3M

Technical Data Bulletin

OH&ESD

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AIR PURIFYING RESPIRATORS IN AUTOMOTIVE PAINT-SPRAY OPERATIONS

INTRODUCTION

The following bulletin is a guideline for use of air purifying respirators when spray painting vehicles or vehicle parts in a paint spray booth.

The use of a respirator (air purifying or supplied air) in an automotive body shop requires that all elements of the Occupational Safety and Health Administration (OSHA) respiratory protection standard 29 CFR 1910.134 be implemented. This bulletin will concentrate on two elements in that standard:

I. Respirator Selection
II. Cartridge change schedules

Included in this bulletin is a summary of the necessary steps for respirator selection and cartridge change schedule, presented in outline form, schematic diagram, and detailed text.

SUMMARY

I. RESPIRATOR SELECTION

A. Exposure Assessment
   1. Paint solvents
      a. Select solvents –Material Safety Data Sheets (MSDS)
      b. Monitor painter's exposure using appropriate air sampling methods, e.g. 3M™ Organic Vapor Monitor with Analysis # 37023
   2. Diisocyanate vapors and aerosol
      a. Air sampling
      1. Industrial Hygiene Consultants
      2. State OSHA Consultation Service
      b. Objective data
      1. Industry studies
      2. Trade association studies
      3. National Institute for Occupational Safety and Health (NIOSH) Control Matrix

B. Respirator Selection
   1. 3M™ Respirator Selection Guide
   2. NIOSH Control Matrix

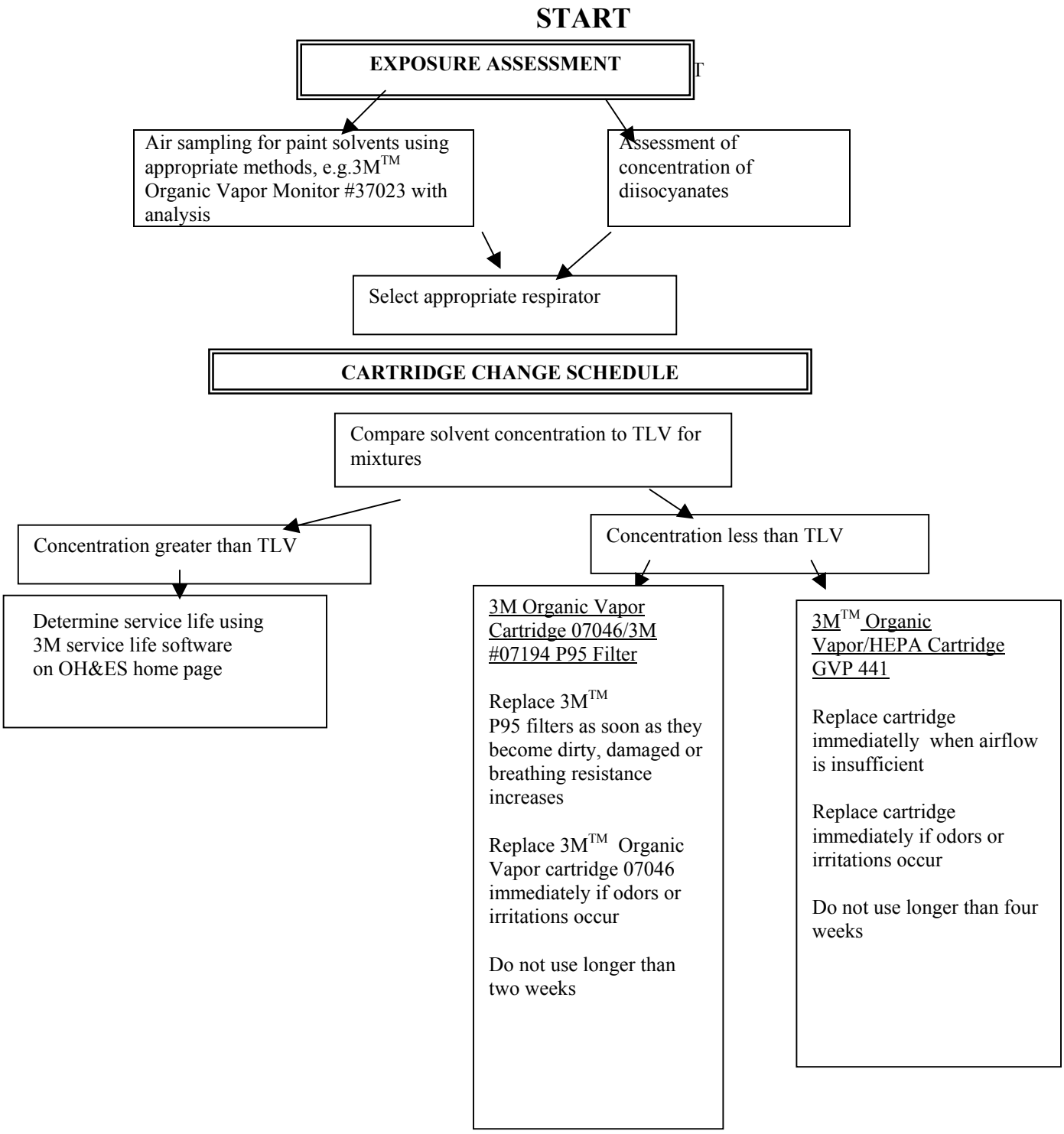
II. CARTRIDGE CHANGE SCHEDULE

A. Compare solvent exposure from (I)(A)(1)(b) to Threshold Limit Value (TLV)
   1. Calculate exposure for solvent mixtures

B. Calculate cartridge service life
   1. If (II)(A)(1) is 0.75 or greater use 3M™ Service Life Software
   2. If (II)(A)(1) is less than 0.75 use particulate filter loading

C. Determine cartridge change schedule
   1. when (II)(A)(1) is 0.75 or greater
      a. change cartridge before calculated end of service life
   2. When (II)(A)(1) is less than 0.75
      a. Change cartridge when particulate filter becomes clogged
      b. Change cartridge when painter detects odor or irritation
      c. Change when cartridge reaches maximum use recommendation
         (1) 3M Organic Vapor Cartridge #07046 2 weeks
         (2) 3M Organic Vapor/HEPA Cartridge #GVP 441 4 weeks

Respirator Selection and Cartridge Change Schedule for air purifying respirators in automotive paint-spray booths



DETAILED DISCUSSION

I. RESPIRATOR SELECTION

29 CFR 1910.134, paragraph (d)(1) - General Requirements

This section of the OSHA standard states that "the employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed …..".

Paragraph (d)(1)(iii) "The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) …..".

For employees involved in spray painting operations, the most common potential respiratory hazards are:

A. Exposure to organic solvent vapors
B. Exposure to diisocyanate vapors (when diisocyanate-containing paints are sprayed)
C. Exposure to paint overspray particles
D. Exposure to diisocyanate particles

A. Determination of Exposure to Organic Solvent Vapors

Step 1 Exposure Monitoring for Solvents

1. Select a normal day for painting operations.

2. Examine the Material Safety Data Sheet (MSDS) forms provided by the paint supplier. Based on NIOSH studies and 3M analysis reports, you should determine the top three solvents as listed by weight percent in the primer, color coat, clear coat and hardner. If using the 3M™ organic vapor monitor with analysis 37023, enter these solvents onto the included form. A list of commonly used solvents is shown on page 9 of this bulletin.

3. Select a painter to be monitored and fasten the #37023 organic vapor monitor to his/her collar or lapel. Have the painter wear the monitor for the entire day, including time spent in the paint booth and mixing room as well as all other working time. If the painter leaves the shop for lunch, remove the monitor and place into a sealed plastic bag. Reattach the monitor when the painter returns to the shop. Follow the instructions included with the monitor.

4. Complete the form and labels included with the monitor and send to the laboratory for analysis.

Step 2 Interpret Monitoring Results and Respirator Selection

Following analysis, the laboratory will send a report detailing the concentration in the air of the selected solvents. An example of an analysis report is shown on page 9 of this bulletin.

The numbers of interest are in the column "PPM" (parts per million)

Compare the monitoring results to the Threshold Limit Value (TLV) of each solvent. The TLVs of some commonly used solvents are contained on page 9 of this bulletin. The TLV values for other solvents can be found on the paint MSDS forms.

To determine if the concentration of solvents is at or above the TLV for the solvent mixture enter the information from the monitor analysis report in the table below and complete the calculations as outlined on page 10.

Solvent	Concentration (C) (from analysis report)	TLV (ppm)	C/TLV
TOTAL			

An example of this calculation is illustrated on page 10 of this bulletin.

If the total value is less than 0.75

The solvent concentrations do not violate OSHA health standards. Respirator selection can be based on other factors.

If the total value is 0.75 or greater

Select the appropriate respirator by accessing the 3M OH&ESD home page on the internet (http://www.mmm.com/occsafety/) and click "Software." Click on the "run free on web" Selection Software. Enter the concentrations of all three solvents plus particulate contaminants and follow the instructions for respirator selection.

If internet access is not available, call 3M Technical Service at 1-800-243-4630.

B) Determination of Exposure to Diisocyanate Compounds

The diisocyanates (TDI, HDI, and MDI) will exist both as a vapor and as a particulate in a spray painting operation.

The position of OSHA, as outlined in their Compliance Directive CPL 2-0.120 "Inspection Procedures for the Respiratory Protection Standard" 9/25/1998 is as follows:

"The employer must identify hazardous airborne contaminants that employees may
inhale and make a reasonable estimate of employee exposures in determining the appropriate respirator for employees to use.

Although the most reliable and accurate method to determine exposure is to conduct personal air monitoring, it is not explicitly required by the respirator standard. Instead, other means can be used to estimate workplace exposures.

Acceptable means include use of objective data - this is the use of data obtained from industry studies, trade associations, or from tests conducted by chemical manufacturers The objective data shall represent the highest contaminant exposures likely to occur under reasonably foreseeable conditions of processing, use, or handling. The employer must document the use of objective data as part of their written program."

1. Air Sampling

   a. Personal air monitoring can be conducted by industrial hygiene consultants. A list of consultants can be found on the web page of the American Industrial Hygiene Association (AIHA) http://www.aiha.org/.

b. OSHA Consultation Service

Using a free consultation service largely funded by the U.S. Occupational Safety and Health Administration (OSHA), employers can find out about potential hazards at their worksites. Primarily targeted for smaller businesses, this safety and health consultation program is completely separate from the OSHA inspection effort. In addition, no citations are issued or penalties proposed. It's confidential; any unsafe or unhealthful working conditions that the consultant uncovers will not be reported routinely to the OSHA inspection staff. A description of the consultation service can be found on the internet: http://www.osha.gov/oshprogs/consult.html.

Consultants are listed on the OSHA web site by state: http://www.osha.gov/oshdir/consult.html

c. Insurance carrier

The insurance carriers for body shops usually have loss control departments and they often provide air sampling services.

2. Objective Data

One example of objective data is a series of NIOSH studies in autobody shops in the mid-1990s in which they conducted personal monitoring studies on painters in spray-paint booths. Some of their results are shown on page 11 of this bulletin.

As a result of a series of empirical field studies by NIOSH , the matrix below was developed.

CONTROL MATRIX FOR PAINTING IN AUTOBODY REPAIR SHOPS

OPERATION	BOOTH	SPRAY GUN	RESPIRATOR
Painting car in booth	Downdraft Average airflow around car of 80 fpm and no point with an air flow less than 60 fpm	HVLP	Air purifying or supplied air Assigned Protection Factor (APF) = 10 or greater
• Painting car in booth • Painting car parts in booth	• Semi-downdraft • crossdraft	• HVLP • conventional	Air purifying or supplied air APF = 25 or greater
Painting car parts that are not attached to car	Downdraft – paint overspray directed at front or back of booth	HVLP	Air purifying or supplied air APF = 10 or greater

The matrix permits the use of air purifying respirators (OV cartridge plus particulate pre-filter) in properly operated spray painting booths.

This matrix does not address truck or bus painting. In the absence of exposure monitoring data for painting oversized vehicles, a supplied air respirator should be used.

For an employer in an autobody shop to use the NIOSH data on page 11 the following conditions must be met:

a. A respiratory protection program (29 CFR 1910.134) must be in place

b. A spray booth maintenance program to insure that the required operating conditions are met must be in place

c. The spray booth is operating according to conditions outlined on page 12 of this bulletin

II. CHEMICAL CARTRIDGE SERVICE LIFE AND CHANGE SCHEDULE

A. Service Life

Paint Solvents

If the total value calculated on page 5 is less than 0.75, the solvent concentrations do not exceed any OSHA standards, and a service life calculation is not required.

If the total value calculated on page 2 is 0.75 or greater, determine the service life of the cartridge by accessing the 3M OH&ESD home page on the internet (http://www.mmm.com/occsafety/) and click on "Cartridge Change". Scroll down to point 3 – web based version. Enter the concentrations of all three solvents and follow the instructions for determining the cartridge service life.

Diisocyanates

The maximum exposure to HDI vapor in the NIOSH studies summarized on page 13 was 0.750 mg/m3. Using the 3M Service Life program, under conditions of high humidity and heavy work the following breakthrough times were calculated:

3M™ Organic Vapor Cartridge 07046	999 hours (software program maximum)
3M Organic Vapor/HEPA Cartridge GVP cartridge # 441	999 hours (software program maximum)

Since the diisocyanate does not break through the carbon sorbent, the limiting factor in cartridge service life will be loading of the particulate filter.

B. Determine Cartridge Change Schedule

When the TLV for a single solvent or solvent mixture is exceeded:

1. Calculate the cartridge service life using the Service Life software as outlined above. Use this information as a guide in determining a cartridge change schedule.
2. Do not use the 07046 for longer than two weeks regardless of the service life estimate.
3. Do not use the GVP 441 for longer than four weeks regardless of the service life. estimate
4. Change the cartridge earlier if it becomes damaged, breathing resistance increases, or the painter detects odors or irritations within the respirator.

When the TLV for a single solvent or solvent mixture is not exceeded:

Cartridge/filter 3M™ Organic Vapor Cartridge 07046
3M™ P95 Replacement Filter 07194

Replace the filters as soon as they become dirty, damaged or breathing resistance increases. Replace the chemical cartridges every two weeks, or immediately if they become damaged, or if a painter notices odors or irritations within the respirator.

Cartridge/filter GVP 441

1. Check the airflow daily using the airflow meter included with the Belt-Mounted Powered Air Purifying Respirator Assembly (PAPR).. See page 14 of the PAPR User Instructions for details. If the ball fails to move fully inside or above the test circle, insufficient airflow is being provided. Check to insure that the battery s fully charged. If the battery is fully charged and the airflow is insufficient, the particulate filter has become loaded and the GVP 441 cartridge/filter should be discarded.

2. If airflow is sufficient, the cartridge/filter should be changed if objectionable odors or irritations are detected within the respirator.

3. If the airflow is sufficient and no odors or other irritations are detected, the GVP 441 should be used no longer than four weeks.

Threshold Limit Value (TLV) of Some Organic Solvents Commonly Used in Automotive Paint Systems

SOLVENT	TLV (ppm)
Toluene	50
Xylene	100
Acetone	500
n-butyl acetate	150
Methyl isobutyl ketone	50
Methyl ethyl ketone	200
Styrene	20
Ethyl Benzene	100
Ethyl acetate	400

Example Analysis Report

3M

Diffusional Monitor
Analysis Report

Report Number	
No. of Monitors	**Test Method Used** 3M OVM Monitor
Analysis Performed	**Report Date**
Analyzed by:	

Client: XYZ Autobody Repair
Mr. John Doe

User Identification	Monitor Code	Sampling Date	Sampling Time	Weight	Concentration
		Compounds			Mg/m3 PPM

XX105 1/15/02 660 min.

Acetone	367	15.2	6.41
n-butyl acetate	83.2	3.72	0.79
Toluene	170	8.19	2.18

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Example of Comparing Analysis Data to Solvent Mixture TLV

Use the information from the analysis report on page four.

Solvent	Concentration	TLV
Acetone	6.41	500
n-butyl acetate	0.79	150
Toluene	2.18	50

a) Enter the concentration of each solvent into the worksheet.

b) Enter the solvent TLV into the worksheet

c) Divide the solvent concentration by the TLV and enter into the worksheet.

Solvent	Concentration (C) (from analysis report)	TLV (ppm)	C/TLV
Acetone	6.41	500	0.0128
n-butyl acetate	0.79	150	0.0053
Toluene	2.18	50	0.0436
TOTAL			0.0617

Since the total is less than 0.75, the solvent mixture does not exceed the TLV. Therefore, other factors can be used to determine a cartridge change schedule.

SUMMARY OF NIOSH STUDIES IN AUTOBODY PAINT SPRAY OPERATIONS

DOWNDRAFT					
DIISOCYANATE FORM	**EXPOSURE**	**SAMPLING TIME (min)**	**LIMIT**	**OVER EXPOSURE**	**COMMENTS**
HDI aearosol	0.1 – 1.3 mg/m3	17 - 94	0.5 mg/m3 TWA 1.0 mg/m3 ceiling	YES	One sample out of 4 was at 1.3X ceiling limit and >2X TWA
HDI vapor	8 tests – 7 below detectable limit 1 at 0.750 mg/m3	8	0.140 mg/m3 (NIOSH) ceiling	7 – NO 1 – YES	One sample of 8 was at 5.4X ceiling limit
HDI aerosol	0.038 – 0.065 mg/m3		0.5 mg/m3 TWA 1.0 mg/m3 ceiling	NO	
HDI vapor	0			NO	
HDI aerosol	0 – 0.230 mg/m3		1.0 mg/m3 ceiling	NO	
SEMI-DOWNDRAFT					
HDI vapor	9 samples 0.004 – 0.067 mg/m3	4 - 22	0.140 mg/m3 NIOSH ceiling 0.035 mg/m3 TWA	YES	1 sample at 0.067 mg/m3 – exceed TWA
HDI aerosol	8 samples 0.12 – 0.212 mg/m3	4 - 22	0.5 mg/m3 TWA 1.0 mg/m3 ceiling	NO	5/8 samples were non-detectable
CROSSDRAFT					
HDI vapor	0.003 – 0.075 mg/m3	40 - 100	0.035 mg/m3 TWA	YES	2 samples out of 4 were up to 2X TWA
HDI aerosol	0 – 0.261 mg/m3	40 - 100	0.5 mg/m3 TWA 1.0 mg/m3 ceiling	NO	
HDI vapor	0 – 0.099 mg/m3	24 - 190	0.035 mg/m3 TWA	YES	1 sample out of 6 at 2X TWA
HDI aerosol	0	24 - 190		NO	

OPERATING CONDITIONS FOR SPRAY BOOTHS IN NIOSH STUDIES

PARAMETER	SPECIFICATION
Paint application rate	Under 150 gal/min of paint with a solids content of 50%
Polyisocyanate content of applied paint solids	Less than 33%
Number of painters	One only
Minimum distance between painted surface and workers chin	2 feet
Booth airflow rate	10,000 – 14,000 cfm
Booth size	Approx. 12’ x 25’ x 8’ high
Cornice for illuminating parts	No more than 1 foot on each side of booth
Air velocity around car in downdraft booth	The air velocity around the perimeter of a car is to be measured at 10 points. Three points are on the side of each car and two are next to the front and rear of the car. These measurements are taken 1.65 feet from the side of the car and 3 feet above the booth floor. The mean value of these measurements is to be greater than 1.3 feet per second and no point is to have a velocity less than 1 foot per second.
Air velocity for crossdraft and semi-downdraft booths	• 100 cfm/ft^2 of cross sectional area. • When width times height is greater than 150 ft^2, the criteria is 50 cfm/ft^2 of cross sectional area
HDI monomer content of paint	HDI monomer content of the sprayed liquid shall be less than 0.2% of the polyisocyanate. If the monomer content is greater than 0.2%, the shop must show that the workers exposure to HDI monomer is less than 20 ppb or have the workers use supplied air respirators