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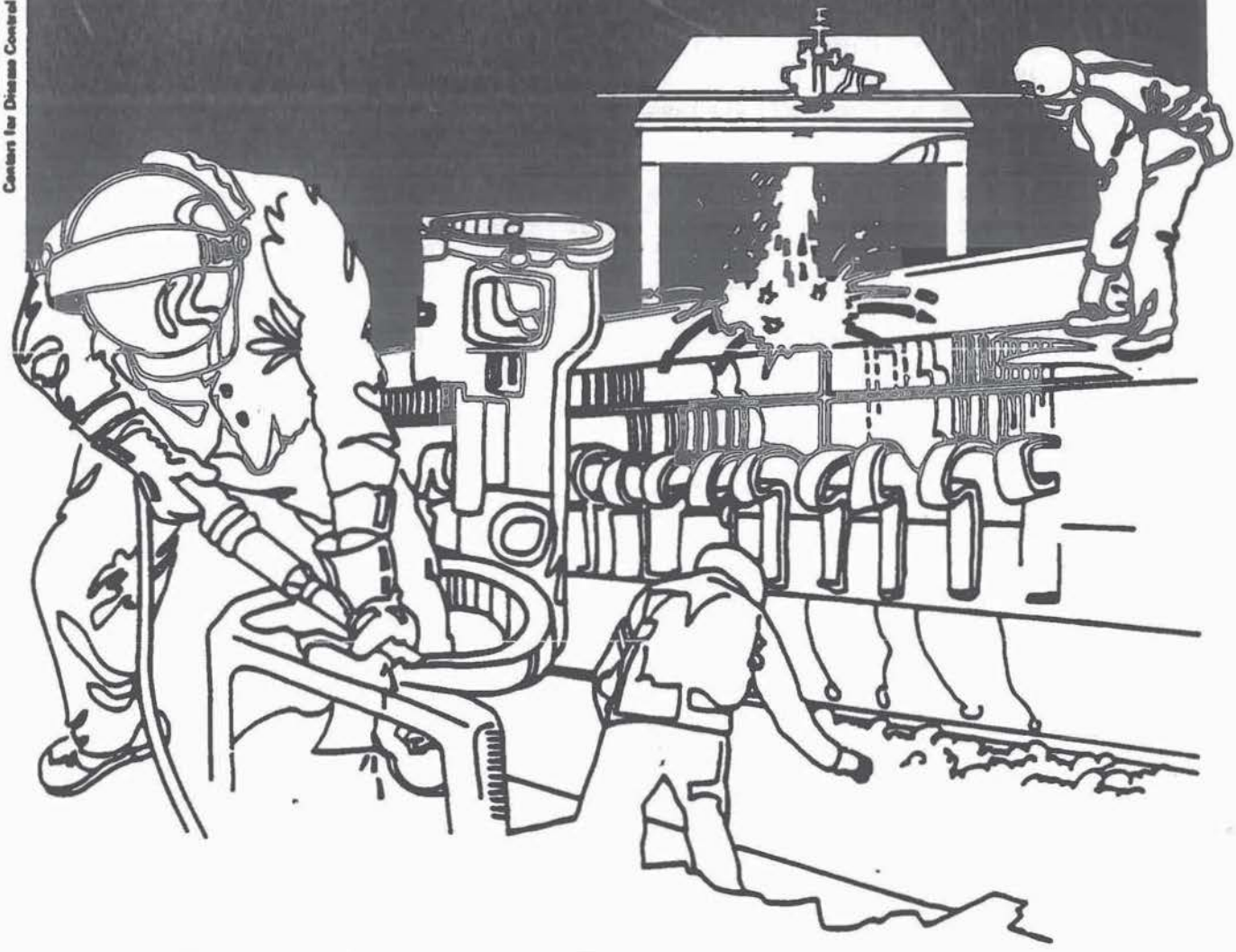

Health Hazard Evaluation Report

HETA 83-270-1656
LAMINATING CORPORATION OF AMERICA
EATONTOWN, NEW JERSEY

PREFACE

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

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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LAMINATING CORPORATION OF AMERICA
EATONTOWN, NEW JERSEY

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I. SUMMARY

In May 1983 the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation at the Laminating Corporation of America in Eatontown, New Jersey. The company produces numerous paper and vinyl wall coverings, and the request focused on possible adverse health effects from solvent and lead exposure.

Staff from the Occupational Health Program of the New Jersey State Department of Health conducted the evaluation under a cooperative agreement with NIOSH. Walkthrough investigations were conducted in January and July 1984 and exposure and medical evaluations were conducted on July 17-19, 1984. At the time of the investigation lead was no longer being used in the workplace; thus the evaluation focused solely on solvent exposure.

Environmental sampling for methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, acetone, and toluene yielded results below OSHA (Occupational Safety and Health Administration) Permissible Exposure Limits (PEL) and NIOSH recommended limits for these individual solvents as well as for mixed solvent exposure. Previous sampling for regulatory purposes by OSHA had shown exposure levels in excess of the OSHA PEL for mixed solvent exposure.

Biologic monitoring for methyl ethyl ketone showed average post-shift blood levels of 1.44 ppm in exposed workers, with undetectable pre-shift levels in all but one of these employees, thus indicating that employees were absorbing solvent during the workday.

Observation of work practices and engineering controls indicated potential for skin absorption of solvent and revealed areas where improved local ventilation might reduce airborne solvent exposure.

Medical evaluation consisted of a questionnaire and physical examination designed to elicit acute and chronic effects of solvent exposure primarily on the nervous system, kidneys and liver.

Nine of 25 exposed workers reported symptoms related to problems of the peripheral nervous system, as opposed to one of seven unexposed workers. These symptoms included pain, numbness, weakness, cramps, numbness and burning of arms or legs. Three of the nine symptomatic exposed workers also had abnormalities of the peripheral nervous system on physical examination (decreased sensation in arms and/or legs), while the exams of all unexposed workers were normal. One of the three symptomatic workers had abnormal nerve conduction results, indicating the presence of peripheral nervous system

disease.

Symptoms of chronic solvent intoxication, such as decreased memory and concentration, fatigue, irritability, and depression, were found in 16 of the 25 exposed employees versus two of the seven controls. Symptoms suggesting acute solvent intoxication, including dizziness, nausea, headache and blurred vision, were present in 10 of the 25 exposed workers as compared with one of the seven controls.

These results suggest the possibility of both acute and chronic adverse effects of solvent exposure among exposed workers. Such effects have been reported with exposure levels comparable to those found at Laminating Corporation. In this investigation, the apparent excess in number and extent of symptoms could not be adequately explained by pre-existing disease, alcohol or drug use, or age. The symptomatology did not appear to be related to exposure duration or environmental or biologic monitoring results.

The results of the environmental and medical evaluations suggest that a health hazard from mixed solvent exposure exists at Laminating Corporation. Recommendations for a medical monitoring program, providing periodic examination of all exposed employees, as well as suggestions for improved work practices and engineering controls are found in Section VII of this report.

Key Words: SIC Code 2649, Converted Paper and Paperboard Products, NEC; solvents; neurotoxicity; peripheral neuropathy.

II. INTRODUCTION

NIOSH received a request for a Health Hazard Evaluation (HHE) of conditions at the Laminating Corporation of America in Eatontown, New Jersey, from the Amalgamated Clothing and Textile Workers Union, which represents workers at the plant. The request, dated May 4, 1983, was assigned to the New Jersey Department of Health (NJDOH) under their Cooperative Agreement with NIOSH. The request concerned exposure to solvents, including methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK) and toluene. In addition, there was concern about exposure to lead pigments.

The investigation included a site visit and walkthrough on January 19 and July 12, 1984, and an industrial hygiene and medical evaluation on July 17-19, 1984.

III. BACKGROUND

Laminating Corporation produces numerous paper and vinyl wall coverings. The major product is PVC sheeting laminated with a water or plastisol (vinyl) based adhesive. The process involves two primary areas: printing and laminating.

The printing department includes seven presses using from one to four colors at a time. Each press is run and monitored by approximately four employees--a printer, a helper, a middleman and a backtender. Inks are applied automatically to rollers at the front end of the press from open trays, which are filled by the press operators. After the ink is applied, the sheeting moves through a vented drying oven which drives off the solvent. When more than one color is used, the process is repeated until all colors have been applied and dried.

Potential exposures in the printing process consist primarily of those solvents used to carry the inks and to clean the presses between runs. The main solvents used in this process are MEK and MIBK. Cyclohexanone is used in smaller quantities for particular products.

Adjacent to the printing department is the mixing room, where batchmakers and colormatchers prepare the inks. Approximately 150 drums of inks are located in this room. Batchmakers ladle inks from the drums to make up the required batches. The room is ventilated with supplied air along one wall and exhaust ducts along the floor of the opposite wall.

At the other end of the printing department is the laminating department, which consists of three presses. Rolled polyvinyl chloride sheeting is mounted on one end of the press. An adhesive is applied to the sheet and a layer of paper or cloth sheeting is joined with it. The two sheets are then pressed by steam-heated rollers to form the laminate product. Operators on this process monitor the

presses, supply rolls of sheet materials as needed, and keep the adhesive supply tray filled.

Chemicals used at Laminating Corporation include the inks, printing resins (or clears) and the laminating adhesives along with the solvents used to thin the inks, and to clean the printing presses. Printing is done with a mixture of the inks, which include the pigments, and clears, which contain large amounts of MEK, MIBK and smaller amounts of toluene, acetone and xylene. These solvents constitute the primary exposures throughout the plant. The laminating adhesives are primarily water based and contain little or no volatile materials.

OSHA has conducted two inspections of the Laminating Corporation plant, the first in late 1982 and the second in February 1984. Both inspections resulted in citations for overexposure to mixed solvents including MEK, MIBK, toluene and acetone. The first inspection cited exposures at 1.28 and 1.34 times the OSHA standard in the ink room and 1.13 times the standard on printer #4. The second inspection resulted in a citation for exposure at 1.58 times the OSHA mixed solvent standard on printer #7.

The New Jersey State Department of Labor-OSHA Consultations Service inspected the Laminating Corporation facility on April 13, 1983, and addressed the use of lead pigmented inks. Lead was detected on wipe samples from employees' hands in the ink room and printing operation. Air levels were determined to be less than 1 ug/m3. According to plant personnel, the use of lead pigmented inks was discontinued before our evaluation began.

In addition to this background environmental data, NJDOH, through its clinic, was aware of two cases of neurologic problems among solvent exposed employees from Laminating: one case of optic neuritis and one of paresthesias (numbness and tingling of the arms and legs). Both conditions have been reported in connection with solvent exposure. On the basis of NJDOH's review of these cases, neither was considered to be of occupational origin.

IV. MATERIALS AND METHODS

A. Study Participants

All employees working in processes using MEK and other solvents were invited to participate in the evaluation. The approximately 26 eligible employees worked in the ink room and the printing department.

Approximately 22 employees working in the Laminating Department were considered to be unexposed to MEK or other solvents. All these employees were invited to participate in the study as a control (comparison) group.

B. Exposure Evaluation

Exposure assessments were designed to determine the extent of mixed solvent exposure, to investigate the relationship between exposure and health parameters, and to help identify the sources of exposure and methods of exposure reduction.

1. Air Monitoring

Previous environmental monitoring by OSHA indicated that MEK, MIBK, cyclohexanone, acetone and toluene were all present in the workroom air at Laminating. To rule out other significant solvent exposures, air samples were taken in several areas and analyzed for all organic solvents (volatile organic scan, NIOSH Method P&CAM 127).

To determine actual solvent exposures to workers in several relevant job titles, personal air monitoring was conducted on proof press operators, batchmakers, colormatchers, backtenders, middlemen, and print operators. These samples were taken by NIOSH Method P&CAM 127 using Dupont P2500 air pumps and 125 mg. charcoal adsorbant tubes. Pumps were calibrated before and after sampling at approximately 0.2 lpm. A series of short term samples (less than 90 min.) were obtained with measurements totaling at least 6 hours on each job. Samples were analyzed within 10 days of collection. Analysis of the back-up section of several samples was conducted separately to ensure that no breakthrough had occurred.

In addition to these personal samples, area samples were collected to help determine the sources of contamination and to assess exposure in the "low exposure area", the laminating department. Samples were obtained from printer #5 several feet from the ink trays, in the middle of the mixing room five feet above the floor, at the door between the printing department and the warehouse, and between laminating presses 8 and 9.

2. Exposure History

A work history was obtained by questionnaire (Appendix I) for all employees in the study to determine how many months they had worked in areas of solvent exposure at Laminating, whether they had solvent exposure at previous places of employment, and whether they had any non-occupational exposures to solvents.

3. Biologic Monitoring (measurement of an agent in body tissue)

To determine whether employees were actually absorbing measurable amounts of MEK during a workshift, we performed pre- and post-shift blood sampling for MEK on exposed and unexposed workers. All study participants were requested to undergo this biologic monitoring. The assays were carried out by the NJDOH laboratories according to the method described by Tolos (1).

Because a previously published case report (2) indicated that elevated levels of methanol were found in an MEK-exposed patient with optic neuritis and suggested that methanol might be a metabolic breakdown product of MEK, pre- and post-shift methanol levels were determined for all members of the study group who agreed to blood drawing. This assay was also performed by NJDOH laboratories using methodology described by Tolos (1).

It should be noted that for both MEK and methanol there is no definitive information available on the relationship between environmental exposure and blood levels or the relationship between blood levels and health effects.

4. Existing Control Technology

Work practices and existing ventilation equipment were observed in the printing department and mixing room. Qualitative assessments of the adequacy of these systems were made on the basis of these observations; however, specific recommendations for redesign and improvement of ventilation equipment would require further quantitative assessment.

C. Medical Evaluation

The medical evaluation encompassed the known acute and chronic effects of the solvents on the central nervous system (CNS--nerves in the brain and spinal cord), peripheral nervous system (PNS--nerves outside the central nervous system, such as those involved in muscle and sensory function of the arms and legs) and other organ systems.

The initial evaluation tools included a questionnaire, a limited physical examination, and blood studies of liver and kidney function.

The medical questionnaire (Appendix II), administered by NJDOH personnel, was designed to elicit signs and symptoms of peripheral and central nervous system problems as well as information on confounding factors--that is, factors other than workplace exposure which are associated with such problems.

Other potential manifestations of solvent toxicity included in the questionnaire were liver disease, skin problems, reproductive problems and bladder problems. The questionnaire was administered in Spanish where necessary.

The physical examination was conducted by NJDOH physicians and included examination of the skin, abdomen and nervous system (primarily PNS). The protocol for the neurologic exam is contained in Appendix III.

Blood studies of liver and kidney function included evaluation of liver enzymes (serum glutamic-oxalacetic transaminase, serum glutamic-pyruvic transaminase, and gamma-glutamyl transpeptidase) and serum creatinine. Analysis was carried out by Metpath Laboratory of

Teterboro, New Jersey.

D. Follow-up Nerve Conduction Studies

Follow-up nerve conduction studies (measurement of electrical conduction of nerves in the arms and legs) performed by a Board-certified neurologist were offered to all employees who had an abnormal physical examination of the nervous system or who had two or more symptoms consistent with abnormalities of the peripheral nervous system.

E. DATA ANALYSIS

Data were used to determine the following:

1. Whether there was an excess of manifestations of acute or chronic solvent toxicity among the exposed workers. This was done by comparing the presence and extent of symptoms of the exposed and unexposed employees.

2. Whether confounding factors might have influenced the results.

3. Whether there was a relationship between exposure and health effects. For chronic effects, duration of employment in a solvent-exposured job at Laminating was used as a measurement of "dose"; for acute effects, potential "dose" measures were job title, which was related to solvent air levels (see below), and biologic monitoring results.

Because of the small size of the study group, no formal statistical testing was undertaken.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 days per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverses health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health

effects even if the occupational exposures are controlled at the level set by the evaluation criteria. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes and this increases the overall exposure potential. Finally, evaluation criteria may change as new information on the toxic effects of an agent or combination of agents become available.

The primary sources for evaluation criteria for the chemical agents in this Health Hazard Evaluation are NIOSH Criteria Documents and recommendations and the U.S. Department of Labor (OSHA) occupational health standards. Often the NIOSH recommendations are lower than the corresponding OSHA standards. NIOSH recommendations are based on more recent information than are the OSHA standards. OSHA standards may be required to consider the feasibility of controlling exposures in various industries where the agents are used; the NIOSH recommended standards, in contrast, are based primarily on concerns related to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

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

For the solvents of concern at Laminating Corporation, the OSHA Permissible Exposure Limits, based on an 8-hour TWA, are as follows: MEK - 200 ppm; MIBK - 100 ppm; cyclohexanone - 50 ppm; acetone - 1000 ppm; toluene - 200 ppm, with a peak allowable concentration of 300 ppm for a maximum of 10 minutes. Based on its review of toxicity data, NIOSH has recommended lowering three of these standards: MIBK - 50 ppm; cyclohexanone - 25 ppm; acetone - 250 ppm; toluene - 100 ppm, with a 200 ppm ceiling concentration.

Because most solvents are CNS depressants (see below), simultaneous exposure to several of them may produce additive effects even when exposure to each individual solvent is at or below its recommended concentration. In such mixed solvent exposure, acceptable levels have been defined using the following formula:

$$C1/PEL1 + C2/PEL2 + C3/PEL3 + \ldots + Cn/PELn = \text{composite concentration}$$

where C = concentration of a substance, and
PEL = exposure limit of that substance

Calculations of the composite concentration may be made using any set of recognized exposure limits. For this study we used both the OSHA PELs, to compare with previous OSHA results, and the NIOSH recommended exposure limits. Exposure is considered to be below the

Mixed Solvent PEL when the composite concentration is less than 1.0.

B. Toxicologic and Medical Criteria (references 3,4 unless otherwise indicated)

Methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), acetone, cyclohexanone and toluene are all solvents possessing similar toxic effects.

1. Acute Effects of Individual Agents

MEK, MIBK, acetone and cyclohexanone are members of the same chemical family. All can be absorbed through the skin as well as by inhalation and ingestion.

With acute exposure, sufficiently high concentrations of these ketones can cause irritation of the eyes, nose and respiratory system (mouth, throat and lungs). Short-term overexposure can result in depression of the central nervous system, with symptoms ranging from fatigue, weakness, nausea, confusion, headache, dizziness and drowsiness to unconsciousness at sufficiently high exposure levels.

Since the irritant effects were thought to occur at lower concentrations than the acute narcotic effects, the current standards were designed to prevent acute irritant effects in workers exposed to these agents.

Toluene can similarly be absorbed through skin as well as the respiratory and gastrointestinal tracts. Like the ketones described above, short-term high exposure is associated with irritation of the eyes, skin, and respiratory tract as well as CNS depression. High exposure has also been associated with paresthesias of the hands and feet.

2. Chronic Effects of Exposure to Individual Agents

a. Skin -- Dermatitis has been reported in workers chronically exposed to MEK, acetone, and toluene.

b. Liver and Kidney -- Animal studies have shown liver and kidney damage with high level exposure to MIBK and cyclohexanone. Liver damage has been reported in humans after high-level, long-term toluene exposure.

c. Cataracts -- In animal studies, acetone and cyclohexanone have been associated with the development of cataracts.

d. Peripheral neuropathy -- Ever since the discovery of the potent neurotoxicity of chronic exposure to methyl butyl ketone (MBK), suspicion has been focused on other members of the ketone family. MBK, as well as another hexacarbon, n-hexane, have been associated with the development of weakness and decreased sensation in the arms and legs of exposed workers in many industrial settings. These

effects on the PNS have been reproduced and elucidated in multiple animal studies. As a result of these findings, MEK has been substituted for MBK in many industrial settings.

Several case reports have implicated MEK exposure as a cause of peripheral neuropathy (3,5,6), and a 1978 NIOSH HHE found a possible excess of mild peripheral neuropathy in workers exposed to MEK and toluene (7). But most of these exposure situations have been complex, involving multiple agents. Thus it has been impossible to pinpoint MEK as a sole or contributory causal agent in these instances. Animal studies of the PNS effects of MEK alone have been negative (3,8).

In contrast to this is the combination of MEK with MBK and n-hexane. In both animals and humans, MEK has been shown to increase the toxic effect of these hexacarbons on the PNS (9).

MIBK has been implicated in a case of peripheral neuropathy (9,10), but animal studies have been negative.

While peripheral neuropathies have been reported in mixed exposures involving toluene and MBK, toluene alone has not been shown to be a PNS toxin. (11)

Thus chronic exposure to the individual solvents in use at Laminating has not been clearly linked to adverse effects on the PNS.

e. Chronic CNS Effects -- Toluene abuse (intentional inhalation of toluene to get a "high") has resulted in multiple chronic CNS problems, including psychiatric disease, encephalopathy (degenerative disease of the brain), and abnormal electroecephalograms (EEGs - recordings of electrical activity of the brain). But recent studies of industrial populations have not revealed any adverse CNS effects of chronic exposure to pure toluene (9).

No information was found concerning the CNS effects of chronic single-agent exposure to MEK, MIBK, acetone or cyclohexanone.

3. Effects of Exposure to Mixed Solvents

With regard to chronic effects of mixed solvent exposure, reports from early in this century document the presence of abnormal fatigue, concentration difficulties, memory impairment, general irritability and alcohol intolerance in groups of solvent-exposed workers. These exposures were probably far higher than those currently encountered in most workplaces (12).

More recently, studies of several groups of workers exposed to mixed solvents have indicated effects on both the central and peripheral nervous systems after long-term but relatively low exposures (12,13,14,15,16,17). These effects have included an excess of CNS-related symptoms, diminished performance on various psychologic tests, abnormal EEGs, decreases in nerve conduction

velocities (speed of electrical impulses in nerve fibers) in both motor and sensory nerves, and abnormal PNS findings on physical examination.

VI. RESULTS

A. Exposure Evaluation

1. Air Monitoring

Results of the volatile organic scans indicated that the solvents of concern were MEK, MIBK, cyclohexanone, acetone and toluene. Small amounts of ethylbenzene (less than 0.5ppm) and xylenes (less than 2.0 ppm) were also detected, but because of the minute quantities no further evaluation of these was undertaken.

Time-weighted average concentrations of the monitored solvents for each job title are given in Table 1. TWAs for each individual solvent, as well as mixed solvents, were well below not only the OSHA PELs (0.14 to 0.34 X Composite TLV re OSHA) but also the NIOSH recommended exposure limits (0.22 to 0.59 X Composite TLV ré NIOSH). Employees working in the mixing room and as middlemen on printing presses had the highest measured exposures, 0.59 times the NIOSH recommended composite exposure limit.

Results of area samples are presented in Table 2. The highest levels (greater than the NIOSH recommended composite exposure limit) were detected at the front end of the printing press (1.27 X Composite TLV re NIOSH) and in the mixing room (1.09 X Composite TLV re NIOSH). As expected, very low levels of the solvents were detected in the warehouse and laminating department samples (0.09 and 0.06 X Composite TLV re NIOSH).

On the basis of these air samples, it was possible to identify two groups in the study population. Those working in the laminating department were designated "unexposed", while the remainder of the group, working in the mixing room, print department and proof press, were considered "exposed".

2. Exposure History

These results are presented in the medical results section below.

3. Biologic Monitoring

Pre- and post-shift blood monitoring for MEK and methanol was conducted on 22 study participants, including 21 exposed employees and one control.

Only one sample contained detectable MEK at the beginning of the shift (limit of detection = 0.4 ppm). This individual had a pre-

shift level of 0.74 ppm and a post-shift level of 1.14 ppm. It is possible that the pre-shift level resulted from his working in his solvent-exposed job before the pre-shift MEK blood levels were drawn.

Mean post-shift blood MEK levels for each job title are presented in Table 3 along with with the corresponding MEK personal air monitoring results. These results indicate that, among the exposed workers, the average biologic monitoring levels follow the same trend as the environmental monitoring levels. The single unexposed worker for whom data is available had a post-shift MEK level of .42 ppm (just over the detection limit of 0.4 ppm), suggesting that some minimal absorption of MEK also occurred in the control group. The clinical significance of any of these levels is unknown at present; however, these findings do indicate that there is sufficient exposure during a workday to elevate body burdens of solvents.

Only one employee had detectable methanol in his blood; levels were detected in both pre- and post-shift samples. Probably these results either represent laboratory variability or reflect some factor not considered in this study.

4. Work Practices and Control Technology

a. Mixing Room

Work procedures in the mixing room require color matchers and batchmakers to manually transfer solvent-based inks from open drums into buckets and to blend the mixtures by hand. This technique involves exposure to solvent vapors as well as contamination of unprotected skin. In addition, the batchmaker washes the five gallon mixing buckets by hand with MEK and scrub brush. After washing and draining, the buckets are left to dry inside the mixing room. High airborne and skin exposures would be anticipated during this process and some of the highest exposures measured were obtained during this operation.

The mixing room is supplied with a well-designed general ventilation system providing approximately 65,000 cfm (according to our measurement) drawn across the room from the work area to the drum storage area. While this system provides significant dilution of the air solvent concentration, local exhaust ventilation would be more effective in controlling employee exposures in this room.

b. Proof Press

Two proof press operators are exposed to solvents in the course of printing small "proof" prints. While the operation has limited output, it requires frequent changing of inks and rollers and hand manipulation of the entire process. Solvents drip from the rollers into open pans, potentially creating high solvent levels in the work area. Each of these processes require operators and middlemen to remain in close contact with the inks and solvent vapor sources.

Each press ventilation system is constructed differently and some of the systems are more effective than others. Air is supplied to dry the paper between inkings and exhausted to remove the solvent from the workroom air. In order for these systems to work properly, the supply air (blowing on surface of paper) must be carefully balanced with the exhaust, and the drying chambers have to be well sealed. The net flow of air must be into the machine to prevent contaminated air from being released into the work areas. The systems are currently not performing as efficiently as they should. Drafts are created when there is a net flow of air into the workroom. In addition, many of the ink trays have no exhaust ventilation near their surface, leading to evaporation of solvent into the workroom.

B. Medical Evaluation

1. Characteristics of the exposed and control groups

Of the 26 employees identified as potentially exposed to solvents, 25 agreed to participate in the study. Of these 25, 15 were Hispanic, six were Caucasian, and four were Black. All were male. Their ages ranged from 22 to 62 years, with a mean of 35. The average number of months spent working at Laminating in a job involving solvent exposure was 53, with a range of four to 120. Age and job history information were missing for one of the 25 members of the exposed group.

Only seven of the 22 unexposed employees participated in the study, six Hispanics and one Black. Their ages ranged from 19 to 37 years, with an average of 28. All were male.

With regard to alcohol use, among the 25 exposed workers there were three non- or ex-drinkers and three who did not answer the question. Among the remaining 19 who indicated that they were current drinkers, the average number of drinks per week was 15.2, with a range from 2 to 42.

Among the seven members of the control group, the average number of drinks per week among the six current drinkers was 14, with a range of one to 24. Drinking information was unavailable for one member of the unexposed group.

Data on previous drinking habits was considered too sparse and unreliable to be utilized in the analysis; thus current alcohol use was the only index available to estimate ethanol exposure.

Thus, in summary, 25 exposed and seven unexposed employees participated in the study; their ethnic backgrounds and drinking habits were comparable, but the control group was, on the average, younger than the group of exposed workers.

2. Peripheral Nervous System

Peripheral nervous system symptoms were elicited in questions 8a-h and 9o-p of the questionnaire (Appendix II). For question 8, the occurrence of the symptom at least once per week was considered a positive response. Potential confounding factors considered in the analysis included diabetes, thryoid disease, history of back, wrist or neck injury, arthritis, carpal tunnel syndrome, Raynaud's disease (question 2), alcohol use (questions 11 and 12), and age; each of these factors may be associated with the development of peripheral neuropathy (disease of the peripheral nervous system).

a. Symptoms (see Table 4)

Symptoms suggesting possible peripheral nervous system problems were reported by nine of the 25 exposed employees (36%) and one of the seven controls (14%). These symptoms included pain, numbness, weakness, cramps, numbness and burning of arms or legs.

Of the nine positive responders in the exposed population, four had one symptom only, two had two symptoms, two had three positive responses, and one had six positive responses. Thus five members of the exposed group (20%) had two or more symptoms.

The single positive responder in the control group had only one positive response.

b. Physical Examination

Abnormal peripheral nervous system findings, consisting of decreased sensation in the arms and/or legs, were present in only three individuals; all were symptomatic members of the exposed group with two or more positive responses. Thus three of the five exposed employees with two or more symptoms also had physical findings suggestive of peripheral nervous system pathology.

c. Follow-up Nerve Conduction Studies

After results of the initial evaluation were tabulated, the five employees with two or more symptoms consistent with peripheral nervous system disease were invited to undergo nerve conduction studies to measure electrical conduction of motor and sensory nerves in both arms (ulnar and median nerves) and one leg (peroneal and posterior tibial). Four of the five agreed to have the test, which was performed by a neurologist at his office. Three of the four had normal nerve conduction measurements. The fourth had abnormal sensory nerve conduction (decreased amplitude of conduction waves) in all measured nerves and conduction velocities in the low normal range. This individual also had an abnormal physical examination of the peripheral nervous system. He is thus considered to have a (mild) peripheral neuropathy.

d. Confounding Factors

Because there were so few responders in the control group, the exposed and unexposed workers could not be compared with respect to confounding factors which might explain the apparent excess of symptomatology in the exposed workers. Thus, to examine this question, the symptomatic workers in the exposed group were compared to the asymptomatic members of the exposed group to see whether, within the group, the presence or extent of symptoms could be accounted for by preexisting disease, age or alcohol use.

As ascertained by the questionnaire, no responder had preexisting disease associated with peripheral nervous system problems.

The average age of the symptomatic exposed employees was 33 years (range 22-60); among those five workers with two or more symptoms, the average age was 39 years (range 25-60). The average age among the asymptomatic employees was 37 years (range 22-62). Thus there was no meaningful difference in average age between the symptomatic and asymptomatic members of the exposed group.

With regard to current alcohol use, the symptomatic exposed group included two nondrinkers and two employees for whom drinking information was not available; only one of the symptomatic group (with three symptoms) was considered to be a heavy drinker (more than 21 drinks per week). The two other heavy drinkers identified in the exposed group had no symptoms. Thus there appears to be no association between ethanol use and the presence or number of symptoms in the exposed group.

The single symptomatic employee in the unexposed group fell into the heavy drinking range.

d. Exposure-Response Relationship

Using the number of months working with solvents at Laminating as a quantitative index of exposure, there was no tendency for the symptomatic members of the exposed group (average 47 months) to have longer exposure than the asymptomatic group (average 56 months). It is of interest that several of the symptomatic employees had worked for less than five years at Laminating but had been exposed to solvents at previous jobs; The employee who had abnormal nerve conduction studies was among this group. Thus, while no dose-response relationship could be demonstrated on the basis of exposure history at Laminating, we cannot rule out the possibility that such a relationship would exist if ascertainment were complete.

3. Symptoms of Chronic Solvent Intoxication

Questions 9a-j dealt with CNS symptoms possibly associated with long-term solvent exposure. Confounding factors considered in this analysis included the use of certain drugs (question 5), history of

head injury with loss of consciousness or history of epilepsy (question 6), alcohol use (questions 11 and 12), and age.

a. Symptoms (Table 4)

Central nervous system symptoms known to be adverse effects of chronic solvent exposure, such as decreased memory, decreased concentration, irritability, depression, and fatigue, were found in 16 of the 25 exposed employees (64%) and two of the seven employees in the control group (29%).

Of the 16 positive responders in the exposed group, seven had only one symptom, five had two symptoms, one had three, one four, and two had five positive responses. Among the control group, one employee had one symptom, and another individual had two. Thus nine of the 25 exposed employees (36%) and one of the seven controls (14%) had two or more symptoms.

Six of the 16 symptomatic employees in the exposed group had also complained of peripheral nervous system symptomatology; five of these six had at least two chronic CNS symptoms.

b. Confounding Factors

Once again, because the small control group made meaningful comparison difficult, exposed employees with chronic CNS symptoms were compared to those members of the exposed group without such symptoms to investigate the influence of preexisting disease, age and ethanol use on the apparent excess symptomatology in the exposed group.

No preexisting disease related to chronic CNS symptoms was present among the symptomatic exposed employees.

The average age of the exposed employees with symptoms was 31 years (range 22-47); among the nine with two or more symptoms, the average age was 31 years (range 22-47). The average age of the asymptomatic exposed workers was 34 (range 23-47). Thus age does not appear to be related to the presence or extent of chronic CNS symptoms.

Similarly, there was no association between the presence or number of symptoms and current ethanol use.

c. Exposure-Response Relationship

The average duration of exposure to solvents at Laminating was less in the symptomatic exposed workers (45 months), including those with two or more symptoms (47 months), compared with the asymptomatic exposed workers (68 months). It should be noted, however, that six symptomatic exposed employees (including four of the nine with more than one symptom) had solvent exposure at previous jobs. Thus a possible relationship between duration of exposure and

presence or number of symptoms cannot be accurately assessed.

4. Symptoms of Acute Solvent Intoxication

Symptoms of the acute (immediate) adverse effects of solvent exposure on the CNS were elicited in question 10a-g. The presence of a symptom at least one day per week was considered a positive response. Questions 9k-m sought information on non-CNS symptoms of acute solvent intoxication. Alcohol use (questions 11 and 12) was considered a possible confounding factor in this analysis.

a. Symptoms (Table 4)

Central nervous system symptoms known to be associated with acute solvent intoxication, including dizziness, loss of balance, nausea, blurred vision and headache, were reported by 10 of the 25 exposed employees (40%) vs. one of the seven unexposed workers (14%).

Of the 10 symptomatic exposed workers, six complained of one symptom, three had two symptoms, and one had four symptoms. Eight of these 10 had also complained of chronic CNS symptoms and five had complained of peripheral nervous system symptoms. Three of the 10 also complained of non-central nervous system symptoms associated with acute solvent intoxication. None had a preexisting disease felt to predispose to acute CNS or non-CNS symptomatology.

The positive responder in the unexposed group had only one symptom, had negative PNS and chronic CNS responses, and had a positive medical history for disease possibly associated with this type of symptoms.

b. Confounding Factors

Current alcohol use was not related to presence nor number of symptoms in either group. Age was not felt to be relevant to the analysis.

c. Dose-Response Relationship

Because these were symptoms of acute overexposure, long-term exposure history was not felt to be relevant in this analysis. Neither post-shift MEK levels nor job title were related to the presence or extent of symptoms.

5. Other

a. Liver

No one in either the exposed or control group had liver disease as ascertained by the questionnaire. Physical examination of the abdomen was also negative. Because of technical problems (freezing of blood samples), liver function results could not be analyzed.

b. Skin

Eight of the 25 exposed employees (32%) and one of the seven controls (14%) complained of dry or itching skin--a problem which may be associated with solvent exposure.

c. Reproductive Effects

This information was felt to be incompletely ascertained and thus no analysis was performed.

d. Bladder Problems

No symptoms of neurologic bladder problems were found in either the exposed or control groups.

e. Renal Function

Average creatinine values were similar in both the exposed and unexposed workers and all creatinine results were within the laboratory's normal range.

VII. DISCUSSION AND CONCLUSIONS

The results of our environmental and medical evaluations suggest that a health hazard from mixed solvent exposure exists at Laminating Corporation.

The existence of a hazard is suggested by an apparent excess of central and peripheral nervous system symptoms in exposed workers in conjunction with mixed solvent air concentrations associated in previous studies with nervous system toxicity. The excess CNS symptoms were those characteristic of acute as well as chronic solvent toxicity.

The apparent excess of symptoms among exposed workers did not appear to be related to age, pre-existing disease, or current alcohol or drug use. Nor did the data indicate a dose-response relationship between exposure and presence or extent of symptoms. However, as discussed above, incomplete ascertainment of exposure and confounding factor information may be responsible for these negative findings.

One case of peripheral neuropathy was found among the exposed

employees. Other than solvent exposure, which he experienced both during his employment at Laminating and in a previous job, this individual had no identifiable risk factors for the development of peripheral nervous system disease.

Individual solvent concentrations as well as the composite level measured by us were considerably below the NIOSH and OSHA recommended exposure limits. However, the skin exposure present in the plant could lead to considerable absorption of solvent and, as noted above (Evaluation Criteria), nervous system toxicity has been identified at or below these air levels. Previous measurements by OSHA identified mixed solvent concentrations above the PEL. The differences between NIOSH and OSHA measurements may reflect the normal day-to-day variation in exposure levels. However, the lower values obtained by NIOSH may also reflect that only four of the seven presses were operating during NIOSH sampling, and that sampling was undertaken on only a single day during the summer with windows and doors open.

Although this study suggests that a health hazard exists at Laminating, it does not provide definitive evidence of such a hazard.

The small size of the control group makes it impossible to estimate statistically whether the excess of symptoms in the exposed workers is real or whether the observed difference was likely to have occurred merely by chance.

The possibility that factors other than workplace exposure might have caused the observed difference between exposed and unexposed workers could not be definitively ruled out.

In addition, the presence of symptoms does not in itself indicate the presence of an adverse health effect. Documentation of PNS or chronic or acute CNS deficits requires corroboration by physical examination and/or by more sophisticated neurophysiologic testing. When such testing was conducted for peripheral nervous system disease on the symptomatic members of the study group, one case of peripheral neuropathy was found.

But despite the fact that, for these and other reasons inherent to this study method, we cannot conclude that a health hazard to the nervous system from mixed solvent exposure definitely exists at Laminating Corporation, the possibility of such a hazard must be taken seriously. At present there is no other clearcut explanation for the apparent excess of PNS and CNS symptoms among the exposed workers. The fact that in previous studies such symptoms have been associated with exposure levels comparable to those at Laminating adds to the concern, as does the finding of a peripheral neuropathy in one of the exposed workers.

VIII. RECOMMENDATIONS

A. Environmental

There is sufficient information present to warrant additional exposure control measures and improved work practices. Institution of these controls is needed to reduce employee exposure and thus reduce the chance of employee illness. An additional benefit may also be gained by reducing air solvent levels. Laminating is currently installing a charcoal bed air filtration system to increase solvent recovery. Increased collection efficiency of workroom ventilation would enable this system to recover even more solvent.

1. Mixing Room

a. Workers required to manually handle solvents and inks should be provided with impervious gloves (natural rubber is recommended for use with ketones) and additional protective clothing as necessary to prevent all skin contact with the solvents.

b. Drum storage should be isolated from the work area to minimize the time workers are exposed to solvent vapors emanating from open drums and spilled inks.

c. Ventilated work stations similar to paint spray booths should be constructed in the mixing room. To the extent possible, mixing of inks and solvents, cleaning and drying of ink buckets, or any other process which may create airborne solvent exposure should be done within this ventilated area.

d. Respiratory protection may be used to prevent solvent exposure while the above changes are being made or for jobs requiring short-term exposure for which no feasible engineering control can be devised. Where respirators are used, a respiratory protection program should be set up in full compliance with the OSHA respiratory protection standard (29 cfr 1910.134). This includes providing employees with a medical exam, properly fitting respirators chosen for maximum comfort, and an adequate supply of charcoal adsorbant filters. Employees should be fully trained in the use and limitations of their respirators. In addition, a clean, solvent-free storage area should be set up for respirator storage.

2. Proof Presses

a. If possible the proof presses should be equipped with local exhaust ventilation to minimize release of printing solvents into the air. If the work process precludes attachment of local exhaust hoods onto the press, a ventilated work station should be constructed around the press creating a draft away from the operator's work station.

b. Proof press operators are required to wash down the presses repeatedly. Impervious gloves should be supplied for this

process. In addition, properly fitted and maintained respirators should be supplied, as in A4, above.

3. Printing

a. A practical ventilation design has been developed for the printing presses at Laminating. However, each press is not equipped with a full system. Even those presses which do have complete systems do not have adequate maintenance to ensure maximum efficiency and minimal solvent release into the work room. Presses with inadequate systems should be provided with full ventilation before they are operated. Presses which already have full systems should be fully evaluated by a qualified ventilation engineer and a regular preventive maintenance program should be instituted to ensure efficient operation of the systems. All systems should be designed and maintained to create a net flow of air from the work room into the press.

b. Ink trays should all be supplied with slot exhaust vents to minimize solvent release into the air.

c. Buckets of solvent or inks should be kept tightly sealed. Impervious gloves should be supplied to prevent the need for immersing hands in solvent. When handwashing is neccesary to remove ink, a water-based solvent detergent should be used.

B. MEDICAL

In addition to the measures aimed at reducing exposure described above, we recommend that long-term medical monitoring for neurologic disease among solvent-exposed workers be instituted at Laminating Corporation. Medical monitoring--that is, a periodic search for potential disease in exposed employees--is useful to ensure the effectiveness of exposure controls and to provide early diagnosis of possible work-related disease. Such a program might include biennial (every other year) evaluation of these employees by questionnaire and physical exam of central and peripheral nervous system function, with group results (names deleted) made available to workers and management and individual results communicated to each employee. Any employee felt to have a solvent-related problem should undergo further medical evaluation and should be offered a job that does not entail solvent exposure. Details of program design should be mutually agreed upon by union and management; as in most such programs, participation should be optional. NIOSH personnel would be available to make more detailed suggestions concerning the contents of the questionnaire and physical examination.

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Copies of this report have been sent to:

1. Laminating Corporation of America, Eatontown, New Jersey
2. Local 271 Amalgamated Clothing and Textile Workers Union (ACTWU)
3. Department of Occupational Safety and Health, ACTWU
4. NIOSH Region II
5. U.S. Department of Labor, OSHA, Region II

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

TABLE I

PERSONAL EXPOSURE RESULTS

Job Title	Number of Jobs Sampled	No. of Samples	Average Minutes Sampled per Job	MEK Range*	MEK TWA*	MIBK TWA*	Cyclo Hexane TWA*	Toluene TWA*	Acetone TWA*	Composite TWA + (NIOSH)	Composite TWA + (OSHA)
Proof-Press Operator	2	15	363	2.4-100	37.8	2.5	1.1	6.2	5.6	0.37	0.27
Batch Maker/ Color Matcher	3	24	437	6.6-49.2	28.9	6.5	0.8	16.3	31.7	0.59	0.34
Back Tender Print	1	7	415	3.2-23.8	12.1	3.5	0.4	5.6	4.0	0.22	0.14
Operator/ Printer	1	7	358	6.7-23.9	15.3	7.3	0.6	8.7	9.6	0.37	0.21
Middleman Print	3	22	362	4.2-51.3	26.5	10.3	0.6	13.6	22.3	0.59	0.34

* PPM (parts per million)

\+ Recommended Composite TWA < 1.0

TAB

AREA SAMPLING RESULTS

Job Title	Number of Samples	Total Minutes	MEK*	MIBK*	Cyclo-* Hexanone	Toluene*	Acetone*	Composite TWA (NIOSH)
Printer, next to Ink Rollers	3	443	74.3	24.2	2.0	25.3	21.7	1.27
Mixing Room	3	439	25.2	4.8	0.6	13.2	24.6	1.09
Warehouse/ Printing	3	427	3.4	0.9	0.1	5.1	1.1	0.09
Laminating	3	464	3.0	1.1	0.1	2.3	0.8	0.06

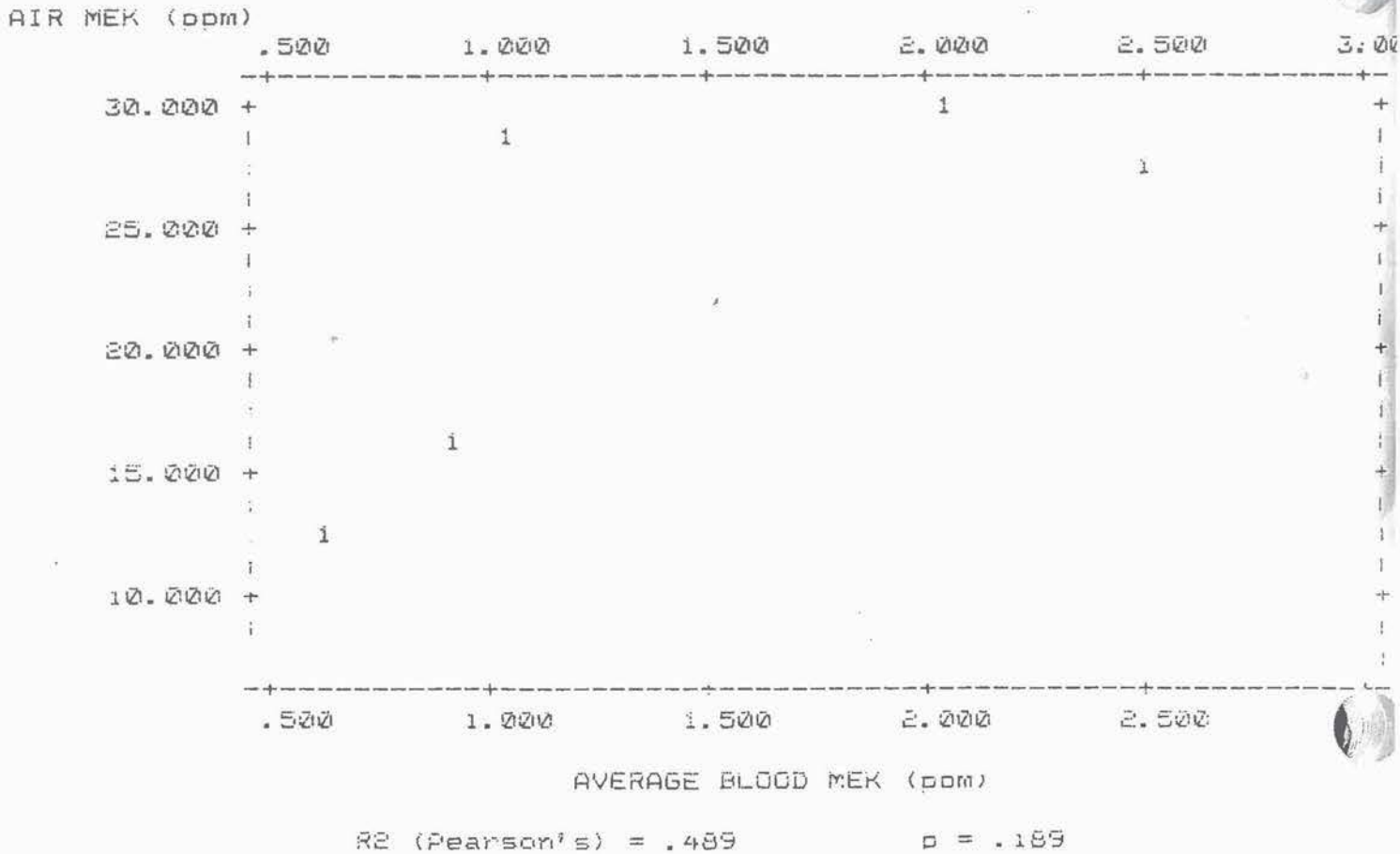
* PPM (parts per million)

\+ Recommended Composite TWA < 1.0

TABLE 3

POST SHIFT MEK BLOOD LEVELS

Job Title	Number of Samples	Average MEK Levels (PPM)	Air MEK Level (PPM)
Machine Operator-Laminating	1	0.42	-
*Print Set Up	1	0.69	-
Batcher	1	2.05	29.7
Color Matcher	3	1.05	28.7
Back Tender-Print	5	0.64	12.1
Middleman Print	7	2.51	26.5
Pressman Print	4	0.92	15.3
Total Exposed	22	1.44	-



R2 (Pearson's) = .489 p = .189

TABLE 4

OCCURRENCE OF SYMPTOMS IN EXPOSED AND UNEXPOSED WORKERS

	Number of Symptoms	Number of Exposed Employees (total=25)	Number of Control Employees (total=7)
PNS	0	16 (64%)	6 (86%)
	1	4 (16%)	1 (14%)
	2	2 (8%)	
	3	2 (8%)	
	6	1 (4%)	
Chronic CNS	0	9 (36%)	5 (72%)
	1	7 (28%)	1 (14%)
	2	5 (20%)	1 (14%)
	3	1 (4%)	
	4	1 (4%)	
	5	2 (8%)	
Acute CNS	0	15 (60%)	6 (86%)
	1	6 (24%)	1 (14%)
	2	3 (12%)	
	4	1 (4%)	

APPENDIX I

WORK HISTORY QUESTIONNAIRE

I.D. No. ______

Now I would like some information about each of the jobs, part time or full time, that [you] held for three months of more after completing your education. Please include work in [the arm]ed services. We will start with your first full time job after leaving school and [continu]e up to your most recent job.

Q-1 What was the name and address of the Company/Employer you worked for? Q-2 What did they do or manufacture? Q-3 What was your job title?	Q-4 Mo/Yr Start Q-5 Mo/Yr Stop Q-6 Was job full time or part time	Q-7 What were the duties?	Q-8 Were you exposed to hazardous materials	Q-9 Did You Wear Protective Clothing/Equipment?
1. 2. 3.	4. 5. 6. ☐ Part-Time ☐ Full-Time	7.	8. ☐ Yes–Specify ☐ No	9. ☐ No ☐ Yes, Spec.
1. 2. 3.	4. 5. 6. ☐ Part-Time ☐ Full-Time	7.	8. ☐ Yes–Specify ☐ No	9. ☐ No ☐ Yes, Spec.
1. 2.	4. 5. 6. ☐ Part-Time ☐ Full-Time	7.	8. ☐ Yes–Specify ☐ No	9. ☐ No ☐ Yes, Spec.
1. 2. 3.	4. 5. 6. ☐ Part-Time ☐ Full-Time	7.	8. ☐ Yes–Specify ☐ No	9. ☐ No ☐ Yes, Spec.
1. 2. 3.	4. 5. 6. ☐ Part-Time ☐ Full-Time	7.	8. ☐ Yes–Specify ☐ No	9. ☐ No ☐ Yes, Spec.

[An]y adverse effects noted from above jobs? [L]ist by Job Number.

Ever Live Near Plant, Mine or Facility that could have released hazardous material?

☐ Yes ☐ No

Where ______

[A]ny of your hobbies involve adverse exposure?

☐ Yes ☐ No

______

[Expo]sures ______

Anyone in the family work in a trade where hazardous materials could have been brought home (viz, asbestos, lead, beryllium, vinyl chloride, etc.)? ☐ Yes ☐ No

If yes, what materials ______

[E]S-7
[O]CT 82

Now, I would like to ask you some question about your experience while working at Laminating Corporation of America.

1. When did you start to work at this facility?
   (building constructed in 1961)

   month _____ year _____

2. Did you work for Laminating Corp. before they moved here from Newark in 1976?

   yes _____ no _____

   If yes, when did you start to work for Laminating?

   month _____ year _____

3. Please tell me all of the different jobs you have held since starting to work at this facility. USE NEXT PAGE

For convenience a number of current job titles are listed below:

- color matcher
- print middle man
- 2 color crewman
- laminator
- back-up laminator
- back tender
- color matcher (A or B)
- laminating machine operator
- printer
- master printer
- color pressman
- ink room batcher

e	DURATION Start Month/Year	Stop Month/Year	Describe your duties in this job. If you were exposed to solvents in this job describe how this happened

4. Do you wear a respirator while peforming your current job?

(Check one)

Always _____

Usually_____

Sometimes for special jobs_____

Rarely____

Never____

5. If solvent exposures are found to be a potential health hazard in your work area, what do you think could be done to reduce these exposures?) _____

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX II

MEDICAL QUESTIONNAIRE

MEDICAL HISTORY FOR LAMINATING EMPLOYEES

Now, I would like to ask you some questions about your health status.

1. Do you consider your health to be

   a. excellent _____
   b. good _____
   c. average _____
   d. fair _____
   e. poor _____

2. Has your doctor ever told you had any of the following conditions since a year ago?

a.	Diabetes mellitus (sugar in your blood or urine)	1. Yes 2. No
b.	Kidney failure (nephritis)	1. Yes 2. No
c.	Thyroid disease	1. Yes 2. No
d.	Back, wrist or neck injury	1. Yes 2. No
e.	Arthrits	1. Yes 2. No
f.	Carpal tunnel syndrome	1. Yes 2. No
g.	Raynaud's disease (pronounced "RAY-NODES)	1. Yes 2. No
h.	Prostate gland disease or enlarge	1. Yes 2. No
i.	Smoke	1. Yes 2. No

3. During the past 12 months did you have any of the following conditions?
Please circle where appropriate

a. cirrhosis of the liver
b. fatty liver
c. hepatitis or yellow jaundice — 1. Yes
d. any other LIVER trouble — 2. No

4. During the past 12 months did you have any of the following conditions?
Please circle where appropriate

a. a tumor or cyst or growth of the skin
b. dry or itching skin
c. trouble with acne
d. a skin ulcer
e. dermatitis or rash or any other SKIN trouble — 1. Yes, 2. No

5. Has your doctor prescribed any of the following drugs for your since a year ago?

a. Dilantin (also called "Phentoin")

b. Sedative (such as Librium, Valium, Tranxene, or Restoril — 1. Yes, 2. No

c. Drugs for depression (such as Elavil, Amitriptyline, Norpramin, Triavil, or Tofranil) — 1. Yes, 2. No

6. Please answer the following questions.

a. Have you ever had an injury to your head which required a doctor's attention? — 1. Yes, 2. No

b. Has your doctor ever told you that you have epilepsy or seizures? — 1. Yes, 2. No

c. Have your parents or brothers or sisters ever had a disease or the nervous system? — 1. Yes, 2. No

7 a. FOR MEN: Was your wife pregnant at any time since a year ago?
FOR WOMEN: Were you pregnant at any time since a year ago?

1. Yes
2. No

If yes, answer b-f

b. Did this pregnancy end in a miscarriage (also called "spontaneous abortion")?
1. Yes (Skip to "f")
2. No

c. Did this pregnancy end in a live birth?
1. Yes
2. No

d. Did the baby have a birth defect?
1. Yes
2. No

e. What was the defect or condition? (if none, please leave blank)
_____
(defect or condition)

f. Before this pregnancy, did your wife/ you ever have a miscarriage?
1. Yes
2. No

8. HOW OFTEN HAVE YOU HAD ANY OF THE FOLLOWING CONDITIONS DURING THE PAST 4 WEEKS?

a. Cramps in muscles of your arms or legs
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

b. Twitching of the muscles of arms or legs
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

c. Do you need help getting out of a chair?
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

d. Do you have difficulty opening screw top lids on jars?
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

e. Tingling or "pins and needles" sensation in your hands, arms, feet or legs
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

f. Numbness (parts of your body "go to sleep" for no apparent reason)
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

g. A burning sensation in your arms or legs
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

h. Pain in your arms after work when resting
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

i. Do you have to strain in order to start the urine flow?
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week
4. Never

j. Do you have to push on your abdomen in order to start the urine or keep the urine flowing?
1. 5-7 days per week
2. 1-4 days per week
3. Less than once a week

Continued

k. Have you noticed blood in your urine
   5-7 days per week
   2 1-4 days per week
   3. Less than once a week
   4. Never

l. Have you noticed any burning or tingling when you pass your urine?
   1. 5-7 days per week
   2. 1-4 days per week
   3. Less than once a week
   4. Never

m. Do the tingling sensations in your arms or the numbness or the pain in your arms occur mostly at night?
   1. 5-7 days per week
   2. 1-4 days per week
   3. Less than once per week
   4. Never

HAVE YOU HAD ANY OF THE FOLLOWING CONDITIONS DURING THE PAST 4 WEEKS?

a. Do you have a poor memory?
   1. Yes
   2. No

b. Have your relatives told you that you have a poor memory?
   1. Yes
   2. No

c. Do you often have to make notes about what you must remember?
   1. Yes
   2. No

d. Do you often have to go back and check things you have done such as turned off the stove, locked the door, etc?
   1. Yes
   2. No

e. Do you generally find it hard to get the meaning from reading newspapers and books?
   1. Yes
   2. No

f. Do you often have problems with concentrating?
   1. Yes
   2. No

g. Do you often feel irritated without any particular reason?
   1. Yes
   2. No

h. Do you often feel depressed without any particular reason?
   1. Yes
   2. No

i. Are you abnormally tired?
   1. Yes
   2. No

j. Are you less interested in sex than what you think is normal?
   1. Yes
   2. No

k. Do you have palpitations of the heart even when you don't exert yourself?
   1. Yes
   2. No

2. No

m. Do you perpire without any particular reason?
1. Yes
2 No

n Do you have a headache at least once a week?
1. Yes
2. No

o. Do you often have painful tingling in some part of your body?
1. Yes
2. No

p. Do you have any problems with buttoning and unbuttoning?
1. Yes
2. No

HOW OFTEN HAVE YOU HAD ANY OF THE FOLLOWING CONDITIONS DURING THE PAST 4 WEEKS?

a. Dizziness or light-headed feeling (Do not count dizziness or light-headed feeling that might occur just after standing up from a sitting or reclining position)
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

b. Feeling drunk (when you were not drinking)
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

c. Loss of balance
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

d. Loss of consciousness (blackout)
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

e. Nausea
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

f. Blurred vision
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

g. Headache
1. 5-7 days per week
2. 1-4 days per week
3. Less than once per week
4. Never

The following are questions about your drinking habits.

11. DO YOU NOW DRINK WINE, BEER OR LIQUOR?
1. Yes
2 No

If NO, please skip to Question 12.

IF YES TO 11

b. HOW MANY DAYS EACH WEEK DO YOU NOW DRINK WINE, BEER OR LIQUOR?
(Please circle the number of days) 1 2 3 4 5 6 7

c. WHEN YOU DRINK, HOW MANY DRINKS DO YOU HAVE AT ONE SITTING?
1. 1-2
2. 3-4
3. 5-6
4. 7-8
5. 9-10
6. 11-12
7. 13-14
8. 15 or more

d. HOW OLD WERE YOU WHEN YOU STARTED DRINKING BEER, WINE OR LIQUOR REGULARLY?
☐☐ age in years

(Please skip to next page.)

12. DID YOU EVER DRINK WINE, BEER OR LIQUOR?
1. Yes
2. No

IF YES TO 12

b. HOW MANY DAYS EACH WEEK DID YOU DRINK WINE, BEER OR LIQUOR?
(Please circle the number of days) 1 2 3 4 5 6 7

c. WHEN YOU DRANK, HOW MANY DRINKS DID YOU HAVE AT ONE SITTING?
1. 1-2
2. 3-4
3. 5-6
4. 7-8
5. 9-10
6. 11-12
7. 13-14
8. 15 or more

d. HOW OLD WERE YOU WHEN YOU STARTED DRINKING BEER, WINE OR LIQUOR?
☐☐ age in years

e. HOW OLD WERE YOU WHEN YOU STOPPED DRINKING BEER, WINE OR LIQUOR?
☐☐ age in years

13. a. Do you or did you smoke cigarettes? Yes___ No ___

b. If yes, how many cigarettes so you (or did you) smoke on an average day? _____

c. What year did you start smoking? _____

d. If you have quit smoking in what year did you quit? _____

14. a. How often do you eat fish each month? _____

b. Do you catch and eat your own fish? Yes___ No___

c. If yes to 14b, describe the source (i.e. what river, lake, bay etc.) _____

_____

and the amount of fish you catch (pounds fish per month) _____

_____

15. Thank you for answering these questions.

Do you have any questions or comments about this survey? _____

_____

_____

_____

_____

Physician's Name_____

PHYSICAL EXAM

Blood Pressure_____ Pulse _____

General Appearance _____

1. Skin -

Face _____

Trunk _____

Hands _____

2. Abdomen -

Liver Size _____

Tenderness _____

Pulses

I Cranial Nerves: (note tests used)

Right		Left
	I	
	II	
	III	
	IV	
	V	
	VI	
	VII	
	VIII	
	IX	
	X	
	XI	
	XII	

II Gait and Station: _____

Heel walk: _____

Toe walk: _____

Tandem walk: _____

Romberg test: _____

III Coordination: _____

Finger-to-nose: _____

Heel-shin: _____

Rapid-alternating movement: Fingers: _____
Hands: _____
Feet: _____

IV Deep Tendon Reflexes: Biceps R _____ L _____

Triceps R _____ L _____

Brachioradialis R _____ L _____

Patellar R _____ L _____

Achilles R _____ L _____

Plantar R _____ L _____

V Abnormal Movements:

VI Muscle Strength and Atrophy: (Grade strength on a 0 to 5 scale)

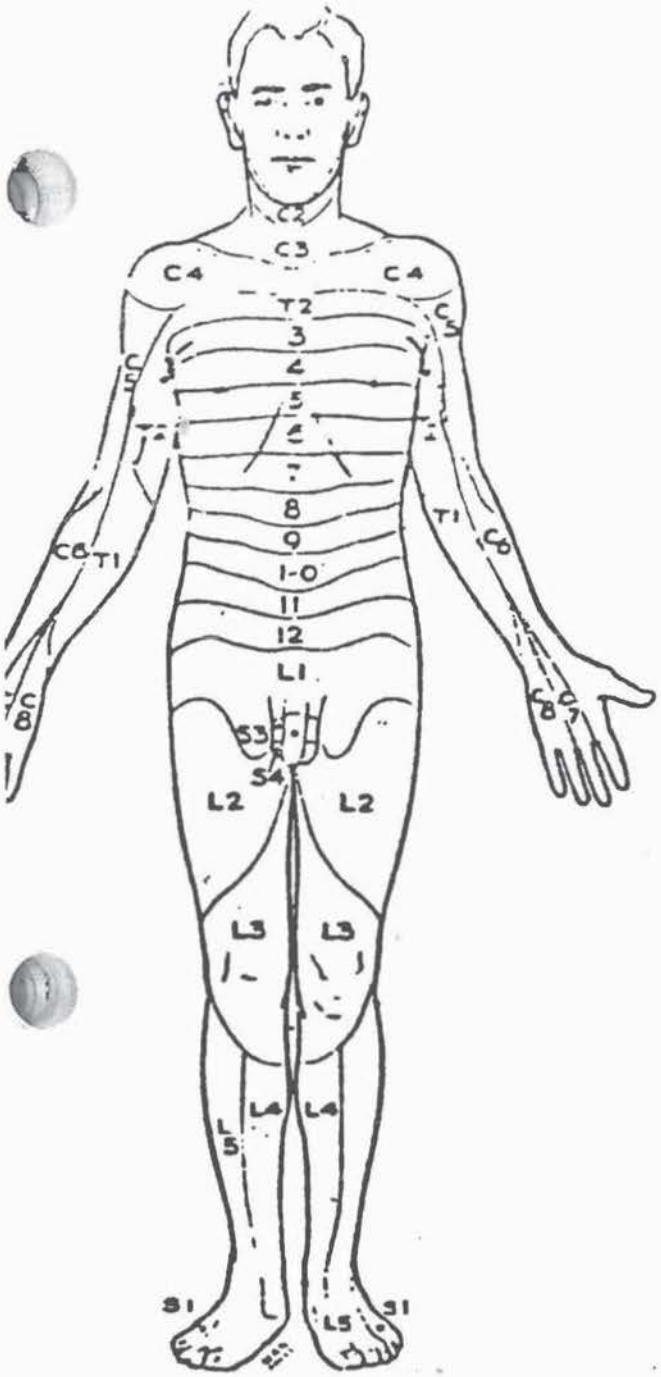
Right		Left
	Wrist flexors	
	Wrist extensors	
	Elbow flexors	
	Elbow extensors	
	Deltoid	
	Hip flexors	
	Knee flexors	
	Knee extensors	
	Ankle plantar-flexors	
	Ankle dorsi-flexors	
	Foot invertors	
	Foot evertors	

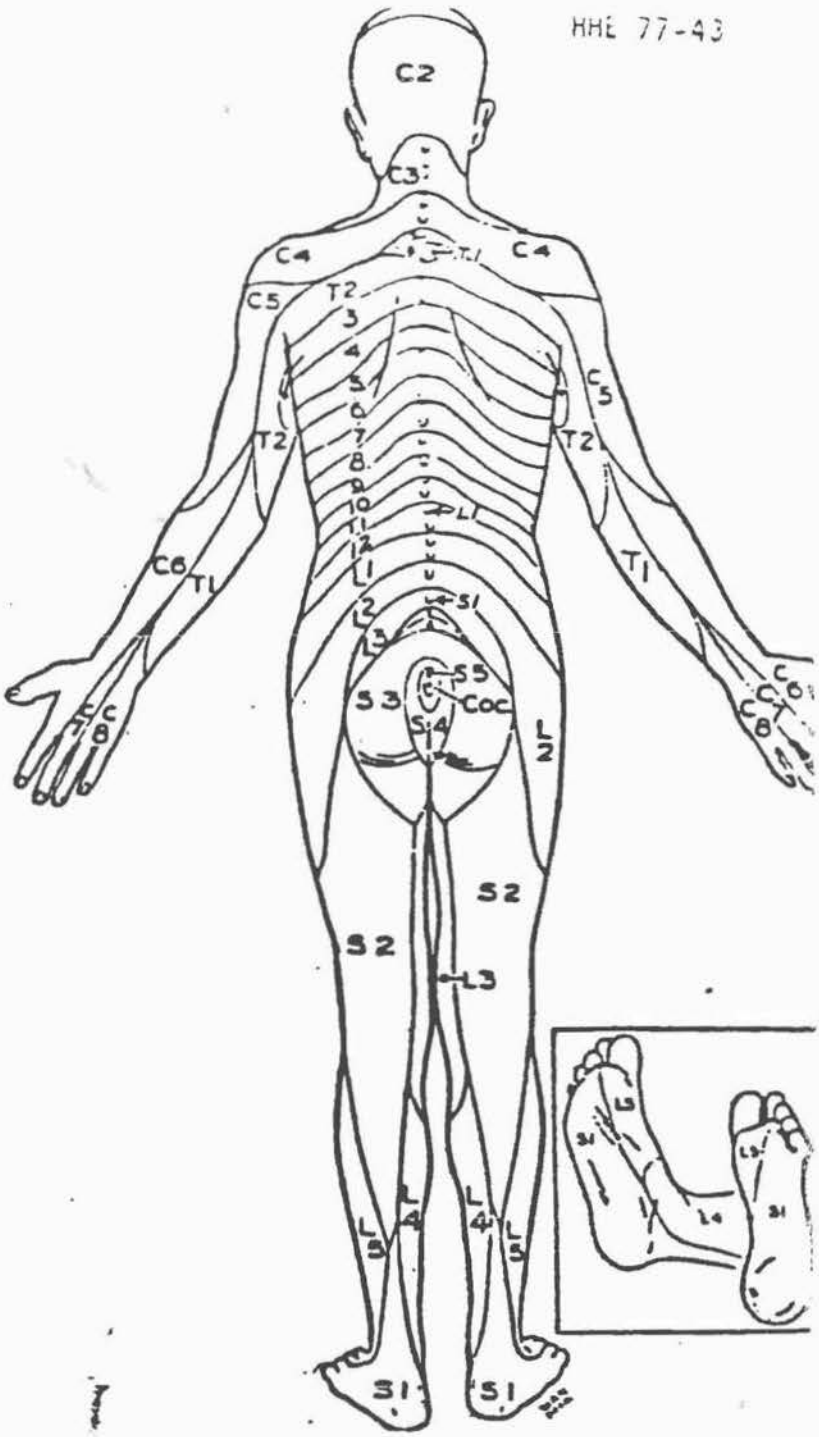
Other muscles as needed to document peripheral neuropathy (such as intrinsic muscles of hands of feet)

VII Sensory (please note the scale used in grading sensory response):
(If abnormal, please map abnormality on diagram on following page)

Right		Left
	Touch	
	Pin prick	
	Joint position	
	Vibration	

Other sensory as needed to document degree of loss





scribe the following when tested.

Two Point

Stereognosis

Traced Figures

Extinction

Localization

APPENDIX III

Protocol for Neurologic Examination
Laminating Corporation
July 17-19, 1984

1. Cranial Nerves III-XII

2. Sensory Examination: pinprick and light touch: bilateral distal upper and lower extremities

   vibration: olecrenon process, medial and lateral wrist, first metacarpal-phalangeal joint, patella, medial and lateral malleoli, first metatarsal-phalangeal joint.

3. Motor Examination: all muscles of the shoulder girdle and scapula, elbow joint, forearm and wrist, hands and fingers, hip girdle, thigh, knee, lower leg and ankle, foot and great toe.

4. Deep Tendon Reflexes: biceps, triceps, brachioradialis, patella, ankle

5. Cerebellar Function: finger-nose, heel-shin, Rhomberg

6. Pathologic Reflexes: plantar