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. 76-61-337

TRW INCORPORATED
PHILADELPHIA, PENNSYLVANIA

OCTOBER, 1976

I. TOXICITY DETERMINATION

The following determinations have been made based upon environmental air samples collected on July 1, 1976, confidential employee interviews, evaluation of ventilation systems, evaluation of work procedures and available toxicity information:

1. Employees exposures to butyl cellosolve, ethyl alcohol, and xylene in the Filament-Draw Department did not pose a health hazard at the concentrations measured during this evaluation. Employees may, however, be exposed to potentially toxic concentrations of mercury.

2. Exposures to trichloroethylene in the Lead-Heading Room do not constitute a health hazard.

3. Workers in the Mold Department were not exposed to toxic concentrations of phenol or nuisance dusts.

4. Employees exposures to xylene, 1,1,1 trichloroethane, MEK and toluene in the Sub-Assembly area did not constitute a health hazard.

5. The plating room operator was not exposed to toxic levels of lead or fluorides.

6. The medical program at this TRW facility appears to be adequate. The program adheres to the medical criteria as recommended by NIOSH criteria documents. Appropriate biological monitoring and medical surveillance are being done. Medical interviews with workers revealed no work related health complaints. A review of company medical records also produced no significant findings.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of the Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) TRW, Inc., Philadelphia, Pennsylvania
b) Authorized representatives of employees
c) U.S. Department of Labor - Region III
d) NIOSH - Region III

For the purpose of informing the approximately "60" "affected workers" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place 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 a request from four employees of TRW, Inc., regarding employees exposure to plastic and fiberglass dusts, various solvents and lead. The request stated that employees were experiencing health problems due to exposure to these chemicals. Symptoms included rashes, vision distortion, numbness in fingers and toes, irritation and groggy feeling. The request also indicated the lack of an adequate medical program.

IV. HEALTH HAZARD EVALUATION

A. Conditions of Use.

This TRW facility deals with the production of various types of electrical resistors. The facility contains six main production areas, filament-draw, lead-heading, mold room, sub assembly, wirewound and plating department.

1. Filament-Draw Department

The filaments for electrical resistors are made in the filament-draw department. The processes in this department are proprietary but it can be stated that the machines use a solution composed primarily of butyl cellosolve, ethyl alcohol, and xylene. In addition, each machine has a small mercury test system. The room also contains four ventilated mercury blocks where the filaments are tested to determine if they meet specifications. Approximately twenty employees work in this department. All employees are provided with uniforms which must be changed when they leave the area. Gloves are also provided.

2. Lead-Heading Room

The leads for the resistors are finished in the lead-heading room. The machines in this room use LM-7 (trichloroethylene) as a lubricant. Wire is drawn over a pad saturated with the trichloroethylene. The trichloroethylene is supplied to the pad from an enclosed glass container. The container has a capacity of approximately 1/3 liter and each container is refilled twice per day by the operators. Five employees work in the room, two operators, two mechanics and one controller. The room is air conditioned due to the need for constant temperature.

3. Mold Department

The mold department contains nineteen presses which apply, in most cases, a phenolic based resin to the resistors. The resin is supplied to the presses from 55 gallon drums by suction. The resin is heat cured in the presses. After removal from the presses the mold forms are cleaned periodically at the worksite using compressed air. Approximately thirty employees work in this department. The mold department also contains a mold storage and powder bank. The resins are stored in the room and when necessary the resins are baked to remove moisture. One employee works in this area approximately two hours per day. In addition an Oakite Stripper M-3 system is located in the mold department. This system contains two Oakite tanks and a rinse tank. Ventilation measurements (breathing zone of operator measured 50-100 fpm), observation of work practices and an interview with the operator indicated that adequate controls were present and no further evaluation was deemed necessary.

4. Sub-Assembly

In the sub-assembly department two leads and a filament are fused together using conductorial paint (resin based). (One machine applied a flameproof coating which has a xylene base.) The processes are automated with the resin materials being in an enclosed system and posed no health hazard to employees. The bases of the machines are cleaned by two employees. These base washers remove parts from the machine and clean them in open solvent compartments on movable carts. The solvent (1,1,1 trichloroethane) is brushed on with a paint brush and then wiped with a rag before replacing. The base washers wear rubber gloves and disposable dust masks. Additional solvents, toluene and methyl ethyl ketone (MEK) are used by the machine adjusters for cleaning parts and pumps.

5. Wirewound Department

The wirewound department was eliminated from further investigation after observing the operations. The resistor made in this department consists of two leads and a filament composed of a coated fiberglass cord. To make the filament, fiberglass cord is wound with wire and then coated with a silicone resin. Both these operations are done by machine. The construction of the resistor from its components is also performed by machine. Exposure to employees is limited to loading the machines and maintenance. Due to the limited nature of the exposure, it was felt no further investigation was warranted.

6. Plating Department

A separate room houses the anode lead plating operation. In this operation, copper wire is plated with lead using a fluoroboric acid system. The operation is automatic with exposure being limited to supplying raw materials and maintenance. Ventilation measurements showed a front face velocity on the tanks of 50-150 fpm and at the sides, 300-400 fpm. Only one employee works in the plating room.

B. Evaluation Progress

An initial survey was conducted on June 24 & 25, 1976. This survey included a walk-through survey in those areas where the alleged hazards were present, conducting confidential employee medical interviews, review of medical records and biological test results and the collection of breathing zone and area environmental samples in the five areas of the plant covered by the request.

C. Evaluation Methods

1. Environmental

Employee exposures to organic vapors were evaluated by collecting breathing zone and area samples on charcoal tubes and analyzing by gas chromatography.

One area and two personal samples for mercury were collected using iodine impregnated charcoal tubes for mercury vapor. Analysis for mercury was performed using a tantalum boat technique.

Exposure to nuisance dust was determined by collecting breathing zone samples on pre-weighed VM-1 filters.

All samples collected for phenol, were area samples. The samples were collected in impingers containing sodium hydroxide and analyzed by gas chromatography.

The plating operation was evaluated by collecting area samples for lead on AA filters which were analyzed by atomic absorption. Impinger samples were also collected for fluorides. The samples were collected in sodium acetate and analyzed by a specific ion electrode.

2. Medical

Nineteen employees were interviewed regarding health problems and/or symptoms related to their work environment. Non work-related health problems and/or symptoms were also discussed with each individual. The employees interviewed were randomly selected from the following work areas: Lead Heading, Mold Room, Subassembly, Filament Draw and Wire Plating; job titles included machine operators, mechanics, spotcheckers, molders, baseworkers, platers, machine adjusters, and floormen.

Approximately thirty-five company medical records were reviewed. Special attention was given to signs and symptoms associated with exposure to the following: trichlorethelyne, mercury, lead and phenols. Results of urine mercury and urine/blood lead tests were also reviewed.

D. Evaluation Criteria

1. Physiological Effects

The following is a brief summary of the adverse effects resulting from excessive exposure to each of the substances of concern:

Butyl Cellosolve - Exposure to butyl cellosolve may cause respiratory and eye irritation, narcosis and damage to the liver and kidneys. Butyl cellosolve is not significantly irritating to the skin, but is readily absorbed through the skin.

Ethyl Alcohol - The inhalation of ethyl alcohol vapor causes local irritation of the eyes and upper respiratory tract, headaches, sensation of heat, intraocular tension, stupor, fatigue and a great need for sleep.

Xylene - Excessive exposure to xylene may cause dermatitis, irritation of mucous membranes, nausea, vomiting, anorexia and heart burn. Dizziness, incoordination and a staggering gait may also occur.

Mercury - Acute intoxication from inhaling mercury vapor may occur at high concentrations. The condition is characterized by a metallic taste, nausea, abdominal pains, vomiting, diarrhea, and headache. After a few days, the salivary glands swell, stomatitis and gingivitis develop, and a dark line of HgS forms on the inflamed gums. The teeth may loosen and ulcers may form on the lips and cheeks. The chronic form of mercurealism is characterized by psychic and emotional disturbances. Symptoms include loss of ability to concentrate, depression, headache, fatigue and weakness.

Trichloroethylene - The predominant physiological response from exposure to trichloroethylene is one of central nervous system depression. Visual disturbance, mental confusion, fatigue and sometimes nausea and vomiting are observed. The National Cancer Institute has recently reported that trichloroethlene is carcinogenic in animals; however there is no evidence available that it is carcinogenic in humans.

Phenol - Exposure to phenol results in marked irritation of the mucous membranes of the eyes, nose and throat. Severe chronic poisoning has been characterized by nausea, vomiting, difficulty swallowing, diarrhea, anorexia, headache, vertigo, and possibly by a skin eruption. The disease is fatal when there is extensive kidney and liver damage.

Nuisance Dust - Nuisance dusts have little adverse effects on the lungs and do not produce significant desease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled the architecture of the alveoli remains intact: little or no scar tissure is formed: and any reaction provoked is potentially reversible. Excessive concentration in workroom air may reduce visibility, cause unpleasnat accumulations in the eyes, ears, nose, and secondarily cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

1,1,1 Trichloroethane - The main effect of exposure to 1,1,1 trichloroethane is anesthesia. High concentrations may produce mild irritation and minimal impairment of coordination. The skin shows only slight reddening and scaliness from contact. The reaction is increased on repeated exposures.

Methyl Ethyl Ketone (MEK) - Industrial exposure to MEK are mainly those of inhalation and skin and eye contact. Skin absorption, while it may occur, is not considered to present a problem. Exposure to vapors of this agent may produce mucous membrane irritation, skin irritation, and dermatitis. More prolonged exposure may result in nausea, vomiting, headache, paresthesia and narcosis.

Lead - Absorption of excessive levels of lead may result in lead poisoning. Some of the signs and symptoms include abdominal pain with tenderness, constipation headache, weakness, muscular aches, and cramps, loss of appetite, nausea, vomiting, weight loss, anemia with pallor and lead lines in the gum tissues.

Fluorides - The inhalation of fluorides fumes and gases may produce respiratory and eye irritation. Nose bleeds also may occur at higher concentrations. If fluoride intake exceeds fluoride excretion rate for a sufficiently long period of time, chronic bone damage may occur.

2. Environmental Standards

To assess the concentrations of air contaminants found in the place of employment, three primary sources of criteria were used: (1) NIOSH criteria for recommended standards for occupational exposure to substances (Criteria Documents); (2) recommended and proposed threshold limit values (TLV's) and their supporting documentations as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) (1975): (3) occupational health standards as promulgated by the U.S. Department of Labor (29 CFR Part 1910: 1000).

In the following tabulation, criteria selected for this evaluation by the author are presented with references.

Substances	Permissible Exposures (8-hour time weighted average)
[1]Butyl cellosolve	50 ppm*
[1]Ethyl alcohol	1000 ppm
[1]Phenol	5 ppm
[1]1,1,1 Trichloroethane	350 ppm
[1]MEK	200 ppm

[1]Fluorides	2.5 mg/M^3 **
[2]Nuisance Dust	10 mg/M^3
[3]Xylene	100 ppm
[4]Trichloroethylene	100 ppm
[5]Mercury	0.05 mg/M^3
[6]Lead	0.15 mg/M^3

[1]Reference: The 1975 ACGIH TLV and current Occupational Safety and Health Administration (OSHA) standard.
[2]Reference: The 1975 ACGIH TLV. The current OSHA standard is 15 mg/M^3.
[3]Reference: The NIOSH 1975 criteria document, the 1975 ACGIH TLV and the current OSHA standard.
[4]Reference: The NIOSH 1973 criteria document, the 1975 ACGIH TLV and the current OSHA standard.
[5]Reference: The NIOSH 1973 criteria document and the 1975 ACGIH TLV. The current OSHA standard is 0.1 mg/M^3.
[6]Reference: The NIOSH 1972 criteria document and the 1975 ACGIH TLV. The current OSHA standard is 0.2 mg/M^3.

*Units of measured concentrations are:
(a) ppm - parts of gas or vapor per million parts of air
**(b) mg/M^3 - milligrams of substance per cubic meter of air
(c) ug/M^3 - micrograms of substance per cubic meter of air

TLV's or standards for substances are established at levels designed to protect workers occupationally exposed on a 8-hour per day, 40-hour per week basis over a working lifetime. Because of the wide variation in individual susceptibility some workers may experience an evaluation of the workplace cannot be based entirely upon comparisons made against such TLV's or standards, as various TLV's and standards do not represent absolute protection of all workers.

E. Evaluation Results and Discussion

1. Filament-Draw Department - The four environmental samples collected in the filament-draw department for solvents showed only low levels of xylene (2.3-4.6 ppm) and ethyl alcohol (1.5-2.9 ppm). No levels of butyl cellosolve were detected. Sample results are presented in Table I. Although no hazard due to inhalation exists, it was noted that several employees had skin contact with the solvents. Excess solvent was wiped from the skin using rags. Because of the low vapor pressure at room temperature of substances such as butyl cellosolve, the hazard of skin absorption could be greater than inhalation or contribute substantially to the overall hazard involve in using the solvent. Therefore, employees should avoid solvent contact with the skin. If contact occurs, the solvents should be removed immediately using soap and water.

Two personal and one area sample for mercury were also collected in the filament-draw department. (Table II). The personal sample on the spot-checker showed the mercury level to be 0.008 mg/M^3. The personal sample collected on a filament draw operator and the area sample collected beside one of the mercury test systems showed mercury levels of 0.052 mg/m^3 and 0.064 mg/M^3 respectively. NIOSH recommends that workers not be exposed to concentrations of mercury greater than 0.05 mg/M3.

A review of urine mercury results showed only one elevated level (130 ug mercury/liter urine). The laboratory doing the test considers 100 ug mercury/liter of urine as permissible for an occupational exposure. The majority of mercury levels were around 50 ug/l. The plant physician was contacted by the NIOSH investigator regarding follow-up of the employee with the elevated level. The physician stated that the employee has been on vacation and the test would be repeated upon the employee's return to work. The physician stated that policy regarding elevated levels of urine mercury is as follows: 1. Urine samples are repeated; 2. If the repeat sample is also elevated, a blood sample is taken for analysis; 3. If the blood level is elevated, the employee is removed from further exposure until the level has returned to normal. In addition, a thorough history is taken to determine other sources of exposure and the employee is observed for signs and symptoms.

Based on the environmental concentrations and urine mercury results, a potential health hazard due to exposure to mercury is considered to exist. The following recommendations are made in regard to using and handling mercury.

1. Hand washing should be manditory before breaks, lunch and when leaving the building. The practice of no eating and smoking in the work area should be continued.

2. Provide clean protective clothing daily and when contaminated with mercury.

3. Vacuum mercury spills and droplets instead of sweeping them. The vacuum system should be one that contains a trap for the mercury and should be equipped with mercury vapor absorbing filters to prevent dispersal of mercury vapor into the work environment.

4. Containers of mercury should be kept covered when it is not necessary to have them open for process operations.

5. On the filament-draw machines, the surface of the mercury should be covered with an aqueous layer to prevent vaporization of the mercury. If the operations of the machines do not permit this, the mercury system should be covered, possibly with a small piece of plexiglass, to confine the mercury vapor.

6. NIOSH recommends the following criteria for interpreting mercury levels in urine and blood.

Urine
(ug mercury/liter urine)

30	Increased absorption
100	Warning level
150	Removal of employee from exposure

Blood
(ng mercury/ml blood)

25	Increased absorption
35	Removal of employee from exposure

2. Lead-Heading Department - Personal breathing zone samples for trichloroethylene were collected on three employees in the lead-heading department. (Table III) Concentrations of trichloroethylene ranged from 76-90 ppm. (The present standard for trichloroethylene is 100 ppm) During the medical interviews, three employees from the lead heading department stated that they felt "groggy" or "high" from the solvent "fumes". Another employee from the same department complained of eye irritation. However, these employees stated that this was not a constant problem and relate the above symptoms specifically to a time when the ventilation system was out of order. Therefore, based on environmental samples and employee interviews, no health hazard was documented at the time of the survey. However, care should be taken to insure that the ventilation system is in proper working order at all times. (It should also be noted that the company plans to replace the trichloroethylene with 1,1,1 trichloroethane in the near future.)

3. Mold Department - The possibility of the presence of phenol from the phenolic based resins used in the mold department was determined by collecting area impinger samples. The four samples taken for phenol showed no detectable levels. (Table IV)

Personal breathing zone samples for total nuisance dust also were collected in the mold department. Results are given in Table V. The concentrations for nuisance dust ranged from 0.56-2.45 mg/M^3. All concentrations are well below levels believed to cause adverse health effects (10 mg/M^3).

4. Sub Assembly - Personal breathing zone samples for 1,1,1 trichloroethane, MEK and toluene, all used as cleaning agents in sub-assembly, were collected on charcoal tubes. The concentrations of 1,1,1 trichloroethane ranged from 6 to 83 ppm. No detectable levels of MEK or toluene were found. Although no health hazard is considered to be present, it was noted that the base washers were provided with and using disposable dust masks. This type of mask provides no protection against organic solvents. If employees are to use respirators, they should be provided with respirators which are approved for organic vapors.

An area sample also was collected for xylene on the machine which applied a flameproof coating. The concentration of xylene was 1.2 ppm.

5. Plating Department - The plating department was evaluated by collecting area samples for lead and fluorides adjacent to the plating line. No detectable levels of lead were reported. (Limit of detection-2 ug/filter). Biological monitoring (blood) is also done on those employees exposed to lead. A review of these results showed no abnormalities. The medical laboratory doing the tests considers 80 ug lead/100ml blood as acceptable. All levels were reported to be below 60 ug lead/100ml blood. The concentrations of the fluoride samples were 0.55 mg/M^3 and 0.12 mg/M^3. The present standard for fluoride is 2.5 mg/M^3.

6. Medical

A. Medical Findings

All employees interviewed, with the exception of the three workers in lead-heading department denied any work related health problems and/or symptoms. Several employees stated that they were under the care of their private physicians for non work-related health problems (e.g. hypertension, glaucoma, sinus problems and allergies). Most of the employees interviewed stated that they were in excellent health. The above statements were verified by the following:

1. Observation by the NIOSH investigator

a) No dermatitis, tremors, emotional instability, nor evidence of eye irritation was observed.

b) All of the employees observed appeared energetic, in good health and most appeared younger than their stated age.

2. A review of the company medical records

The most recent physical examinations were conducted two weeks prior to the NIOSH visit. A review of records produced no significant findings.

B. Medical Program

The plant does have an area designated as a health unit which until a year ago was staffed by a full-time registered nurse. Medical examinations are conducted by a local physician on a contract basis.

The biological samples are analyzed by a commercial laboratory which is licensed by CDC in toxicology and are interpreted by the physician.

The medical program at this TRW facility consists of the following:

1. Pre-employment physical examinations are done on all new employees.

2. Comprehensive medical examinations with emphasis on signs and symptoms of unacceptable mercury and/or lead absorption, are conducted annually on exposed employees.

3. Urine samples are analyzed for mercury and/or lead every six months.

4. Several employees have been trained in First Aid by the Red Cross. Injured or ill employees are sent to the plant physician's office or to a local hospital.

The employees interviewed stated that, in their opinion, the medical examination was very thorough. They had no complaints regarding the plant medical program. All of the employees interviewed seemed to be informed regarding the hazards associated with the substances to which they are exposed. They also seemed very aware of good work and sanitation practices.

For the above reasons, it is the opinion of the NIOSH investigator that the medical program at TRW adheres to medical criteria as recommended by NIOSH.

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Table I

TRW Incorporated
Philadelphia, Pennsylvania
(Filament Draw)

July 1, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume liters	Butyl Cellosolve (ppm)	Xylene (ppm)	Ethyl Alcohol (ppm)
Filament Draw Operator (1)	CT-9	8:10-12:15	52.4	N.D*	2.3	2.7
Area Sample (Machines 23 &24)	CT-10	8:17-12:15	46.1	N.D.	3.2	2.9
Filament Draw Operator (2)	CT-11	8:11-12:14	50.9	N.D.	2.3	1.5
Area Sample (Machines 5 & 6)	CT-12	8:15-12:17	52.3	N.D.	4.6	1.9
Environmental Criteria					100	1,000

*N.D. - Non Detected - Limit of Detection 0.01 mg/tube

Table II

TRW Incorporated
Philadelphia, Pennsylvania
(Filament Draw)

July 1, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Mercury mg/M^3
Area (Machines 5 & 6)	M-1	8:15-12:15	46.9	0.064
Filament Draw Operator	M-2	8:00-12:13	58.2	0.052
Spot Checker	M-3	8:06-12:14	36.4	0.008
Environmental Criteria				0.05

Table III

TRW Incorporated
Philadelphia, Pennsylvania
(Lead Heading Room)

July 1, 1976

Charcoal Tube Samples for Trichloroethylene

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Trichloroethylene (ppm)
Machine Operator (1)	CT-1	8:27-13:10	29.0	83*
Machine Operator (2)	CT-2	8:25-13:25	43.7	76
Mechanic	CT-3	8:28-13:10	45.9	90
Environmental Criteria				100

*Limit of Detection 0.01 mg/tube

Table IV

TRW Incorporated
Philadelphia, Pennsylvania
(Mold Department)

July 1, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Phenol (mg/M^3)
Bake Area	P-1	8:52-13:03	376	N.D.*
Area (Machine 42)	P-2	8:53-13:02	373	N.D.
Area (Machine 37)	P-3	8:50-13:02	378	N.D.
Area (Machine 31)	P-4	8:52-13:03	375	N.D.
Environmental Criteria				19

*N.D. - Not Detected; Limit of Detection 0.02 mg/sample

Table V

TRW Incorporated
Philadelphia, Pennsylvania
(Mold Department)

July 1, 1976

Filter Samples for Total Nuisance Dust

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Total Dust mg/M^3
Floorman (1)	V1325	8:42-12:20	218	0.87
Mold Operator (35)	V1891	8:44-12:20	216	2.45
Mold Operator (43)	V1168	8:46-12:21	215	0.56
Floorman (2)	V1186	8:40-12:20	220	1.00
Envrionmental Criteria				10

Table VI

TRW Incorporated
Philadelphia, Pennsylvania
(Sub-Assembly)

July 1, 1976

Charcoal Tube Samples For 1,1,1 Trichloroethane, MEK and Toluene

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	1,1,1 Trichloroethane (ppm)	MEK (ppm)	Toluene (ppm)
Machine Adjuster (1)	CT-5	9:02-12:35	45.8	6.0	N.D*	N.D.
Base Washer (1)	CT-6	8:59-12:25	40.3	83.	N.D.	N.D.
Base Washer (2)	CT-7	8:52-12:25	39.9	54.	N.D.	N.D.
Machine Adjuster (2)	CT-8	9:03-12:24	43.9	8.6	N.D.	N.D.
Environmental Criteria				350	200	100

*N.D. - Not Detected: Limits of detection 0.01 mg/tube