

**CLEAN AIR
INITIATIVES
IMPACTING THE
COATINGS INDUSTRY**

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OVERVIEW OF THE UNITED STATES EPA CLEAN AIR INITIATIVES IMPACTING SOLVENTS^a

Volatile Organic Compound (VOC) Regulations Under Title I of 1990 Clean Air Act Amendments (CAAA)

Primary objectives are to reduce ozone in nonattainment areas and to prevent deterioration of ambient air quality in attainment areas.

Motivation will be by states setting emission limits on facilities and collecting fees for VOC emission permits under Title V of CAAA.

EPA is drafting Control Technique Guidelines (CTGs) specifying Reasonably Available Control Technology (RACT) for major industry source categories to be applied to sources in nonattainment areas.

Major source categorization threshold is dependent on degree of nonattainment.

State and local regulations can be more stringent than federal regulations.

Hazardous Air Pollutants (HAPs) Regulations (Air Toxics) Under Title III of CAAA

Primary objective is to minimize cancer and long-term health risk.

The list of 189 chemicals and chemical categories includes Industrial Toxic Project (ITP) 33/50 list plus methyl alcohol, many ethylene oxide-based solvents, dimethylformamide, isophorone, 2-nitropropane, and ethylene glycol.

EPA is developing Maximum Achievable Control Technology (MACT) standards based on best performing 12% of the existing sources and on best performing source for new sources. This is to be reviewed every eight years.

MACT standards apply to sites emitting 10 tons/year of a single HAP or 25 tons/year of two or more HAPs.

Target Promulgations:

1994—Printing, Ships, Wood Furniture, Epoxies

1997—Autos, Paper, and Polyesters

2000—Wood Paneling, Appliance, Can, Coil, Metal Furniture, and Plastic Parts

Enforcement of regulations is to occur within three years of promulgation.

EPA must ensure that MACT compliance is protecting public health based on Residual Risk studies to be performed in 1998 to 2006. If studies show excessive risk, EPA must enforce stricter standards.

Early Reductions Program for Hazardous Air Pollutants

Reduced requirements are allowed for early participants who commit prior to promulgation.

Participants must document a 90% reduction in HAPs from about 1987 to the year of category promulgation.

Incentive for early reduction is a six-year extension of compliance date for achieving MACT standards for HAPs (maximum three years from promulgation to compliance).

During extension, participating companies are exempt from regulations on chemicals that are later added to the HAPs list.

Parts of facilities may participate.

^aThis overview was designed to highlight major provisions and differences in regulations and is not comprehensive. The contents of this overview do not constitute legal advice or opinion. For specific legal questions, customers should contact their legal council. For questions regarding Environmental Protection Agency policies, customers should contact their regional EPA representative.

Stratospheric Ozone Protection Under Title VI of CAAA

Control of ozone-depleting substances under Title VI is similar to the Montreal Protocol, an international treaty coordinated by the United Nations Environment Programme with which the United States has agreed to comply.

EPA must create a list of regulated ozone-depleting substances. Each listed substance must be assigned numerical values representing ozone depleting potential (ODP), chlorine and bromine loading potentials, and atmospheric lifetime.

Some regulations under Title VI phase out production, restrict use, and require recycling and safe disposal of ozone-depleting substances. Other Title VI regulations ban nonessential products which contain ozone-depleting substances and require that products which contain, or are manufactured with, an ozone-depleting substance bear a warning label for consumers. Under the provisions of Title VI, EPA is developing regulations to phase out CFCs (chlorofluorocarbons, methyl chloroform, and carbon tetrachloride) by January 1, 1996, and halons by January 1, 1994. HCFCs (hydrochlorofluorocarbons) will be fully phased out by January 1, 2030, but those with the highest ozone-depleting potential will likely be eliminated earlier.

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III)

Objective is to encourage emergency planning and provide Community Right to Know (also known as Emergency Planning and Community Right to Know Act—EPCRA).

Title III of SARA is unrelated to hazardous substance cleanup objective of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), generally known as the Superfund.

Section 313 requires suppliers to inform their customers when chemicals listed in Section 313 are contained in suppliers' products.

The list of 328 chemicals and chemical categories includes products on the HAPs list (except dimethylformamide and isophorone). Acetone, n-butyl alcohol, sec-butyl alcohol are also included.

Industrial Toxic Project (ITP 33/50 Project)

ITP is an effort by EPA to demonstrate EPA/industry voluntary "Partnership in Prevention" versus "Command and Control."

The list of 17 priority chemicals includes methyl ethyl ketone, methyl isobutyl ketone, toluene, xylene, 1,1,1-trichloroethane, and methylene chloride.

The objectives are a 33% reduction in the emissions of listed chemicals by 1992 and a 50% reduction by 1995 using 1988 as a baseline; identification of impediments to pollution prevention; and learning how to establish regional and state 33/50 programs.

Pollution prevention is to be fostered over treatment and disposal.

Participation is **voluntary**. Only **entire** facilities are eligible. A partial list of companies participating in the EPA 33/50 Program is on page 7.

Incentives for participation are public recognition, awards, and credit by EPA for reduction achieved.

PROJECTS AND SCHEDULE

CTG/Source	Draft	Final
1 SOCMI ^a Distillation	12/91	12/92
2 SOCMI Reactors	12/91	12/92
3 Wood Furniture	4/92	6/93
4 Plastic Parts: Business Machines	4/92	6/93
5 Plastic Parts: Other	4/92	6/93
6 Offset Lithography	4/92	6/93
7 Industrial Wastewater	4/92	6/93
8 Autobody Refinishing	4/92	6/93
9 SOCMI Batch Processing	4/92	6/93
10 VOL ^b Storage Tanks	4/92	6/93
11 Cleanup Solvents	9/92	11/93
12 Aerospace Coatings	TBD ^c	11/93
13 Ship Building and Repair	TBD ^c	11/93

^a*Synthetic Organic Chemicals Manufacturing Industry*
^b*Volatile Organic Liquid*
^c*Schedule to Be Determined, Projects Started in Fiscal Year 1992.*

PROPOSED TIMETABLE FOR REGULATING AIR TOXICS SURFACE COATING SOURCE CATEGORIES

Category	Emission MACT Standards Due by November 15 of Year ^a
Aerospace Industries	1994
Magnetic Tapes	1994
Printing/Publishing	1994
Ship Building and Repair	1994
Wood Furniture	1994
Auto and Light Duty Truck	1997
Paper and Other Webs	1997
Flat Wood Paneling	2000
Large Appliances	2000
Manufacture of Paints, Coatings, and Adhesives	2000
Metal Can	2000
Metal Coil	2000
Metal Furniture	2000
Miscellaneous Metal Parts and Products	2000
Plastics Parts and Products	2000
Printing, Coating, and Dyeing of Fabrics	2000

^aCompliance due 3 years later.

PROPOSED TIMETABLE FOR REGULATING AIR TOXICS RESINS PRODUCTION SOURCE CATEGORIES

Category	Emission MACT Standards Due by November 15 of Year ^a
Epoxy Resins	1994
Amino Resins	1997
Polyester Resins	1997
Polyether Polyols	1997
Alkyd Resins	2000

^aCompliance due 3 years later.

REGULATORY LISTINGS FOR COMMONLY USED SOLVENTS

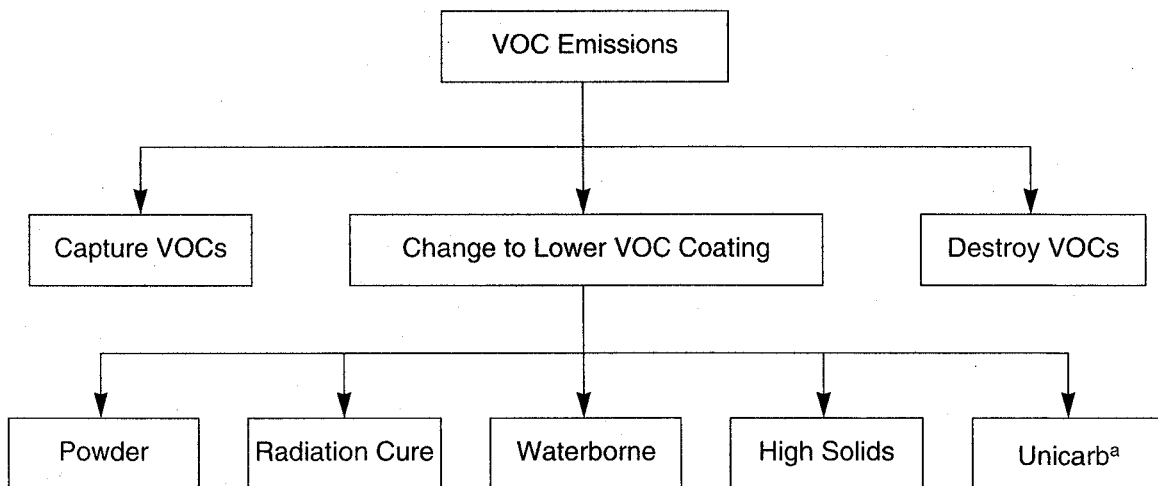
Chemical	SARA 313	ITP 33-50	CAA Air Toxics
Acetone	•	—	—
Methyl Ethyl Ketone	•	•	•
Methyl Isobutyl Ketone	•	•	•
Toluene	•	•	•
Xylene	•	•	•
Ethylene Oxide-Based Glycol Ethers and Glycol Ether Esters	•	—	•
Methylene Chloride	•	•	•
Methyl Alcohol	•	—	•
n-Butyl Alcohol	•	—	—
sec-Butyl Alcohol	•	—	—
1,1,1 Trichloroethane ^a	•	•	•
Dimethylformamide	—	—	•
Isophorone	—	—	•

^aClass I ODC (ozone-depleting chemical)

COMPLYING WITH CLEAN AIR INITIATIVES

- Identify and Quantify Facility Air Emissions
- Review Regulatory Guidelines and Compliance Schedules
- Evaluate Control Technologies (see chart below)
- Develop Compliance Strategies
- Implement as Regulations Are Promulgated
- Participate With the Government in Establishing Regulations

DEVELOPING COMPLIANT COATING PROCESSES



^aUnion Carbide

PARTIAL LIST OF COMPANIES PARTICIPATING IN EPA 33/50 PROGRAM^a

3M Company • Abbott Laboratories • Adolph Coors • Aluminum Company of America • America Akzo • American Cyanamid • American Standard • American Toy and Furniture • Amity Leather Products • Amoco • Anheuser-Busch • Armstrong World Industries • Ashland Oil • AT&T • Atlantic Richfield • B. Braun of America • B. F. Goodrich • Ball Corporation • Barnhardt Manufacturing • BASF • Bassett Furniture Industries • Baxter International • Bell & Howell • Bemis Company • Benjamin Moore • Bethlehem Steel • Black & Decker • Borden • Bostik • BP America • Bridgestone/Firestone • Bristol-Myers Squibb • Burroughs Wellcome • Cabot • Calig Steel Drum • Canon Business Machines • Capital Resin • Case • Casket Shells • Caterpillar • Cello-Foil Products • Certainteed • Champion Parts • Chemdesign • Chevron • Chrysler • Ciba-Geigy • Coleman • Colorado Paint • Columbia Corrugated Box • Commercial Enameling • Commercial Metals • Congoleum • Crown Cork & Seal • Crown Metal Finishing • Dallas Woodcraft • Deere • Deft • Degussa • Dexter • Dock Resins • Dow Chemical • Dow Corning • DSM Chemicals North America • Du Pont • Duracell International • Eastman Kodak • Elf Atochem North America • Eli Lilly • Emerald Packaging • Emerson Electric • Enamellers & Japanners • Essex Group • Exxon • Federal Paper Board • Ferro • Fischer Chair • Flexsteel Industries • Flint Ink • FMC • Ford Motor • Frost Paint and Oil • Futura Coatings • GAF • Garden State Tanning • Gencorp • General Dynamics • General Electric • General Motors • General Tire • Georgia-Pacific • Gilbert Spruance Holding • Gillette • Girard Custom Coaters • Globe Manufacturing • Goodyear Tire & Rubber • Gordon Bartels • Green Bay Packaging • Guardsman Products • H. B. Fuller • Hewlett-Packard • Hoechst-Celanese • Hoffman-LaRoche • Honda of America Motor • Hoover Systems • ICI Chemicals Polymers Holdings • Jacobson Manufacturing • Jamestown Paint & Varnish • Johnson Controls • Kelley Technical Coatings • Kimberly-Clark • Kitchen Innovations • La-Z-Boy Chair • Lyondell Petrochemical • MacDonald Carbide • Mallinckrodt • Martin Marietta • Mautz Paint • McDonnell Douglas • Mead • Meco • Memorex • Merck • Metal Container • Metal Litho International • Metal-Cote • Midwest Lacquer Manufacturing • Milliken • Mobil • Modern Metal Products • Morton Coatings • Motorola • Nalco Chemical • Nordson • Occidental Petroleum • Olin • Packaging Corp. of America • Penn Jacobson • Philip Morris • Pitney Bowes • Polaroid • PPG Industries • Production Paint Finishers • Quality Coatings • Red Spot Paint & Varnish • Reinz Wisconsin Gasket • Reliance Finishing • Rhone-Poulenc • Rico • Coatings • Sadolin Paint Products • Salz Leathers • Samsonite • Sartomer • Schenectady Chemicals • Seaboard Metal Finishing • Shell Oil • Sheller-Globe • Sherwin-Williams • Shop Vac • Silver Furniture • Sony USA • Spray Products • Stanley Works • Steelcase • Stepan • Sterling Casket Hardware • Sun Metal Products • Sunset Fireplace Fixtures • Tenneco • Texaco • Texas Instruments • U.S. Steel • Union Camp • Union Carbide • United Coatings • Valspar • Velsicol Chemical • W. M. Barr • W. R. Grace • Westvaco • Whirlpool • Witco • Wood Preservers • Zippo Manufacturing

^a"EPA's 33/50 Program, Third Progress Update," March 1993.

GLOSSARY

CAA (Clean Air Act)—The Clean Air Act, as amended, provides the foundation for EPA's efforts to improve air quality. The Clean Air Act, building on earlier legislation, was passed in 1970 and was amended in 1977 and again in 1990.

CTG (Control Technique Guideline)—Guidance developed by EPA to advise states of "presumptive" RACT for VOC sources in ozone nonattainment areas; CTGs are to be expanded and revised under the CAAA.^a

HAP (Hazardous Air Pollutant)—Any air pollutant listed pursuant to subsection (b) of the Clean Air Act. The Administrator shall periodically review the list established by this subsection and publish the results thereof and, where appropriate, revise such list by rule, adding pollutants which present, or may present, through inhalation or other routes of exposure, a threat of adverse human health effects (including, but not limited to, substances which are known to be, or may reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic; which cause reproductive dysfunction; or which are acutely or chronically toxic) or adverse environmental effects whether through ambient concentrations, bioaccumulation, deposition, or otherwise, but not including releases subject to regulation under subsection (r) as a result of emissions to the air.

MACT (Maximum Achievable Control Technology)—The level of control technology defined for a hazardous air pollutant.

RACT (Reasonably Available Control Technology)—The lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available, considering technological and economic feasibility. RACT is usually applied to existing sources in nonattainment areas and in most cases is less stringent than new source performance standards.

VOC (Volatile Organic Compound)—Any organic compound that participates in atmospheric photochemical reactions; i.e., any organic compound other than those that the Administrator designates as having negligible photochemical reactivity. VOC may be measured by a reference method, an equivalent method, an alternative method, or by procedures specified under any subpart. A reference method, an equivalent method or an alternative method, however, may also measure nonreactive organic compounds. In such cases, an owner or operator may exclude the nonreactive organic compounds when determining compliance with a standard. The Administrator has designated the following organic compounds as negligibly reactive: methane, ethane, 1,1,1-trichloroethane (methyl chloroform), methylene chloride, trichlorofluoromethane (CFC-22), trifluoromethane (FC-23), trichlorotrifluoroethane (CFC-113), di-chlorodifluoromethane (CFC-14), and chloropentafluoroethane (CFC-115).

^a"The Clean Air Act and the Paint and Coatings Industry," National Paint and Coatings Association, Inc., 1992.

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ALTERNATIVE SOLVENTS^a

HAP Solvent (Evaporation Rate)	Alternative (Evaporation Rate)
Xylene (0.7)	n-Butyl Acetate (1.0) Eastman PM Solvent (0.7) Methyl Isoamyl Ketone (0.5) Eastman PM Acetate (0.4) Isobutyl Isobutyrate (0.4)
Toluene (1.9)	Isopropyl Acetate (3.0) Methyl n-Propyl Ketone (2.3) n-Propyl Acetate (2.3) Isobutyl Acetate (1.4)
Methyl Ethyl Ketone (3.8)	Methyl Acetate (5.3) Ethyl Acetate (4.2) Isopropyl Acetate (3.0)
Methyl Isobutyl Ketone (1.6)	Methyl n-Propyl Ketone (2.3) n-Propyl Acetate (2.3) Isobutyl Acetate (1.4) n-Butyl Acetate (1.0)

^aFor specific information on solvent reformulation, contact your Eastman representative.

SELECT EASTMAN SOLVENTS^a

Esters	
Methyl Acetate	Ethylene Glycol Diacetate
n-Propyl Acetate	Eastman PM Acetate
Isopropyl Acetate	EEP Solvent
Isobutyl Acetate	n-Butyl Acetate
Isobutyl Isobutyrate	Ethyl Acetate
2-Ethylhexyl Acetate	
Alcohols	Ketones
Ethyl Alcohol (<i>Tecsol</i> special industrial and proprietary solvents)	Methyl n-Propyl Ketone
n-Propyl Alcohol	Methyl Isoamyl Ketone
2-Ethylhexanol	Methyl n-Amyl Ketone
Eastman PM Solvent	Diisobutyl Ketone
<i>Texanol</i> Ester-Alcohol	
Isobutyl Alcohol	

^aFor a complete list of Eastman solvents, see Publication M-167.

Eastman, *Tecsol*, and *Texanol* are trademarks.

Formulating Guidelines for Selecting Toluene and Xylene Substitutes

- One formulating option is to use a combination of active solvent, alcohol, and an aliphatic hydrocarbon.
- The use of an active solvent and alcohol will help dissolve the resins. Lower cost is achieved by the addition of an aliphatic hydrocarbon.
- The ratio of active solvent, alcohol, and aliphatic hydrocarbon has to be determined for each coating system because coating resins vary widely in their aliphatic hydrocarbon tolerance.
- The evaporation rate profile of the substitute blend should be structured to ensure adequate flow and proper film formation during drying.
- In most two-package polyurethane coatings, the use of alcohols and glycol ethers should be avoided.
- Under high bake conditions, it may be possible to replace xylene with a higher-boiling exempt aromatic hydrocarbon such as Aromatic 100 hydrocarbon solvent. Low levels of an active solvent could be used to enhance activity, if needed, while maintaining reasonable cost.
- The direct substitution of toluene with isobutyl acetate, or xylene with IBIB, might be advisable when the original formula contains low levels of either aromatic hydrocarbon. This approach would be more cost-effective than developing alternative blends.
- High-solid coatings are often applied by electrostatic spray techniques. A coating designed for electrostatic spraying should have an electrical resistance value in a range that maximizes transfer efficiency. Ester solvents will provide electrical resistance values closer to xylene than will ketones, alcohols, or glycol ethers.

The solvent blends included in this publication are only suggested starting points for developing alternative systems. They should be thoroughly evaluated to determine their suitability for a specific application.

SUGGESTED REPLACEMENTS FOR TOLUENE^{a,b}

Solvent		NC Lacquer	CAB/Acrylic Lacquer	Vinyl Lacquer
Toluene	100	—	—	—
Isobutyl Acetate	—	50	60	—
MPK ^c	—	—	20	40
Isobutyl Alcohol	—	20	—	—
VM&P Naphtha	—	30	20	60
Property				
Evaporation Rate (n-BuOAc=1)	1.9	2.1	1.7	2.5
Hansen Solubility Parameters				
Dispersion	8.8	7.5	7.5	7.6
Polar	0.7	1.2	1.8	1.5
Hydrogen Bonding	1.0	3.2	2.3	0.9
Total Hansen	8.8	8.2	8.0	7.8

^aAll values are by volume.
^bThese solvent blends are only suggested starting points for developing alternative systems. They should be thoroughly evaluated to determine their suitability for a specific application.
^cMPK—Methyl n-Propyl Ketone (MPK contains approximately 5% MIBK.)

SUGGESTED REPLACEMENTS FOR XYLENE^{a,b}

Solvent		NC Lacquer	High Solids	Vinyl Lacquer
Xylene	100	—	—	—
Isobutyl Acetate	—	—	20	—
MAK ^c	—	—	—	60
IBIB ^d	—	50	60	—
Special Naphtholite 66/3	—	30	20	40
Isobutyl Alcohol	—	20	—	—
Property				
Evaporation Rate (n-BuOAc=1)	0.7	0.7	0.6	0.6
Hansen Solubility Parameters				
Dispersion	8.6	7.4	7.4	7.7
Polar	0.5	1.3	1.2	1.7
Hydrogen Bonding	1.5	3.0	2.4	1.2
Total Hansen	8.7	8.1	7.9	8.0

^aAll values are by volume.
^bThese solvent blends are only suggested starting points for developing alternative systems. They should be thoroughly evaluated to determine their suitability for a specific application.
^cMAK—Methyl n-Amyl Ketone
^dIBIB—Isobutyl Isobutyrate

SUGGESTED REPLACEMENTS FOR MEK^{a,b}

Solvent		NC Lacquer	High Solids	Vinyl Lacquer
MEK ^c	100	—	—	—
Ethyl Acetate	—	100	80	—
MPK ^d	—	—	20	40
Acetone	—	—	—	60
Property				
Evaporation Rate (n-BuOAc=1)	3.8	4.1	3.7	3.8
Hansen Solubility Parameters				
Dispersion	7.6	7.7	7.7	7.7
Polar	4.4	2.6	2.8	4.5
Hydrogen Bonding	2.5	3.5	3.3	3.0
Total Hansen	9.1	8.8	8.8	9.4

^aAll values are by volume.
^bThese solvent blends are only suggested starting points for developing alternative systems. They should be thoroughly evaluated to determine their suitability for a specific application.
^cMEK—Methyl Ethyl Ketone
^dMPK—Methyl n-Propyl Ketone (MPK contains approximately 5% MIBK.)

SUGGESTED REPLACEMENTS FOR MIBK^{a,b}

Solvent		NC Lacquer	High Solids	Vinyl Lacquer
MIBK ^c	100	—	—	—
Isobutyl Acetate	—	100	80	—
MPK ^d	—	—	20	80
MAK ^e	—	—	—	20
Property				
Evaporation Rate (n-BuOAc=1)	1.6	1.4	1.5	1.5
Hansen Solubility Parameters				
Dispersion	7.5	7.4	7.5	7.8
Polar	3.0	1.8	2.2	3.5
Hydrogen Bonding	2.0	3.1	2.9	2.2
Total Hansen	8.3	8.2	8.3	8.9

^aAll values are by volume.
^bThese solvent blends are only suggested starting points for developing alternative systems. They should be thoroughly evaluated to determine their suitability for a specific application.
^cMIBK—Methyl Isobutyl Ketone
^dMPK—Methyl n-Propyl Ketone (MPK contains approximately 5% MIBK.)
^eMAK—Methyl n-Amyl Ketone

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EASTMAN

**AMERICAN PAINT
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Technical Focus:
Solvents

Options for reducing

HAPs emissions

using **MPK** and **MAK** solvents

By Ron Stout

Technical Focus: Solvents

Options for reducing

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Introduction

THE CLEAN AIR Act Amendments of 1990 are certain to force coatings producers and users to reduce emissions of hazardous air pollutants (HAPs). Title III of the amendments targets a list of 189 toxic substances for such reductions, and the list includes several solvents commonly used in coatings.

While engineering controls designed to reduce emissions from coatings-application processes present one option to deal with the mandates in the Clean Air Act Amend-

ments, coatings formulators will be looked to as a source of solutions to the emissions-reduction challenge.

Reformulation of coatings to reduce the use of HAPs presents one option to coatings producers and users. This article offers suggestions on formulating with ketone-based solvents that are not included on the Clean Air Act Amendments list of HAPs, but that provide the properties required to retain performance properties sought by coatings producers and users.

Overview of HAPs regulation*

Title III of the Clean Air Act Amendments (CAAA) of 1990 established a list of chemicals and chemical categories that are designated as hazardous air pollutants (HAPs). According to the U.S. House of Representatives committee report, HAPs are pollutants that pose particularly serious health risks.

Table 1
Proposed Timetable
for Regulating Air Toxics
Surface Coating Source Categories
(Emission MACT Standards
Due by Nov. 15 of Year Shown*)

Category	
Aerospace industries	1994
Magnetic tapes	1994
Printing/publishing	1994
Shipbuilding and repair	1994
Wood furniture	1994
Auto and light-duty truck	2000
Paper and other webs	2000
Flat wood panelling	2000
Large appliances	2000
Manufacture of paints, coatings and adhesives	2000
Metal can	2000
Metal coil	2000
Metal furniture	2000
Miscellaneous metal parts and products	2000
Plastics parts and products	2000
Printing, coating and dyeing of fabrics	2000

*Compliance due 3 years later.

Table 2
Proposed Timetable
for Regulating Air Toxics
Resins Production Source Categories
(Emission MACT Standards
Due by Nov. 15 of Year Shown*)

Category	
Epoxy resins	1994
Amino resins	1997
Polyether polyols	1997
Polyester resins	2000
Alkyd resins	2000

*Compliance due 3 years later.

MACT standards for surface coatings and resin production source categories are shown in Tables 1 and 2. An existing source must comply with MACT standards as expeditiously as possible but no later than three years after promulgation of the standard. Compliance with the applicable MACT standard must be incorporated in construction plans for new sources or major modifications of existing sources.

Compliance options

Reduction of HAPs emissions can be achieved in many ways. Some options are:

- Install engineering controls to destroy or recycle the HAPs solvents. This may often be the most effective HAPs emission control option for a coating operation. It will also aid in satisfying other current air pollution regulations, while allowing the use of materials that maximize coating performance and minimize cost. It may not be the most cost-effective option, however.

- Switch to alternative coating technologies such as powder, supercritical carbon dioxide technology, high-energy cure, waterbornes, and high-solids coatings that may contain little or no HAPs solvents.

- Reformulate solvent systems to replace HAPs solvents. Resin and solvent produc-

This list includes several solvents that are widely used in the coatings industry, e.g., methanol, MEK, MIBK, many ethylene oxide-based solvents, toluene, and xylene.

The EPA is developing Maximum Achievable Control Technology (MACT) standards for various source categories. MACT standards apply to sites emitting 10 tons per year of a single HAP or 25 tons per year of two or more HAPs.

Proposed schedules for promulgation of

*This overview was designed to highlight provisions in the regulations and is not comprehensive. The contents of the overview do not constitute legal advice or opinion. The reader must decide if these regulations are applicable to his particular operation and how best to comply with these regulations.

Technical Focus:

Table 3
Resin Solution Viscosity
Viscosity, mPas (cP)

Solvents	Evaporation Rate ^a	8 wt. % Nitrocellulose		
		20 wt. % Elvacite ^b 2010	60 wt. % Joncryl 587 ^c	
Methyl n-propyl ketone	2.3	14	46	1350
n-Propyl acetate	2.3	22	120	2800
Toluene	1.9	^d		5500
Isopropyl alcohol	1.7			8750
Methyl isobutyl ketone	1.6	19	96	2400
VM&P naphtha	1.6			
Isobutyl acetate	1.4	32	360	4950
n-Butyl acetate	1.0	30	230	4100
Xylene	0.7			11000
PM Solvent	0.7	80	570	9150
Methyl n-amyl ketone	0.4	25	220	3150
Isobutyl isobutyrate	0.4	100		20900
PM acetate	0.4	64	275	11200

^an-Butyl acetate = 1

^bAcrylic resin — Du Pont Co., Inc.

^cAcrylic resin — S. C. Johnson Polymer

^d = Insoluble

ers, coating formulators and applicators will need to work together to develop the best strategies to reduce HAPs emissions, while meeting other federal, state and local regulations.

Solvent reformulation

Reformulating to reduce HAPs emissions involves more than just replacing HAPs with solvents not listed under Title III. The reformulated solvent blend, used in nonattainment areas, must also satisfy the requirements of Title I of the CAAA, which restricts the weight per volume of VOCs that can be used in regulated surface coating processes.

In light of these regulations, non-HAPs solvents that are most efficient in lowering

Table 4
Solvent Density

Solvents	Evaporation Rate ^a	kg./L. (lb./gal.)
n-Propyl acetate	2.3	0.89 (7.39)
Toluene	1.9	0.87 (7.25)
Isopropyl alcohol	1.7	0.78 (6.54)
Methyl isobutyl ketone	1.6	0.80 (6.67)
VM&P naphtha	1.6	0.75 (6.27)
Isobutyl acetate	1.4	0.87 (7.25)
n-Butyl acetate	1.0	0.88 (7.35)
Xylene	0.7	0.87 (7.20)
PM Solvent	0.7	0.86 (7.69)
Methyl n-amyl ketone	0.4	0.82 (6.80)
Isobutyl isobutyrate	0.4	0.86 (7.13)
PM acetate	0.4	0.97 (8.06)

^an-Butyl acetate = 1

the viscosity of coating resins and that have low density offer the best opportunity for success. In general, as illustrated in Table 3, ketone solvents provide lower solution vis-

Table 5
Reformulation of Nitrocellulose Lacquer
to Minimize HAPs Solvents

Components	Original Blend	Reformulated Blend
	Weight	Weight
MEK	15.0	—
Isopropyl alcohol	15.0	16.2
Isobutyl acetate	21.0	21.0
Isobutyl alcohol	6.0	6.0
VM&P naphtha ¹	18.0	20.0
Toluene	12.0	7.2 ²
Xylene	7.0	0.6 ²
MAK	6.0	7.0
MPK ³	-	15.0
Ethyl acetate, 99%	-	7.0
	100.0	100.0
Properties		
Evaporation rate (n-butyl acetate = 1)	2.0	2.0
Wt./vol., kg./L. (lb./gal.)	0.82 (6.78)	0.82 (6.78)
Estimated weight of HAPs, kg. (lbs.)	15.6 (34.4)	4.1 (9.0) ⁴
Solution viscosity ⁵ , 21° C. mPa.s (cP)	46	43
Calculated VOC ⁵ , g/l (lb./gal.)	692 (5.78)	691 (5.77)

¹VM&P naphtha contained approximately 2 weight % of HAPs solvents.

²Weight % of toluene and xylene could not be reduced below the level shown because the alkyd resin was supplied in a blend of the solvents.

³Methyl n-propyl ketone typically contains 5 weight % MIBK, which is a HAPs solvent.

⁴The weight of HAPs can be reduced further by using an alkyd resin supplied in a non-HAPs solvent.

⁵40/42/18 by weight nitrocellulose/alkyd/DOTP (dioctyl terephthalate) solution at 22 weight % solids.

cosity for coating resins than other classes of solvents. They also have low weight per gallon, as shown in **Table 4**.

Methyl n-propyl ketone (MPK) and methyl n-amyl ketone (MAK) are non-HAPs ketone solvents that have these desirable properties. They can replace HAPs solvents in many coatings formulations to achieve HAPs and VOC emission reductions (**Tables 5 and 6**).

Solvent blends for a nitrocellulose lacquer and an acrylic/melamine enamel were reformulated using MPK and MAK to minimize HAPs solvents. The reformulated blends gave equal or better properties, but with a much lower level of HAPs solvents. Replacing low-cost HAPs solvents will increase costs; however, this additional expense must be compared with the cost of implementing other options.

Summary

The most effective emission reduction strat-

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Table 6
Reformulation of Acrylic/Melamine Enamel to Minimize HAPs Solvents

Components	Original Blend Weight	Reformulated Blend Weight
Xylene	51.0	—
n-Butyl acetate	34.0	40.0
Isobutyl alcohol	15.0	15.0
MAK	—	30.0
MPK	—	15.0
	100.0	100.0
Properties		
Evaporation rate (n-butyl acetate = 1)	0.8	0.8
Weight/volume, kg./L. (lb./gal.)	0.86 (7.16)	0.84 (6.99)
Estimated weight of HAPs, kg. (lb.)	23.1 (51)	0.36 (0.8) ¹
Solution viscosity ² , 23° C., mPa.s (cP)	809	637
Calculated VOC ² , g/l (lb./gal.)	409 (3.42)	403 (3.37)

¹Methyl n-propyl ketone typically contains 5 weight % MIBK, which is a HAPs solvent.

²70/30 by weight acrylic/melamine solution at 60 weight % solids.

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egy to satisfy regulations in Title III is likely to be the installation of engineering controls. Other options, however, such as alter-

nate coating technologies and/or solvent reformulations may be more practical solutions.