U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-150-378

REINELL BOATS, INC.
POPLAR BLUFF, MISSOURI

APRIL 1977

I. TOXICITY DETERMINATION

A combined environmental-medical study has been completed at Reinell Boats, Inc., Poplar Bluff, Missouri. An initial survey and two follow-up evaluations were conducted during the periods of November 12-13, 1975, February 17-18, 1976, and April 12-13, 1976, respectively. Environmental assessment was accomplished by obtaining measurements of airborne exposures to organic vapors, methylene bisphenyl isocyanate, and compounds containing cobalt; observing work practices; and evaluating spray booth ventilation. Medical evaluation consisted of taking medical histories, obtaining blood samples, performing limited physical examinations, and conducting pre- and post-shift pulmonary function tests. The primary airborne contaminant to which workers in the lamination areas (primary areas of study) were exposed was found to be styrene with less significant exposure to acetone and methylene chloride. A detailed discussion of the environmental findings for the lamination areas and other areas of the plant are contained in the body of the report.

It is the judgement of the investigators that a toxic exposure to workers existed in the lamination areas at the time of the investigation. There was a marked increase in signs and symptoms of upper respiratory irritation in these workers. It is evident from the pulmonary function studies that lamination area workers who smoke have an increased incidence of reduced MMEF values on their pulmonary function studies (a reduction in MMEF is thought to represent small airway disease). Non-smokers in the lamination areas as well as smokers and non-smokers in the control population showed no reduction in MMEF values. There was also evidence of dermatitis related to direct contact with solvents in lamination workers. Recommendations for medical and environmental control of conditions at this plant are contained in the body of the report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) Reinell Boats, Inc., Poplar Bluff, Missouri
b) Authorized Representative of Employees - United Steelworkers Local 7882
c) U.S. Department of Labor - Region VII
d) NIOSH - Region VII

For the purpose of informing the approximately 160 "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees alleging that workers employed as carpet layers, engine installers, deck assemblers, laminators, large boat final assemblers, and upholsterers were experiencing symptoms of burning eyes, nose and throat irritation, headaches, and respiratory irritation from exposure to chemicals used in the workplace.

IV. HEALTH HAZARD EVALUATION

A. Process Description - Conditions of Use

This facility is engaged in the manufacture of fibrous glass pleasure boats of 15 feet to 30 feet in length with full production of 12-14 boats per day. At the time of the survey economic conditions resulted in a cutback to an eight boat per day production schedule. Assembly areas and the operations associated with each are discussed below.

1. Lamination

Decks, hulls, and small parts are laminated in three separate locations but production steps are very similar. The mold (whether deck, hull, or small part) is cleaned and waxed and then gel coated. The gel coat is the same resin system as used for lamination except that the resin contains pigment to yield the desired color. The resin is a styrene modified polyester resin using methyl ethyl ketone peroxide as a catalyst. The styrene acts as a vehicle and also crosslinks with the polyester resin to form the final polymer. There are also minor constituents in the resin to act as promoters (cobalt octoate or cobalt naphthenate are commonly used), a thixatropic agent, and possibly a small amount of ethylene or polypropylene glycol. The gel coat is applied with

a spray gun in a spray booth; decks, hulls, and small parts are gel-coated in separate booths. Examples of laminated small parts are rudders, side lockers, motor boxes, and hard tops. The mold is then removed from the spray booth and the lamination step is performed. Lamination is accomplished by spraying the resin system and chopped roving (chopped fibrous glass strands) using a chopper gun onto the mold; the required amounts of resin and catalyst are automatically metered. The resin and chopped roving is rolled by hand after spraying by three or four workers while the resin is still fluid. In the past two coats of chopped roving and resin had been applied; however, at the time of this evaluation one heavy coat of roving and resin was being used for decks. Hull lamination differs slightly from the above procedure. The layer of chopped roving and resin followed by application of a fibrous glass sheet which is then smoothed with squeegees and by hand.

Decks are stiffened by laying wooden supports in the mold followed by lamination. The wood adds strength and also provides a solid support to which accessories such as rails, horns, lights, etc. may be attached. Flooring and stringers are attached to the hull prior to the lamination. After the resin sets, the hull, deck or small part is removed from the mold by prying at a point and blowing compressed air between the mold and part.

Workers in the lamination area are exposed to components of the resin system from the spray operation, primarily styrene vapors. The catalyst, methyl ethyl ketone peroxide (MEKP), is mixed with the resin at the chopper gun when spraying the resin and is potentially present. The amount of MEKP used is about 1 percent of the amount of resin that is used in this operation. Acetone is used for cleanup and is available in containers where workers clean tools and hands by dipping them into the liquid solvent.

Several workers perform polyurethane foaming operations in the deck and hull lamination areas. The foam is added to the hull and decks to provide flotation pockets. There is also an area where stringers are foamed. The stringers are placed in the hull and not only provide flotation but become an integral part of the hull on which plywood flooring is laid. The polyurethane resin system utilized methylene bisphenyl isocyanate (MDI) as the free isocyanate at the time of the evaluation although toluene diisocyanate had been used previously. Methylene chloride is used to clean the foaming guns which presents potential for vapor exposure, especially to workers performing foaming.

There was no local exhaust ventilation installed at the time of evaluation in any of the laminating areas with the exception of the spray booths where the gel coat was applied. There was general dilution ventilation in the deck lamination area provided by four exhaust ducts along the wall separating the deck lamination area from the Pregunwale Assembly area with fresh air returned by twelve overhead ducts. In the hull lamination area exhaust ventilation was provided by four wall fans mounted at floor level in the outside wall of this area. The relative remoteness of the exhaust ducts to the spray areas made them ineffective in controlling vapor exposure at the lamination operations.

2. Assembly (Pre-Gunwale)

This assembly area has two lines in one large room: one side for hulls and the other side for decks. Templates are placed on the deck and holes are drilled for bow rails, windshields, horn, reflectors, etc. The deck then proceeds down the line where the various accessories are attached at several different stations in the line. The hull is cut out by saw and routed to accommodate drive train and engine; carpet is laid in the hull using a glue to attach it; and waterproof paint is applied to the stern area of the hull and to the transom where leaks may occur around the power plant. The engine is then installed and all prewiring is completed for the power plant and accessories. At this point the deck and hull have not been joined.

Defects in molds are repaired by three to four workers in this area. The patching material is a binder into which an asbestos filler has been mixed. This operation consequently exposes these workers to airborne asbestos especially when the asbestos is mixed with the binder to prepare the patching substance.

Workers installing carpeting and using waterproof paint may be exposed to acetone, toluene, xylene, and methyl ethyl ketone. Since carpeting and painting are performed in the same area, carpet layers or painters are exposed to all these substances. There is no ventilation in this area, however, a large fan is used to blow vapors away from the carpet layers and painters into other work areas. Workers in the grinding area have cutaneous and respiratory exposure to fibrous glass dust.

3. Assembly (Post-Gunwale)

This area is a completely separate building from the lamination operations and the Assembly (Pre-Gunwale) area discussed earlier. The deck is attached to the hull and the boat goes to either a small boat or large boat line. In these lines seats are installed, upholstery padding is attached to the sides, motor box cover is added, and the galley is installed. The boat then undergoes touch up of paint as needed and is polished (referred to as clean and patch). The engine is then started to check the electrical system, and the boat is then taken outside to a test tank area. The boat is floated in the tank to test the integrity of the hull and to give the wiring a final check. The clean and patch workers in this area may be exposed to acetone, styrene, toluene, xylene and naphtha; all these substances may be used to clean the boats prior to final checkout.

4. Miscellaneous Activities

Other areas of the plant were visited which support the main production areas outlined above. These areas are: warehouse - parts are stocked and distributed to production areas as needed; upholstery - seat cushions and sleeper seats are fabricated, and canvas is prepared for convertible tops; wood shop - galleys are fabricated and wood strips for deck reinforcement are sawed; and the load out area - boats are checked and loaded on trailers for shipment.

B. Evaluation Progress and Design

1. Initial Survey - November 11-13, 1975

Several areas were selected for more detailed evaluation based upon the use of substances with known toxicological properties, amounts of substances in use, mode of exposure, work practices, proximity of workers to generation point, and professional judgement. Areas of the plant selected were:

a. Laminating areas - small parts, decks, and hulls
b. Foam stations in laminating
c. Mold preparation and repair
d. Clean and patch - small and large boats
e. Carpet installation and water proof painting

2. Follow-up Evaluation - February 17-19, 1976

After the initial survey report had been reviewed, it was deemed necessary to conduct a follow-up study to obtain further medical data. Twenty-seven workers were interviewed and examined. Limited environmental samples were obtained at the same time. After examining the results, it was thought necessary to conduct a thorough environmental-medical evaluation, which was performed April 12-13, 1976.

3. Follow-up Environmental-Medical Evaluation-Study Design - April 12-13, 1976

A total of 22 employees from the lamination areas were tested. Nineteen workers from low or no exposure areas served as controls. The control population was matched as closely as possible to the exposure group for sex, age and smoking history. A medical history and physical examination was performed on each of the workers from the exposed and control cohorts utilizing the questionnaire attached (Appendix A). In addition to this, a complete blood count, serum multiphasic analysis-21, serum thyroxin by radioimmunoassay, thyroid stimulating hormone and pre- and post-shift pulmonary function studies were performed on each worker.

The workers from the lamination areas (exposed cohort) were all monitored for exposure to organic vapors for the entire shift. Workers performing foaming operations in lamination areas were monitored with full shift samples for MDI exposure. The remaining workers from lamination areas were monitored for MDI or cobalt exposure: approximately half for MDI exposure and approximately half for cobalt exposure. Area samples were collected in lamination areas to assess levels of organic vapors, MDI, and cobalt.

For the control cohort, approximately half of these workers were monitored for exposure to organic vapors with full shift samples. The remaining workers of the control cohort were monitored for either cobalt or MDI

exposure. Since several job classifications were represented in the control cohort, at least one personal sample for each of the organic vapors, MDI, and cobalt were obtained for job classifications represented in the control cohort. Area samples were collected in areas where workers from the control cohort were located.

During this study those substances potentially present and most likely related to symptoms and signs of exposed workers were chosen for detailed evaluation; these substances were organic vapors, free isocyanates, and the cobalt from cobalt soaps used as promoters in the polyester resin. This sampling strategy required each worker to wear at least two sampling trains which is a practical limit for the type of movement required in their jobs. It also was desired to monitor MEKP exposures but at the time of the study a sampling analytical technique for this substance was not available. Other substances which are potentially present are aerosols of the dimethyl phthalate used as a diluent for MEKP, the polyester resin, and fibrous glass dust produced by the chopper gun; however, no visible aerosol was observed and these substances were not further considered for detailed evaluation.

C. Methods of Evaluation

1. Environmental

Organic vapors - samples for determination of airborne concentrations of organic vapors were collected by adsorbing vapors onto charcoal contained in glass sampling tubes. Air was drawn through the tubes at a flow rate of 50 cubic centimeters (cc)/minute with vacuum sampling pumps. Personal samples were obtained by attaching the pump to the worker's belt with the charcoal sampling tube contained in a holder attached to the lapel of the worker. The sampling tubes were transmitted to the laboratory for analysis by gas chromatography.[1] The limit of detection for this method was 0.01 milligrams (mg) for each individual organic compound per charcoal tube.

Asbestos - samples of airborne asbestos were obtained with mixed esters of cellulose membrane filters (0.8 micron (u) average pore size) contained in an open-face cassette attached to the lapel of the worker. Air was drawn through the filter at a flow rate of 1.0 liter/minute with a vacuum pump attached to the belt of the worker. The amount of asbestos fibers collected on the filter were counted with a microscope using 400-450 magnification and phase contrast illumination.

Cobalt - samples for determination of airborne concentrations of cobalt compounds were obtained with mixed esters of cellulose membrane filters (0.8 u average pore size) contained in a closed-face cassette. Air was drawn through the filter at a flow rate of 1.5 liters/minute with a vacuum pump attached to the belt of the worker. The amount of cobalt on the filter was determined by an atomic absorption analytical method.[2] The limit of detection for this method was 0.001 mg of cobalt per filter.

MDI - samples for determination of airborne concentrations of MDI were obtained with midget impingers containing 15 milliliters of Marcali absorbing solution. Air was drawn through the impinger at a flow rate of 1.0 liter/minute with a vacuum pump attached to the belt of the worker. The amount of MDI contained in the impinger was determined by a colorimetric analytical method.[3] The limit of detection for this method was 0.0025 mg of MDI per impinger.

2. Medical

All specimens, after having been appropriately prepared by NIOSH personnel, were analyzed by National Health Laboratories, Arlington, Virginia. The pulmonary function studies were done using "Vitalograph" Pulmonary Function Machines. The parameters evaluated included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1) and Maximal Mid Expiratory Flow rate ($MMEF_{25-75}$). Predicted normal values for each worker were derived from the values reported by Kamburoff.[4] The pulmonary function results were calculated and placed in table form by the medical investigator. The data was analyzed by the NIOSH statistical support group using paired T-tests to assess any significant differences between the high exposure (Lamination) and the control cohorts.

D. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are : (1) NIOSH Criteria Documents with recommended standards for occupational exposure, (2) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation, and (3) Federal occupational health standards, promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor. For the substances evaluated during this study, the primary environmental criteria used were:

Substance	Standard or Guide	
	ppm*	mg/M3**
Acetone	1000 (2,3)***	2400
Asbestos	****	
Cobalt	----	0.1 (2,3)
Methyl acetate	200 (2,3)	610
Methylene bisphenyl isocyanate (MDI)	0.02 (2,3)	0.2
Methylene chloride	75 (1)	261
Methyl ethyl ketone	200 (2,3)	590
Methyl ethyl ketone peroxide	0.2 (2)	1.5
Petroleum distillates (naphtha)	500 (3)	2000
Styrene	100 (2,3)*****	420
Toluene	100 (1,2)	375
Xylene	100 (1,2)	435

* Parts of vapor per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

** Approximate milligrams of substance per cubic meter of air.

*** Reference numbers in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

**** NIOSH recommends the following criteria for occupational exposure to airborne asbestos fibers. No employee may be exposed to an 8-hour time-weighted average airborne concentration of asbestos fibers in excess of 100,000 fibers greater than 5 micrometers in length per cubic meter (or 0.1 fiber >5 um/cc) of air, as determined on the basis of a 40-hour work week. No employee may be exposed to airborne concentrations of asbestos fibers in excess of 500,000 fibers greater that 5 micrometers in length per cubic meter (or 0.5 fibers >5 um/cc) of air, as determined over a period up to 15 minutes. "This recommended standard of 100,000 fibers <5 um in length per M^3 is intended to (1) protect against the non-carcinogenic effects of asbestos and (2) materially reduce the risk of asbestos-induced cancer (only a ban can assure protection against carcinogenic effects of asbestos)." (Revised Criteria for a Recommended Standard - Occupational Exposure to Asbestos (1976), NIOSH, Cincinnati, Ohio, transmitted to OSHA by memorandum December 15, 1976.)

***** The OSHA Standard includes a ceiling concentration of 200 ppm not to be exceeded for 5 minutes in any 3 hours with a maximum peak of 600 ppm.

Occupational health exposure limits for individual substances are generally established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

Although sources other than the Federal Standard were considered in this study for arriving at a Toxicity Determination, the only legal enforceable standard is the Federal Standard which is administered by the Occupational Safety and Health Administration of the Department of Labor.

Ventilation characteristics of the gel coat spray booths were evaluated using criteria contained in a Manual of Recommended Practice for Industrial Ventilation.[5]

2. Medical

Toxic Substances Data[6,7,8,9]

Styrene (Phenyl Ethylene)

This substance causes eye and mucous membrane irritation at 200-400 ppm and drowsiness and listlessness, muscle weakness and unsteadiness at 800 ppm. Transient nausea, vomiting, loss of appetite and general weakness have been described. Impaired night vision, slight gastric irritation and leukopenia

with relative lymphocytosis have been reported at exposures of 25-50 ppm. It has been reported that chronically exposed workers have prolonged simple reaction time and that chronic animal long-term exposures of 1300 ppm, 8 hours per day showed no effects of a consistent nature.

Methyl Ethyl Ketone Peroxide (MEKP)

This substance is used to initiate polymerization of plastic monomers. Little human data is available but available animal studies suggest that it is moderately toxic. Exposed animals show liver and kidney damage at moderate to high levels. Animal experiments also show that it is less toxic than Benzoyl Peroxide which has a TLV of 5 mg/M^3. Hence the 1.5 mg/M^3 standard should be reasonably safe.

Cobalt

Used in the process as cobalt naphthanate or cobalt octoate. Cobalt and cobalt chloride have been reported to cause changes in red blood cell morphology and have been described as a goitrogenic agent.

Rockhold[10] in 1955 investigated the toxicity of the following naphthenates: cobalt, copper, calcium, manganese and zinc. He reported that metal naphthenates show a low acute and oral toxicity for rats (lethal doses LD_{50} between 4 grams/kilogram (g/kg) and over 6 g/kg. Because of the low toxicity and the low concentration at which they are used, metal naphthenates, especially those of cobalt, manganese and calcium can be used without damage in materials intended for use in the food industry.

Methylene Bisphenyl Isocyanate (MDI)

Exposure may result in irritation to eyes, skin, respiratory tract, and mucous membranes. May cause pulmonary sensitization with resultant airway constriction in susceptible individuals.

Acetone

Primary effect is a narcotic-type action, eye, nose and throat irritation, drowsiness, loss of muscle control and coma at higher doses.

Toluene

Primary effect is narcosis. May produce fatigue, weakness, confusion, lacrimation and paresthesia at lower doses. At higher concentrations euphoria, headache, dizziness, dilated pupils and nausea may occur.

Asbestos

Exposure to asbestos may lead to pulmonary fibrosis and emphysema with resultant dyspnea and debilitation. Asbestos exposures have been associated with lung cancer mesothelioma and gastrointestinal.

E. Results and Discussion

1. Initial Survey - November 11-13, 1975

The results of environmental sampling and any related symptoms reported by lamination workers are shown in Table 1. Styrene is the primary airborne contaminant to which these workers were exposed. Three of these 17 personal samples were in excess of 100 ppm (the OSHA Standard and ACGIH TLV) with twelve samples greater than one-half of the styrene standard. All results of methyl acetate were less than the detection limit of the GC analytical method used. Acetone and methylene chloride are present primarily due to the poor work practices which were observed to be commonplace. Acetone is used for clean-up of the chopper guns after resin has been sprayed, but it is also used to remove resin from the exposed skin of workers which is contacted during the rolling of the resin before it sets up. Only one worker was observed to wear gloves consistently to protect the exposed surfaces of hands and arms. Methylene chloride is used to clean MDI from guns after foaming. One operator at a foaming station was observed spraying the methylene chloride directly onto the floor during clean-up.

Since styrene, acetone, and methylene chloride may have similar effects in humans, the results for individual substances were combined and compared to a combined standard of 1.0 by the method outlined in 29 CFR 1910.1000. Combined exposures ranged from 0.34 to 1.54 with the same three samples in excess of the combined standard that were in excess of the styrene standard. The symptoms that were reported by workers who were interviewed are also shown in Table 1. Fourteen of the 17 workers sampled were interviewed on the day sampling was performed. All 14 workers reported symptoms by history, and nine of the 14 reported at least one symptom on the day of sampling.

A number of samples were obtained during November 12-13, 1975, in the stringer, deck, and hull foaming areas to evaluate exposure of workers to free isocyanates. However, all of the eleven samples leaked during shipment to the laboratory and the results could not be interpreted and therefore are not reported.

Table 2 contains environmental/medical data from three areas; clean and patch, mold repair, and the carpet laying and waterproof painting area. Several different solvents may be used by the workers in the clean and patch area depending upon the specific cleaning job and also worker preferences for particular solvents. While the exposure to styrene is much lower than to the laminating workers, in the clean and patch area some exposure to naphtha occurs. Combined solvent exposures were considerably lower in clean and patch than in the laminating area. Symptoms by history were less prevalent and a lower percentage (two of seven) reported themselves to be symptomatic on the day of evaluation. The mold repair worker who was monitored had a much higher combined solvent exposure than clean and patch workers although this worker did not report any symptoms on the day of evaluation.

Carpet layers and the hull router work in the same area although performing different job functions. The relatively high exposure of the hull router may be explained by this worker's location relative to the waterproof painting. The hull router usually works from the floor and his breathing zone is in close proximity to freshly painted areas while routing the hull and transom.

Three workers were monitored in the mold repair area for exposure to asbestos fibers. Asbestos is added to a resin and used by these workers to repair small damaged areas of the molds as needed. The measured exposure of these workers was 0.02, 0.05, and 0.07 fibers/cc. Although these levels are less than the NIOSH recommended standard, exposure to asbestos should be minimized to the greatest extent feasible in view of its human carcinogenic activity. Recommendations are contained in this report to further control this hazard.

The highest result was obtained for a worker who mixed the asbestos and resin binder during the shift which may account for the slightly higher result. A sample of Cab-o-Sil® used in mold repair was analyzed by X-ray diffraction for free silica content; no free silica was detected in this sample.

Table 3 contains a compilation of reported symptoms , both acute and chronic, elicited from workers utilizing the non-directed questionnaires and are presented by work area. Most of the symptoms are consistent with the solvent vapor exposure present in the work areas. As would be expected the high prevalence of symptoms in laminating seems related to the airborne exposures reported in Table 1.

Based upon visual inspection of the disc sanding area, it was judged that airborne concentrations for sanding operations of molded parts following removal from the molds were excessive. Review of sampling records furnished to the company by their insurance carrier confirmed this observation with breathing zone total dust levels of 30.9 mg/M^3 for hull sanding, 59.4 mg/M^3 for deck sanding, and 19.7 mg/M^3 in small parts sanding having been reported. An immediate recommendation for local exhaust control of the hand grinders was made with this same recommendation contained in a follow-up letter.

2. Follow-up Visit - February 17-18, 1976

In view of the large proportion of workers reporting symptoms during the initial survey visit, a follow-up visit was made during the dates indicated above. Twenty seven workers were interviewed and examined at that time. Limited personal sampling was conducted in the lamination areas to determine worker exposure to organic vapors and airborne cobalt.

The production rate at the time of this visit was eight boats per day; the same production rate as at the time of the initial survey. Results for organic vapor and airborne cobalt exposure are contained in Table 4. The primary environmental contaminant present was styrene with one sample slightly in excess of 100 ppm and one sample approaching this level. Some exposure to acetone and minor amounts of methylene chloride (8 to 11 percent of the environmental criteria) were also measured. Methyl acetate was not detected for one sample and only 0.4 ppm (0.2 percent of the environmental criteria) for the second sample. Combined exposures to organic vapors were 1.04 and 1.15 respectively. Results of airborne cobalt exposure for two personal samples were less than the detection limit of the analytical method used.

After examining the results of the medical interviews and examinations, it was judged necessary to conduct a thorough environmental-medical follow-up study.

3. Follow-up Study - April 12-13, 1976

a. Environmental

(1) Organic Vapor Exposures

Table 5 contains the results of personal and area sampling that was performed during the follow-up environmental/medical study for the lamination workers for exposure to organic vapors on April 12, 1976. The plant was operating at a production rate of eight boats/day which was the same rate of production at which the plant has been operating at the time of the prior visits of November, 1975, and February, 1976.

The exposure for workers in the deck lamination area were generally higher than those in the hull lamination and small parts lamination areas. Of the five personal samples obtained in the deck lamination area, four samples either approached or exceeded the styrene environmental criteria of 100 ppm (range of 91 to 111 ppm) while these four samples all exceeded the combined environmental criteria for organic vapors expressed as a unity standard. Even the general area sample located approximately 10-15 feet from the deck lamination station was essentially equal to the styrene criteria (99 ppm compared to 100 ppm). A possible explanation for the elevated levels of styrene vapor in the deck lamination area compared to hull lamination and small parts lamination areas may be due to overspray in the deck lamination area. The deck molds are in a horizontal position during spraying and therefore the spray does not strike a vertical obstruction which would tend to restrict the overspray. Hulls on the other hand are held in a vertical position during lamination and the spray is directed into the hull which has a tendency to contain the overspray. Poor work practices were again observed when the freshly sprayed resin was rolled by hand; only one worker was observed to wear impervious gloves when doing the rolling. Workers were observed cleaning exposed skin surfaces with acetone. Frequently workers immersed their hands directly into the acetone to remove resin. Methylene chloride used for cleaning MDI foaming guns was the only source of this solvent identified in the workplace. The small amount of foaming compared to resin spraying accounts for the relatively low exposure to this solvent.

On April 12, 1976, Drager® detector tubes were used to assess peak level exposures to styrene in the lamination areas of the plant. In the small parts lamination area two detector tube measurements were obtained in workers' breathing zones; measured concentrations were 300 ppm during both resin spraying and resin rollout. Ten detector tube measurements were made in the deck lamination area; seven samples obtained in workers' breathing zones during resin rollout ranged from 200 to 300 ppm, two general area samples ranged from 70 to 160 ppm, and one breathing zone sample during spraying resulted in a 130 ppm concentration. Twenty seven detector tube measurements were made in the hull lamination area; 17 samples in workers' breathing zones during spraying of resin ranged from 100 to 400 ppm, four breathing zone samples during resin rollout ranged from less than 50 to 400 ppm, four breathing zone samples at the hull stiffening station ranged from 130 to 400 ppm, and two general area samples ranged from 70 to 100 ppm. None of these measurements exceeded the present maximum peak of the OSHA Standard which is 600 ppm.

The styrene ceiling of 200 ppm not to be exceeded for five minutes in a three hour period was not evaluated with short-term charcoal tube samples. However, those operations where a series of detector tube measurements were made in workers' breathing zones, sufficient data was collected to show that at times the 200 ppm ceiling was exceeded for a five minute period. Such operations were: hull stiffening station where concentrations of 400 ppm were measured over a five minute period, hull spraying station where concentrations of 300 ppm were measured over a five minute period, hull spraying and applying the fibrous glass reinforcement sheet where concentrations from 200 to 300 ppm were measured over a four minute period, and hull rollout where concentrations from 300 to 400 ppm were measured over a five minute period. Series of detector tube samples over sufficiently long periods of time were not obtained to fully evaluate deck lamination spraying and rollout in comparison to the 200 ppm ceiling. Based upon detector tube results which were obtained, length of time required for spraying and rollout, and operator work practices, it is the judgement of the investigator that at times the 200 ppm ceiling for five minutes would be exceeded in the deck lamination area.

In summary, the primary organic vapor to which workers in the lamination cohort were exposed was styrene. Of the 22 personal samples obtained during this follow-up evaluation, three samples exceeded the styrene criteria of 100 ppm. Levels of styrene were in general elevated for this group as illustrated by the fact that a total of seven of the 22 personal samples exceeded 90 ppm and a total of ten of the 22 exceeded 80 ppm. Six of the 22 personal samples exceeded the combined exposure criteria (expressed as a factor of unity) for the four solvents evaluated. There were also operations identified where 200 ppm was exceeded for more than five minutes in a three hour period and other operations where it would probably be exceeded.

Table 6 contains the results of personal and area sampling for organic vapors that was conducted during the follow-up environmental/medical study for workers in the control cohort. It was not possible to select a control cohort in this plant without including some workers with potential exposure to solvent vapors. However, the control cohort did have much lower exposure to solvent vapors than the lamination cohort. One worker (Subject 151) did have a significant exposure to styrene and acetone on the day of evaluation. With the exception of this one worker, the highest combined exposure in the control cohort was 0.17 which is less than the lowest combined exposure of 0.25 for a worker from the lamination cohort.

(2) Free Isocyanate Exposure

Table 7 contains the results of personal and area sampling for MDI for the lamination cohort. All samples were less than the detection limit for MDI. Since a plant representative reported that a change from toluene diisocyanate (TDI) to MDI had recently been made, all samples also were analyzed for TDI. All samples also were less than the detection limit for TDI. This procedure was followed for the results reported below in Table 8 and Table 9.

Table 8 contains results of MDI exposure for the Stringer Foamer Operator. This operator was the only worker assigned a primary responsibility for foaming operations and had the greatest potential for exposure to MDI. A full shift sample and three 15-minute short term samples during foaming operations were obtained for this worker. All four of these samples were less than the detection limit of the analytical method for MDI and TDI.

Table 9 contains the results for workers in the control cohort monitored for free isocyanate exposure. All of these samples were less than the detection limit of the analytical method for MDI and TDI.

These results are consistent with the use of MDI in a foaming operation. Since there was no spraying of the polyurethane resin system, the potential for airborne MDI would be minimized. However, these results are not necessarily representative of conditions that existed prior to this evaluation when TDI was used as the free isocyanate in the polyurethane foam system. TDI has sufficient vapor pressure to become airborne as a vapor whereas MDI is a solid at room temperature and becomes airborne as an aerosol such as in a spray application. The foaming as conducted did not generate an aerosol and for this reason no airborne exposure to MDI was detected.

(3) Cobalt Exposure

Table 10 contains the results of exposure to airborne cobalt compounds for the lamination cohort while Table 11 contains the results of the same monitoring for the control cohort. All results of monitoring for airborne cobalt exposure were less than the limit of detection of the analytical method.

(4) Methyl Ethyl Ketone Peroxide (MEKP) Exposure

Subsequent to the April, 1976, follow-up study, a sampling/analytical method for MEKP was developed under NIOSH contract. Tentative plans were made to evaluate MEKP exposures in lamination areas in October, 1976. However, it was discovered that the plant had reduced production to approximately two boats/day and was anticipating a complete shutdown. A check in December, 1976, confirmed that the plant had discontinued operation and no further attempts at MEKP evaluations were made.

(5) Ventilation - Gel Coat Spray Booths

Gel coating was performed within exhausted spray booths; three booths were provided, one in each of the hull (Gel Coat Booth #2), deck (Gel Coat Booth #3), and small parts (Gel Coat Booth #4) lamination areas. Gel Coat Booth #2 contained 30 filtered exhaust openings (20 inches x 20 inches each), 15 at each corner of the back wall. Gel Coat Booths #3 and #4 each contained a total of 24 filtered exhaust openings (20 inches x 20 inches each), 12 at each corner of the back wall. Makeup air was provided through filtered openings in the doors and ceilings of the booths. Exhaust capacities were compared to the recommendations for Auto Spray Paint Booths (page 5-69)[5] for airless spray painting. The recommended exhaust capacity recommended is 60 cubic feet per minute (cfm) per square foot of cross sectional area or about 8640 cfm for these booths. The results of exhaust capacity measurements for Booths #2, #3, and #4 were approximately 12340, 6700, and 6700 cfm respectively. During the November, 1975 evaluation, filters were observed to be overloaded from dried overspray and in other cases were missing; at the time of the April, 1976 evaluation, a number of filters had recently been changed and in general were in better condition. The design of the exhaust opening was not as recommended in the previously cited reference and in two cases booths were operating at capacities less than recommended. The Gel Coat Booth operators were wearing NIOSH approved organic cartridge respirators when gel coating in the booths.

b. Medical

During the medical portion of HHE 75-150 a total of 41 employees were studied. The workers were divided into a Lamination cohort (that is those from high vapor exposure areas) and a control cohort (those from other areas of the plant and other buildings). A total of 22 workers comprised the Lamination group and 19 workers the control population. These employees were matched on a one to one basis for age, sex and smoking history. Three workers who volunteered for the control group did not present themselves for study hence the difference in cohort size.

The Lamination cohort was examined on Monday, the control group on Tuesday. Pre- and post-shift pulmonary function studies, complete blood counts, thyroid stimulating hormone levels, serum thyroxine determinations, serum multiphasic analysis-21, medical history and physical examinations were performed on both groups. The SMA-21 consisted of glucose, BUN, creatinine,

sodium, potassium, chloride, carbon dioxide, uric acid, total protein, albumin, globulin, A/G ratio, calcium, inorganic phosphorus, cholesterol, triglycerides, alkaline phosphatase, SGOT (Serum Glutamic Oxalic Transaminase), SGPT (Serum Glutamic Pryuvic Transaminase), LDH (Lactic Dehydrogenase) and total bilirubin. The results of the laboratory and medical evaluations are listed in Tables 12-23.

After statistical analysis of the laboratory blood results, only the serum uric acid values in the control and Lamination cohorts differed at a significant level ($p < .05$), the Lamination cohort being elevated over the control population , but still within the limits of normal. Individual abnormalities in the many blood parameters investigated were attributed to underlying medical disorders (diabetes, hypothyroidisium, etc.), and were not felt to be related to occupational exposure.

The Lamination and control groups were divided into smokers and non-smokers in each cohort and matched comparisons made. There were no significant differences when comparing FVC and FEV_1 in these groups. Analysis of the MMEF showed that the smokers in the Lamination cohort had a significant change ($p < .05$) from pre- to post-shift when compared with the smokers in the control cohort. No MMEF changes were noted in the non-smoking exposed group when compared with the non-smoking control cohort. It must be noted that one worker in the smoking exposed cohort was not included in the final statistical analysis because of non-job related chronic lung disease. See Tables 12-17.

Results of the medical history and physical examinations can be seen in Tables 22 and 23. One hundred percent (22 of 22) of the Lamination population complained of symptoms related to their work at the time of evaluation. Burning or tearing of the eyes (95%), nasal congestion (82%), shortness of breath (54%), dry or sore throat (45%), and fatigue (36%), were the most common symptoms elicited from the Lamination group. Fifty-four percent (12 of 22) of the control group stated that they had had symptoms related to work. However, nine of the 12 who reported positive symptoms had skin rash or back strain as their only complaint. In the control cohort, 37% reported burning or tearing of the eyes, 37% nasal congestion, 26% dry or sore throat.

As seen in Tables 22 and 23 positive physical findings were more prevalent in the exposed group as compared with the control group. Nasal erythema (86% vs. 63%), mouth and throat erythema (45% vs. 32%), conjunctival erythema (41% vs. 5%), and skin rash (14% vs. 0%) constituted the most impressive differences.

Conclusions

On the basis of the environmental bio-medical evaluation conducted at Reinell Boats, Inc. including the results of exposure to airborne contaminants, laboratory blood results, pulmonary function data, and the medical history and physical examinations, it is apparent that a toxic situation existed at the time of the investigation. It is evident from

the pulmonary function studies that smokers in the lamination areas are at higher risk of developing MMEF changes than non-smokers in the lamination areas, and smokers and non-smokers in the control cohort. The primary airborne contaminant to which workers were exposed was determined to be styrene vapors although there was simultaneous exposure to less significant levels of acetone and methylene chloride. A sampling/analytical method for determining airborne levels of MEKP was not available at the time of the April 1976 follow-up evaluation, and therefore no judgement can be made as to what association this substance might have had with adverse health effects. Since the MMEF (where the abnormalities exist) is thought to represent small airway disease, it is likely that engineering control of the airborne exposure(s) would result in the abatement of adverse health effects to employees in these areas. Continued exposure may lead to irreversible airway disease.

It also is apparent that those employees in the lamination areas have a marked increase in the symptoms and signs of upper respiratory irritation presumably due to the elevated styrene levels.

Each worker tested was notified of his or her results. The workers' private physicians received copies of the test results if the worker so desired and the appropriate release form was signed.

V. RECOMMENDATIONS

1. Smoking of tobacco should be discouraged in those people who work in the high exposure areas.

2. Pre-employment and periodic bio-medical testing (at least every two years) including pulmonary function studies, blood counts, chext X-rays, histories and physical examinations should be provided.

3. Exposures in laminating areas should be controlled by engineering methods. It is suggested that the feasibility of performing laminating operations in large exhausted spray booths should be investigated. In addition to reducing employee exposure this type of control would also confine the overspray to a limited area.

4. Since a company spokesman stated it was possible, asbestos should be replaced with a less toxic substance. The area where asbestos has been used should be thoroughly cleaned by vacuuming with waste disposal in sealed impermeable containers. Until this substitution has been accomplished, the provisions concerning medical monitoring contained in 29 CFR 1910.1001 shall be followed.

5. A preventative maintenance program should be instituted for spray booths. Filters were nearly plugged from overspray at the time of the initial survey and needed to be replaced. Face velocities did not appear adequate to remove overspray in two of the three Gel Coat spray booths.

6. Spray painting in the post-gunwale area was observed during the initial survey. Overspray exposes the painter and others unnecessarily; such spray painting should be done only in a booth.

7. Acetone is used for cleanup of workers' hands and arms and this practice should be discontinued. Splash-proof safety goggles should be used by workers in spray areas to prevent eye contact with the reson. Impervious gloves with cotton inserts should be used by workers with direct contact with resin or solvents.

8. Respirator selection and use in a number of cases was improper. A respirator program meeting requirements of 29 CFR Part 1910.134 should be instituted.

9. The welding area in the maintenance shop should have a local exhaust system to control welding emissions.

10. First aid kits did not have adequate supplies. All kits should have similar items stocked and specified personnel (e.g. foremen) should have first aid training.

11. Eyewash fountains should be installed in areas where chemical splashes may occur.

12. An education program should be instituted to teach employees the hazards associated with substances in use, appropriate protective measures, and first aid procedures.

13. Air hoses should not be used to clean up dust. Vacuum cleaners should be used for such cleanup.

14. Discarded MEKP bottles should not be reused. The TLV for this substance indicates it is a relatively toxic substance and reusing these containers may subject workers to additional unnecessary exposure as well as create a safety hazard.

15. Solvents used for gun cleaning should be emptied into containers which can be covered when not in use.

16. Local exhaust should be added to the hand grinders in the grinding area.

VI. REFERENCES

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TABLE 1 - RESULTS OF ENVIRONMENTAL/MEDICAL EVALUATION IN LAMINATING AREAS OF REINELL BOATS - NOVEMBER 12, 1975

Subject	Area	Length of sample (Min.)	Time-Weighted Average Concentration in ppm				Combined Exposure	Symptoms by History	Symptoms Days of Testing
			Styrene	Acetone	Methyl Acetate	Methylene Chloride			
1	Deck Lamination	365	66	65	<1	3	0.77	a,e,f,l	Yes
2	" "	355	81	74	<1	3	0.92	a,e,i,l	Yes
3	" "	355	61	69	<1	3	0.72	e,h,i	Yes
4	" "	393	70	30	<1	2	0.76	b,e,f,g,l	Yes
5	Gel Kote #3 - Deck	355	35	50	<1	5	0.47	a,c,e,f,h,i	Yes
6	Lam. Stiffening Deck	350	54	20	<1	1	0.57	e,f,i	Yes
7	" " "	355	40	48	<1	<1	0.45	e,f,g,i,l,m	Yes
8	Small Parts Lamination	359	47	79	<1	2	0.58	a,b,c,e,h	No
9	" " "	336	79	43	<1	3	0.87	a,e,l	No
10	Splam - Gel Kote	335	36	72	<1	3	0.47	Not interviewed	--
11	Hull Lamination	336	54	30	<1	6	0.65	a,d,e,g,h,i,l	Yes
12	" "	331	61	27	<1	5	0.70	a,e,f,g,i,j	Yes
13	" "	336	129	15	<1	6	1.39	e,i,l	No
14	" "	141	55	69	<1	16	0.83	i,l	No
15	Lam. Stiffening - Hull	321	144	37	<1	5	1.54	e,f,m	No
16	Foam Sta. - Hull Lam.	337	25	23	<1	5	0.34	Not interviewed	--
17	Gel Kote #2 - Hull	340	109	103	<1	2	1.22	Not interviewed	--
Environmental Criteria			100	1000	200	75	1.0		

Key to Symptoms - Tables 1 and 2

a - Headache
b - Dizziness
c - Fatigue and drowsiness
d - Irritability or nervousness
e - Eye irritation
f - Nose irritation
g - Throat irritation
h - Chest pain
i - Shortness of breath
j - Cough
k - Respiratory problems (asthma/T.B.)
l - Rash on skin
m - Cracked hands

TABLE 2 - RESULTS OF ENVIRONMENTAL/MEDICAL EVALUATION IN THE CLEAN AND PATCH AREAS, MOLD REPAIR-DECK, AND MOTOR AND CARPET INSTALLATION NOVEMBER 13, 1975

Subject	Area	Length of Sample (Min.)	Time-Weighted Average of Concentration (Mg/M^3)								Combined Exposure	Symptoms	
			Styrene	Acetone	Toluene	Methylene Chloride	Naptha	Mold Release	Xylene	MEK		History	Day of Testing
19	Clean and patch	261	1	36	5	Not used	12	Not used	Not used	Not used	0.12	None	No
21		-	3	43	2	" "	11	" "	" "	" "	0.12	m	Yes
25	Small boats	249	5	89	3	" "	33	" "	" "	" "	0.24	e,m	Yes
20	Clean and patch	199	1	23	3	" "	6	" "	" "	" "	0.08	e,f,i,e,m	No
22		-	20	2	11	" "	21	" "	" "	" "	0.35	b,d,l,m	No
23	Large Boats	262	8	63	3	" "	14	" "	" "	" "	0.20	a	No
24		263	23	18	3	" "	16	" "	" "	" "	0.31	None	No
26	Mold repair deck	372	29	203	18	3	11	99	" "	" "	0.93	e,f	No
27	Carpet layers	345	Not used	33	40	Not used	Not used	Not used	1	27	0.58	e,d,h,i,l,m	Yes
28		175	" "	33	54	" "	" "	" "	1	38	0.77	None	No
29	Hull routing	338	" "	35	119	" "	" "	" "	3	74	1.63	No Q	No Q
Environmental Criteria			100	1000	100	75	500	500	100	200	1.0		

TABLE 3 - REPORTED SYMPTOMS FROM MEDICAL QUESTIONNAIRE IN PLANT AREAS OF REINELL BOATS, INC. NOVEMBER 12-13, 1975

Plant Area	Number of Workers	Central Nervous System				Irritation				Cardio - Pulmonary			Skin	
		Headache	Dizziness	Fatigue or Drowsiness	Nervous or Irritable	Eye	Nose	Throat	Cough	Chest Pain	Shortness of Breath	Predisposed Condition	Rash	Cracked
Laminating - Small parts, decks, hulls	23	9	5	4	3	19	8	4	4	5	16	1	15	5
Mold Preparation and Repair	9	2	1	1	0	6	3	2	1	2	1	1	5	2
Clean & patch small boats	4	1	0	0	0	2	1	0	0	0	0	0	1	2
Clean & patch large boats	6	2	1	0	1	2	1	1	0	0	1	1	2	3
Carpet Inst. & W.P. Painters	3	0	1	1	1	2	0	0	0	1	1	0	2	0
Miscellaneous Janitors, deck, Assy. & Maintenance	4	1	1	0	0	0	0	0	2	1	2*	0	2	0
Total	49	15	9	6	5	31	13	7	7	9	21	3	27	12

*Report Shortness of Breath only when in the laminating areas.

TABLE 4 - RESULTS OF PERSONAL SAMPLING FOR EXPOSURE TO ORGANIC VAPORS
REINELL BOATS, INC. FEBRUARY 18, 1976

			Time-Weighted Average Exposure in PPM				
Sample No.	Activity sampled	Time of Sample	Styrene	Acetone	Methylene Chloride	Methyl Acetate	Combined Exposure
CT1, CT3, CT5	Deck Lamination	6 hrs.	87	89	6	nd	1.04
CT2, CT4, CT6	Hull Lamination	6 hrs. 28 min.	102	19	8	0.4	1.15
Environmental Criteria			100	1000	75	200	1.0

RESULTS OF PERSONAL SAMPLING FOR EXPOSURE TO AIRBORNE COBALT

Sample No.	Activity	Time of Sample	Cobalt - Mg/m^3
AA1	Deck Stiffening	6 hr. 44 min.	nd
AA2	Hull Lamination	6 hr. 40 min.	nd
Environmental Criteria			0.1

nd = none detected

TABLE 5 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO ORGANIC VAPORS
EXPOSED VAPORS - REINELL BOATS, INC., APRIL 12, 1976

Sample No.	Activity Sampled	Time of Sample	Time-Weighted Average Exposure in PPM				Combined Exposure	Medical Study Subject Number
			Styrene	Acetone	Methylene Chloride	MEK		
5C, 5B	Deck Lamination	7 hr. 16 min.	91	93	2	nd	1.03	119
18C, 18B	" "	7 hr. 12 min.	111	90	1	nd	1.21	139
19C, 19B	" "	6 hr. 55 min.	99	69	3	nd	1.10	141
17C, 17B	Stiffening & Foaming Decks	7 hr. 18 min.	91	78	4	nd	1,04	129
11C, 11B	Gel Kote Booth #3 Decks	7 hr. 23 min.	54	144	1	nd	0,70	113
22C	Lamination-Decks-Gen. area	6 hr. 47 min.	99	nd	1	nd	1.00	--
6C, 6B	Hull Lamination	7 hr. 10 min.	86	48	3	nd	0.95	134
7C, 7B	" "	7 hr. 5 min.	53	31	2	nd	0.59	131
9C, 9B	" "	6 hr. 47 min.	81	39	3	nd	0,89	132
10C, 10B	" "	6 hr. 58 min.	31	30	1	nd	0.35	135
13C, 13B	" "	7 hr. 28 min.	44	28	2	nd	0,50	130
21C, 21B	" "	7 hr. 19 min.	36	38	1	nd	0,41	133
2C, 2B	Stiffening & Foaming-Hulls	7 hr. 35 min.	91	54	1	0,3	0,98	136
15C, 15B	" " " "	7 hr. 14 min.	62	33	2	nd	0,68	126
IC, IB	Gel Kote, Booth #2 Hulls	7 hr. 42 min.	100	77	1	0.9	1,09	111
25C	Hull Lamination-Gen. area	6 hr. 35 min.	30	22	3	nd	0.36	--
24C	Hull Foaming-Gen. area	6 hr. 40 min.	39	60	1	nd	0,46	--
4C, 4B	Small Parts Lamination	7 hr. 26 min.	85	45	1	0,1	0.91	117
12C, 12B	" " "	7 hr. 33 min.	66	52	1	nd	0.73	112
20C, 20B	" " "	6 hr. 58 min.	71	34	4	nd	0.80	138
14C, 14B	Gel Kote, Booth #4,Small parts	7 hr. 10 min.	61	30	2	0,4	0,67	123
23C	Small Parts Lamination-Gen. Area	6 hr. 42 min.	54	27	1	nd	0.58	--
3C, 3B	Lamination-Mold Repair	7 hr. 48 min.	19	61	1	nd	0.26	121
8C, 26 B&C	" " "	7 hr. 16 min.	9	9	11	nd	0.25	124
16C, 16B	" " "	7 hr. 14 min.	108	84	2	nd	1.19	140
82	Stringer Foamer	3 hr. 25 min.	12	nd	1	nd	0.13	--
	Environmental Criteria		100	1000	75	200	1.00	--

TABLE 6 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO ORGANIC VAPORS--
CONTROL COHORT, REINELL BOATS, INC., APRIL 13, 1976

Sample No.	Activity Sampled	Time of Sample	Time Weighted Average Exposure in PPM						Combined Exposure	Medical Study Subject Number
			Styrene	Acetone	Methylene Chloride	MEK	Toluene	Xylene		
52, 72	Deck Assembly--Pregunwale	7 hr. 8 min.	7	7	nd	2	nd	nd	0.09	147
58,77	" " "	6 hr. 49 min.	14	14	nd	3	nd	nd	0.17	146
59,78	" " "	6 hr. 55 min.	nd	nd	nd	nd	nd	nd	0.00	144
60	Deck Assembly--Pregunwale Gen. area	7 hr. 20 min.	9	9	nd	3	nd	nd	0.11	--
61	Deck Assembly--Pregunwale Gen. area	7 hr. 18 min.	10	10	nd	3	nd	nd	0.13	--
50,70	Large Boat-Final Assembly	7 hr. 22 min.	62	81	nd	3	1	nd	0.73	151
51,71	" " " "	7 hr. 29 min.	nd	18	nd	<1	1	nd	0.03	154
63	Large Boat-Final Assembly -General Area	7 hr. 23 min.	nd	2	nd	<1	<1	nd	<0.02	--
62	Large Boat-Final Assembly -General Area	7 hr. 29 min.	nd	3	nd	<1	<1	nd	<0.02	--
56,75	Gunneler	7 hr. 23 min.	nd	3	nd	<1	1	nd	<0.02	158
53,73	Carpet Installer	6 hr. 57 min.	9	12	nd	11	nd	nd	0.16	157
57,76	Wood Shop	7 hr. 17 min.	nd	1	nd	<1	1	nd	<0.02	152
64,79	Fork Truck Driver	6 hr. 38 min.	nd	nd	nd	nd	nd	nd	0.00	160
55,74	Upholsterer	6 hr. 12 min.	nd	1	nd	<1	1	nd	<0.02	153
54	Lunch Room--Gen. Area	7 hr. 45 min.	3	3	nd	1	nd	nd	0.04	--
	Environmental Criteria		100	1000	75	200	100	100	1.00	

TABLE 6 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO ORGANIC VAPORS--
CONTROL COHORT, REINELL BOATS, INC., APRIL 13, 1976

Sample No.	Activity Sampled	Time of Sample	Time Weighted Average Exposure in PPM						Combined Exposure	Medical Study Subject Number
			Styrene	Acetone	Methylene Chloride	MEK	Toluene	Xylene		
52, 72	Deck Assembly--Pregunwale	7 hr. 8 min.	7	7	nd	2	nd	nd	0.09	147
58,77	" " "	6 hr. 49 min.	14	14	nd	3	nd	nd	0.17	146
59,78	" " "	6 hr. 55 min.	nd	nd	nd	nd	nd	nd	0.00	144
60	Deck Assembly--Pregunwale Gen. area	7 hr. 20 min.	9	9	nd	3	nd	nd	0.11	--
61	Deck Assembly--Pregunwale Gen. area	7 hr. 18 min.	10	10	nd	3	nd	nd	0.13	--
50,70	Large Boat-Final Assembly	7 hr. 22 min.	62	81	nd	3	1	nd	0.73	151
51,71	" " " "	7 hr. 29 min.	nd	18	nd	<1	1	nd	0.03	154
63	Large Boat-Final Assembly -General Area	7 hr. 23 min.	nd	2	nd	<1	<1	nd	<0.02	--
62	Large Boat-Final Assembly -General Area	7 hr. 29 min.	nd	3	nd	<1	<1	nd	<0.02	--
56,75	Gunneler	7 hr. 23 min.	nd	3	nd	<1	1	nd	<0.02	158
53,73	Carpet Installer	6 hr. 57 min.	9	12	nd	11	nd	nd	0.16	157
57,76	Wood Shop	7 hr. 17 min.	nd	1	nd	<1	1	nd	<0.02	152
64,79	Fork Truck Driver	6 hr. 38 min.	nd	nd	nd	nd	nd	nd	0.00	160
55,74	Upholsterer	6 hr. 12 min.	nd	1	nd	<1	1	nd	<0.02	153
54	Lunch Room--Gen. Area	7 hr. 45 min.	3	3	nd	1	nd	nd	0.04	--
	Environmental Criteria		100	1000	75	200	100	100	1.00	

TABLE 7 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO FREE ISOCYANATE-EXPOSED COHORT, REINELL BOATS, INC., APRIL 12, 1976

Sample No.	Activity Sampled	Time of Sample	Time-Weighted Average Exposure-mg/m^3 Methylene bisphenyl isocyanate (MDI)	Medical Study Subject Number
I-6, I-17	Deck Lamination	6 hr. 46 min.	nd	141
I-7, I-20	" "	6 hr. 44 min.	nd	139
I-8, I-18	" "	5 hr. 43 min.	nd	138
I-2, I-16	Stiffening & Foaming-Decks	7 hr. 15 min.	nd	129
I-100	Deck Lamination-Gen. Area	6 hr. 51 min.	nd	--
I-5, I-24	Hull Lamination	6 hr. 20 min.	nd	131
I-9, I-23	" "	5 hr. 29 min.	nd	133
I-10, I-15	" "	6 hr. 9 min.	nd	135
I-4, I-22	" "	6 hr. 41 min.	nd	132
I-1, I-13	Stiffening & Foaming Hulls	7 hr. 16 min.	nd	126
I-3, I-14	" " " "	6 hr. 55 min.	nd	136
I-102	Hull Lamination-Gen. Area	6 hr. 47 min.	nd	--
I-11, I-19	Lamination Mold Repair	5 hr. 26 min.	nd	124
I-12, I-21	" " "	4 hr. 56 min.	nd	123
I-101	Small Parts Lamination-General Area	6 hr. 55 min.	nd	--
	Environmental Criteria		0.200	

TABLE 8 - RESULTS OF PERSONAL SAMPLING FOR FREE ISOCYANATE-FOAMING OPERATIONS
REINELL BOATS, INC., APRIL 13, 1976

Sample No.	Activity Sampled	Time of Sample	Exposure to MDI mg/m^3	Remarks
I-207, I-216	Stringer Foamer Operator	7 hr. 6 min.	nd	Foamed, stringers for 5 boats, foamed flotation pocket in one boat
I-104	" " "	15 min.	nd	Foamed stringers for one small boat
I-105	" " "	15 min.	nd	Foamed flotation pocket for one boat
I-208	" " "	15 min.	nd	Foamed stringers for one boat
	Environmental Criteria		0.200	

TABLE 9 - RESULTS OF PERSONAL FOR EXPOSURE TO FREE ISOCYANATE-CONTROL COHORT
REINELL BOATS, INC., APRIL 13, 1976

Sample No.	Activity Sampled	Time of Sample	Time-Weighted Average Exposure-mg/m^3 Methylene bisphenyl isocyanate (MDI)	Medical Study Subject Number
I-203, I-217	Deck Assembly-Pregunwale	6 hr. 25 min.	nd	150
I-202, I-211	Upholsterer	7 hr. 10 min.	nd	159
I-204, I-213	Small Boat, Final Assembly	7 hr. 21 min.	nd	156
I-205, I-214	Large Boat, Final Assembly	7 hr. 38 min.	nd	155
I-206, I-215	Fork Truck Driver	7 hr. 40 min.	nd	160
I-201, I-210	Woodshop Worker	6 hr. 30 min.	nd	149
	Environmental Criteria		0.200	

TABLE 10 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO COBALT COMPOUNDS-
EXPOSED COHORT, REINELL BOATS, INC., APRIL 12, 1976

Sample No.	Activity Sampled	Time of Sample	Time Weighted Average Exposure Cobalt Compounds - mg/m^3	Medical Study Subject No.
AA1	Deck Lamination	6 hr. 14 min	nd	140
AA2	" "	6 hr. 15 min.	nd	119
AA10	Deck Lamination-General Area	6 hr. 52 min.	nd	--
AA7	Deck Lamination-Gel Kote Booth	6 hr. 38 min.	nd	113
AA4	Hull Lamination	6 hr. 5 min.	nd	134
AA5	Hull Lamination	6 hr. 4 min.	nd	130
AA6	Hull Lamination	6 hr. 8 min.	nd	111
AA11	Hull Lamination-Gen Ar.	6 hr. 49 min.	nd	--
AA12	Hull Lamination Foaming Sta. Gen.Area	6 hr. 47 min.	nd	--
AA8	Small Parts Lamination	5 hr. 52 min.	nd	117
AA3	Small Parts Lamination Stiffening Station	7 hr. 2 min.	nd	112
AA9	Small Parts Lamination-Gen. Area	6 hr. 55 min.	nd	--
AA13	Lamination-Mold Repair	5 hr. 34 min.	nd	121
	Environmental Criteria		0.1	

TABLE 11 - RESULTS OF PERSONAL AND AREA SAMPLING FOR EXPOSURE TO COBALT COMPOUNDS
CONTROL COHORT, REINELL BOATS, INC., APRIL 13, 1976

Sample No.	Activity Sampled	Time of Sample	Time-Weighted Average Exposure Cobalt Compounds-mg/m^3	Medical Study Subject No.
AA203	Deck Assembly-Pregunwale	7 hrs. 9 min.	nd	145
AA207	Deck Assembly-Pregunwale-General Area	6 hr. 53 min.	nd	--
AA204	Large Boat-Final Assembly	7 hr. 8 min.	nd	148
AA205	Large Boat-Final Assembly-Gen. Area	6 hr. 50 min.	nd	--
AA202	Upholsterer	8 hr. 7 min.	nd	143
AA 201	Woodshop	7 hr. 22 min.	nd	127
	Environmental Criteria		0.1	

TABLE 12
FORCED VITAL CAPACITY
LAMINATION AREAS
REINELL BOATS

SMOKERS				
	Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS	PERCENT PREDICTED	LITERS
121	123	(6.35)	121	(6.24)
136	98	(5.65)	98	(5.70)
119	105	(3.34)	112	(3.55)
111	92	(4.90)	90	(4.81)
117	128	(4.51)	126	(4.47)
140	100	(3.90)	95	(3.71)
126	103	(5.98)	103	(5.98)
132	95	(5.25)	97	(5.34)
135	109	(5.45)	108	(5.40)
141	61	(2.00)	71	(2.35)
MEAN	101	(4.73)	102	(4.75)

NON-SMOKERS				
	Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS	PERCENT PREDICTED	LITERS
131	101	(4.31)	111	(4.73)
124	108	(6.45)	106	(6.36)
134	108	(5.34)	113	(5.60)
113	103	(5.52)	100	(5.35)
112	133	(6.14)	130	(5.98)
130	102	(5.04)	102	(5.04)
123	108	(6.10)	107	(6.04)
129	113	(6.33)	108	(6.02)
133	113	(6.95)	111	(6.87)
139	90	(3.44)	102	(3.90)
138	113	(4.13)	114	(4.25)
MEAN	108	(5.43)	109	(5.47)

TABLE 13
FORCED VITAL CAPACITY
CONTROL AREAS
REINELL BOATS

SMOKERS					NON-SMOKERS				
	Pre-Shift		Post-Shift			Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS	PERCENT PREDICTED	LITERS	WORKER NUMBER	PERCENT PREDICTED	LITERS	PERCENT PREDICTED	LITERS
147	93	(5.60)	94	(5.70)	149	114	(5.90)	110	(5.70)
148	109	(6.45)	109	(6.45)	150	110	(5.70)	106	(5.51)
153	106	(5.46)	105	(5.40)	151	108	(6.04)	95	(5.30)
143	97	(5.52)	97	(5.55)	152	99	(4.46)	100	(4.50)
144	114	(3.85)	114	(3.85)	154	105	(5.84)	103	(5.76)
155	93	(5.76)	93	(5.76)	156	100	(5.37)	100	(5.37)
157	80	(4.55)	81	(4.65)	145	96	(3.50)	94	(3.42)
158	105	(4.30)	102	(4.20)	159	112	(3.72)	108	(3.60)
146	123	(3.80)	121	(3.74)	160	98	(4.95)	95	(4.80)
MEAN	102	(5.03)	102	(5.03)	MEAN	105	(5.05)	101	(4.88)

TABLE 14
FORCED EXPIRATORY VOLUME IN ONE SECOND
LAMINATION AREAS
REINELL BOATS

SMOKERS

WORKER NUMBER	Pre-Shift PERCENT PREDICTED	Pre-Shift LITERS IN ONE SECOND	Post-Shift PERCENT PREDICTED	Post-Shift LITERS IN ONE SECOND
121	124	(5.40)	121	(6.24)
136	91	(4.50)	98	(5.70)
119	86	(2.20)	82	(2.10)
111	99	(4.52)	96	(4.40)
117	115	(3.42)	108	(3.24)
140	88	(2.94)	82	(2.71)
126	113	(5.61)	113	(5.61)
132	98	(4.60)	99	(4.66)
135	107	(4.50)	108	(4.52)
141	45	(1.22)	49	(1.33)
MEAN	97	(3.89)	96	(4.05)

NON-SMOKERS

WORKER NUMBER	Pre-Shift PERCENT PREDICTED	Pre-Shift LITERS IN ONE SECOND	Post-Shift PERCENT PREDICTED	Post-Shift LITERS IN ONE SECOND
131	101	(3.32)	109	(3.60)
124	105	(5.26)	103	(5.17)
134	112	(4.78)	116	(4.96)
113	106	(4.68)	102	(4.53)
112	131	(5.02)	130	(5.00)
130	97	(4.10)	100	(4.26)
123	105	(5.12)	114	(5.52)
129	105	(5.07)	103	(4.96)
133	120	(6.35)	118	(6.23)
139	92	(3.02)	106	(3.46)
138	99	(3.04)	102	(3.13)
MEAN	107	(4.52)	109	(4.62)

TABLE 15
FORCED EXPIRATORY VOLUME IN ONE SECOND
CONTROL AREAS
REINELL BOATS

SMOKERS

WORKER NUMBER	Pre-Shift PERCENT PREDICTED	Pre-Shift LITERS IN ONE SECOND	Post-Shift PERCENT PREDICTED	Post-Shift LITERS IN ONE SECOND
147	103	(5.16)	101	(5.06)
148	104	(5.23)	112	(5.63)
153	105	(4.62)	102	(4.50)
143	100	(4.77)	102	(4.85)
144	105	(3.04)	95	(2.76)
155	94	(4.96)	97	(5.12)
157	83	(4.03)	86	(4.16)
158	104	(3.65)	101	(3.54)
146	119	(3.01)	117	(2.95)
MEAN	102	(4.27)	101	(4.29)

NON-SMOKERS

WORKER NUMBER	Pre-Shift PERCENT PREDICTED	Pre-Shift LITERS IN ONE SECOND	Post-Shift PERCENT PREDICTED	Post-Shift LITERS IN ONE SECOND
149	118	(4.73)	104	(4.17)
150	117	(5.08)	114	(4.96)
151	108	(5.17)	101	(4.82)
152	91	(3.40)	98	(3.64)
154	105	(5.00)	107	(5.14)
156	93	(4.32)	92	(4.24)
145	99	(3.10)	103	(3.22)
159	111	(3.18)	110	(3.08)
160	102	(4.51)	100	(4.41)
MEAN	105	(4.28)	103	(4.19)

TABLE 16
MAXIMAL MID EXPIRATORY FLOW RATE
LAMINATION AREAS
REINELL BOATS

SMOKERS					NON-SMOKERS				
	Pre-Shift		Post-Shift			Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75	WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75
121	124	(5.93)	120	(5.78)	131	72	(2.45)	83	(2.81)
136	76	(4.30)	75	(4.24)	124	91	(5.07)	86	(4.82)
119	47	(1.29)	33	(0.91)	134	118	(5.73)	125	(6.06)
111	135	(7.16)	129	(6.72)	113	109	(5.36)	108	(5.33)
117	86	(2.76)	72	(2.31)	112	115	(5.02)	120	(5.23)
140	66	(2.34)	59	(2.08)	130	78	(3.74)	85	(4.08)
126	124	(7.05)	116	(6.61)	123	106	(5.95)	106	(5.98)
132	102	(5.45)	101	(5.40)	129	82	(4.56)	86	(4.59)
135	88	(4.19)	95	(4.52)	133	147	(8.82)	145	(8.70)
141	19	(0.55)	20	(0.57)*	139	102	(3.54)	130	(4.52)
MEAN	94	(4.50)	89	(4.29)	138	66	(2.07)	71	(2.23)
					MEAN	99	(4.76)	104	(4.94)

*Worker not included because of severe respiratory disease non work related.

TABLE 17
MAXIMAL MID EXPIRATORY FLOW RATE
CONTROL AREAS
REINELL BOATS

SMOKERS					NON-SMOKERS				
	Pre-Shift		Post-Shift			Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75	WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75
147	118	(6.50)	102	(5.62)	149	103	(4.35)	85	(3.58)
148	116	(6.61)	121	(6.88)	150	113	(5.56)	116	(5.45)
153	95	(4.84)	91	(4.62)	151	108	(5.84)	111	(6.00)
143	99	(5.24)	111	(5.89)	152	72	(2.97)	77	(3.20)
144	83	(2.75)	72	(2.36)	154	108	(5.45)	108	(5.89)
155	92	(5.51)	101	(6.06)	156	76	(4.08)	73	(3.91)
157	94	(5.18)	97	(5.12)	145	111	(3.74)	114	(3.85)
158	110	(4.42)	104	(4.15)	159	124	(3.80)	118	(3.61)
146	99	(2.81)	92	(2.60)	160	134	(6.83)	126	(6.44)
MEAN	101	(4.87)	99	(4.81)	MEAN	105	(4.74)	103	(4.66)

TABLE 17
MAXIMAL MID EXPIRATORY FLOW RATE
CONTROL AREAS
REINELL BOATS

SMOKERS				
	Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75
147	118	(6.50)	102	(5.62)
148	116	(6.61)	121	(6.88)
153	95	(4.84)	91	(4.62)
143	99	(5.24)	111	(5.89)
144	83	(2.75)	72	(2.36)
155	92	(5.51)	101	(6.06)
157	94	(5.18)	97	(5.12)
158	110	(4.42)	104	(4.15)
146	99	(2.81)	92	(2.60)
MEAN	101	(4.87)	99	(4.81)

NON-SMOKERS				
	Pre-Shift		Post-Shift	
WORKER NUMBER	PERCENT PREDICTED	LITERS 0.25-0.75	PERCENT PREDICTED	LITERS 0.25-0.75
149	103	(4.35)	85	(3.58)
150	113	(5.56)	116	(5.45)
151	108	(5.84)	111	(6.00)
152	72	(2.97)	77	(3.20)
154	108	(5.45)	108	(5.89)
156	76	(4.08)	73	(3.91)
145	111	(3.74)	114	(3.85)
159	124	(3.80)	118	(3.61)
160	134	(6.83)	126	(6.44)
MEAN	105	(4.74)	103	(4.66)

TABLE 18
LAMINATION AREAS
COMPLETE BLOOD COUNT, THYROXINE (T_4), THYROID STIMULATING HORMONE (TSH)
REINELL BOATS

WORKER NUMBER	Hct	Hgb	RBC (Million)	WBC (Thousand)	LYMPHS %	EOS %	SEGS %	STAB % MONO*	BASO %	MCV MICRONS	MCH MICRO-MICRO GM	MCHC %	PLATLETS	T_4 Mcg/dl	TSH MICRO-UNITS/ml
1	55.7	17.4	5.60	8.6	29	6	65	0	0	100	30.8	31.0	Adequate	4.6	6.0
2	49.8	16.0	5.50	6.1	46	8	46	0	0	91	28.7	32.1	Adequate	9.2	3.1
3	48.8	15.4	5.45	7.8	29	4	65	2*	0	90	27.9	31.5	Adequate	12.0	3.5
4	54.0	17.0	6.08	7.3	54	3	41	2*	0	89	27.7	31.3	Adequate	11.0	3.5
5	48.6	15.3	5.12	8.4	-	-	-	-	-	95	29.7	31.3	-	11.5	5.2
6	47.3	15.1	5.28	6.6	-	-	-	-	-	90	28.6	31.7	-	6.0	2.0
7	48.7	15.5	5.38	5.4	-	-	-	-	-	91	28.8	31.6	-	6.2	2.2
8	48.3	15.5	5.20	10.9	-	-	-	-	-	93	29.8	32.0	-	7.6	2.4
9	48.3	15.1	4.94	11.5	54	2	42	0	2	98	30.1	31.1	Adequate	8.4	2.8
10	50.5	16.0	5.50	7.1	26	2	72	0	0	92	28.8	31.7	Adequate	9.4	3.9
11	51.8	16.0	5.61	7.5	54	0	44	2*	0	93	28.3	30.7	Adequate	6.5	6.0
12	48.6	15.7	5.44	6.6	36	0	62	0	2	90	28.5	32.2	Adequate	7.4	3.5
13	47.4	13.9	5.73	7.4	-	-	-	-	-	83	24.3	28.7	-	10.5	3.7
14	49.6	15.7	5.26	6.7	-	-	-	-	-	95	29.8	31.4	-	5.0	2.5
15	50.1	16.2	5.29	7.0	-	-	-	-	-	95	30.7	32.2	-	6.0	2.0
16	49.6	16.0	5.22	10.9	-	-	-	-	-	95	30.6	32.0	-	5.0	3.2
17	52.6	16.3	5.49	7.9	45	0	54	1*	0	96	29.4	30.8	Adequate	7.2	7.2
18	49.3	15.4	5.21	8.3	48	4	48	0	0	95	29.2	31.1	Adequate	5.6	5.4
19	48.8	15.3	5.41	6.7	28	0	71	1*	0	91	27.9	31.2	Adequate	7.4	4.4
20	46.0	14.2	4.75	10.7	24	2	74	0	0	97	29.4	30.7	Adequate	9.8	3.5
21	44.0	13.7	5.05	7.0	28	9	63	0	0	87	26.7	31.2	Adequate	14.5	7.2
28	47.3	15.0	5.02	7.1	40	2	54	4*	0	95	29.6	31.8	Adequate	9.4	5.0
MEAN	49.3	15.5	5.34	7.9						92.8	28.9	31.3		8.2	4.0
STD DEV	2.55	0.9	.29	1.7						3.9	1.4	.8		2.6	1.6

TABLE 19
CONTROL AREAS
COMPLETE BLOOD COUNT, THYROXINE (T_4), THYROID STIMULATING HORMONE (TSH)
REINELL BOATS

WORKER NUMBER	Hct	Hgb	RBC (Million)	WBC (Thousand)	LYMPHS %	EOS %	SEGS %	STAB % MONO*	BASO %	MCV MICRONS	MCH MICRO-MICRO GM	MCHC %	PLATLETS	T_4 Mcg/dl	TSH MICRO-UNITS/ml
101	50.5	16.1	5.40	8.1	28	2	70	0	0	94	29.5	31.7	Adequate	9.4	5.0
102	47.4	15.0	5.02	10.1	26	8	66	0	0	95	29.5	31.4	Adequate	7.0	3.1
103	45.2	13.8	5.11	7.8	40	1	58	0	1	89	26.7	30.6	Adequate	7.2	14.0
104	48.9	15.7	5.41	7.1	24	0	74	2*	0	91	28.7	31.9	Adequate	6.8	5.4
105	49.4	15.7	4.62	5.8	46	2	52	0	0	107	33.5	31.6	Adequate	5.4	2.8
106	45.6	15.3	5.05	6.5	38	0	62	0	0	91	29.9	33.5	Adequate	7.4	4.4
107	52.4	17.0	5.85	5.4	31	0	64	2*	3	90	28.9	32.4	Adequate	6.0	8.0
108	48.5	15.5	5.02	9.9	16	2	82	0	0	97	30.6	31.9	Adequate	9.6	4.4
109	45.0	14.3	4.84	6.2	31	7	60	2*	0	93	29.1	31.8	Adequate	6.6	8.0
110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
112	49.0	15.1	5.32	6.2	16	2	78	2*	2	89	28.1	32.1	Adequate	8.8	5.0
113	45.9	14.4	4.64	12.0	18	0	80	2*	0	99	30.7	31.4	Adequate	8.4	3.9
114	51.6	16.6	5.96	9.4	50	2	46	2*	0	87	29.6	32.0	Adequate	6.8	3.9
115	46.3	15.0	5.08	6.0	22	2	74	2*	0	92	29.2	32.5	Adequate	7.4	3.9
116	48.7	15.8	5.06	12.2	22	0	77	1*	0	97	30.9	32.3	Adequate	7.8	2.8
117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
118	51.1	16.3	5.29	7.6	44	0	55	1*	0	97	30.4	31.7	Adequate	6.4	3.5
119	45.8	14.3	5.07	11.8	26	2	70	0	2	91	27.8	31.1	Adequate	13.5	5.4
120	52.4	16.4	5.33	7.7	28	2	70	0	0	99	30.4	31.1	Adequate	8.4	40.0
121	38.9	12.2	4.19	7.8	34	0	66	0	0	93	28.7	31.6	Adequate	7.2	2.8
122	46.0	15.2	5.20	5.6	44	2	54	0	0	89	28.9	33.1	Adequate	7.4	4.4
MEAN	47.7	15.2	5.13	8.1						93.7	29.4	31.9		7.8	6.9
STD DEV	3.3	1.1	.41	2.2						4.8	1.5	.7		1.8	8.4

TABLE 20
LAMINATION AREAS
SERUM MULTIPHASIC ANALYSIS-21
REINELL BOATS

WORKER NUMBER	GLUC mg/dl	BUN mg/dl	CREAT mg/dl	Na+ meq/l	K+ meq/l	CL- meq/l	CO_2 meq/l	URIC ACID mg/dl	TOTAL PROT g/dl	ALBUM g/dl	GLOB g/dl	A/G	Ca mg/dl	P mg/dl	CHOL mg/dl	TRIG mg/dl	ALK PHOS u/l	SGOT u/l	SGPT u/l	LDH u/l	BILI mg/dl
1	108	15	1.0	141	4.6	101	25	6.3	7.0	4.5	2.50	1.80	10.3	3.4	172	100	62	20	25	158	0.4
2	130	10	0.9	140	4.0	97	26	5.7	7.4	4.3	3.10	1.39	10.2	3.5	159	155	67	19	19	162	0.3
3	83	24	1.0	142	3.9	104	23	5.2	6.6	3.8	2.80	1.36	9.5	2.7	161	186	87	22	25	198	0.2
4	143	14	1.1	140	4.0	100	23	8.4	7.2	4.2	3.00	1.40	10.2	3.5	225	360	125	18	27	156	0.5
5	100	16	0.9	137	4.7	102	23	5.7	7.0	4.3	2.70	1.57	10.1	3.1	236	146	73	25	13	199	0.5
6	120	12	1.1	137	4.4	101	25	7.2	7.0	4.1	2.90	1.41	10.0	3.2	182	161	76	27	34	166	0.4
7	83	15	1.1	139	3.9	103	25	6.6	6.2	3.9	2.30	1.70	9.4	2.4	142	267	66	20	17	136	0.4
8	92	13	1.0	138	4.2	102	24	5.5	6.7	4.1	2.60	1.58	9.6	3.0	194	260	49	30	47	214	0.4
9	100	11	1.1	137	4.5	101	18	5.6	7.0	4.1	2.90	1.41	9.0	2.7	144	119	44	21	12	117	0.3
10	82	16	1.1	138	4.4	98	25	5.6	7.3	4.1	3.20	1.28	10.4	3.1	182	157	85	22	13	158	0.6
11	94	13	1.3	140	4.3	97	26	5.3	7.5	4.6	2.90	1.59	10.1	3.0	234	102	57	35	23	156	0.4
12	55	20	0.9	140	3.9	98	27	5.3	7.3	4.4	2.90	1.52	10.7	3.1	148	74	67	25	16	160	0.5
13	115	8	1.0	136	4.0	103	18	6.1	6.9	3.8	3.10	1.23	9.5	3.2	199	234	96	21	17	140	0.4
14	91	18	1.1	138	4.4	100	26	5.6	7.0	4.3	2.70	1.59	9.8	3.3	207	103	51	23	21	152	0.4
15	86	15	1.0	140	3.8	102	25	6.0	7.2	4.4	2.80	1.57	10.0	2.6	181	163	71	24	29	164	0.8
16	110	15	1.1	137	4.1	101	23	5.7	7.1	4.2	2.90	1.45	9.9	2.8	212	321	83	33	55	131	0.2
17	81	12	1.0	140	4.2	97	24	6.8	7.7	4.6	3.10	1.48	9.6	2.7	212	112	117	25	31	185	1.3
18	97	12	1.0	138	4.5	102	22	5.1	7.2	4.3	2.90	1.48	9.8	3.0	232	188	61	19	22	138	0.2
19	109	19	0.9	140	4.0	95	28	6.1	7.7	4.5	3.20	1.41	10.1	3.7	199	68	84	17	20	184	0.4
20	78	12	0.9	140	4.7	102	22	3.9	6.5	3.9	2.60	1.50	9.4	4.1	148	78	46	10	11	144	0.2
21	114	16	0.7	140	4.2	98	26	4.3	7.1	4.0	3.10	1.29	9.7	3.2	177	168	127	9	15	80	2.2
28	74	11	1.0	141	4.5	100	26	6.3	6.7	4.1	2.60	1.58	9.9	3.3	178	437	97	28	35	167	0.4
MEAN	97.5	14.4	1.0	139	4.2	100	24	5.8	7.1	4.2	2.8	1.48	9.8	3.1	187	180	77	22	24	158	0.4
STD DEV	20	3.6	0.1	1.6	0.3	2.4	2.5	0.9	0.4	0.2	0.2	0.14	0.4	0.4	30	97	24	6	11	29	0.2

TABLE 21
CONTROL AREAS
SERUM MULTIPHASIC ANALYSIS-21
REINELL BOATS

WORKER NUMBER	GLUC mg/dl	BUN mg/dl	CREAT mg/dl	Na+ meq/l	K+ meq/l	CL- meq/l	CO_2 meq/l	URIC ACID mg/dl	TOTAL PROT g/dl	ALBUM g/dl	GLOB g/dl	A/G	Ca mg/dl	P mg/dl	CHOL mg/dl	TRIG mg/dl	ALK PHOS u/l	SGOT u/l	SGPT u/l	LDH u/l	BILI mg/dl
101	93	12	1.2	139	5.3	100	24	4.9	6.5	4.3	2.20	1.95	11.0	3.4	146	92	78	21	14	128	0.3
102	384	19	0.9	135	5.0	95	26	2.9	6.8	4.1	2.70	1.52	9.4	4.1	149	241	144	21	22	156	0.3
103	98	21	1.2	141	3.3	100	24	7.0	6.9	3.9	3.00	1.30	9.5	1.8	161	279	86	22	15	207	0.3
104	106	11	1.1	140	3.7	99	27	3.7	6.3	3.7	2.60	1.42	9.5	2.3	139	128	86	23	16	169	0.5
105	94	14	0.8	137	4.3	98	23	6.3	7.0	4.2	2.80	1.50	9.6	3.3	180	84	85	24	19	203	0.5
106	58	17	1.0	142	4.1	100	25	5.8	7.3	4.2	3.10	1.35	9.7	3.5	144	272	72	25	21	201	0.7
107	90	12	1.1	138	4.0	95	25	6.1	7.8	4.4	3.40	1.21	9.9	2.4	221	630	101	31	62	156	0.5
108	92	13	0.9	141	4.3	99	24	7.7	7.0	4.5	2.50	1.80	10.3	3.1	211	255	95	42	58	183	0.4
109	84	12	1.0	136	4.6	101	21	4.0	6.8	3.8	3.00	1.27	9.9	2.9	175	50	46	19	8	129	0.3
110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
112	90	15	1.0	141	4.3	101	25	4.9	7.2	4.1	3.10	1.32	9.5	3.9	153	100	71	19	17	137	0.3
113	82	6	0.7	138	3.8	99	21	3.2	7.0	4.3	2.70	1.59	9.6	3.7	134	75	90	19	11	153	0.3
114	94	14	1.1	141	4.4	102	22	4.1	6.7	4.1	2.60	1.58	10.4	3.0	141	89	77	20	16	147	0.4
115	141	11	0.9	138	4.2	98	23	5.6	7.1	4.3	2.80	1.54	9.5	2.3	169	115	86	19	13	160	0.5
116	80	10	1.0	141	3.9	100	26	5.6	7.0	4.5	2.50	1.80	9.4	2.6	148	136	76	20	10	205	0.6
117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
118	97	11	0.9	140	4.2	99	24	4.9	7.1	4.3	2.80	1.54	9.6	2.9	195	131	66	25	22	141	0.5
119	89	12	0.9	139	4.6	100	22	5.0	7.1	4.0	3.10	1.29	10.1	2.4	169	114	55	23	19	178	0.3
120	88	14	0.9	138	4.8	99	24	4.2	7.2	4.0	3.20	1.25	9.7	3.1	220	88	64	11	10	156	0.4
121	91	9	0.7	139	4.5	100	26	3.7	6.8	4.0	2.80	1.43	9.9	3.7	169	61	73	13	16	147	0.3
122	68	17	1.0	139	4.2	101	25	5.7	6.9	3.9	3.00	1.30	9.4	3.7	118	93	80	23	25	168	0.3
MEAN	106	13	1.0	139	4.3	99	24	5.0	7.0	4.1	2.8	1.48	9.8	3.1	165	159	81	22	21	164	0.4
STD DEV	69	4	0.1	2	0.5	1.8	1.7	1.3	0.3	0.2	0.3	0.2	0.4	0.6	29	135	20	6.5	14	25	0.1

TABLE 22
HIGH EXPOSURE POPULATION
DATA TABLE
REINELL BOATS

NUMBER

Male	16	Average Age	28.7
Female	6	Average Age	35.2

Work Related Complaints - 22 of 22 - 100%

SYMPTOMS BY HISTORY		Percent
Sore or Dry Throat	10 of 22	45
Burning or Tearing Eyes	21 of 22	95
Nasal Congestion	18 of 22	82
Cough	5 of 22	23
Chest Tightness	5 of 22	23
Wheezing	4 of 22	18
Shortness of Breath	12 of 22	54
Nausea & Vomiting	0 of 22	0
Weight Loss	0 of 22	0
Muscle Weakness	1 of 22	4
Fatigue	8 of 22	36
Headache	3 of 22	14
Smokers	10 of 22	45
Past Smokers	4 of 22	18
Non-Smokers	8 of 22	36

PHYSICAL EXAMINATION		
Skin Rash	3 of 22	14
Conjunctival Erythema	9 of 22	41
Nasal Erythema	19 of 22	86
Mouth & Throat Erythema	10 of 22	45
Neck (Thyroid Abnormal Size)	3 of 22	14
Lungs (Wheezes, Rales)	2 of 22	9
Heart	1 of 22	4

TABLE 23
CONTROL POPULATION
DATA TABLE
REINELL BOATS

NUMBER

Male	13	Average Age	29.6
Female	6	Average Age	34.0
Work Related Complaints		12 of 22	- 54%
A) Skin Rash Only		7 of 12 in past	
B) Back Strain		2 of 12 in past	
C) Symptoms while in lamination Worker now in different area		1 of 12	

SYMPTOMS BY HISTORY		Percent
Sore or Dry Throat	5 of 19	26
Burning or Tearing of Eyes	7 of 19	37
Nasal Congestion	7 of 19	37
Cough	4 of 19	21
Chest Tightness	3 of 19	16
Wheezing	1 of 19	5
Shortness of Breath	2 of 19	11
Nausea & Vomiting	0 of 19	0
Weight Loss	0 of 19	0
Muscle Weakness	1 of 19	5
Fatigue	1 of 19	5
Headache	1 of 19	5
Smokers	10 of 19	53
Past Smokers	3 of 19	21
Non-Smokers	6 of 19	32

PHYSICAL EXAMINATION		
Skin Rash	0 of 19	0
Conjunctival Erythema	1 of 19	5
Nasal Erythema	12 of 19	63
Mouth & Throat Erythema	6 of 19	32
Neck (Thyroid Abnormal Size)	1 of 19	5
Lungs (Wheezes, Rales)	0 of 19	0
Heart	0 of 19	0

APPENDIX A

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
522 POST OFFICE BUILDING
CINCINNATI, OHIO 45202

CONSENT

I voluntarily agree to participate in a study at the Reinell Boat Company, Poplar Bluff, Missouri, conducted by the U.S. Public Health Service. I understand that the medical evaluation will consist of my answering questions about my health, a physical examination, if deemed necessary by the examining physician, and any other tests that may be required to carry out this evaluation.

I understand that my participation in this study is voluntary and that all information obtained will be considered confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1).

DATE_____ SIGNATURE_____

AUTHORITY TO GIVE MEDICAL REPORT

I agree to allow the Public Health Service to inform:

A. My personal physician

Name_____

Address_____ _____
Signature

City_____

B. Plant Physician

Address_____ _____
Signature

City_____

of any significant results of this study.

Information obtained in this study will be kept confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1).

(2/6/76)

QUESTIONNAIRE #1 STUDY_____

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

1. Name_____
Last First Middle

2. Current Address: (Number, Street or Rural Route, City or Town, County, State, Zip Code)

_____

_____

_____

3. Phone Number _____

4. Social Security Number _____

5. Birthday (Month, Day, Year) _____

6. Age Last Birthday _____

7. Sex: Male_____ Female_____

8. Race: Black_____ White_____ Other_____

How long have you been employed at Reinell Boats? _____

OCCUPATIONAL HISTORY TABLE

Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment (6 months or less) should be omitted.

Employer & Location	Tenure of Employment From Mo./Yr.	To Mo./Yr.	Specific Occupation or Job Title	No. of Years on Job

9. Do you have or have you had in the past any health complaints or problems which you feel may be related to your work at this plant?

Yes____ No____

a) If yes, what are they? _____

_____

_____

_____

_____

b) To what are they related and why? _____

_____

_____

c) When do they occur? _____

_____

d) Do the symptoms diminish after you leave work for the day or over the weekend when you are off?

_____

_____

e) Have you seen a physician about the problem?

Yes____ No____

Details_____

_____

_____

REQUEST AND AUTHORIZATION FOR RELEASE OF MEDICAL INFORMATION

I, _____, hereby request and
(Patient Name)

Authorize _____
(Personal and/or Company Physician)

_____
(Address)

to release to the National Institute for Occupational Safety and Health (NIOSH) such of my medical records as are requested by NIOSH as a part of Health Hazard Evaluation Number 75-150.

_____
Signature of Worker

_____
Date

_____
Witness

10. Do you have any other health complaints or problems which do not seem related to your work? Yes _____ No _____ If "yes":

    a. What? when? etc. _____

    _____

    _____

11. Have you ever had? (✓ or 0)

    a. Chest or lung problems: _____
    b. Heart problems _____
    c. Pneumonia _____
    d. Pulmonary TB _____
    e. Bronchial asthma _____
    f. Skin rash or other skin problems _____
    g. Gastrointestinal problems _____
    h. Kidney or bladder problems _____
    i. Neurological problems _____

    (Expound on any (+) findings): _____

    _____

12. Do you have any present problems for which you are seeing a doctor? Yes _____ No _____ If "yes", what are they? _____

    _____

    _____

13. Are you presently taking any medication? Yes _____ No _____

    If yes, what medication? _____

    _____

14. Do you have or have you had any allergies in the past? Yes ___ No _

    If yes, what are they? _____

    _____

    If present or past, did you have this before working in the plant?

    Yes _____ No _____

15. Have you ever had to change jobs in this plant because of health reas
    Yes _____ No _____ If yes, why and when? _____

    _____

16. Have you ever had any of the following problems

PROBLEMS RELATED TO YOUR WORK	NO	SOMETIMES	USUALLY	RELATED TO WHAT	TIME	DURATION
1. Dry or sore throat						
2. Burning or itching eyes						
3. Tearing of the eyes						
4. Stuffy nose						
5. Runny nose						
6. Coughing						
7. Chest tightness, soreness, or heaviness						
8. Wheezing or whistling in your chest						
9. Shortness of breath						
10. Burning on urination						
11. Nausea and/or vomiting						
12. Weight loss						
13. Muscle weakness						
14. Loss of consciousness						

SMOKING HISTORY

17. Are you presently:

a. a cigarette smoker? Yes___ No___ How Much_____ How Long_____

b. a cigar smoker? Yes___ No___ How Much_____ How Long_____

c. a pipe smoker? Yes___ No___ How Much_____ How Long_____

18. Were you ever:

a. a cigarette smoker? Yes___ No___ How Much_____ How Long_____

b. a cigar smoker? Yes___ No___ How Much_____ How Long_____

c. a pipe smoker? Yes___ No___ How Much_____ How Long_____