

**MASKING AND CLEANING OF EPOXY AND POLYESTER MATRIX
THERMOSETTING COMPOSITE MATERIALS**

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

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1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) describes methods of masking and cleaning commercial aircraft, epoxy and polyester matrix, composite parts prior to their entry into the composites shop, masking and cleaning of on-wing repair areas in preparation for carrying out repairs and wipe cleaning during repair and prior to bonding. If this document is used for the masking or cleaning of materials other than epoxy and polyester matrix thermosetting composite materials, the fitness for this purpose must be determined by the user.

The methods of masking and cleaning described in this document have specific limited application and are not interchangeable. The methods shall only be used when specified in an approved repair procedure or with the agreement of the Original Equipment Manufacturer (OEM) or regulatory authority.

The intention of the descriptions in this document is to describe materials and equipment generically in sufficient detail to allow a suitable commercial product to be purchased. It is not intended that the information provided be biased to any particular manufacturer and no commercial product is recommended in preference to any other.

1.1 Purpose:

The purpose of this ARP is to provide a set of standard methods for masking and cleaning of thermosetting composite materials that may be referenced in repair documents produced by airlines or airframe and engine manufacturers. It is intended that this ARP be one of a number of ARPs that will cover other aspects of the techniques required to perform composite repairs. These ARPs will provide a suite of available repair techniques that are acceptable for use throughout the commercial aircraft industry.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 1526	Aircraft Exterior Surfaces, Water Miscible Pressure Spraying
AMS 1528	Aircraft Exterior Surfaces, Emulsion, Pressure Spraying
AMS 1530	Aircraft Exterior Surfaces, Wipe on, Wipe off, Water Miscible
AMS 1532	Aircraft Exterior Surfaces, Wipe on, Wipe off, Emulsion Type
AMS 3819	Cloths, Cleaning, For Aircraft Primary and Secondary Structural Surfaces

AIR4844	Composites and Metal Bonding Glossary
ARP4977	Drying of Thermosetting Composite Materials

2.1.2 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 56	Flash Point by Tag Closed Tester
ASTM D 329	Acetone
ASTM D 740	Methyl Ethyl Ketone
ASTM D 1153	Methyl Isobutyl Ketone
ASTM D 4376	Vapor-Degreasing Grade Perchloroethylene

2.1.3 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

O-A-51	Federal Specification, Acetone, Technical
O-T-634	Federal Specification, Trichloroethylene, Technical
TT-I-735	Federal Specification, Isopropyl Alcohol

2.2 Other References:

PA-TR-4883	Processing Handbook on Surface Preparation for Adhesive Bonding. Arthur H. Landrock, 1975. Materials Engineering Division, Feltman Research Laboratory, Picatinny Arsenal, Dover, NJ 07801.
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2.3 Definitions:

All the terms used in this ARP are defined in AIR4844.

3. GENERAL ENVIRONMENTAL AND HEALTH ASPECTS OF CLEANING:

General guidelines are given regarding the relative hazards to the user and to the environment of the materials and equipment listed. However the user shall obtain the Material Safety Data Sheet (MSDS) from the supplier prior to using any of the materials. The relevant environmental, health and safety organizations shall be consulted regarding safe use, transportation and disposal of the cleaners and the waste solutions.

4. PERSONAL PROTECTIVE EQUIPMENT (PPE):

Specific personal protective equipment required to handle a specific material safely should be outlined in the supplier's material and safety data sheet (MSDS). Material suppliers are also a good source of information in the safe use of their materials. Safe handling and use can also be determined by a qualified health and safety professional.

The exposure routes most frequently encountered when working with cleaning materials are the skin, eyes, and respiratory tract. Guidance is given on the kinds of equipment that may be required and typical uses.

Before using any type of safety equipment, training shall be given to ensure that the equipment is used safely and correctly.

Inspect all PPE before use to ensure that it is in good working order. Holes in gloves, cracked face masks, and damaged air lines are typical problems.

It should be noted also that PPE such as gloves, as well as protecting the person performing the repair, protects the repair from contamination. Contamination of the repair area can cause a poor quality repair which if not detected may be a hazard to the aircraft and its passengers and crew.

4.1 Exhaust System, Local:

Local exhaust systems shall be capable of providing a good flow of fresh air to personnel using solvents in confined spaces. The system shall be air operated or use flameproof motors if it is to be used in areas where fuel or other flammable vapors may be present.

A local exhaust system may be used as a method of providing a safe environment, with solvent fume concentrations below the allowable limits, in confined spaces where solvent vapors may accumulate.

4.2 Extraction/Ventilation System for Extracting and Neutralizing Vapors from Steam Cleaning:

Extraction systems for use with steam cleaners shall be capable of extracting vapors from the cleaner such that the levels of vapor are kept below the allowable limits for the cleaning vapor as defined on the material safety data sheet. If alkaline cleaners are used, the condensate may require neutralizing prior to disposal. The exact disposal requirements shall be obtained from the cleaner supplier and the relevant regulatory authorities.

Extraction systems shall be used for fixed steam cleaning facilities and any steam clean operation where allowable concentrations may be exceeded.

4.3 Eye Wash:

The eye wash facility shall conform to the local standards and shall be capable of hands free operation to allow the user to hold the eyelids open while operating the eye wash.

Eye wash facilities shall be used if eyes are exposed to cleaning materials or solvents.

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4.4 Face Shield, Safety:

The face shield shall fit on the head comfortably and still allow the wearing of other related safety equipment.

A safety face shield shall be used when operating steam or hot water wash cleaning equipment and shall be used with safety goggles.

4.5 Gloves, Disposable, Lint Free Cotton:

The gloves shall allow full hand dexterity and shall not be coated with any material that may contaminate cleaned parts.

Clean lint free cotton gloves shall be used whenever cleaned parts are being handled in order to prevent recontamination from oils or perspiration from the hands.

4.6 Gloves, Disposable (Butyl, Nitrile, Neoprene, or Natural Rubber):

These gloves are disposable and shall not have any lubrication materials or coating that may contaminate the parts being cleaned.

The gloves shall be used to protect hands from cleaning materials including solvents during hand wiping operations and to protect the parts from recontamination from oils or perspiration from the hands.

Choose the correct glove material for the chemical that will be used. Consult the MSDS and the glove supplier for further information.

4.7 Goggles, Chemical Safety:

The safety goggles shall conform to the local standards for chemical splash and impact resistant goggles and shall have sides that fit snugly around the face.

Safety goggles shall be used when handling solvents or concentrated cleaning materials and whenever called for by the material safety data sheet for the material being handled.

4.8 Processing Equipment for Neutralizing Waste and Used Steam and Water Wash Solutions and/or Recycling Cleaning Solutions:

Processing equipment for neutralizing waste from steam and water wash cleaners shall be capable of recycling or neutralizing waste solutions prior to disposal. The exact disposal and recycling requirements shall be obtained from the cleaner supplier and the relevant regulatory authorities.

Systems shall be used for all steam cleaning and water washing facilities unless the cleaning material is approved for direct disposal by the appropriate regulatory authorities.

4.9 Protective Clothing:

Protective clothing, gloves, shoes and face masks shall be capable of protecting against alkaline detergent, steam and water splashing.

Protective clothing shall be worn whenever steam or water wash equipment is being used.

4.10 Respirator, Chemical Cartridge (with organic vapor cartridge):

These respirators can be disposable with the mask covering nose and mouth or of the permanent full face type. This type of respirator is not for use in atmospheres that are immediately dangerous to life and health.

When it is not practical to provide a safe breathable air environment, the respirators may be used as a method of providing a safe environment for a limited time when using solvents in confined spaces or when the allowable vapor concentrations may be temporarily exceeded. If large concentrations or exposure times are anticipated, a supplied air respirator shall be used.

4.11 Respirator, Supplied Air, With a Full Face Mask:

This type of respirator is of the pressure demand type and is capable of being used in atmospheres that are immediately dangerous to life and health.

These type of respirators may be used as a method of providing a safe environment when using solvents in confined spaces or at any time when the allowable vapor concentrations may be exceeded. If anticipated allowable concentration is not large, a chemical cartridge type respirator is more appropriate. The material safety data sheet and advice from the supplier will give guidance in the appropriate choice of respirator.

4.12 Emergency Showers:

The showers shall conform to the local standards and shall be capable of hands free operation.

Emergency showers shall be used if skin is exposed to aggressive concentrated cleaning materials or in the event of burns or scalds from steam or hot water cleaning equipment.

5. MASKING AND SURFACE PROTECTION MATERIALS:

Masking materials come in two basic types, film and pressure sensitive adhesive tape. Generally both are used in all the types of masking that are required to keep repair areas clean and to prevent moisture from entering the part.

Apart from the masking that is required as a temporary repair to hardware that is going to continue to fly, the most common and the most practical masking materials are those consumable materials designed for use when performing composite cures. Therefore, films designed as bagging or release films are very suitable and will withstand the heat applied during the repair's cure cycle. When using release film, however, care should be taken to choose the nonperforated versions for masking.

5.1 Films:

The most common films available are polyethylene, polyvinyl chloride (PVC), polyester, fluorinated ethylene propylene (FEP) and nylon. All films used in masking shall be new and clean and have been stored such that no condensation can form on the film.

- 5.1.1 Polyethylene Film: Care should be taken if polyethylene film is to be used as a masking material as it will soften or melt if the part is subjected to heat during curing or steam cleaning. Rolls of polyethylene film used in a shop environment for protection from dust and paint do not always have the same level of cleanliness as films used for composite curing.

Clean polyethylene bags are readily available in a range of sizes and are useful for storing cleaned parts until they are needed in the repair.

- 5.1.2 Polyvinyl Chloride (PVC) Film (Vinyl Film): The same cautionary notes apply to this film as to polyethylene film above with the additional concern that plasticizers used to improve the film's flexibility can migrate and cause contamination of bond lines, particularly if the film becomes warm.

- 5.1.3 Polyester Film: Polyester is the stiffest of the commonly available films and this should be taken into consideration when using this as a masking material. It has suitable temperature resistance for all types of epoxy cures.

- 5.1.4 Nylon Film: Nylon films are commonly used for making vacuum bags and so are highly suitable for masking though again may be quite stiff. Nylon films absorb moisture which acts as a plasticizer. Film used in low humidity environments may become brittle and difficult to work with. Like PVC film, these may also be subject to plasticizer migration if they are not used in a controlled environment. Films stored in a humidity controlled clean room will give the best performance.

- 5.1.5 Fluorinated Perfluorethylene Propylene (FEP) Film: FEP films are used as release films for all types of epoxy cure and are lightweight and easily conformable for masking. As both polyester and FEP films are commonly available in perforated form, care should be taken to select the nonperforated type.

5.2 Pressure Sensitive Adhesive Tape:

Tapes are used in all types of masking situations. Below is a description of different types of tape and their common uses. All tapes used in masking shall be new and clean and have been stored such that no condensation can form on the tape.

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- 5.2.1 Thermoplastic Film Tape: Thermoplastic film tape, commonly known as flashbreaker tape, is used to hold down the edges of the film used for masking and can be obtained in heavier weights to provide a neat edge where resin may flow over the edge requiring the tape to break a thin layer of adhesive. The base of the tape may be polyester, nylon, or polytetrafluorethylene (PTFE) and the adhesive may be a rubber base or a fully cured silicone. These types of tape can be used for any type of masking with the exception of the temporary flight repair. They are all capable of withstanding epoxy cure temperatures.

Tapes with silicones that are not fully cured shall not be used due to the risk of contamination from unreacted silicones.

- 5.2.2 Metal Foil Tape: This family of tapes usually consists of aluminum or stainless steel foil tape and is often referred to as speed tape. It consists of a ductile metal foil with a pressure sensitive adhesive that is strong enough to resist the peel forces of the airflow when it is used as a temporary flight repair. This type of tape shall be used to mask damages to parts that are to continue in flight service to prevent moisture from entering the damage area prior to a repair being implemented. They may also be used if the part is to stand outside for a significant period of time prior to being brought into controlled conditions for repair.
- 5.2.3 Radome Tape: This family of tapes usually consists of polyurethane, polyethylene, polyester, or PTFE tape with a pressure sensitive adhesive. The adhesive must be strong enough to resist the peel forces of the airflow when it is used as a temporary flight repair. This type of tape shall be used to mask damages on radomes that are to continue in flight service to prevent moisture from entering the damage area prior to the repair being implemented. Moisture entrapment will have a significant effect on radar performance. Radar repair tape shall not contain any metallic fillers or have metallic coatings.

5.3 Masking Materials That Should Not be Used:

There are a large number of materials that may appear suitable for masking. However most can, under some circumstances, cause problems.

- 5.3.1 Used Materials: Although it may seem to be a cost saving to reuse masking materials the risk of contamination is such that they should be avoided if at all possible. An expensive repair may have to be repeated because of a small cost "saved".
- 5.3.2 Paper Based Materials: Although in the past unwaxed Kraft paper and paper masking tape have been used in masking composite repairs they are not recommended due to their flammability when used in an oven or autoclave or with any form of hot cure. Also their absorbency can lead to moisture and oils being absorbed unnoticed.
- 5.3.3 Domestic or Office Supplies: Tapes and films used in homes and offices often will not withstand the temperature of a hot cure and many of the adhesives used on the tapes can cause contamination and a poor bond when they are used as a maskant on a composite repair. Also some products are dissolved by the solvents commonly used for cleaning.

6. CLEANING AGENTS:

WARNING: IN ALL COUNTRIES THE LOCAL REGULATIONS SHALL BE CONSULTED BEFORE USING ANY CHEMICAL. YOUR COMPANY REGULATIONS AND HEALTH AND SAFETY EXPERTS SHALL ALSO BE CONSULTED.

In Table 1 typical examples are given of the allowable concentrations of the solvents described in the following sections, as stipulated by the Occupational Safety and Health Administration (OSHA) of the U.S.A. and by Dutch Government requirements. This information is correct in February 1995 and is for guidance only to the relative hazard of the materials. The higher a solvent's evaporation rate the quicker exposed liquid solvent will cause a given concentration in the atmosphere.

TABLE 1 - Allowable Solvent Concentrations

Solvent	OSHA Time Weighted Average (ppm)	Dutch Government Time Weighted Average (ppm)
MEK	200	200
MIBK	50	25
Acetone	750	750
1-1-1 Trichloroethane	750	200
Isopropyl Alcohol	400	400
Perchloroethylene	25	
Trichloroethylene	100	

NOTE: The OSHA values are permissible exposure levels (PEL) based on an 8 hour time weighted average. In most cases higher levels are permissible for durations up to 15 minutes. The MSDS sheet will give guidance.

NOTE: All the flash points quoted are closed cup in accordance with ASTM D 56.

6.1 Methyl Ethyl Ketone (MEK):

Methyl Ethyl Ketone is a commonly used wipe solvent today. It is also used as a diluent in some sprayable epoxy adhesives and primers. Efforts are being made to replace it as a cleaner due to its rating of "serious flammability," with a flash point of 20 °F (-7 °C) and some evidence of toxicity in animals. For typical allowable concentration in air, see Table 1.

Methyl Ethyl Ketone may be procured to ASTM D 740.

6.2 Methyl Isobutyl Ketone (MIBK):

Methyl Isobutyl Ketone is a less commonly used solvent similar to MEK but with a higher flash point of 64 °F (18 °C) and a lower evaporation rate. For typical allowable concentration in air, see Table 1.

Methyl Isobutyl Ketone may be procured to ASTM D 1153.

6.3 Acetone:

Acetone is a commonly used wipe solvent today. Efforts are being made to replace it as a cleaner due to its rating of "serious flammability," with a flash point of -4 °F (-20 °C) and its very high evaporation rate. For typical allowable concentration in air, see Table 1.

Acetone may be procured to O-A-51 or ASTM D 329.

6.4 Isopropyl Alcohol (IPA):

Isopropyl Alcohol or Isopropanol is a wipe solvent used as a less hazardous replacement for MEK, Acetone or 1-1-1 Trichloroethane. It is rated as flammable with a flash point of 53 °F (11.7 °C) and is toxic by inhalation and ingestion. For typical allowable concentration in air, see Table 1. Its slow evaporation rate can increase the time required to clean with it.

Isopropyl Alcohol may be procured to TT-I-735.

6.5 Perchloroethylene:

Perchloroethylene also known as tetrachloroethylene is being increasingly used as a replacement for 1-1-1 trichloroethane. It has a higher boiling point (250 °F) than 1-1-1 trichloroethane and is listed by International Agency for Research on Cancer (IARC) as a possible carcinogen.

Perchloroethylene may be procured to ASTM D 4376.

6.6 Trichloroethylene:

Trichloroethylene, like perchloroethylene, is being used as a replacement for 1-1-1 trichloroethane and is listed by IARC as a possible carcinogen. Its boiling point of 189 °F (87 °C) is closer to 1-1-1 trichloroethane making the conversion of existing equipment easier.

Trichloroethylene may be procured to O-T-634.

6.7 1-1-1 Trichloroethane:

1-1-1 Trichloroethane, also known as methyl chloroform, was a commonly used wipe and vapor degreasing solvent. Overexposure can cause liver and kidney damage. For typical allowable concentration in air, see Table 1.

As it is an ozone depletive, the production of this chemical is now prohibited or severely restricted in most countries. For this reason it is not used in the methods in this document.

6.8 Citrus Based Cleaners:

This is a group of cleaners that are based on the chemical d-limonene. Typically they do not contain any hazardous ingredients as defined by OSHA and are considered nontoxic. They have flash points in the range 130 to 140 °F (54 to 60 °C) so are considered combustible liquids and unused liquid is considered ignitable for disposal although some may be diluted in water to raise the flash point prior to disposal. Initial evaluation has shown this group to be very effective cleaners with the solvent dissolving organic contaminants and the water dissolving salts. Some cleaners may leave a residue particularly if used in concentrated form and not given a subsequent water rinse. They are not easily recyclable but provide easy disposal provided the contaminant that is removed is not hazardous.

These cleaners are not currently recommended for cleaning immediately prior to adhesive bonding or lay up of co-cured composite materials.

6.9 Emulsion Type Cleaners:

This is a group of cleaners that contain a combination of emulsifiers and surfactants. The surfactants lift the oil off the surface to form a weak emulsion. Many contain some chemicals, usually glycol ethers or propylene glycol, which may have special waste disposal requirements. Initial evaluation has shown this group to be effective on light oil types of contamination. Some may leave surfactant residues. This group can be recycled by separation and ultra filtration to remove oil type contaminants.

There are serious health concerns with some glycol ethers. Glycol esters are absorbed through the skin, therefore, gloves are mandatory. Refer to the MSDS for special handling instructions.

These cleaners are not currently recommended for cleaning immediately prior to adhesive bonding or lay up of co-cured composite materials.

Cleaners conforming to AMS 1528 should be specified when using emulsion cleaners with pressure spray equipment.

Cleaners conforming to AMS 1532 should be specified when using emulsion cleaners for hot or cold water, hand wipe cleaning.