IN-DEPTH SURVEY REPORT
OF
VIKING YACHT COMPANY
NEW GRETNA, NEW JERSEY

ECTB Report No. 107-14b

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Date of Survey:
July 12 - 16, 1982

Report Written By:
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Date Of Report:
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Materials Processing Section
Engineering Control Technology Branch
Division of Physical Sciences and Engineering
National Institute for Occupational Safety and Health
Cincinnati, Ohio

Purpose of Survey:

This in-depth survey was performed to evaluate the ventilation system of the Viking Yacht Company. This plant was selected because it was recommended as an excellent example of ventilation by another boatbuilding company.

Employer Representatives Contacted:

Mr. William Healey, President
Mr. Robert Lacovara, Laminations Supervisor

Employee Representatives Contacted:

None

Standard Industrial Classification of Plant:

SIC 3732 Boatbuilding and Repairing

Analytical Work Performed by:

Utah Analytical Testing Laboratories

Acknowledgements:

The data was analyzed by Mr. Stanley Shulman, Statistician, DPSE, NIOSH using the SAS Multivariate Analysis computer program.

CONTENTS

INTRODUCTION

The Viking Yacht Company is located in New Gretna, New Jersey. It is a privately owned company producing a line of power boats from 30 feet to 46 feet in length. A new mold is being prepared to produce a 51 foot boat. The plant layout is shown in Figure 1.

Viking Yacht Company dates from an operation begun in 1950 in Egg Harbor City, New Jersey as Viking Builders. Power cruisers measuring 36 feet and 38 feet were made at that time. In 1964, the Company was purchased by Robert and William Healey, the present owners. The operation was moved to New Gretna, New Jersey and the name changed to Viking Yacht Company. Larger boats were introduced over the years.

The lamination and assembly building is about two years old. It was constructed to both expand and update production facilities and to improve the styrene control system. The ventilation system designed for the new facility consists of five 36 by 1 foot floor air slots each of which nominally evacuate 20,000 CFM from the building. These air slots are located beneath the hull molds. There are also eight 12,000 CFM ceiling exhaust fans for summer use. The assembly of decks takes place just in front of the hull molds. There is no special provision for removing the styrene vapors from the deck lamination spray operation but the general air movement is eastward toward the hull molds and airslots. Operation during the summer is carried out with the side baydoors open. These doors are located midway on the north and south walls and allow air to sweep through the building and to the east toward the lamination areas.

This in-depth survey was performed at the Viking Yacht Company to evaluate the effectiveness of ventilation to remove styrene vapors from the vicinity of the lamination operations and for controlling the general level of styrene in the building. The approach used for this survey was to monitor the exposure of lamination workers for several 1/2 hour periods, to monitor levels of styrene in the building, to measure air velocity and direction in the building and to observe work practices used to minimize worker exposure.

This plant was selected for the in-depth study as a result of a preliminary study performed in February 1982. The evaluation criteria includes the capability of the controls to maintain styrene vapor level below the OSHA PEL of 100 ppm and to prevent exposures to higher concentrations of styrene for brief periods of time. A similar criterium applies to acetone with a PEL of 1000 ppm.

OPERATIONS AND PRODUCTION

The production at Viking Yacht was about 1 1/2 boats per week which consumed about 8000 #/week of styrene resin. The above number of persons worked in the Applications Building during the period of this study. The lamination of the boat hulls was performed by 6 workers and one supervisor. During our study, Viking Yacht was laying up a 36 foot and a 46 foot hull. The work day was from 7:00 am to 3:30 pm.

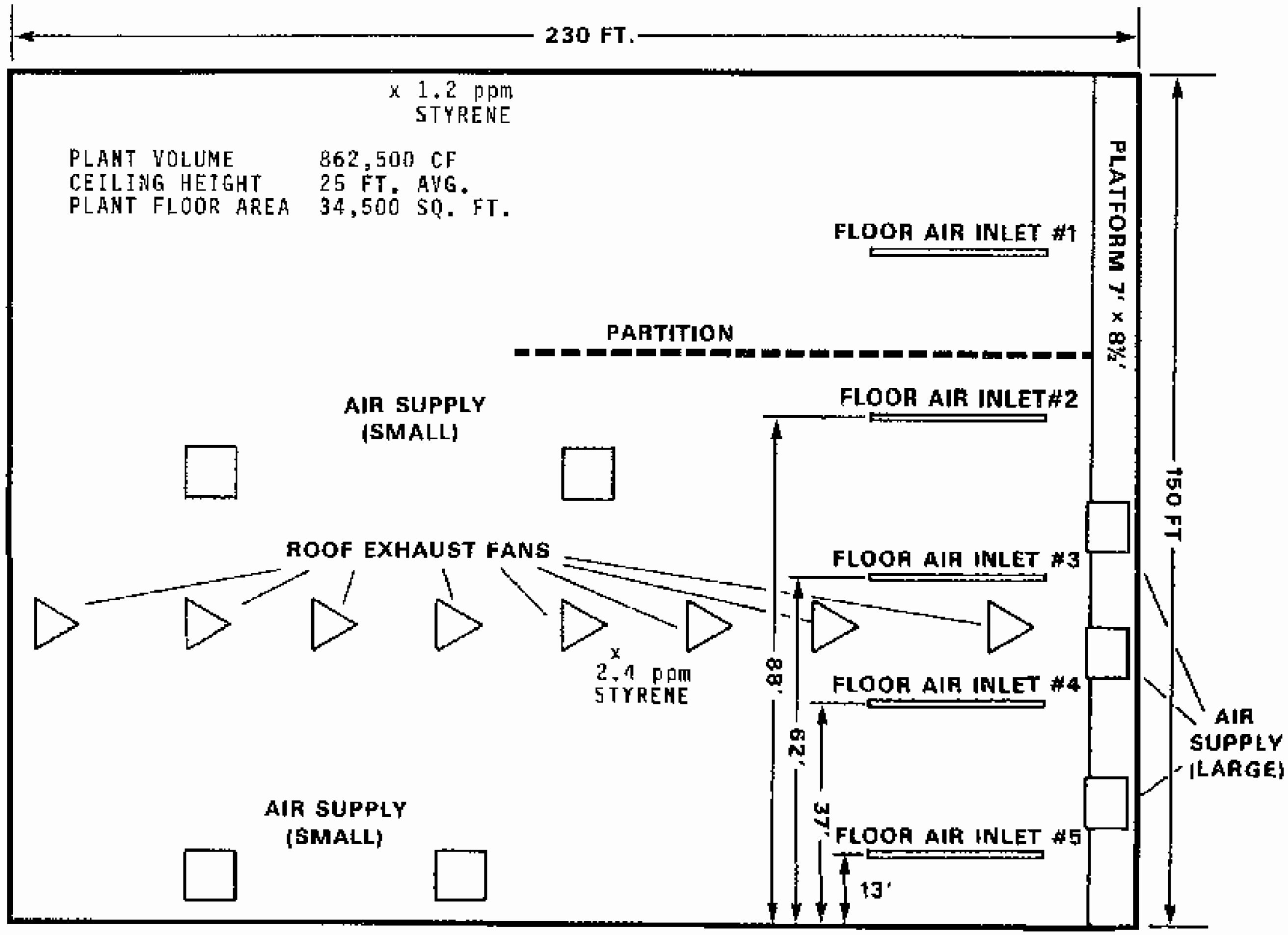


Figure 1. DIAGRAM OF APPLICATIONS BUILDING

The boat production at Viking Yacht is carried out in two buildings. The older building is now used for materials storage and preparation. The new assembly building measures 630 feet long by 150 feet wide and averages 25 feet in hight. This new building is divided into three modules. The lamination is carried out in the 230 foot long eastern module. Installation of engine, electrical and plumbing systems is performed in the middle 200 foot long module, and interior finishing is carried out in the western 200 foot long module. Assuming an average height of 25 feet, the eastern, Applications module, has a volume of 862,500 cubic feet.

The hull lay-up (see Figure 2) is performed in tiltable molds mounted over the floor air slots. FRP boats are fabricated from glass fiber woven roving and chopped glass strand cemented with a styrene polyester resin. Acetone is used as a clean-up solvent. The decks, hulls, superstructure, fuel tanks, and other small parts are laminated at the east side of the Applications module. The boats are moved westward through the buildings and emerge as a completed yacht at the western end. The boat mold is an inverse shape of the hull; it is referred to as a female mold because the boat hull is laid-up inside the mold with the gel-coat or finish coat applied first. The mold itself is formed on a hull form called the "plug". The glass fiber woven roving is applied to the mold in a series of laminations, each layer of roving is glued with resin. Stringers (braces) and bulkheads (partitions) are made of plywood. These are secured with roving and resin. The boat hull, when pulled from the mold with gantry cranes, has the polished finish of the waxed mold.

Boat decks and small parts are also laid up in waxed and polished female molds. The lay-up of decks uses the same lamination techniques as used for hulls except they are not as thick. Decks are laid up in the open areas and depend upon general ventilation to disperse the styrene vapors. The small parts lay-up at Viking Yacht does not use chopper spray-guns. They use woven roving and glass felt with resin applied by airless spray guns. This cuts down on styrene emissions by minimizing resin overspray.

Viking Yacht uses Resin Transfer Molding (RTM) for some small parts, such as hatch covers and radar arches. This system uses mated molds with the resin pumped at high pressures to displace the air. Suction applied to the exit ports of the mold assists the removal of air and transfer of the resin. Viking Yacht intends to expand the use of RTM to items requiring larger moldings. Since styrene emissions are decreased tremendously by this method, its use could be a significant factor in reducing styrene exposures in these plants.

At Viking Yacht the surface of the set resin is abraded before each lamination to insure the highest degree of bonding strength. Grinding is also required on the edges of the molded pieces prior to assembly to insure good bonding and fitting of mating edges. This operation generates resin and fiberglass dust which creates, at times, a noticable haze in the room air. The sander operators wear particulate filter respirators. Dust levels were not measured.

FLOOR VENTILATION SYSTEM

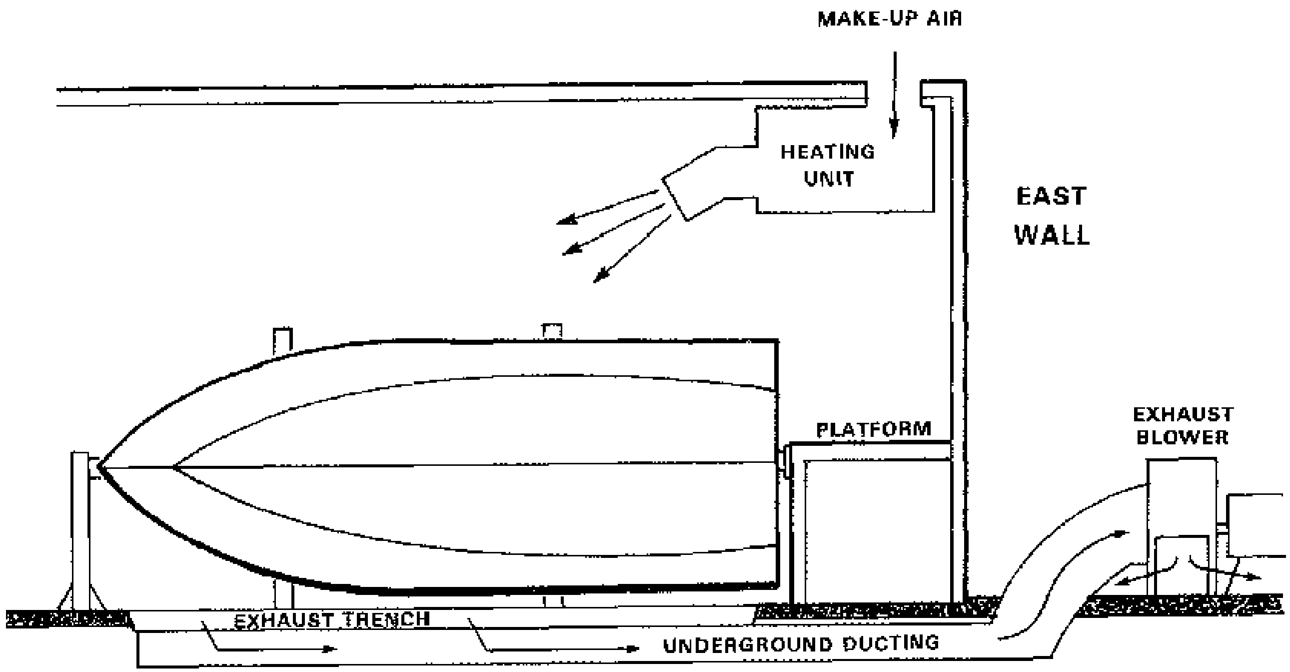


Figure 2. FLOOR VENTILATION SYSTEM

The polyester/styrene resin used by Viking Yacht is manufactured by Reichold Chemical Company and is identified as Polylite 90-550. This resin contains less than 50 % styrene by weight. The gel-coat used is obtained from Cook Gel Cote™ of Kansas City, Missouri. The product description is Polyester Off-White GC 944-W-096. Viking Yacht is currently trying a new resin supplied by Ashland Chemical (product description AROPOL EP 034716, 2183-9-566033) on the 46 foot boat being laminated during our visit. This resin contains 40 % styrene, which is low for resins used in boatbuilding. The effect on styrene exposure when using this chemical is not known. The material safety data sheets are in Appendix A.

EVALUATION PROCEDURE

The number of workers in the applications building, though normally 35, was 24 due to production cutbacks. All 24 were involved in lamination except the support workers. The staffing breakdown is shown in Table 1.

Table 1. Staffing Breakdown in Applications Building

WORK AREA	NORMAL STAFF	CURRENT STAFF
Hull lamination	12	7
Trunk cabin (deck)	5	4
Egg crating (hull stiffening)	6	3
Resin transfer molding	2	2
Small parts	5	3
Support personnel*	5	5
Totals	35	24

* Support personnel consists of:

2 Equipment mechanics
1 Mold repairman
2 Stringer and bulkhead assemblers
(preassemble wood parts)

The seven hull laminators are most exposed to the styrene vapors. To determine the effectiveness of controls, the breathing zone concentration of styrene and acetone were measured for three days by personal samples on selected workers. The samples were collected for 30 minutes (nominal) to determine what specific operations might result in exposure. The styrene and acetone were collected in 150 mg charcoal tubes using personal pumps calibrated at 50 cc/minute. The tube contents were grouped into front and back sections and desorbed into 1 ml of carbon disulfide. The analysis was performed by gas chromatography using a flame ionization detector at the Utah Biological Testing Laboratory. To determine the role of background levels of styrene in the total exposure of workers, area samples were collected at points adjacent to work sites. Except for duration (240 minutes) and sampling rate (10 cc/minute), sampling and analysis were identical to the personal samples noted above.

The sampling approach was to obtain charcoal tube samples for 1/2 hour (nominal) periods. This, along with the sample sheet notations, would provide information on the effect of certain tasks on the level of exposure. MDA Accuhaler pumps were used. These were calibrated at 50 cc/min (nominal) for hull lamination workers and 10 cc/min for RTM workers and area samples.

The four lamination workers were sampled for 41 half hour periods and a total of 151 personal samples. Tasks other than spray-on and roll-out performed by these workers were; hull sanding, grinding, sweeping floor, rolling out paper, and preparing a mold. These other tasks are noted on the sample sheets. The workers took breaks at 9:00 - 9:10 a.m., 11:00 - 11:30 (lunch) and 1:30 - 1:40 p.m. The evalution of the data took this into consideration. Exposures were calculated on an overall basis by grouping all data to represent a Time Weighted Average (TWA) and by selecting samples which reflect only active lamination tasks. Other aspects of the exposure data could be interpreted to reflect differences in exposure between; the 46' and 41' hull laminations, the effect of draping the back of the hull to induce better ventilation, and the effect of tilting the 46' hull to the north (partitioned side) or to the south (open side). The results of these data analyses will be covered next.

CONTROLS:

Ventilation System Design

The plant ventilation system is a novel design incorporating five 35' x 1' exhaust air slots in the floor and eight ceiling exhaust fans. The air floor slots lead to exhaust fans located outside the east wall of the building. (See Figure 1.) The blower design capacity of each of these air slots is 20,000 CFM. The actual flow is less. Because the ductwork is underground, a pitot traverse of the duct was not performed. The flow was measured at the air slot inlet and at the blower outlet. The make-up air is supplied in the winter by three blower/heaters at the east end of the applications building above the hull molds and several smaller heaters toward the west end of the building. These blowers direct air into the boat hulls except for the 46' hull in the right tilt position which faces a partition and the 30' hull in a left tilt position which faces the building's south wall. In the summer, the supply air is provided by opening the center bay doors on each side of the building. With the building volume at 862,500 cubic feet, the 185,000 CFM air flow will change the air every 4 minutes or 15 times each hour. The open doors in the north and south walls of the building must add further ventilation air to the middle of the building, but the amount is not known. This volume flow of air is adequate for dilution ventilation but the effect is augmented by selective exhaust of air from the mold lamination area.

Air Flow Measurements:

The air velocity into and exiting from the exhaust system was measured using the Kurz hot wire anemometer. The inlet velocity was measured at the air slot. The total calculated flow was 17,780 CFM. Velocity readings were also obtained at the fan grill and the calculated flow was 16,000 CFM. This is 10% lower than that obtained at the air slot. The value of 17,780 CFM obtained at the air slot is assumed to be the more accurate estimate. The total exhaust flow for this building, based upon fan capacities, is estimated to be 185,000 CFM which includes the 96,000 CFM from the eight ceiling fans. The flow will be lower in cold weather when fewer ceiling fans operate.

Air velocity measurements were made about the hull molds on the 41' and 46' boats with the Kurz hot wire anemometer. The air velocity was measured at points located: each 2 feet of hull length; one foot intervals above the floor; and one foot intervals from the edge of the air slot in the floor. About 350 measurements were made on the 41' hull. Fewer, about 280 were made for the 46' hull because less time was available. The air flow pattern for each side of the 46' hull is shown in Figure 3, which is a traverse section of the 46' hull mold in a left tilt position. These data points represent the mean value of all points similarly located along the hull and bounded by the limits of the floor air slot. Figure 4. shows the flow pattern for the 41' hull mold.

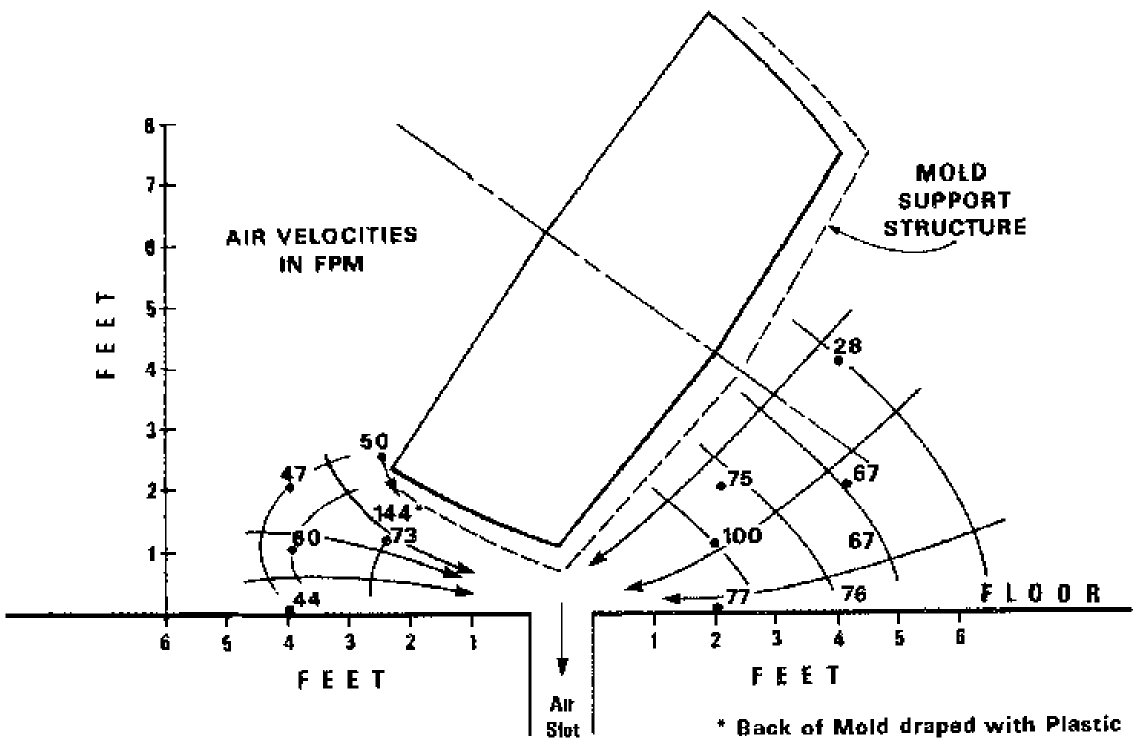
After blocking the back of each hull mold with 3 mil plastic film, the maximum air flow was determined at each point along the open side of the hull and between the floor and the boat gunwhale. The mean value and location of the maximum velocity is entered on each of the previous figures and noted by an asterisk. As expected, the air velocity and probably the air volume flow about doubled. However, the effect on the styrene exposure was not significant. Although there is a tendency for air displaced from the hull to be drawn into the air slot, the slot effect does not selectively draw air from the mold. Increasing the air displacement from the hull and into the air slot will require a uniform flow of air directed through the hull space toward the floor air slot. This type of flow was observed on the 44' mold, line #2, during the March, 1982 preliminary survey as shown in Figure 5. The overhead heater/blowers were operating at that time and provided a downward draft of air which produced air velocities of 10 to 30 FPM in the hull. The purging efficiency of the hull ventilation system, i.e., collecting a greater portion of the displaced air in the floor slot, might be improved by doubling the air flow velocity in that space between the hull and floor only if more hull air can be directed into the air slot. This would be difficult to accomplish with conventional hardware.

Process Modification:

The use of resin transfer molding (RTM) can be classified as a process modification. This molding technique uses closed molds to fabricate small parts with very little escape of styrene vapor. Resin is pumped under high pressure into the prepared mold. Viking Yacht Company prepares hatch covers and radar arches by RTM. The two laminators who perform this operation have very low TWA values for styrene. This will be discussed later.

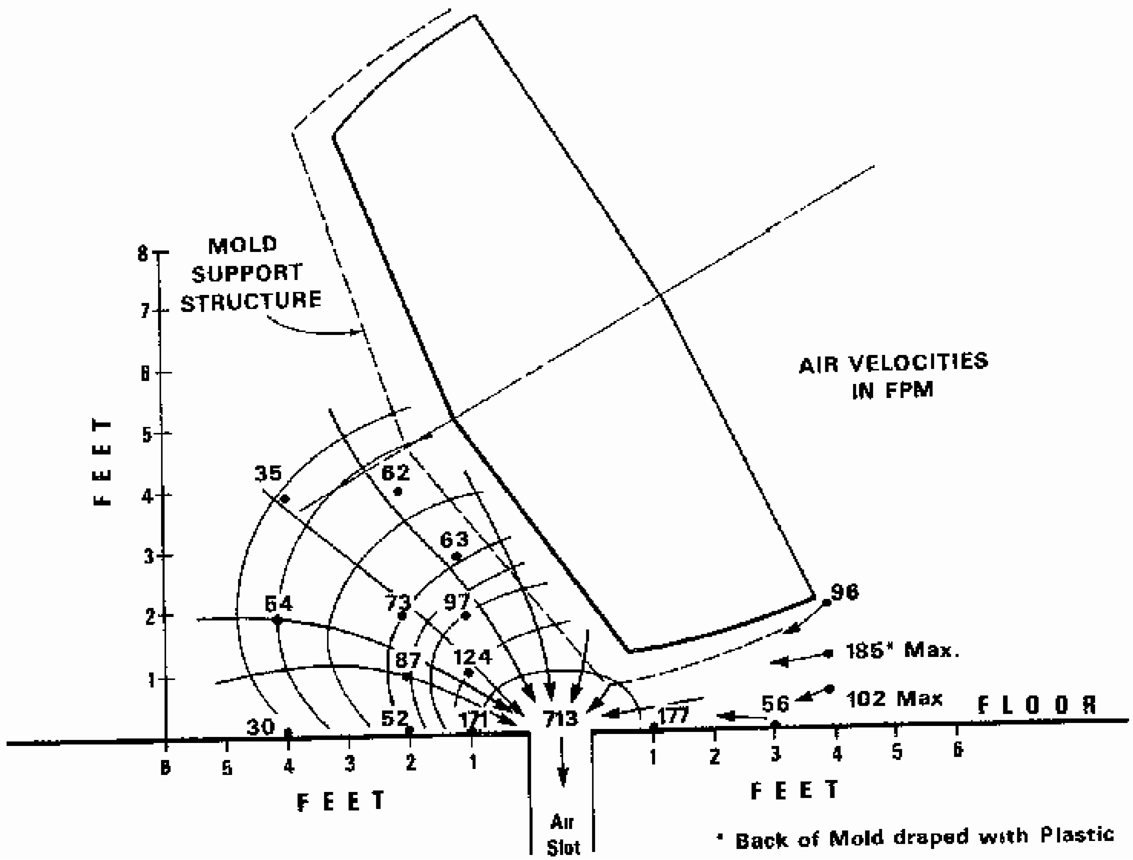
AIR FLOW PATTERN AROUND 46' HULL

Figure 3. AIR FLOW PATTERN AROUND 46' HULL



AIR FLOW PATTERN AROUND 41' HULL

Figure 4. AIR FLOW PATTERN AROUND 4   HULL



AIR FLOW THROUGH MOLD #2, 44' HULL

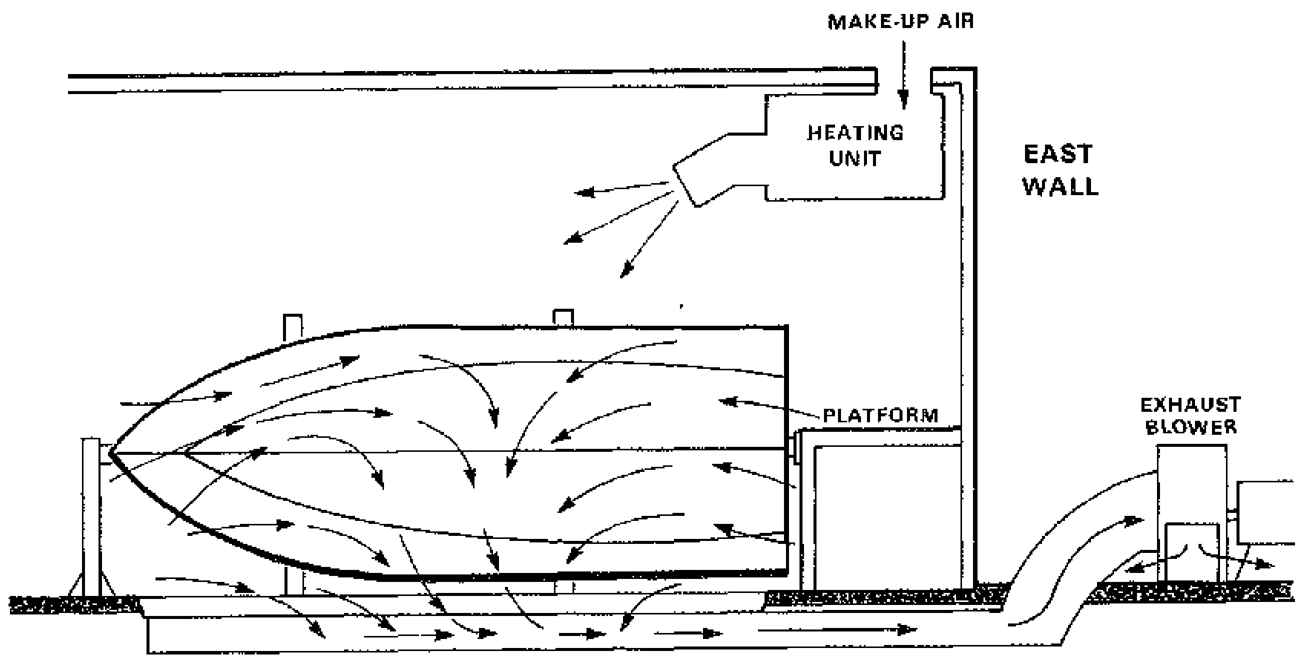


Figure 5. AIR FLOW THROUGH MOLD #2, 44' HULL

Personal Protective Equipment:

Lamination workers are provided with disposable coveralls, organic vapor respirators (quarter face mask), rubber gloves and goggles. The hull grinding operation to roughen the resin surface for the next lamination produces dust. The grinder operators are protected with supplied air respirators, coveralls and gloves. No local ventilation equipment is used to remove the grinding dust at the source. The dust either settles or is drawn into the floor air slots.

Work Practices:

The work practices can be discussed in terms of employee behavior and safety equipment provided by management. The protective equipment provided by management is used conscientiously by boat hull laminators during the spray-on and roll-out of resin. This was observed even though the weather was hot and humid. During spraying, the resin was directed away from the other workers most of the time. Exceptions to this were when additional resin was needed at a spot being rolled out or when working at the extreme stern where spray bounceback becomes a problem.

RESULTS OF PERSONAL AND AREA SAMPLES

The production at Viking Yacht was about 1/3 the normal rate. This limited the choices for sampling to the 46' hull on line #1 and the 41' hull on line #3. Sampling was also performed on the resin transfer molding process.

Hull Lamination

The lamination of these large hulls requires the workers to enter the tilted hull. The tilt allows the workers to walk on a surface only slightly sloped except for the bow area. The tilt also allows ventilation of the hull into the floor air slot which is the feature of this control system design.

The average exposure of the four lamination workers and the lamination team leader is 18 ppm. If the team leader is not included in the group, the average exposure of the hull laminators is 21 ppm. This exposure level includes all tasks performed by the workers, not just lamination. Because actual sample times varied between 14 and 53 minutes, each sample was time weighted to reflect the actual sample time. This weighted value more accurately reflects the lamination worker's exposure. There is some variation in the exposure of each worker as seen in Table 2.

No differences in the work habits or tasks were noted which could explain a consistently lower exposure for B. Worker C had the highest average exposure 25 ppm styrene and also had the two highest styrene samples, 114 ppm and 137 ppm.

TABLE 2. Worker Exposure to Styrene and Acetone

Worker	TWA, ppm Styrene	TWA, ppm Acetone
A	21	22
B	17	16
C	25	9
D	21	21
Mean	21	17

PEL (permissible exposure limit) Styrene = 100; Acetone = 1000

Because the personal sampling data has a skewed distribution, statistics other than the mean needed to be carried out on the log transform of the data. The log transform produces a more normal distribution from which statistical inferences may be drawn. An analysis of variance (ANOVA) was performed to compute levels of signifigance among the several variables considered in the survey.

Of the various factors tested in the ANOVA, the only factor found to be significant was the right and left tilt of the 46 foot hull mold. Thirty seven samples were taken on the left tilt and 18 on the right tilt. This number of samples allows a good test of the significance. The tilt of the 46 foot hull mold was found to be significant at the 90% confidence level. This difference had been anticipated because the right tilt of the hull mold faces a ceiling height partition which interferes with the flow of air through the hull.

The draping of the backs of each hull mold with 3 mil plastic was expected to produce better air movement through the hulls by inducing greater flow on the work side. The difference was statistically significant at the 66% confidence level. Since the SAS model rejects any confidence level lower than 85%, this difference was judged not significant. This result was not anticipated because the increase of air flow under the front of the hull mold was noticably greater after the rear of the mold was draped with the 3 mil plastic. The conclusion is that the effect of this increase in air flow does not reach back into the boat hull. The additional air is drawn mainly from the floor of the plant. It was thought that two samples for worker C having high values of 114 and 137 ppm could be outliers (significantly above the mean to be rejected from the data) and could affect the test for the effect of draping. The statistical tests were rerun without the two data points and no change in the outcome resulted. Whether those two points are outliers is then irrelevant in the analysis.

It should be pointed out that in performing these statistical tests of significance of differences in data, it is not certain that the conclusion is correct. Inferring that there is a real difference between two samples while in fact the observed difference is due only to chance is referred to as a Type I error. For example the above tests indicate that the probability of the conclusion being incorrect is 10% which is the chance of committing a Type I error. The Type II error is the probability of concluding that there is no real difference between the two samples while the difference does in fact exist. We can decrease the chance of committing a Type II error by increasing the sample size. In this test the sample size is limited by the length of the survey and the number of workers available so we have little control of it.

Two workers operate the resin transfer molding (RTM) apparatus. The RTM operation eliminates direct contact of the resin with air by the use of a two piece closed mold into which the resin is pumped under high pressure. Viking Yacht makes small parts such as hatch covers and radar arches in this operation. Sampling pumps were placed on the two RTM workers to determine how much reduction in exposure can be achieved with this apparatus. Worker F was sampled for 19.3 hours and worker G for 12.7 hours. The mean exposure of worker F was 3 ppm and of worker G, 2.6 ppm. These values are very low compared to lamination by spray-on and roll-out operations.

The area samples were also an indication of how the styrene is distributed within the plant. Samples were set in two areas, the RTM control panel and the deck lamination area, see Figure 1. Both of these areas had styrene levels of 3 ppm or less and is indicative of the degree of dilution in the plant air due probably to the two large side doors being open for ventilation. The results for the area samples are shown in Table 3.

Table 3. Mean Levels of Styrene and Acetone in Plant

Work Area	Styrene (ppm)	Acetone (ppm)
RTM	1.2	7.2
Deck Lamination	2.4	2.8

The worker exposure to acetone was very low as indicated in Table 2. The PEL of 1000 ppm acetone is in no case approached by any sample. The mean exposure to acetone of all hull lamination workers is 17 ppm. The range in value of all 30 minute samples is from less than 2 ppm to 177 ppm acetone.

CONCLUSIONS AND RECOMMENDATIONS

The mean exposure of the four lamination workers is 21 ppm styrene. the effectiveness factor os then 4.8 for a PEL of 100 ppm styrene. This indicated a very effective control system for removing rhe styrene vapors from the boat hulls. This is in contrast to results obtained during the preliminary survey in March 1982 when the building was closed for winter and hada total exhaust ventilation of approximately 125,000 CFM. The average of five samples was 65 ppm and ranged from 51 ppm to 91 ppm.[1] This yields an effectiveness factor, K, of only 1.5 compared to the recommended minimum of 3. This value is not very reliable however since only 5 samples were taken during the preliminary survey in cold weather. Although unreliable as a statictical estimate, this does suggest that tehe plant might have a problem meeting the NIOSH recommendation for a styrene TLV 8 hour TWA of 50 ppm. Acetone exposure does not seem to be a problem in this plant. Acetone is used to claen tools after a lamination is completed, The acetone mean concentration for the four lamination workers was only 17 ppm. This low value is attributed to the effectiveness of the exhaust air slots in collecting air near the floor where the tool cleaning is carried out.

The draping of the back of the hull molds was an attempt to enhance the effect of the collection mechanism by increasing the amount of air pulled from the working side of the hull. The statistical analysis however indicated that the difference between the exposures with draped and undraped hulls was not significant. The conclusion is that the floor vents do not effectively remove the air from the boat hull. Air can however be displaced from the hull mold by other means and directed into the floor exhaust air slots. The use of propellor fans improves the displacement of air from the hull mold but risks overcoming the effect of the floor exhaust air slots to raise the styrene background level in the plant.

The only personal exposure test values having statistical significance are those comparing the left and right tilt of the 46' hull mold. The right tilt position has significantly higher exposures than the left tilt. The apparent reason for this is the restriction of air flow into the hull mold due to the partition on the right side of the mold. This supports the conclusion that the effect of the floor exhaust air slots is to remove room air, not to selectively remove air from the boat hull.

REFERENCES

1. Preliminary Survey Report of Viking Yacht Company
March, 1982, W. Todd.

APPENDIX A

Material Safety Data Sheets

TECHNICAL BULLETIN

(90-550) current designation

POLYLITE® 90-565 POLYESTER RESIN

TYPE OF POLYESTER

Rigid, low viscosity, unpromoted, thixotropic laminating resin formulated for hand lay-up and spray-up application using glass reinforcement.

MAJOR USES AND FEATURES

1. Designed for marine fabrication and other FRP plastic parts requiring freedom from drainage on vertical surfaces.
2. Development of minimum fiber pattern "print-through" of reinforcement material, particularly that of woven glass roving.
3. Exceptional wetting of glass reinforcement with minimum air entrapment.
4. Significantly lower styrene vapor emission during roll-out and prior to gelation when compared to conventional laminating resin systems.
5. Extended liquid resin stability using benzoyl peroxide catalyzation.

SPECIFICATIONS OF LIQUID POLYLITE® 90-565

Viscosity, Brookfield* @ 25°C	375-500 cps.
Color, uncatalyzed	Brown
Density, kg/liter	1.05 - 1.10
Weight Per Gallon	8.8 - 9.2 lbs.
Uncatalyzed stability @ 25°C, minimum	3 months

*Model LVF, Spindle #3, 60 RPM

TYPICAL PROPERTIES OF CURED UNFILLED CASTINGS OF POLYLITE® 90-565

Barcol Hardness	46-50
Tensile Strength, PSI	8,000
Elongation, percent	1.5
Flexural Strength, PSI	12,500
Flexural Modulus, PSI x 10^5	5.5
Compressive Strength, PSI	23,000
Heat Distortion Temperature	98°C
Water absorption, % gain	
24 hours @ 25°C	0.1 - 0.15
2 hours @ 100°C	0.3 - 0.4

®Registered U.S. Patent Office

continued.........

REICHHOLD CHEMICALS, INC • RCI BUILDING, WHITE PLAINS, N Y. 1060

APPLICATION

Polylite® 90-565 is specifically designed for use with aniline promotion and benzoyl peroxide catalysis in dual component dispensing equipment. The quantities of catalyst and promotor used will determine the gel and cure characteristics of the resin system. Benzoyl peroxide paste (Superox® 706) or granules(Superox 717) is the preferred catalyst, while dimethylaniline(DMA) or diethylaniline(DEA) can be efficiently used for promotion to effect gel and cure properties at ambient temperatures. Typical values are shown as follows:

% Superox 706	% DMA	Gel Time @ 25°C
1.5	.15	50-55
1.5	.175	43-45
1.5	.20	34-37
2.0	.10	50-55
2.0	.125	38-42
2.0	.15	33-37
2.0	.20	25-30
2.5	.075	55-60
2.5	.10	46-50
2.5	.15	32-35

It is always recommended to standardize on catalyst level and adjust promotors to compensate for gel time adjustments such as required for ambient temperature changes.

Caution: Promotors and catalysts should always be mixed with the resin separately and should never be mixed directly together.

TYPICAL PROPERTIES OF 1/8 INCH FIBERGLASS LAMINATE:

Laminate Construction: 2 plies 10 oz. glass cloth, 2 plies 1 1/2 oz. glass mat.

Glass Content	34%
Barcol Hardness	50-55
Tensile Strength, PSI	14-16,000
Flexural Strength, PSI	27-32,000
Flexural Modulus, PSI x 10^6	1.3-1.5
Compressive Strength, PSI	22-26,000
Water Absorption, % gain	
24 hours @ 25°C	.05-.07
2 hours @ 100°C	.20-.30

Each user must determine the suitability of this product in their particular mode of operation. Field testing of finished laminates before commercial production is recommended to determine that production methods are adequate to obtain required properties.

11/79

MATERIAL SAFETY DATA SHEET

FOR COATINGS, RESINS AND RELATED MATERIALS

DATE OF PREP P-S-9/77 (Approved by U.S. Department of Labor "Essentially Similar" to Form OSHA-20)

Section I

MANUFACTURER'S NAME REICHHOLD CHEMICALS, INC.

STREET ADDRESS 525 North Broadway CITY, STATE, AND ZIP CODE White Plains, New York 10603

EMERGENCY TELEPHONE NO (914) 682-5700

PRODUCT CLASS Unsaturated polyester in monomer

TRADE NAME POLYLITE® Polyester Resin MANUFACTURER'S CODE IDENTIFICATION 90-565

Section II – HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT	TLV PPM	TLV mg/M^3	LEL PPM	VAPOR PRESSURE (mm Hg)
Unsaturated Polyester	> 50	---			N.A.
Styrene Monomer	< 50	100		11000	< 5

STYRENE HAZARDS: SEE MCA CHEMICAL SAFETY DATA SHEET SD-37

Section III – PHYSICAL DATA

APPEARANCE Hazy, brown liquid.

VAPOR DENSITY ☒ HEAVIER ☐ LIGHTER THAN AIR

BOILING RANGE > 145°C

EVAPORATION RATE ☐ FASTER ☒ SLOWER THAN ETHER

PERCENT VOLATILE BY VOLUME (%) < 50

SPECIFIC GRAVITY (H_2O=1) 1.05 - 1.10

Section IV – FIRE AND EXPLOSION HAZARD DATA

DOT CATEGORY Flammable Liquid FLASH POINT 89°F (Setaflash)

EXTINGUISHING MEDIA

Foam, carbon dioxide or dry chemical.
Class B extinguisher per National Fire Protection Association.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Styrene will polymerize readily at elevated temperatures of fire conditions. If this occurs in a closed container, there is a possibility of violent rupture.

SPECIAL FIRE FIGHTING PROCEDURES

None - fight like a fuel oil fire.

Section V — HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE Styrene 100 ppm (See Section II).

EFFECTS OF OVEREXPOSURE

Styrene @ 400 ppm or in strong concentration is irritating to all parts of the respiratory tract and eyes. May be fatal @ 10,000 ppm. Somewhat anaesthetic.
(N.B.) Styrene vapor generation of polyester resins will rarely exceed 200 ppm.

EMERGENCY AND FIRST AID PROCEDURES

Remove victim from exposure to well-ventilated area - make comfortably warm but not hot - use oxygen or artificial respiration as required. In case of eye contact, flush promptly with copious amounts of water for 15 minutes and seek medical attention.

Section VI — REACTIVITY DATA

STABILITY ☐ UNSTABLE ☒ STABLE

CONDITIONS TO AVOID

Heat, direct sunlight and ignition sources.

INCOMPATABILITY (Materials to avoid)

Strong acids, peroxides and other oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide and dioxide, low molecular weight hydrocarbons and organic acids.

HAZARDOUS POLYMERIZATION ☒ MAY OCCUR ☐ WILL NOT OCCUR

CONDITIONS TO AVOID

Sunlight, open flames, contamination and prolonged storage above 100°F.

Section VII — SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Remove saturated clothing promptly and wash affected areas with soap and water.
Remove all sources of ignition (flames, heat and sparking). Ventilate area.
Use protective measures outlined in Section VIII.

WASTE DISPOSAL METHOD Absorb with inert materials such as vermiculite or sand and place in closed container for disposal as solid waste. Wash area well with trisodium phosphate and water. Disposal must conform to local, state and federal regulations.

Section VIII — SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION Up to 100 ppm: None
100 ppm and above: U.S. Bureau of Mines approved air line mask or self-contained breathing apparatus.

VENTILATION

Provide general dilution or local exhaust ventilation to comply with Sections II and IV. (Styrene vapor is heavier than air). Use explosion-proof motors.

PROTECTIVE GLOVES Neoprene or non-soluble plastic.

EYE PROTECTION Use safety wear designed to protect against splash or liquids.

OTHER PROTECTIVE EQUIPMENT Safety showers and eye wash stations should be available.

Section IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS Avoid improper addition of promoter and/or catalyst. Consult product bulletin. A promoter (metal organic such as cobalt or aniline type) and catalyst (organic peroxide type) used with roduct should always be mixed separately with the product and should never ed directly together.

Ashland

Ashland Chemical Company
DIVISION OF ASHLAND OIL, INC
5200 PAUL G BLAZER MEMORIAL PARKWAY, DUBLIN, OHIO 43017 • (614) 889-3333

ENVIRONMENTAL AND
OCCUPATIONAL SAFETY DEPARTMENT
R H Toenjskoetter, Manager

REPLY TO:
P.O. Box 2219
Columbus, Ohio 43216

August 26, 1982

NIOSH (R-5)
4676 Columbia Pkwy.
Cincinnati, OH 45226

Attn: William Todd

Dear Customer:

In response to your recent request, an Ashland Material Safety Data Sheet is enclosed for the following product(s):

Aropol EP 34716

If you have any questions, please contact me.

Very truly yours,

Ira A. Mac Donald

Ira A. Mac Donald
Environmental and
Occupational Safety

IAM/ss

Enclosure(s)

ACCEPTED BY O.S.H.A. AS ESSENTIALLY SIMILIAR TO O.S.H.A. FORM 20

24-HOUR EMERGENCY TELEPHONE: 606-324-1133 (LOCATED AT ASHLAND, KENTUCKY)

ASHLAND PRODUCT NAME: AROPOL EP 034716

DATA SHEET NO: 0142663-000
LATEST REVISION DATE: 08/82-82237

SECTION I-PRODUCT IDENTIFICATION

GENERAL OR GENERIC ID. UNSATURATED POLYESTER RESIN

HAZARD CLASSIFICATION: (03) FLAMMABLE LIQUID (173.115)

SECTION II-HAZARDOUS COMPONENTS

INGREDIENT	PERCENT	PEL	*
STYRENE	35-40 %	100 PPM	(1)

(1). ACGIH RECOMMENDS A TLV OF 50 PPM.

SECTION III-PHYSICAL DATA

PROPERTY	REFINEMENT	MEASUREMENT
INITIAL BOILING POINT	FOR COMPONENT(35-40 %)	293.00 DEG F (145.00 DEG C) @ 760.00 MMHG
VAPOR PRESSURE	FOR COMPONENT(35-40 %)	5.00 MMHG @ 68.00 DEG F (20.00 DEG C)
VAPOR DENSITY		HEAVIER THAN AIR
SPECIFIC GRAVITY		GREATER THAN WATER
PERCENT VOLATILES		35-40 %
EVAPORATION RATE		SLOWER THAN ETHER

SECTION IV-FIRE AND EXPLOSION DATA

FLASH POINT(CLOSED CUP) 73-103 DEG F
(23-38 DEG C)

LOWER EXPLOSIVE LIMIT (LOWEST VALUE OF COMPONENT) 1.1 %

EXTINGUISHING MEDIA: REGULAR FOAM OR WATER FOG OR CARBON DIOXIDE OR DRY CHEMICAL

HAZARDOUS DECOMPOSITION PRODUCTS: MAY FORM TOXIC MATERIALS:, CARBON DIOXIDE AND CARBON MONOXIDE, VARIOUS HYDROCARBONS, ETC.

SPECIAL FIREFIGHTING PROCEDURES: SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE MODE.

UNUSUAL FIRE & EXPLOSION HAZARDS: VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL ALONG THE GROUND OR MAY BE MOVED BY VENTILATION AND IGNITED BY PILOT LIGHTS, OTHER FLAMES, SPARKS, HEATERS, SMOKING, ELECTRIC MOTORS, STATIC DISCHARGE, OR OTHER IGNITION SOURCES AT LOCATIONS DISTANT FROM MATERIAL HANDLING POINT.
NEVER USE WELDING OR CUTTING TORCH ON OR NEAR DRUM (EVEN EMPTY) BECAUSE PRODUCT (EVEN JUST RESIDUE) CAN IGNITE EXPLOSIVELY.

SECTION V-HEALTH HAZARD DATA

PERMISSIBLE EXPOSURE LEVEL: NOT ESTABLISHED FOR PRODUCT. SEE SECTION II.

EFFECTS OF OVEREXPOSURE: FOR COMPONENTS

EYES - CAN CAUSE SEVERE IRRITATION, REDNESS, TEARING, BLURRED VISION.
SKIN - PROLONGED OR REPEATED CONTACT CAN CAUSE MODERATE IRRITATION, DEFATTING, DERMATITIS.
BREATHING - EXCESSIVE INHALATION OF VAPORS CAN CAUSE NASAL IRRITATION, DIZZINESS, WEAKNESS, FATIGUE, NAUSEA, HEADACHE, POSSIBLE UNCONSCIOUSNESS, AND EVEN ASPHYXIATION.
SWALLOWING - CAN CAUSE GASTROINTESTINAL IRRITATION, NAUSEA, VOMITING, DIARRHEA.

FIRST AID

IF ON SKIN: THOROUGHLY WASH EXPOSED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. LAUNDER CONTAMINATED CLOTHING BEFORE RE-USE.

IF IN EYES: FLUSH WITH LARGE AMOUNTS OF WATER, LIFTING UPPER AND LOWER LIDS OCCASIONALLY. GET MEDICAL ATTENTION.

IF SWALLOWED: DO NOT INDUCE VOMITING. KEEP PERSON WARM, QUIET AND GET MEDICAL ATTENTION. ASPIRATION OF MATERIAL INTO THE LUNGS DUE TO VOMITING CAN CAUSE CHEMICAL PNEUMONITIS WHICH CAN BE FATAL.

CONTINUED ON PAGE: 2

SECTION V-HEALTH HAZARD DATA (CONTINUED)

IF BREATHED IF AFFECTED, REMOVE INDIVIDUAL TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. KEEP PERSON WARM, QUIET, AND GET MEDICAL ATTENTION.

SECTION VI-REACTIVITY DATA

HAZARDOUS POLYMERIZATION: CAN OCCUR --AVOID EXPOSURE TO EXCESSIVE HEAT, PEROXIDES AND POLYMERIZATION CATALYSTS.
STABILITY: STABLE

INCOMPATABILITY. AVOID CONTACT WITH., STRONG ALKALIES., STRONG MINERAL ACIDS.

SECTION VII-SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

SMALL SPILL ABSORB LIQUID ON PAPER, VERMICULITE, FLOOR ABSORBENT, OR OTHER ABSORBENT MATERIAL AND TRANSFER TO HOOD.

LARGE SPILL. ELIMINATE ALL IGNITION SOURCES (FLARES, FLAMES INCLUDING PILOT LIGHTS, ELECTRICAL SPARKS). PERSONS NOT WEARING PROTECTIVE EQUIPMENT SHOULD BE EXCLUDED FROM AREA OF SPILL UNTIL CLEAN-UP HAS BEEN COMPLETED. STOP SPILL AT SOURCE, DIKE AREA OF SPILL TO PREVENT SPREADING, PUMP LIQUID TO SALVAGE TANK. REMAINING LIQUID MAY BE TAKEN UP ON SAND, CLAY, EARTH, FLOOR ABSORBENT OR OTHER ABSORBENT MATERIAL AND SHOVELLED INTO CONTAINERS.

WASTE DISPOSAL METHOD:

SMALL SPILL: ALLOW VOLATILE PORTION TO EVAPORATE IN HOOD. ALLOW SUFFICIENT TIME FOR VAPORS TO COMPLETELY CLEAR HOOD DUCT WORK. DISPOSE OF REMAINING MATERIAL IN ACCORDANCE WITH APPLICABLE REGULATIONS.

LARGE SPILL DESTROY BY LIQUID INCINERATION IN ACCORDANCE WITH APPLICABLE REGULATIONS
CONTAMINATED ABSORBENT MAY BE DEPOSITED IN A LANDFILL IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII-PROTECTIVE EQUIPMENT TO BE USED

RESPIRATORY PROTECTION: IF TLV OF THE PRODUCT OR ANY COMPONENT IS EXCEEDED, A NIOSH/MSHA JOINTLY APPROVED AIR SUPPLIED RESPIRATOR IS ADVISED IN ABSENCE OF PROPER ENVIRONMENTAL CONTROL OSHA REGULATIONS ALSO PERMIT OTHER NIOSH/MSHA RESPIRATORS UNDER SPECIFIED CONDITIONS. (SEE YOUR SAFETY EQUIPMENT SUPPLIER) ENGINEERING OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO REDUCE EXPOSURE.

VENTILATION PROVIDE SUFFICIENT MECHANICAL (GENERAL AND/OR LOCAL EXHAUST) VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).

PROTECTIVE GLOVES: WEAR RESISTANT GLOVES SUCH AS., POLYVINYL ALCOHOL

EYE PROTECTION: CHEMICAL SPLASH GOGGLES IN COMPLIANCE WITH OSHA REGULATIONS ARE ADVISED; HOWEVER, OSHA REGULATIONS ALSO PERMIT OTHER TYPE SAFETY GLASSES. (CONSULT YOUR SAFETY EQUIPMENT SUPPLIER)

OTHER PROTECTIVE EQUIPMENT: NORMAL WORK CLOTHING COVERING ARMS AND LEGS.

SECTION IX-SPECIAL PRECAUTIONS OR OTHER COMMENTS

CONTAINERS OF THIS MATERIAL MAY BE HAZARDOUS WHEN EMPTIED. SINCE EMPTIED CONTAINERS RETAIN PRODUCT RESIDUES (VAPOR, LIQUID, AND/OR SOLID), ALL HAZARD PRECAUTIONS GIVEN IN THIS DATA SHEET MUST BE OBSERVED.

OVEREXPOSURE TO STYRENE HAS APPARENTLY BEEN FOUND TO CAUSE THE FOLLOWING EFFECTS IN LABORATORY ANIMALS: LIVER ABNORMALITIES, KIDNEY DAMAGE, AND LUNG DAMAGE.

THE INFORMATION ACCUMULATED HEREIN IS BELIEVED TO BE ACCURATE BUT IS NOT WARRANTED TO BE WHETHER ORIGINATING WITH ASHLAND OR NOT. RECIPIENTS ARE ADVISED TO CONFIRM IN ADVANCE OF NEED THAT THE INFORMATION IS CURRENT, APPLICABLE, AND SUITABLE TO THEIR CIRCUMSTANCES.

Ashland Chemical Company
DIVISION OF ASHLAND OIL INC
P O BOX 2219 COLUMBUS, OHIO 43216 • (614) 889-3333

Ashland

MATERIAL SAFETY DATA SHEET

DEFINITIONS

THIS DEFINITION PAGE IS INTENDED FOR USE WITH MATERIAL SAFETY DATA SHEETS SUPPLIED BY THE ASHLAND CHEMICAL COMPANY. QUESTIONS CONCERNING THESE SHEETS SHOULD BE DIRECTED TO THE ENVIRONMENTAL AND OCCUPATIONAL SAFETY DEPARTMENT.

SECTION I PRODUCT IDENTIFICATION

PRODUCT CLASS. GENERAL OR GENERIC IDENTIFICATION.

HAZARDOUS CLASSIFICATION. PRODUCT MEETS DOT CRITERIA FOR HAZARDS LISTED.

SECTION II HAZARDOUS COMPONENTS

A HAZARDOUS INGREDIENT IS ONE WHICH MEETS ONE OR MORE OF THE FOLLOWING CRITERIA

1 IT IS LISTED IN THE ANNUAL REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES, OR IT IS KNOWN TO BE TOXIC WITHIN THE PARAMETERS OF THAT REGISTRY

AND/OR

2 IT HAS A OSHA ESTABLISHED, 8-HOUR TIME-WEIGHTED AVERAGE PERMISSABLE EXPOSURE LIMIT (PEL) OR ACCEPTABLE CEILING (C), OR AN AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS' (ACGIH) THRESHOLD LIMIT VALUE, AND BY NATURE OF THE PRODUCT OR ITS KNOWN USE, IT IS LIKELY TO BECOME AIRBORNE

AND/OR

3 IT CONTRIBUTES TO ONE OR MORE OF THE FOLLOWING HAZARDS OF THE PRODUCT

A FLASHPOINT BELLOW 200 DEG F (CC), OR SUBJECT TO SPONTANEOUS HEATING OR DECOMPOSITION.

B. CAUSES SKIN BURNS (DOT)

C STRONG OXIDIZING AGENT. (DOT)

D SUBJECT TO HAZARDOUS POLYMERIZATION

EACH INGREDIENT MEETING ONE OR MORE OF THE ABOVE CRITERIA IS LISTED IN SECTION II IF PRESENT AT A LEVEL AT LEAST GREATER THAN ONE PERCENT. INGREDIENTS WHICH ARE CLAIMED TO BE CARCINOGENS, TERATOGENS, MUTAGENS, OR CAUSATIVE AGENTS OF OTHER REPRODUCTIVE DISORDERS ARE LISTED IF KNOWN OR BELIEVED TO BE PRESENT, PROVIDED THAT THE DATA SUPPORTING SUCH CLAIMS IS CONSIDERED VALID

EACH HAZARDOUS INGREDIENT IS LISTED BY CHEMICAL, GENERIC, OR PROPRIETARY NAME. ITS LEVEL IN THE PRODUCT IS EXPRESSED AS 1% OR LESS, 1-10%, 10-30%, 30-60%, OR GREATER THAN 60%, OR BY OTHER MEANS.

SECTION III PHYSICAL DATA

INITIAL BOILING POINT. IF LIQUID AT 68 DEG F

VAPOR PRESSURE. IF LIQUID AT 68 DEG F OR WHICH SUBLIMES

VAPOR DENSITY. FOR VOLATILE PORTION OF PRODUCT

SPECIFIC GRAVITY. IF SPECIFIC GRAVITY OF PRODUCT IS NOT KNOWN, INDICATED AS <1, =1, OR >1

PERCENT VOLATILES. PERCENTAGE OF MATERIAL WITH INITIAL BOILING POINT BELOW 425 DEG F.

EVAPORATION RATE. INDICATED AS FASTER OR SLOWER THAN ETHYL ETHER, UNLESS STATED

SECTION IV PRODUCT IDENTIFICATION

FLASH POINT. CLOSED CUP.

LOWER EXPLOSION LIMIT. INDICATED FOR COMPONENT WITH LOWEST VALUE

HAZARDOUS DECOMPOSITION PRODUCTS. KNOWN HAZARDOUS PRODUCTS RESULTING FROM HEATING, BURNING, ETC., OR REACTED RAW MATERIALS WHICH MAY ARISE THROUGH HEATING, BURNING, ETC.

SPECIAL FIREFIGHTING PROCEDURES. INDICATES EQUIPMENT TO PROTECT FIREMEN FROM TOXIC PROCEDURES OF COMBUSTION OR IF WATER IS NOT TO BE USED.

UNUSUAL FIRE AND EXPLOSION HAZARDS. HAZARDS NOT COVERED BY OTHER SECTIONS OF THIS REPORT ARE SHOWN HERE.

SECTION V HEALTH HAZARD DATA

RECIPIENTS OF THIS SHEET SHOULD CONSULT THE OSHA SAFETY AND HEALTH STANDARDS (29 CFR 1910), PARTICULARLY SUBPART G - OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL, AND SUBPART I - PERSONAL PROTECTIVE EQUIPMENT, FOR GENERAL GUIDANCE ON CONTROL OF POTENTIAL OCCUPATIONAL HEALTH HAZARDS

PERMISSIBLE EXPOSURE LEVEL. OSHA ESTABLISHED PEL--IF NONE AVAILABLE, ADOPTED VALUE.

EFFECTS OF OVEREXPOSURE. GIVEN IN GENERAL TERMS, LOCAL AND SYSTEMIC EFFECTS TO THE EYES, SKIN, IF MATERIAL IS INHALED, UNLESS NOT APPLICABLE DUE TO PHYSICAL FORM OF PRODUCT

SECTION VI REACTIVITY DATA

HAZARDOUS POLYMERIZATION. CONDITIONS TO AVOID HAZARDOUS POLYMERIZATION RESULTING IN A LARGE RELEASE OF ENERGY

STABILITY. CONDITIONS TO AVOID IF UNSTABLE UNDER NORMAL CIRCUMSTANCES.

INCOMPATIBILITY. MATERIALS TO AVOID

SECTION VII SPILL OR LEAK PROCEDURES

REASONABLE PRECAUTIONS TO BE TAKEN AND THE METHODS OF CLEAN-UP TO BE USED IN THE EVENT OF SPILLAGE OF THE PRODUCT CONSULT FEDERAL, STATE AND LOCAL REGULATIONS FOR ACCEPTED PROCEDURES AND ANY REPORTING OR NOTIFICATION REQUIREMENTS

SECTION VIII PROTECTIVE EQUIPMENT TO BE USED

THIS SECTION INDICATES PROTECTIVE EQUIPMENT TO BE USED WHEN HANDLING THE PRODUCT

SECTION IX SPECIAL PRECAUTIONS OR OTHER COMMENTS

THIS SECTION IS TO COVER ANY RELEVANT POINTS NOT PREVIOUSLY MENTIONED

ADDITIONAL COMMENTS

ASHLAND WISHES TO INFORM YOU THAT SERIOUS ACCIDENTS HAVE RESULTED FROM THE MISUSE OF "EMPTIED" CONTAINERS (DRUMS, 1 AND 5 GALLON PAILS, ETC.) REFER TO SECTIONS IV AND IX

WE RECOMMEND THAT CONTAINERS BE EITHER PROFESSIONALLY RECONDITIONED FOR REUSE BY CERTIFIED FIRMS OR PROPERLY DISPOSED OF BY CERTIFIED FIRMS TO HELP REDUCE THE POSSIBILITY OF AN ACCIDENT. DISPOSAL OF CONTAINERS SHOULD BE IN ACCORDANCE WITH APPLICABLE LAWS AND REGULATIONS "EMPTY" DRUMS SHOULD NOT BE GIVEN TO INDIVIDUALS

APPENDIX B.

Results of Personal Sampling Data

RESULTS OF PERSONAL SAMPLING OF LAMINATION WORKERS

WORKER	JOB TITLE	DAY 1 STYRENE, ppm	DAY 1 ACETONE, ppm	DAY 2 STYRENE, ppm	DAY 2 ACETONE, ppm	DAY 3 STYRENE, ppm	DAY 3 ACETONE, ppm
A 1/2 hour samples	HULL LAMINATOR	LT 1.4	LT 2.5	5	4	Did not work	
		*14	5	16	21		
		*61	12	1.6	LT 3		
		*13	36	LT .8	1.5		
		*25	7	*24	9		
		*42	35	*41	7		
		*18	326	*32	8		
		LUNCH BREAK		*40	6		
		* 6.7	2	LUNCH BREAK			
		*18	11	*34	18		
		* 5	7	*26	24		
		2	4	*52	4		
		LT 3	LT 5				
	MEAN	17	6	26	10		
B 1/2 Hour Samples	HULL LAMINATOR	LT 1	17	* 4	8	LT 1.5	LT 2.5
		*19	5	*22	11	3	2
		*83	18	1.5	32	9	LT 2.8
		*21	6	LT 1	8	4	5
		*27	93	*16	31	*16	16
		*31	48	*37	6	* 5	28
		* 6	19	*28	9	*17	23
		Lunch Break		* 9	8	*27	10
		14	9	Lunch Break		Lunch Break	
		22	14	*21	9	*29	6
		7	10	*37	20	*12	47
		1	LT 2	*52	27	3	6
		1	2	*31	32	*24	11
		1.5	8	*18	35	*21	10
	MEAN	17	19	23	19	13	13

* Worker is laminating
LT = Less than

RESULTS OF PERSONAL SAMPLING OF LAMINATION WORKERS

WORKER	JOB TITLE	DAY 1 STYRENE, ppm	DAY 1 ACETONE, ppm	DAY 2 STYRENE, ppm	DAY 2 ACETONE, ppm	DAY 3 STYRENE, ppm	DAY 3 ACETONE, ppm
C 1/2 Hour Samples	Hull Laminator	LT 1	LT 2	4	6	1	4
		* 17	9	* 29	8	* 11	3
		* 55	5	* 18	LT 1.5	*137	13
		* 15	23	LT 1.7	3	Void	
		* 13	3	* 21	5	Void	
		* 51	21	* 53	7	3	25
		* 8	7	*114	9	* 48	7
		Lunch Break		* 16	2	* 24	8
		* 11	8	Lunch Break		Lunch Break	
		* 19	8	* 10	23	* 25	9
		* 6	8	LT 5	17	* 46	21
		2	2	* 77	16	8	LT 2
		3	6	* 37	19	* 37	4
		LT 5	LT 8			* 15	5
	MEAN	15	8	28	10	31	9
D 1/2 Hour Samples	Hull Laminator	* 14	10	5	8	LT 1.3	LT 2
		* 46	11	* 35	8	* 9	7
		* 19	6	* 21	25	* 60	12
		* 35	6	LT 1	LT 3	* 19	9
		* 31	14	* 25	10	Void	
		* 8	23	* 44	5	6	15
		Lunch Break		* 41	14	* 34	177
		* 14	39	* 16	3	* 12	11
		* 22	18	Lunch Break		Lunch Break	
		* 9	21	* 31	75	* 13	14
		3	42	* 44	29	* 30	106
		1	11	* 43	28	5	9
		LT 1	LT 2	* 44	20	* 30	9.5
				* 24	25	* 21	11
	MEAN	16	18	29	20	19	26

* Worker is laminating
LT = Less than

RESULTS OF PERSONAL SAMPLING OF LAMINATION WORKERS

WORKER	JOB TITLE	DAY 1 STYRENE, ppm	DAY 1 ACETONE, ppm	DAY 2 STYRENE, ppm	DAY 2 ACETONE, ppm	DAY 3 STYRENE, ppm	DAY 3 ACETONE, ppm
E 3 Hour Samples	Team Leader	1.5	2.6	8 7	4 8	1 7	4 5

Average styrene (3 days)= 4.9 ppm
Average acetone (3 days)= 4.7 ppm

WORKER	JOB TITLE	DAY 1 STYRENE, ppm	DAY 1 ACETONE, ppm	DAY 2 STYRENE, ppm	DAY 2 ACETONE, ppm	DAY 3 STYRENE, ppm	DAY 3 ACETONE, ppm
F 3 Hour Samples	RTM* Laminator	1.3 2.2	2.2 10	4 4	27 93	4 2	21 9

Average styrene (3 days)= 2.9 ppm
Average styrene (3 days)= 27 ppm

WORKER	JOB TITLE	DAY 1 STYRENE, ppm	DAY 1 ACETONE, ppm	DAY 2 STYRENE, ppm	DAY 2 ACETONE, ppm	DAY 3 STYRENE, ppm	DAY 3 ACETONE, ppm
G 3 Hour Samples	RTM* Laminator	1.3 2	7 16	3 4	13 90	6	11

Average styrene (3 days)= 3.3 ppm
Average acetone (3 days)= 27.4 ppm

* Resin Transfer Molding