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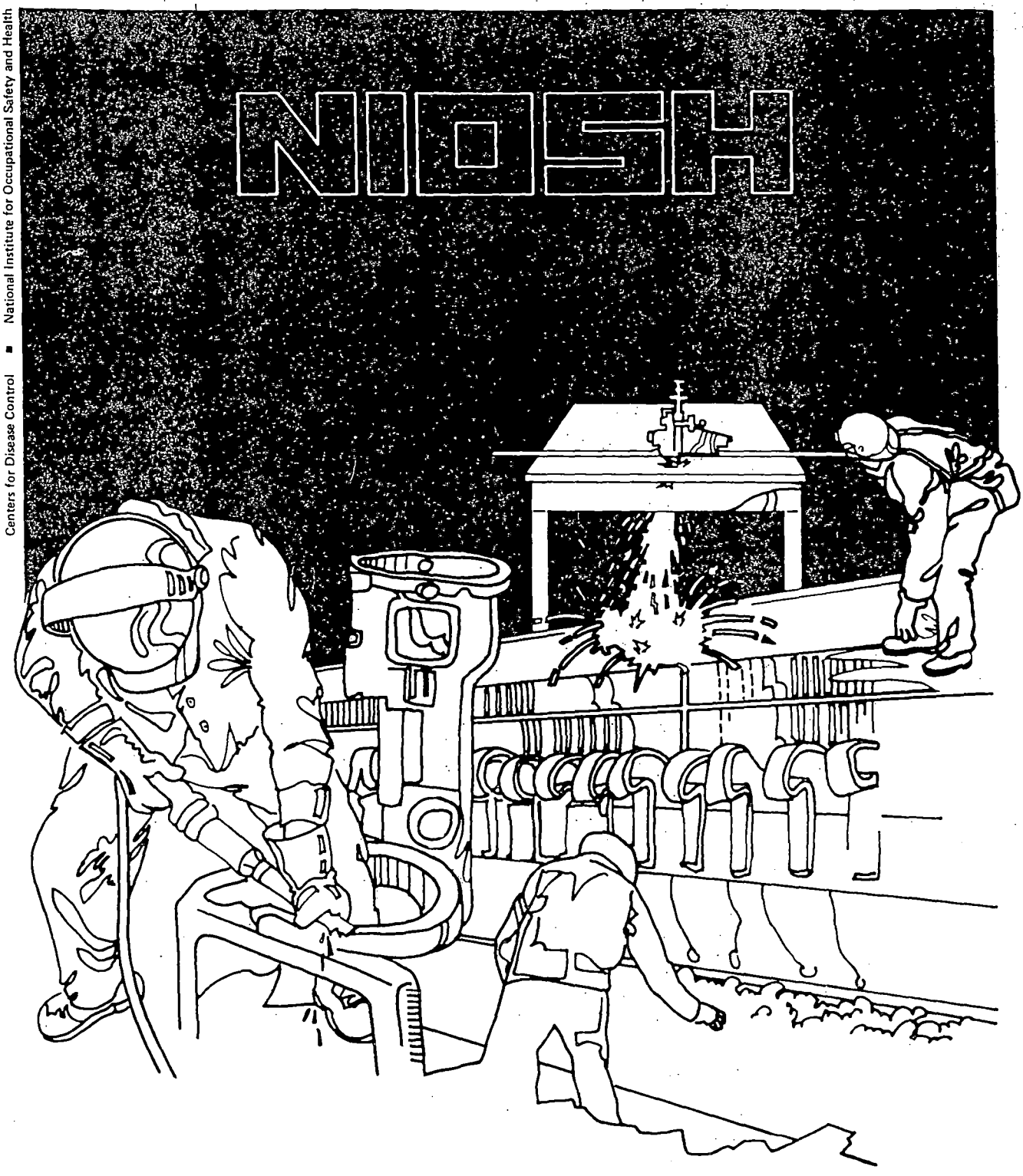

Health Hazard Evaluation Report

HETA 78-52-1483
WESTINGHOUSE CORPORATION
TRAFFORD, PENNSYLVANIA

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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I. SUMMARY

In January of 1978 the National Institute for Occupational Safety and Health (NIOSH) was asked to evaluate symptoms of conjunctivitis, rhinitis, and intermittent wheezing and dyspnea among workers who produced epoxy insulators in the Westinghouse Plant in Trafford, Pennsylvania. A possible association of these symptoms with occupational exposure to hexahydrophthalic anhydride (HHPA) was reported. Completion of this evaluation was delayed due to legal proceedings to obtain access to company records.

In January, 1979, NIOSH investigators collected air samples for measurement of exposure to particulates, 1,1,1-trichloroethane, Freon 11, Freon 12, and hexahydrophthalic anhydride HHPA. Measured exposure for total particulates (mean 0.7, range 0.1 to 3.4 mg/cu. m), Freon 11, Freon 12, and 1,1,1,-Trichloroethane (mean 54 ppm, range 6 to 520 ppm), were all well below the relevant evaluation criteria except for one short term personal sample for 1,1,1-trichloroethane (520 ppm) that exceeded the 350 ppm NIOSH recommended 15-minute exposure limit. Air levels of HHPA ranged from 0.1 to 1.3 ppm in TC-74. There is no standard on recommended exposure criteria for HHPA. Smoke tube observations and air velocity measurements showed that air generally flowed out of TC-74 into the surrounding areas. Levels of HHPA ranging from 0.2 to 0.4 ppm were found in area samples obtained in the nearby departments TC-3 and TC-6.

The medical evaluation consisted of medical interviews, review of company medical records, pre- and post-shift pulmonary function testing, complete blood count tests and radioallergosorbent technique (RAST) tests to detect the presence of HHPA-specific IgE antibody in the blood. The pre- and post-shift pulmonary function tests were within normal limits, and the medical records did not contain any information regarding allergic or irritant health effects occurring in the TC-74 work force. The majority of the 26 TC-74 respondents noted nasal (14 workers) and ocular (19) symptoms and four reported symptoms compatible with asthma. All six self-selected participants from nearby areas reported ocular and nasal symptoms, and three of them reported asthma-like symptoms. Seven of the 21 TC-74 employees tested showed the presence of HHPA-specific IgE antibody. These 7 workers had worked in TC-74 for a significantly longer period than the 14 antibody negative workers (mean of 4.1 years versus 1.2 years) and 5 of the 7 had worked at jobs with the highest exposures to HHPA. Five of the six self-selected workers from nearby areas had IgE-specific antibodies against HHPA. The three with the highest antibody levels had rhinitis, conjunctivitis, and asthmatic symptoms that appeared to be associated with substances emanating from TC-74.

The results indicate that workers employed in TC-74 and in nearby work areas were exposed to a sensitizing agent (HHPA) that is capable of inducing the production of HHPA specific IgE antibodies and may cause allergic ocular and respiratory symptoms in some exposed workers. Recommendations are contained in Section VIII.

Key Words: SIC Code 3079, hexahydrophthalic-anhydride (HHPA), phthalic anhydride, allergy, IgE antibodies, radioallergosorbent-technique.

II. INTRODUCTION

On February 22, 1978, the National Institute for Occupational Safety and Health (NIOSH) received a request from Local 601 of the International Union of Electrical Workers to evaluate occupational exposures to chemical substances in areas TC-72 and TC-74 of the Westinghouse Power Circuit Breaker Plant in Trafford, Pennsylvania. The requestor stated that some TC-74 employees were experiencing eye irritation, nasal discharge, and/or difficulty breathing because of occupational exposures. The concerns in TC-72 centered on the location of an employee locker and eating area adjacent to a degreasing tank, and odors of MEK emanating from an operation using Epanol paper.

On April 21, 1978, a site visit was conducted by a NIOSH industrial hygienist and two contract physician consultants. They concluded that the problems in Department TC-72 were being remedied, so the subsequent investigation involved only the TC-74 area. The investigators found that employees in TC-74 could be experiencing allergic symptoms (rhinitis, conjunctivitis, asthma) from exposure to chemicals used in TC-74. They believed that the most likely chemical substance to be causing the allergic symptoms in TC-74 was hexahydrophthalic anhydride. This substance is very similar chemically to phthalic anhydride (PA), a chemical which has been shown to cause occupational rhinitis and asthma.[1] In late December, 1978, NIOSH completed the development of a method to measure the environmental concentration of HHPA and subsequently conducted combined medical-industrial hygiene evaluations at the Trafford plant on January 15-16, 1979, and February 5-6, 1979. A NIOSH request to examine the plant medical records of present and former employees of the TC-74 area was refused by the company. NIOSH instituted legal proceedings and, after the federal courts affirmed NIOSH's right of access to the medical records, these records were evaluated in June, 1982. Interim reports describing NIOSH preliminary results were sent to the company and to the requestor on May 1, 1978, October 31, 1978, March, 1979, May 7, 1979 and June 6, 1979.

III. BACKGROUND

The Westinghouse Plant in Trafford, Pennsylvania, produces large electric circuit breakers for electric power transmission. Department TC-74, which produces large epoxy insulators, employs 33 workers. The requestor stated that workers in TC-74 were experiencing symptoms of eye irritation, rhinorrhea, and nasal congestion, and that two employees in the area had experienced episodes of shortness of breath while handling hexahydrophthalic anhydride (HHPA), a chemical which was used there in large amounts as a curing agent for epoxy resin. In addition, several employees in work areas near TC-74 were experiencing eye irritation, rhinitis and difficulty breathing when they entered

TC-74, and also while at their own work stations. They had postulated that their symptoms might be due to an airborne substance originating in TC-74 that was carried to their work stations by air flowing out of TC-74.

Department TC-74 is located in a large open bay. In the department, HHPA-cured plastic resins were mixed and then molded into components for electrical equipment. Employees called molders operated a large enclosed and automated Wellex mixing system, which was used to mix the resins. The resin components were weighed out automatically and delivered to the mixer. After the resin was mixed, it was poured into a mold under vacuum. The mold was then cured exothermically in ovens which were exhausted to the outside. After a batch of resin had been poured, the mixer was cleaned with 1,1,1-trichloroethane. This was an automatic cleaning system which was used approximately every hour. The 1,1,1-trichloroethane was filtered and reused in the system. The cleaning system was enclosed and vented.

A small manually-filled mixer, which was used one to two times per day, was located adjacent to the automatic Wellex mixer. HHPA, epoxy resin, and filler materials (e.g. pigments and amorphous silica), after being weighed out by hand in five-gallon cans, were manually added to the mixer. Once loaded the mixer operated under vacuum. When the resin was mixed, employees called loaders poured it into buckets and carried it into a walk-in oven (oven #9). They poured the resin into molds previously placed in the oven. The molds were then cured in the oven. The loaders wore respirators while handling the HHPA resin, because of HHPA's irritating effects on the nose and respiratory system.

After being cured, the cores from both the walk-in oven and the other ovens were removed from the molds by two employees called strippers. The strippers then blew out the molds with compressed air, cleaned them with 1,1,1-trichloroethane, and then sprayed the molds with a silicone release material using an aerosol can with a Freon propellant.

After the cores were removed from the molds, the cores were taken to the finishing area. There, the cores were cut, machined, and polished to produce finished parts.

IV. METHODS

A. Environmental

Work place environmental levels for total particulate, 1,1,1-trichloroethane, Freon 11, Freon 12, and hexahydrophthalic anhydride (HHPA) were obtained using the following methods.

PARTICULATE--Samples were collected on pre-weighed vinyl metrical filters for approximately four hours. Total particulate samples were obtained at a flow of 1.0 liter per minute (lpm) directly into

the filter cassette. Respirable particulate samples were obtained at a flow of 1.7 lpm by first passing the sample through a cyclone separator to remove the non-respirable (greater than ten micron) particles. The filters were subsequently reweighed to determine loading.

1,1,1-TRICHLOROETHANE, FREON 11 AND 12--Samples were collected on activated charcoal at approximately 100 cubic centimeters per minute (cc/min) for durations from short term (less than one hour) to full shift. Desorption was with carbon disulfide, and analysis was by gas chromatography. (P&CAM Method 127 [2])

HEXAHYDROPHTHALIC ANHYDRIDE--Air was sampled at 1.0 lpm for approximately four hours using midget impingers containing a 0.003M carbonate/bicarbonate solution. Samples were analyzed by ion chromatography.

FREE CRYSTALLINE SILICA--Two substances, "shot blast sand" and the amorphous silica used as a filler material in the epoxy resin, were analyzed to determine the free crystalline silica concentration in each. Bulk samples of several grams were collected in sample vials and analyzed by x-ray diffraction.

In addition to the above procedures, workroom air was drawn through silica gel and charcoal sorbent tubes at 100 cc/min for a full workshift and submitted for qualitative analysis. The silica gel tubes were desorbed with methanol, the charcoal with carbon disulfide. Both eluents were analyzed by gas chromatography and mass spectrometry.

Measurements of air velocity at various locations, especially at points of local exhaust ventilation, were made using smoke tubes and a thermal anemometer.

B. Medical Methods

All persons employeed in Department TC-74 were invited to participate in the medical evaluation. In addition, six workers from the surrounding departments (e.g. TC 7 and TC 3) who were experiencing respiratory or irritative symptoms at work that they thought might be caused by substances originating in Department TC-74 asked to participate. The medical evaluation consisted of the following:

1. Blood Tests

On January 15, 27 Westinghouse employees gave blood samples for a RAST test (radioallergosorbent technique[3]) to detect the presence of specific IgE antibodies against HHPA and PA. A complete blood count and white blood cell differential was also done.

2. Questionnaire

Participating employees answered a brief questionnaire regarding their allergic history and bronchitic symptoms as well as the occurrence of eye irritation, nasal discharge, cough, chest tightness, wheezing, or shortness of breath in relation to their activities at work.

3. Pulmonary Function Tests

On January 15 and 16, employees performed pulmonary function tests prior to beginning and at the end of their first work shift of the week. A Vitalograph wedge spirometer was used to measure forced vital capacity (FVC) and one-second forced expiratory volume (FEV) and the results were reduced to body temperature, saturated with water vapor (BTPS), ambient pressure and expressed as percentages of the values predicted by the equations of Morris[14].

On February 5, pre- and post-shift PFT tests were again performed on the employees because of the possibility that normal operating conditions were not present on January 15-16 due to an equipment malfunction which forced the shutdown of the Wellex mixer at about noon on January 15. The day shift employees were retested prior to their February 6 workshift to detect possible delayed reactions to occupational exposure.

V. EVALUATION CRITERIA

A. General

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 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects 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 criterion. These combined effects are often not considered in the evaluation criteria. Also, some

substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating 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 only 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 eight- to ten-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.

B. Specific Substances

1. Hexahydrophthalic Anhydride

Hexahydrophthalic anhydride is a clear, colorless, viscous liquid or a glassy solid with a melting point of 109 degrees F. Its vapor is irritating to the skin and mucous membranes. There is no established evaluation criteria for HHPA, but it is very similar in chemical structure to phthalic anhydride (see figure 1), which is also an irritant of the eyes, skin and respiratory tract and has a TLV of 6 mg/m^3 (1/ppm) set on the basis of its irritation threshold.[4,5] While there have been no reports concerning the adverse health effects of HHPA, phthalic anhydride (PA) has been reported to cause allergic rhinitis, conjunctivitis and asthma.[1] Some of the PA-sensitive workers with asthma reported that their asthmatic symptoms occurred when exposed to PA at work, while others reported that their symptoms occurred in the evening while they were home after a workday spent exposed to phthalic anhydride. Workers with asthmatic symptoms associated with exposure to PA were found to have specific IgE antibodies against PA in their

blood.[1,6] The presence of these IgE antibodies suggested that the workers asthmatic symptoms resulted from an IgE mediated allergic reaction to phthalic anhydride.

2. Fluorocarbon 11 and Fluorocarbon 12

Fluorocarbon 11 and Fluorocarbon 12 (Freons) are hydrocarbons containing chlorine and fluorine. Their most common use is as refrigerant gases, and they have been used as propellants for aerosol sprays. Both compounds are considered relatively non-toxic, but at high concentrations (10,000 ppm) they may cause central nervous system depression. Inhaling high concentrations may also produce cardiac arrhythmias, possibly secondary to sensitization of the myocardium to epinephrine. The TLV is 1000 ppm for both compounds.[5,7]

3. Poly-Siloxanes (Silicone)

Siloxanes are compounds which contain oxygen, hydrogen, silicon and usually carbon. The siloxane molecules can be built into large units (poly-siloxanes) which can exist in the form of resins, elastomers or oils. The siloxane oils are commonly termed silicones and, among other uses, are employed as release agents to make parts easily removable from molds. The silicones are considered to be non-toxic, but exposed workers may experience conjunctivitis when exposed to silicone vapor.[8]

4. 1,1,1-Trichloroethane

1,1,1-trichloroethane is irritating to the eyes on contact. Exposure to the vapors depresses the central nervous system. Symptoms include dizziness, incoordination, drowsiness, and increased reaction time. Unconsciousness and death can occur from exposure to excessive concentrations.[7] The OSHA Federal Standard[9] and the ACGIH TLV [5] are 350 ppm. The NIOSH ceiling limit is 350 ppm for a fifteen minute exposure.[10]

5. Particulate

The airborne particulate in TC-74 consists mainly of cured resin dust, which is formed when the insulators are finished. There is currently no specific criterion for evaluating airborne concentrations of plastic resin dusts. However, the American Conference of Governmental Industrial Hygienists (ACGIH) has established a "nuisance dust" standard [5] with a threshold limit value (TLV) for respirable particulates of 5.0 mg/m^3, and that for total particulates of 10 mg/m^3. The corresponding Federal OSHA Standard [9] is 5.0 mg/m^3 for respirable particulates, and 15 mg/m^3 for total particulates. The ACGIH Documentation of TLV's states that nuisance"

dusts are dusts which have a long history of little adverse effect on the lungs and do not produce significant organic disease or toxic effects when exposures are kept under reasonable control."[4] While there is not sufficient information available to classify plastic resin dust as a nuisance dust, the nuisance dust TLV has been used for purposes of comparison since there is no applicable exposure standard.

EVALUATION CRITERIA

The following table summarizes the various limits for airborne environmental contaminant concentrations.

OCCUPATIONAL EXPOSURE LIMIT*

Substance	OSHA Standard**	ACGIH TLV***	NIOSH Recommendation	Health Effect
Total Particulate	15 mg/cu meter	10 mg/cu meter	----------	Eye, skin and upper respiratory irritation
Respirable Particulate	5 mg/cu meter	5 mg/cu meter	----------	Eye, skin and upper respiratory irritation
1,1,1-Trichloroethane	350 ppm	350 ppm; 450 ppm STEL	350 ppm ceiling	Headaches, CNS depressant, eye irritation
Freon 11 and 12	1000 ppm	1000 ppm	----------	CNS depressant at high concentrations
HHPA	----------	----------	----------	Eye, skin, and upper respiratory irritation

* Limits are Time Weighted Average unless otherwise noted
** For OSHA Standards see Ref. 9
***For ACGIH TLV's see Ref. 5

VI. RESULTS

A. Environmental

The environmental results obtained on January 15 and 16, 1979 are presented in Tables I - III. The environmental results obtained on February 5 and 6, 1979 are shown in Tables IV and V. In general, most levels measured were below the relevant evaluation criteria. However, one personal sample for 1,1,1-trichloroethane (Table II) exceeded the 350 ppm NIOSH ceiling. All Freon 11 and 12 measurements were below the evaluation criteria, usually by two orders of magnitude.

On January 15 and 16 (Table I) the level of HHPA in area air samples ranged from 0.1 to 0.9 ppm. On February 5 and 6 (Table V) the levels of HHPA in area and personal breathing zone samples ranged from 0.1 to 1.3 ppm. The molders and loaders (the employees who work near the Wellex mixer) showed higher exposures to HHPA (mean 0.6 ppm) than did workers from other parts of the department (mean 0.3 ppm). Two loaders had the highest HHPA exposures (both 1.3 ppm). Area samples in two nearby departments (TC-3 & TC-6) showed HHPA levels ranging from 0.2 to 0.3 ppm.

Three area samples for measurement of particulates (Table III) approached 40% of the evaluation criterion, but all personal and all other area samples for both respirable and total particulate were less than a quarter of the standard. Analysis of the shot blast material indicated that it contained 6% quartz. Analysis of silica material used as a filler material in the resin showed no free crystalline silica. Qualitative analysis of area sample absorbent tubes taken to determine the major chemical contaminants present in Department TC-74 indicated trichloroethane as the major component. Other compounds present included toluene, cellosolve, freons, and poly-siloxanes. (The freons and poly-siloxanes come from the mold release spray used in the department.)

Ventilation measurements and observations for various systems and locations in the TC-74 department were as follows:

DOUBLE HAND GRINDING TABLE - Measurements indicate 300 - 400 fpm around the edge of table, directly above the exhaust slot, and less than 75 fpm over the remainder of the table top (recommended flow rate is 150-250 fpm[11]). Smoke tubes and dust from grinding operations showed dust moving away from the grinding table into the work area, and in other spots little air movement in any direction.

SINGLE HAND GRINDING TABLE - Measurements indicated approximately 50 fpm at the workpiece (150-250 fpm recommended[11]). The grinding operation sometimes threw dust toward vent, sometimes away

from vent. Smoke tubes showed little air flow from the workpiece into the exhaust system.

SPRAY BOOTH - Face velocity with clean filters (pressure drop 0.02 inches of water) ranged from 100 to 300 fpm (minimum recommended rate is 100 fpm). Smoke released at head level inside the face of the booth circulated back into the breathing zone.

WELEX MIXER - The measured air velocity was 250 fpm at the face of the hood, 75-125 fpm at the top of the mixer, approximately 50 fpm in the breathing zone of the man pouring off mixed resin (the movable curtain was approximately half closed). Smoke showed slow but steady air flow from the breathing zone of the pour-off man up past the mixer into the overhead hood. Depending on how the employee positions himself during pour off, the resin vapors could be drawn through his breathing zone.

OVEN #9 - The air flow at the oven door was approximately 50 fpm. Smoke showed little to no flow, especially inside the oven.

GRINDING HOOD (near WELEX, also used for weighing of powder) - The average face velocity was less than 50 fpm; smoke showed slight draw into hood with the glass door all the way up.

GENERAL AREA - Smoke showed a constant flow out of TC-74 into the TC-6 area. Measurements showed generally 50-75 fpm with up to 125 fpm for short periods.

B. Medical Results

1. RAST Test and CBC Results

Twenty-seven workers employed in Department TC-74 or in nearby areas gave blood samples for RAST test and blood count. Twenty-one worked in TC-74, which employed 33 workers and 6 workers (who felt that they might be allergic to some substance originating in TC-74) worked in areas near TC-74 (eg., TC-3, TC-7). The RAST values ranged from below 5% (negative result) to about 25% (strongly positive). Seven employees from TC-74 and 5 from nearby areas had RAST test results above 5% that indicated the presence of IgE antibody to HHPA in their blood.

The individual results of the antibody determinations and the responses to questions regarding the presence of work related nasal, ocular, and respiratory symptoms are shown in Table VI. In that table the workers are grouped by job assignment (molder-loader or jobs other than molder or loader) and the results of the HHPA antibody determinations. (Seven interviewed workers, who worked in jobs other than loader or

molder, did not have blood drawn for antibody determination and are listed after the workers for whom antibody determination was performed.)

Five of the seven TC-74 workers with antibodies to HHPA had worked in the jobs of loader or molder (Table VI) which have higher exposure to HHPA. The mean length of work in TC-74 was 4.2 years for the seven employees with HHPA antibody and only 1.6 years for the 14 without HHPA antibody. This difference was statistically significant ($p = .03$) The six workers from the nearby areas (five were HHPA-antibody positive) had worked in those areas for an average of six years (range three to 12 years).

The eight people with highest percent binding in the HHPA RAST tests showed cross allergenicity (positive RAST tests) to phthalic anhydride (PA), which is chemically very similar to HHPA. (PA was not used in the plant.)

The complete blood count (CBC) results for all the participants were generally within normal limits except for three workers who had an elevated proportion of eosinophils (greater than 5%) among their white blood cells. The three elevated eosinophil percentages (7,10,13%) occurred in HHPA antibody-positive workers with asthmatic symptoms. (The three antibody-negative workers with asthmatic symptoms had eosinophil percentages of 2% or less.)

The 12 participants who had IgE antibodies to HHPA in their blood tended to have higher eosinophil counts than the 14 antibody negative participants (AB+ mean 5%, AB- mean 2%, [$p= 0.05$]). In the 21 participants from the TC-74 area tested for HHPA antibody, the seven HHPA antibody-positive workers also tended to have higher eosinophil counts (mean 4%) than the 14 HHPA antibody negative workers (mean 2%) but the difference in means was not statistically significant.

2. Questionnaire

Twenty-seven out of the 33 workers employed in TC-74 were interviewed. In addition six self-selected men who were employed in other areas of the plant and thought that substances originating in TC-74 were causing them discomfort were interviewed.

The questionnaire revealed one man who reported symptoms of chronic bronchitis. This employee reported that his symptoms were present prior to working in TC-74 and had not changed since he began employment in the department.

The majority of the TC-74 respondents noted nasal (14/26) and ocular (19/26) symptoms, and four reported symptoms compatible with asthma. All six participants from nearby areas reported ocular and nasal symptoms, and three of them reported asthma-like symptoms.

The percent of positive responses for each symptom for the TC-74 employees grouped by work exposure and antibody response is shown in Table VII. Of the 21 TC-74 employees who had antibody determinations for HHPA, the seven who had detectible antibody to HHPA did not report symptoms with significantly greater frequency than did the 14 antibody-negative workers. However, the two TC-74 workers with the most strongly positive RAST tests had more severe symptoms. (One of these workers reported that his nose "ran like a faucet" whenever he was exposed to HHPA, and the other worker experienced attacks of cough, wheezing, and shortness of breath temporally associated with exposure to HHPA. The five employees who had less strongly positive RAST tests to HHPA had fewer complaints, and their symptoms did not differ appreciably from the complaints of the other employees in TC-74 who occasionally experienced symptoms such as sneezing, nasal congestion, nasal discharge, itchy, watery, or burning eyes that they associated with exposure to HHPA or other irritating substances in TC-74 (e.g. mold release spray, trichlorethane, dust, etc.).

Of the three HHPA antibody-negative TC-74 employees with asthma-like symptoms, one had experienced wheezing and shortness of breath prior to begininning work in TC-74 and had not noted any worsening of his symptoms since starting work in the department. One had a prior history of asthma and, after beginning work in TC-74, had experienced approximately one episode per month of nocturnal attacks of wheezing and difficulty breathing. The third had noted episodes of cough and chest tightness approximately three times per month that he thought might be related to the use of the silicone mold-release spray.

Among the six workers from nearby areas, the severity of symptoms correlated with the level of the antibody test. The three with the highest HHPA RAST binding levels had nasal, ocular, and asthmatic symptoms. Two of these three reported that several days a week they would have chest tightness, wheezing, and shortness of breath, along with nasal congestion and eye irritation while at their work stations. These symptoms would would become much worse if they entered TC-74. Their symptoms would improve when they went home, and would not occur on weekends or during vacations. The third employee also intermittently noted eye symptoms while at his work station. If he entered TC-74 his eye irritation would appreciably worsen

and he would also develop nasal congestion and rhinorrhea. He had experienced episodes of wheezing, and shortness of breath that would occur late in the evening or would awaken him from sleep. These attacks were most likely to occur on evenings following workdays in which his eyes had experienced particularly severe irritation or after days in which he had been in TC-74. The other three employees from nearby areas experienced nasal and ocular symptoms that would occur intermittently while they were at their work stations and that would become worse when they entered TC-74. One of the two employees with HHPA antibody but without asthmatic symptoms had previously worked in TC-74, but the other four employees with HHPA antibody had never worked in that department.

3. Pulmonary Function Testing

On January 15 and 16 (the first workshift of the week), pre- and post- shift pulmonary function testing was performed on 25 workers (23 from TC-74 and two from nearby areas). On February 5 and 6 (first workshift of week), pre- and post-shift pulmonary function testing was performed on 22 workers (17 from TC-74 and five from nearby areas) because of concern that operating conditions may not have been normal on January 15, due to equipment malfunctions.

During the days of testing, none of the four HHPA antibody positive workers who had reported asthmatic symptoms experienced any chest tightness or shortness of breath, and none of them experienced a diagnostically significant (more than 15%) decrement in pulmonary function over the workshift. (The largest decrement between pre- and post-shift FEV_1 or FVC in the four workers with asthmatic symptoms and the presence of antibody in their blood was 2.6%.) None of the three HHPA antibody-negative TC-74 Workers who reported experiencing asthmatic symptoms had diagnostically significant decrements in pulmonary function over their workshifts.

Only one worker (who did not report ever experiencing shortness of breath at work) showed a decrement more negative than - 15% between pre- and post-shift testing (-17% in FEV_1 on Jan. 15). At that time he was recovering from an upper respiratory infection, and in repeat testing on Feb. 5 he showed less than a 3% decrement in pulmonary function over the work shift.

In neither testing period did the group as a whole (25 on Jan. 15, 22 on Feb. 5) experience a significant decrement in pulmonary function over the workshift. If only workers among the 21 employees from TC-74 who had determinations for HHPA antibody are considered, there was no significant difference in the pre- to post-shift change of pulmonary function (FVC or

FEV_1) between the workers with the presence of HHPA antibody and the workers without HHPA antibody on either of the days of testing.

4. Record Review

In June 1982 the records for the 123 present and former TC-74 employees were reviewed to determine if there were data showing the occurrence of adverse health effects in the TC-74 employees. There was no indication in serial pulmonary function tests, blood count results, or reported symptoms that indicated adverse effects on the health of TC-74 workers, beyond entries regarding the two individuals mentioned in the Background section who became short of breath while working in TC-74. The records did not indicate that any individuals previously employeed in TC-74 had transferred from that department because of allergic or irritative symptoms.

VII. DISCUSSION

A. Environmental

Particulate concentrations were all below the recommended standard. One 50-minute trichloroethane sample was above the NIOSH recommended 15-minute exposure ceiling limit (350 ppm) for that compound. The 8-hr. time-weighted average exposure on this employee, however, would not be expected to exceed the OSHA standard due to the nature of his job.

There is currently no standard or other evaluation criterion published for HHPA, and the toxicity of this compound has not yet been determined. However, the ACGIH TLV for the chemically similar compound phthalic anhydride is 1 ppm for an 8-hour TWA. (This standard was set for the irritation caused by PA and did not consider its allergenic properties.) Results obtained on January 15, 1979 (Table I) revealed HHPA concentrations up to 0.9 mg/m^3. This may be due to a leak above the automatic mixing tower in the piping system carrying HHPA. The NIOSH investigators were told that this leak began shortly before mid-day. The HHPA samples shown in Table I seem to reflect this, since the two samples taken on the automatic mixing tower were relatively high, while other samples throughout TC-74 were generally lower.

Samples obtained on the Welex mixing tower on February 5 and 6 (a period of normal operations) showed HHPA levels in the 0.3 to 0.6 ppm. range. The HHPA area samples obtained on the day shift February 5 showed that there was a background level of 0.2 to 0.5 ppm in all parts of the TC-74 area. Personal breathing zone samples obtained on workers performing certain tasks were somewhat higher. The workers who operate the Welex Mixer showed the highest

prolonged exposures. The loaders who carried buckets of warm HHPA to oven #9 to fill molds showed potential exposures up to 1.3 ppm. (The workers used respirators while performing this task.)

It is of interest that the levels of HHPA found on the February 5th day and evening shifts (Table V) in areas TC-6 (0.3 ppm) and TC-3 (0.2 - 0.3 ppm) are comparable to the HHPA levels in general area samples obtained in TC-74. Note that smoke tube and air velocity measurments showed a constant flow out of TC-74 into TC-6. Measurements generally showed flows of 50 - 75 fpm and up to 125 fpm for short periods. Thus, since HHPA was not used in other areas of the plant, and the air flowed out of TC-74, the levels of HHPA detected in TC-6 and TC-3 must have originated in TC-74.

B. Medical

Seven of the twenty-one TC-74 workers who submitted blood for RAST testing had HHPA-specific IgE antibody in their blood. These results indicate that exposure to HHPA in concentrations of approximately 1 ppm TWA over a prolonged interval can provoke the production of specific IgE antibodies to HHPA. The TC-74 HHPA antibody-positive workers tended to have worked in TC-74 for considerable periods of time (mean 4.2 years) and to have worked in the jobs with higher exposure to HHPA. However, antibody production was induced in individuals from nearby departments (TC-3 & TC-7) who had never worked in the department. Presumably, the sensitization of these workers in nearby departments occurred secondary to HHPA that was carried to their work stations by air currents emanating from TC-74. It is possible however, that these workers became sensitized during infrequent visits to TC-74.

The data gathered in this evaluation indicate that HHPA is one of a number of anhydride compounds (e.g. phthalic anhydride, trimelletic anhydride, himic anhydride[13]) that can cause IgE-mediated disease. However, in the TC-74 workforce, the presence of HHPA antibody did not necessarily predict the existence of nasal, eye, or respiratory symptoms. Only the two TC-74 employees with the most strongly positive HHPA RAST tests reported experiencing symptoms associated with exposure to HHPA of noticeably greater severity than the symptoms of the HHPA antibody-negative TC-74 employees. (One had asthma temporally associated with exposure to HHPA, and the other had severe rhinitis also provoked by ambient levels of HHPA in TC-74.) The five TC-74 employees who had less strongly positive RAST tests to HHPA had less severe symptoms, and their complaints did not differ appreciably from the complaints of the other employees in TC-74, who occasionally experienced sneezing, rhinitis, nasal congestion, itchy, watery, or burning eyes. With exposure to an irritating chemical such as HHPA, it is not necessary to be "allergic" to have symptoms of rhinitis or conjunctivitis, since at sufficiently high concentrations the

irritating nature of this substance will cause these symptoms in most people. It is likely that such irritation accounts for the majority of the symptoms reported by the TC-74 workforce, including the symptoms of the five HHPA antibody-positive workers with symptoms similar to those of the HHPA antibody-negative TC-74 workers.

It is not fully understood what factors control the development of allergic symptoms to a chemical substance like HHPA, but the level and duration of exposure are important factors. It is possible that if the ambient HHPA concentrations were lowered and intermittent high exposures prevented, fewer exposed employees would become allergic. However, unless HHPA exposure is entirely eliminated, sensitization cannot be totally prevented, and some exposed individuals will experience allergic symptoms. For those workers who do develop allergic symptoms, changing the work station to a place in TC-74 with a lower ambient concentration of HHPA may help to some extent, but the only way for the employee to avoid symptoms is to transfer to a part of the factory where HHPA is not present.

The occurrence of symptoms compatible with asthma in four employees in TC-74 and three employees from the surrounding areas is of concern. The etiology of the symptoms cannot be definitely determined, but the four cases that occurred in workers with positive RAST tests for HHPA IgE antibody were likely due to an allergic reaction to HHPA. The occurrence of eosinophilia in three of these cases is of interest. However, since eosinophilia can occur in people with asthma both on an allergic or non-allergic basis, it is not clear if the eosinophilia might be secondary to the presence of asthma, allergy to HHPA, or both.

An interesting aspect of this evaluation is that some of the symptomatic employees worked in areas surrounding TC-74 rather than in it. Given the observed pattern of air flow out of TC-74 into the surrounding plant areas, and the exacerbation of the employee's symptoms if they entered TC-74, the symptoms described by the five HHPA antibody-positive workers from nearby areas are probably due to substances emanating from TC-74. The following data indicate that it is most likely that these worker's symptoms are due to an allergic reaction to HHPA:

1. Their strongly positive RAST tests for HHPA specific IgE antibody.

2. The industrial hygiene results showing the presence of HHPA in their work areas.

3. The fact that occupational exposure to a similar chemical, phthalic anhydride (PA), has been documented to cause

asthmatic, nasal, and ocular symptoms, as well as the induction of PA-specific IgE antibody in occupationally exposed workers.

If the symptoms of the study participants from TC-3 and TC-7 are caused by an airborne contaminant from TC-74 such as HHPA, then these participants' symptoms will not occur if airborne contaminants do not escape from TC-74.

VIII. RECOMMENDATIONS

1. The company should continue efforts to minimize employee exposure to HHPA through engineering and work practice controls. In case of an HHPA spill or in instances where HHPA must be handled in non-enclosed operations, suitable respirators should be worn. Wherever possible, production operations that require the use of HHPA in non-enclosed operations should be eliminated by engineering modifications.

2. Periodic maintenance and adjustment of the local exhaust ventilation to assure optimum capture of dusts and chemical vapors will decrease the level of potentially irritating or allergenic substances in Department TC-74.

3. Plant ventilation should be maintained so that air currents will not carry contaminants out of TC-74 into the surrounding plant areas.

4. Symptoms of an allergy to HHPA should be sought during the annual employee medical evaluations. Any workers who note asthmatic symptoms or increasing severity of nasal or eye symptoms should be evaluated for possible allergy to HHPA. Those workers who are found to be allergic to HHPA should transfer to areas of the plant where HHPA is not present.

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1. Local 601 of the International Union of Electrical Workers
2. Westinghouse Power Circuit-Breaker Plant, Trafford, Pennsylvania
3. NIOSH, Region III
4. OSHA, Region III

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

TABLE I

HHPA CONCENTRATIONS

Westinghouse
Trafford, Pennsylvania

January 15 & 16, 1979
HE 78-52

Description	Type*	Day	Duration	Concentration PPM
Sampler placed on upper level of automatic mixing tower	A	1/15	8:20am-11:55am	0.4
Sampler placed on upper level of automatic mixing tower	A	1/15	12:25pm-3:20pm	0.9
Sampler placed on middle level of automatic mixing tower	A	1/15	8:20am-11:55am	0.2
Sampler placed on middle level of automatic mixing tower	A	1/15	12:25pm-3:20pm	0.8
Sampler placed near end of ovens where molds being stripped	A	1/16	12:35am-3:45am	0.2
Sampler placed near end of ovens where molds being stripped	A	1/16	3:45am-6:45am	0.1
Sampler placed near grinding booth	A	1/16	1:45am-2:45am	0.3

*"A" indicates sampler placed in general work area

TABLE II

1,1,1-TRICHLOROETHANE CONCENTRATIONS

Westinghouse
Trafford, Pennsylvania

January 15, 1979
HE 78-52

Description	Type*	Duration	Concentration
Epoxy coater, uses trichloroethane for cleaning workpieces	P	8:50am-2:40pm	20 ppm
Employee cleaning trichloroethane still	P	1:50pm-2:40pm	520 ppm
Hand finishing operation, some mold release spray being used	P	8:20am-12:40pm	4 ppm
Hand finishing operation, some mold release spray being used	P	12:40pm-3:20pm	29 ppm
Sampler placed at top of stairs leading up to automatic mixing platform	A	9:50am-12:05pm	31 ppm
Sampler placed at top of stairs leading up to automatic mixing platform	A	12:15pm-3:25pm	84 ppm
Recommended Standard Ceiling (ACGIH)			350 ppm
Recommended Standard-Ceiling Value (NIOSH)			350 ppm

*"P" indicates personal breathing zone sample
"A" indicated samples placed in general work area

TABLE III

PARTICULATE CONCENTRATIONS

Westinghouse
Trafford, Pennsylvania

January 15, 1979
HE 78-52

Description	Type*	Day	T/R**	Duration	Concentration mg/m^3
Resistor plate cleaner	P	1/15	T	8:10am-11:50am	ND
Resistor plate cleaner	P	1/15	T	12:45pm-3:20pm	ND
Near grinders Breathing Zone while grinding	A	1/15	T	8:00am-11:50am	5.5
Near grinders Breathing Zone while grinding	A	1/15	T	12:45pm-3:20pm	3.6
Near grinding operations	A	1/15	R	1:25pm-3:15pm	ND
Shot blaster	P	1/15	R	8:05am-11:45am	0.1
Shot blaster	P	1/15	R	12:50pm-3:20pm	ND
Grinder	P	1/15	R	12:40pm-3:20pm	ND
Near grinding operations	A	1/15	T	6:35pm-10:00pm	0.1
Mixer	P	1/15	R	4:15pm-6:25pm	1.3

TABLE III (continued)

PARTICULATE CONCENTRATIONS

Westinghouse
Trafford, Pennsylvania

January 15, 1979
HE 78-52

Description	Type*	Day	T/R**	Duration	Concentration mg/m^3
Grinder	P	1/15	T	4:45pm-10:00pm	0.7
Near automatic mixer	A	1/15	T	6:00pm-12:40am	3.7
Recommended Standard (ACGIH)					$10mg/m^3$ Total $5mg/m^3$ Respirable

* "P" indicates personal breathing zone sample
  "A" indicates sampler placed in general work area

**"T" indicates samples results shows total airborne particulate
  "R" indicates samples results shows respirable portion of airborne particulate

TABLE IV

Concentrations of Trichloroethane and Freons

Westinghouse Electric Corp.
Trafford, Pa.

February 5 & 6, 1979
HE 78-52

Description	Day	Type*	Duration	Concentration (PPM) 1,1,1-Trichloroethane	Freon 11	Freon 12
On writing Platform, Top Level of Automatic Mixing System	2/5	A	11:00am-3:20pm	6.8	0.2	1.0
Stripper	2/5	P	1:10pm-3:10pm	7.0	2.1	5.7
On Tool Locker Near Exit End of Oven #2	2/5	A	4:35pm-12:30am	0.7	2.3	4.2
Stripper	2/5	P	8:00am-8:50am	1.5	8.2	23.0
Stripper	2/5	P	8:00am-8:50am	1.8	18.0	2.0
Stripper	2/6	P	12:45am-7:05pm	1.7	3.5	4.2
Stripper	2/6	P	12:40am-7:05am	1.1	2.3	1.4
Recommended Maximum Concentration (ACGIH)				350	1000	1000

*"A" indicates general work area sample
"B" indicates personal breathing zone sample

TABLE V

HHPA Concentrations

Westinghouse Electric Corp.
Trafford, PA

February 5 & 6, 1979
HE 78-52

Description	Day	Type*	Duration	Conc. PPM
Epoxy mixer, Welex	2/5	P	8:10am-10:55am	0.9
Epoxy mixer, Welex	2/5	P	10:55am-3:10pm	0.5
Molder, Welex	2/5	P	8:10am-10:50am	0.5
Molder, Welex	2/5	P	10:50am-3:10pm	0.4
Epoxy loader, Welex	2/5	P	8:20am-11:40am	0.4
Epoxy loader, Welex	2/5	P	1:00pm-3:10pm	0.4
Hand finisher	2/5	P	8:25am-11:30am	0.5
Hand finisher	2/5	P	1:00pm-3:10pm	0.4
Tester	2/5	P	8:30am-11:45am	0.5
Tester	2/5	P	12:40pm-2:15pm	0.3
Tester	2/5	P	2:30pm-3:10pm	0.3
Finisher	2/5	P	8:30am-11:55am	0.3
Finisher	2/5	P	12:40pm-3:05pm	0.3
Move man	2/5	P	8:30am-12:40pm	0.4
Move man	2/5	P	12:40pm-3:10pm	0.3
Lathe operator	2/5	P	8:35am-11:45am	0.4
Lathe operator	2/5	P	12:40pm-3:40pm	0.3
Lathe operator	2/5	P	3:45pm-7:10pm	0.1
Stripper A	2/5	P	8:45am-11:40am	0.4

TABLE V (continued)

HHPA Concentrations

Westinghouse Electric Corp.
Trafford, PA

February 5 & 6, 1979
HE 78-52

Description	Day	Type*	Duration	Conc. PPM
Stripper B	2/5	P	8:55am-11:40am	0.5
On work bench, breathing zone (BZ) level, approx. 30 ft. in front of Welex	2/5	A	8:35am-12:15pm	0.5
On work bench, breathing zone (BZ) level, approx. 30 ft. in front of Welex	2/5	A	12:15pm-3:05pm	0.4
At doorway to TC-6, BZ level	2/5	A	8:35am-3:05pm	0.8
At stairway up to Welex, BZ level	2/5	A	8:40am-12:20pm	0.5
On Welex platform after operation had been shut down and cleaned for the day	2/5	A	12:20pm-3:05pm	0.4
BZ level, near center aisle at piller 13	2/5	A	8:45am-3:05pm	0.5
On tool cabinet at end of oven #2	2/5	A	8:50am-3:10pm	0.5
Held in BZ of man loading Welex	2/5	H	8:48am-9:05am	0.6
Held in BZ of man loading Welex	2/5	H	9:05am-9:20am	< 0.5
Held in BZ of man loading Welex	2/5	H	9:20am-10:00am	0.6
Held in BZ of man operating crane to transfer HHPA from drum to storage tank	2/5	H	9:08am-9:13am	< 1.6
Held in BZ of man pouring HHPA from drum to storage tank	2/5	H	9:08am-9:30am	0.6
Held in BZ of men filling molds in over #9	2/5	H	10:12am-10:32am	1.3

TABLE V (continued)

HHPA Concentrations

Westinghouse Electric Corp.
Trafford, PA

February 5 & 6, 1979
HE 78-52

Description	Day	Type*	Duration	Conc. PPM
Held in BZ of man moving epoxy from Welex to oven #9	2/5	H	10:00am-10:45am	0.6
On locker in TC-6, near post 11B	2/5	A	9:00am-3:20pm	0.3
Near center of TC-3	2/5	A	9:35am-4:00pm	0.3
On writing platform, top level of automatic mixing system	2/5	A	10:25am-3:10pm	0.3
Near sight glass, middle level of automatic mixing system	2/5	A	2:25pm-11:15pm	0.6
Epoxy loader	2/5	P	4:20pm-9:15pm	1.3
Molder	2/5	P	4:20pm-8:10pm	0.2
Finisher	2/5	P	4:25pm-11:10pm	0.2
Stripper C	2/5	P	4:35pm-10:55pm	0.3
Stripper D	2/5	P	4:35pm-10:55pm	0.3
Near center of TC-3	2/5	A	4:00pm-11:25pm	0.2
On locker, near center aisle, at pillar 14	2/5	A	4:20pm-11:30pm	0.2
BZ level, approx. 30 ft from Welex	2/5	A	4:20pm-11:15pm	0.2
On locker, in TC-6, near pole 11-B	2/5	A	4:25pm-11:25pm	0.3
On table in stripping area	2/6	A	12:40am-7:20am	0.4
Stripper	2/6	P	12:40am-7:10am	0.2

*"P" indicates personal breathing zone samples
"A" indicates general work area sample
"H" indicates sampler held in breathing zone

TABLE VI

Summary of Blood Antibody Results and Worker Symptoms

Westinghouse Electric Corp.
Trafford, PA

January 1979

Work Area/Job	Worker	HHPA	PA	% Eosin	Resp*	Nasal	Eye
Nearby Areas	1	23.4	14.6	13	A	+	++
	2	18.0	18.0	3	A	+	++
	3	16.6	11.6	7	A	+	+
	4	15.3	17.8	5	-	++	++
	5	5.1	8.7	2	-	++	++
	6	4.4	-		-	+	+
TC-74 Loaders	7	21.4	23.5	3	-	++	-
or Molders	8	8.7	4.8	10	A	+	+
HHPA Antibody	9	8.4	9.7	3	-	+	+
Positive	10	7.5	-	2	-	-	-
	11	6.5	-	5	-	+	-
TC-74 Loaders	12	4.8	-	2	-	-	+
or Molders	13	4.5	-	1	-	+	++
HHPA Antibody	14	4.4	-	5	-	-	-
Negative	15	3.8	-	4	-	+	++
	16	3.1	-	5	-	-	++
	17	3.0	-	4	-	+	+
Other TC-74	18	6.3	-	1	-	-	-
Employees	19	5.3	-	2	-	-	+
HHPA Antibody Positive							

* A signifies the presence of asthmatic symptoms.

TABLE VI (continued)

Summary of Blood Antibody Results and Worker Symptoms

Westinghouse Electric Corp.
Trafford, PA

January 1979

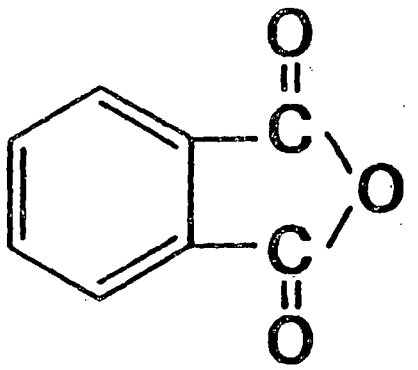
Work Area/Job	Worker	HHPA	PA	% Eosin	Resp*	Nasal	Eye
Other Employees	20	4.5	-	2	A	+	++
HHPA Antibody	21	3.7	-	2	-	-	-
Negative	22	3.6	-	1	A	+	+
	23	3.6	-	1	-	-	-
	24	3.4	-	2	-	-	++
	25	3.3	-	0	-	+	+
	26	3.1	-	0	-	-	+
	27	2.9	-	2	A	+	+
Other Employees	28	-	-	-	-	+	+
HHPA Antibody	29	-	-	-	-	-	+
Undertermined	30	-	-	-	-	+	+
	31	-	-	-	-	+	+
	32	-	-	-	-	-	-
	33	-	-	-	-	+	+

*A signifies the presence of asthmatic symptoms.

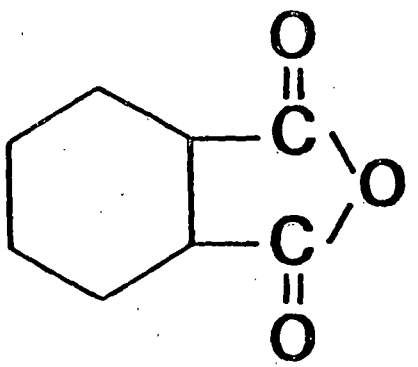
TABLE VII

Summary of Symptoms of TC-74 Workers Grouped by Work Area and HHPA Antibody Results

Employee Group	Number	Percent with Symptoms		
		Nasal	Eye	Asthma
TC-74 Loaders or Molders HHPA Antibody Positive	5	80	40	20
TC-74 Loaders or Molders HHPA Antibody Negative	6	50	83	0
Other TC-74 Workers HHPA Antibody Positive	2	0	50	0
Other TC-74 Workers HHPA Antibody Negative	8	50	75	38
Other TC-74 Workers HHPA Antibody Undertermined	6	67	83	0



Phthalic (PA)



Hexahydrophthalic (HHPA)

FIGURE I

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