NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2002-0379-2901
Superior Label Systems
Mason, Ohio

May 2003

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act (OSHA) of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Copies of this report have been sent to employee and management representatives at Superior Label Systems, Inc., and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation

A Follow-up Evaluation of Visual Disturbances Related to Amine Exposure

In 2001, NIOSH performed a health hazard evaluation (HHE) at Superior Label Systems, Inc., (SLS) because some employees were having blurry vision at work. NIOSH investigators took air samples, had workers complete questionnaires, and performed eye examinations. We found that employees had work-related vision problems which were associated with two chemicals – dimethylisopropanolamine (DMIPA) and dimethylaminoethanol (DMAE). The company stopped using DMIPA and employee complaints decreased. A follow-up survey was conducted in August 2002 to determine how DMIPA and DMAE levels in the air had changed and whether employees no longer had blurry vision.

What NIOSH Did

- We took air samples of 2 chemicals, DMIPA and DMAE.
- We sampled the day and night shift employees in the line and prime divisions over a two day period.
- We asked these employees if they were having blurry vision at work.

What NIOSH Found

- None of the 40 employees that we spoke with in either the line or prime divisions had blurry vision at work.
- There was little to no DMIPA in the air in either the line or prime divisions.
- There was DMAE in the air, but the amounts were lower than those measured in the first NIOSH survey.
- As in the first NIOSH survey, DMAE concentrations were higher in the prime division than in the line division.
- Visual complaints stopped after management began to dilute pH adjuster (which contains DMIPA) with water.
- The company had improved the ventilation in the line and prime divisions by keeping the exhausted air from re-entering the building.

What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2002-0379-2901

Health Hazard Evaluation Report 2002-0379-2901
Superior Label Systems, Mason, Ohio
May 2003

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SUMMARY

In January 2001, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from Superior Label Systems, Inc., (SLS) Mason, Ohio, a large flexographic printing operation for consumer product labels. Employees in the line division were experiencing intermittent blurred vision, while those in the adjacent prime division had few vision complaints. Workers and management had been unable to associate these visual changes with any particular substance in use. NIOSH investigators conducted medical questionnaires, eye exams, and personal breathing-zone (PBZ) sampling for two amines used in the label printing process, dimethylisopropanolamine (DMIPA) and dimethylaminoethanol (DMAE). The mean time-weighted average (TWA) concentration of DMIPA was significantly higher in the line division than in the prime division (7.8 milligrams per cubic meter [mg/m^3] vs. 1.9 mg/m^3, $p<0.01$), as was the mean TWA concentration for total amines (10 mg/m^3 vs. 5.1 mg/m^3, $p<0.01$). Conversely, the mean TWA concentration of DMAE was significantly higher in the prime division than the line division (3.2 mg/m^3 vs. 2.3 mg/m^3, $p<0.01$). Exposures to these amines were associated with visual and ocular changes and NIOSH investigators notified SLS management that the pH adjuster, which contained DMIPA, may be responsible for workers' visual complaints. The SLS management promptly began diluting the pH adjuster, which contained DMIPA, and eventually replaced it with a product containing only DMAE. This appeared to result in a resolution of visual complaints among the workers.

In August 2002, NIOSH investigators returned to SLS for additional air sampling for DMIPA and DMAE to determine how exposures had changed since eliminating the use of the pH adjuster. We also asked employees if they were having blurry vision at work. A total of 64 PBZ air samples were collected on 40 day- and evening-shift employees in the line and prime divisions over a two-day period. Trace concentrations of DMIPA (between 0.06 and 0.2 mg/m^3) were measured on 16 PBZ samples; no DMIPA was detected on the remaining 48 samples. DMAE concentrations ranged from 0.02 to 4.5 mg/m^3 in the line division and from 0.71 to 5.0 mg/m^3 in the prime division. Overall, DMIPA concentrations in both the prime and line divisions sharply decreased between the initial and follow-up surveys, while DMAE concentrations remained relatively unchanged. The continued presence of DMAE was not unexpected since DMAE was still used in both areas. No blurry vision or other visual problems were reported by any interviewed workers.

A health hazard related to the use of DMIPA and DMAE no longer exists at this facility. The continued use of DMAE, and the accompanying lower total amine concentrations, do not appear to be causing any visual problems among the workers. A recommendation was made to continue covering all open 5-gallon ink pails to reduce chemicals vaporizing into the work environment.

Keywords: SIC Code 2759 (Commercial Printing, Not Elsewhere Classified), blurry vision, halo vision, cornea, amines, tertiary amines, dimethylaminoethanol, dimethylisopropanolamine, DMIPA, DMAE.

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INTRODUCTION

Initial Survey (Feb.- May 2001)

In January 2001 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from Superior Label Systems, Inc., (SLS) Mason, Ohio. Employees in the line division were reporting intermittent blurred vision, described as looking through a fog or a mist. It was most noticeable when looking at lights, causing a halo appearance. These visual changes, which occurred on an intermittent basis, typically resolved within a few hours after leaving work. Workers and management had not been able to associate these visual changes with any particular substance in use. The symptoms were reported only by employees in the line division of the plant, only on Mondays through Thursdays, and not on weekends when production was lower.

Site visits were conducted on April 23-26 and April 30-May 3, 2001, during which medical questionnaires, eye exams, and extensive industrial hygiene monitoring were performed. Study participants were notified of the results of their eye examinations at the end of each shift.

NIOSH investigators concluded that exposure to two tertiary amines, dimethylaminoethanol (DMAE) and dimethylisopropanolamine (DMIPA), was associated with blurry, halo, and blue-grey vision, corneal opacity, and decrements in visual acuity and contrast sensitivity. The re-entry of exhausted air was also identified as a potential problem, and NIOSH concluded that the ventilation in the line division was not adequate. In addition to immediately reducing the amount of DMIPA used in the line and prime printing divisions, the company had also begun ventilation improvements to prevent re-entrainment of exhaust air. The company and NIOSH investigators suspected that DMIPA was likely the primary cause of the vision problems experienced by the workers since higher concentrations of DMIPA were measured in the line division compared to the prime division. Eventually the company replaced the DMIPA-containing product. A more complete discussion of these findings is contained in HETA 2001–144–2867.[1]

Follow-up Survey (Aug. 2002)

NIOSH investigators received an HHE request from SLS management in August 2002 to re-evaluate the line and prime divisions and determine if process changes implemented by the company, such as eliminating the use of DMIPA, had reduced the amine exposures. A follow-up survey was conducted on August 21-22, 2002, during which industrial hygiene monitoring for DMAE and DMIPA was performed. During this follow-up survey employees were also asked if they were currently experiencing blurry vision at work. Based on the results of employee interviews from the initial survey, NIOSH investigators found that reporting of blurry vision was usually the indicator of other vision problems.

BACKGROUND

Facility and Process Description

Aside from the elimination of DMIPA from the printing process, little had changed in the production areas at SLS in the time between the two surveys. With about 360 employees in four facilities located in Ohio, Texas, and Arizona, this company is one of the largest flexographic printing operations for consumer product labeling in the United States. The Ohio label production plant, which opened in 1995, has approximately 100 production workers and about 78,000 square feet (ft^2) of floor area. It operates two ten-hour shifts on Monday through Thursday. There are three primary jobs in the production areas: press operators, rewinder operators, and press assistants. There are skeleton crews working on Friday through Sunday.

Labels are printed on paper or plastic materials using water-based, ultraviolet (UV)-cured, and flourescent inks. The production area is divided into two parts, the line division and the prime division. The line division, with approximately 15,000 ft^2, has eight high-speed printing presses using primarily water-based inks for printing less detailed labels such as those used on milk and orange juice containers. There is occasional use of fluorescent inks, but no use of UV inks. The prime division, with approximately 9000 ft^2, has 7 lower speed printing presses using mainly water-based inks to print more detailed labels such as those found on cosmetic and automotive products. UV and fluorescent inks are also used in the prime division. Presses in each division use 5-gallon pails for holding inks before they are pumped to ink troughs.

The water-based inks contain 1% DMAE and, depending on the specific ink, varying concentrations of ammonia, isopropyl alcohol, and glycol ether. During the initial survey clean print additive (a compound containing 45% DMAE and 55% water) was used mainly on the prime side to increase drying time on the inks.[a] A compound referred to as pH adjuster (containing DMIPA) was used daily in the line division. At the conclusion of the initial NIOSH survey the pH adjuster was suspected to be associated with the visual complaints among the workers. As a result, the company immediately began diluting the pH adjuster with water, and eventually replaced it with the DMAE-containing clean print additive.

Along with these two tertiary amines, both the line and the prime divisions use adhesives and UV varnishes for overprint laminating. In addition, various cleaning agents, including alcohol, ammonia, ethyl acetate, 2-butoxyethanol, and mild soap and water, are routinely used to clean inks, varnishes, and adhesives on presses and other equipment. Air sampling conducted during the initial survey for these chemicals measured very low concentrations.

[a] Clean print additive is currently used in both the prime and line divisions.

METHODS

Industrial Hygiene Evaluation

Initial Survey (Feb.- May 2001)

Initial characterization sampling by NIOSH investigators showed the most abundant compounds were DMIPA, DMAE, ethyl acetate, ammonia, ethanol, and isopropyl alcohol. DMIPA concentrations were higher in the line division than in the prime division, while DMAE was present in similar concentrations in both areas. DMIPA and DMAE were selected for further monitoring for the following reasons: (1) they were the most abundant airborne compounds identified; (2) other similar amine compounds were known to cause visual disturbances consistent with those reported by SLS workers; and (3) no other chemicals present in the plant were known to cause such visual disturbances.

The sampling method used was a modification of NIOSH Manual of Analytical Methods (NMAM) No. 2007.[b] Although the original method called for a silica gel sorbent tube, a NIOSH laboratory desorption study found that DMIPA and DMAE were recovered at the highest rate from XAD-7 tubes. A total of 108 full-shift personal breathing-zone (PBZ) air samples were collected to assess workers' full-shift exposures in the line and prime divisions to DMIPA and DMAE. Each sample was collected on a XAD-7 tube connected to air sampling pumps pre- and post-calibrated at 100 cubic centimeters of air per minute (cc/min). In accordance with the modified NMAM No. 2007, analysis for both DMIPA and DMAE was by gas chromatography (GC) equipped with a flame ionization detector (FID). Using this method, the limit of detection for DMAE and DMIPA was 0.6 and 0.3 microgram per sample (µg/sample),

[b] The reliability of NMAM No. 2007 had been in question because of a history of yielding non-detectable results even when amine compounds were present.

respectively. The limit of quantification for DMAE and DMIPA was 20 and 10 µg/sample, respectively.

Follow-up Survey (Aug. 2002)

As in the initial survey, PBZ air samples were collected for DMIPA and DMAE in accordance with the modified NMAM No. 2007. Samples were collected on XAD-7 sorbent tubes (sampling flow rate of 100 cc/min) and analyzed by GC-FID. A total of 64 samples were collected in the line and prime divisions over two consecutive days during the first and second shifts.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs®, or whichever is the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Amines

Aliphatic amines are ammonia derivatives in which an alkyl or alkanol group replaces one or more hydrogen atoms. They are classified as primary, secondary, or tertiary amines and are used as solvents, chemical intermediates, catalysts, preservatives, and in drugs and herbicides.[5] The tertiary amines can be irritants to both the skin and mucous membranes. Systemic symptoms related to inhalational exposure to tertiary amines include headache, nausea, and faintness. A number of reports describe blurred vision, halo vision, or blue-grey vision (glaucopsia) among persons

exposed to a variety of amines. In all published reports, these effects have been reversible. Proposed mechanisms for the visual changes include swelling of the cornea or dilation of the pupil and paralysis of the ciliary muscle.[6]

No reports were found of humans experiencing visual disturbances after exposure to DMAE, the tertiary amine still present in the inks at SLS. However, animal experiments did document corneal opacification, corneal edema, and ulcerative keratitis at exposures greater than 861 milligrams per cubic meter (mg/m^3).[7] Exposure to 71.8 mg/m^3 of DMAE resulted in corneal opacity in animals that regressed during non-exposure periods.[7] DMIPA, the primary component of the pH adjuster that is no longer used at SLS, had not been reported to cause visual disturbances in humans. There are no occupational exposure limits for either DMIPA or DMAE.

RESULTS

Industrial Hygiene Evaluation

Air Sampling - Initial Survey

As shown in Table 1, the mean TWA concentrations of DMIPA were significantly higher in the line division than in the prime division (7.8 mg/m^3 vs. 1.9 mg/m^3, $p<0.01$), as was the mean TWA concentration for total amines (10 mg/m^3 vs. 5.1 mg/m^3, $p<0.01$). Conversely, the mean TWA concentration of DMAE was significantly higher in the prime division than the line division (3.2 mg/m^3 vs. 2.3 mg/m^3, $p<0.01$).

Air Sampling - Follow-up Survey

As shown in Table 1, only trace concentrations of DMIPA (between 0.12 to 0.40 mg/m^3) were measured in either division. In contrast, DMAE was still present in both the line and prime divisions, with the mean TWA concentrations of DMAE higher in the prime division than in the line (3.1 mg/m^3 vs. 0.76). This was not surprising considering that clean print additive, which contains DMAE, was still used in both areas. Appendix A contains all of the individual sample data collected during both the follow-up surveys.

Medical Evaluation

Initial Survey

Of the 36 line workers who completed questionnaires, 32 (89%) reported having experienced blurry vision while at work in the past 12 months, compared to 3 of 24 (12.5%) of the prime workers ($p<0.01$). Findings were similar for halo and blue-grey vision. Symptoms developed an average of 4.3 hours after the start of the shift. NIOSH investigators also found episodes of corneal opacity, decreased bilateral visual acuity, decreased bilateral contrast sensitivity (at 2.5% and 1.25% contrast), and increased corneal thickness. In all instances of corneal opacity, there was complete clearing by the beginning of the worker's next shift.

There was a positive association between reported visual symptoms, corneal opacity, and corneal thickness and increasing concentrations of total amines (calculated by summing the DMIPA and DMAE concentrations). Findings were similar when looking at each amine individually. Since concentrations of the two chemicals were highly correlated to one another, it was not possible to determine by statistical analysis if exposure to only DMIPA or DMEA was responsible for the visual problems experienced by the workers.

Follow-up Survey

All 40 employees in the line and prime divisions who agreed to PBZ air sampling were asked if they were having blurry vision which they felt may be work related. No visual problems were reported by any of the interviewed workers.

DISCUSSION

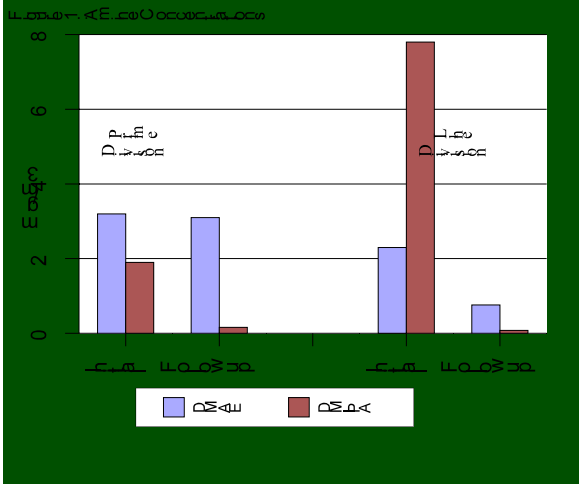
There have been case reports of blurry, halo, and/or blue grey vision, increased corneal thickness, corneal edema, and decrements in visual acuity and contrast sensitivity among workers exposed to a variety of amines.[8,9,10] In the initial survey, NIOSH investigators documented an association between these symptoms and TWA exposure to two tertiary amines, DMAE and DMIPA. Neither of these amines, however, had previously been reported to cause visual disturbances in humans.

A follow-up survey was conducted since DMAE and DMIPA concentrations measured in the first study were highly correlated, making it difficult to separate their effects. However, DMIPA was believed to be causing the visual changes in this group of workers for the following reasons:

1) Visual symptoms were more common in the line division, where concentrations of DMAE were significantly lower than in the prime division.
2) Airborne DMIPA concentrations in the line division were significantly higher that in the prime division.
3) DMIPA, with a vapor pressure of 14.7 torr, is a more volatile chemical than DMAE, which has a vapor pressure of 4.0 torr.[11]
4) Shortly after the initial NIOSH survey, SLS began diluting the pH adjuster (which contained DMIPA) with water. This resulted in no visual complaints by the workers.

Results from the follow-up survey supported the hypothesis that DMIPA was the primary cause of the vision problems. As shown in Figure 1, DMIPA concentrations in both the prime and line divisions decreased between the initial and follow-up surveys, while DMAE concentrations remained relatively unchanged. This was not unexpected since DMAE-containing compounds such as inks and clean print additive are still used in both divisions. Alternately, it is possible that the concentration of total amines in the air was responsible for the visual effects, and that since DMIPA was present in higher concentrations, its elimination significantly lowered the overall level.

CONCLUSIONS



In the first survey, exposure to amines at SLS had been associated with blurry, halo, and blue-grey vision, corneal opacity, and decrements in visual acuity and contrast sensitivity. This follow-up survey confirms that this hazard no longer exists at SLS.

RECOMMENDATIONS

Initial Survey

Recommendations were made to cover open ink containers in the line and prime divisions, reduce the re-entrainment of exhaust air by the local exhaust ventilation systems, and use gloves made of butyl rubber that are impermeable to the amine compounds as well as isopropyl alcohol, ammonia, and 2-butoxyethanol used by workers.[12] NIOSH investigators also recommended additional industrial hygiene monitoring following process changes or when new chemical products (i.e., inks and additives) were introduced. This last recommendation was part of the impetus for conducting this follow-up evaluation.

Follow-up Survey

The company had implemented all of the recommendations contained in the initial report. NIOSH investigators did observe some uncovered ink containers in the press areas, although the number of open containers had declined from the initial survey. Covering containers of inks and other solvents will further reduce airborne concentrations.

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Table 1
Comparison of Tertiary Amine Concentrations from Full-shift
Personal Breathing-zone Samples Collected in in the Prime and Line Divisions, by Survey
Superior Label Systems, Inc.

Compound	Prime Division (mg/m^3) ■				Line Division (mg/m^3) ■			
	Initial Survey n=15		Follow-up Survey n=18		Initial Survey n=95		Follow-up Survey n=46	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
DMAE	3.2	1.7-4.2	3.1	0.71-5.0	2.3	0.18-4.5	0.72	0.02-4.5
DMIPA	1.9	0.86-2.9	0.16	0.05-0.37	7.8	0.66-17	0.06	0.04–0.29
Total	5.1	2.7-6.7	3.2	0.76-5.3	10	0.84-20	0.78	0.08-4.8

n = number of personal breathing-zone samples collected
■ = concentration, expressed in milligrams per cubic meter
DMAE = dimethylaminoethanol
DMIPA = dimethylisopropanolamine
Total = sum of DMAE and DMIPA concentrations

Appendix A
Air Sampling Results for Amines - Follow-up Survey
Superior Labels System, Inc.
Sampling Date: August 21, 2002

Job	Sampling Time (minutes)	Sample Volume (liters)	Concentration, mg/m^3		
			DMAE	DMIPA	Total Amines
Line Division (Day Shift)					
Packer	481	48.1	0.85	ND	0.91
Press Feeder	571	57.1	0.60	ND	0.66
Press Operator	569	56.9	1.1	Trace	1.2
Rewinder	483	48.3	0.85	ND	0.91
Packer	486	48.6	0.86	ND	0.92
Press Feeder	486	48.6	0.91	ND	0.97
Packer	461	46.1	0.65	ND	0.71
Shipping	457	45.7	0.39	ND	0.45
Utility Person	525	52.5	0.67	ND	0.73
Lead Man	273	27.3	0.29	ND	0.35
Press Operator	352	35.2	0.57	ND	0.63
Fan Folder	291	29.1	0.76	ND	0.82
Prime Division (Day Shift)					
Press Operator	424	42.4	2.8	Trace	2.9
Press Operator	526	52.6	1.9	Trace	2.0
Press Operator	416	51.6	2.2	ND	2.3
Press Operator	518	51.8	2.1	Trace	2.2
Press Operator	350	35	1.9	ND	2.0
Minimum Detectable Concentration (MDC)		50	0.12	0.06	N/A
Minimum Quantifiable Concentration (MQC)		50	0.40	0.20	N/A

DMAE = dimethylaminoethanol
DMIPA = dimethylisopropanolamine
ND = not detectable (below the MDC)
Trace = between the MDC and MQC
Total = sum of DMEA and DMIPA
N/A = not applicable

Note: For DMEA and DMIPA concentrations which fell between the MDC and MQC for this sample set, imputed values were used based on either the MDC (for the not detected values) or the reported laboratory value (for the Trace concentrations). For DMIPA, 0.06 mg/m^3 was used for ND values. For DMEA, 0.12 mg/m^3 was used for ND values. All concentrations have been rounded to two significant digits.

Appendix A (continued)
Air Sampling Results for Amines - Follow-up Survey
Superior Labels System, Inc.
Sampling Date: August 21, 2002

Job	Sampling Time (minutes)	Sample Volume (liters)	Concentration, mg/m^3		
			DMAE	DMIPA	Total Amines
Line Division (Night Shift)					
Packer	611	61.1	0.46	ND	0.52
Packer	56	56	0.96	ND	1.0
Press Operator	562	56.2	1.4	ND	1.5
Press Operator	558	55.8	4.5	Trace	4.7
Press Operator	521	52.1	1.2	ND	1.3
Rewinder	516	51.6	0.91	ND	0.97
Press Operator	413	41.3	0.73	ND	0.79
Press Operator	488	48.8	1.3	ND	1.4
Press Operator	550	55	0.60	ND	0.66
Press Operator	537	53.7	1.1	ND	1.2
Press Operator	400	40	0.70	ND	0.76
Maintenance	569	56.9	1.0	ND	1.1
Press Operator	439	43.9	0.68	ND	0.74
Prime Division (Night Shift)					
Press Operator	611	61.1	4.9	Trace	5.1
Packer	553	55.3	4.1	Trace	4.3
Press Operator	291	29.1	4.1	Trace	4.3
Press Operator	269	26.9	4.5	Trace	4.7
Minimum Detectable Concentration (MDC)		50	0.12	0.06	N/A
Minimum Quantifiable Concentration (MQC)		50	0.40	0.20	N/A

DMAE = dimethylaminoethanol
DMIPA = dimethylisopropanolamine
ND = not detectable (below the MDC)
Trace = between the MDC and MQC
Total = sum of DMEA and DMIPA
N/A = not applicable

Note: For DMEA and DMIPA concentrations which fell between the MDC and MQC for this sample set, imputed values were used based on either the MDC (for the not detected values) or the reported laboratory value (for the Trace concentrations). For DMIPA, 0.06 mg/m^3 was used for ND values. For DMEA, 0.12 mg/m^3 was used for ND values. All concentrations have been rounded to two significant digits.

Appendix A (continued)
Air Sampling Results for Amines - Follow-up Survey
Superior Labels System, Inc.
Sampling Date: August 22, 2002

Job	Sampling Time (minutes)	Sample Volume (liters)	Concentration, mg/m^3		
			DMAE	DMIPA	Total Amines
Line Division (Day Shift)					
Packer	657	65.7	Trace	ND	0.46
Packer	795	79.5	Trace	ND	0.46
Press Operator	389	38.9	1.1	ND	1.2
Packer	50	5.0	Trace	ND	0.46
Fan Folder	335	33.5	Trace	ND	0.46
Rewinder	513	51.3	Trace	ND	0.46
Shipping	752	75.2	Trace	ND	0.46
Lead Man	266	26.6	Trace	ND	0.46
Press Operator	302	30.2	Trace	ND	0.46
Press Operator	533	53.3	0.81	ND	0.87
Press Feeder	580	58	Trace	ND	0.46
Press Feeder	541	54.1	Trace	ND	0.46
Prime Division (Day Shift)					
Press Operator	302	30.2	4.3	Trace	4.5
Press Operator	575	57.5	2.5	Trace	2.7
Press Operator	573	57.3	3.3	Trace	3.5
Press Operator	571	57.1	3.4	Trace	3.6
Press Operator	564	56.4	4.6	Trace	4.8
Minimum Detectable Concentration (MDC)		50	0.12	0.06	N/A
Minimum Quantifiable Concentration (MQC)		50	0.40	0.20	N/A

DMAE = dimethylaminoethanol
DMIPA = dimethylisopropanolamine
ND = not detectable (below the MDC)
Trace = between the MDC and MQC
Total = sum of DMEA and DMIPA
N/A = not applicable

Note: For DMEA and DMIPA concentrations which fell between the MDC and MQC for this sample set, imputed values were used based on either the MDC (for the not detected values) or the reported laboratory value (for the Trace concentrations). For DMIPA, 0.06 mg/m^3 was used for ND values. For DMEA, 0.12 mg/m^3 was used for ND values. All concentrations have been rounded to two significant digits.

Appendix A (continued)
Air Sampling Results for Amines
Superior Labels System, Inc.
Sampling Date: August 22, 2002

Job	Sampling Time (minutes)	Sample Volume (liters)	Concentration, mg/m^3		
			DMAE	DMIPA	Total Amines
Line Division (Night Shift)					
Press Operator	513	51.3	Trace	ND	0.46
Packer	507	50.7	Trace	ND	0.46
Press Operator	500	50	Trace	ND	0.46
Rewinder	500	50	Trace	ND	0.46
Press Operator	250	25	Trace	ND	0.46
Packer	210	21	Trace	ND	0.46
Press Operator	497	49.7	Trace	ND	0.46
Press Operator	756	45.6	0.59	ND	0.46
Rewinder	501	50.1	Trace	ND	0.46
Prime Division (Night Shift)					
Press Operator	490	49	1.5	ND	1.6
Press Operator	490	49	3.2	ND	3.3
Press Operator	497	49.7	3.1	Trace	3.3
Packer	486	48.6	2.1	Trace	2.3
Minimum Detectable Concentration (MDC)		50	0.12	0.06	N/A
Minimum Quantifiable Concentration (MQC)		50	0.40	0.20	N/A

DMAE = dimethylaminoethanol
DMIPA = dimethylisopropanolamine
ND = not detectable (below the MDC)
Trace = between the MDC and MQC
Total = sum of DMEA and DMIPA
N/A = not applicable

Note: For DMEA and DMIPA concentrations which fell between the MDC and MQC for this sample set, imputed values were used based on either the MDC (for the not detected values) or the reported laboratory value (for the Trace concentrations). For DMIPA, 0.06 mg/m^3 was used for ND values. For DMEA, 0.12 mg/m^3 was used for ND values. All concentrations have been rounded to two significant digits.

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