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# Project Summary

# Radome Depainting Evaluation at Tinker Air Force Base

**Methyl ethyl ketone (MEK), a hazardous chemical, is used in chemical depainting of aircraft radomes at Tinker Air Force Base (TAFB). This report summarizes a laboratory scale screening study which evaluated ten solvent solutions as a potential replacement for MEK in TAFB depainting operations.**

**A test program was developed by Pacific Environmental Services, Inc. (PES) to determine the feasibility of using alternative solvents, less hazardous to the environment and public health than MEK. PES prepared a test protocol for conducting the evaluation, which specified the stripping solutions to be evaluated, all necessary equipment, test procedures, and method of evaluating each test.**

**A qualitative approach was used to determine the removal efficiency of each solvent. The testing involved immersing a 2" x 2" square of an aircraft radome (a fiberglass and epoxy or polyester composite material, in a honeycomb structure) in a beaker of the selected solvent. The parameters evaluated included a visual assessment of the degree of attack (% removal) on the coating in 0.5-, 1-, 2-, 4-, 8-, and 24-hr increments. MEK was tested to establish a baseline. Ten potential solvents were then evaluated to determine which chemical, if any, would be a suitable substitute for MEK.**

**Test results indicated that several of the solvents stripped the paint quicker and more efficiently than MEK (EZE 540, EZE 542, Turco 6776 Lo, Turco 6776 Thin, and Turco 6813). Although visual examination showed no damage to the substrate, there was some concern over potential substrate damage due to the complete and aggressive removal of all three coats (primer, polyurethane rain-erosion coating, and polyurethane anti-static topcoat).**

**Three of the Huntsman solvents (7210-60-1, 7210-60-2, and 7210-60-5) completely removed the top two coats while leaving the primer untouched. This concept of leaving the primer layer intact is being considered by the USAF as a suitable alternative to complete removal. Leaving the primer layer intact would ensure that the substrate is not damaged during the depainting operation. Additionally, there may be some economic advantages in material and manpower savings. Further testing of the Huntsman solvents at TAFB is anticipated later this year.**

***This Project Summary was developed by EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

## Introduction

The U.S. EPA is encouraging the development of programs to reduce the generation or emissions of hazardous wastes. The Waste Reduction at Federal Sites

(WREAFS) program is part of this effort. This Project Summary covers radome depainting, a single phase of efforts to prevent pollution at Tinker Air Force Base where heavy aircraft such as the B-52, KC-135, etc. are overhauled. When an aircraft is overhauled, paint and soils are first removed so that the underlying structure can be carefully inspected and repaired if necessary. The radome, which is a large ellipsoid structure made of an epoxy impregnated glass over a honeycomb, is coated with three layers of paint: primer, rain erosion layer, and the topcoat. The two outercoats are usually urethanes, and the primer is an epoxy. In the present depainting process, the radome is placed on end in a large ventilated booth, and the outer coats are scored so that the solvent will penetrate to the primer. Methyl ethyl ketone (MEK) is sprayed over the surface for a period of up to 3 hours during which the primer dissolves, and the topcoat chips slough off and are collected in a sump. The MEK in the sump is recycled; evaporative losses in 1993 were about 50,000 lb, while about 700 lb of paint chips were sent to disposal.

Air Force personnel wanted to replace MEK for several reasons: It is flammable (flash point 26°F), and has a high vapor pressure, so that it evaporated easily, causing high air emissions as well as solvent loss. MEK vapors cannot be captured on activated carbon, as there are instances of it causing fires in the carbon bed. A previous study at TAFB had demonstrated that low volatility solvent blends could replace MEK, but the best one contained NMP, whose toxicity had become suspect. EPA decided that other propylene carbonate blends might be effective paint strippers, while retaining the desired low toxicity, high flash point, and low volatility. Huntsman again made and supplied five blends, two containing lowered concentrations of NMP, and three having none. These were then evaluated and compared to five commercial strippers and MEK in laboratory tests on 2"x 2" pieces cut from a discarded radome. The compositions of the ten strippers are given below.

- **Huntsman Formulation C #7210-60-1**
  - 40 - 60% Propylene carbonate
  - 10 - 30% Methyl-2-pyrrolidinone
  - 15 - 35% Dibasic ester (DuPont)*
  - 4 - 10% Methyl-2-hexanone (methylisoamyl ketone)
- **Huntsman Formulation D #7210-60-2**
  - 20 - 40% Propylene carbonate
  - 10 - 30% Methyl-2-pyrrolidinone
  - 25 - 45% Dibasic ester
  - 10 - 20% Ethylene glycol diacetate
- **Huntsman Formulation E #7210-60-3**
  - 15 - 35% Propylene carbonate
  - 40 - 60% Dibasic ester
  - 20 - 40% Butyrolactone (gamma)
- **Huntsman Formulation F #7210-60-4**
  - 35 - 55% Propylene carbonate
  - 30 - 50% Dibasic ester
  - 5 - 15% Triethylene glycol
- **Huntsman Formulation G #7210-60-5**
  - 30 - 50% Propylene carbonate
  - 30 - 50% Dibasic ester
  - 10 - 30% Diethylene glycol monobutyl ether
- **EZE 540**
  - 28 - 35% Benzyl Alcohol
  - 10 - 15% Formic Acid
  - 1 - 5% Petroleum Hydrocarbon
- **EZE 542**
  - 30 - 40% Benzyl Alcohol
  - 5 - 10% Ethanolamine
  - 1- 5% 2-Ethylhexyl Mercaptoacetate
  - 1 - 5% Petroleum Hydrocarbon
- **Turco** 6776 Lo
  - 15% Proprietary Ingredient No. 1
  - 5% Formic Acid
  - <5% High Boiling Aromatic Solvent
  - 10% Proprietary Ingredient No. 2
  - Also contains:
  - Unk.% Water
- **Turco 6776 Thin**
  - 10% Proprietary Ingredient No. 1
  - 10% Formic Acid
  - 10% Solvent Refined Hydrotreated Middle Distillate
  - 10% Proprietary Ingredient No. 2
  - Also contains:
  - Unk.% Water
  - Unk.% Sodium Xylene Sulfonate
- **Turco 6813**
  - 40% Proprietary Ingredient
  - <5% High Boiling Aromatic Solvent
  - Also contains:
  - Unk.% Water
  - Unk.% Hexynol
  - Unk.% Ammonium Hydroxide (Ammonia)

## Test Procedure

A test program was developed by Pacific Environmental Services, Inc. (PES) to determine the feasibility of using these alternative solvents, comparing them to MEK. PES prepared a test protocol for conducting the evaluation, which specified the stripping solutions to be evaluated, all necessary equipment, test procedures, and method of evaluating each test.

A qualitative approach was used to determine the removal efficiency of each solvent. The testing involved immersing a 2" x 2" square of an aircraft radome (a fiberglass and epoxy or polyester composite material, in a honeycomb structure) in a beaker of the selected solvent. The parameters evaluated included a visual assessment of the degree of attack (% removal) on the coating at 0.5-, 1-, 2-, 4-, 8-, and 24-hr intervals. MEK was included in the test to establish a baseline. The potential depainting compositions were then evaluated to determine which were suitable substitutes for MEK.

Test results indicated that several of the commercially available compositions stripped the paint quicker and more efficiently than MEK. These were EZE 540, EZE 542, Turco 6776 Lo, Turco 6776 Thin, and Turco 6813. While these were effective strippers, there is some concern over ingredients such as formic acid (toxic, as well as corrosive) and ammonia. Although visual examination showed that these caused no damage to the substrate, conversations with TAFB engineers indicated some concern over potential substrate damage due to the complete and aggressive removal of all three coats (primer, polyurethane rain-erosion coating, and polyurethane anti-static topcoat). The visual identification of the three separate coats was easily accomplished due to the distinctive color of each coat. (The top coat was a dark grey, the second or middle coat was white, while the primer coat was red). In addition, the substrate was a distinct yellow-brown.

Three of the Huntsman solvents (7210-60-1, 7210-60-2, and 7210-60-5) completely removed the top two coats while leaving the primer untouched. This concept of leaving the primer layer intact is being considered by the USAF as a suitable alternative to complete removal. Leaving the primer layer intact would ensure that the substrate is not damaged during the depainting operation. Additionally there may be some economic advantages in relation to material and manpower savings. Further testing of the Huntsman solvents at TAFB is anticipated later this year where it is planned to strip a complete radome, and, if time allows, test the adhesion of new topcoats to the primer.

## Test Results

The removal effectiveness of the solvents varied greatly. Some of the solvents aggressively removed all three coats of paint, while others selectively removed only the top two, leaving the primer coat intact.

* A mixture of dibasic esters comprising 24% dimethyl succinate, 60% dimethyl glutarate, 15% dimethyl adipate, plus 1% water and methanol.

Even though visual inspection of the radome test sections indicated no physical signs of damage or deterioration to the substrate upon complete removal of all coats of paint, it may be desirable, when the primer coat is in good condition, to leave it intact, thus ensuring the integrity of the substrate.

For complete removal of the first two coats while leaving the primer coat intact, the following solvents exhibited the best results:

- Huntsman Corporation, Formulation E, 7210-60-3
- Huntsman Corporation, Formulation F, 7210-60-4
- Huntsman Corporation, Formulation G, 7210-60-5

For complete removal of all three coats the following solvents exhibited the best results:

- EZE Products, Inc., EZE 540**
- EZE Products, Inc., EZE 542
- Turco Products, Inc., Turco 6776 Thin**
- Turco Products, Inc., Turco 6776 Lo**

**Required a final waterwash to completely remove the primer coat.

## Costs

Purchase costs for each of the solvents used in this test program are presented in Table 1. The costs for the commercially available strippers are as quoted, while those of the Huntsman formulations are calculated from the cost of the individual components multiplied by their percentage in the final blend; no cost of blending the mixtures or a profit margin for the supplier of the blends are included.

Cost effectiveness of each solvent must also consider solvent loss, waste disposal, depainting time, degree of paint removal, subsequent surface treatment and related factors. Such an evaluation was beyond the scope of this study.

## Conclusions

These screening tests indicate that there are viable replacements for MEK which effectively remove the two topcoats while leaving the primer relatively intact. Further testing must be done to evaluate new top coat adhesion to primer which has been exposed to the stripper in a full scale depainting test; two radomes and solvent blends have been procured for trials planned for late 1994. The results of these full scale trials will then be evaluated by TAFB engineers to determine if installation on a test aircraft is justified.

The full report was submitted in fulfillment of Contract No. 68-D2-0062 by PES, Research Triangle Park, NC, under the sponsorship of the U.S. Environmental Protection Agency.

***Table 1.*** *Purchase Cost Comparison of Selected Solvents*

| *Solvent/Blend* | *Approximate Cost $/gallon* |
|---|---|
| *MEK* | *5.00* |
| *EZE 540* | *14.00* |
| *EZE 542* | *18.00* |
| *Turco 6776 Lo* | *17.00* |
| *Turco 6776 Thin* | *17.00* |
| *Turco 6813* | *17.00* |
| *Huntsman No. 1* | *12.00* |
| *Huntsman No. 2* | *12.00* |
| *Huntsman No. 3* | *9.00* |
| *Huntsman No. 4* | *9.00* |
| *Huntsman No. 5* | *9.00* |

*This Summary was authored by the staff of Southern Research Institute, Birmingham, AL 35205; Pacific Environmental Services, Inc., Research Triangle Park, NC 27709; and EPA author,* ***S. Garry Howell****, National Risk Management Research Laboratory, Cincinnati, OH 45268.*

***James S. Bridges*** *is the EPA Project Officer (see below).*

*The complete report, entitled "Radome Depainting Evaluation at Tinker Air Force Base," (Order No. PB95-230835; Cost: $17.50, subject to change) will be available only from:*

*National Technical Information Service*
*5285 Port Royal Road*
*Springfield, VA 22161*
*Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

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