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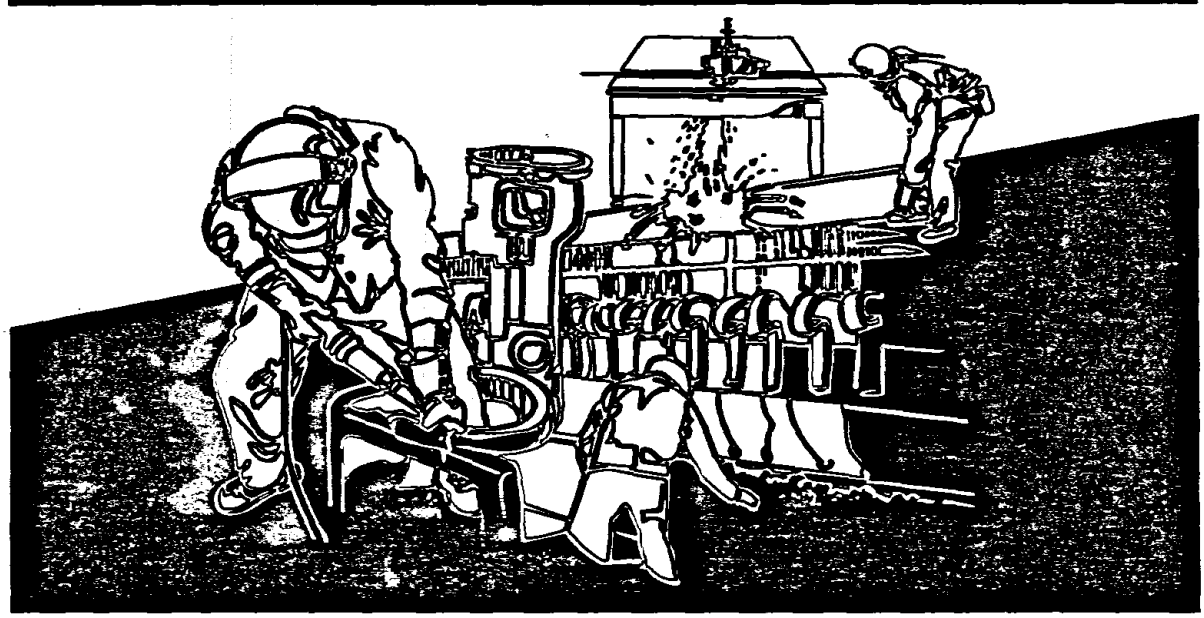
NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 93-0806-2412
PHILIPS DISPLAY COMPONENTS COMPANY
OTTAWA, OHIO



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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 and 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.

HETA 93-0806-2412
APRIL 1994
PHILIPS DISPLAY COMPONENTS COMPANY
OTTAWA, OHIO

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SUMMARY

In March 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the Philips Display Components Company, Ottawa, Ohio. The request concerned ongoing problems such as sore throats, hoarseness, and laryngitis experienced by employees while working in the Aluminizing Department, an area where a thin layer of aluminum is coated to the interior of cathode ray tubes (CRTs).

On July 20-21, 1993, interviews were held with eight Aluminizing Department employees and symptom questionnaires were distributed to 35 first shift employees and 24 second shift employees asking if the worker had experienced symptoms such as eye, nose, or throat irritation, nasal congestion, or headaches. Personal breathing-zone (PBZ) and area air samples were collected in the Aluminizing Department, the Lacquer Room, and outside the plant. These samples were analyzed for inorganic acids (hydrofluoric, nitric, sulfuric, phosphoric, hydrofluoric, and hydrochloric acids) and aluminum, tungsten, and 29 other metals and minerals. Qualitative air samples to identify volatile organic compounds (VOCs) were also collected. Based on estimated amounts of each compound, which ones appeared consistently, and the analytical methods available, six compounds were selected to be quantified. These included acetone, trichloroethylene, n-hexane, toluene, isoamyl acetate, and n-amyl acetate.

Commonly reported symptoms included dry throat and hoarseness, frequent headaches, eye irritation, nasal congestion, and severe fatigue at work. The differences in symptom prevalence between the first shift (where the problem was perceived) and second shift were not statistically significant. The prevalences of symptoms among Aluminizing Department workers were generally elevated when compared with Lacquer Room workers, who were physically separated from the Aluminizing Department employees. In addition, 54% of the first shift participants, and 71% of the second shift workers, perceived working conditions as too hot. A total of 46% of the first shift employees and 71% of the second shift workers complained of too little air movement.

The results from the PBZ and general area air sampling did not identify any substances which exceeded occupational exposure criteria established by NIOSH, the Occupational Safety and Health Administration (OSHA), or the American Conference of Governmental Industrial Hygienists (ACGIH). A time-weighted average (TWA) concentration of 0.13 parts per million (ppm) of hydrochloric acid (HCl) was measured in the Aluminizing Department at the load end of

Carousel #2. While this concentration is below applicable NIOSH, OSHA, and ACGIH exposure criteria, studies have suggested that exposure to HCl below the threshold for taste or eye irritation can still induce sneezing, hoarseness, chest pain, a feeling of suffocation, and lung function impairment. Along with air sampling for the above substances, comfort indicators (temperature and relative humidity) were measured in the Aluminizing Department on July 21, 1993. Temperature and relative humidity levels in this department ranged from 73 to 75°F and 47 to 49%, respectively. These levels are within the comfort range recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for thermal comfort.

NIOSH investigators determined that a health hazard did not exist in the Aluminizing Department during this investigation. While it is unlikely that chronic exposure to the low levels of HCl measured at the load end of Carousel #2 (0.13 ppm, TWA) will cause any significant health effects, it is possible this concentration may elicit irritative symptoms in some of the more sensitive workers. A recommendation has been made for the company to conduct additional sampling in an attempt to identify the source of the HCl which is entering the Aluminizing Department.

Keywords: SIC 3671 (Electron Tubes), IEQ, IAQ, aluminum, tungsten, television tubes, electronics, hydrochloric acid, temperature, humidity

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from management at the Philips Display Components Company, Ottawa, Ohio, concerning health problems among some workers in the Aluminizing Department. Approximately 10-12 employees had reportedly experienced sore throats and hoarseness. Some of these workers, who had subsequently transferred out of this department, had seen their symptoms subside.

Prior to this NIOSH evaluation, the Aluminizing Department had been evaluated by Philips health, safety, and engineering personnel, by the company's insurance carrier, and by an outside bioaerosol consultant. No definitive findings, except carbon dioxide (CO_2) levels above 1000 parts per million (ppm), had been documented. Carbon dioxide levels are often used to evaluate the adequacy of ventilation systems in *non-industrial* work settings. Levels above 1,000 ppm (in the absence of CO_2 sources) suggest that an insufficient amount of outside air is being introduced into the occupied space. However, several factors, including a large work space and high ceilings, along with potential CO_2 sources (such as forklifts) and a low worker density, make CO_2 levels an unreliable indicator of ventilation adequacy in the Aluminizing Department.

BACKGROUND

The Philips Display Components Company employs approximately 1800 persons over three shifts in the manufacture of cathode ray tubes (CRTs). The original plant, constructed in 1947, has been expanded over the years to increase production capacity or to add new product lines. Currently this facility produces approximately 15,000 CRTs per day in a variety of sizes. The focus of this NIOSH HHE was the Aluminizing Department. Approximately 100 people work over three shifts in this department.

Aluminizing Department

During the manufacture of CRTs, a thin layer of aluminum is coated to the interior of the glass tube. As the CRTs travel along a continuous, overhead conveyor/rack system, small aluminum pellets are manually placed inside the tube along with a coiled tungsten heating element.* The aluminum coating process is achieved by

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* At this manufacturing stage, the front "screen" section and the rear "neck" sections of the CRT have not been permanently joined. This permits easy access to the interior of the tube assembly.

creating an environment similar to what occurs inside a tungsten-filament light bulb. Moving along either of two oval-shaped carousel lines (these lines are designated as either the "large" or "small" carousel line based on the tube sizes which are conveyed), a high vacuum is drawn inside the CRT. The CRT assembly is then heated to vaporize the aluminum pellets and coat the interior of the tube. After coating, the CRT is opened and the tungsten heating coil is removed. The tungsten coil, which also acts as a catalyst in this coating process, can be used approximately 20 times before needing replacement. A diagram of the Aluminizing Department is shown in Figure 1.

Prior to this survey, company personnel determined that the Aluminizing Department is under a slight negative pressure in relation to adjacent CRT manufacturing operations such as the Lacquer Room, Reclaim/Panel Prep, and Mask Prep. Some of the chemicals used in these surrounding areas include toluene, acetone, hydrofluoric acid (HF), caustic soda (NaOH), and calcium silicate. While the entrances to the Aluminizing Department are sealed with doors or plastic strip curtains, an open conveyor tunnel connects the Aluminizing Department with the Reclaim/Panel Prep area. Some of the Aluminizing Department workers suspected that airborne contaminants (such as NaOH and HF) were migrating from the Reclaim/Panel Prep area through this tunnel.

Air sampling had been conducted by Philips personnel in the Aluminizing Department prior to this NIOSH evaluation for caustic soda, HF, aluminum, oil mist, volatile organic compounds (VOCs), and tungsten. Levels of these substances, however, were low and substantially below their respective occupational exposure criteria.

EVALUATION METHODS

Medical Evaluation

During the site visit on July 20-21, 1993, interviews were held with eight employees, including all five workers who operated the "small" carousel, and three workers who were assigned to the "large" carousel. Symptom questionnaires were distributed to 35 first shift employees and 24 second shift employees working in the Aluminizing Department. The questionnaire asked if the employee had experienced, while at work on the day of the survey, any of several symptoms (irritation, nasal congestion, headaches, etc.). The questionnaire also asked about the frequency of these symptoms while at work in the building during the four weeks preceding the survey, and whether these symptoms tended to get worse, stay the same, or get better when they were away from work. The final section of the questionnaire asked about environmental comfort (too hot, too cold,

unusual odors, etc.) experienced while the employees were working in the building during the four weeks preceding the questionnaire administration.

For further analysis, NIOSH investigators compared responses from seven workers on each shift who worked in the adjacent Lacquer Room. These workers were physically separated from the Aluminizing Department employees, and thus served as an "unexposed" comparison population. Results from the symptom questionnaires were then assessed to see if the responses from either the first- or second-shift Aluminizing Department workers differed from those of Lacquer Room workers (from both shifts combined).

Environmental Evaluation

Personal breathing-zone (PBZ) and general area air samples were collected on July 21, 1993, in the Aluminizing Department, the Lacquer Room, and outside the plant. A scan for inorganic acids, including HF, nitric, sulfuric, phosphoric, hydrobromic, and hydrochloric acids was conducted. Air samples were analyzed for aluminum, tungsten, and 29 other metals and minerals. Qualitative samples to identify any VOCs present were collected using extremely sensitive thermal desorption (TD) tubes. Based on the estimated amounts of each compound, which ones appeared consistently, and the analytical methods available for quantitation, six compounds were selected to be quantified. These included acetone, trichloroethylene, n-hexane, toluene, isoamyl acetate, and n-amyl acetate. Table 1 summarizes the air sampling techniques and analytical methods used in this evaluation. Temperature and relative humidity measurements were also made to evaluate employee thermal comfort.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by work place exposures, NIOSH field staff employ evaluation criteria for the assessment of a number of chemical (and physical) agents. The primary sources of environmental evaluation criteria for the work place are the following: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), (2) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs), and (3) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values® (TLVs).[1,2,3] The objective of these criteria for chemical agents is to establish levels of inhalation exposure to which the vast majority of workers may be exposed without experiencing adverse health effects.

Full-shift and shorter duration inhalation criteria are available depending on the specific physiologic properties of the chemical substance. Full-shift limits are

based on the time-weighted average (TWA) airborne concentration of a substance that most workers may be repeatedly exposed to during a normal eight or 10-hour day, up to 40 hours per week for a working lifetime, without adverse effect. Some substances have recommended short-term exposure limits (STELs) or ceiling limits which are intended to supplement the full shift criteria where there are recognized irritative or toxic effects from brief exposures to high airborne concentrations. STELs are based on TWA concentrations over 15 minute time periods, whereas ceiling limits are concentrations which should not be exceeded even momentarily.

Occupational health criteria are established based on the available scientific information provided by industrial experience, animal or human experimental data, or epidemiologic studies. Differences between the NIOSH RELs, OSHA PELs, and ACGIH TLVs may exist because of different philosophies and interpretations of technical information. It should be noted that RELs and TLVs are guidelines, whereas PELs are standards which are legally enforceable. OSHA PELs are required to take into account the technical and economical feasibility of controlling exposures in various industries where the agents are present. The NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility of the affected industries and as such tend to be conservative. A Court of Appeals decision vacated the OSHA 1989 Air Contaminants Standard in *AFL-CIO v OSHA,* 965F.2d 962 (11th cir., 1992); and OSHA is now enforcing the previous 1971 standards (listed as Transitional Limits in 29 CFR 1910.1000, Table Z-1-A).[2] However, some states which have OSHA-approved State Plans will continue to enforce the more protective 1989 limits. NIOSH encourages employers to use the 1989 limits or the RELs, whichever are lower.

It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these occupational health exposure criteria. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, previous exposures, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other work place exposures, or with medications or personal habits of the worker (such as smoking, etc.) to produce health effects even if the occupational exposures are controlled to the limit set by the evaluation criterion. These combined effects are often not considered by the chemical specific evaluation criteria. Furthermore, many substances are appreciably absorbed by direct contact with the skin and thus potentially increase the overall exposure and biologic response beyond that expected from inhalation alone. Finally, evaluation criteria may change over time as new information on the toxic effects of an agent become available. Because of these reasons, it is prudent for an employer to maintain worker exposures well below established occupational health criteria.

RESULTS

Medical

Interviews were conducted with eight employees. Several of the interviewed workers reported experiencing health symptoms while in the building. Commonly reported symptoms included dry throat and hoarseness that progressed throughout the work week, frequent headaches, eye irritation, nasal congestion, and severe fatigue at work. In addition, employees reported that they frequently worked in an environment that was too hot.

During the site visit, questionnaires were collected from 35 (79% response rate) first shift and 24 (75% response rate) second shift workers in the Aluminizing Department. Among first shift employees, five currently smoked cigarettes, eight were former smokers, and 21 had never smoked. Among second shift workers, five currently smoked cigarettes, five were former smokers, and 14 had never smoked cigarettes. First shift respondents had worked in the building for an average of 16.2 years and worked an average of 43 hours per week (range 40-65 hours). Second shift workers had considerably less seniority than their first shift counterparts. Second shift respondents had worked in the building for an average of 8.5 years, and worked an average of 43 hours per week (range 40-60 hours).

The questionnaire results are shown in Table 2A. The first column of Table 2A shows the percentage of first shift respondents who reported the occurrence of symptoms while at work on the day of the survey. Table 2B shows the same report of symptoms from the second shift. Sore or dry throat, unusual fatigue, nasal congestion, and headache are the most commonly reported symptoms. The symptom prevalences among the two shifts were generally similar and the few differences were not statistically significant.

The second column of Tables 2A and 2B shows the percentage of employees who reported experiencing the respective symptom once a week or more often while at work during the four weeks preceding the survey. With few exceptions, these symptom prevalences are similar to those for symptoms experienced on the day of the survey.

The third column shows the percentage of employees who reported experiencing symptoms once a week or more often while at work during the four weeks preceding the survey and also reported that the symptom tended to get better when they were away from work. This latter criterion was used to define a "work-related" symptom, but it is possible that a symptom which does not usually improve when away from the building could also be due to conditions at work.

The reported "work-related" frequent symptom prevalences shown in the third column of Tables 2A and 2B, are generally lower than the corresponding symptom prevalence over the last four weeks (shown in the second column) and are consistent for the symptoms described above. Overall, twenty (57% of the 35) first shift respondents, and 13 (54% of the 24) second shift respondents reported having one or more symptoms that had occurred at work one or more days a week during the preceding four weeks and tended to get better when away from work.

For further analysis, NIOSH investigators compared responses from seven workers on each shift who worked in the adjacent Lacquer Room. These workers were physically separated from the Aluminizing Department employees, and thus served as an "unexposed" comparison population. Results from the symptom questionnaires were then assessed to see if the responses from either the first- or second-shift Aluminizing Department workers differed from those of Lacquer Room workers (from both shifts combined). The prevalence of symptoms from Aluminizing Department workers were generally higher than Lacquer Room workers (Table 3). These results, however, show no statistical difference in prevalence rate ratios (all confidence intervals overlap one).

Tables 4A and 4B (first and second shift respectively) show results of employee reports regarding environmental conditions at their workstations on the day of the survey and during the four weeks preceding the survey. Column one shows the results for the day of the survey. It shows that 60% of the first shift and 71% of the second shift respondents perceived that the ventilation system was not providing sufficient air movement, 66% of the first shift respondents and 71% of the second shift respondents thought it was too hot, and only 3% of the first shift and none of the second shift felt that it was too cold during at least part of their work day.

The second column shows the responses to the questions about environmental comfort conditions experienced in the facility during the four weeks preceding the survey. Adverse environmental conditions (too hot, too cold, odors, etc.) were considered "frequent" if they were reported to occur at work once a week or more often. Fifty-four percent of the first shift participants perceived working conditions as too hot, compared to 71% of the second shift workers who indicated their work site was too hot. A total of 46% of the first shift employees indicated that there was too little air movement while 71% of the second shift workers complained of too little air movement. In addition, 49% of the first shift workers considered the air too dry while 34% of the workers indicated that the air was too humid. Similarly, 46% of the second shift workers felt the air was too dry and 38% indicated that the air was too humid.

Environmental

No substances were identified in any of the air samples collected which exceed any occupational exposure criteria. Table 5 contains the quantitative results from the analysis of the six dominant VOCs identified from the qualitative analyses of the thermal desorption tubes (see Figure 2). Only trace amounts of acetone, trichloroethylene, toluene, and n-amyl acetate were detected in the Aluminizing Department. Solvent levels in the Lacquer Room were slightly higher, but still below any applicable exposure criteria. Hexane and isoamyl acetate were not detected in any of these air samples.

Table 6 summarizes the results from the elemental analysis of four area air samples. The ten metals listed in the table were those elements which were present in quantifiable amounts. None of these metals, however, exceeded any applicable exposure criteria. Although the elements barium and yttrium are not typically found in most industrial settings, the low levels measured in this evaluation are not unexpected since both metals are used in the manufacturing of CRTs.

Table 7 contains the results from the samples collected for inorganic acids. As with the previous air monitoring results, these levels were below their respective occupational exposure criteria.

Along with air sampling for the above substances, temperature and relative humidity levels were measured in the Aluminizing Department and surrounding areas on July 21, 1993. Temperatures in the Aluminizing Department remained very consistent, ranging from 73 to 75°F. Relative humidity levels behaved in a similar fashion, ranging from 47 to 49%. These levels are within the comfort range recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for thermal comfort.

DISCUSSION AND CONCLUSIONS

In general, the results from the PBZ and general area air sampling conducted during this evaluation did not identify any substances which were present in concentrations that would readily explain the symptoms reported by some employees in the Aluminizing Department. However, a TWA concentration of 0.13 ppm of hydrochloric acid (HCl) was measured at the load end of Carousel #2. While this concentration is below the NIOSH, OSHA, and ACGIH exposure criteria, some studies have suggested that exposure to HCl below the threshold for taste or eye irritation can induce sneezing, hoarseness, chest pain, and a feeling of suffocation.[4] In other research, both odor detection and temporary pulmonary function impairment were observed in individuals exposed to HCl levels ranging

from 0.067 to 0.134 ppm.[5] In another study eye irritation was observed following exposure to HCl concentrations below occupational exposure criteria.[6]

NIOSH investigators did not determine where the gaseous HCl may be originating. While it is unlikely that chronic exposure to these low levels of HCl will cause any significant health effects, it is possible the concentration of HCl measured near Carousel #2 (0.13 ppm, TWA) may elicit irritative symptoms in some of the more sensitive workers.

RECOMMENDATIONS

Additional full-shift sampling for HCl should be conducted in the Aluminizing Department (specifically, near the load end of Carousel #2) and in the nearby Reclaim/Panel Prep area. Since the levels of this inorganic acid may be very low, the sample volumes should be sufficiently large to obtain suitably low minimum detectable and minimum quantifiable concentrations for the sample set.
In addition, a chemical audit should be conducted to identify any source(s) of HCl and the route this chemical is entering the Aluminizing Department.

REFERENCES

1. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. MMWR 37 (supp. S-7).

2. Code of Federal Regulations [1989]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

3. ACGIH [1992]. Threshold limit values and biological exposure indices for 1992-1993. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

4. WHO [1982]. Environmental health criteria: chlorine and hydrogen chloride. World Health Organization, Environmental Health Criteria, p. 75.

5. Finkel AJ, ed [1983]. Hamilton and Hardy's Industrial Toxicology, 4th ed. John Wright, PSG Inc., Boston, MA, p. 179.

6. ITI [1985]. Toxic and hazardous industrial chemicals safety manual. The International Technical Information Institute, Tokyo, Japan, pp. 272-273.

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Copies of this report have been sent to:

1. Philips Display Components, Ottawa, Ohio
2. IBEW, Local 1654
3. OSHA, Region V

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 1
Sampling and Analytical Methods
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 07/21/93

Method (where applicable)	Collection Device	Sampling Flow Rate	Analytical Method	Comments
NIOSH Method No. 7300 (Elements)	Mixed cellulose ester filter, 37 millimeters in diameter, 0.8 micron pore size	2.0 lpm (full-shift samples)	Inductively coupled plasma emission spectrometer Limit of Detection: Ranged from 0.005 to 5.0 µg/sample (depending on element) Limit of Quantitation: Ranged from 0.017 to 15.0 µg/sample (depending on element)	Full-shift general area air samples collected during the work day.
NIOSH Method No. 7903 (inorganic acids)	Silica gel tubes (100/50 mg size)	200 cc/min (full-shift samples)	Ion chromatography Limit of Detection: 0.7 to 3.0 µg/sample (depending on inorganic acid) Limit of Quantitation: 2.1 to 7.0 µg/sample (depending on inorganic acid)	Full-shift general area samples collected to evaluate exposures during the work day
NIOSH Method No. 1022 (selected organic solvents) (quantitative analysis)	Charcoal tubes (100/50 mg size)	100 cc/min (full-shift samples)	Flame ionization gas chromatography Limit of Detection: 1 to 3 µg/sample (depending on organic solvent) Limit of Quantitation: 4 to 14 µg/sample (depending on organic solvent)	Personal breathing-zone and area samples collected to quantitate selected VOCs, including acetone, trichloroethylene, toluene, and n-amyl acetate
VOCs (qualitative analysis)	Charcoal tubes (100/50 mg size) Thermal desorption tubes (three layers, containing Carbotrap C, Carbotrap, and Carboxen 569)	200 cc/min (full-shift CT samples) 20 cc/min (short-term TD samples)	Flame ionization gas chromatography was used to qualitatively analyze the CT samples (qualitative analysis only) A Perkin-Elmer ATD 400® thermal desorption system used to analyze the TD tubes (qualitative analysis only)	Full-shift CT samples qualitatively analyzed and compared to qualitative analysis of the TD tubes. This information was used to select the predominate VOCs present in the samples

Abbreviations and Comments:

cc/min = cubic centimeters of air per minute
FID = Flame Ionization Detector
LPM = liters of air per minute
mg = milligrams
VOC = Volatile Organic Compounds
GC = Gas Chromatography
CT = charcoal tube
TD = A stainless steel thermal desorption tube. Each tube contained three layers of sorbent material (Carbotrap C, Carbotrap, and Carboxen) and were prepared by NIOSH chemists.

Source for analytical methods:

Eller PM, ed. [1989]. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH)

Table 2A
Symptoms Experienced At Work (Shift 1)
Phillips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Symptoms of 35 First Shift Workers	Experienced on Days of Survey While at Work	Frequently Experienced Last Four Weeks While at Work	Have Frequent Symptoms that Improve When Away from Work
Dry, itching, or irritated eyes	29%	26%	23%
Tired or strained eyes	26%	29%	23%
Stuffy nose, or sinus congestion	29%	37%	26%
Sneezing	14%	14%	3%
Sore or dry throat	51%	54%	46%
Dry or itchy skin	20%	23%	11%
Unusual fatigue or drowsiness	34%	40%	29%
Headache	29%	37%	29%
Tension, irritability or nervousness	29%	20%	14%
Difficulty with memory or concentration	11%	11%	0%
Nausea or upset stomach	3%	3%	3%
Feeling depressed	14%	11%	9%
Pain or stiffness in back, shoulders, or neck	46%	46%	23%
Dizziness or lightheadedness	11%	11%	9%
Cough	14%	20%	9%
Chest tightness	3%	3%	0%
Wheezing	6%	6%	0%
Shortness of breath	6%	14%	9%

Table 2A
Symptoms Experienced At Work (Shift 1)
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Symptoms of 35 First Shift Workers	Experienced on Days of Survey While at Work	Frequently Experienced Last Four Weeks While at Work	Have Frequent Symptoms that Improve When Away from Work
Dry, itching, or irritated eyes	29%	26%	23%
Tired or strained eyes	26%	29%	23%
Stuffy nose, or sinus congestion	29%	37%	26%
Sneezing	14%	14%	3%
Sore or dry throat	51%	54%	46%
Dry or itchy skin	20%	23%	11%
Unusual fatigue or drowsiness	34%	40%	29%
Headache	29%	37%	29%
Tension, irritability or nervousness	29%	20%	14%
Difficulty with memory or concentration	11%	11%	0%
Nausea or upset stomach	3%	3%	3%
Feeling depressed	14%	11%	9%
Pain or stiffness in back, shoulders, or neck	46%	46%	23%
Dizziness or lightheadedness	11%	11%	9%
Cough	14%	20%	9%
Chest tightness	3%	3%	0%
Wheezing	6%	6%	0%
Shortness of breath	6%	14%	9%

Table 2B
Symptoms Experienced At Work (Shift 2)
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Symptoms of 24 Second Shift Workers	Experienced on Days of Survey While at Work	Frequently Experienced Last Four Weeks While at Work	Have Frequent Symptoms that Improve When Away from Work
Dry, itching, or irritated eyes	29%	33%	21%
Tired or strained eyes	29%	29%	17%
Stuffy nose, or sinus congestion	29%	37%	17%
Sneezing	17%	25%	8%
Sore or dry throat	50%	38%	21%
Dry or itchy skin	25%	58%	13%
Unusual fatigue or drowsiness	38%	25%	25%
Headache	29%	42%	25%
Tension, irritability or nervousness	21%	25%	17%
Difficulty with memory or concentration	25%	29%	13%
Nausea or upset stomach	13%	8%	8%
Feeling depressed	17%	8%	8%
Pain or stiffness in back, shoulders, or neck	46%	46%	25%
Dizziness or lightheadedness	17%	8%	4%
Cough	8%	8%	4%
Chest tightness	4%	8%	8%
Wheezing	13%	17%	8%
Shortness of breath	8%	8%	8%

Table 3
Comparison of Prevalence Rate Ratios, Aluminizing Dept. Shifts #1 and #2 vs. Lacquer Room
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Symptom	Prevalence Rate Ratio (PRR) (95% Confidence Intervals)		
	Shift 1 vs. Lacquer Room*	Shift 2 vs. Lacquer Room	All Aluminizing vs. Lacquer Room
Dry, itching or irritated eyes	0.83 (0.2-3.34)	0.88 (0.1-8.8)	0.82 (0.12-6.9)
Tired or strained eyes	0.83 (0.2-3.34)	0.73 (0.16-3.23)	0.82 (0.22-3.06)
Stuffy nose or sinus congestion	2.21 (0.32-15.14)	1.45 (0.19-11.15)	1.88 (0.28-12.57)
Sneezing	Undefined	Undefined	Undefined
Sore or dry throat	1.20 (0.45-3.19)	1.09 (0.39-3.04)	1.15 (0.45-2.97)
Dry or itchy skin	0.83 (0.10-6.92)	1.09 (0.10-9.03)	0.94 (0.13-6.83)
Unusual fatigue or drowsiness	2.76 (0.41-18.46)	1.82 (0.25-13.28)	2.35 (0.36-15.45)
Headache	1.1 (0.29-4.20)	1.09 (0.27-4.34)	1.10 (0.31-3.95)
Tension, irritability or nervousness	1.1 (0.14-8.54)	1.45 (0.19-11.15)	1.25 (0.18-8.74)
Difficulty with memory or concentration	Undefined	Undefined	Undefined
Nausea or upset stomach	Undefined	Undefined	Undefined
Feeling depressed	0.55 (0.06-5.34)	0.73 (0.08-6.97)	0.63 (0.08-4.93)
Pain or stiffness in back, shoulders, or neck	0.97 (0.25-3.77)	0.91 (0.22-3.78)	0.94 (0.26-3.45)
Cough	0.55 (0.06-5.34)	0.36 (0.03-5.15)	0.47 (0.06-3.99)
Chest Tightness	Undefined	Undefined	Undefined
Wheezing	Undefined	Undefined	Undefined
Shortness of breath	Undefined	Undefined	Undefined
Dizziness or Lightheadedness	Undefined	Undefined	Undefined

Comments:

1. Prevalence Rate Ratios (PRRs) compare the rate of symptoms among Aluminizing Department shift workers with symptoms rates among Lacquer Room employees. Numbers above "1" indicate that Aluminizing Department workers have higher symptom prevalences than Lacquer Room workers. Numbers less than "1" indicate that Aluminizing Department employees have symptoms prevalences that are lower than Lacquer Room workers.
2. *Undefined* occurs when the symptom is not reported in the control group (in this case the Lacquer Room employees). Thus the rate would be "0" for the control group. Since any number divided by zero is undefined, the rate ratios have been labeled "undefined."

* Controls were all Lacquer room employees.

Table 4A
First Shift Workers: **Description Of Work Place Conditions**
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Conditions	Experienced at Work During Days of the Survey 35 Workers	Frequently Experienced While at Work During Previous Four Weeks 35 Workers
Too much air movement	0%	0%
Too little air movement	60%	46%
Temperature too hot	66%	54%
Temperature too cold	3%	3%
Air too humid	40%	34%
Air too dry	49%	49%
Tobacco smoke odors	11%	11%
Chemical odors (e.g., paint, cleaning fluids, etc.)	23%	31%
Other unpleasant odors (e.g., body odor, food odor, perfume)	17%	17%

Table 4B
Second Shift Workers: **Description Of Work Place Conditions**
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 7/21/93

Conditions	Experienced at Work During Days of the Survey 24 Workers	Frequently Experienced While at Work During Previous Four Weeks 24 Workers
Too much air movement	4%	0%
Too little air movement	71%	71%
Temperature too hot	71%	71%
Temperature too cold	0%	0%
Air too humid	38%	38%
Air too dry	42%	46%
Tobacco smoke odors	0%	4%
Chemical odors (e.g., paint, cleaning fluids, etc.)	33%	29%
Other unpleasant odors (e.g., body odor, food odor, perfume)	13%	17%

Table 5
Results of Personal Breathing-Zone and Area Air Samples for Acetone, Trichloroethylene, Toluene, and n-Amyl Acetate
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 07/21/93

Sample Location	Sample #	Sample Type	Sampling Time (military time)	Sample Flow Rate	Sample Volume (liters)	Concentration, parts per million			
						Acetone	Trichloroethylene	Toluene	n-Amyl Acetate
Carousel #2, Unloader	5	PBZ	0747 to 1458	100 cc/min	43.1	Trace	Trace	Trace	Trace
Carousel #2, Unloader	6	PBZ	0749 to 1501	100 cc/min	43.2	Trace	Trace	Trace	Trace
Mass Loader (Between Carousel #1 and #2	7	PBZ	0752 to 1502	100 cc/min	43.0	Trace	Trace	Trace	Trace
Carousel #1, Unloader	8	PBZ	0801 to 1459	100 cc/min	41.8	Trace	Trace	Trace	Trace
Outside at Guard's Station	17	GA	0917 to 1545	100 cc/min	77.6	Trace	Trace	Trace	ND
Lacquer Line #2, Unload End	18	GA	0749 to 1520	100 cc/min	45.1	0.52	0.05	1.9	Trace
Carousel #1, Slugging Area (South End)	20	GA	0803 to 1523	100 cc/min	44.0	Trace	Trace	Trace	ND
Minimum Detectable Concentration (MDC)					40.0	0.02	0.01	0.01	0.01
Minimum Quantifiable Concentration (MQC)					40.0	0.08	0.05	0.05	0.07
Exposure Criteria (expressed in parts per million)									
NIOSH Recommended Exposure Limit (REL)						250 TWA	Ca; 25 TWA; 2 Ceiling	100 TWA; 150 STEL	100 TWA
OSHA Permissible Exposure Limit (PEL)						1000 TWA	100 TWA; 200 Ceiling	200 TWA	100 TWA
ACGIH Threshold Limit Value (TLV)						750 TWA	50 TWA; 100 STEL	50 TWA	100 TWA

Abbreviations:
ND = Not detected
TWA = Time Weighted Average (8-hours)
STEL = Short-term Exposure Limit (15 minutes)
Trace = Value is between the MDC and the MQC
GA = General area air sample
PBZ = Personal breathing-zone air sample
Ceiling = Level which should not be exceeded
Ca = NIOSH considers this compound to be and recommends that exposures be kept as low as is feasible.

Comments:
Hexane and isoamyl acetate were not detected on the air samples collected in this evaluation. The MDC for each of these compounds was 0.01 ppm.

Table 6
Results of General Area Air Samples for Elements
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 07/21/93

Sample Location	Sampling Time (military time)	Sample Volume (liters)	Concentration, micrograms per cubic meter									
			Aluminum	Barium	Calcium	Chromium	Iron	Magnesium	Sodium	Yttrium	Zinc	Zirconium
Take-off end of bismuth spray area, approx. 12 ft. from bismuth spray cabinet	0803 to 1518	870	Trace	0.05	3.0	1.0	Trace	Trace	8.0	4.0	Trace	ND
At Carousel #2 (Load End)	00806 to 1521	870	Trace	Trace	21.0	Trace	Trace	Trace	ND	1.0	9.0	ND
Face of bismuth spray cabinet (no employee stationed at this location)	0759 to 1518	876	9.0	1.7	3.0	1.0	4.0	0.7	340	4.0	Trace	0.4
Outside (Near guard station at the front gate)	0917 to 1545	776	2.0	ND	4.0	ND	ND	Trace	ND	ND	Trace	Trace
Minimum Detectable Concentration (MDC)		870	0.6	0.02	0.3	0.2	0.9	0.2	6.0	0.01	0.4	0.04
Minimum Quantifiable Concentration (MQC)		870	2.0	0.05	1.0	0.5	3.0	0.5	17	0.03	1.2	0.14

Exposure Criteria

The blank corrected, time-weighted average concentrations of the above elements are measured during this evaluation were well below their respective NIOSH Recommended Exposure Limits, OSHA Permissible Exposure Limits, and the ACGIH Threshold Limit Values.

Abbreviations:
ND = Not detected
Trace = Value is between the MDC and the MQC

Comments:
The following elements were not detected in these air samples:

Arsenic	Beryllium	Cadmium	Cobalt	Selenium	Thallium
Copper	Lithium	Manganese	Molybdenum	Silver	Titanium
Nickel	Lead	Phosphorus	Platinum	Tellurium	Vanadium

Table 7
Results of Area Air Samples for Inorganic Acids
Philips Display Components, Ottawa, Ohio
HETA #93-0806
Date: 07/21/93

Sample Location	Sample #	Sampling Time (military time)	Sample Flow Rate	Sample Volume (liters)	Concentration of inorganic acids, expressed in parts per million			
					Nitric	Sulfuric	Hydrochloric	Hydrofluoric
Reject wash area, north end (near the conveyor tunnel leading to the Aluminizing Department)	9	0745 to 1358	200 cc/min	74.6	ND	Trace	Trace	Trace
Carousel #2, Load end	10	0815 to 1403	200 cc/min	73.4	Trace	Trace	0.13	Trace
Hallway between Aluminizing Department and Panel Prep (near inspection station)	11	0753 to 1400	200 cc/min	69.6	ND	Trace	Trace	Trace
Outside the plant (near front gate)	12	0917 to 1545	200 cc/min	77.6	ND	0.01	Trace	ND
Minimum Detectable Concentration (MDC)				74.0	0.004	0.003	0.01	0.03
Minimum Quantifiable Concentration (MQC)				74.0	0.01	0.01	0.03	0.10
Exposure Criteria (expressed in parts per million)								
NIOSH Recommended Exposure Limit (REL)					2 ppm TWA; 4 ppm STEL	0.25 ppm TWA	5 ppm Ceiling	3 ppm TWA; 6 ppm STEL
OSHA Permissible Exposure Limit (PEL)					2 ppm TWA	0.25 ppm TWA	5 ppm Ceiling	3 ppm TWA; 5 ppm Ceiling
ACGIH Threshold Limit Value (TLV)					2 ppm TWA; 4 ppm STEL	0.25 ppm TWA	5 ppm Ceiling	3 ppm Ceiling

Abbreviations:
ND = Not detected
TWA = Time Weighted Average (8-hours)
STEL = Short-term Exposure Limit (15 minutes)
Trace = Value is between the MDC and the MQC
GA = General area air sample
Ceiling = Level which should not be exceeded
Trace = Level is between the MDC and the MQC

Comments:
Phosphoric and hydrobromic acids were not detected. The MDCs for phosphoric acid and hydrobromic acid are 0.01 and 0.004 ppm, respectively.

Figure 1
Diagram of Aluminizing Department
Philips Display Components
HETA 93-0806