the program mirror those presented in the EPA Handbook, "Control Technologies for Hazardous Air Toxics," June 1991, EPA-625/6-91/014, and the EPA's "Control Cost Manual," March 1990, EPA-450/3-90/006.
A secondary purpose of HAP-PRO is to generate reports that list all facilities containing:

- A specified pollutant in their emission stream(s), or
- A specified type of emission stream (for example, organic or inorganic vapors and particulates).

HAP-PRO also includes an expert review system for the design of thermal incinerators, catalytic incinerators, and carbon adsorber systems. The program reviews the design results generated, makes recommendations for changes, and allows easy evaluation of design sensitivities. By using HAP-PRO and inputting the necessary data from your existing or proposed facility, you can assess the approximate costs of VOC emission control technologies (An EPA representative suggested increasing the HAP-PRO costs by 20% to allow for inflation). This database and associated manuals is available on the internet at: http://www.epa.gov/ttncatc1/products.html #software.

- Additional guidance is also available in "Carbon Adsorbers," U.S. EPA, December 1995 (http://www.epa.gov/ttncatc1/products.html#cccinfo).

7.3.3 Paint Gun Cleaning - Many paint shops do not currently have enclosed gun-cleaning systems. Often, antiquated open-air solvent washers are used. The most effective method for cleaning paint spray guns is the enclosed paint gun washer. According to "Automatic Paint Gun Washer," Joint Service Pollution Prevention Handbook, August 1996, enclosed gun washers are similar to conventional home dishwashing machines, except that the thinners and solvents in the automatic washers are not heated in the process. The washers can be used to clean conventional air spray, HVLP, electrostatic, airless, or air-assisted paint guns. Solvents used in the automatic paint gun washer are recycled and reused in the cleaning process. The paint gun to be cleaned is attached to a nozzle within the automatic paint gun washer, and the machine is sealed. Most automatic paint gun washers can wash two to three paint guns at a time. The exterior of the paint gun is cleaned with atomized paint thinner using a dishwasher action. The interior of the paint gun is cleaned by circulating solvent through the nozzle attachment. Automatic paint gun washers collect used solvent in a reservoir. Impurities in the used solvent are filtered out in the reservoir. The filtered solvent is then ready for reuse instead of being disposed of as hazardous waste. The solvent impurities form a sludge, which is collected and disposed. The typical solvent capacity of the spray gun washer is 3 gallons; it must be changed out every 3 to 8 weeks, depending on usage.

Inland Technology EP-921 Cleaner: Corrosion control personnel at Beale AFB, CA have had excellent results when using Inland Technology EP-921, Cleaning Compound/Solvent, for paint spray gun cleaning applications. According to the Defense Logistics Agency "Environmental Products" guide, this cleaner is an alternative for methyl ethyl ketone (MEK), MEK/toluene blends, and lacquer washes. This product contains propylene carbonate and d-limonene and is available under the following NSNs:

6850-01-381-3300, Five Gallon Can, $295.04;
6850-01-381-4408, 55 Gallon Drum, $2,479.88.

Paint Gun Washer Cost analysis: The capital cost for automatic paint gun washers will vary, depending upon the unit size, unit type, and the application. Capital costs for these washers range from $600 to $2,400.

Assumptions:

- 18 spray guns are cleaned per week
- Solvent required for automatic gun cleaning: 6 gallons/month
- Solvent required for manual gun cleaning: 36 gallons/week
- Hazardous waste disposal cost: $20/gallon
- Solvent procurement cost: $4/gallon
- Labor rate: $30/hour
- Labor, manual gun cleaning: 10 min/gun or 3 hr/week
- Labor, automatic gun cleaning: 1 min/gun or 0.3 hr/week
- Electrical costs are negligible

Annual Operating Cost Comparison for
Automatic Washing and Manual Washing of Paint Guns.

Operational Costs	Automatic Wash	Manual Wash
Labor:	$470	$4,700
Material	$290	$7,500
Waste Disposal	$1,400	$37,400
Total Operational Costs:	$2,160	$49,600
Total Recovered Income	$0	$0
Net Annual Cost/Benefit:	-$2,160	-$49,600

Economic Analysis Summary

- Annual Savings for Automatic Washing: $47,440
- Capital Cost for Diversion Equipment/Process: $600

- Payback Period for Investment in Equipment/Process: Immediate

Vendors: The following is a list of automatic paint gun washer manufacturers. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- Butler Compressor and Spray Equipment Co., 657 Monterey Pass Road, Monterey Park, CA 91754, Phone: (626) 289-4247, Fax: (626) 284-9971
- Graco Inc., P.O. Box 1441, Minneapolis, MN 55440, Phone: (612) 623-6709, Fax: (612) 623-6777

Solvent Distillation: Consider distillation of the thinner/reducer to extend its life as a cleaner and minimize both air emissions and hazardous waste. Solvent distillation as a means of recycling, is a viable alternative to the single use/disposal of solvents. It is environmentally benign and reduces the amount of solvent purchased and disposed. Solvent distillation is best suited for processing waste solvents with excessive contamination. Solvent distillation units process waste solvents in separate, stand-alone batch, on-line batch, or continuous systems. The distillation units heat the waste solvent to its boiling point. This causes the solvent to evaporate and the solvent vapors are then condensed in a separate container. The remaining contaminants in the process chamber are disposed. The basic components of a distillation unit are the process chamber or boiler, encapsulated heaters, a water-cooled chamber, and associated piping and instrumentation. Temperature sensors monitor the temperature and help maintain the required distillation temperature. Disposable vessel liners can be used to provide simple collection and disposal of still bottoms. Vacuum pumps that can distill high-boiling solvents at lower temperatures are also available.

Solvent Distillation Economic Analysis: Solvent distillation systems need to be specific to the type of solvent, the contaminants being removed, the batch size or throughput, and the type of cleaning operation. This leads to a wide range of costs. For instance, self-contained, batch-distillation units vary in price from $2,000 to more than $30,000. Costs of the units depend on the size, the materials of construction, and the options selected. Capacities typically range from 1- to 250-gallon batches. The following cost estimate is for the use of a 2-gallon capacity solvent distillation recycling unit.

Assumptions:

- Freon 113 usage (single use of solvent application): 500 gal/yr
- Freon 113 usage (with distillation unit): 100 gal/yr
- Freon procurement cost: $70.85/gal
- Waste solvent (single use of solvent application): 400 gal or 640 lb/yr
- Distillation unit waste sludge (still bottoms): 250 lb/yr
- Waste solvent disposal cost: $1.40/lb
- Still bottoms disposal cost: $1.25/lb
- Labor required for disposal of waste solvent: 1 hr/wk or 52 hr/yr
- Distillation unit electrical requirements: 480 kw-hr/yr
- Electricity: $0.08/kw-hr
- Labor rate: $45/hr

- Total labor requirements recycling unit operation: 2 hr/wk or 104 hr/yr
- Solvent distillation unit cost (installation and training): $3,800

Annual Operating Cost Comparison for
Solvent Distillation and Solvent Disposal

	Solvent Distillation	Solvent Disposal
Operational Costs:		
Material	$7,085	$35,425
Labor:	$4,680	$2,340
Electricity	$38	$0
Waste Disposal	$313	$896
Total Operational Costs:	$12,116	$38,661
Total Recovered Income:	$0	$0
Net Annual Cost/Benefit:	-$12,116	-$38,661

Economic Analysis Summary

- Annual Savings for Solvent Distillation: $26,545
- Capital Cost for Diversion Equipment/Process: $3,800
- Payback Period for Investment in Equipment: <1 year

Distillation units are available by ordering one of the following two NSNs and specifying the desired volume - NSN 4940-01-395-9468 or NSN 4940-01-395-9469. Small units are single phase; the large units are three-phase; and all models are 220 VAC, although 440 VAC versions are available.

Vendors:

The following is a list of vendors and manufacturers of solvent distillation units. This is not meant to be a complete list, as there are other manufacturers of this type of equipment.

- Branson Ultrasonics Corporation, 41 Eagle Road, Danbury, CT 06813-1961, Phone: (203) 796-0400
- Detrex Corporation, 322 International Parkway, Arlington, TX 76011, Phone: (800) 525-1496
- Finish Thompson Inc., 921 Greengarden Road, Erle, PA 16501-1591, Phone: (814) 455-4478, Fax: (814) 455-8518
- PBR Industries, 143 Cortland Street, Lindenhurst, NY 11757, Phone: (516) 226-2930, Fax (516) 226-3125

7.3.4 Paint Application – One of the most effective strategies for reducing the VOC emissions from painting operations is to improve the transfer efficiency of the operation. This depends on the painter's distance from the painting target. In general, as the distance increases, transfer efficiency diminishes. As the distance decreases, however, the spray painter needs to reduce the fluid and/or air pressure to avoid applying too much coating to the target. Improving the transfer efficiency will minimize the air emissions and will also save paint due to reduced over spray.

Primer/Coating Application: High Volume Low Pressure paint spray system is an efficient technology for the application of paint to specific pieces of work. These systems operate at low pressures, which result in the application of paint at low velocities. HVLP paint systems atomize paint via a high volume of air delivered at a low pressure (less than 10 psi). In some HVLP systems, the air supply is turbine generated; in others, shop air (100 psi) is reduced to less than 10 psi. Because the atomized paint particles are delivered at low velocities to the object being painted, less paint is lost as over spray, bounce, and blow back. Typically the transfer efficiency with HVLP paint system is 50 to 65%. The effect this technology has on pollution prevention is that the paint delivered at low velocity results in higher transfer efficiency as compared to conventional paint spray systems. In conventional spray systems, a stream of liquid paint is met by jets of pressurized air that forms the paint into a fine mist. A typical system employs 100 psi of constant air pressure in a volume of approximately 25 cfm. The atomized paint particles travel at high velocities and tend to bounce off the object being painted rather than adhering to the surface. In addition, the expanding high pressure air (above 100 psi) passing through the small face cap openings causes turbulent flow of the paint stream following air currents within the paint booth. The amount of paint that bypasses the work piece (over spray) is relatively high for air pressure atomized spray painting. Transfer efficiencies of 15 to 30% are associated with conventional spray systems.

HVLP paint spray systems can be used in a wide variety of painting applications. The finer atomization of HVLP systems produces smoother surface finishes. There are many paint gun models, with a variety of tip sizes to accommodate most coatings, including solvent-based paints, water based coatings, fine finish metallic, high-solids polyurethane, contact adhesives, varnish, top coats, lacquer, enamel primer, latex, primer, epoxy, and vinyl fluids. The efficiency of these systems is reduced if painting is done in exposed areas.

Economic Analysis: Costs will vary depending upon specific applications, painting/coating type, paint volume, work specifications, and technique. Generally, HVLP paint spray system equipment costs approximately $1,000 for a gun, hose, and paint pot. Airless or air-assisted airless paint spray systems range from $2,000 to $3,500. Installation costs will also vary, depending upon location.

Assumptions:

- Gallons of paint applied to surface per year: 5,000 gallons
- Gallons of paint purchased per year with HVLP system: 10,000 gallons
- Gallons of paint purchased per year with high velocity spray system: 20,000 gallons
- Paint procurement cost: $10/gallon
- Transfer efficiency of HVLP gun: 50%

- Transfer efficiency of high velocity spray system: 25%
- Labor requirements: 200 hours for HVLP system, 400 hours for high velocity spray system
- Labor rate: $45/hr.
- Waste paint collected using dry filter system.
- Dry filter replacement rate: 1.25 dry filters/hour
- Dry filter disposal cost: $1/filter

Annual Operating Cost Comparison for HVLP Spray Systems and High Velocity Spray Systems.

Operational Costs	HVLP Spray Systems	High VelocitySpray Systems
Labor:	$ 9,000	$18,000
Paint:	$100,000	$200,000
Waste Disposal	$250	$500
Total Costs:	$109,300	$218,500
Annual Benefit:	-$109,300	-$218,500

Economic Analysis Summary

- Annual Savings for HVLP Spray Systems: $109,200
- Capital Cost for Diversion Equipment/Process: $1,000
- Payback Period for Investment in Equipment/Process: Immediate

Vendors: The following is a list of HVLP suppliers and manufacturers. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- Accuspray, Inc., 23350 Merchantile Rd., Cleveland, OH 44122, Phone: (800) 618-6860 or (216) 595-6860, Fax: (216) 595-6868

- Binks Manufacturing Co., 9201 W. Belmont Ave., Franklin Park, IL 60131, Phone: (708) 671-3000, Customer Service Fax: (708) 671-3067

- Graco, Inc., P.O. Box 1441, Minneapolis, MN 55440-1441, Phone: (800) 367- 4023, Fax: (612) 623-6777.

When using an air atomizing or HVLP spray gun, a common method is available for flushing coating from the fluid hose of the gun back into the container or reservoir. Using this technique greatly reduces the amount of solvent required to clean out the hose. This techniques is described as follows:

- Turn down the fluid pressure from the reservoir but keep the valve open.
- Set the air pressure to the gun at approximately 40 psi.
- Hold a cloth tightly in position in front of the gun air cap, and pull the gun trigger. The air, which cannot escape from the cap, enters the fluid hose and forces the coating in the hose all the way back to the reservoir.

- After the paint returns to the reservoir, use a small amount of solvent to clean the inside of the hose.

Plural Component Proportioning Systems: Plural component proportioning systems are self-contained paint proportioning and mixing systems. These systems provide proper mixing and precise generation of paint required by an application and consequently generate minimal waste.

Paint mixtures are prepared by premixing a base and a catalyst, and combining them in appropriate proportions in a separate container. After mixing and waiting the specified time, application of the paint to the workpiece may proceed. Paint ingredients have a limited pot life once mixed which cannot be exceeded without affecting the characteristics of the paint. If the pot life is exceeded, the mixture must be disposed, and the application equipment must be cleaned with a solvent. Under conventional methods, the mixture is prepared by hand. This frequently results in the generation of excess paint, which requires solvent cleanup and disposal of the paint and solvent as a hazardous waste.

Plural component proportioning systems are used in conjunction with application devices. The proportioning and application system layout typically includes the following components: 1) proportioning pump module, 2) mix manifold, 3) mixer, 4) application device, 5) material supply module, and 6) purge or flush module. These systems optimize painting operations by maximizing efficiency and minimizing waste generated.

The plural component proportioning system for paints provides total control of materials from container(s) to application. They are accurate and can provide more consistent material quality than hand mixing. These systems can also keep pace with higher production requirements. They mix on demand (i.e. as the gun is triggered), which results in no significant quantities of wasted materials. Material cleanup requires less labor and maintenance, and generates less waste because the mixed material can be purged with solvent from the mix manifold, mixer, hose, and applicator before it cures. The plural component proportioning system is a closed system and, as a result, there are fewer spills, less contamination or waste to clean up, and less contact between personnel and potentially hazardous materials. In addition, the proportioning system makes bulk purchase of material practical.

No new wastestreams are generated using Plural Component Proportioning Systems as compared to conventional methods.

Capital costs for plural component proportioning systems can range from $50,000 to $70,000 for systems that mix multiple materials or $6,000 to $7,000 for basic units that mix two materials. Application systems are additional and their capital costs can range from $500 to $5,000. Each application needs to be evaluated on a case-by-case basis with respect to material and labor costs and savings.

The following is an example of the replacement of a hand-mixing paint operation with a relatively simple Plural Component Proportioning System.

Assumptions:

- Annual paint usage for hand mixing system: 4,000 gallons
- Annual solvent usage for hand mixing system: 2,250 gallons
- Annual labor required for equipment cleaning using hand mixing system: 250 hours
- Annual solid paint waste generated using hand mixing system: 5,500 pounds
- Paint cost: $85/gallon
- Solvent cost: $7/gallon
- Labor rate: $45/hr
- Paint solid waste disposal at $1/pound
- Solvent waste disposal at $3/gallon
- All solvent is disposed as waste
- Plural component proportioning system reduces paint usage by 15%
- Plural component proportioning system reduces solvent usage and waste by 50%
- Plural component proportioning system reduces labor usage by 50%
- Plural component proportioning system reduces paint waste by 50%

Annual Operating Cost Comparison for
Plural Component Proportioning System and Hand Mixing System

	Plural Component Proportioning System	Hand Mixing System
Operational Costs:		
Labor:	$5,600	$11,300
Paint and Solvent:	$296,900	$355,800
Waste Disposal	$6,100	$12,300
Total Costs:	$308,600	$379,400
Total Income:	$0	$0
Annual Benefit:	-$308,600	-$379,400

Economic Analysis Summary

- Annual Savings for Plural Component System: $70,800
- Capital Cost for Diversion Equipment/Process: $15,000
- Payback Period for Investment in Equipment/Process: <1 year

Vendors: The following is a list of plural component proportioning system manufacturers. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- DeVilbiss Ransburg Industrial Liquid Systems, 320 Phillips Avenue, Toledo, OH 43612, Phone: (800) 233-3366, Fax: (419) 470-2270.

- Graco Inc., P.O. Box 1441, Minneapolis, MN 55440-1441, Phone: (800) 367-4023, Fax: (612) 623-6777.
- Binks Manufacturing Company, 9201 Belmont Avenue, Franklin Park, IL 60131-2887, Phone: (847) 671-3000, Fax: (847) 671-4248.

7.3.5 Paint Removal – We recommend recycling spent plastic media bead (PMB) blasting material. Spent PMB may be recycled in such a manner as to exclude the material from being regulated as a solid waste. Title 40, Code of Federal Regulations (CFR), Part 261, "Identification and Listing of Hazardous Waste", subpart 261.2, "Definition of solid waste," states materials are not a solid waste when recycled providing the materials are recycled by being: used or reused as an ingredient in an industrial process to make a product, provided they are not to be reclaimed; used or reused as effective substitutes for commercial products; or returned to the original process from which they are generated, without first being reclaimed. The material must be returned as a substitute for raw material feedstock, and the process must use raw materials as principal feedstock.

Further, Title 40 CFR, Part 261.1, "Purpose and scope," a material is considered reclaimed if it is processed to recover a usable product or if it is regenerated. Assuming your recycling contractor will use the spent PMB as an ingredient in an industrial process without reclamation (such as U.S. Technologies, 220 7th Street S.E., Canton, OH 44702, Mr. Ray Williams, (800) 634-9185), it would not require management as a hazardous waste. However, if you contractor recycles the spent PMB in another manner which does not meet the regulatory requirements addressed above, management as a hazardous waste may be required.

Chemical Paint Stripping: Technical Order (T.O.) 1-1-8, "Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment," addresses the procedures and cites materials and equipment to be used on interior and exterior surfaces of aircraft and missiles. This T.O. authorizes the use of phenolic, non-phenolic/non-cresylic, benzyl alcohol, and alkaline strippers. Of these categories, benzyl alcohol and alkaline materials are the most environmentally compliant (not currently listed as hazardous materials for occupational health or environmental contamination). These products offer the advantage of reducing hazardous waste generation and air emissions. The following chemical strippers are recommended:

> To remove epoxy/polyurethane primer and polyurethane topcoats use CeeBee E-1092A, E2000, or E2002A; Eldorado 3131; EZE 541; Turco 6813; or B&B 9400.
>
> To remove polysulfide primers use CeeBee E-1058 or E-1058A; Eldorado SR-125A or SR 145; B&B 5151B; or EZE 542.

Mechanical Paint Removal: Mechanical removal (wire brush, abrasive paper or cloth, abrasive mat discs, or abrasive blasting) is recommended when use of chemical removers is impractical due to structural complexities and/or rinsing difficulties. Of these options, scuff sanding with vacuum assist sanders is the environmentally preferred method. Large areas may be more effectively prepared by using plastic media bead (PMB) blasting (provided the system program manager grants approval). PMB provides effective coating removal and can reduce the amount of hazardous waste generated if the spent media is recycled without reclamation.

Cost analysis: PMB systems can range in cost from $7,000 for a small portable unit to $1,400,000 for a major aircraft stripping facility. The following information on investment costs and costs/payback for PMB systems at Hill AFB, Utah, was provided in "Joint Paint Removal Study; Final Report; Plastic Media Blast, Joint Depot Maintenance Analysis Group, Technology Assessment Division, June 1994."

In 1987, Hill AFB gathered data during the stripping of F-4 aircraft using chemical stripping and PMB.

Assumptions:

- Labor rate: $45/hr
- Work load = 75 aircraft/yr
- Labor per airplane: 183 hrs for blasting, 364 hrs for chemical stripping
- Chemical procurement cost: $11.40/gallon
- Chemical use per airplane: 468 gallons
- Plastic media procurement cost: $1.76/lb
- Plastic media used per airplane: 1,500 lbs
- Water treatment/disposal: $8.24/1000 gallons
- Water usage per airplane: 200,000 gallons
- Electricity usage costs per airplane: PMB = $173; chemical stripping = $333
- Paint and solvent waste disposal: 0.51 ton per airplane at $200/ton
- Spent media and blast waste disposal: 0.85 ton per airplane at $260/ton
- Water purchase costs: $0.43/1000 gallons
- Maintenance costs per airplane: PMB = $1,333; chemical stripping = $667
- Cost per airplane to strip parts which can't be done using PMB: $667

Annual Operating Cost Comparison for PMB and Chemical Stripping.

Operational Costs:	PMB	Chemical Stripping
Labor:	$617,600	$1,228,500
Chemical:	$0	$400,100
Plastic Media:	$198,000	$0
Water Treatment/ Disposal:	$0	$123,600
Electricity:	$13,000	$25,000
Hazardous Waste Disposal:	$16,600	$7,700
Water:	$0	$6,500
Maintenance Cost:	$100,000	$50,000
Cost of parts not done by PMB:	$50,000	$0
Total Operational Costs:	$995,200	$1,841,400
Net Annual Cost/Benefit	$995,200	$1,841,400

Economic Analysis Summary

- Annual Savings for PMB versus chemical stripping: $846,200
- Capital Cost for Diversion Equipment/Process: $1,400,000
- Payback Period for Investment in Equipment/Process: < 2 years

Vendors: The following is a list of PMB manufacturers. This is not meant to be a complete list, as there may be other manufacturers of this type of equipment.

- Pauli & Griffin, 907 Cotting Lane, Vacaville, CA 95688, Phone: (800) 666-1115, Fax: (707) 447-7036

- Schlick-America Inc., P.O. Box 374, Randallstown, MD 21133, Phone: (410) 655-0770, Fax: (410) 521-0483

Leasing Services: The following is a list of PMB leasing services. This is not meant to be a complete list, as there may be other suppliers of this service.

- Solidstrip, Inc., 601 Interchange Blvd., Neward, Delaware 19711, Phone: (800) 677-4568, Fax: (302) 292-8340

- Composition Materials, 1375 Kings Highway East, Fairfield, CT 06430, Phone: (800) 262-7763, Fax: (203) 335-9728

- L.S. Solutions, Incorporated, P.O. Box 309, Deer Park, TX 77536, Phone: (713) 478-6522, Fax: (713) 478-6531

7.3.6 Paint Spray Cans - Paint spray can use can be reduced by switching to Sempen paint applicators or equivalent type applicators for paint touch-up work. The paint used in these applicators has a significantly lower VOC content.

7.3.7 Sempens

Manufacturers Address:

Courtaulds Aerospace Sealants and Coatings
5454 San Fernando Rd.
P.O. Box 1800
Glendale CA 91209
(818) 240-2060

Use Sempens for minor touch-up painting: According to Mr. John Stone, Coatings Engineer, General Services Administration (GSA) Paints and Chemicals Commodity Center, (206) 931-7724, Sempen 10 cc paint pens are available through the GSA. These paint pens contain polyurethane paint qualified to Military Specification MIL-C-85285 and are especially suitable for small touch-up jobs thus eliminating mixing and the use of large quantities of polyurethane paint. Sempens may be ordered under the following NSNs:

MIL-C-85285 Polyurethane Coating Sempens:

COLOR	NSN
Clear, Gloss	8010-01-441-6017
Gloss Red, 11136	8010-01-441-6018
Gloss International Orange 12197	8010-01-441-6019
Gloss Yellow, 13538	8010-01-441-6003
Gloss Dark Blue, 15004	8010-01-441-6004
Gloss Dark Blue, 15050	8010-01-441-6005
Gloss Light Gray, 16473	8010-01-441-6020

MIL-PRF-85285, Type 1, Polyurethane Coating Sempens:

COLOR	NSN
Gloss Black, 17038	8010-01-441-6026
Gloss White, 17925	8010-01-441-6029
Semi-gloss Dark Green, 24052	8010-01-441-6006
Semi-gloss Gray, 26231	8010-01-441-6007
Semi-gloss Gray, 26250	8010-01-441-6035
Semi-gloss Gray, 26251	8010-01-441-6034
Flat, Red, 31136	8010-01-441-6008
Flat, Yellow, 33538	8010-01-441-6009
Flat, Dark Blue, 35044	8010-01-441-6010
Flat, Blue-gray, 35237	8010-01-441-6011
Flat, Gray, 36118	8010-01-441-6021
Flat, Gray, 36173	8010-01-441-6022
Flat, Gray, 36176	8010-01-441-6012
Flat, Gray, 36231	8010-01-441-6027
Flat, Gray, 36251	8010-01-441-6013
Flat, Gray, 36270	8010-01-441-6023
Flat, Gray, 36320	8010-01-441-6024
Flat, Gray, 36375	8010-01-441-6025
Flat, Gray, 36293	8010-01-441-6014
Flat, Light Gray, 36495	8010-01-441-6015
Flat, Black, 37038	8010-01-441-6028
Flat, White, 37875	8010-01-441-6016

MIL-P-23377 Primer Coating Sempens:

COLOR	NSN
Yellow	8010-01-441-6030
Green	8010-01-441-6031

MIL-PRF-85582 Primer Coating Sempens:

COLOR	NSN
Yellow	8010-01-441-6032
Green	8010-01-441-6033

The GSA point of contact for cataloging the Sempen Pens within the Paints and Chemicals Commodity Center is Ms. Yvonne Salas, (253) 931-7082.

7.3.8 Pre-paint Solvent Wipe: PPG Industries Incorporated, 19699 Progress Drive, Strongsville, OH 44136, (440) 572-6111, manufacturers three suitable low VOC wipe solvents. These products are:

DX 390, Low VOC Cleaner, 0.6 pounds per gallon (lbs/gal) VOC;
DX 393 Low VOC Cleaner, 0.6 lbs/gal VOC; and
DX 394, Low VOC Cleaner, 1.4 lbs/gal VOC.

7.3.9 Automotive Paints - HQ USAF/LGT, Warner-Robins Vehicle Management Directorate, and the Air Force Corrosion Office are working jointly to address corrosion control requirements of USAF general and special purpose vehicles. The two primary technical orders are under revision and expected to be merged into a single T.O. in the future. As a result of these efforts, specific guidance on automotive painting is changing. Generally, there are only two requirements: the paint being applied must be compatible with the existing paint; and CARC paint is required if the USAF vehicle is going to be assigned to a joint military force involving the U.S. Army.

Low VOC Primers and Paints (3.5 lb/gal or less): Environmentally complaint paints and primers are available from commercial automotive paint suppliers. For example, PPG Incorporated, 19699 Progress Drive, Strongsville, OH 44136, has distributors nationwide and can provide the appropriate paint, in the correct color, and in low VOC formulation. Call (440) 572-6100 for color availability and a local distributor or (440) 572-6111 for technical support.

The General Services Administration (GSA), Paints and Chemicals Commodity Center has identified and procured numerous low VOC primers and coatings and their use should be standard practice to minimize air pollutants. Low VOC products are available in enamel, epoxy, polyurethane, and acrylic latex formulations. The following is an overview of these paints currently stock listed and available through GSA:

- Epoxy Primer: Epoxy primer, Military Specification MIL-P-53022, Type II, is a fast drying, two-component epoxy primer for use on ferrous and non-ferrous metals. The primer is corrosion-inhibitive, resistant to water, hydrocarbons, and salt spray. Use with polyurethane and epoxy topcoat systems such as Military Specification MIL-C-85282 polyurethane topcoats and MIL-C-22750 epoxy topcoat. The maximum VOC content is 420 g/L and the cost range from $9.09 (2.5 pint kit) to $139.93 (5 gallon kit).

- Metal Primer: Metal primer, Federal Specification TT-P-664, is an iron oxide-alkyd primer for use on ferrous and non-ferrous metal and is compatible with enamel and lacquer. The maximum VOC content is 420 g/L and the cost range from $27.01 (gallon) to $133.06 (5 gallon).

- Acrylic Enamel: Acrylic enamel, Federal Specification TT-E-2784, is intended for use on exterior metal. This enamel provides a long-lasting coating when applied over properly prepared surfaces and is characterized by excellent gloss retention. The maximum VOC content is 200 g/L and the paint costs $9- 17 per quart and is available in gloss, semi-gloss, and flat finishes. Acrylic enamel is also available in a low VOC aerosol, Federal Specification A-A-2787, Type II.

- Alkyd Enamel: Alkyd enamel, Federal Specification TT-E-489, is intended for use on primed interior and exterior metal surfaces and to finish or refinish automobiles and construction equipment. Characterized by good color retention and is resistant to weather, water and hydrocarbons. The maximum VOC content is 420 g/L and the cost range from $5.67 (quart) to $200.08 (5 gallon).

- Polyurethane Coating: Formulated for use on aircraft, this coating is resistant to oils, hydraulic fluids, weather, humidity, heat, and solvents. Kit consists of a container of pigmented polyester resin component, a container of clear aliphatic isocyanate resin curing agent, and if necessary, a container of thinner. These paints are procured to Military Specification MIL-C-85285, Type 1, and have a VOC content of 420 g/L. These paints cost between $4.96 (pint) to $600.00 (10 gallon).

- Also available are polyurethane paints conforming to Military Specification MIL-C-85285, Type II, which are designed for ground support equipment and weapons systems. These coatings are resistant to oils, hydraulic fluids, weather, humidity, heat, and solvent. Their maximum VOC content is 340 g/L and cost ranges from $6.50 (pint) to $200.00 (2 gallon).

- Sempens can also be used for touch-up/stenciling applications. These items are stock-listed and available in several colors. See Sempen reference.

- Zinc Dust Primer: Use Zinc Dust Primer, Type II, Class B for all priming applications. This primer is compatible with polyurethane and enamel paints. It provides galvanic protection and is resistant to water, hydrocarbon, salt spray, heat, and weather. This primer may be ordered under the following National Stock Numbers (NSNs): 8010-01-380-0368, quart, $11.90; or 8010-01-380-0398, gallon, $80.08.

- Chemical Agent Resistant Coating (CARC): The requirement to paint USAF vehicles with CARC paint is based upon the vehicle being co-located with an U.S. Army unit. We recommend discontinuing the use of CARC paint unless specifically required. In those cases where CARC must be used, use coatings conforming to Military Specification MIL-C-53039, Types I and IV, which have a maximum VOC content of 420 g/L. Do not use Type II that has a maximum VOC content of 570 g/L.

7.3.10 Other Coatings - The General Services Administration (GSA), Paints and Chemicals Commodity Center has identified and procured numerous low VOC, water-based or water-reducible primers and coatings and their use should be standard practice to minimize air pollutants. The following is an overview of these coatings currently stock-listed and available through GSA:

- Acrylic Latex paint , Federal Specification TT-P-19, is for exterior use on concrete, masonry, stucco, and wood. Durable, and long-lasting. Suitable for spray, brush, or roller application. Maximum VOC content 250 grams per liter (g/L). $10-12 per gallon.

- Acrylic Enamel, Federal Specification TT-E-2784, is for use on exterior primed metal, concrete, masonry, and wood. Provides a durable long-lasting coating characterized by good gloss retention. Maximum VOC content 200 g/L. $15-42 per gallon.

- Aerosol Acrylic-Latex Enamel, Federal Specification A-A-2787, Type II, is suitable for metal, wood, plaster, masonry. Stone, glass, leather, fiber, and previously painted surfaces. Low VOC. $55-71 per box (12 one pint cans).

- Acrylic Lacquer, Federal Specification A-A-2850, is a suitable substitute for lacquer used in furniture, cabinets, trim, and paneling. Apply by spray or brush. Maximum VOC content 250 g/L/. $44-50 per gallon.

- Alkyd Primer, Federal Specification TT-E-545, is an undercoat primer used with indoor high gloss and semi gloss alkyd and latex paints. For spray and roller application. Maximum VOC content 30 g/L. $16 per gallon.

- Exterior Oil Paint, Federal Specification TT-P-102, is formulated for one-coat exterior use on properly primed or previously painted wood, sealed concrete, or primed metal surfaces. Maximum VOC content 250 g/L. $19-28 per gallon.

- Metal Primer, Military Specification MIL-P-28577, is a waterborne acrylic primer for use on properly prepared exterior or interior metal surfaces in all non-marine environments. Suitable for brush, spray, or roller application. Maximum VOC content 250 g/L. $42 per gallon.

- Floor Sealer, Federal Specification TT-S-223, is a resin-based, water-emulsion sealing and finishing compound for use on cured and uncured concrete floors. Typical VOC content 250 g/L. $15 per gallon.

- Recycled Latex Paint, Federal Specification TT-P-2846, contains a minimum of 50% post-consumer waste. Use on interior or exterior wallboard, concrete, stucco, masonry, and wood. Maximum VOC content 250 g/L. $53-68 per 5 gallon can.

- Stain, Federal Specification TT-S-1992, is for use on new or previously stained exterior wood surfaces. Maximum VOC content 250 g/L $30-32 per gallon.

- Waterborne Traffic Paint, Federal Specification TT-P-1952, is suitable for application on airfield and other traffic-bearing surfaces such as Portland cement concrete, bituminous cement concrete, asphalt, tar, and previously painted areas of those surfaces. Low VOC and lead free. $20-28 per gallon.

7.4 REFERENCES.

"Guide to Cleaner Technologies: Cleaning and degreasing process changes," EPA/625/R-93/017, US EPA, 1994.

"Manual: Pollution Prevention in the Paints and Coatings Industry," EPA/625/R-96/003, US EPA, 1996.

Technical Order 1-1-8, "Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment," Change 17, 18 July 1997.

"Ribbon-cutting marks completion of SERDP project at Barstow," Joint Depot Maintenance Circular, August 1996.

"Joint Service Pollution Prevention Opportunity Handbook," maintained by the Naval Facilities Engineering Service Center (NFESC), undated.

"Supply Catalog," General Services Administration, Spring 1997.

SECTION 8.0

A-106 REPORT SUMMARY

8.1 GENERAL

The references to various equipment vendors in sections 2-8 do not constitute an endorsement by IERA/RSEQ. However, these sections do include suggested equipment justifications for use in submitting requests under the A-106 program. The narratives can be modified, if necessary, and electronically copied and added to WIMS-ES for submission.

All narratives are based on successful A-106 submissions from several installations. No specific manufacturers or models are used in our examples to allow the requester the greatest flexibility in mission accomplishment. The operational aspects and environmental areas of concern are accurate. Pay back periods are estimates and may differ based upon the equipment manufacturer and model and actual operational parameters.

8.2 CLEAN-UP OPERATIONS/ PAINT THINNER RECYCLING

Replace manual paint spray gun cleaning methods with paint spray gun washers.

Narrative: (Manufacturer, nomenclature, model #, part #) paint gun washers will be used by (Facility) to clean HVLP guns. Cleaning solvents are recycled and reused resulting in an 80% reduction in the amount of solvent purchased ($77) and waste disposed in waste disposal ($240), and additional savings ($81) in labor. This purchase supports reduction efforts in the purchase of EPA 17-containing products and generation of hazardous waste as reducing air emissions. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

Install a solvent/thinner distillation unit.

Narrative: (Manufacturer, nomenclature, model #, part #) distillation unit will be used by (Facility) to recycle solvents/thinners. The basic components of a distillation unit are the process chamber or boiler, encapsulated heaters, a water-cooled chamber, and associated piping and instrumentation. This unit will allow the reuse of the material thereby reducing replacement and disposal costs. Disposable vessel liners can be used to provide simple collection and disposal of still bottoms. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

8.3 DEGREASING OPERATIONS.

Replace current petroleum-based solvent tanks with aqueous cleaners.

Narrative: (Manufacturer, nomenclature, model #, part #) aqueous parts washer will be used by (Facility) to clean metal parts. A biodegradable detergent solution is used and may be discharged into the local sewer system (NOTE: determine compliance with local discharge limitations). The cleaning solution is internally filtered by skimming oil from the solution, and removing any sludge waste which has settled to the bottom of the washer. These closed-loop systems enable the user to reuse the detergent solution several times before requiring fresh solution. A parts washer will reduce material costs, air emissions, and hazardous waste generation/disposal. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

8.4 DE-PAINTING OPERATIONS

Replace current sanding and chemical stripping with plastic media bead (PMB) blasting operations.

Narrative: (Manufacturer, nomenclature, model #, part #) Plastic Media Bead Blasting is to be used by (Facility) to replace chemical stripping. Procurement of EPA 17-containing substances would be reduced by 3,744 pounds annually and hazardous waste disposal costs by would be reduced by $7,650 annually. Labor savings contribute the greatest degree of saving ($610,900). The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems. Regulatory compliance requirements of Title 40 CFR 261 are significantly reduced.

Install a vacuum system paint stripping process to collect plastic media bead (PMB), blasting material and removed coating material.

Narrative: (Manufacturer, nomenclature, model #, part #) the vacuum systems paint stripping process will be used by (Facility) to control the release of particulate matter and facilitate the collecting of used PMB for reuse and ultimate recycling. This equipment will result in a 50% reduction in labor saving ($1800) time during set-up and clean up and elimination of hazardous waste ($9000). The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

8.5 PAINT MIXING OPERATIONS

Install a plural component proportioning systems

Narrative: (Manufacturer, nomenclature, model #, part #) plural component proportioning system will be used by (Facility) to proper mixing and precise generation of paint required by an application. Mix on demand saves material, labor and maintenance, and generates less waste. The plural component proportioning system is a closed system and, as a result, there are fewer spills, less contamination or waste to clean up, and less contact between personnel and potentially hazardous materials. In addition, the proportioning system makes bulk purchase of material practical. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

8.6 PAINTING OPERATIONS.

Replace manual paint spray gun cleaning methods with paint spray gun washers.

Narrative: (Manufacturer, nomenclature, model #, part #) paint gun washers will be used by (Facility) to clean HVLP guns. Cleaning solvents are recycled and reused resulting in an 80% reduction in the amount of solvent purchased ($77) and waste disposed in waste disposal ($240), and an additional saving ($81) in labor. This purchase supports reduction efforts in the purchase of EPA 17-containing products and generation of hazardous waste as reducing air emissions. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

Replace current high pressure siphon paint spray guns with high volume low pressure paint spray guns.

Narrative: (Manufacturer, nomenclature, model #, part #) HVLP paint spray guns will be used by (Facility) to replace antiquated high-pressure siphon guns. Fifty percent reductions in air emissions, paint costs, and labor rates can be realized as a result of the higher transfer efficiencies of HVLP guns. This purchase supports hazardous waste reduction goals and reduces air emissions. The purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy" for all industrial, maintenance, cleanup operations, and those used/generated in support of USAF weapons systems.

8.7 PAINT BOOTH VOC EMISSION CONTROL.

Install VOC Emission Controls in Paint Booth.

Narrative: (Manufacturer, nomenclature, model #, part #) carbon adsorbers will be used by (Facility) to reduce volatile organic compound (VOC) emissions. According to "Pollution Prevention Funding Guidance," HQ USAF/ILEV, 12 September 1997, non-recurring projects that reduce air compliance requirements and/or emissions are valid projects for pollution prevention programming and budgeting. Further, the purchase of this equipment supports the hazardous material/waste reduction requirements contained in AFI 32-7080, "Pollution Prevention Program," AFI 32-7086, "Hazardous Materials Management," and the "Air Force Pollution Prevention Strategy."

The above A-106 does not include the cost of the VOC emission control, annual cost savings, or estimated payback. Det 1 HSC/OEBQ cannot provide more accurate cost data for the procurement and installation of a carbon adsorber system due to the number of variables involved. These include targeted VOC, ventilation rates, contaminant generation rates, size of facility, etc. Specific VOC carbon adsorber cost factors also include the volumetric flow of the VOC laden gas passing through the carbon beds; inlet and outlet VOC mass loadings of the gas stream; adsorption time; and working capacity of the activated carbon. Fixed-bed versus canister-type adsorbers further affect costs. Direct annual costs such as steam, cooling water, electricity, carbon replacement, labor, and possibly recovery costs must also be determined.

The best source of information for the cost of these controls is the Hazardous Air Pollutant Program (HAP PRO). The primary purpose of (HAP-PRO) is to assist permit engineers in reviewing applications for control of air toxics. HAP-PRO calculates the capital and annual costs for up to six different volatile organic compounds (VOCs) and three particulate control devices, including selected engineering parameters. Calculations used by the program mirror those presented in the EPA Handbook, "Control Technologies for Hazardous Air Toxics," June 1991, EPA-625/6-91/014, and the EPA's "Control Cost Manual," March 1990, EPA-450/3-90/006.

A secondary purpose of HAP-PRO is to generate reports that list all facilities containing:

- A specified pollutant in their emission stream(s), or
- A specified type of emission stream (for example, organic or inorganic vapors and particulates).

HAP-PRO also includes an expert review system for the design of thermal incinerators, catalytic incinerators, and carbon adsorber systems. The program reviews the design results generated, makes recommendations for changes, and allows easy evaluation of design sensitivities. By using HAP-PRO and inputting the necessary data from your existing or proposed facility, you can assess the approximate costs of VOC emission control technologies (An EPA representative suggested increasing the HAP-PRO costs by 20% to allow for inflation). This database and associated manuals is available on the internet at: http://www.epa.gov/ttncatc1/products.html #software.

Additional guidance is also available in "Carbon Adsorbers," U.S. EPA, December 1995 (http://www.epa.gov/ttncatc1/products.html#cccinfo).

SECTION 9.0

MISCELLANEOUS OPPORTUNITIES

9.1 Fuel Dispensing - It is important to specifically mention AAFES gas stations. Often, emissions from the AAFES gas station contribute up to 50% of a base's HAPs. On 2 August 1996, the EPA published a memorandum titled "Major Source Determinations for Military Installations under the Air Toxics, New Source Review, and Title V Operating Permit Programs of the Clean Air Act." This memo established several policies regarding major source determination at military installations. As mentioned in the 2 Aug 96 memo, military installations include numerous activities that are not normally found at other types of sources. These types of activities include residential housing, schools, day care centers, churches, recreational parks, theaters, shopping centers, grocery stores, BX gas stations, and dry cleaners. These activities are located on military installations for the convenience of military personnel (both active duty and retired), their dependents, and DOD civilian employees working on the base, and they often do not represent essential activities related to the primary military activity(ies) of the base. Therefore, the EPA believes these types of activities may appropriately be considered not to be support facilities to the primary military activities of a base. As such, these activities may be treated as separate sources for all purposes for which an industrial grouping distinction is allowed. Such activities should be separately evaluated for common control, SIC code, and support facility linkages to determine if a major source is present. Many bases have successfully removed their AAFES gas stations from their inventories and do not consider the emissions from this source when determining major source status.

9.2 Woodshop – Most base wood shops uses a large diameter, low efficiency cyclone for dust collection. This type of cyclone may be able to achieve 80% capture efficiency when functioning properly. Particulate emissions reductions could be realized with the installation of a smaller diameter, high efficiency unit. A high efficiency cyclone should achieve 95% to 99% capture efficiency in the type of operation found at most installations.

9.3 Pollution Prevention (P2) Training - It is recommended that training be given on how to determine VOC content to all personnel responsible for ordering VOC containing materials. Personnel responsible for ordering hazardous materials in many of the shops were unfamiliar with available emission reducing product substitutions and how to evaluate these products. Further, it is recommended that general P2 awareness training be given to all supervisors of industrial processes. With their knowledge of the industrial processes, first line supervisors often are able to offer effective pollution prevention ideas if given some fundamental training. General P2 training should focus on equipping supervisors to objectively evaluate their processes using techniques such as product substitution, work practice changes, and equipment modifications.

9.4 Lead-free Ammunition – Air emissions from small arms training can be reduced by using "green bullets." The Department of Defense (DoD) has initiated the Green Bullets program in an effort to eliminate the use of hazardous materials, including heavy metals and organic solvents, in small-caliber ammunition manufacturing processes, as well as in the ammunition itself. This initiative is led by the U.S. Army's Armament Research, Development, and Engineering Center (ARDEC) and encompasses all environmental aspects of small-caliber ammunition, from 5.56 mm through 0.50 caliber. Over 400 million units in this size range are produced each year in the U.S. Elimination of the hazardous materials that constitute small-caliber ammunition could result in production cost reductions totaling several million dollars per year. Several alternatives to lead in primers and projectile slugs are being evaluated, including bismuth, molybdenum, tungsten, steel/iron, and copper. Other benefits of lead-free ammunition include:

- Elimination of indoor range lead contamination;
- Elimination of adverse effects on outdoor ecosystems and reduced costs of any cleanups;
- Reduction of ammunition production costs; and
- Reduction of exposure risks to users and manufacturing personnel.

Stock-listed lead-free training ammunition (reduced range) is currently available to the military in 5.56 mm and 0.50 caliber ball, and tracer sizes. For more information about the Green Bullets program, contact Mr. Wade H. Bunting, U.S. Army ARDEC, (973) 724-6040, DSN 880-6040.

9.5 Solvent Wipe Cloths – Several shops perform handwipe cleaning of surfaces using rags (or other type cloths) and a chemical solvent. Dirty rags/cloths used for handwipe cleaning are then either disposed of in the trash or are placed into a container lined with a plastic bag. Those rags which are placed into bags are then sent off-base for proper disposal or laundering. To reduce VOC emissions, it is recommended that the rags/cloths be placed into plastic bags as soon as possible after use (i.e., do not allow them to air dry). For rags which are extremely saturated with solvent, the excess liquid solvent may be "wrung out" prior to placing the rags into the plastic bag. Of course any liquid solvent which is wrung out of the rags must be placed into a closed container and properly disposed of.

9.6 Fuel Cell Maintenance - This shop uses MEK for cleaning fuel cell surfaces prior to applying sealants and patches. The cleaning is performed in accordance with T.O. 1-1-3, "Inspection and Repair of Aircraft Integral Tanks, and Fuel Cells," and involves using a cheesecloth material to hand wipe the MEK on the surface to be cleaned. Once cleaning is complete, the cheesecloth is usually air dried and placed in the trash. The following are some possible pollution prevention opportunities associated with fuel cell maintenance operations:

a) A review of T.O. 1-1-3 reveals that various alternative compounds may be used in lieu of MEK for surface cleaning and solvent purposes. The alternatives which can be used depends on the specific procedure. The following are examples of some sections in T.O. 1-1-3 which address cleaners/solvents:

- Section 4-8, "Integral Tank Temporary Repairs" – This section allows the use of any of the following compounds for cleaning purposes: MEK, MIL-C-38736 (four-part cleaner), or other solvent listed in Section VIII of T.O. 1-1-3.
- Section 6-8, "Permanent Repairs" – This section allows the use of either MEK or MIL-C-38736 (four-part cleaner) for cleaning purposes.

- Sections 7-8, 7-9, 7-10 – For cleaning purposes, this section allows the use of either MEK, MIBK, or MIL-C-38736 (four-part cleaner). For solvent purposes (e.g., activating and/or re-moistening cement, moistening fittings, etc.), these sections allow the use of either MEK or MIBK.

Due to the relatively high vapor pressure of MEK (≈ 77 mm Hg @ 70° F) and the fact that it is a hazardous air pollutant (HAP), an alternative cleaner/solvent should be used whenever possible. For some procedures, only MEK and one or two other cleaners/solvents are authorized. These other cleaners/solvents are usually MIBK and MIL-C-38736 cleaning solvent. Both MIBK and the MIL-C-38736 cleaning solvent are considered more environmental friendly than MEK. Although MIBK is also a HAP, it has a much lower vapor pressure than MEK. Although the MIL-C-38736 cleaning solvent contains MEK and may contain toluene (another HAP), it does have some non-HAP ingredients and also has a lower vapor pressure than MEK. For some fuel cell maintenance operations (e.g., those specified in Section 4-8 of T.O. 1-1-3) any of the eleven cleaners/solvents listed in Section 8-10.3 of T.O. 1-1-3 can be used. Of these solvents, "Cleaner Compound, MIL-C-87937" appears to be the most environmental friendly since it is an aqueous-based product. Acetone is also considered to be environmental friendly from an air quality perspective since it is not considered to be either a VOC or a hazardous air pollutant. However, it's important to keep in mind that acetone is extremely flammable/volatile and may not be desirable for fire safety reasons. After the MIL-C-87937 cleaner and acetone, from an environmental standpoint we would recommend either isopropyl alcohol, ethyl alcohol, ethyl acetate, or naptha. Next, we would recommend either MIBK or the MIL-C-38736 cleaning solvent.

b) Instead of allowing the cleaner/solvent on the used cheesecloth to evaporate, we recommend placing the wet cheesecloth in an approved static-free bag for purposes of minimizing VOC emissions. It's important that the bag be kept closed at all times and that it be disposed of in accordance with applicable federal, State, and local regulatory requirements (note – if acetone is used as the cleaner/solvent, the cheesecloth can be air dried since acetone is not a VOC).

9.7 Equipment Purchasing Coordination – Evidently, process owners may not be coordinating equipment purchasing decisions with the base environmental planners. Without this coordination, equipment may be purchased without considering opportunities for emissions reductions. Often, the only cost effective time to install lower emitting technologies is when old equipment is replaced. Therefore, the base may be missing out on emissions and cost savings when these purchasing decisions are made without the advice of the environmental staff. It is recommended that the base initiate a better coordination process to ensure the environmental office is included in equipment purchasing decisions.

9.8 Aircraft Engine Testing - Engine coking is a primary reason why most aircraft engines require maintenance and retesting. However, coking can be greatly reduced through the use of JP-8+100 fuel instead of the standard JP-8 fuel. Therefore, switching to JP-8+100 fuel should decrease the amount of jet engine testing performed, and hence, reduce the amount of air emissions from this source category.

SECTION 10.0

POLLUTION PREVENTION WEB SITE RESOURCES

The following alphabetical listing of pollution prevention world wide web (WWW) sites is provided for your use in assessing potential pollution prevention opportunities at base-level. Regulatory saguidance or interpretations/clarifications of regulatory guidance, process-specific product substitutions, waste minimization techniques, and lessons learned are all available through the internet. This listing, while only partial, should prove useful to air quality managers in the management of their programs.

Organization	*Content*	*Website*
Air and Waste Management Association	This site provides quality environmental information on publications, meetings, key links, public outreach, news items, education, and certification.	http://www.awma.
Air Force PRO-ACT	Promotes crossfeed of environmental information	http://www.afcee.brooks.af.mil/PRO-ACT
Army Environmental Center Homepage	The AEC integrates, coordinates and oversees implementation of the Army's environmental programs, and provides technical services and products to HQDA, MACOMs and Commanders.	http://aec-www.apgea.army.mil:8080/
Center for Clean Technology	The Center for Clean Technology WWW Site provides information on the Center's environmental research and associated activities.	http://cct.seas.ucla.edu
Center for Technology Transfer and Pollution Prevention: CT2P2	The Center provides the tools necessary to transfer technical information about the environment and pollution prevention worldwide. It develops and evaluates new computer-based pollution prevention and technology transfer opportunities.	http://pasture.ecn.purdue.edu/cttpp/index

Organization	*Content*	*Website*
Coating Alternatives Guide (CAGE)	An expert system and information base designed to recommend low-emitting alternative coating technologies to coatings users.	http://cage.rti.org/
Defense Environmental Network & Information eXchange (DENIX)	Interesting success stories can be found under "Public Menu", "Environmnetal Security", "Pollution Prevention", under Accomplishments and Future Directions choose "P2 Success Stories", "P2 Success Story", and scroll down for the interesting ones.	http://denix.cecer.army.mil/denix/denix.html
Defense Standardization Program (DSP)	Acquisition Practices Directorate ODUSD(Industrial Affairs & Installations) Frequently Asked Questions page	http://www.acq.osd.mil/es/std/faq.html
Defense Supply Center	This site has information on procurement, suppliers, and links to other environmental procurement sites.	http://www.dscr.dla.mil
Department of Defense	The Defense Standardization Program (DSP)	http://www.acq.osd.mil/es/std/
Environmental Industry Web Site	This site provides information about companies which provide environmental services and products, opportunities for environmentally oriented businesses, and resources for the environmental industry as a whole.	http://www.ec.gc.ca/

Organization	*Content*	*Website*
HAP Status Binder	The purpose of this document is to keep the Services up-to-date on the status of National Emission Standards for Hazardous Air Pollutants, New Source Performance Standards/Emission Guidelines, and Control Technique Guidelines that affect the Military.	http://denix.cecer.army.mil/denix/DOD/ Library/HAP/hapindex.html http://www.denix.osd.mil/denix/DOD/ Library/HAP/hapindex.html (DoD access only)
Information Center for the Environment	ICE is a cooperative effort of an interdepartmental team of environmental scientists at the University of California, and collaborators at over thirty private, state, Federal, and international environmental organizations.	http://ice.ucdavis.edu/
National Defense Center for Environmental Excellence (NDCEE)	The NDCEE was established by the Department of Defense (DoD) to take action in critical areas of environmental concern for the DoD, other government organization, and industry.	http://www.ndcee.ctc.com/
National Pollution Prevention Center for Higher Education	The National Pollution Prevention Center, located at the University of Michigan, was created in 1991 by the U.S. EPA to compile, produce, and distribute educational materials on pollution prevention.	http://www.snre.umich.edu/nppc/
Northeast Business Environmental Network (NBEN)	The NBEN provides access to information about pollution prevention and cleaner production, as well as discussion groups for area businesses.	http://www.fedworld.gov

Organization	*Content*	*Website*
P2 Gems	Developed by the Toxics Use Reduction Institute, P2 Gems is an internet search tool for facility planners, engineers, and managers who are looking for technical and process/materials management information on the Web.	http://www.turi.org/P2GEMS
SAGE	Solvents Alternative Guide	http://clean.rti.org/
U.S. Environmental Protection Agency	Information is provided under headings including rules, regulations, and legislation; science, research, and technology; and EPA standards.	http://www.epa.gov/
U.S. EPA's Significant New Alternatives Policy Program (SNAP)	Information on alternatives to Class I and Class II ODSs.	http://www.epa.gov/ozone/title6/snap/

SECTION 11.0

KEYWORD INDEX*

SECTION

SUMMARY OF AIR EMISSIONS CALCULATIONS IMPROVEMENTS 1.0

actual emissions, calculation methodology, fugitive emissions, JP-8 emission factors, potential to emit, speciation, Title V Permit, transfer efficiency, volatile organic chemicals

AEROSPACE GROUND SUPPORT EQUIPMENT (AGSE) 2.0

combustion, fuel injector, item manager, maintenance, spill prevention

BOILERS 3.0

AFCESA, emergency boilers, low NOx burners, natural gas, recirculation

EMERGENCY GENERATORS 4.0

combustion modification, flue gas, timing, air to fuel ratio

FUEL STORAGE/DISPERSING OPERATIONS 5.0

fixed roof tanks, floating roof tanks, seal, vacuum assist, vapor losses, vapor recovery

SOLVENTS 6.0

alkaline, aqueous, citrus, detergents, enzyme, P-D-680, water-based

SURFACE COATING OPERATIONS 7.0

booths, carbon adsorption, paint gun cleaner, paint stripping, HAP-PRO, HVLP, primer, proportioning system, solvent distillation, VOC compliant,

* Keywords are included for sections 1-7.