

MbOCA Handling Practices of PMA Members

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PURPOSE

The primary goal of this study was to determine whether voluntary work practice guidelines established by the Polyurethane Manufacturers Association (PMA) resulted in reduced exposure to 4, 4'-methylene-bis (2-chloroaniline) [MbOCA or MOCA]. We compared implementation of guidelines (work practice and date implemented) by PMA member companies to the urinalysis data collected in 1992-2008. A secondary goal of this study was to compare the reported practices to those recommended in a 2007 study by the British Health and Safety Executive (HSE).

INTRODUCTION

MbOCA Use In Casting Polyurethane Articles

MbOCA is a chemical curing agent used in the production of some castable polyurethane articles (for example, industrial belts, wheels and rollers). MbOCA is typically used in polyurethane casting operations, which involves pouring a liquid mixture into a mold. Polyurethane articles made with MbOCA can have unique characteristics of strength, flexibility, and durability.

MbOCA, like other aromatic amines, has been extensively studied for potential human carcinogenicity and is regulated as such in England and some other countries. MbOCA is readily absorbed through the skin, the primary route of workplace exposure.

Proper industrial hygiene practices are essential to reduce MbOCA workplace skin exposure, and are particularly important in the production of castable polyurethane articles. This is because "hand casting" can involve weighing MbOCA pellets into small containers for melting, hand mixing of hot liquid MbOCA with isocyanates and other chemicals in a small container, and then hand pouring the mixture into the mold.

Another method for polyurethane casting is "machine casting" where industrial equipment mixes hot liquid MbOCA with other chemicals in an enclosed system and dispenses the mix into a

mold, typically through a tube directed by an operator. Machine casting can reduce, but not eliminate, the potential for skin exposure.

After a partial cure of the casting produced by either method, solidified articles are removed from the mold and typically post-cured in a heated oven.

MbOCA Work Practice Recommendations

The Polyurethane Manufacturers Association (PMA), whose members typically use casting processes, recognized the potential for dermal absorption. The PMA in May 1990 developed the voluntary guidelines *MOCA Use Guidance-Castable Polyurethane Industry (PMA Guidance)*. The PMA Guidance has been updated a number of times, most recently in May 2005.

Other organizations have also developed MbOCA handling guidelines. In November 2007 the British Health and Safety Executive (HSE) published a study (**HSE Study**) that recommended work practices different than some of those in the PMA Guidance (*A Survey of Occupational Exposure to 4, 4'-methylene-bis (2-chloroaniline) (MbOCA) in the Polyurethane Elastomer Industry in Great Britain 2005-2006*). A journal article based on the HSE Study was published in 2009 (*A survey of occupational exposure to 4, 4' – methylene-bis (2-chloroaniline) (MbOCA) in the UK*). An interesting finding of the HSE Study is that urinalysis detected MbOCA dermal exposures from handling partially cured polyurethane articles. Therefore, MbOCA dermal exposure can still occur until the post-cure is complete.

MbOCA Urinalysis

Workplace exposure monitoring can help determine the effectiveness of exposure control practices. Urinalysis is one method used to evaluate MbOCA exposure. A characteristic of MbOCA urinalysis testing is that samples collected in the morning reflect the exposure that the worker experienced the day before. This close association provides feedback that allows for change and correction of work practices.

The PMA Guidance recommends that MbOCA urinalysis results should be maintained at less than 100 ug/L of urine. This is also the State of California regulatory limit. 100 ug/L is approximately 73 ug/g creatinine (personal communication from John Cocker to Thomas Klingner, Colorimetric Laboratories Inc., July 27, 2009). The HSE established a Biological Monitoring Guidance Value (BMGV) of 15 µmol/mol creatinine. This is approximately equivalent to 35ug/g creatinine. Therefore, the current BMVG for the UK is approximately half that of the California standard (and of the PMA Guidance).

In the HSE Study, the 90th percentile of all urinalysis 78 samples was 8.8 µmol/mol creatinine (approximately 21 ug/g creatinine). Based on this result the researchers recommended that the BMGV for urinary MbOCA should be reduced to 10 µmol/mol creatinine (approximately 23 ug/g creatinine).

METHOD

The research project began in December 2008 and was completed in August 2009.

Work Practice Survey

A 60-question survey was designed by the research team and included questions about processing, the physical workspace and personal protective equipment (Appendix C). The survey included questions about practices recommended in either/or the 2005 PMA Guidance and the HSE Study. The survey was distributed to the 53 PMA member companies which produce polyurethane articles (Processors). The PMA member companies that supply chemicals and equipment to the industry (Suppliers) did not receive the surveys.

A total of 20 surveys were returned out of the approximately 53 Processors, a 38 percent response. Since an unknown number the Processors do not use MbOCA (and use or nonuse is a competitive secret), the percent of surveys returned by those companies that use MbOCA cannot be determined.

Each survey question response was given a meets, exceeds, does not meet, or not applicable ranking based on the PMA guidelines and on the HSE guidelines. Based on the category survey answers, each company was then ranked by category (practices, engineering, personal protective equipment [PPE], and miscellaneous) as meets, exceeds, or does not meet.

Urinalysis Data

Urinalysis data was gathered for 14 of the 20 companies that gave permission for use of their historical urinalysis test results. Many of the PMA members use one laboratory for urinalysis (CLI, Colorimetrics Laboratory, Inc., DesPlaines, IL). The study design was to only use urinalysis data from CLI. This may have excluded some PMA member companies from the urinalysis comparisons. But it was decided that the availability of data spanning 17 years using the same laboratory and methodology provided a unique opportunity to compare over time work practices with urinalysis results.

Site Visits

Dr. Hogan conducted site visits to four of the companies that responded to the survey (20% of the respondents). For travel convenience the sites were selected by random from those eight companies within a 300 mile radius of Chicago. The identity of the companies visited was withheld from other contributors to this study. The four sites were visited between July 29, 2009 and August 4, 2009. Two of the sites visited use machine casting, one does hand casting and the fourth uses both methods.

Urinalysis Data

CLI personnel summarized the urinalysis data for each of the companies, and site-coded data was provided to the researchers. Urinalysis data was given in micrograms per liter in the ranges of not-detectable, 0-25, 26-50, 51-100 and over 100 ug/L urine.

The last urinalysis test results for each calendar year were used (ranging from May to December). Urinalysis data was available for 11 of the companies from 1992 through 2008, and data from 1992, 1998, and 2008 were chosen for analysis. These years were chosen because: 1992 since many of the PMA members had begun doing urinalysis; 1998 since there were many additions to the PMA use guidelines in 1997 and the first part of 1998; 2008 since this was the most recent data available.

Data for each company was averaged for each year using the midpoint of the reported ranges (0, 15, 38, 75 and 100 respectively). MbOCA urinalysis data was available total of 140 workers in 2008.

RESULTS AND DISCUSSION

A summary of survey results and urinalysis data for each company may be found in Appendix A. A comparison of 1992, 1998 and 2008 urinalysis results may be found in Appendix B. A comparison of PMA guidelines to the guidelines published as part of the HSE Study is attached as Appendix C. A history of PMA MbOCA Guidelines is attached as Appendix D. The Survey questions may be found in Appendix E.

Work Practices

Each company's PMA Guidance implementation dates for processing, physical workspace were compared to annual urinalysis data to determine if there was a significant decrease in MbOCA exposure after implementation of those policies and practices. No significant correlation was found (Appendix A). An additional finding is that none of the responding companies met the majority of recommendations given by the HSE Study.

Compliance with individual specific practices recommended by either PMA or HSE is not correlated with urinalysis results. The PMA Guidance on spill cleanup and wipe sampling were not being followed by a majority of the respondents.

Two of the responding companies fell far short of the PMA Guidance. The two companies that did not meet the PMA guidelines were machine-casting sites. These companies do not use urinalysis for screening, so the potential for increased exposure for these workers cannot be determined. One reason these companies may not be implementing more of the PMA Guidance is that without urinalysis results they may be unaware of specific work practices contributing to exposure. Also, it is possible that hand-casting shops recognize that their exposure potential is greater and are more likely to implement practices that reduce exposure.

Site Visits

The main finding of the site visits was that technology is available to replace some of the hand casting steps of weighing and mixing. This renders a number of the PMA Guidance and HSE Study recommendations inapplicable for some companies. Even in hand casting operations, the technology used at the sites visited dramatically decreases the potential for exposure to MbOCA as workers operate computer systems that can melt, weigh and dispense MbOCA.

The site visit revealed findings consistent with the survey, specifically that some of the PMA guidelines for spill cleanup and wipe sampling were not being followed. MbOCA pellets were observed on the floor in three of the four sites, raising concern about housekeeping. One site used an organic solvent (a ketone) for surface cleaning, a practice not recommended. One site cleans up spills by sweeping periodically. However, as recommended by the PMA, three of the four sites reported that spills are cleaned up immediately with a HEPA-filtered vacuum or other method designed for MbOCA spills. PMA guidelines for frequent wipe sampling to detect contamination were not followed at the four sites, but one site did follow the PMA guideline to gather exposure data (wipe sampling and urinalysis) when systems are periodically cleaned.

Urinalysis

The comparison of urinalysis results over time is given in Table 1. There was no significant change in urinalysis levels from 1992 to 2008 for the 11 companies that did regular urinalysis testing. This indicates that changes in the PMA recommended workplace practices are not predictors of exposure (Appendix B). However, the companies that regularly performed urinalysis testing have kept exposure below both the British and California recommendations in 1992, 1998, and 2008.

Table 1: Comparison of Urinalysis Results 1992, 1998, and 2008 (11 Companies)

	1992	1998	2008
n	11	11	11
Mean (SD)	13.90 (8.2) (ug/L)	8.98 (10.4) (ug/L)	10.81 (6.65)(ug/L)
Median	15.14	6.18	11.44
90th Percentile	21.33	28.00	17.41

The 2008 urinalysis results are given in Table 2. On average, exposures were below both the British and California recommendations. Only 4 out of 140 (2.85%) of persons monitored by surveyed companies were above the 100 ug/L limit recommended by the PMA.

The 90th percentile of the 2008 PMA member urinalysis results (20 ug/L, approximately 15 ug/g creatinine) is less than the 90th percentile of the HSE Study (8.8 μmol/mol creatinine, approximately 21 ug/g creatinine). This suggests that the voluntary practices employed by PMA member companies yields a similar or better level of protection than the regulatory approach used by HSE.

Table 2: 2008 Urinalysis Data for PMA Members (14 companies)

Mean (SD) (ug/L)	12.2 (7.5) (ug/L)
Median	12.5
90th Percentile	20.0
95% CI	(10.975,13.425)

RECOMMENDATIONS

- Processors should be educated on the importance of proper spill response and periodic wipe sampling of potentially contaminated surfaces
- Periodic urinalysis must be done by all Processors using MbOCA
- The PMA Guidance should be updated to reflect to the findings of this study and to address the changes in technology that have the potential to reduce MBOCA exposure
- Members should participate in this process to identify best industry practices
- Additional urinalysis should be done to detect potential MbOCA dermal exposures from handling partially cured polyurethane articles

DISCLAIMERS AND DISCLOSURES

Disclaimer by Benedictine University

This report is for informational purposes only. Although every reasonable effort is made to assure the accuracy of the data as reported from the source documents or source data, the report is not represented to be error-free. Data may be subject to update and correction without notice. These data do not constitute an offer, inducement, promise, guarantee, warranty or contract of any kind. The report is intended to omit personally-identifiable information as required by FERPA and other federal and state law.

Institutional Review Board Study Approval

Benedictine University's Institutional Review Board approved this research study on December 5, 2008 (Benedictine University application and acceptance file #20081204).

Role of the Funding Agency

The PMA staff coded company names and urinalysis data to maintain confidentiality of the information. They also distributed and collected the electronic surveys and assisted in encouraging PMA member company participation. The PMA's legal counsel, Reinhart, Boerner, VanDueren, also assisted in this process, and also contacted sites for permission for the site visits. Neither the PMA nor its legal counsel had a role in the design of the study or analysis of the data, and did not review this report in draft form. Before data collection began the researchers received permission to submit the study results to a journal without any prior review by the PMA or its legal counsel.

Disclosure of Potential Conflict of Interest

Dr. Hogan has worked as a paid consultant to the Polyurethane Manufacturers Association since 1991 (before employment at Benedictine University). This included participating in the revisions of the PMA MbOCA Use Guidance. Dr. Hogan did not receive additional payment for this current study apart for his normal salary from Benedictine University and for approved direct travel expenses for the site visit. Dr. Hogan is a member of the Board of Directors of The American Conference of Governmental Industrial Hygienists (ACGIH), an international organization that establishes exposure guidelines for chemicals in the workplace, including

exposure guidelines for MbOCA. This report was prepared independent of Dr. Hogan's role as an ACGIH Board Member and the opinions being expressed in this report do not represent the opinions of ACGIH. Dr. Hogan declared in writing to ACGIH in January 2008 the conflict of interest regarding MbOCA.

Carletta Fowle: No Conflict of Interest

Milvis Mamani: No Conflict of Interest

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APPENDIX A

Company	British Recommendations					PMA Guidelines					Urinalysis Data Beg.		Urinalysis Data End		
	Practices	Engineering	PPE	Misc	Urinalysis	Practices	Engineering	PPE	Misc	Urinalysis	Year	Average	Year	Average	n=
102	D	D	D	D	E	E	E	M - coveralls	D	E	Sep-06	53.2	Sep-08	27.0	13
103	D	D	D	D	D	M - spills	D	D	D	D	Sep-92	21.3	Jul-08	20.3	10
106	D	D	D	D	M	M - spills	E	D	M-wipe samp	M	May-06	2.5	Mar-07	13.3	4
108	D	D	D	D	D	E	E	D	M	D	Dec-92	3.3			
157	D	D	D	D	D	D	E	D	D	D					
163	D	D	D	D	M	M-spills	M	D	M-wipe samp	M	Dec-92	17.6	Nov-08	8.7	13
194	D	D	D	D	M	E-spills	E	D	M-train doc	M					
225	M-lid, drum st	D	D	M-others	M	E	M	D	E	M	May-92	12.3	Nov-08	8.3	10
248	D	D	D	E	M	D	E	D	E	M	Oct-92	7.5	Nov-08	12.5	6
288	D	D	D	D	D	M-spills	E	D	M-train doc	D					
358	D	D	D	M-others	M	E	E	E-san resp	E	M	Dec-92	5.8	Nov-08	15.2	20
377	D	D	D	D	M	E	E	E-san resp	E-wipe samp	M	May-92	16.8	Nov-08	16.8	9
542	D	D	D	D	D	D	E	E-san resp	D	D					
557	E-trans sys	D	D	D	E	M-spills	E	D	M-wipe samp	E	Nov-92	15.1	Dec-08	11.4	16
569	E	D	E-inner glove	D	M	E	E	E-san resp	E-wipe samp	M	Jun-92	30.1	Dec-08	8.3	10

677	M-surf, drum st	D	D	D	M	E	E	E-san resp	E-wipe samp	M	May-92	18.2	Jul-08	17.4	17
684	D	D	D	D	E	E	E	E-san resp	E-wipe samp	E	Oct-92	1.6	Nov-08	0.0	10
755	D	D	D	D	D	D	M	E-san resp	E-urine	D					
854	D	D	D	D	M	D	E	E	E-wipe samp	M	Oct-92	6.6	Nov-08	0.0	6
955	D	D	E-outer glove	D	D	E-spills	E	E-san resp	E-wipe samp	D					

Where all but one guideline is met, it is listed next to the ranking.

PPE=Personal Protective Equipment
surf=cleaning surface ares

drum st=storage of drums
others=other employees allowed in workspace
wipe samp=periodic wipe sampling of surfaces
train doc=documentation of employee training
spills=immediate cleanup of splls
san resp=periodic sanitization of respiratory equipment

n= 144.0
Mean 12.2
Median 12.5
90th
Percentile 20.0
StDev 7.5
95% CI (10.975,13.425)

APPENDIX B

COMPARISON OF 1992, 1998 AND 2008 URINALYSIS TEST RESULTS FOR THOSE 11 COMPANIES CONSISTENTLY TESTING FROM 1992 TO 2008

	<u>Month/ Year</u>	<u># of Samples Screened</u>	<u>ND (non detectable)</u>	<u>5-25 ug</u>	<u>26-50 ug</u>	<u>51-100 ug</u>	<u>more than 100 ug</u>	<u>Monitoring Frequency</u>	
358	Dec-92	22	15	6	1	0	0	tri-annual	5.818181818
684	Oct-92	19	17	2	0	0	0	quarterly	1.578947368
854	Oct-92	17	11	5	1	0	0	quarterly	6.647058824
248	Oct-92	6	3	3	0	0	0	bi-annual	7.5
103	Sep-92	12	6	2	2	2	0	bi-annual	21.33333333
569	Jun-92	8	3	1	2	2	0	tri-annual	30.125
163	Dec-92	9	4	3	1	1	0	tri-annual	17.55555556
377	May-92	13	4	7	1	1	0	annual	16.76923077
225	May-92	8	3	4	1	0	0	bi-annual	12.25
557	Nov-92	7	3	2	2	0	0	tri-annual	15.14285714
667	May-92	13	6	4	2	0	1	annual	18.15384615
		134	75	39	13	6	1		
			56%	29%	10%	4%	1%		

Mean 13.90
 Median 15.14
 90th % 21.33
 St Dev 8.20
 n 11

	<u>Month/ Year</u>	<u># of Samples Screened</u>	<u>ND (non detectable)</u>	<u>5-25 ug</u>	<u>26-50 ug</u>	<u>51-100 ug</u>	<u>more than 100 ug</u>	<u>Monitoring Frequency</u>	
358	Sep-98	26	3	13	6	1	3	bi-annual	30.69230769
684	Oct-98	10	6	3	1	0	0	tri-annual	8.3
854	Oct-98	18	15	3	0	0	0	quarterly	2.5
248	Dec-98	6	5	1	0	0	0	quarterly	2.5
103	Nov-98	4	2	2	0	0	0	tri-annual	7.5
569	Nov-98	10	7	3	0	0	0	quarterly	4.5
163	Dec-98	7	4	3	0	0	0	tri-annual	6.428571429
377	Oct-98	6	2	2	1	0	1	tri-annual	28
225	Nov-98	14	12	2	0	0	0	6 times/yr	2.142857143
557	Dec-98	5	5	0	0	0	0	quarterly	0
667	Nov-98	11	8	2	1	0	0	annual	6.181818182

117	69	34	9	1	4
	59%	29%	8%	1%	3%

Mean	8.98
Median	6.18
90th %	28.00
St Dev	10.40
n	11

	<u>Month/ Year</u>	<u># of Samples Screened</u>	<u>ND (non) detectable)</u>	<u>5-25 ug</u>	<u>26-50 ug</u>	<u>51-100 ug</u>	<u>more than 100 ug</u>	<u>Monitoring Frequency</u>	
358	Nov-08	20	11	6	1	1	1	quarterly	15.15
684	Nov-08	10	10	0	0	0	0	quarterly	0
854	Nov-08	6	6	0	0	0	0	quarterly	0
248	Nov-08	6	5	0	0	1	0	annual	12.5
103	Jul-08	10	2	6	1	1	0	bi-annual	20.3
569	Dec-08	10	6	3	1	0	0	monthly	8.3
163	Nov-08	13	7	5	1	0	0	quarterly	8.692307692
377	Nov-08	9	6	0	2	1	0	5 times/yr	16.77777778
225	Nov-08	10	6	3	1	0	0	quarterly	8.3
557	Dec-08	16	11	3	1	0	1	monthly	11.4375
667	Jul-08	17	6	8	2	0	1	tri-annual	17.41176471
		127	76	34	10	4	3		
			60%	27%	8%	3%	2%		

Mean	10.81
Median	11.44
90th %	17.41
St Dev	6.65
n	11

APPENDIX C – A comparison of PMA guidelines published in *MOCA Safe Use Guidance for the Castable Polyurethane Industry* to those published in *A Survey of Occupational Exposure to 4, 4'-methylene-bis (2-chloroaniline) (MbOCA) in the Polyurethane Elastomer Industry in Great Britain 2005-2006*

Category	British Recommendations	PMA Guidelines
PRACTICES	No office workers or visitors allowed in work area	
	In-use kegs lidded and stored in a dedicated dry storage area away from the work area	
	Manual scooping using extraction	If a manual process, should be in an enclosed transfer area
	Spillage during scooping immediately cleaning using a vacuum	Cleanup vacuum should be fitted with an HEPA filter
	If using automatic dispensers, pour carefully under LEV with a drip tray	There should be a closed transfer system from the shipping drum using vacuum or gravity with a spout
	Weighing, melting, mixing and casting under LEV using an enclosed external booth or fume cupboard or canopy or down-draft table	
	Capture velocity of the LEV should be > or = to .8 m/s	
	Molten material should be poured carefully, stirrer should not be placed onto surface liner, allow liquid from stirrer to rain back into the mixture	
	Splashing should be cleaned immediately using a rag	Cleanup done with a specific cleaning solution or HEPA-equipped vacuum.
	Heated mixture should be lidded for transporting	
	Local spillage during casting should be cleaned immediately	Spills cleaned with vacuum and decontaminate solution
	Curing areas equipped with	

	extraction (no extraction necessary for removal of molds)	
		Periodically decontaminate all surfaces
PPE	Overalls, safety shoes, safety glasses and gloves required	Long-sleeved smock
	Recommend cotton inner glove and leather outer glove	Impervious gloves
	Gloves removed correctly and not left on bench when not in use	
	Outer gloves changed frequently	Gloves should be discarded (if disposable) or laundered frequently
	Disposable gloves changed 4 times daily	
	Facepiece fit tested if applicable	Respirators not required but add protection If respirators are used, maintenance and training recommended
		Maintenance personnel should have respirator, hair covering, impervious gloves, smock, shoe covers and adequate ventilation
WORK-PLACE	Stainless steel or polypropylene plastic surfaces	
	Dedicated waste bin	
	No eating, drinking, smoking	
	Remove PPE when leaving work area	
	Provide adequate washing facilities	
	Provide adequate supervision	
MAINTEN-ANCE	LEV maintained at least every 14 months, checked weekly for air velocity, capture velocity > or = .8m/s	
	Face velocity > or = .5m/s	
	Use lockers for clothing	
	Laundry facilities at the workplace	
	Check PPE during use for heavy contamination	
	Maintain RPE. Replace filters in fan-	

	assisted facepieces	
MEDICAL/ OTHER	Urinalysis done at least every 6 months at end of shift	Urinalysis recommended under 100ug/L
	Include maintenance personnel in urinalysis screening	
	Airborne monitoring not required unless urinalysis is high	Air monitoring not required if urinalysis is done
	Regular wipe sampling	Regular wipe sampling
	Training program with documentation for each employee	Training program with documentation for each employee
		Medical surveillance NOT required
		Surface monitoring NOT required
		If airborne monitoring is done, get initial baseline

APPENDIX D

Year Report Chart for the MOCA Safety Guidelines Implementations

MOCA Safety Guidelines Implementations	Environmental Monitoring		Dermal Protection				Sanitation				Urinalysis	Employee Training	Medical Surveillance
	Vacuum System	Gravity System	Gloves	Full length sleeves	Eye-wear	Shoe and Hair Covers	Hand washing	Surface decontamination	Disposable	Air filters and respirators			
May 1990	•	•	•	•	•	•	•	•		•	•		•
November 1993	•	•	•	•	•	•	•	•		•	•		•
March 1997	•	•	•	•	•	•	•	•		•	•	•	•
October 1997	•	•	•	•	•	•	•	•		•	•	•	•
February 1998	•	•	•	•	•	•	•	•	•	•	•	•	
November 1998	•	•	•	•	•	•	•	•	•	•	•	•	
April 1999	•	•	•	•	•	•	•	•	•	•	•	•	
May 2005	•	•	•	•	•	•	•	•	•	•	•	•	

APPENDIX E – SURVEY CONTENT

For purposes of this survey, “workspace” is defined as any area of the facility in which MOCA is used or handled.

SECTION 1, GENERAL INFORMATION

1.1 During which calendar years has MOCA been used at your company?
(for example, 1989-2002, or 1995-Present)

If MOCA has never been used at your company, please disregard this survey and respond via email stating that MOCA has never been used. If MOCA has been used at your company, but is not presently used, please respond to this survey based on the procedures and environment when MOCA was last used.

1.2. How many persons are employed by your company?

1.3. How many persons regularly work with MOCA?

1.4 In how many distinct workspaces is MOCA used?

1.5 How many pounds of MOCA are used by your company each year?

1.6 What is the type of MOCA used at your company? (for example, powder, pellet, liquid, glazed pellet)

1.7 Which country(ies) is the primary source of the MOCA you use?

1.8 The MOCA shipping drums:
are equipped with a gooseneck drum liner
are not equipped with a gooseneck drum liner

SECTION 2, PROCESSING

Select the one answer that best represents the process used at your organization.

2.1 When MOCA shipping drums are delivered:

They are stored in the workspace area where they will be later used

They are stored in a dedicated dry storage area

2.2 When MOCA shipping drums are partially full:

They are immediately covered and kept in the workspace area

They are later covered and kept in the workspace area

They are left open in the workspace area

They are covered and removed to a dedicated storage area

They are left open and moved outside the workspace

2.3 When MOCA shipping drums are essentially empty:

They are used to collect refuse before removal from the premises

They are immediately removed from the premises

2.4 MOCA is transferred from the shipping drum to a melter or dispenser using:

A vacuum transfer system

A contained gravity feed system

A manual system such as a scoop

2.5 When a spill occurs during dispensing:

The spill is immediately cleaned using a vacuum with a HEPA

The spill is cleaned using a vacuum with a HEPA filter at the end of the work day

The spill is immediately cleaned with other than a vacuum immediately

There is no particular procedure for spill clean-up

2.6 Casting is done by

Machine

Hand

If casting is done by machine, please skip to question number 2.10.

2.7 The temperature of the MOCA is measured by:

- A control device with automatic cut-off and/or audible alarm
- A measuring device with no alarm and no automatic cut-off
- The experience of the worker
- 2.8 Melted MOCA is transferred to the mixing stage by:
 - Placing a lid on the container and carrying
 - Carrying the container without a lid
- 2.9 The MOCA/resin mixture is transferred to the casting/molding area:
 - In a covered container
 - In a container without a lid
- If casting is done by hand, please skip to question number 2.11.
- 2.10 When not in use, the tank containing MOCA:
 - Is covered with a nitrogen blanket
 - Is not covered with a nitrogen blanket
- 2.11 Surfaces which are potentially contaminated are cleaned:
 - Daily with a cleaning solution designed for use with MOCA
 - Less often than daily with a cleaning solution designed for use with MOCA
 - Daily with a cleaning solution not specifically designed for use with MOCA
 - Less often than daily with a cleaning solution not specifically designed for use with MOCA
- 2.12 When reactor systems, ovens or ventilation systems are cleaned:
 - Maintenance personnel are monitored via urinalysis and surfaces are subject to wipe sampling
 - Maintenance personnel are monitored via urinalysis, no wipe sampling is done
 - Surfaces are sampled, no urinalysis is done
 - There is no wipe sampling or urinalysis done when reactor, oven or ventilation is cleaned
- 2.13 Materials which are potentially contaminated, such as gloves are placed:
 - In a general garbage can or DOT drum
 - In a garbage can or DOT drum dedicated for contaminated materials only
- 2.14 In what year were your current MOCA processing procedures implemented?
- 2.15 What is the primary source of information used in determining processing procedures:
 - Federal and State government requirements
 - Voluntary guidelines provided by the Polyurethane Manufacturing Association (PMA)
 - Voluntary guidelines from sources other than the PMA

SECTION 3, PHYSICAL WORKSPACE

Please choose the one answer that most closely describes the physical workspace at your company:

- 3.1 The type of ventilation present at the point where MOCA is dispensed and measured is:
 - A local exhaust hood with extraction
 - A local exhaust hood without extraction
 - There is no exhaust hood, windows and/or doors may be open
- 3.2 Weighing and melting MOCA is carried out:
 - In a partially enclosed booth with extraction and make-up air
 - In a partially enclosed booth with extraction and no make-up air
 - In a partially enclosed booth with no extraction
 - Beneath a fume hood
- 3.3 The oven used in casting:
 - Has a canopy hood above it
 - Has internal extraction with venting to outside
- 3.4 Air velocity of ventilation systems is checked and indicated repairs are made:

- At least once per week
- At least once per month
- At least once per year
- No specific schedule has been implemented
- 3.5 The surfaces in the work area are:
 - Stainless Steel
 - Polypropylene Plastic
 - Other than Stainless Steel or Polypropylene Plastic
- 3.6 Hand washing facilities are:
 - Present in the workspace
 - Present, but outside the workspace
- 3.7 In what year was your current physical workspace installed/constructed?
- 3.8 What is the primary source of information used in designing the physical workspace?
 - Federal and State government requirements
 - Voluntary guidelines provided by the Polyurethane Manufacturing Association
 - Voluntary guidelines from sources other than the PMA

SECTION 4, PERSONAL PROTECTIVE EQUIPMENT

Please choose the one answer that most closely describes the personal protective equipment used by employees handling or exposed to MOCA.

- 4.1 The type of inner gloves used by workers with exposure to MOCA are:
 - Nitrile
 - Disposable latex or vinyl
 - Cotton liners
 - Inner gloves are not used
- 4.2 The type of outer gloves used by workers are:
 - Neoprene
 - Nitrile
 - Disposable latex
 - Reusable leather
 - Reusable terry
 - Reusable cotton
 - Outer gloves are not used
- 4.3 If the gloves are reusable, when not in use, they are stored:
 - In lockers or bags in the workspace
 - In lockers or bags outside the workspace
 - They are not stored in lockers or bags
- 4.4 If the gloves are reusable, they are replaced:
 - Each time the worker reenters the workspace (approx. 4 times daily)
 - At least daily
 - At least weekly
 - There is no specific replacement schedule
- 4.5 Outer gloves are removed:
 - Every time the worker leaves the workspace (such as for break)
 - There is no schedule or procedure for glove removal
- 4.6 Workers are required to wear:
 - Reusable coveralls with long sleeves
 - Disposable coveralls with long sleeves

- There is no requirement for worker attire
- 4.7 If coveralls are reusable, they are laundered:
At least weekly near the workspace
At least monthly near the workspace
Less often than monthly near the workspace
Workers must launder their coveralls at home
- 4.8 When handling MOCA, workers are required to wear:
Goggles only
Disposable half-face mask respirators
Reusable half-face mask respirators
Reusable full-face mask respirators
Reusable, fan-assisted or air-fed respirators
No respiratory protective equipment is required
- 4.9 When workers are required to wear half-face respirators:
The respirators are personally fitted to each individual worker
The respirators are not personally fitted to each individual worker
Half-face respirators are not required
- 4.10 When workers are required to wear reusable respirators or goggles, they are sanitized:
At least daily
At least weekly
No specific schedule is followed – they are sanitized as needed
Reusable respirators or goggles are not used
- 4.11 If the goggles or respirators are reusable, when not in use, they are stored:
In lockers or bags in the workspace
In lockers or bags outside the workspace
They are not stored in lockers or bags
Reusable respirators or goggles are not used
- 4.12 If the workers wear safety glasses or corrective lenses, they are sanitized:
Every time they leave the workspace (such as for a break)
At least daily
No specific schedule is followed – they are sanitized as needed
- 4.13 Workers are required to wash their hands:
Every time they remove their gloves
Every time they leave the workspace (such as for a break)
There are no specific hand-washing requirements
- 4.14 Hands are washed using:
Soap and water
A cleanser designed specifically for workers exposed to MOCA and similar substances
- 4.15 Workers are required to:
Wear work boots at all times, removing them when leaving the workspace (such as for a break)
Wear work boots at all times, with no requirement for removing them
There are no requirements for work boots
- 4.16 In what year were your current standards for personal protective equipment implemented?
- 4.17 What is the primary source of information used to decide what personal protective equipment is supplied?
Federal and State government requirements
Voluntary guidelines provided by the Polyurethane Manufacturing Association
Voluntary guidelines from sources other than the PMA

SECTION 5, MISCELLANEOUS

- 5.1 During what portion of the day is a supervisor present in the MOCA workspace? (for example, 25% of the time).
- 5.2 In what year were your requirements for worker training implemented?
- 5.3 All workers attend process and hazard training:
- Upon hire only
 - Upon hire and at least annually thereafter
 - Upon hire and less often than annually thereafter
- 5.4 Workers' attendance at training sessions:
- Is documented and kept in personnel files
 - Is not documented
- 5.5 Training consists of
- Classroom and hands-on instruction
 - Classroom instruction only
 - Hands-on instruction only
- 5.6 Training content is primarily based on
- Manufacturer-provided instructions
 - Knowledge of an experienced employee
 - Information provided by the Polyurethane Manufacturing Association
 - Information provided by sources other than the PMA
- 5.7 MOCA levels are tested:
- At least semi-annually using air monitoring and urinalysis
 - At least semi-annually using air monitoring only
 - At least semi-annually using urinalysis only
 - Less often than semi-annually
 - Never
- 5.8 MOCA contamination is detected:
- Using UV light and/or wipe sampling at least daily
 - Using UV light and/or wipe sampling at least weekly
 - Using UV light and/or wipe sampling less often than every week
- 5.9 Workers other than those involved in the polyurethane manufacture process are allowed in the workspace:
- Frequently
 - Infrequently
 - Never
- 5.10 Eating and drinking are allowed in the workspace:
- Frequently
 - Infrequently
 - Never
- 5.11 In what year was a dermal exposure assessment of the workspace most recently reviewed and updated?
- 5.12 In what year was your emergency response plan most recently reviewed and updated?

SECTION 6. URINALYSIS DATA

For the purposes of this study, we need to correlate data from actual employee exposure to MOCA with the work practices identified in this survey. Therefore, we would like your company's permission to

use the urinalysis data already collected as part of the PMA-sponsored urinalysis monitoring program conducted over the past two decades. Note that we are not asking you to conduct any additional urinalysis monitoring for the purposes of this study; we only need the data that has already been collected. To reduce the burden on survey respondents, and with your permission, the PMA can obtain this data directly from CLI, the laboratory that coordinated the industry's MOCA urinalysis screening program. CLI will release only your company's summary data, not data associated with individual workers. Furthermore, the data released by PMA to the study researchers will not contain any company-identifying information, and any study report that is published will not contain company-identifying information.

6.1 I grant CLI permission to release summary data of my company's complete history of urinalysis data to the PMA for the purposes of this study. I understand that only summary data will be provided, not data on individual workers. I also understand that the PMA will remove any company-identifying information from this data prior to forwarding it to the researchers conducting this study.

I grant permission

I DO NOT grant permission