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Guideline Series:

Control of Volatile Organic Compound Emissions from Coating Operations at Aerospace Manufacturing and Rework Operations

Emission Standards Division

U. S. Environmental Protection Agency
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1.0 INTRODUCTION

The Clean Air Act (CAA) as amended in 1990 requires that State implementation plans (SIP's) for certain ozone nonattainment areas be revised to require the implementation of reasonably available control technology (RACT) to control volatile organic compound (VOC) emissions. The U. S. Environmental Protection Agency (EPA) has defined RACT as the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. The EPA has issued, and is continuing to issue, control techniques guideline documents (CTG's) that present feasible RACT control measures for VOC source categories. The CTG's recommend "presumptive norms" of control for each source category, but individual sources may have alternative RACT requirements imposed by making an adequate infeasibility demonstration (44 FR 53761, September 17, 1979).

Section 183(b)(3) of the CAA requires the EPA Administrator to issue a CTG for the control of VOC emissions from coatings and solvents used in the aerospace industry. This CTG is intended to supersede any potential applicability of the Miscellaneous Metal Part and Products CTG (RACT) requirements for manufacturing and rework operations of aerospace vehicles and components. According to the CAA, this CTG guidance should also reflect control resulting from applying the "best available control (BAC) measures." Section 183(e)(1)(A) defines "BAC" as the "most effective equipment, measures, processes, methods, systems or techniques, including chemical reformulation, product or feedstock substitution, repackaging, and directions for use, consumption, storage, or disposal." Therefore, this CTG departs from the approach followed in the other CTG's by not recommending a single approach for determining RACT, but investigating a range of approaches to reduce VOC emissions from aerospace operations. Several optional approaches comprise the presumptive RACT found in this CTG.

The CTG's are intended to provide State and local air pollution control authorities with an information base for proceeding with their analyses of RACT for their own regulations. The CTG's contain a review of current knowledge and data concerning the technology, impacts, and costs associated with various emission control techniques. Where applicable, the EPA recommends that States adopt requirements consistent with the presumptive RACT. However, these measures are only a recommendation; States may develop their own RACT requirements on a case-by-case basis, considering the economic and technical circumstances of individual sources. It should be noted that no Federal laws or regulations preclude States from requiring more stringent controls than those recommended as RACT. A particular State, for example, may broaden the applicability by revising the "aerospace vehicle or component" definition to include models, mock-ups, prototypes, and production equipment such as molds, jigs, and tooling. Some States may need additional control in order to meet the national ambient air quality standards (NAAQS) for ozone in some areas.

This CTG identifies presumptive RACT for controlling VOC emissions from aerospace coatings and cleaning solvents. National emission standards for hazardous air pollutants (NESHAP) for aerospace manufacturing and rework operations were published on September 1, 1995 (60 FR 45948). While these final standards address the reduction of HAP emissions, the control techniques required by the NESHAP will result in reductions of VOC emissions as well. In addition, the control techniques required by the NESHAP are similar to those addressed in this CTG for reducing VOC emissions. Because the emission reductions, costs, and environmental impacts have already been determined for major HAP sources and are attributed to the NESHAP (see Docket No. A-90-20, Subcategory II-B), these impacts are not summarized in this CTG.

While the Aerospace NESHAP sets limits for maximum HAP and VOC content for topcoats, primers, maskants, clean-up solvents, and cleaning operations, the CTG establishes presumptive RACT limits for VOC's. The CTG includes requirements for Specialty Coatings, which are not covered by the Aerospace NESHAP. The Clean Air Act specifies that solvents will be addressed in the Aerospace CTG. However, because the CTG is guidance to be adopted as individual State regulations and SIP's, it does not specify detailed requirements for monitoring, testing, recordkeeping, and reporting as the NESHAP has done. Rather, the States are directed under previous EPA guidance for establishing RACT (57 FR 13502, April 16, 1992) to develop

"enforceable regulations" containing such requirements. While EPA is providing an example of such a regulation in the model rule (Appendix B), this CTG allows States the flexibility to address those requirements as long as they meet EPA enforceability criteria.

2.0 AEROSPACE MANUFACTURING AND REWORK OPERATIONS

2.1 GENERAL

The aerospace industry being evaluated includes all manufacturing facilities that produce an aerospace vehicle or component and all facilities that rework or repair these aerospace products. Aerospace vehicle or component is defined as, but not limited to, any fabricated part, processed part, assembly of parts, or completed unit of any aircraft including, but not limited to, airplanes, helicopters, missiles, rockets, and space vehicles. In addition to manufacturing and rework facilities, some shops may specialize in providing a service, such as chemical milling, rather than actually producing a component or assembly. In general, aerospace manufacturing and rework facilities are covered by the SIC codes listed in Table 2-1. However, facilities classified under other SIC codes may be subject to the proposed rule if the facility meets the definition of a major source and the definition of an aerospace manufacturing or rework facility.

TABLE 2-1. AEROSPACE MANUFACTURING SIC CODES

SIC Code	Description
3720	Aircraft and Parts
3721	Aircraft
3724	Aircraft Engines and Engine Parts
3728	Aircraft Parts and Equipment
3760	Guided Missiles, Space Vehicles, and Parts
3761	Guided Missiles and Space Vehicles
3764	Space Propulsion Units and Parts
3769	Space Vehicle Equipment
4512	Air Transportation, Scheduled
4581	Airports, Flying Fields, and Services
9711	National Security

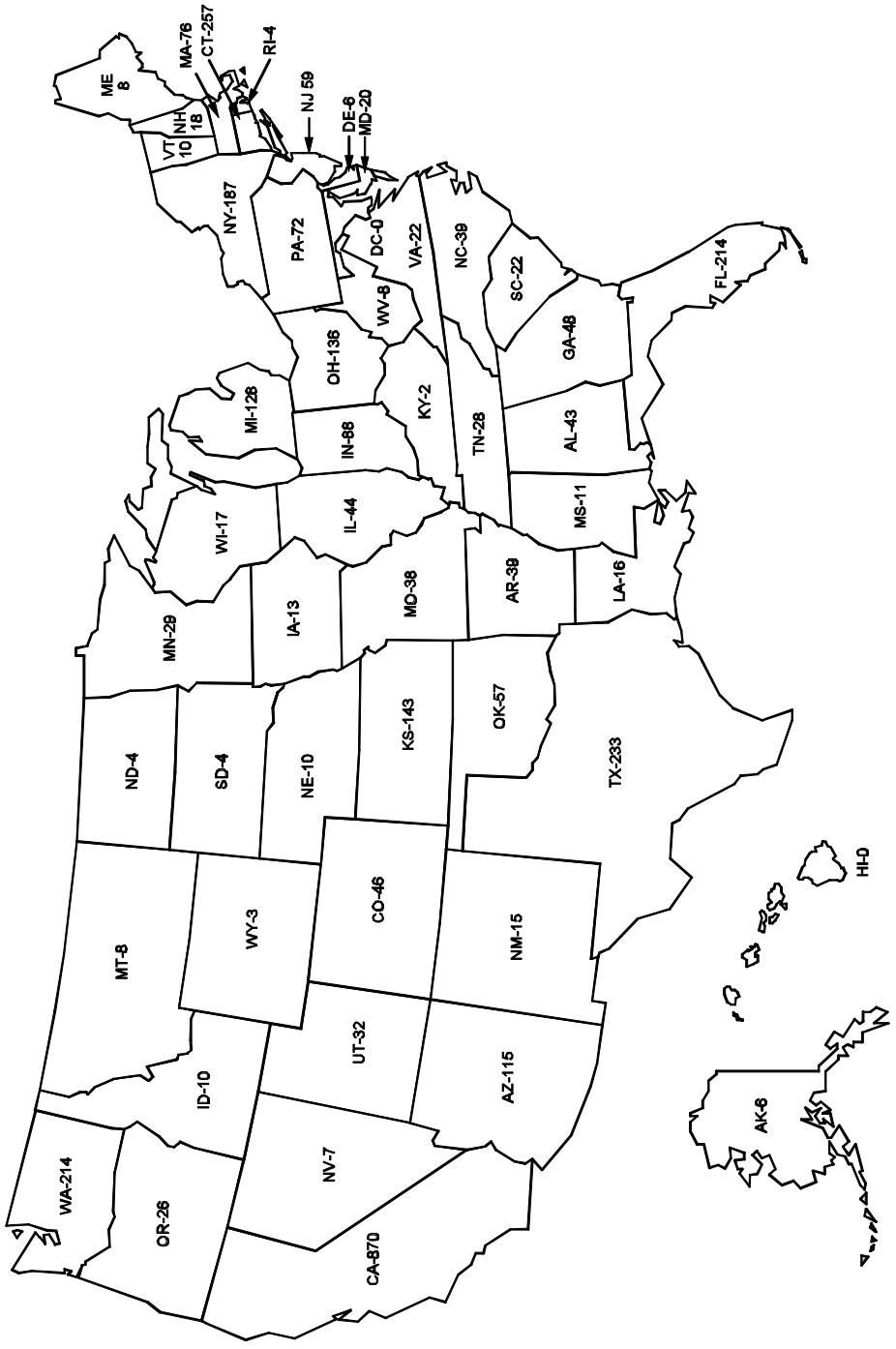
Aerospace facilities may be divided into four market segments: commercial original equipment manufacturers (OEM), commercial rework facilities, military OEM's, and military rework facilities. The commercial OEM segment of the market includes the manufacture of commercial aircraft as well as the production of business and private aircraft. The military OEM segment of the market includes military installations and defense contractors that manufacture aircraft, missiles, rockets, satellites, and spacecraft. Rework facilities, both commercial and military, may rework many of the above end products.

Based on information obtained through the Federal Aviation Administration and the U.S. Department of Commerce - Bureau of the Census, there are an estimated 2,869 aerospace facilities that could be subject to this guidance. Of this number, 1,395 produce or rework commercial products, and 1,474 produce or rework military products. The combined VOC emissions from these facilities are estimated to be over 213,000 megagrams/year (Mg/yr) (234,000 tons/yr).

In addition to these facilities, there are numerous subcontractors that manufacture or rework aerospace vehicles or components. The subcontractors may work directly for the OEM

or rework facilities, or indirectly through first line subcontractors. Because most of these subcontractors perform various types of work, they are often classified under non-aerospace SIC codes. Consequently, an estimate of the number of subcontractors cannot be made. One company alone, however, employs the services of over 5,000 subcontractors.

Aerospace manufacturing facilities and rework operations typically are located in or near industrial centers in areas of medium to high population density. Some States with a large number of aerospace manufacturers are California, Texas, Connecticut, Florida, and Washington. Figure 2-1 presents the number of aerospace manufacturing facilities by State.


ME 8
MA-76
CT-257
RI-4
NJ 59
DE-6
MD-20
VT 10
NH 18
NY-187
PA-72
DC-0
VA-22
NC-39
SC-22
FL-214
WV-8
GA-48
OH-136
KY-2
TN-28
AL-43
MI-128
IN-88
WI-17
IL-44
MS-11
MO-38
AR-39
LA-16
MN-29
IA-13
ND-4
SD-4
NE-10
KS-143
OK-57
TX-233
MT-8
WY-3
CO-46
NM-15
UT-32
AZ-115
ID-10
NV-7
WA-214
OR-26
CA-870
AK-6
HI-0

Aerospace manufacturing facilities range in size from small shops that produce a single aerospace component, such as propellers, to large corporations that produce the entire aircraft. Aerospace rework facilities, however, are usually large facilities that must be able to rework or repair every facet of several models of large commercial or military aircraft.

The hours of operation at aerospace manufacturing and rework facilities may vary greatly due to the production backlog at each facility. The hours of operation may range from 8 hours (or less) per day, 5 days per week, to 24 hours per day, 7 days per week.

2.2 PROCESS DESCRIPTION

Aerospace manufacturing and rework operations typically consist of the following basic operations: materials receiving, machining and mechanical processing, coating application, chemical milling, heat treating, cleaning, metal processing and finishing, coating removal (depainting), composite processing, and testing. Many aerospace manufacturing and rework facilities may employ all of these processes in their operations, as with an OEM facility that produces the entire aerospace vehicle. However, an aerospace facility may only employ a subset of these operations, as with a facility that produces a single component or assembly or a facility that provides a service such as chemical milling. Of these operations, coating application and cleaning are the significant sources of VOC emissions and are the processes covered by this Aerospace CTG in the following sections.

2.2.1 Coating Application

A coating is a material that is applied to the surface of a part to form a decorative, protective, or functional solid film. The most common coatings are the broad categories of nonspecialized primers and topcoats that are regulated for major sources under the Aerospace NESHAP. There are also numerous specialty coatings covered by this guidance that provide

additional performance characteristics, such as temperature, fluid, fire resistance, flexibility, substrate compatibility, antireflection, temporary protection or marking, sealing, adhesively joining substrates, enhanced corrosion protection, or compatibility with a space environment. Each material is different because it must meet individual performance standards particular to a specific design. The quality of the coatings is critical to the airworthiness and safety of the final product. Aerospace vehicle manufacturing is strictly controlled by the Federal Aviation Administration, the Department of Defense, and specific customer requirements. Industry specifications for coatings are dictated by these requirements.

Most aerospace coatings are solvent-borne, which contain a mixture of organic solvents, many of which are VOC's. The most common VOC solvents used in coatings are toluene, xylene, methyl ethyl ketone, and methyl isobutyl ketone. The VOC content ranges differ for the various coating categories.

2.2.1.1 Sealing. Sealants, predominately composed of polysulfide, are applied throughout the aerospace vehicle structure primarily to seal out moisture and contaminants to prevent corrosion, such as on faying (i.e., closely or tightly fitting) surfaces, inside holes and slots, and around installed fasteners. They are also used to seal fuel tanks and pressurized components. Sealants are applied using tubes, spatulas, brushes, rollers, or spray guns. Sealants are often stored frozen and thawed before use, and many are two-component mixtures that cure after mixing. Typically, a sealant is applied before assembly or fastener installation, and the excess is squeezed out or extruded from between the parts as the assembly is completed. This ensures a moisture-tight seal between the parts.

2.2.1.2 Adhesive Bonding. Adhesive bonding involves joining together two or more metal or nonmetal components. This process is typically performed when the joints being formed are essential to the structural integrity of the aerospace vehicle or component. Bonding surfaces are typically roughened mechanically or etched chemically to provide increased surface area for bonding and then treated chemically to provide a stable corrosion-resistant oxide layer. The surfaces are then thinly coated with an adhesive bonding primer to promote adhesion and protect from subsequent corrosion. Structural adhesives are applied as either a thin film or as a paste. The parts are joined together and cured either at ambient temperature, in an oven, or in an autoclave to cure the adhesive and provide a permanent bond between the components.

Figure 2-1. Active U.S. aerospace manufacturing facilities

Nonstructural adhesives are used to bond materials that are not critical to the structural integrity of the aerospace vehicle or component, such as gaskets around windows and carpeting or to nonstructurally joined components. These adhesives are applied using tubes, brushes, and spray guns.

2.2.2 Cleaning

Cleaning agents for hand-wipe, flush, and spray equipment cleaning consist of solvents such as methyl ethyl ketone, methyl isobutyl ketone, toluene, various solvent blends, or alkaline materials.

2.2.2.1 Hand-Wipe and Flush Cleaning. Aerospace components are cleaned frequently during manufacturing to remove contaminants such as dirt, grease, and oil, and to prepare the components for the next operation. Cleaning is typically performed by a hand wiping process using a wide variety of cleaning solvents. Assemblies and parts with concealed or inaccessible areas may be flush-cleaned by passing the cleaning agent over, into, or through the part. The cleaning agent is then drained from the part and the procedure is repeated as many times as necessary to ensure the required cleanliness.

2.2.2.2 Spray Gun and Coating Line Cleaning. Spray guns and coating lines used to apply the various coatings used at aerospace facilities must be cleaned when switching from one coating to another and when they are not going to be immediately reused. Spray guns can be cleaned either manually or with enclosed spray gun cleaners. Manual cleaning involves disassembling the gun and placing the parts in a vat containing an appropriate cleaning solvent. The residual paint is brushed or wiped off the parts. After reassembling, the cleaning solvent may be sprayed through the gun for a final cleaning. Paint hoses/coating lines are cleaned by passing the cleaning solvent through the lines until all coating residue is removed. Enclosed spray gun cleaners are self-contained units that pump the cleaning solvent through the gun within a closed chamber. After the cleaning cycle is complete, the guns are removed from the chamber and typically undergo some manual cleaning to remove coating residue from areas not exposed to the cleaning solvent, such as the seals under the atomizing cap.

3.0 EMISSION CONTROL TECHNIQUES

The principal technique used by the aerospace industry to control VOC emissions from coating application and cleaning is product substitution, which eliminates or reduces the generation of emissions. The emission reduction is obtained using less energy and producing less waste than using a control device to achieve the same emission reductions.

The VOC emissions may be controlled by replacing products containing high concentrations of VOC's with ones that have reduced or eliminated VOC's. Different aerospace manufacturers use different processes to produce their product. Therefore, they typically have different specifications for the coatings and cleaning solvents used on the components of the end products. Each individual facility must evaluate the ability of the new product to maintain standards of quality and performance. In addition, the potential overall environmental benefit of the reformulated products must be carefully evaluated.

The following sections describe the available product substitutions for coatings and cleaning solvents. While alternative methods, such as control devices (carbon adsorbers, incinerators, etc.), are occasionally used to reduce emissions, they do not represent RACT and are, therefore, not discussed below.

3.1 COATING SUBSTITUTIONS

Waterborne and high solids materials are generally used for coating substitutions. Specialty coatings typically have relatively low usage, so reformulation to lower VOC contents does not produce significant air quality benefits nor is it economically feasible for the paint suppliers. Paint suppliers and the aerospace industry generally have targeted high volume materials for reformulation efforts. Therefore, lower VOC formulations are not available for most of the low volume specialty coating categories.

3.2 EQUIPMENT CHANGES

The aerospace industry has implemented several equipment changes that directly reduce the level of VOC emissions. While there are equipment changes that effect emissions from every process, the three changes predominantly used in the industry are high transfer efficiency spray guns, spray gun cleaners, and conventional high transfer efficiency methods. Each of these equipment changes are discussed below.

3.2.1 High Transfer Efficiency Spray Guns

Emissions from spray coating operations can be reduced through the use of spraying systems with higher transfer efficiency. Transfer efficiency, expressed as a percentage, can be defined as the ratio of coating solids actually applied to the surface of the component being coated to the amount of solids released from the spray gun. Spraying systems with a higher transfer efficiency can coat the same surface area using less coating. Therefore, the VOC emissions resulting from the use of this equipment are reduced compared to applying the same coating with conventional spray equipment. The transfer efficiency values reported in this section depend on coating sprayed, part configuration, spray booth air velocity, and other variables.

Most aerospace components are coated using manual spray equipment utilizing conventional airspray or airless spraying technology. The following sections discuss two types of high transfer coating application equipment generally used in the aerospace industry for the application of primers and topcoats: high volume, low pressure (HVLP) and electrostatic (use of these types of high transfer efficiency for specialty coatings is limited).

3.2.1.1 High Volume Low Pressure Spray Guns. High volume low pressure and electrostatic spraying systems are the primary high efficiency spray methods used by the industry. High volume low pressure spray guns use high volumes [10 to 25 standard cubic feet per minute (scfm)] of low pressure [2 to 10 pounds per square inch gauge (psig)] air to deliver the paint. The lower air pressure creates a lower particle speed, resulting in a more controlled spray pattern with less overspray and bounce back from the substrate, thus improving transfer efficiency.

High volume low pressure systems have been in use in the United States for approximately 10 years. In early systems, turbines were used to supply a high volume of low pressure air to the spray guns through large hoses. The second generation used compressed air with an air regulator to maintain the required low pressure. The third and current generation of HVLP equipment uses

restrictors within the gun to reduce the atomization pressure to a maximum of 10 psi at the air cap.

One disadvantage of HVLP spray guns is that some very high solids coatings are difficult to atomize due to their higher viscosities. However, when a turbine is used, the temperature of the atomizing air increases which aids in reducing the viscosity of the coating. Other disadvantages of HVLP spray guns are that they cannot be used with extension nozzles, and they may slow production rates because of the low fluid delivery rates.

It is estimated that HVLP can apply approximately 80 percent of the coating currently used in the aerospace industry, including primers, waterborne coatings, and both single and two-component topcoats. A medium commercial/rework facility utilizes HVLP equipment with high solids paint and has had a reduction of 22 to 30 percent in coating usage for various aircraft types. The HVLP technology has proven easy to use and maintain. It also provides high transfer efficiency and appears to be the preferred spray technology in the aerospace industry at this time.

Table 3-1

TABLE 3-1. PERCENT REDUCTION IN COATING EMISSIONS (PRIMERS AND TOPCOATS) WITH HIGH TRANSFER EFFICIENCY EQUIPMENT FROM SECTION 114 DATA

Size	Commercial or military	OEM or rework	High transfer equipment	% Reduction in emissions
Large	Military	OEM	HVLP	20
Large	Military	OEM	HVLP	20
Large	Military	OEM	HVLP	25
Large	Commercial	OEM	Unspecified	30
Large	Commercial	OEM	Unspecified	18
Medium	Commercial Military Military	OEM OEM Rework	HVLP	25
Medium	Commercial Military Military	OEM OEM Rework	HVLP	20-40
Medium	Military	OEM	HVLP and electrostatic	40
Medium	Military	OEM	HVLP and electrostatic	40
Medium	Military	OEM	HVLP	40
Medium	Military	OEM	HVLP	10
Medium	Military Military	OEM Rework	Electrostatic	30-40
Medium	Military	Rework	HVLP and electrostatic	35-40
Medium	Commercial	OEM	Unspecified	30
Medium	Commercial	OEM	Unspecified	33
Medium	Commercial	Rework	HVLP and electrostatic	50

shows the reduction in emissions obtained from the Section 114 questionnaire responses from various facilities utilizing high transfer efficiency equipment such as HVLP or electrostatic equipment, either alone, in conjunction with each other, or, in one case, HVLP equipment with high solids coatings.

3.2.1.2 Electrostatic Spray Guns. With electrostatic spray systems, atomized particles of coating acquire an electric charge as they pass through a high voltage field at the end of the spray nozzle. This electric charge causes the particles to be attracted to the parts being painted, which are electrically grounded. Although other substrates can be pretreated with conductive coatings, this technology is primarily used for metal parts. The electrostatic effect can be utilized in conjunction with air spray, airless, and air-assisted airless systems to enhance the transfer efficiencies of these basic technologies. See Table 3-1 for examples of percent reduction obtained at various facilities using electrostatic spray guns or electrostatic spray guns in combination with HVLP spray guns.

3.2.2 Spray Gun Cleaning

Spray guns are typically cleaned at the end of every job, as well as between color changes. Manual cleaning of spray guns involves disassembling the gun and placing the parts in a tray containing an appropriate cleaning solvent. The residual paint is brushed or wiped off the parts, then cleaning solvent is sprayed through the gun after it is reassembled. Various methods are used to minimize the resulting emissions from spray gun cleaning and are discussed below.

Enclosed system. Enclosed spray gun cleaners are completely enclosed units that spray the cleaning solvent through and over the spray gun. The enclosed unit eliminates most of the exposure of the cleaning solvent to the air, thereby greatly reducing the VOC emissions from evaporation.

Nonatomized cleaning. Cleaning solvent is placed in the pressure pot and forced through the gun with the atomizing cap in place. No atomizing air is to be used. The cleaning solvent from the spray gun is directed into a vat, drum, or other waste container that is closed when not in use.

Disassembled spray gun cleaning. Manual cleaning (described above) with the components cleaned by hand in a vat, which is only closed when not in use. Alternatively, the components are soaked in a vat, which is closed at all times except when components are being inserted or removed.

Atomizing cleaning. Cleaning solvent is forced through the spray gun and the resulting atomized spray is directed into a waste container that is fitted with a device designed to capture the atomized solvent emissions.

3.2.3 Conventional High Transfer Efficiency Application Methods

Conventional high transfer efficiency application methods for primers and topcoats include dip, roll, brush, and flow coating (use of these methods for specialty coatings is limited). These methods are discussed below.

Dip Coating. With dip coating application, parts are immersed into a tank of coating. The parts are then removed from the tank and held over it until the excess coating drips back into the tank. This method is simple and allows many different parts to be coated with high transfer efficiency. However, dip coating is limited to parts that can fit into the dip tank. Other parts difficult to dip coat could include complex parts that would trap the coating, allowing unequal coating thicknesses.

Roll Coating. In roll coating application, a series of mechanical rollers are used to coat flat surfaces. This method achieves high efficiency with high rates of application and automation. However, roll coating is limited to flat parts.

Brush Coating. In brush coating application, brushes and hand rollers are used to apply the coating manually. This method is used with operations (e.g., touch-up and detail painting) that cannot tolerate the overspray associated with spray gun application. For example, if a facility needs to paint only the tail section of an airplane, it may be easier to brush coat this area than to mask the entire plane to protect the rest of the shell from overspray. This application method typically involves high labor costs, increased production time, and poor coating thickness control.

Flow Coating. In flow coating application, the part is conveyed over a closed sink, and a pumped stream of coating gently flows over the surface of the part. The excess coating is drained into the sink, filtered, and pumped to a holding tank for reuse. Flow coating is typically limited to flat sheets and noncritical parts. Coating thickness is difficult to control using flow coating.

3.3 HAND-WIPE CLEANER SUBSTITUTIONS

Product substitutions for hand-wipe cleaning that are prevalent in the aerospace industry can be classified as aqueous, semiaqueous, citrus-based, and reduced vapor pressure. Each category is discussed below.

3.3.1 Aqueous and Semiaqueous

Aqueous and semiaqueous cleaners contain water as the base component rather than an organic solvent or mixture of solvents. Other components may include corrosion inhibitors,

alkalinity builders, and organic surfactants, depending on the desired soil removal properties. Aqueous and semiaqueous cleaners have been used in noncritical areas where strict cleanliness requirements do not have to be met, or where there are no confined spaces that may trap residues of the cleaner.

The advantages of using aqueous and semiaqueous cleaning solvents include reduced VOC emissions. Disadvantages are increased production time due to slower evaporation rates, possible decreased efficiency, and possible increase in wastewater treatment requirements. In addition, aqueous cleaners may not be applicable to all aerospace parts, especially those components that have small confined spaces where the cleaner residues cannot be adequately removed.

3.3.2 Citrus-Based

Citrus-based terpenes such as d-limonene are the primary components in many alternative cleaning solutions. While these solutions have high VOC contents, their vapor pressure is very low, leading to reduced evaporation rates. These cleaners have been found to be effective in some cleaning operations except for cleaning prior to adhesive bonding. Some disadvantages include possible worker sensitivity, VOC emissions, lack of rinseability in water, and increased production time due to slower evaporation rates.

3.3.3 Reduced Vapor Pressure

Reduced vapor pressure cleaning solvents have a maximum VOC composite vapor pressure of 45 millimeters of mercury (mmHg) at 20°C. Cleaning solvent emissions are reduced because their lower vapor pressure leads to reduced evaporation rates. These cleaners are effective in many cleaning operations except for some limited operations such as cleaning oxygen systems.

4.0 PRESUMPTIVE RACT REQUIREMENTS

The presumptive RACT requirements for the aerospace component and vehicle cleaning and coating operations are described in the following sections. The operations covered by this CTG shall not be subject to another CTG. The operations and applications exempted under this CTG shall not be subject to another CTG. Applicable definitions are included in Appendix A.

These presumptive RACT requirements do not apply to manufacturing or rework operations involving space vehicles; rework operations performed on antique aerospace vehicles or components; or to the following activities where cleaning and coating of aerospace components and vehicles may take place: research and development, quality control, laboratory testing, and electronic parts and assemblies (except for cleaning and coating of completed assemblies).

4.1 SPECIALTY COATINGS

Presumptive RACT for coatings used on aerospace components and vehicles is based on VOC content. Except as provided in Sections 4.0 and 4.1, the presumptive RACT for coating VOC content is the use of coatings with a VOC content less than or equal to that given in Table 4-1: Specialty Coatings VOC Content Limits.

TABLE 4-1. SPECIALTY COATINGS VOC CONTENT LIMITS (g/L)[a]

Coating type	Limit	Coating type	Limit
Ablative Coating	600	Epoxy Polyamide Topcoat	660
Adhesion Promoter	890	Fire-Resistant (interior) Coating	800
Adhesive Bonding Primers:		Flexible Primer	640
Cured at 250°F or below	850		
Cured above 250°F	1030		
Adhesives:			
Commercial Interior Adhesive	760		
Cyanoacrylate Adhesive	1,020		
Fuel Tank Adhesive	620		
Nonstructural Adhesive	360		
Rocket Motor Bonding Adhesive	890		
Rubber-based Adhesive	850		
Structural Autoclavable Adhesive	60		
Structural Nonautoclavable Adhesive	850		
Antichafe Coating	660		
Bearing Coating	620		
Caulking and Smoothing Compounds	850		
Chemical Agent-Resistant Coating	550		
Clear Coating	720		
Commercial Exterior Aerodynamic Structure Primer	650		
Compatible Substrate Primer	780		
Corrosion Prevention Compound	710		
Cryogenic Flexible Primer	645		
Cryoprotective Coating	600		
Dry Lubricative Material	880		
Electric or Radiation-Effect Coating	800		
Electrostatic Discharge and Electromagnetic Interference (EMI) Coating	800		
Elevated-Temperature Skydrol-Resistant Commercial Primer	740		

Exemptions. The following applications are exempt from the presumptive RACT coating limits in Table 4-1:

1. Touchup, aerosol, and DOD classified coatings;

2. Coatings used on space vehicles; and

3. Facilities that use separate formulations in volumes of less than 50 gallons per year, subject to a maximum exemption of 200 gallons for all such formulations applied annually.

4.2 PRIMERS, TOPCOATS, CHEMICAL MILLING MASKANTS

The broad categories of primers, topcoats (including self-priming topcoats), and chemical milling maskants (Type I/II) are not specialty coatings as listed in Table 4-1 and are regulated for major sources under the Aerospace NESHAP requiring MACT limits with a compliance date specified in 40 CFR 63.749(a). These limits may be assumed to represent RACT limits 1 year after the major sources are required to meet the MACT limits and, therefore, shall not be effective until 1 year after the NESHAP compliance date of September 1, 1998. The requirements do not apply to facilities that use separate formulations of primers, topcoats, and chemical milling maskants (Type I/II) in volumes of less than 50 gallons per year, subject to a maximum exemption of 200 gallons total for such formulations applied annually.

4.3 APPLICATION EQUIPMENT FOR PRIMERS AND TOPCOATS

Presumptive RACT for primer and topcoat (including self-priming topcoats) application equipment used on aerospace components and vehicles is based on current practices and requirements in some States. Except as provided in Section 4.3 and Subsection 4.3.1, the presumptive RACT for primer and topcoat (including self-priming topcoat) application equipment is the use of one or more of the following application techniques: flow/curtain coat; dip coat; roll coating; brush coating; cotton-tipped swab application; electrodeposition coating; high volume low pressure (HVLP) spraying; electrostatic spray; or other coating application methods that achieve emission reductions equivalent to HVLP or electrostatic spray application methods.

4.3.1 Exemptions

The following situations are exempt from the presumptive RACT application techniques described in Section 4.3:

1. Any situation that normally requires the use of an airbrush or an extension on the spray gun to properly reach limited access spaces;

2. The application of specialty coatings;

3. The application of coatings that contain fillers that adversely affect atomization with HVLP spray guns and that the permitting agency has determined cannot be applied by any of the application methods specified in Section 4.3;

4. The application of coatings that normally have a dried film thickness of less than 0.0013 centimeter (0.0005 in.) and that the permitting agency has determined cannot be applied by any of the application methods specified in Section 4.3;

5. The use of airbrush application methods for stenciling, lettering, and other identification markings;

6. The use of hand-held spray can application methods; and

7. Touch-up and repair operations.

4.3.2 Timing (Schedule) of Compliance

The application techniques identified as presumptive RACT are regulated for major sources under the Aerospace NESHAP requiring MACT application equipment with a compliance date of September 1, 1998 specified in 40 CFR 63.749(a). These equipment requirements may be assumed to represent RACT requirements 1 year after the major sources are required to meet the MACT equipment requirements and, therefore, shall not be effective until 1 year after the NESHAP compliance date of September 1, 1998.

4.4 CLEANING OPERATIONS

For solvent cleaning operations, this guidance departs from the standard presumptive RACT requirement to incorporate MACT level controls. Therefore, the requirements of Section 4.2 shall not become effective prior to the Aerospace NESHAP compliance date of September 1, 1998. The MACT and RACT for solvent cleaning is based on work practices and cleaning solvent composition. Except as provided in Section 4.0 and Subsection 4.4.2, MACT and RACT for certain activities is described below.

4.4.1 Housekeeping

All fresh and used cleaning solvents, except semiaqueous cleaning solvents, used in solvent cleaning operations shall be stored in containers that shall be kept closed at all times except when filling or emptying. It is recommended that cloth and paper, or other absorbent applicators, moistened with cleaning solvents be stored in closed containers. Cotton-tipped swabs used for very small cleaning operations are exempt. In addition, the owner or operator must implement handling and transfer procedures to minimize spills during filling and transferring the cleaning solvent to or from enclosed systems, vats, waste containers, and other cleaning operation equipment that hold or store fresh or used cleaning solvents. The above requirements are known

collectively as housekeeping measures. Aqueous cleaning solvents are excluded from these housekeeping requirements.

4.4.2 Hand-Wipe Cleaning

Hand-wipe cleaning operations require the use of cleaning solvents which are aqueous or have a VOC composite vapor pressure less than or equal to 45 millimeters of mercury (mm Hg) at 20°C.

Exemptions

The following cleaning operations would be exempt from the cleaning solvent composition and vapor pressure requirements stated in Section 4.4.2:

1. Cleaning during the manufacture, assembly, installation, maintenance, or testing of components of breathing oxygen systems that are exposed to the breathing oxygen;

2. Cleaning during the manufacture, assembly, installation, maintenance, or testing of parts, subassemblies, or assemblies that are exposed to strong oxidizers or reducers (e.g., nitrogen tetroxide, liquid oxygen, hydrazine);

3. Cleaning and surface activation prior to adhesive bonding;

4. Cleaning of electronics and assemblies containing electronics;

5. Cleaning of aircraft and ground support equipment fluid systems that are exposed to the fluid, including air-to-air heat exchangers and hydraulic fluid systems;

6. Cleaning of fuel cells, fuel tanks, and confined spaces;

7. Surface cleaning of solar cells, coated optics, and thermal control surfaces;

8. Cleaning during fabrication, assembly, installation, and maintenance of upholstery, curtains, carpet, and other textile materials used on the interior of the aircraft;

9. Cleaning of metallic and nonmetallic materials used in honeycomb cores during the manufacture or maintenance of these cores, and cleaning of the completed cores used in the manufacture of aerospace vehicles or components;

10. Cleaning of aircraft transparencies, polycarbonates, or glass substrates;

11. Cleaning and cleaning solvent usage associated with research and development, quality control, or laboratory testing;

12. Cleaning operations, using nonflammable liquids, conducted within 5 feet of energized electrical systems. Energized electrical systems means any AC or DC electrical circuit on an

assembled aircraft once electrical power is connected, including interior passenger and cargo areas, wheel wells, and tail sections; and

13. Cleaning operations identified as essential uses under the Montreal Protocol for which the Administrator has allocated essential use allowances or exemptions in 40 CFR § 82.4.

4.4.3 Flush Cleaning

For cleaning solvents used in the flush cleaning of aerospace parts, assemblies, and coating unit components, the used cleaning solvent (except for semiaqueous cleaning solvents) must be emptied into an enclosed container or collection system that is kept closed when not in use or captured on wipers and disposed of in accordance with Section 4.4.1. Aqueous cleaning solvents are excluded from these flush cleaning requirements.

4.4.4 Spray Gun Cleaning

All spray guns must be cleaned by one or more of the following methods:

1. Enclosed spray gun cleaning system that is kept closed when not in use, provided that leaks from enclosed spray gun cleaners are repaired within 14 days from when the leak is first discovered. If the leak is not repaired by the 15th day after detection, the cleaning solvent shall be removed and the enclosed cleaner shall be shut down until the leak is repaired or its use is permanently discontinued;

2. Unatomized discharge of cleaning solvent into a waste container that is kept closed when not in use;

3. Disassembled spray gun that is cleaned in a vat and kept closed when not in use; or

4. Atomized spray into a waste container that is fitted with a device designed to capture atomized cleaning solvent emissions.

5.0 GUIDANCE TO STATE ENFORCEMENT AGENCIES

This chapter presents information for air quality management agencies to consider in developing an enforceable rule limiting VOC emissions from coating and solvent cleaning operations at aerospace manufacturing and rework facilities. The State or other implementing agency can exercise its prerogative to consider other options provided that they meet the objectives prescribed in this chapter.

This guidance is for instructional purposes only and, as such, is not binding. In the development of a State or local aerospace manufacturing and rework operations rule, the State or other enforcement agency should consider all information presented in the CTG and the promulgated NESHAP along with additional information about specific sources to which the rule will apply. The reasonably available control technology (RACT) rule, however, should address all the factors listed in this chapter and in Section 4 to ensure that the rule has reasonable provisions for demonstrating compliance and is enforceable. A model rule which contains all these requirements is provided in Appendix B. The model rule is guidance only and the State or local agency has the flexibility to adopt alternative measures, including market-based incentive programs, provided they meet EPA enforceability criteria.

5.1 DEFINITIONS

The RACT rule should accurately describe the types of sources that would be affected and clearly define terms used to describe the industry or applicable control methods. Example definitions of pertinent terms are presented in Appendix A for reference by the State or local agency.

5.2 APPLICABILITY

The recommended RACT described in this document applies to the manufacture of aerospace vehicles and components as well as the rework or repair of these aerospace products. (See Section 2.) This guidance has been developed for affected sources in areas of moderate, serious, or severe nonattainment that have the potential to emit greater than or equal to 25 tons per year of VOC's. The guidance is intended to apply to affected sources in extreme areas, however, if potential VOC emissions are greater than or equal to 10 tons per year. The State or local agency has the flexibility to apply RACT as deemed necessary. For example, an agency may apply RACT to all sources that have actual emissions at 50 percent of these thresholds.

5.3 COMPLIANCE, MONITORING, RECORDKEEPING & REPORTING PROVISIONS

The State or local agency is responsible for ensuring that appropriate requirements for compliance determination (testing), monitoring, recordkeeping and reporting are incorporated into its RACT rule. These requirements must meet two objectives: (1) the agency's need to demonstrate VOC emission reductions and (2) EPA's criteria for enforceability. Because source types, compliance methods, and agency requirements may vary substantially across the nation, specific provisions for compliance determination (testing), monitoring, recordkeeping and reporting are not included in this CTG.

However, for a State's RACT rules to be enforceable, they must definitively set forth recordkeeping, monitoring, and compliance determination (testing) requirements appropriate to the type of source(s) being regulated and sufficient to allow determinations whether the source(s) are in compliance. Therefore, EPA's Model Rule, which accompanies this CTG, contains suggested recordkeeping, testing, and monitoring provisions that EPA believes are sufficient to enable EPA and the States to determine compliance with the RACT requirements of the Model Rule. The State or other implementing agency can exercise its prerogative to consider various recordkeeping, testing, and monitoring requirements provided they meet the objectives prescribed in this CTG. This guidance is for instructional purposes only and, as such, is not binding.

APPENDIX A. DEFINITIONS

Terms used in this CTG and the Model Rule in Appendix B are defined in the Clean Air Act (Act), or in this section as follows:

Ablative coating means a coating that chars when exposed to open flame or extreme temperatures, as would occur during the failure of an engine casing or during aerodynamic heating. The ablative char surface serves as an insulative barrier, protecting adjacent components from the heat or open flame.

Adhesion promoter means a very thin coating applied to a substrate to promote wetting and form a chemical bond with the subsequently applied material.

Adhesive bonding primer means a primer applied in a thin film to aerospace components for the purpose of corrosion inhibition and increased adhesive bond strength by attachment. There are two categories of adhesive bonding primers: primers with a design cure at 250°F or below and primers with a design cure above 250°F.

Aerosol coating means a hand-held, pressurized, nonrefillable container that expels an adhesive or a coating in a finely divided spray when a valve on the container is depressed.

Aerospace vehicle or component means any fabricated part, processed part, assembly of parts, or completed unit, with the exception of electronic components, of any aircraft including but not limited to airplanes, helicopters, missiles, rockets, and space vehicles.

Aircraft fluid systems means those systems that handle hydraulic fluids, fuel, cooling fluids, or oils.

Aircraft transparency means the aircraft windshield, canopy, passenger windows, lenses and other components which are constructed of transparent materials.

Antichafe coating means a coating applied to areas of moving aerospace components that may rub during normal operations or installation.

Antique aerospace vehicle or component means an aircraft or component thereof that was built at least 30 years ago. An antique aerospace vehicle would not routinely be in commercial or military service in the capacity for which it was designed.

Aqueous cleaning solvent means a solvent in which water is at least 80 percent of the solvent as applied.

Bearing coating means a coating applied to an antifriction bearing, a bearing housing, or the area adjacent to such a bearing in order to facilitate bearing function or to protect base material from excessive wear. A material shall not be classified as a bearing coating if it can also be classified as a dry lubricative material or a solid film lubricant.

Bonding maskant means a temporary coating used to protect selected areas of aerospace parts from strong acid or alkaline solutions during processing for bonding.

Caulking and smoothing compounds means semi-solid materials which are applied by hand application methods and are used to aerodynamically smooth exterior vehicle surfaces or fill cavities such as bolt hole accesses. A material shall not be classified as a caulking and smoothing compound if it can also be classified as a sealant.

Chemical agent-resistant coating (CARC) means an exterior topcoat designed to withstand exposure to chemical warfare agents or the decontaminants used on these agents.

Chemical milling maskant means a coating that is applied directly to aluminum components to protect surface areas when chemical milling the component with a Type I or II etchant. Type I chemical milling maskants are used with a Type I etchant and Type II chemical milling maskants are used with a Type II etchant. This definition does not include bonding maskants, critical use and line sealer maskants, and seal coat maskants. Additionally, maskants that must be used with a combination of Type I or II etchants and any of the above types of maskants (i.e., bonding, critical use and line sealer, and seal coat) are not included. Maskants that are defined as specialty coatings are not included under this definition.

Cleaning operation means collectively spray-gun, hand-wipe, and flush cleaning operations.

Cleaning solvent means a liquid material used for hand-wipe, spray gun, or flush cleaning. This definition does not include solutions that contain no VOC.

Clear coating means a transparent coating usually applied over a colored opaque coating, metallic substrate, or placard to give improved gloss and protection to the color coat. In some cases, a clearcoat refers to any transparent coating without regard to substrate.

Closed-cycle depainting system means a dust free, automated process that removes permanent coating in small sections at a time, and maintains a continuous vacuum around the area(s) being depainted to capture emissions.

Coating means a material that is applied to the surface of an aerospace vehicle or component to form a decorative, protective, or functional solid film, or the solid film itself.

Coating operation means using a spray booth, tank, or other enclosure or any area, such as a hangar, for applying a single type of coating (e.g., primer); using the same spray booth for applying another type of coating (e.g., topcoat) constitutes a separate coating operation for which compliance determinations are performed separately.

Coating unit means a series of one or more coating applicators and any associated drying area and/or oven wherein a coating is applied, dried, and/or cured. A coating unit ends at the point where the coating is dried or cured, or prior to any subsequent application of a different coating. It is not necessary to have an oven or flashoff area to be included in this definition.

Commercial exterior aerodynamic structure primer means a primer used on aerodynamic components and structures that protrude from the fuselage, such as wings and attached components, control surfaces, horizontal stabilizers, vertical fins, wing-to-body fairings, antennae, and landing gear and doors, for the purpose of extended corrosion protection and enhanced adhesion.

Commercial interior adhesive means materials used in the bonding of passenger cabin interior components. These components must meet the FAA fireworthiness requirements.

Compatible substrate primer means either compatible epoxy primer or adhesive primer. Compatible epoxy primer is primer that is compatible with the filled elastomeric coating and is epoxy based. The compatible substrate primer is an epoxy-polyamide primer used to promote adhesion of elastomeric coatings such as impact-resistant coatings. Adhesive primer is a coating that (1) inhibits corrosion and serves as a primer applied to bare metal surfaces or prior to adhesive application, or (2) is applied to surfaces that can be expected to contain fuel. Fuel tank coatings are excluded from this category.

Confined space means a space that (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (for example, fuel tanks, fuel vessels, and other spaces that have limited means of entry); and (3) is not suitable for continuous employee occupancy.

Corrosion prevention system means a coating system that provides corrosion protection by displacing water and penetrating mating surfaces, forming a protective barrier between the metal surface and moisture. Coatings containing oils or waxes are excluded from this category.

Critical use and line sealer maskant means a temporary coating, not covered under other maskant categories, used to protect selected areas of aerospace parts from strong acid or alkaline solutions such as those used in anodizing, plating, chemical milling and processing of magnesium, titanium, or high- strength steel, high-precision aluminum chemical milling of deep cuts, and aluminum chemical milling of complex shapes. Materials used for repairs or to bridge gaps left by scribing operations (i.e., line sealer) are also included in this category.

Cryogenic flexible primer means a primer designed to provide corrosion resistance, flexibility, and adhesion of subsequent coating systems when exposed to loads up to and surpassing the yield point of the substrate at cryogenic temperatures (-275°F and below).

Cryoprotective coating means a coating that insulates cryogenic or subcooled surfaces to limit propellant boil-off, maintain structural integrity of metallic structures during ascent or re-entry, and prevent ice formation.

Cyanoacrylate adhesive means a fast-setting, single component adhesive that cures at room temperature. Also known as "super glue."

Dry lubricative material means a coating consisting of lauric acid, cetyl alcohol, waxes, or other noncross linked or resin-bound materials that act as a dry lubricant.

Electric or radiation-effect coating means a coating or coating system engineered to interact, through absorption or reflection, with specific regions of the electromagnetic energy spectrum, such as the ultraviolet, visible, infrared, or microwave regions. Uses include, but are not limited to, lightning strike protection, electromagnetic pulse (EMP) protection, and radar avoidance. Coatings that have been designated as "classified" by the Department of Defense are exempt.

Electrostatic discharge and electromagnetic interference (EMI) coating means a coating applied to space vehicles, missiles, aircraft radomes, and helicopter blades to disperse static energy or reduce electromagnetic interference.

Elevated-temperature Skydrol-resistant commercial primer means a primer applied primarily to commercial aircraft (or commercial aircraft adapted for military use) that must withstand immersion in phosphate-ester (PE) hydraulic fluid (Skydrol 500b or equivalent) at the elevated temperature of 150°F for 1,000 hours.

Epoxy polyamide topcoat means a coating used where harder films are required or in some areas where engraving is accomplished in camouflage colors.

Exempt solvent means a specified organic compound that has been determined by the EPA to have negligible photochemical reactivity and is listed in 40 CFR 51.100.

Fire-resistant (interior) coating means for civilian aircraft, fire-resistant interior coatings are used on passenger cabin interior parts that are subject to the FAA fireworthiness requirements. For military aircraft, fire-resistant interior coatings are used on parts that are subject to the flammability requirements of MIL-STD-1630A and MIL-A-87721. For space applications, these coatings are used on parts that are subject to the flammability requirements of SE-R-0006 and SSP 30233.

Flexible primer means a primer that meets flexibility requirements such as those needed for adhesive bond primed fastener heads or on surfaces expected to contain fuel. The flexible coating is required because it provides a compatible, flexible substrate over bonded sheet rubber and rubber-type coatings as well as a flexible bridge between the fasteners, skin, and skin-to-skin joints on outer aircraft skins. This flexible bridge allows more topcoat flexibility around fasteners and decreases the chance of the topcoat cracking around the fasteners. The result is better corrosion resistance.

Flight test coating means a coating applied to aircraft other than missiles or single-use aircraft prior to flight testing to protect the aircraft from corrosion and to provide required marking during flight test evaluation.

Flush cleaning means removal of contaminants such as dirt, grease, oil, and coatings from an aerospace vehicle or component or coating equipment by passing solvent over, into, or through the item being cleaned. The solvent may simply be poured into the item being cleaned and then

drained, or assisted by air or hydraulic pressure, or by pumping. Hand-wipe cleaning operations where wiping, scrubbing, mopping, or other hand action are used are not included.

Fuel tank adhesive means an adhesive used to bond components exposed to fuel and must be compatible with fuel tank coatings.

Fuel tank coating means a coating applied to fuel tank components for the purpose of corrosion and/or bacterial growth inhibition and to assure sealant adhesion in extreme environmental conditions.

Grams of VOC per liter of coating (less water and less exempt solvent) means the weight of VOC per combined volume of total volatiles and coating solids, less water and exempt compounds, and can be calculated by the following equation:

$$\text{grams of VOC per liter of coating (less water and less exempt solvent)} = \frac{W_s - W_w - W_{es}}{V_s - V_w - V_{es}}$$

W_s = weight of total volatiles in grams

W_w = weight of water in grams

W_{es} = weight of exempt compounds in grams

V_s = volume of coating in liters

V_w = volume of water in liters

V_{es} = volume of exempt compounds in liters

Hand-wipe cleaning operation means removing contaminants such as dirt, grease, oil, and coatings from an aerospace vehicle or component by physically rubbing it with a material such as a rag, paper, or cotton swab that has been moistened with a cleaning solvent.

High temperature coating means a coating designed to withstand temperatures of more than 350°F.

High volume low pressure (HVLP) spray equipment means spray equipment that is used to apply coating by means of a spray gun that operates at 10.0 psig of atomizing air pressure or less at the air cap.

Insulation covering means material that is applied to foam insulation to protect the insulation from mechanical or environmental damage.

Intermediate release coating means a thin coating applied beneath topcoats to assist in removing the topcoat in depainting operations and generally to allow the use of less hazardous depainting methods.

Lacquer means a clear or pigmented coating formulated with a nitrocellulose or synthetic resin to dry by evaporation without a chemical reaction. Lacquers are resoluble in their original solvent.

Leak means any visible leakage, including misting and clouding.

Limited access space means internal surfaces or passages of an aerospace vehicle or component that cannot be reached without the aid of an airbrush or a spray gun extension for the application of coatings.

Metalized epoxy coating means a coating that contains relatively large quantities of metallic pigmentation for appearance and/or added protection.

Mold release means a coating applied to a mold surface to prevent the molded piece from sticking to the mold as it is removed.

Nonstructural adhesive means an adhesive that bonds nonload bearing aerospace components in noncritical applications and is not covered in any other specialty adhesive categories.

Operating parameter value means a minimum or maximum value established for a control equipment or process parameter that, if achieved by itself or in combination with one or more other operating parameter values, determines that an owner or operator has continued to comply with an applicable emission limitation.

Optical antireflection coating means a coating with a low reflectance in the infrared and visible wavelength ranges that is used for antireflection on or near optical and laser hardware.

Part marking coating means coatings or inks used to make identifying markings on materials, components, and/or assemblies. These markings may be either permanent or temporary.

Pretreatment coating means an organic coating that contains at least 0.5 percent acids by weight and is applied directly to metal or composite surfaces to provide surface etching, corrosion resistance, adhesion, and ease of stripping.

Primer means the first layer and any subsequent layers of identically formulated coating applied to the surface of an aerospace vehicle or component. Primers are typically used for corrosion prevention, protection from the environment, functional fluid resistance, and adhesion of subsequent coatings. Primers that are defined as specialty coatings are not included under this definition.

Radome means the nonmetallic protective housing for. electromagnetic transmitters and receivers (e.g., radar, electronic countermeasures, etc.).

Rain erosion-resistant coating means a coating or coating system used to protect the leading edges of parts such as flaps, stabilizers, radomes, engine inlet nacelles, etc. against erosion caused by rain impact during flight.

Research and development means an operation whose primary purpose is for research and development of new processes and products and that is conducted under the close supervision of technically trained personnel and is not involved in the manufacture of final or intermediate products for commercial purposes, except in a de minimis manner.

Rocket motor bonding adhesive means an adhesive used in rocket motor bonding applications.

Rocket motor nozzle coating means a catalyzed epoxy coating system used in elevated temperature applications on rocket motor nozzles.

Rubber-based adhesive means a quick setting contact cement that provide a strong, yet flexible bond between two mating surfaces that may be of dissimilar materials.

Scale inhibitor means a coating that is applied to the surface of a part prior to thermal processing to inhibit the formation of scale.

Screen print ink means an ink used in screen printing processes during fabrication of decorative laminates and decals.

Sealant means a material used to prevent the intrusion of water, fuel, air, or other liquids or solids from certain areas of aerospace vehicles or components. There are two categories of sealants: extrudable/rollable/brushable sealants and sprayable sealants.

Seal coat maskant means an overcoat applied over a maskant to improve abrasion and chemical resistance during production operations.

Self-priming topcoat means a topcoat that is applied directly to an uncoated aerospace vehicle or component for purposes of corrosion prevention, environmental protection, and functional fluid resistance. More than one layer of identical coating formulation may be applied to the vehicle or component.

Semiaqueous cleaning solvent means a solution in which water is a primary ingredient ($\geq$60 percent of the solvent solution as applied must be water).

Silicone insulation material means an insulating material applied to exterior metal surfaces for protection from high temperatures caused by atmospheric friction or engine exhaust. These materials differ from ablative coatings in that they are not "sacrificial."

Solids means the nonvolatile portion of the coating that after drying makes up the dry film.

Solid film lubricant means a very thin coating consisting of a binder system containing as its chief pigment material one or more of the following: molybdenum, graphite, polytetrafluoro-ethylene (PTFE), or other solids that act as a dry lubricant between faying (i.e., closely or tightly fitting) surfaces.

Space vehicle means a man-made device, either manned or unmanned, designed for operation beyond earth's atmosphere. This definition includes integral equipment such as models, mock-ups, prototypes, molds, jigs, tooling, hardware jackets, and test coupons. Also included is auxiliary equipment associated with test, transport, and storage, that through contamination can compromise the space vehicle performance.

Specialty coating means a coating that, even though it meets the definition of a primer, topcoat, or self-priming topcoat, has additional performance criteria beyond those of primers, topcoats, and self-priming topcoats for specific applications. These performance criteria may include, but are not limited to, temperature or fire resistance, substrate compatibility, antireflection, temporary protection or marking, sealing, adhesively joining substrates, or enhanced corrosion protection.

Specialized function coating means a coating that fulfills extremely specific engineering requirements that are limited in application and are characterized by low volume usage. This category excludes coatings covered in other Specialty Coating categories.

Spray gun means a device that atomizes a coating or other material and projects the particulates or other material onto a substrate.

Structural autoclavable adhesive means an adhesive used to bond load-carrying aerospace components that is cured by heat and pressure in an autoclave.

Structural nonautoclavable adhesive means an adhesive cured under ambient conditions that is used to bond load-carrying aerospace components or other critical functions, such as nonstructural bonding in the proximity of engines.

Surface preparation means the removal of contaminants from the surface of an aerospace vehicle or component or the activation or reactivation of the surface in preparation for the application of a coating.

Temporary protective coating means a coating applied to provide scratch or corrosion protection during manufacturing, storage, or transportation. Two types include peelable protective coatings and alkaline removable coatings. These materials are not intended to protect against strong acid or alkaline solutions. Coatings that provide this type of protection from chemical processing are not included in this category.

Thermal control coating means a coating formulated with specific thermal conductive or radiative properties to permit temperature control of the substrate.

Topcoat means a coating that is applied over a primer on an aerospace vehicle or component for appearance, identification, camouflage, or protection. Topcoats that are defined as specialty coatings are not included under this definition.

Touch-up and repair coating means a coating used to cover minor coating imperfections appearing after the main coating operation.

Touch-up and repair operation means that portion of the coating operation that is the incidental application of coating used to cover minor imperfections in the coating finish or to achieve complete coverage. This definition includes out-of-sequence or out-of-cycle coating.

Volatile organic compound (VOC) means any compound defined as VOC in 40 CFR 51.100. This includes any organic compound other than those determined by the EPA to be an exempt solvent. For purposes of determining compliance with emission limits, VOC will be measured by the approved test methods. Where such a method also inadvertently measures compounds that are exempt solvent, an owner or operator may exclude these exempt solvents when determining compliance with an emission standard.

VOC composite vapor pressure means the sum of the partial pressures of the compounds defined as VOC's and is determined by the following calculation:

$$PP_c = \sum_{i=1}^{n} \frac{\frac{W_i}{MW_i} \times VP_i}{\frac{W_w}{MW_w} + \frac{\sum_{i=1}^{n} W_e}{MW_e} + \sum_{i=1}^{n} \frac{W_i}{MW_i}}$$

W_i = Weight of the "i"th VOC compound, grams.

W_w = Weight of water, grams.

W_e = Weight of nonwater, non-VOC compound, grams.

MW_i = Molecular weight of the "i"th VOC compound, g/g-mole.

MW_w = Molecular weight of water, g/g-mole.

MW_e = Molecular weight of exempt compound, g/g-mole.

PP_c = VOC composite partial pressure at 20°C, mm Hg.

VP_i = Vapor pressure of the "i"th VOC compound at 20°C, mm Hg.

Waterborne (water-reducible) coating means a coating which contains more than 5 percent water by weight as applied in its volatile fraction.

Wet fastener installation coating means a primer or sealant applied by dipping, brushing, or daubing to fasteners that are installed before the coating is cured.

Wing coating means a corrosion-resistant topcoat that is resilient enough to withstand the flexing of the wings.

APPENDIX B. AEROSPACE MANUFACTURING AND REWORK OPERATIONS MODEL RULE

B.1 APPLICABILITY

(a) Provisions of this Rule

(1) Except as noted in (a)(2) and (a)(3), this rule applies to the manufacture or rework of commercial, civil, or military aerospace vehicles or components at facilities located in severe, serious, and moderate ozone nonattainment areas that have the potential to emit 25 tons per year of VOC or more or are located in extreme nonattainment areas and have potential to emit 10 tons per year or more.

(2) This rule does not apply to the following activities where cleaning and coating of aerospace components and vehicles may take place: research and development, quality control, laboratory testing, and electronic parts and assemblies (except for cleaning and coating of completed assemblies).

(3) This rule does not apply to manufacturing or rework operations involving space vehicles or rework operations performed on antique aerospace vehicles or components.

B.2 DEFINITIONS

For the purpose of this rule the definitions listed in Appendix A shall apply.

B.3 REQUIREMENTS

(a) VOC content of coatings.

(1) A person shall not apply to aerospace vehicles or components any specialty coatings, including any VOC-containing materials added to the original coating supplied by the manufacturer, that contain VOC in excess of the limits specified below:

VOC CONTENT LIMITS FOR SPECIALTY COATINGS (g/L)[a]

Coating type	Limit
Ablative Coating	600
Adhesion Promoter	890
Adhesive Bonding Primers:	
Cured at 250°F or below	850
Cured above 250°F	1030
Adhesives:	
Commercial Interior Adhesive	760
Cyanoacrylate Adhesive	1,020
Fuel Tank Adhesive	620
Nonstructural Adhesive	360
Rocket Motor Bonding Adhesive	890
Rubber-based Adhesive	850
Structural Autoclavable Adhesive	60
Structural Nonautoclavable Adhesive	850
Antichafe Coating	660
Bearing Coating	620
Caulking and Smoothing Compounds	850
Chemical Agent-Resistant Coating	550
Clear Coating	720
Commercial Exterior Aerodynamic Structure Primer	650
Compatible Substrate Primer	780
Corrosion Prevention Compound	710
Cryogenic Flexible Primer	645
Dry Lubricative Material	880
Cryoprotective Coating	600
Electric or Radiation-Effect Coating	800
Electrostatic Discharge and Electromagnetic Interference (EMI) Coating	800
Elevated-Temperature Skydrol-Resistant Commercial Primer	740
Epoxy Polyamide Topcoat	660
Fire-Resistant (interior) Coating	800
Flexible Primer	640
Flight-Test Coatings:	
Missile or Single Use Aircraft	420
All Other	840
Fuel-Tank Coating	720
High-Temperature Coating	850
Insulation Covering	740
Intermediate Release Coating	750
Lacquer	830
Maskants:	
Bonding Maskant	1,230
Critical Use and Line Sealer Maskant	1,020
Seal Coat Maskant	1,230
Metallized Epoxy Coating	740
Mold Release	780
Optical Anti-Reflective Coating	750
Part Marking Coating	850
Pretreatment Coating	780
Rain Erosion-Resistant Coating	850
Rocket Motor Nozzle Coating	660
Scale Inhibitor	880
Screen Print Ink	840
Sealants:	
Extrudable/Rollable/Brushable Sealant	280
Sprayable Sealant	600
Silicone Insulation Material	850
Solid Film Lubricant	880
Specialized Function Coating	890
Temporary Protective Coating	320
Thermal Control Coating	800
Wet Fastener Installation Coating	675
Wing Coating	850

[a] Coating limits expressed in terms of mass (grams) of VOC per volume (liters) of coating less water and less exempt solvent.

(2) The following coating applications are exempt from the VOC content limits listed in paragraph (B.3)(a)(1):

(i) Touchup, aerosol, and DoD "classified" coatings

(ii) Coating of space vehicles

(iii) Facilities that use separate formulations in volumes of less than 50 gallons per year subject to a maximum exemption of 200 gallons total for such formulations applied annually.

(3) Primers, Topcoats, Chemical Milling Maskants. The broad categories of primers, topcoats (including self-priming topcoats), and chemical milling maskants (Type I/II) are not specialty coatings as listed in the table in (B.3)(a)(1) and are regulated for major sources under the Aerospace NESHAP requiring MACT limits with a compliance date of September 1, 1998 as specified in 40 CFR 63.749(a). These limits may be assumed to represent RACT limits 1 year after the major sources are required to meet the MACT limits and, therefore, shall not be effective until 1 year after the NESHAP compliance date. The requirements do not apply to facilities that use separate formulations of primers, topcoats, and chemical milling maskants (Type I/II) in volumes of less than 50 gallons per year, subject to a maximum exemption of 200 gallons total for such formulations applied annually.

(b) Application equipment.

(1) A person shall use one or more of the following application techniques in applying any primer or topcoat to aerospace vehicles or components: flow/curtain coat; dip coat; roll coating; brush coating; cotton-tipped swab application; electrodeposition coating; high volume low pressure (HVLP) spraying; electrostatic spray; or other coating application methods that achieve emission reductions equivalent to HVLP or electrostatic spray application methods.

(2) The following situations are exempt from application equipment requirements listed in paragraph (B.3)(b)(1):

(i) Any situation that normally requires the use of an airbrush or an extension on the spray gun to properly reach limited access spaces;

(ii) The application of specialty coatings;

(iii) The application of coatings that contain fillers that adversely affect atomization with HVLP spray guns and that the permitting agency has determined cannot be applied by any of the application methods specified in Section (B.3)(b)(1);

(iv) The application of coatings that normally have a dried film thickness of less than 0.0013 centimeter (0.0005 in.) and that the permitting agency has determined cannot be applied by any of the application methods specified in Section (B.3)(b)(1);

(v) The use of airbrush application methods for stenciling, lettering, and other identification markings;

(vi) The use of hand-held spray can application methods; and

(vii) Touch-up and repair operations.

(3) The application techniques listed in paragraph (B.3)(b)(1) are regulated for major sources under the Aerospace NESHAP requiring MACT application equipment with a compliance date of September 1, 1998 specified in 40 CFR 63.749(a). These equipment requirements may be assumed to represent RACT requirements 1 year after the major sources are required to meet the MACT equipment requirements and, therefore, shall not be effective until 1 year after the NESHAP compliance date of September 1, 1998.

(c) Solvent cleaning. The following requirements apply to solvent cleaning operations and shall not be effective until the Aerospace NESHAP compliance date of September 1, 1998:

(1) Hand-wipe cleaning. Cleaning solvents used in hand-wipe cleaning operations shall:

(i) Meet the definition of aqueous cleaning solvent in Appendix A, or

(ii) Have a VOC composite vapor pressure less than or equal to 45 millimeters of mercury (mm Hg) at 20°C.

(2) The following solvent cleaning operations are exempt from the requirements in paragraph (B.3)(c)(1):

(i) Cleaning during the manufacture, assembly, installation, maintenance, or testing of components of breathing oxygen systems that are exposed to the breathing oxygen;

(ii) Cleaning during the manufacture, assembly, installation, maintenance, or testing of parts, subassemblies, or assemblies that are exposed to strong oxidizers or reducers (e.g., nitrogen tetroxide, liquid oxygen, hydrazine);

(iii) Cleaning and surface activation prior to adhesive bonding;

(iv) Cleaning of electronics parts and assemblies containing electronics parts;

(v) Cleaning of aircraft and ground support equipment fluid systems that are exposed to the fluid, including air-to-air heat exchangers and hydraulic fluid systems;

(vi) Cleaning of fuel cells, fuel tanks, and confined spaces;

(vii) Surface cleaning of solar cells, coated optics, and thermal control surfaces;

(viii) Cleaning during fabrication, assembly, installation, and maintenance of upholstery, curtains, carpet, and other textile materials used on the interior of the aircraft;

(ix) Cleaning of metallic and nonmetallic materials used in honeycomb cores during the manufacture or maintenance of these cores, and cleaning of the completed cores used in the manufacture of aerospace vehicles or components;

(x) Cleaning of aircraft transparencies, polycarbonate, or glass substrates;

(xi) Cleaning and solvent usage associated with research and development, quality control, or laboratory testing;

(xii) Cleaning operations, using nonflammable liquids, conducted within 5 feet of energized electrical systems. Energized electrical systems means any AC or DC electrical circuit on an assembled aircraft once electrical power is connected, including interior passenger and cargo areas, wheel wells and tail sections; and,

(xiii) Cleaning operations identified as essential uses under the Montreal Protocol for which the Administrator has allocated essential use allowances or exemptions in 40 CFR § 82.4.

(3) Flush cleaning. For cleaning solvents used in the flush cleaning of parts, assemblies, and coating unit components, the used cleaning solvent (except for semiaqueous cleaning solvents) must be emptied into an enclosed container or collection system that is kept closed when not in use or captured with wipers provided they comply with the housekeeping requirements of (B.3)(c)(5). Aqueous cleaning solvents are exempt from these requirements.

(4) Spray gun cleaning. All spray guns must be cleaned by one or more of the following methods:

(i) Enclosed spray gun cleaning system provided that it is kept closed when not in use and leaks are repaired within 14 days from when the leak is first discovered. If the leak is not repaired by the 15th day after detection, the solvent shall be removed and the enclosed cleaner shall be shut down until the leak is repaired or its use is permanently discontinued,

(ii) Unatomized discharge of solvent into a waste container that is kept closed when not in use,

(iii) Disassembly of the spray gun and cleaning in a vat that is kept closed when not in use, or,

(iv) Atomized spray into a waste container that is fitted with a device designed to capture atomized solvent emissions.

(5) Housekeeping. All fresh and used cleaning solvents, except semiaqueous cleaning solvents, used in solvent cleaning operations shall be stored in containers that shall be kept closed at all times except when filling or emptying. It is recommended that cloth and paper, or other absorbent applicators, moistened with cleaning solvents be stored in closed containers. Cotton-tipped swabs used for very small cleaning operations are exempt. In addition, the owner or operator must implement handling and transfer procedures to minimize spills during filling and transferring the cleaning solvent to or from enclosed systems, vats, waste containers, and other cleaning operation equipment that hold or store fresh or used cleaning solvents. The above requirements are known collectively as housekeeping measures. Aqueous cleaning solvents are exempt from these requirements.

(d) Control equipment and monitoring.

(1) Each owner or operator may comply with the provisions of paragraph (B.3)(a) by using approved air pollution control equipment provided that the control system has combined VOC emissions capture and control equipment efficiency of at least 81 percent by weight.

(2) Each owner or operator shall submit a monitoring plan that specifies the applicable operating parameter value, or range of values, to ensure ongoing compliance with (B.3)(d)(1). The monitoring device shall be installed, calibrated, operated, and maintained in accordance with the manufacturer's specifications.

(3) Each owner or operator using an enclosed spray gun cleaner shall visually inspect the seals and all other potential sources of leaks at least once per month. Each inspection shall occur while the spray gun cleaner is in operation.

B.4 RECORDKEEPING REQUIREMENTS

(a) Each owner or operator using coatings listed in (B.3)(a) shall:

(1) Maintain a current list of coatings in use with category and VOC content as applied.

(2) Record coating usage on an annual basis

(b) Each owner or operator using cleaning solvents required in (B.3)(c) shall:

(1) For aqueous and semiaqueous hand-wipe cleaning solvents, maintain a list of materials used with corresponding water contents.

(2) For vapor pressure compliant hand-wipe cleaning solvents:

(i) Maintain a current list of cleaning solvents in use with their respective vapor pressures or, for blended solvents, VOC composite vapor pressures.

(ii) Record cleaning solvent usage on an annual basis.

(3) For cleaning solvents with a vapor pressure greater than 45 mm Hg used in exempt hand-wipe cleaning operations:

(i) Maintain a list of exempt hand-wipe cleaning processes.

(ii) Record cleaning solvent usage on an annual basis.

(c) Each owner or operator using control equipment under paragraph (B.3)(d) shall record monitoring parameters as specified in the monitoring plan required under (B.3)(d)(2).

(d) Except for Specialty Coatings, any source that complies with the recordkeeping requirements of the Aerospace NESHAP, 40 CFR 63.752, is deemed to be in compliance with the requirements of this paragraph (B.4).

B.5 TEST METHODS

(a) For coatings which are not waterborne (water-reducible), determine the VOC content of each formulation (less water and less exempt solvents) as applied using manufacturer's supplied data or Method 24 of 40 CFR part 60, Appendix A. If there is a discrepancy between the manufacturer's formulation data and the results of the Method 24 analysis, compliance shall be based on the results from the Method 24 analysis. For water-borne (water-reducible) coatings, manufacturer's supplied data alone can be used to determine the VOC content of each formulation.

(b) Cleaning solvents.

(1) For aqueous and semiaqueous cleaning solvents manufacturers' supplied data shall be used to determine the water content.

(2) For hand-wipe cleaning solvents required in paragraph (B.3)(c)(1), manufacturers' supplied data or standard engineering reference texts or other equivalent methods shall be used to determine the vapor pressure or VOC composite vapor pressure for blended cleaning solvents.

(c) Control equipment. Measurements of VOC emissions subject to paragraph (B.3)(d) shall be conducted in accordance with EPA Methods 18, 25, and/or 25A (40 CFR 60, Appendix A).

(d) Except for Specialty Coatings, any source which complies with the test method requirements of the Aerospace NESHAP, 40 CFR 63.750, is deemed to be in compliance with the requirements of this paragraph (B.5).