HAP EMISSIONS REDUCTION SURVEY FOR ELMENDORF AIR FORCE BASE ALASKA

Submitted To:

3 CES/CEVQ
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-3240

Prepared By:

Air Quality Branch
Environmental Analysis Division
Institute for Environment, Safety, and
Occupational Health Risk Analysis (IERA)
2513 Kennedy Circle Brooks AFB, TX 78235-5123
DSN 240-3305, COMM 210-536-3305
Fax 210-536-3945
Website: http://sg-www.satx.disa.mil/iera/rse/air.htm

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HAP Emissions Reduction Survey Elmendorf AFB, AK

As part of a continuing strategic plan to prevent and reduce pollution, Elmendorf AFB (3 CES/CEV) requested the Air Quality Branch of the Institute for Environment, Safety and Occupational Health Risk Analysis (IERA/RSEQ) conduct a comprehensive Hazardous Air Pollutant (HAP) emissions reduction survey. The purpose of this survey was to determine methods of reducing HAP emissions through project initiatives. This report provides evaluation of engineering controls, process changes, administrative controls, and other cost effective means to reduce air emissions.

The HAP emission reduction survey at Elmendorf AFB was conducted in two phases. The first phase included an on-site survey of the installation, which was conducted from 21 to 25 Jun 99. During the site visit, Capt Grant Johnson and Mr. Mark Wade gathered data for process operations and material consumption, and interviewed installation personnel. The second phase of the survey involved researching methods to reduce emissions and determining emission reduction strategies.

The overall intention of this effort was to provide Elmendorf AFB with a list of project initiatives, including cost estimates, to reduce actual and potential air emissions, thereby diminishing regulatory permit requirements. A hierarchical approach was used in evaluating opportunities with emphasis on pollution elimination and reduction. The base's existing Air Emission Inventory (AEI) and Title V Permit Application were reviewed to determine those processes responsible for the greatest actual and potential HAP emissions and those processes that would potentially benefit the most from a project designed to reduce emissions. During the field survey, the project team visited each process or shop that was identified as a significant source of HAP emissions. The project team then researched and evaluated available opportunities for emissions reduction.

Overall, Elmendorf AFB has made significant strides towards reducing air emissions while maintaining operational capability and flexibility. Nevertheless, further emissions reductions are possible. Project initiatives were identified for the following sources: surface coating operations, internal combustion engines, incinerators, gasoline distribution, and aircraft engine testing.

The survey was conducted within the following constraints: prevalent Air Force Instructions, military technical orders, Air Force Civil Engineer Support Agency (AFCESA) guidance, base level practices, federal, regional, and/or state air pollution guidance.

SECTION 1

INTRODUCTION

At the request of 3 CES/CEV, a team from the Institute for Environment, Safety, and Occupational Health Risk Analysis (IERA), accomplished a Hazardous Air Pollutant Emissions Reduction Survey from 21 through 25 Jun 99. The objective of this survey was to determine methods of reducing HAP emissions through project initiatives, thereby diminishing regulatory permit requirements. This report provides evaluation of engineering controls, process changes, administrative controls, and other cost effective means to reduce air emissions.

The survey included a document review of the air emission inventory (AEI), Title V Permit Application, HAZMART Pharmacy reports, and Material Safety Data Sheets (MSDS). During the field survey, team members visited selected industrial work centers and interviewed key personnel to validate existing operations and assess opportunities for emission reductions. Certain industrial work centers were targeted because of their contribution of emissions and potential for emissions reductions. The primary areas investigated include Corrosion Control, Transportation, AAFES service station, Base Fuels, Aerospace Ground Support Equipment (AGSE), and Civil Engineering.

Survey Team Members: Capt Grant Johnson, Consultant Engineer, Team Leader
Mr. Mark Wade, Consultant Engineer

Following is a list of key personnel contacted during the completion of this survey:

Mr. David Bennett	CEVQ	DSN 317-552-2760
Mr. Hansen	CEV	DSN 317-552-1741
Mr. Steve Cambell	Corrosion Control	DSN 317-552-4378
SSgt Twiford	Transportation	DSN 317-552-9512
SMSgt Lewis	Transportation	DSN 317-552-0223
Station Manager	AAFES	(907) 753-7120
Mr. Welch	AGSE	DSN 317-552-5035
TSgt Sas	AGSE	DSN 317-552-5035
Capt Merkle	HAZMART	DSN 317-552-7446
SSgt Whitten	Fuels Management	DSN 317-552-2941
Mr. Schramm	CE Paint Shop	DSN 317-552-2556
Ms. Anne Schlapia	Municipality of Anchorage	(907) 343-4715

SECTION 2

SURFACE COATING OPERATIONS

Surface coating operations involve the application of primers and/or topcoats to protect a large range of equipment and surfaces. Elmendorf AFB currently operates eight paint booths where most of the surface coating work is conducted. One large and two small paint booths are located at the Corrosion Control Shop and one booth located on the North side of the base is also used to paint aircraft parts, two booths are located at the Transportation Shop, one booth is located at the Aerospace Ground Support Equipment Shop, and one booth is located at the Civil Engineering Vertical Repair Shop. Paint removal operations are conducted either in a large walk-in media-blasting booth, in smaller glove-box media blasting booths, or by hand with sanding equipment. Paint touch-up operations occur in both the booths and in the open.

FACILITY OR PROCESS EVALUATIONS

Corrosion Control Shop: This facility is primarily responsible for surface coating operations for all aircraft. Typically, the aircraft or the section of the aircraft requiring work is first scuff sanded, via vacuum sanders, then an epoxy primer is applied followed by a polyurethane topcoat. Some low VOC 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. The large paint spray booth is equipped with three-stage particulate filters along with carbon adsorption. The two smaller booths in the Corrosion Control Shop and the booth on the North side of the base are equipped with only single-stage particulate filters. According to Mr. Steve Cambell, 30 to 40% of the painting is conducted in the smaller booths without carbon adsorption. The painters have discontinued using MEK as a wipesolvent and now use only isopropyl alcohol for solvent wipedowns. Coatings are applied with a High Volume Low Pressure (HVLP) paint spray gun.

Transportation Shop: This shop is primarily responsible for surface coating operations of motor vehicles. According to shop personnel, approximately 20 vehicles are painted each month. This shop operates two side-draft paint booths equipped with single-stage dry particulate filters. Paint is applied to the vehicles with a HVLP spray system. The painters utilize a Herkules brand gun cleaner filled with polyurethane thinner. They also have vacuum assist sanding equipment for control of particulate emissions from sanding dust. Most of the paints that are used in the booths are not considered low VOC paints. PPG, the manufacturer who supplies most of the automotive paints, carries both the high and low VOC paints which are approved for use on government vehicles. Also, according to SSgt Twiford, approximately 12 paint spray cans are used daily for various touch-ups.

Aerospace Ground Support Equipment (AGSE) Shop: This shop utilizes one paint spray booth for the surface coating of various AGSE equipment. The booth is equipped with a single-stage dry particulate filter. The painters utilize a Herkules brand gun cleaner filled with polyurethane thinner. According to shop personnel, approximately 30 to 35 pieces of AGSE are painted per month with paint usage of approximately 2 gallons per day. The painters use only isopropyl alcohol as a wipe solvent and use vacuum-assisted sanders inside a separate booth for preparation of the pieces for painting.

Autohobby Shop: The booth in this shop is no longer operational.

Civil Engineering Paint Shop: This shop is responsible for painting the base infrastructure (e.g. buildings, swimming pools, parking lot markings, etc). Paint is applied with HVLP, airless, and conventional spray guns. A paint booth is used infrequently and is fitted with single-stage particulate filters. Some low VOC coatings are used but many coatings contain high levels of VOCs.

OPPORTUNITY ASSESSMENTS

Paints: The base has begun switching to high solids/low VOC paints, but not all paints currently used are considered low VOC. Further emissions reductions can be realized by completing the switch to low VOC (e.g., high solids/low solvent) paints/primers. The HAP emissions from surface coating operations will be reduced as the VOC content is reduced in the paints applied. Also, using Sempen paint applicators for most touch-up applications can reduce HAP emissions. It is recommended that shops begin using strictly low VOC paints since they are available and approved for use.

As an example of the emissions that could be saved from switching completely to low VOC paints, we estimated the emissions savings in the Transportation, Corrosion Control, AGSE, and Civil Engineering Shops from simply using low VOC paints. The available low VOC paints typically have a reduced HAP content of approximately 50% of the concentration in the paints presently used. The difference in cost between the low VOC alternatives and those paints with higher VOC content is minimal.

EMISSIONS REDUCTIONS USING LOW VOC PAINTS

Shop	Pollutant	Actual Emissions (lb/yr)	Emissions Using Low VOC Paints (lb/yr)	Emissions Reductions (lb/yr)
Transportation	VOC	633.6	384	249.6
	Toluene	174	87	87
	Xylene	42	21	21
	MEK	45.6	22.8	22.8
	Other HAPs	30	15	15
Corrosion Control & AGSE	VOC	2813.2	2208.4	
	Toluene	126.9	63.45	604.8
	Xylene	12.4	6.2	6.2
	MIBK	316	158	158
	MEK	164.1	82.1	82.1
	Ethyl Benzene	6.2	3.1	3.1
Civil Engineering	VOC	712.6	560	152.6
	Toluene	94.1	47.1	47.1
	Xylene	67.6	33.8	33.8
	Ethyl Benzene	13	6.5	6.5
	Methanol	19.5	9.8	9.8

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 than paint spray cans (see the Sempen section starting on the next page). If paint spray cans must be used due to the size of the touch-ups, low VOC paint spray cans are available. Most of the aerosol spray paints used in the Transportation Shop have a high VOC content which is typically 80% to 85% VOC. Low VOC aerosol paints are available through government supply or through a local supplier. Typically the VOC content is 60%.

Presently Used NSN	Replacement NSN
8010-00-141-2950	8010-01-350-5259
8010-00-582-5382	8010-01-331-6108, 8010-01-331-4707
8010-00-584-3150	8010-01-331-6106, 8010-01-350-5255
8010-00-290-6984	8010-01-331-6107
8010-00-721-9749	8010-01-331-6107
8010-00-721-9747	8010-01-350-4757
8010-00-290-6983	8010-01-371-6105, 8010-01-350-5254
8010-00-721-9746	8010-01-331-6115, 8010-350-4758
8010-00-079-3760	8010-01-331-6109

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 Chemical Agent Resistant Coating (CARC) paint is required if the USAF vehicle is going to be assigned to a joint military force involving the U.S. Army.

Environmentally compliant 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 stocked and available through GSA:

- 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 - 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 - 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 - 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).

- 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 list below). However for automobile touch-up we recommend the use of automotive touch-up paints with small brush applicators.

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

COLOR	NSN
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.

The General Services Administration (GSA), Paints and Chemicals Commodity Center has also identified and procured numerous low VOC, water-based or water-reducible primers and coatings for architectural use. 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.

Paint Booths: Another option to reduce HAP emissions from surface coating operations is to install a booth utilizing carbon adsorption that removes at least 85% of the hydrocarbons and HAPs in those areas that currently do not use carbon adsorption. Often it is most cost effective to replace the booth when installing carbon adsorption due to the myriad of parts that need to be upgraded. Currently, Corrosion Control operates the only booth utilizing carbon adsorption. The remaining booths on the base could be replaced with units capable of providing carbon adsorption. According to Mr. Jeff Brunn of JBI, Inc. (800-848-8738), a 20'x30'x8' booth utilizing carbon adsorption and three-stage particulate filters can be installed for approximately $70,000.

As an example of the emissions that could be saved from utilizing carbon adsorption in the rest of the booths on base, we estimated the emissions savings in the Transportation, Corrosion Control, AGSE, and Civil Engineering Shops:

EMISSIONS REDUCTIONS USING CARBON ADSORPTION ON PAINT BOOTHS

Shop	Pollutant	Actual Emissions (lb/yr)	Emissions Using Carbon Adsorption on the Paint Spray Booths (lb/yr)	Emissions Reductions (lb/yr)
Transportation	VOC	633.6	95.04	538.6
	Toluene	174	26.1	147.9
	Xylene	42	6.3	35.7
	MEK	45.6	6.84	38.8
	Other HAPs	30	4.5	25.5
Corrosion Control & AGSE	VOC	2813.2	422	2391.2
	Toluene	126.9	19	107.9
	Xylene	12.4	1.9	10.5
	MIBK	316	47.4	268.6
	MEK	164.1	24.6	139.5
	Ethyl Benzene	6.2	0.9	5.3
Civil Engineering	VOC	712.6	106.9	605.7
	Toluene	94.1	14.1	80
	Xylene	67.6	10.1	57.5
	Ethyl Benzene	13	2	11
	Methanol	19.5	2.9	16.6

A good 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 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).

Paint Gun Cleaning: Emissions could be reduced by installing automatic paint gun washers. The Corrosion Control Shop currently does not have any gun cleaners. Painters clean the guns by hand in the paint booths. The Transportation, AGSE, and CE shops use polyurethane thinner in Herkules gun cleaners. 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.

We estimated the emissions that could be saved with automatic gun cleaners, based on the solvent currently in use. We estimated base-wide thinner usage could be reduced by approximately 240 gallons per year with the usage of automatic paint gun washers. This would reduce VOC emissions by 1,700 lb/yr, MEK emissions by 520 lb/yr, toluene emissions by 180 lb/yr, and xylene emissions by 120 lb/yr.

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 typically range from $600 to $2,400.

Assumptions:

- 18 spray guns are cleaned per week
- Solvent required for automatic gun cleaning: 1 gallon/month
- Solvent required for manual gun cleaning using solvent distillation: 6 gallons/month
- 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	$50	$290
Waste Disposal	$230	$1,400
Total Operational Costs:	$750	$6,390
Total Recovered Income	$0	$0
Net Annual Cost/Benefit:	-$750	-$6390

Economic Analysis Summary

- Annual Savings for Automatic Washing: $5,640
- Capital Cost for Diversion Equipment/Process: $600-$2400
- 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

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. Although EP-921 is more expensive than thinner, it would further reduce emissions from the gun cleaning process since it contains no HAPs. 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 Application: One of the most effective strategies for reducing the 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.

Dr. Ron Joseph conducts an excellent training session for painters and their managers on how to reduce emissions through proper painting techniques. He would be able to put on a training seminar for the painters on Elmendorf AFB for approximately $20,000. He can be reached at (408) 446-9736 or (http://www.paintcoatings.net/218.htm).

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: Emissions reductions are possible through the use of a plural component proportioning system at the Corrosion Control and AGSE shops. 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.

We estimated the emissions that could be saved with a plural component proportioning system, compared to the operations currently in use. Based on the assumption below, we estimate such a system would reduce VOC emissions by 705 lb/yr, MEK emissions by 115 lb/yr, toluene emissions by 50 lb/yr, MIBK emissions by 48 lb/yr, and xylene emissions by 22 lb/yr if implemented at Corrosion Control and AGSE.

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: 2,000 gallons
- Annual solvent usage for hand mixing system: 1,125 gallons
- Annual labor required for equipment cleaning using hand mixing system: 125 hours
- Annual solid paint waste generated using hand mixing system: 2,800 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:	$2,800	$5,650
Paint and Solvent:	$148,450	$177,900
Waste Disposal	$3,050	$6,150
Total Costs:	$154,300	$189,700
Total Income:	$0	$0
Annual Benefit:	$154,300	$189,700

Economic Analysis Summary

- Annual Savings for Plural Component System: $35,400
- 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.

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.

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

SECTION 3

INTERNAL COMBUSTION ENGINES

During the winter months, the airshed in and around the Municipality of Anchorage experiences elevated levels of carbon monoxide (CO). This phenomenon is due mainly to the incomplete combustion of fossil fuels in internal combustion engines at cold temperatures. Incomplete combustion is most likely to occur at low air-to-fuel ratios in the engine. These conditions are common during vehicle starting when air supply is restricted ("choked"), when cars are not tuned properly, and at altitude, where "thin" air effectively reduces the amount of oxygen available for combustion (except in cars that are designed or adjusted to compensate for altitude). Carbon monoxide emissions from automobiles increase dramatically in cold weather. This is because cars need more fuel to start at cold temperatures, and because some emission control devices (such as oxygen sensors and catalytic converters) operate less efficiently when they are cold. Due to the carbon monoxide serious nonattainment status of the Municipality of Anchorage, increasing attention has been placed on methods to reduce CO emissions. Mr. David Bennett, 3 CES/CEVQ, requested that IERA research available information pertaining to the use of block heaters, natural gas vehicles, and hybrid vehicles in reducing CO emissions.

Carbon monoxide (CO) is a colorless, odorless, poisonous gas consisting of a carbon atom and an oxygen atom linked together. Carbon monoxide is a public health concern because as it enters the bloodstream through the lungs it forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart disease are especially sensitive to carbon monoxide poisoning and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive. Carbon monoxide can affect healthy individuals, impairing exercise capacity, visual perception, manual dexterity, learning functions, and ability to perform complex tasks.

Block or Headbolt Heaters: Studies have been conducted to determine the efficacy of the use of headbolt or block heaters in reducing carbon monoxide emissions. The premise is that at very cold temperatures, heating the engine with an electric heater prior to starting will shorten the time to warm-up and therefore reduce cold-start emissions. A recent study presented at the 1997 Society of Automotive Engineers' International Fall Fuels & Lubricants Meeting & Exposition shows a sizeable reduction in both carbon monoxide and hydrocarbon (HC) emissions with the use of a block heater at cold temperatures. At minus 15 degrees Celsius, the researchers report a reduction in CO and HC emissions of 60% and 65%, respectively with the use of a block heater. The Municipality of Anchorage has also conducted emissions testing to determine the CO reductions with the use of block heaters. The Municipality's tests, conducted in 1998 and 1999, show a reduction in cold-start CO emissions ranging from 45% to 87% with the use of block heaters. Costs for block heaters can range from $20 to $100.

Natural Gas Vehicles: Another means of reducing carbon monoxide emissions is to switch to natural gas powered vehicles. According to the Natural Gas Vehicle Coalition, natural gas is the cleanest burning alternative transportation fuel available today. There are three primary reasons natural gas is an environmentally friendly fuel. First, natural gas typically consists of about 90 percent methane (CH_4). The emissions from natural gas vehicles also are primarily unburned methane. Methane is not a volatile organic compound (VOC). This is important because unburned and evaporative VOCs combine with oxides of nitrogen (NOx) in the presence of

sunlight to form ground level ozone. Natural gas also contains almost no toxic components. Gasoline and diesel fuels and their exhaust contain numerous harmful chemical agents. Diesel exhaust, for instance, contains over 40 substances listed by the U.S. EPA as hazardous air pollutants (HAPs) and by the California Air Resources Board (CARB) as toxic air contaminants. Gasoline exhaust contains many similar components.

Second, the fuel cycle emissions of natural gas are much less than other transportation fuels. Fuel cycle emissions include emissions that occur during energy extraction, processing, conversion, transportation, and distribution. Because it generally is not refined or transported by truck or barge, natural gas does not pose nearly the transportation related environmental and safety hazards associated with gasoline and diesel.

Third, as a motor fuel, natural gas provides superior emissions performance relative to gasoline and diesel. Among the reasons for this are that NGVs have virtually no evaporative and running loss emissions due to their sealed fuel systems and negligible refueling emissions and have lower cold-start emissions. Compared with most gasoline powered vehicles, dedicated natural gas powered vehicles typically reduce exhaust emissions of carbon monoxide considerably. In a report available on the U.S. EPA's Office of Mobile Sources website, ("Modeling Emissions from Natural Gas Vehicles," http://www.epa.gov/orcdizux/), researchers conducted emissions tests on a variety of diesel, gasoline, and natural gas powered vehicles. The following tables show their results:

	Emissions (lb/year)			Percent Reduction
	Diesel	**CNG**	**Reduction**	
School Bus				
PM	6.5	0.9	5.6	86%
NOx	121	65	56	46%
VOC	22	6	16	73%
CO	95	7	88	93%
CO2	28,904	24,857	4,047	14%
Garbage Truck				
PM	30.1	5.1	25	83%
NOx	629	342	287	46%
VOC	113	37	76	67%
CO	493	36	457	93%
CO2	150,097	129,083	21,014	14%

	Emissions (lb/year)			Percent Reduction
	Gasoline	**CNG**	**Reduction**	
Passenger Cars – Denver				
NOx	28	17	12	41%
VOC	19	1	18	96%
CO	163	20	143	88%
CO2	21,173	16,938	4,235	20%
Passenger Cars – Baltimore				
NOx	23	14	9	41%
VOC	21	1	20	95%

	Emissions (lb/year)			Percent Reduction
	Gasoline	CNG	Reduction	
CO	283	34	249	88%
CO2	21,173	16,938	4,235	20%

In recent emissions testing by the Municipality of Anchorage, several gasoline and natural gas vehicles were tested to compare cold-start emissions. This testing showed the following emissions characteristics:

Vehicle	Amount of CO (grams)
Dirtiest Gasoline Vehicle	498.8
Average Gasoline Vehicle	138.4
Cleanest Gasoline Vehicle	24
Dedicated-Fuel CNG Vehicle	2.7

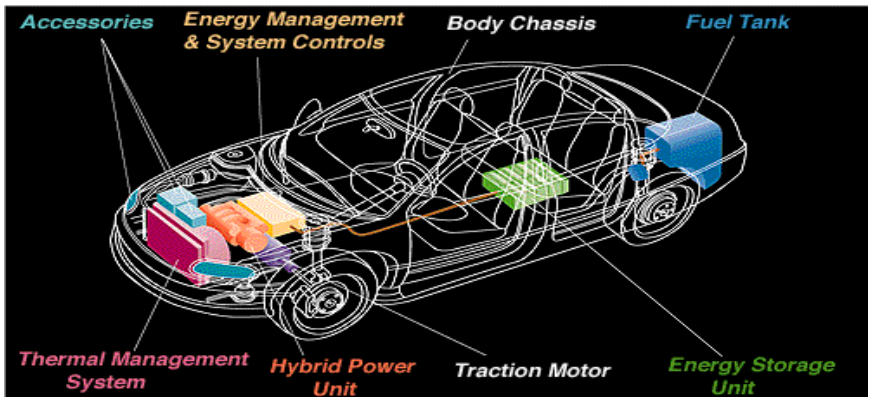
This testing shows approximately a 98% reduction in CO emissions from the dirtiest gasoline vehicle to a dedicated-fuel CNG vehicle.

According to Mr. Vince Fiore, vice president and general manager of the natural gas business unit of the Gas Research Institute (GRI), "Cummins Engine Co. is far and away the leaders in the heavy-duty natural gas vehicle engine arena." In January 1998, Cummins was the first heavy-duty engine manufacturer to receive the Environmental Protection Agency (EPA) Ultra-Low Emissions Vehicle (ULEV), EPA Low Emissions Vehicle (LEV) and California Air Resources Board (CARB) Optional Low NOx emissions certifications for its complete alternative fuels product line. As such, cost information is provided for the currently available natural gas engines manufactured by Cummins in the chart below:

Engine Platform	Rated Power (hp @ rpm)	Torque Peak (ft-lb @ rpm)	Cost
B5.9G	230 @ 2800	500 @ 1600	$18,998
	195 @ 2800	420 @ 1600	$17,048
	150 @ 2500	375 @ 1500	$16,058
C8.3G	275 @ 2400	750 @ 1400	$37,415
	250 @ 2400	660 @ 1400	$28,826
L10G	300 @ 2100	900 @ 1300	$27,009
	280 @ 2100	900 @ 1300	$27,009

The cost of natural gas engines are typically 75% greater than a comparably sized diesel engine. Operational costs for natural gas vehicles are lower, however, compared to diesel or gasoline powered vehicles. According to the Natural Gas Vehicle Coalition, fleet operators are reporting savings on fuel costs of up to 40 percent and savings on maintenance of up to 15 percent. For more information on these engines contact Cummins, Inc. at 800-343-7357 or visit the website at: http://www.cummins.com

Hybrid Vehicles: Another method of reducing CO emissions would be to replace some or all of the base's light duty passenger vehicles with hybrid electric/gas vehicles when they become available.



A hybrid electric vehicle (HEV) is a vehicle that has two sources of motive energy. There are many hybrid system concepts using fuel cells, gas turbines, diesels, and lean burn gasoline engines in combination with flywheels, batteries, and ultracapacitors. No matter which concept is used, there are two ways to build the electric and fuel system of an HEV; using a parallel configuration or a series configuration. In a parallel design, the energy conversion unit and electric propulsion system are connected directly to the vehicle's wheels. The primary engine is used for highway driving; the electric motor provides added power during hill climbs, acceleration, and other periods of high demand. In a series design, the primary engine is connected to a generator that produces electricity; the electricity charges batteries and drives an electric motor that powers the wheels.

HEVs have several advantages over traditional internal combustion engine (ICE) vehicles. Some of these include:

- Regenerative braking capability, which helps minimize the energy lost when driving.
- Engine is sized to average load, not peak load, which reduces the weight of the engine.
- Fuel efficiency is greatly increased, while emissions are greatly decreased.
- HEVs can be operated using alternative fuels, therefore they need not be dependent on fossil fuels.

Regenerative braking is the process of making the motor work like a generator when the brake pedal is pushed, or when the vehicle is coasting. The kinetic energy of the vehicle (its mass and its velocity or speed) is converted back into electrical energy. The drive motor's electronic controller changes the motor to a generator and converts its AC electrical output to DC for the battery. Depending on how much start-and-stop driving or speed changes are experienced, a 15 to 20 percent increase in the range potential of the vehicle can be realized. A great advantage of regenerative braking is some of the energy that was expended to accelerate is recuperated. An added benefit is that this can also increase brake lining life.

The auto manufacturers' goal is to achieve these benefits with no appreciable loss in vehicle performance, range, and safety. With two drive trains (ICE running on gasoline or alternative fuels and a battery-driven electric drive train) the HEV is able to operate approximately two times more efficiently than traditional ICE vehicles. This is because the energy loss of an HEV is much less than that of a traditional ICE vehicle.

There are currently no Hybrid Vehicles available for sale in the United States; however, Toyota plans to introduce their HEV (the Prius) in the U.S. in 2000 (it's already being sold in Japan). Honda hopes to have their HEV, code-named "VV," on sale at Honda dealerships in all fifty states starting in the fall of 1999.

The Prius is a 4-5 passenger, 4 door sedan, whereas the Honda VV is a two passenger coupe that reportedly will weigh in at under 2000 pounds. The Honda "VV", which is expected to get in excess of 70 mpg in combine City/Highway driving cycles, borrows heavily from Honda's Integrated Motor Assist (IMA) system first shown in the J-VX concept car at the 1997 Tokyo Motor Show. According to Honda's official press release, the "IMA system features an extremely efficient 1.0-liter, 3-cylinder, lean-burn VTEC engine that is 'assisted' by an electric motor during acceleration." Coupled with a new 5-speed transmission, the VV is expected to have the same performance as a 1.5-liter, four-cylinder engine, but produce a fraction of the current emissions. Honda states the new engine will meet California's Ultra Low Emission Vehicle (ULEV) standards. The batteries will be nickel metal-hydride.

Honda VV

Toyota Prius

At a minimum, the Department of Energy (DOE) has specified that the propulsion systems developed in the Hybrid Vehicle Propulsion Program will meet Federal Tier II standards, which are 1.8, 0.16, and 0.13 g/mile for CO, NOx, and HC, respectively (versus the current Federal standards of 4.2, 0.60, and 0.31 g/mile).

For More Information, Contact:

- National Alternative Fuels Hotline 800-423-1DOE
- Office of Transportation Technologies Web Site: www.ott.doe.gov
- Toyota's Prius Web Site: http://www.toyota.co.jp/e/pr/1997/1014.1.html
- Honda's VV Web Site: http://www.evworld.com/reports/hondavv.html
- Department of Energy (DOE**)** On-line Resource Center http://www.hev.doe.gov/

Aerospace ground support equipment (AGSE): AGSE is used to support flightline operations. The equipment consists of generators, hydraulic pumps, engine starters, air compressors, light units, air conditioners, and heaters. Either internal combustion or turbine engines burning primarily JP-8 fuel typically power these units. Diesel and gasoline are also used as fuel, but to lesser extent.

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.

The Clean Cam Technology System (CCTS) is another promising new system that has the ability to reduce NOx, CO, and hydrocarbon emissions. The CCTS was briefly tested at the end of the Green AGSE study conducted by Brooks AFB. The technology reduced NOx emissions by over 70% and CO emissions by 43% on an AM32A-86D generator.

The patented CCTS emissions reduction technology uses a two-part system to effectively reduce emissions from conventional diesel engines. The first part involves the strategic redesign of both the exhaust cam profile and the cylinder liner. These modifications increase the volume of residual exhaust gases that remain in the cylinder during the compression, combustion, and power strokes. This redesign decreases the time required to achieve combustion temperature, effectively increasing the compression ratio and pressure. The increased heat absorption capacity of the residual exhaust gases (the exhaust gases remaining in the cylinder following the scavenge stroke) absorbs more combustion heat than standard designs and reduces peak combustion temperature.

The reduction in peak combustion temperature reduces NOx produced by the engine and allows for the injection timing to be advanced. In addition the advanced injection timing reduces PM emissions.

The second part of the CCTS emission reduction system involves the installation of a turbocharger component to provide additional oxygen to the combustion process. In order to install the CCTS modified engine in the –86 generator, it is necessary to relocate the blower from the right side of the engine to the left side. Additional oxygen provided to the heated combustion chamber of the engine accelerates the oxidation of the soluble organic fraction contained within the cylinder chamber. This additional charge of oxygen-rich air further increases the compression pressure causing the combustion mixture to reach its auto ignition temperature quicker and leads to an earlier combustion. The process affects a more complete combustion of the fuel which results in less CO and hydrocarbon emissions.

The projected costs to undertake additional testing of the CCTS are shown below:

Contract Labor- $20,000
Testing and Analysis, Travel- $65,000
CCTS and Transportation- $30,000
Oversite- $15,000
Total- $130,000

References:

Ahlvik, P., Almen, J., Westerholm, R., and Ludykar, D., “Impact of a Block Heater on Regulated and Some Unregulated Emissions from a Gasoline Fueled Car at Low Ambient Temperatures.” Society of Automotive Engineers, 1997.

SECTION 4

INCINERATORS

Based on the last air emissions inventory, Elmendorf AFB could eliminate the emissions shown in the following chart by replacing the non-medical waste incinerators (classified waste and overseas foodwaste) with alternative processes:

Emissions from Non-Medical Waste Incinerators at Elmendorf AFB

Pollutant	Actual Emissions (tons/yr)	Potential Emissions (tons/yr)
NOx	0.0	2.60
SO2	0.0	2.65
CO	0.004	0.25
PM-10	0.0	2.82
HCl	0.0	1.77
Aggregated HAPs (incl HCl)	0.03	1.78

Classified Waste Incinerator: Offut AFB has replaced their classified waste incinerators with the following disintegrating/degaussing equipment from Security Engineered Machinery (SEM):

- Classified Film Model 22HDS – Waste film is then sent to a reclaimer for recovery of precious metals (GSA price: $16,160.00)
- Magnetic tapes and CD's Model 1436
- Classified Paper and Plastics Model 1012 (GSA price: $9,090.00)

SEM can be contacted at 800-225-9293 or (http://www.semshred.com) for determining the proper size disintegrator for you operation.

The air quality manager at Offutt AFB is Mr. Bill Nettelmann and he can be reached at DSN 271-7621.

Literature on these devices is included in the appendix.

Overseas Foodwaste Incinerator: According to Mr. David Reeves, Safeguarding and Test Management Office, Plant Protection and Quarantine, U.S. Department of Agriculture, (301) 734-6799, there are two approved methods for destruction of foodstuffs from overseas returning aircraft: incineration and steam (autoclave) sterilization. We coordinated further with Dr. Ronald Caffey, USDA, (301) 734-7633, who stated existing USDA regulations allow for incineration or sterilization (internal temperature of 212 degrees F for a minimum of 30 minutes). Further, beverage containers (cans, tins, bottles, or plastics) do not require treatment providing these containers have been restricted to the aircraft drink cart and have not come in contact with food waste or other garbage. If these containers have come into contact with food waste or other garbage, then treatment is required prior to disposal as a solid waste. Dr. Caffey also stated autoclave treatment is less expensive than incineration and air emissions are eliminated. These units may be obtained from such manufacturers as:

- Sanipak, (209) 836-2310
- Bondtech Incorporated, (800) 414-4231

According to Sanipak, the cost to operate one of their sterilization units, including materials, labor utilities, hauling, maintenance, disposal costs and the capital equipment amortization, is between $.02 and $.04 per lb. with hauling costs between US $.02 and US $.05 per lb. for a total cost of US $.04 to US $.09 per lb.

Additional waste minimization may be achieved by segregating the trash prior to collection. For example, all aluminum cans or glass bottles can be collected from the aircraft passengers and bagged separately. Treatment of these items is still required to eliminate the potential for the release of animal or plant diseases to the environment. However, after treatment the items may be recycled thus reducing the amount of solid waste disposed of. Non-recyclable material can be disposed of as non-hazardous solid waste after treatment. Dr. Caffey cautioned this trash segregation to facilitate recycling is a deviation from established USDA procedures. He stated his office would authorize this deviation providing a compliance agreement between the generator and the local USDA was developed. This agreement should address the procedures to be used in handling the waste and how recyclables will be managed. For additional guidance, you can contact him (or Dr. John Gray or Dr. Liz Klontz, same telephone number) or you may mail your proposed compliance agreement to: USDA APHIS PPQ, Veterinary Medical Office, 4700 River Road, Unit 129, Riverdale, MD 20737-1231.

SECTION 5

GASOLINE DISTRIBUTION

One of the most cost effective methods to reduce hydrocarbon and HAP emissions at an Air Force installation is to install stage I and II vapor recovery at the government and AAFES service stations. The difference in the emissions of a gasoline station that is equipped with just submerged fill on the tanks and a service station that is equipped with stage I and II vapor recovery is shown below:

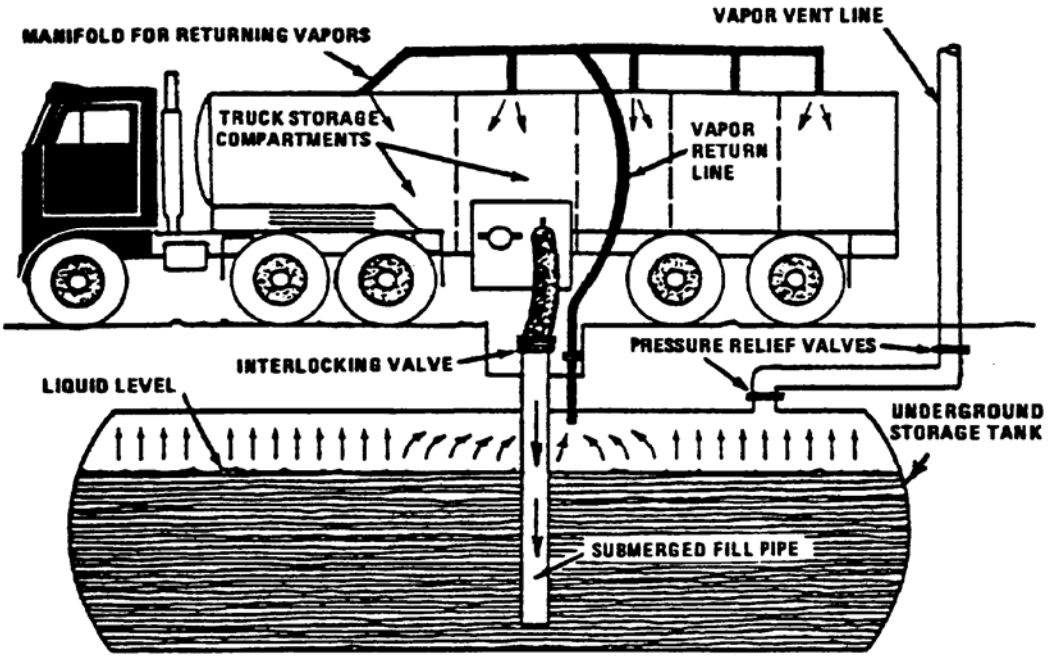
Station with Submerged Fill	lb/yr	Station Equipped with Stage I and II	lb/yr
Tanks with submerged fill VOC emissions	13,154.4	Tanks with Stage I VOC Emissions	540.6
Uncontrolled vehicle filling losses	19,822	Stage II Vapor Recovery VOC Emissions	1982.2
Benzene	197.9	Benzene	15.14
Cumene	6.56	Cumene	0.5
Ethylbenzene	13.19	Ethylbenzene	1
Hexane	164.88	Hexane	12.6
Methyl-tert-butyl Ether	1516.9	Methyl-tert-butyl Ether	116.04
Naphthalene	230.83	Naphthalene	17.66
2,2,4-Trimethylpentane	230.83	2,2,4-Trimethylpentane	17.66
Xylene	65.9	Xylene	5

From this example and the last Elmendorf AFB air emissions inventory, the following chart shows the expected emissions if the AAFES and Base Fuels stations utilized stage I and II controls:

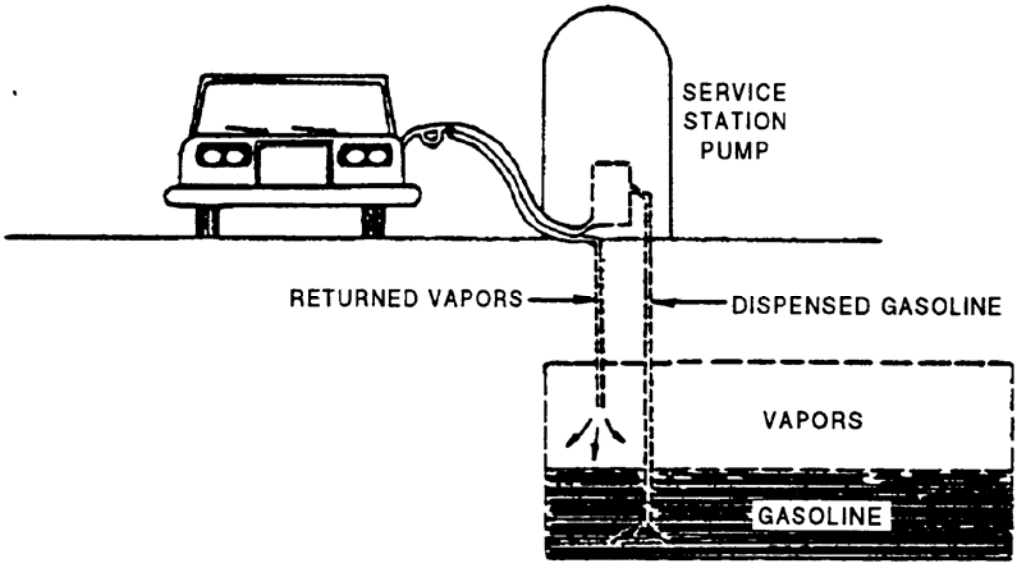
Pollutant	Actual Uncontrolled Annual Emissions (tons/yr)	Potential Uncontrolled Annual Emissions (tons/yr)	Actual Controlled Annual Emissions (tons/yr)	Potential Controlled Annual Emissions (tons/yr)
Total VOC Emissions	35.1	139.6	2.7	10.68
Benzene	0.53	2.1	0.04	0.16
Aggregated HAPs (incl benzene)	1.64	6.56	0.13	0.5

Stage I vapor recovery requires both the underground gasoline tank and the delivery truck to be retrofitted. The tank needs to be equipped with a co-axial fill pipe that extends within 6 inches of the bottom of the tank and pressure relief valves on the vent lines. The tanker must have a co-axial fill adapter. The cost of these devices should be less than $2000.00. According to the AAFES gasoline station manager, the AAFES service station is plumbed for stage I vapor recovery. Also, according to SSgt Whitten, the base's government vehicle gasoline station is plumbed for stage I and stage II vapor recovery. However, the current fuel supplier for both AAFES and Base Fuels, Service Oil and Gas, does not operate fuel trucks plumbed for stage I vapor recovery.

Schematic of Stage I Vapor Control



Schematic of Stage II Vapor Control



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 to illustrate the relative costs of stage II vapor recovery system components:

- 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

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):

recovered vapor = ((1,340 mg/liter)(.95)) + ((120 mg/liter)(.95) = 1,387 mg/liter

The following example of recovery credit based on the approximate amount of gasoline pumped per month at the AAFES and Base Fuels gasoline stations:

$$1{,}387 \text{ mg/liter} \times 709{,}424 \frac{\text{liters}}{\text{month}} \times \frac{\text{kg}}{1\text{E}6 \text{ mg}} \times \frac{\text{liter}}{0.67 \text{ kg}} \times \frac{12 \text{ mo.}}{\text{year}} \times \$0.275/\text{liter} = \$4846/\text{year}$$

Administrative action: It may be possible to work with your air permitting regulators to administratively remove the AAFES gasoline station from the base's AEI. 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. 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.

Air Combat Command (ACC) bases have been very successful in applying this guidance to their AAFES gasoline stations. Most ACC bases do not include the emissions from their Army and Air Force Exchange Service (AAFES) gasoline stations when performing a Major Source determination. A point of contact for ACC is:

Ms. Mary Ruth Senn
DSN 574-9363
email: maryr.senn@langley.af.mil
HQ ACC/CEV
11817 Canon Blvd., Suite 503
Newport News VA, 23606-2558.

References:

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

Emissions Inventory Improvement Program (EIIP), *Volume III: Chapter11, "Gasoline Marketing (Stage I and Stage II),"* September 1997.

SECTION 6

AIRCRAFT ENGINE TESTING

According to the last air emissions inventory, Elmendorf AFB tests approximately 345 F100-PW-100 engines per year. The primary reason that engines require testing is mandatory maintenance required when an engine reaches a specified number of hours of operation.

OPPORTUNITY ASSESSMENT

The use of incorrect emission factors for jet engines may overstate your actual criteria and HAP emissions. Below are the most accurate emission factors the Air Force has for the F100-PW-100 engine.

Aircraft Engine Emission Factors F100-PW-100
(lb/1000 lb Fuel)

Power Setting	Fuel (lb/hr)	NOx	CO	THC	Particulate
Idle	1097	4.38	35.29	8.65	2.06
Approach	2745	12.33	3.49	0.15	2.63
Intermediate	6725	30.89	0.91	0.21	2.06
Military	10104	39.44	0.91	0.29	1.33
Afterburner	54074	6.62	9.57	0.05	1.15

Aircraft Engine Emission Factors F100-PW-100
(lb/1000 lb Fuel)

Compound	Idle	Approach	Intermediate	Military	Afterburner
Formaldehyde	0.861	0.61	0.02	0.01	0.01
Acetaldehyde	0.235	0.15	0.01	0.01	0.01
Acrolein	0.111	0.06	ND	ND	ND
Isobutylaldehyde	0.009	0.02	0.00	0.00	0.00
Naphthalene	0.095	0.0007	0.00049	0.00034	0.00054
Benzene	0.045	0.0024	0.00052	0.0005	0.00028
Toluene	0.022	0.0017	0.00095	0.00092	0.000298
Ethylbenzene	0.0059	0.00044	ND	0.00039	0.000084
Xylene	0.051	0.00735	0.002	0.00450	0.00095
Styrene	0.00409	ND	ND	ND	ND

References:

"Engine and Hush House Emissions from a F100-PW-100 Jet Engine Tested at Langley AFB", Radian Corp, November 1996.

"Aircraft Engine and Auxiliary Power Unit Emissions Testing", EQM/Weston Inc., December 1998.

SECTION 7

MISCELLANEOUS RECOMMENDATIONS

Air Emission Calculations: Our office has recently published a guidance document for calculating emissions from sources found on a typical Air Force base. This guidance document addresses both actual and potential emission calculation methodologies. Our AEI guidance document is available for download at the following website: http://sg-www.satx.disa.mil/iera/rse/air.htm. We recommend this guidance document be followed when conducting the next air emissions inventory.

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 or 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.

SECTION 8

POLLUTION PREVENTION WEB SITE RESOURCES

The following alphabetical listing of world wide web (WWW) sites is provided for your use in assessing potential pollution prevention opportunities. Regulatory guidance 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 in the management of the air program.

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.org
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, MAJCOMs 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://ingis.can.purdue.edu:9999/cttpp/cttpp.html
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/

Organization	*Content*	*Website*
Defense Environmental Network & Information exchange (DENIX)	Interesting success stories can be found under "Public Menu", "Environmental 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.htm
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/
Department of Defense Link	Department of Defense of link is an excellent source for publications and links to other related sites.	http://www.dtic.dla.mil/defenselink/
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.doe.ca/
Environmental Security Technology Certification Program	ESTCP's goal is to demonstrate and validate promising, innovative technologies that target DoD environmental needs. These technologies provide a return on investment through cost savings and improved efficiency.	http://estcp.xservices.com/projects/pollutn/index.htm
Environmental Technology Office	The ETO oversees the U.S. Army's pollution prevention environmental technology program and the Department of Defense's National Defense Center for Environmental Excellence (NDCEE).	http://es.inel.gov/program/p2dept/defense/army/dodeto.html
Enviroene	Enviroene, funded by the Strategic Environmental Research and Development Program (SEDRP) and the Environmental Protection Agency (EPA), allows for the dissemination of technical pollution prevention material	http://es.inel.gov/index.html

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)
Hazardous Technical Information Services	For hazardous material substitutions.	http://www.dgsc.dla.mil/this/this.htm
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/
Joint Service Pollution Prevention Technical Library	Identifies off the shelf P2 technologies, management practices, and process changes.	http://enviro.nfesc.navy.mil/p2library/
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/
Naval Facilities Engineering Service Center	One of the Navy's leading environmental centers, helping to solve environmental cleanup, compliance, and pollution prevention problems.	http://www.nfesc.navy.mil/enviro/index.html
Navy Environmental Leadership Program	Finding new and innovative ways to manage Navy environmental programs since 1993.	http://www.nasni.navy.mil/~nelp/nelp.htm

Organization	*Content*	*Website*
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
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.uml.edu/TURI
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 Atmospheric Pollution Prevention Division	A division of the U.S. EPA Office of Atmospheric Programs, it provides information on CFC/PFC substitutes, improving energy efficiencies, pollution prevention programs and publications.	http://www.epa.gov.docs/GCDOAR/OAR-APPD.html
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/
U.S. EPA – Office of Pollution Prevention	Information on pollution prevention.	http://www.epa/gov/opptintr/index.html