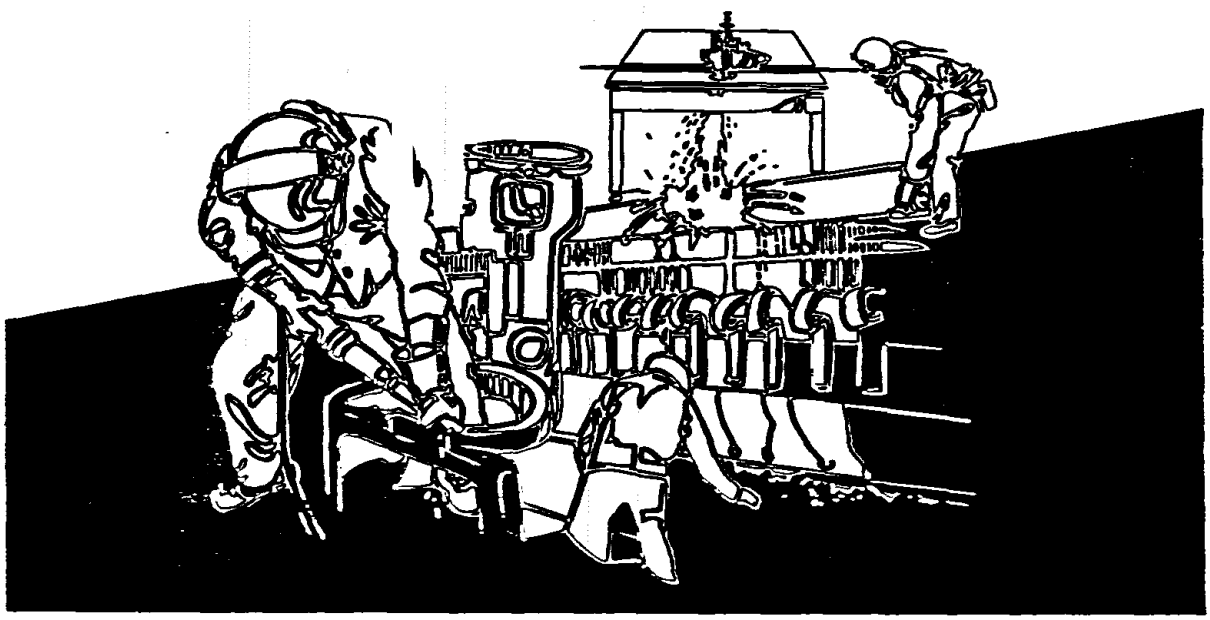
NIOSH

HEALTH HAZARD EVALUATION REPORT

HETA 91-051-2177
AVX CORPORATION
MYRTLE BEACH, SOUTH CAROLINA



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

CDC
CENTERS FOR DISEASE CONTROL

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 91-051-2177
FEBRUARY 1992
AVX CORPORATION
MYRTLE BEACH, SOUTH CAROLINA

NIOSH INVESTIGATORS:
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I. SUMMARY

In December 1990, the National Institute for Occupational Safety and Health (NIOSH) received a joint request for a Health Hazard Evaluation (HHE) from both the International Brotherhood of Electrical Workers, Local 1591 and the AVX Corporation concerning possible occupational dermatitis and complaints of hoarseness among employees in the screener-stacker area at the AVX plant in Myrtle Beach, South Carolina. This facility manufactures multi-layer ceramic capacitors for electronic applications.

On February 12, 1991, a walk-through survey was conducted, air samples were collected for qualitative analysis, surface wipe and bulk samples were obtained, and medical interviews were conducted.

Area air samples were collected near a screener-stacker, a dicer, and an oven; these samples were analyzed for volatile organic compounds (VOCs), aliphatic amines, aldehydes, palladium, and other elemental metals. Qualitative analysis by mass spectrophotometry identified the following VOCs: xylene isomers, 1,1,1-trichloroethane, toluene, methoxy ethanol, methyl isobutyl ketone, limonene, and C_9-C_{12} aliphatic and aromatic hydrocarbons (similar to petroleum naphtha). Formaldehyde, acetaldehyde, and unidentified aliphatic amines were also detected. Airborne elemental metals were not detected with the exception of a small amount of iron.

Wipe samples of work surfaces revealed contamination by aluminum, barium, cadmium, lead, silver, titanium, zinc, chromium, and palladium. Energy dispersive X-ray diffraction spectra analysis identified sulphur, silicon, magnesium, calcium, titanium, barium, neodymium, samarium, aluminum, and zirconium in dust (and waste fragments). collected from dicer machines.

Bulk samples of the product were heated similar to process temperatures within a chamber and the thermal decomposition products were analyzed. Acetaldehyde was the aldehyde detected in the highest concentration. Other aldehydes detected included formaldehyde, acrolein, propanal, butanal, hexanal, and valeraldehyde. Acrylic acid esters (methyl acrylate, methyl methacrylate, ethyl acrylate, and ethyl methacrylate) were also present.

Twenty of the 36 interviewed employees had histories consistent with work-related contact dermatitis. Three workers had skin rash, consistent with a contact dermatitis, on the day we visited.

On the basis of data obtained in this investigation, the NIOSH investigators determined that a potential health hazard existed among workers in the screen-stacker and dicer areas due to contact with multiple skin irritants including, but not limited to, barium, titanium, palladium and mineral spirits. Recommendations for reducing the potential for skin irritation and dermatitis from chemical contact are provided in Section IX of this report.

Keywords: SIC 3674 (semiconductors and related devices), ceramic capacitors, dermal irritation, dermatitis, throat irritation, latex film, titanium dioxide, barium, precious metal ink, palladium, aldehydes.

II. INTRODUCTION

In December 1990, the National Institute for Occupational Safety and Health (NIOSH) received a joint request for a health hazard evaluation (HHE) from both the International Brotherhood of Electrical Workers, Local 1591 and the AVX Corporation concerning possible occupational dermatitis and complaints of hoarseness among employees in the screener-stacker area of the AVX plant located in Myrtle Beach, South Carolina.

On February 12, 1991, a walk-through survey was conducted, air samples were collected for qualitative analysis, surface wipe and bulk samples were obtained, and medical interviews were conducted. In a letter dated March 14, 1991, which was sent to the company and union, we summarized the activities of our initial visit and reviewed the types of air, wipe, and bulk samples collected.

III. BACKGROUND

A. Process Description

AVX Corporation manufactures multi-layer ceramic capacitors for electronic applications. These capacitors are constructed by alternating layers of dielectric tape with electrically conducive ink which contains precious metal paste (including silver and palladium). The dielectric tape is a latex formulation which has been dried into a thin film and contains barium titanate, as well as specialty ingredients which provide the ceramic properties. A variety of capacitors are manufactured with different latex tape formulations and metal paste mixtures.

The layering is performed with screen-stacker machines which cut the latex tape, apply the metal ink (using a screen applicator), and press multiple layers of "printed" tape into pads. The operator removes the pad and laminates it with a heat plate so that all of the layers are bound together. The operator also changes the rolls of dielectric tape and dispenses the metal ink into the screen-stacker.

Following lamination, the pads are diced into small chips by workers operating dicer machines which use either a straight knife blade or a small circular saw. To make the cuts easier (and smoother), the pad is preheated before it is diced. After the pad is diced, workers remove the edge (which does not have metal ink layers) and inspect a selected sample of chips under a magnifying glass. Some employees wear cotton gloves when handling the pads and chips. Other workers do not wear any gloves because they decrease dexterity.

The chips are heated in an oven to drive off the volatile compounds. Following oven firing, the chips are sintered in high

temperature kilns, which forms a dense ceramic material. The chips, fired and sintered in beds of sand, are removed with sieves. The chips are then "harperized" (a procedure where the corners are rounded and residual sand is removed in a vibrating vessel using aluminum oxide grit, water, and detergent). Employees in the kiln area transfer the trays of chips between ovens and kilns, manually sieve the sand, and harperize the chips. The last process attaches electrical terminals to the capacitors and the final quality control inspections and electrical tests are made.

B. Health Problems

In May 1990, several employees in the dicer and screener-stacker areas began experiencing itching and skin rashes on exposed areas. The rash was reported to be primarily on the forearms, face, neck, and back of hands, with a few cases involving the legs and back. A few employees also experienced throat irritation and transient episodes of hoarseness and loss of voice. Although employees in other areas of the plant, such as raw material mixing, slip casting (latex film formulating), and metals mixing have exposure to the same materials, the complaints were primarily among employees located in the screen-stacker and dicing areas. Employees attributed the symptoms to smoke emissions generated from the lamination and dicer reheat plates, especially when using nos. 924 and 832 tape bodies. In response to these problems, the company installed local exhaust ventilation over the plates, and the complaints of symptoms reportedly declined. However, the skin rash eventually recurred, persisting mostly in the dicing workers.

C. Review of AVX Medical Records

A review of the records supplied by AVX was helpful in evaluating the course of the dermatitis experienced by the employees, as well as documenting the recommendations suggested by the medical consultants. The following is a summary of the chronology of events relating to the dermatitis problem at this facility.

In early June 1990, the occupational physician for AVX Raleigh toured the Myrtle Beach facility, interviewed affected employees, and contacted several employees' personal physicians. He also contacted a local dermatologist who had seen several patients. In late June, this dermatologist examined and interviewed 13 AVX employees from all shifts, toured "problem areas" of the AVX plant, and skin-patch tested five employees and managers. The skin-patch tests were all normal. In his written conclusions, he stated "a review of the composition of the no. 924 material reveals several water soluble irritants." It was his contention that the raw no. 924 material, combined with perspiration, was the cause of most of the skin rashes seen at the AVX plant. As a result of his medical consultation, the following recommendations were made:

1. several affected employees should be removed from potential exposure to no. 924 material until they were completely recovered from their skin rash;

2. when free of the dermatitis, the removed employees should be returned to work with appropriately protective white cotton gloves, arm gauntlets, and plastic face shields;

3. appropriate steps should be taken to minimize contact of the bare skin with no. 924 material;

4. soapless skin cleaner should be supplied to the affected employees.

In July 1990, the local dermatologist continued his follow-up of dermatitis cases. A questionnaire was administered to employees in the dicing and screener-stacker areas by the AVX nurse to document symptoms of skin problems. Results of the questionnaire revealed that 68% of the 34 participants complained of any of 4 symptoms [itching (68%), burning (26%), bumps (56%), or redness (32%)]. Recommendations by the dermatologist at that time were to continue with the previous recommendations (listed above), and to interview employees experiencing skin problems prior to vacation and on return to work to determine if their skin problems improved while away from work.

In July 1990, the medical director of AVX's insurance carrier contacted AVX management. After reviewing the information gathered by AVX, she concluded that the employees had been sensitized and cross-sensitized to several substances and recommended long-sleeve clothing. She stated that the longer a dermatological problem existed, the longer it would take to resolve it because of re-irritation by work- and non-work related sources.

Two employees reported symptoms of hoarseness and sore throat when working in the dicing area. Both had extensive physical examinations by occupational health physicians, dermatologists, allergists, and otolaryngologists. Patch testing was performed on both employees; results were negative. The examining physicians could not arrive at consensus with definitive diagnoses in either patient, although several physicians recommended that the employees be transferred from the dicing area, as a preventive measure.

IV. EVALUATION DESIGN AND METHODS

A. Environmental Evaluation

On February 12, 1991, area air samples were collected by NIOSH investigators during normal production to screen the air contaminant emissions in the following three locations: 1) outside a ventilated box exhausting a laminator, 2) outside a ventilated enclosure exhausting the heating plate of a dicer, and, 3) above an oven door (where there was a dark residue stain suggesting a leaking door seal). Four different samples were collected (at each location); they were analyzed for volatile organic compounds (VOCs), aldehydes, aliphatic amines, palladium and other metals.

Charcoal tubes were used to adsorb VOCs; they were analyzed using a gas chromatograph with a mass spectrophotometer detector (GC/MS). The advantage of this method is that it is very sensitive and is capable of detecting unsuspected compounds. However, the disadvantage of the GC/MS analysis is that it is a qualitative method which can only provide relative quantification. A qualitative aldehyde screen (for formaldehyde, acetaldehyde, acrolein, and other aldehydes) was also performed using Orbo 23® sorbent tubes for collection and GC/MS for analysis.

Silica gel sorbent tubes were used to adsorb aliphatic amines which were analyzed using a modified NIOSH Method 2010.[1] Airborne particulates were collected on mixed cellulose ester filters and analyzed for metals with an intra-coupled plasma (ICP) spectrophotometer in accordance with NIOSH Method 7300.[1]

Two wipe samples were collected from the working surface of tables located near a screener-stacker and a dicer. A wipe sample was also obtained from the interior of a work glove used by an operator of a screener-stacker machine. These samples were obtained from an approximate area of 100 square centimeters (cm^2) using Whatman® smear tabs dampened with distilled water. These samples were analyzed for elements using ICP according to NIOSH Method 7300.[1]

In addition to the air samples and surface wipes, a number of bulk samples of the product, in various stages of production, were obtained for thermal decomposition analysis. Latex tape bodies nos. 924 and 832 (with & without metal ink) were collected prior to being laminated. These bulks were heated by NIOSH chemists within a controlled chamber to a temperature of 130°C to evaluate chemical emissions which may occur during lamination. The air within the chamber was sampled using charcoal and Orbo 23® sorbent tubes, which were then qualitatively analyzed by GC/MS. The other bulk samples were scrap pieces of tape bodies nos. 924, 832, and 015 (with 1721 or 1766 metal ink) which had been laminated previously.

These bulks were heated to a higher temperature (400°C) to assess potential chemical emissions generated by the burnout ovens. The thermal decomposition products from these samples were also collected and analyzed.

Bulk samples of dust and waste fragments were also removed from a blade dicer and a rotary saw dicer. These samples were analyzed using polarized light microscopy (PLM) and transmission electron microscopy (TEM) to evaluate the potential for mechanical irritation due to the particle geometry (i.e., sharp burrs or edges present on the dust particles which could pierce or otherwise penetrate intact skin). Energy dispersive X-ray diffraction spectra (EDX) of these samples were also obtained for comparative analysis to EDX patterns of known elements to confirm the composition of the dicer dust and waste fragments.

B. Medical Evaluation

The medical component of this investigation consisted a review of the Occupational Safety and Health Administration (OSHA) injury and illness logs for 1990, personal interviews with 36 employees in the screener-stacker area, observation of work practices, and review of materials assembled by AVX management. These included medical records of individuals examined by private physicians and consulting physicians hired by AVX.

V. EVALUATION CRITERIA

The following are some of the materials identified in the NIOSH surface wipe and/or air sampling conducted as part of this evaluation, along with a brief discussion of their irritant effects and occupational exposure limits.

A. Acetaldehyde

Acetaldehyde, an irritant of the eyes and mucous membranes, can cause irritation of the throat and the respiratory tract. If kept on the skin for prolonged periods of time, the liquid causes erythema and burns. Repeated contact may result in dermatitis due to primary irritation.[2] The fruity odor of acetaldehyde may be recognized by some persons at concentrations of 25 parts per million (ppm).[3] For airborne exposures to acetaldehyde, the OSHA Permissible Exposure Limit (PEL) is 100 ppm as a time-weighted average over an eight-hour period, the same as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV).[4,5] NIOSH considers acetaldehyde to be a potential carcinogen and recommends that exposure be reduced to the lowest feasible limit.[6]

B. Palladium

While exposure to palladium may cause a contact dermatitis,[7] little additional data are available regarding the health effects from exposure to this substance. There are currently no evaluation criteria for palladium.

C. Barium

Skin contact with barium, and many of its compounds, may cause local irritation to the eyes, nose, throat and skin, and may cause dryness and cracking of the skin and skin burns after prolonged contact.[8] The current OSHA PEL, ACGIH TLV, and NIOSH Recommended Exposure Limit (REL) is 0.5 milligrams per cubic meter (mg/m^3) for airborne exposures.[4,5,6]

D. Formaldehyde

Formaldehyde is an irritant of the eyes and mucous membranes and can cause irritation of the throat and the respiratory tract. Strong formaldehyde solutions on the skin, as well as exposure to the gas, have caused primary skin irritation.[9] Allergic contact dermatitis is also a well-recognized risk.[3] The current OSHA PEL and ACGIH TLV for formaldehyde is 1 ppm, TWA.[4,5] NIOSH has identified formaldehyde as a potential carcinogen and recommends that exposure be reduced to the lowest feasible limit.[6,10]

VI. RESULTS

A. Environmental

In all of the charcoal tube samples collected for VOCs, xylene isomers were identified to be the compounds present in the largest relative quantity. Other compounds identified on these samples include 1,1,1-trichloroethane, toluene, methoxy ethanol, methyl isobutyl ketone, limonene, and C_9-C_{12} aliphatic and aromatic hydrocarbons (similar to petroleum naphtha). All of these samples had the same compounds with varying concentrations.

Neither aliphatic amines nor aldehydes were detectable in air samples collected near the screener-stacker and dicer. Traces of formaldehyde and acetaldehyde were detected in air samples taken near the (leaking) seal of the burnout oven door. Aliphatic amines were also detected at this location. The specific identity of the aliphatic amine could not be positively established, although it was possibly dimethyl or diethyl amine. None of the air samples collected for metals had detectable amounts, with the exception of a trace amount of iron found in an area air sample collected near a dicing machine.

Wipe samples of work surfaces near a screener-stacker revealed contamination by aluminum, barium, cadmium, lead, silver, titanium, zinc, chromium, and palladium. These same elements were detected in the dicer wipe sample, with the exception of silver, aluminum, chromium, and palladium (and the addition of magnesium). Barium, calcium, cadmium, iron, lead, silver, sodium, titanium, and zinc were detected in the wipe sample obtained from the interior of a used work glove. The specific quantities (measured in micrograms) of these samples is provided in Table 1.

Energy dispersive X-ray diffraction (EDX) spectra analysis identified sulphur, silicon, magnesium, calcium, titanium, barium, neodymium, samarium, aluminum, and zirconium in dust (and waste fragments) collected from dicer machines. Surprisingly, silver and palladium were not identified in the dicer dust by the EDX method. The PLM and TEM analysis of the dust revealed that the particle geometry alone (without respect to the chemical/elemental composition) was not conducive to causing mechanical irritation; that is, the particles had no sharp corners or edges.

Thermal decomposition analysis of the bulks heated to 130°C failed to identify any significant peaks collected on charcoal tubes, although there were a few traces of unidentified compounds. Acetaldehyde and formaldehyde were detected on the Orbo 23® sorbent tubes used to sample the air from all of the bulk samples heated to this temperature.

Significantly higher concentrations were observed (with a wide variety of decomposition products) for the bulk samples heated to 400°C. Acetaldehyde was detected in the highest concentration. Other aldehydes detected included formaldehyde, acrolein, propanal, butanal, hexanal, and valeraldehyde. Acrylic acid esters (methyl acrylate, methyl methacrylate, ethyl acrylate, and ethyl methacrylate) were also present. The MS analysis of the thermal decomposition products from the bulk samples heated to 400°C also revealed a number of unidentified hydrocarbons containing oxygen and a few containing nitrogen.

B. Medical

On February 12, 1991, the dispensary logs were reviewed and the company nurse was interviewed by NIOSH investigators concerning medical surveillance conducted on AVX workers for dermatitis. In the six months prior to this evaluation, 28 cases of suspected work-related contact dermatitis were recorded. A few individuals had multiple entries. Medical interviews and limited physical examinations (if there was evidence of rash apparent) were conducted with 36 employees. The workers included those identified by the union and those serially sampled from a seniority employee

roster from the screener-stacker and dicer areas, as well as those identified by the medical surveillance.

Results from Employee Interviews and Limited Physical Examinations

1. Thirty-one of the 36 employees interviewed were female. The mean age of those interviewed was 37 years (range 28-51) and they had a mean of 11 (8-19) years of experience at AVX.

2. The parts of the body most commonly reported to be affected were the hands and face. Two individuals reported rashes which appeared in the areas where they placed their fingers to scratch themselves (after working with the palladium-coated dielectric tape). Both workers reported the rash on their shoulder areas or near their shoulder blades, as well as their face. Several employees stated that they commonly wiped or scratched their faces while working with the dielectric tape.

3. If gloves were worn by the workers, cotton gloves were used. Those who used them continued to use the same pair for several days without cleaning them or exchanging them for a new pair.

4. All of the skin disorders had developed in the last 3 years.

5. Several employees stated that their skin rashes improved when they were away from the workplace for extended periods of time (as on a long vacation), and the rash would reappear with return to the workplace.

6. The agents suspected to cause the skin rashes (as reported by the employees) were the palladium powder, the no. 924 latex tape, and the solvents used to clean the burners in the dicer and screener-stacker areas.

7. Twenty workers had histories consistent with work-related contact dermatitis; however, only three had a skin rash present on the day of our visit. These individuals all had a mild to moderate macular erythema (discrete areas of redness of the skin) on their forehead and chin.

VII. DISCUSSION

A. Dermatitis

There have been intermittent outbreaks of skin problems reported at AVX for the last two years, with an intensive search for the cause. Much time has been spent trying to identify a single culprit responsible for the skin rash found in several employees. Many potential causes of contact dermatitis were identified from the substances used at the AVX plant in Myrtle Beach. Table 2 lists the substances and formulations used in the screener-stacker and dicer areas of the plant which are known to contain skin irritants. The Material Safety Data Sheets (MSDSs) on many of these products stated that many may irritate and cause dermatitis with prolonged skin contact. MSDSs can be very useful in identifying substances known or suspected to be skin irritants (as well as having other health and safety information).

Although most skin problems result from direct contact with a chemical substance, it is often difficult to isolate one causative substance when many irritants are present in the workplace. Chemicals may act alone, or in conjunction with other substances, to cause dermatitis. Simultaneous or subsequent exposure may lead to an additive effect and increased reactions, where each chemical alone would elicit only a minor reaction, or none at all.[11]

Skin contact with these agents may occur in the following ways:

1. Direct contact with contaminated surfaces.

2. Direct contact with hands and fingers, then transfer of the irritant to other body parts (face, shoulders, etc.).

3. Absorption of the irritant by cotton gloves, which may act as a "wick", which are then transferred to the skin. The irritant may also be transferred from the glove to other parts of the body (e.g. touching the face with contaminated gloves), or from contaminated fingers.

4. Penetration of the gloves by the contaminant.

5. The use of personal protective equipment (gloves and apron) which are soiled on the inside, or direct contact with the (contaminated) exterior surfaces during removal.

6. Contact with chemicals, vapors, or airborne dust from irritant materials.

It is important to note that the workers with existing dermatitis may continue to experience problems. Follow-up studies, lasting 3

to 10 years, of occupational contact dermatitis cases indicate that only about 25% experience complete resolution of dermatitis and remain symptom free, while 50% improve but continue to have periodic recurrences. The remaining 25% of the cases develop chronic persistent eczema, which is as severe (or worse) as the initial dermatitis.[12]

Preventive measures that should be taken when working with the metal pastes, latex films, and solvents include good housekeeping (keeping the area free of spills, drips, spatters, and dust accumulations). Frequent changes of gloves is also important, with special attention directed to avoiding contamination of the inside of the gloves with irritant materials. Protective clothing and barrier creams, when used, should be water-repellent.

B. Throat Irritation and Throat Hoarseness

Many of the compounds used at the plant are known irritants which are capable of causing throat (as well as eye and nose) irritation. For example, chemical analyses were able to detect formaldehyde and acetaldehyde in air samples. Although the method of analysis was qualitative, the relative quantities (based on comparison to blank sample values) were measured in the microgram range. Some individual workers may be sensitive to formaldehyde and may experience mucous membrane irritation at very low concentrations (even at concentrations below the PEL). The medical records of the two affected employees did not reveal any definitive explanation for their sore throats and hoarseness.

VIII. CONCLUSIONS

Many of the substances used at AVX are known irritants. Some of these substances, most notably palladium, barium, and formaldehyde, have caused skin disorders in other plants.[2,3,7,9] Based on historical and medical information, as well as work practices and exposures, we conclude the skin rashes at AVX are likely to be due to exposure to multiple irritants found in the workplace. Workers with existing cases of dermatitis may continue to experience problems. To avoid new cases of dermatitis, the employer and employees must assure that further skin contact with the irritants is minimized. It is quite possible that the throat irritation and skin irritation/dermatitis are unrelated and may actually be due to separate causative agents.

IX. RECOMMENDATIONS

A. Education

1. Workers should be educated about the effects of the chemicals they work with and the types of work practices that will minimize their exposure to chemicals. The scope of the

educational activities should include clear identification of work activities where exposures are likely and the recognition of early signs and symptoms of dermatitis.

2. The nurse should review the topic of occupational contact dermatitis with workers seeking treatment for dermatitis.

B. Engineering Controls

1. Improve the ventilation effectiveness of the boxes used to remove contaminants from the environment by providing a more complete enclosure. Furthermore, to minimize worker contact with chemical emissions, laminated pads should not be removed until they are completely cooled.

2. If dermatitis continues, consider the practicality of providing ventilated glove box work stations for the dicers to isolate the contaminants (irritants) from contact with the worker.

C. Work Practices

1. Good factory housekeeping should been continued.

2. Employees should avoid any skin contact with irritant materials and should not handle rags soaked with solvents unless they are wearing appropriate impermeable gloves.

3. Workers should avoid touching their faces or other exposed skin with their gloves or unwashed hands. Those workers who experience any skin problem should change their gloves more frequently than once per shift.

D. Medical Evaluation Issues

1. Any suspected work-related skin problem should be reported immediately to the production supervisor. Affected workers should be referred to the company medical department, to evaluate the need for further dermatologic work-up.

2. Substances used in the workplace, as well as any available technical information about them, should be made available to dermatologists for diagnostic purposes, including consideration for use in patch testing.

3. We agree with the recommendation proposed by the AVX internal working group that a consultation with an industrial psychologist may be useful in terms of developing good strategies for addressing the frustrating problem of the recurrent rash and attitudes of workers and management towards

the problem. Names of licensed Industrial Psychologists can be obtain from American Industrial Psychologists Association.

E. Protective Equipment

1. Impervious gloves should be used. Dust or other contaminants may penetrate porous cotton gloves and/or be absorbed by the glove material.

2. Skin cleaners and barrier creams should be used, as appropriate. Barrier creams should be made available to the workers at several locations and not limited to the medical dispensary.

3. Skin exposure should be minimized. Long pants and sleeves should be worn. Sleeves should be worn on the outside of the glove.

4. Two of the ideas that were suggested in the AVX Action Plan dated November 29, 1990, (providing lockers and laundering of smocks) may reduce the workers' potential for contact during off hours.

F. Re-Assignment of Affected Workers

1. Continued rash should be an indication for removal of an employee from further exposure to the materials associated with that rash, and alternative work for that employee should be found. Failure of the rash to improve, however, does not necessarily mean that the original diagnosis was wrong or that the employee would be no worse if he or she returned to work involving exposure to the causative agent.

X. REFERENCES

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XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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1. AVX Corporation, Myrtle Beach, South Carolina
2. IBEW, local 1591, Myrtle Beach, South Carolina
3. OSHA Region IV
4. NIOSH, Cincinnati, Ohio
5. NIOSH, Atlanta, Georgia

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. Surface Contamination
AVX Corporation, Myrtle Beach, SC.

Element	Contaminant Weights (μg/wipe sample)		
	Screen Stacker	Dicer	Glove Interior
Aluminum	20	ND*	ND
Arsenic	ND	ND	ND
Barium	32	150	21
Beryllium	ND	ND	ND
Calcium	10	22	32
Cadmium	2	2	4
Cobalt	ND	ND	ND
Chromium	3	ND	ND
Copper	ND	ND	ND
Iron	6	8	8
Lithium	ND	ND	ND
Magnesium	ND	7	6
Manganese	ND	ND	ND
Molybdenum	ND	ND	ND
Nickel	ND	ND	ND
Lead	19	15	2
Palladium	22	ND	ND
Phosphorus	ND	ND	ND
Platinum	ND	ND	ND
Selenium	ND	ND	ND
Silver	48	ND	4
Sodium	70	110	230
Tin	ND	ND	ND
Tellurium	ND	ND	ND
Thallium	ND	ND	ND
Titanium	17	78	20
Tungsten	ND	ND	ND
Vanadium	ND	ND	ND
Yttrium	ND	ND	ND
Zinc	4	8	31
Zirconium	ND	ND	ND

* ND - non-detectable (Limit of detection ranged from 1 to 20 μg depending on the element.)

Table 2
List of Potential Irritants
In the Screener-Stacker and Dicer Areas

AVX Corporation
Myrtle Beach, South Carolina
HETA 91-051

ACETALDEHYDE
BARIUM
CERIUM OXIDE
DEHYDROABIETYLAMINE
ETHYL BENZENE
EXXAL 13 (ALIPHATIC ALCOHOL)
FORMALDEHYDE
HEXYLENE GLYCOL
MINERAL SPIRITS
PALLADIUM
RHOPLEX HA-12 EMULSION
RHOPLEX HA-8 EMULSION
RHOPLEX B-5 EMULSION
RHOPLEX AC- 73 EMULSION
SILVER
TAMOL 901 DISPERSING AGENT
TAMOL 850 DISPERSING AGENT
TITANIUM DIOXIDE
1-TRIDECANOL
XYLENE
ZIRCONIUM OXIDE