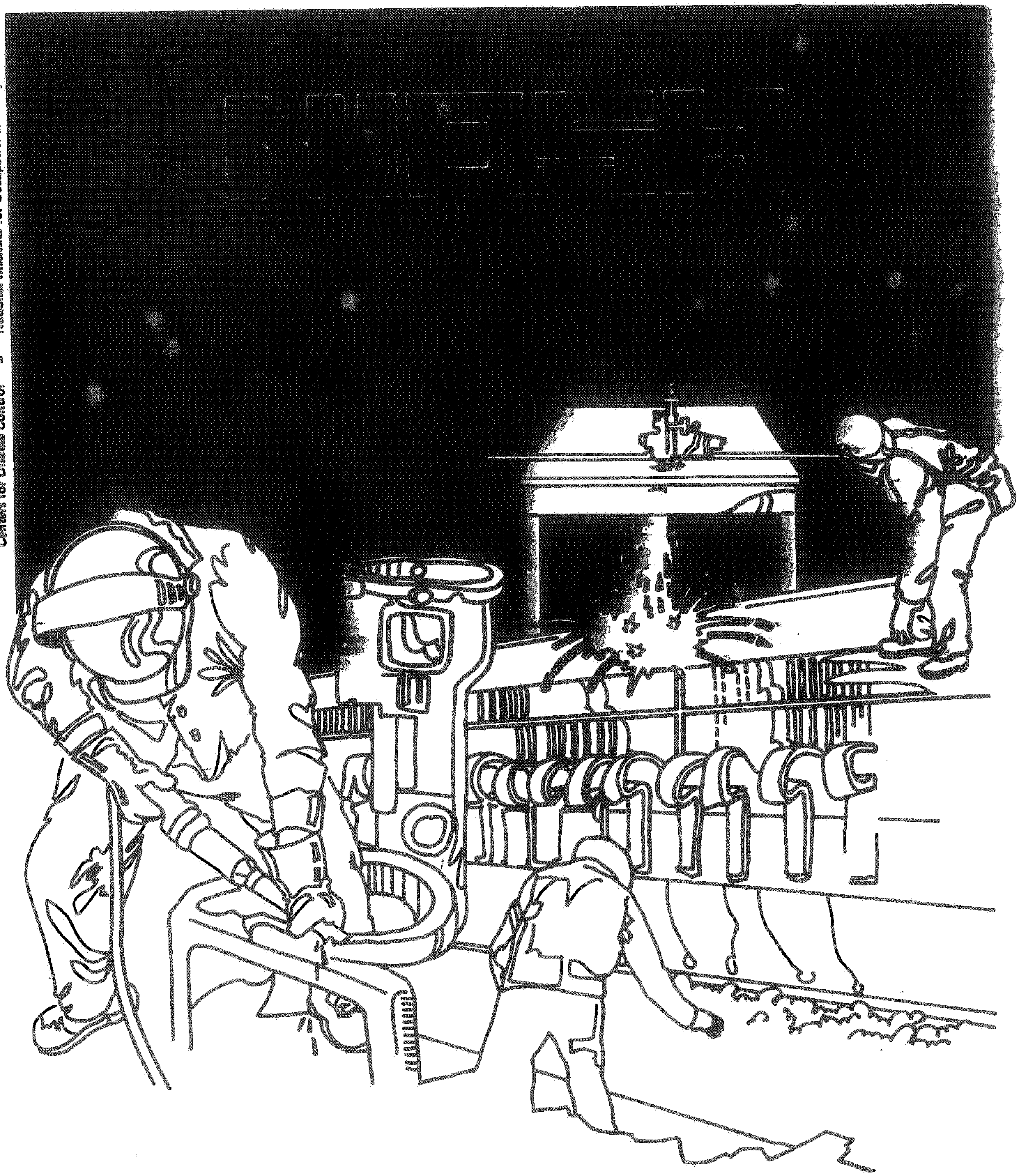
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 83-269-1430
SIEMENS COMPONENTS, INC.
BROOMFIELD, COLORADO

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.

HETA 83-269-1420
MARCH 1984
SIEMENS COMPONENTS, INC.
BROOMFIELD, COLORADO

NIOSH INVESTIGATORS:
Bobby J. Gunter
Theodore Thoburn, M.D.

I. SUMMARY

In June, 1983 the National Institute for Occupational Safety and Health (NIOSH) received a request from Siemens Components, Inc., Broomfield, Colorado to evaluate a group of workers in the Assembly and Diffusion Assembly who were accidentally exposed to solvent vapors during an atmospheric inversion which occurred in late April of 1983. These workers (54), along with 36 other workers, were interviewed and had pulmonary function tests taken on June 24, 1983.

Environmental sampling was performed on July 13, 1983 including breathing zone and general room air samples taken for 1,1,1-trichloroethane, isopropanol, methanol, total particulate, aluminum oxide, noise and radiofrequency.

Exposure levels of 1,1,1-trichloroethane ranged from less than detectable to 40 mg/M^3. Isopropanol exposure levels ranged from 14 mg/M^3 to below 0.01 mg/M^3. Methanol exposure levels were 150 and 5 mg/M^3. Total particulate exposure levels ranged from 0.45 mg/M^3 to 0.16 mg/M^3. Aluminum oxide levels ranged from 0.04 mg/M^3 to less than 0.005 mg/M^3. All analytical results were far below the evaluation criteria. Radio frequency measurements did not detect an exposure to either the electric or magnetic fields. Five 8-hour time weighted noise level measurements were made on 5 workers in the noisiest areas of the plant; two workers were exposed at the 85 dBA level recommended by NIOSH.

Pulmonary function studies showed some correlation with smoking habits, but none with work area. Interviews showed that 17 of the 90 interviewed had work-related health complaints (12 respiratory in nature, 5 others) and 27 had non-work related health complaints. None of the complaints were related to the exposure which prompted this study. The technicians, as a group, had proportionally more work related complaints than did the other job categories. (4 with complaints out of 6 as opposed to 13 out of 84 for the rest.)

On the basis of the environmental and medical data and employee interviews, NIOSH concluded that a potential health hazard due to noise exposure did exist at the time of this survey. Recommendations for improving the workplace environment are included in this report.

KEYWORDS: SIC 3674 (Semiconductors, Pulmonary function, Solvents, Noise, Radiofrequency).

II. INTRODUCTION

In June 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from management of Siemens Components, Inc., Broomfield, Colorado, to evaluate a group of workers in the Assembly and Diffusion Assembly that were accidentally exposed to solvent vapors during a temperature inversion in late April, 1983.

On June 23 and 24, and July 13, 1983, NIOSH conducted the medical and environmental evaluations. Results of these testings have been discussed with the plant management on several occasions.

III. BACKGROUND

Siemens Corporation produces four products in its Broomfield, Colorado facility: (1) power MOS-FETS, (2) Thyristors, (3) Rectifiers/Schottky Diodes, and (4) Modules.

Assembly area workers were concerned about being exposed to solvent vapors during a late spring snow fall that precipitated an atmospheric inversion. Workers in this area have contact with 1,1,1-trichloroethane, isopropanol, methanol, and aluminum oxide.

IV. DESIGN AND METHODS

A. Environmental

Five breathing zone air samples were collected for measurement of 1,1,1-trichloroethane and isoproponal. These samples were collected on organic vapor charcoal sampling tubes using vacuum pumps operating at 50 cc per minute and analyzed according to NIOSH method No. P&CAM 127. Five breathing zone air samples were collected for total particulate and aluminum oxide measurement. These were analyzed according to NIOSH method No. P&CAM 173 and by filter weight difference. Five methyl alcohol samples were collected on silica gel tubes using vacuum pumps operated at 50 cc/per minute and analyzed according to NIOSH Analytical Method No. S-59. Noise and radiofrequency measurements were made using standard direct reading instrumentation.

B. Medical

As the Assembly workers and the Diffusion Assembly workers were most effected by fumes during the atmospheric inversion which prompted this study, an effort was made to include all workers from these two departments in the study. Other workers were included on a volunteer basis. In all, 41 of 46 Assembly workers were seen, 13 of 13 Diffusion Assembly workers, and 36 of the other 201 workers, for a total of 90 of 260 workers. Workers were selected from those who thought they had been exposed during the atmospheric inversion.

Evaluation included a brief questionnaire administered by a public health advisor and pulmonary function tests (forced vital capacity (FVC), one-second forced expiratory volume (FEV_1), maximal mid-expiratory flow (MMEF)) Pulmonary function tests included forced vital capacity (FVC), administered by the industrial hygienist (certified in pulmonary function testing) using an Ohio Medical Products Model 822 Spirometer. Predicted values for each test based on sex, race, age, and height were calculated by a Model 200 Spirotech computer utilizing the formulae of Knudson, et al.[1]

V. EVALUATION CRITERIA

A. Environmental

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 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

	Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis	
1,1,1-trichloroethane	1900 mg/M^3	NIOSH
		ACGIH
		OSHA
Isopropanol	980 mg/M^3	NIOSH
		ACGIH
		OSHA
Methanol	260 mg/M^3	NIOSH
		ACGIH
		OSHA
Total Particulate	10 mg/M^3	ACGIH
	15	OSHA
Aluminum Oxide	10 mg/M^3	ACGIH
	15	OSHA
Noise	85 dBA	NIOSH
	85 dBA	ACGIH
	90 dBA	OSHA
Radiofrequency		
Magnetic	0.3 A^2/M^2	NIOSH
	0.25 A^2/M^2	OSHA
Electric	37,070 V^2/M^2	NIOSH
	40,000 V^2/M^2	OSHA

mg/M^3 = milligrams of substance per cubic meter of air.
A^2/m^2 = amperes^2/meter^2
V^2/m^2 = volts^2/meter^2
dBA = decibels
C = ceiling level and should never be exceeded.

B. Medical

The pulmonary function tests included measurements of forced vital capacity (FVC), one-second forced expiratory volume (FEV_1), maximal mid-expiratory flow (MMEF), and calculation of the ratio of FEV_1/FVC. FVC measures the total amount of air one can force out of his lungs after breathing in as deeply as possible. FEV_1 measures the amount of air one can breathe out in the first second. The MMEF measures the flow rate of the expired air between the time when 25% of the FVC has been expelled until the time when 75% of the FVC has been expelled. The FVC can be impaired by restrictive lung disease, such as pulmonary fibrosis. FEV_1 and MMEF can be impaired by cigarette-related lung damage or some other conditions causing obstruction to air flow. Any condition that impairs FVC usually impairs FEV_1, but the reverse is not true. Conditions that impair FEV_1 do not necessarily impair FVC. The FEV_1/FVC ratio is also used to help evaluate obstructive lung disease.

In interpreting the results, the best test results are used. They are compared to "predicted values" which take into account age, height, sex, and race.[1] Pulmonary function is considered "normal" if the best FEV_1 and the best FVC are each 80 percent or more of their respective predicted values and the FEV_1/FVC ratio using the best values is 70 percent or more. Interpretation of the MMEF is more difficult as there is wide variation among apparently healthy individuals. It is of more value in following an individual over time. The computer calculates the acceptable range for the MMEF for each individual. As a rough guide, MMEFs as low as 50% of predicted may be within the acceptable range.

The computer then screens the results of the three tests and the ratio of FEV_1/FVC for low values and assigns a "Severity Code". A "0" code represents acceptable results. Codes of "1" or higher represent results which may have clinical significance.

C. Toxicological

1,1,1-trichloroethane is a colorless liquid with a mild odor similar to chloroform. Trichloroethane may enter the body by inhalation of the vapors, ingestion, and absorption through the skin. Exposure to 1,1,1-trichloroethane may cause central nervous system depression, liver and heart effects. Human subjects exposed to 900-1000 PPM for 20 minutes have experienced light-headedness, incoordination, impaired equilibrium and transient eye irritation. A few scattered reports have indicated mild kidney and liver injury from severe exposure. Skin irritation has occurred from occupational contact. A number of human fatalities related to industrial exposure in closed spaces have been reported. 20,000 PPM for 60 minutes is expected to produce coma and possible death.[2]

NIOSH is currently recommending an action level of 200 PPM for classifying "inhalation exposure" to 1,1,1-trichloroethane. When in excess of this level, personnel should be warned of possible congenital abnormalities.[3] In current Intelligence Bulletin #27, NIOSH has suggested that 1,1,1-trichloroethane be treated in the workplace with caution because of its chemical similarity to four other chloroethanes shown to be carcinogenic in laboratory animals.

Isopropyl Alcohol (isopropanol) The current OSHA standard for isopropyl alcohol is 400 ppm or 980 mg/M^3. NIOSH recommends 400 ppm (980 mg/M^3) and a 15 minute ceiling concentration of 800 ppm (1900 mg/M^3). Isopropyl alcohol can affect the body either by inhalation, ingestion, or skin contact.

Exposure to high concentrations of isopropyl alcohol may cause irritation of the eye, nose, and throat. Drowsiness, headache, and incoordination may also occur. Ingestion of isopropanol may cause drowsiness, unconsciousness and death. Systemic effects may include abdominal cramps, nausea, vomiting, and diarrhea may also occur. The only long term health hazard from skin exposure to isopropanol is a defatting dermatitis. It is very rare to find an overexposure to isopropanol in an industrial situation.[4]

Methyl Alcohol has two common routes of occupational exposure, inhalation and absorption through the skin. Signs and symptoms of methyl alcohol intoxication include headache, dizziness, nausea, vomiting, weakness, vertigo, chills, shooting pains in the lower extremities, unsteady gait, dermatitis, multiple neuritis characterized by paraesthesia, numbness, prickling and edema of the arms, nervousness, gastric pain, insomnia, blurred vision, general visual disturbances, blindness and acidosis.

Methyl alcohol is not known to be a liver toxin in humans. There have been no long-term epidemiologic studies of chronic, low-level occupational exposure. There have been a few animal studies where autopsy revealed deterioration of basic liver tissue (parenchymatous degeneration) proceeding, in the more severe case, to focal necrosis (localized areas of tissue death). It is difficult to interpret these reports of liver toxicity in animals which were done in the early 1900's. The data is presented summarily and not in sufficient detail for careful evaluation. In general, the animal data in inconclusive. It is reported that primates and non-primates metabolize methyl alcohol differently, and the importance of this difference is not well known.

There have been autopsy reports of pancreatic necrosis in humans after acute ingestion of methyl alcohol. As with liver toxicity, the pancreatic pathology in humans is not specific, and chronic ethanol intake is usually an important confounding and likely causative factor.

Total Particulate - Exposures to respirable particulate may cause unpleasant deposits in the eyes and nasal passages. Some respirable problems due to deposition in the lungs may also occur.

Aluminium Oxide - The primary route of entry is the respiratory system. Cases of pulmonary fibrosis have been reported. This causes shortness of breath, dry cough, and chest pain on respiration. The progression of this disease is very slow. Personnel with significant work and exposures to aluminum oxide should have an annual chest X-ray and pulmonary function.[5]

Noise[6] is commonly defined as unwanted sound, covers the range of sound which is implicated in harmful effects. Noise can be classified into many different types, including wide-band noise, narrow-- band noise, and impulse noise. To describe the spectrum of a noise the audible frequency range is usually divided into eight frequencybands, each one-octave wide, and sound pressure level (SPL) measurements are made in each band using a special sound level meter. A wide-band noise is one where the acoustical energy is distributed over a large range of frequencies. Examples of wide-band noise can be found in the weaving room of a textile mill and in jet aircraft operations.

Narrow-band noises with most of their energy confined to a narrow range of frequencies, normally produce a definite pitch sensation. For a true narrow-band noise, only a single octave band will contain a significant SPL. The noise caused by a circular saw, planer, or other power cutting tools is occasionally of the narrow-band type, but usually there is some spreading of the acoustic energy to several of the octave bands.

The impulse type of noise consists of transient pulses, occurring in repetitive or non-repetitive fashion. The operation of a rivet gun or a pneumatic hammer usually produces repetitive impulse noise. The firing of a gun is an example of non-repetitive impulse noise.

Exposure to intense noise causes hearing losses which may be temporary, permanent, or a combination of the two. These impairments are reflected by elevated thresholds of audibility for discrete frequency sounds, with the increase in dB required to hear such sounds being used as a measure of the loss. Temporary hearing losses, also called auditory fatigue, represent threshold losses which are recoverable after a period of time away from the noise. Such losses may occur after only a few minutes of exposure to intense noise. With prolonged and repeated exposures (months or years) to the same noise level, there may be only partial recovery of the threshold losses, the residual loss being indicative of a developing permanent hearing impairment.

Radiofrequency (RF) The absorption of excessive RF energy by humans may cause adverse thermal effects due to heating of deep body tissue. The current OSHA standard[7] which limits exposures to below 10 milliwatts per square centimeter (mW/cm^2) averaged over any 0.1-hour period was promulgated to protect against thermal effects. In the far field, a power density of 10 mW/cm^2 is equivalent to an electric field strength of 40,000 $volts^2/meter^2$ V^2/m^2) and a magnetic field strength of 0.25 $amperes^2/meter^2$ (A^2/m^2).

Absorption of RF energy may also result in "nonthermal" effects within the human body, which may occur without a measurable increase in tissue or body temperature. These reported "nonthermal" effects in animals at relatively low energy levels (below 10 mW/cm^2) include microscopic ocular changes,[8,9] alterations in neuroendocrine function.[10,11] alterations in the central nervous system,[12,13] behavioral changes, [14,15] changes in the immunologic system,[16] embroyotoxic effects,[12,17] and reproductive effects.[18,19]

VII. RESULTS AND DISCUSSION

A. Environmental

On July 13, 1983 breathing zone air samples were collected for 1,1,1-trichloroethane, methanol and Isopropyl alcohol. Results ranged from less than 0.01 mg/M^3 to 40 mg/M^3 for 1,1,1,-trichloroethene and from 0.01 mg/M^3 to 14 mg/M^3 for isopropyl alcohol. Total particulate and aluminum oxide analyzes were performed on breathing zone air samples taken in the abrasive blasting department. All results were below the laboratory limit of detection of .005 mg/M^3 except one which only indicated a trace (0.04 mg/M^3) of aluminum oxide. Total particulate ranged from 0.16 to 0.45 mg/M^3 averaging 0.25 mg/M^3 being far below the evaluation criterial of 10 mg/M^3. Noise and Radiofrequency measurements were also made. Five noise dosimeters were worn for 8 hours, two which showed exposures of 85 dBA which is at the level where protection should be made available. Radiofrequenry measurements were negative but were beneficial since employees are always asking if they are being exposed to any type of "radiation" or "energies" coming from these machines.

B Medical

Table I presents demographic, pulmonary function, and questionnaire data by job category. Table IA presents some selected statistics for Table I as well as a listing of jobs included in three groups composed of a variety of jobs. Supervisor and lead workers were included with the rest of the workers in any give job category. There were no statistically significant differences between the job categories for the four pulmonary functions, nor for ages. However, the "Other" group had a statistically significant greater longevity in the plant (p less than 0.01).

The distribution of workers with significant decreases in pulmonary function (Severity Code greater than 0) and with symptoms identified as not work related did not show statistical significance. There were insufficient numbers of workers with significant decrease in pulmonary function and work related complaints to draw conclusions.

Eleven (11) workers had respiratory complaints which they attributed to exposure to chemicals and/or fumes at work (4 from Assembly, 3 from Diffusion Assembly, 2 technicians, 1 from Schottky Assembly and the worker from the Research and Development Laboratory complained of chemical exposures due to an inadequately functioning hood). In addition, one Facilities & Maintenance worker complained of dust from the grinder . One material handler and two technicians complained of headaches they felt were due to work exposures, one also listed nausea and numbness as additional symptoms. Other worker complaints included one back strain from lifting, one rash from skin contact with plastic, occasional acid burns, and one complaint of an unspecified sickness from exposure to the chemicals. As a group, more of the technicians had work related complaints than was the case in other job categories (Fisher's exact probability = 0.011). No workers mentioned health problems due to the atmospheric inversion which prompted this study.

Table II presents pulmonary function data in relation to smoking habits and symptomatology. It is of note that the current smokers (male smokers in particular) did not do as well as others in tests other than forced vital capacity (FVC). They can get the air out, but not as easily. Using the Severity Code as a guide to clinically significant decreases in pulmonary function, it can be seen the smokers were more likely to have a severity code greater than 0, although this relationship does not quite reach statistical significance (p = 0.088). However, respiratory and/or allergic symptoms (other than skin allergies) were fairly evenly distributed among the several smoking status groups.

The relationship between smoking habits and pulmonary function is to be expected. Although it appears that the women are less effected than the men by their smoking, it also appears that in this sample they make up the bulk of the smokers, both because they represent 64.4% of those seen, and because 66% of the women smoked as opposed to only 47%of the men. (On the other hand 19% of the men were ex-smokers whereas only 3% of the women were.)

VII. SUMMARY

Environmental sampling for 1,1,1-trichloroethane, methanol, isopropyl alcohol, aluminum oxide, and total particulates were all well within the recommended exposure criteria. Radiofrequency measurements were also negative. Some noise monitoring showed cumulative doses as high as 85 dBA, the level at which a hearing conservation program should be started. Pulmonary function studies showed some correlation with smoking, but not with the department to which workers were assigned. There were a scattering of work-related complaints, the technicians as a group having more than other job categories.

VIII. RECOMMENDATIONS

1. The company nurse should continue employee training on recognition of all potential chemical and physical hazards.

2. Routine industrial hygiene evaluations with collection of appropriate samples in all Assembly areas of the plant should be conducted.

3. Appropriate medical monitoring should be continued, such as: 1) hearing tests on overexposed, and 2) Blood tests on workers exposed to solvents including complete blood counts and liver enzymes.

IX. REFERENCES

1. Knudson, R.J., Slatin, R.C., Lebowitz, M.D., Burrows, B. "The Maximal Expiratory Flow-Volume Curve", American Review of Respiratory Disease, Volume 113, pp. 587-600 (1976).

2. Chemical Hazards of the Workplace, Proctor, N.H., Hughes, J.P., 1978, pp. 488-489.

3. NIOSH Current Intelligence Bulletin #27, Chloroethanes: Review of Toxicity, DHEW No. 78-181, August 1978.

4. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, NIOSH, DHHS (NIOSH) Publication No. 81-123 (1978).

5. E.R. Plunkett, M.D., Handbook of Industrial Toxicology, 1976, pp. 19-20.

6. Occupational Disease - A Guide to Their Recognition, Revised Edition. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Publication No. 77-181, June 1977, pp. 510-513.

7. OSHA Safety and Health Standards (29 CFR 1910), 1910.97 Non-ionizing Radiation, U.S. Department of Labor, Occupational Safety and Health Administration, Rev. November 7, 1978.

8. Balutina A.P. and T.L. Korobkova: Pathohistological Alteration in the Eyes of the Rabbits Exposed to SHF-UHF Radiation. Gig. Tr. Prof. Zabol. 13(4):57-58, (1969) (Rus).

9. Tahchert, J. and E. Chmurko: Investigations on the Cataractogenic Influence of Microwaves of 10 cm Band. Klin. Oczna. 42:979-83, (1972) (Pol).

10. Novitskii, A.A., B.F. Murashov, P.E. Krasnovaev and N.F. Markizova: Functional State of the Hypothalamus - Hypophysis-Adrenal Cortex System as a Criterion in Setting Standards for Superhigh Frequency Electromagnetic Radiation. Voen., Med. Zh. (8):53-56 (1977) (Rus).

11. Zalyubovskaya, M.P. and R.I. Kiselev: The Effect of Radio Waves of a Millimeter Frequency Range on the Body of Man and Animals. Gig Sanit. 43(8):35-39 (1978) (Rus).

12. Gordon, A.V., Y.A. Lobanova, I.A. Kitsovskaya and M.S. Togskaya: Biological Effect of Microwaves of Low Intensity. Med Electron. Biol. Eng. 1:67-69 (1963).

13. Dumanskii, J.D. and M.G. Shandala: The Biologic Action and Hygienic Significance of Electromagnetic Fields of Superhigh and Ultrahigh Frequencies in Densely Populated Areas, in Biologic Effects and Health Hazard of Microwave Radiation -- Proceedings of an International Symposium, Warsaw, October 15-18, 1973. Warsaw, Ploish Medical Publisher, 1974, pp. 289-093.

14. Frey, A.H. Behavioral Effects of Electromagnetic Energy, in Hazard DG (ed.): Symposium on Bilogical Effects and Measurement of Radio Frequency/Microwave Radiation -- Proceedings of a Conference, Rockville, U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Bureau of Radiological Health, 1977, pp. 11-22.

15. Gilliar, J., B. Servantic, G. Betharion, A.M. Servantic, J. Obrenovitch and J.C. Perrin: Study of Microwave-Induced Pertubations of the Behavior by the Open-Field Test into the White Rat, in Johnson CC, Shjore ML (eds.): Biological Effects of Electromagnetic Waves -- Selected Papers of the USNC/URSI Annual Meeting, Boulder, Colorado, October 20-23, 1975, DHHS Publication No. (FDA) 77-8010. Rockville, U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Bureau of Radiological Health, 1976, Vol. 1, pp. 175-86.

16. Serdiuk, A.M.: Biological Effect of Low-Intense Ultrahigh Frequency Fields. Vrach. Delo. (11):108-11, (1969) (Rus).

17. Bereznitskay, A.N. and T.Z. Rysina: Embroyotropic Effects of Microwaves, in Gordon ZV (ed.): Biological Effects of Radio Frequency Fields, JPRS 63321. Arlington, Virginia, U.S. Joint Publications Research Service, 1974, pp. 230-36.

18. Bereznitskay, A.M. and I.M. Kazbekov: Studies on the Reproduction and Testicular Microstructure of Mice Exposed to Microwaves, in Gordon ZV (ed.): Bilogical of Effects of Radio Frequency Electromagnetic Fields, JPRS 63321. Arlington, Virginia, U.S. Joint Publications Research Service, 1974, pp. 221-29.

19. Varma, M.M. and E.A. Traboulay, Jr.: Biological Effects of Microwave Radiation on the Testes of Swiss Mice. Experientia 31:301-02, (1975).

X. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By: Bobby J. Gunter, Ph.D.
Industrial Hygienist
NIOSH, Region VIII
Denver, Colorado

Theodore W. Thoburn, M.D.
Medical Officer
NIOSH, Region VIII
Denver, Colorado

Acknowledgments: Phil Strine
Director, State & Regional Operations Coordination
NIOSH, Centers for Disease Control
Atlanta, Georgia

Originating Office: Hazard Evaluation and Technical Assistance Branch (HETAB)
Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS)
NIOSH, Cincinnati, Ohio

Report Typed By: Kristi L. Ramsey
NIOSH, Region VIII
Denver, Colorado

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Siemens Components, Inc.
2. U.S. Department of Labor/OSHA - Region VIII.
3. NIOSH - Region VIII.
4. Colorado Department of Health

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

Age, Years in Plant, Pulmonary Func..on, and Complaints by Job Classification.

Siemens Components, Inc.
Broomfield, CO

June 23 & 24, 1983

Job Classification / Characteristic		Assembly	Diffusion Assembly	Engineers	Facilities & Maintenance **	Material Handlers	Technicians	Other Manufacturing **	Other **	Total
Number		41	13	5	8	2	6	9	6	90
Age - Yrs.	Mean	39.1	37.2	40.4	34.1	44.0	29.0	39.6	42.5	38.2
S.D. (Standard Deviation)		± 12.7	± 10.9	± 15.5	± 10.2	± 21.2	± 5.3	± 11.3	± 9.0	± 11.9
Years in Plant	Mean	3.45 *	3.94	4.90	2.31	3.00	3.75	3.75	8.05 *	3.81 *
	S.D.	± 1.74	± 1.50	± 4.23	± 1.47	± 0.00	± 1.14	± 2.34	± 4.42	± 2.36
% Men		20	15	100	100	100	50	22	33	35.6
% Current Smokers		71	54	0	25	50	67	78	50	58.9
Pulmonary Function Tests										
FEV_1 (Forced Expiratory Volume in 1 second) % of Predicted										
	Mean	90.7	93.2	94.6	95.5	90.0	99.3	99.2	90.5	93.1
	S.D.	± 15.1	± 12.0	± 3.8	± 9.6	± 22.6	± 13.7	± 12.6	± 18.0	± 13.8
FVC (Forced Vital Capacity) % of Predicted										
	Mean	91.0	95.9	96.0	92.5	97.0	103.3	96.9	93.0	93.8
	S.D.	± 15.4	± 11.5	± 7.9	± 10.9	± 7.1	± 14.3	± 12.0	± 10.8	± 13.4
MMEF (Mid-Maximal Expiratory Flow) % of Predicted										
	Mean	74.2	75.5	69.8	82.5	57.5	74.2	93.3	76.5	76.6
	S.D.	± 24.0	± 17.0	± 11.4	± 12.9	± 44.5	± 17.1	± 28.3	± 38.8	± 23.6
FEV_1/FVC %	Mean	82.0	80.4	79.4	83.6	74.0	79.5	83.3	78.7	81.3
	S.D.	± 7.2	± 5.7	± 4.3	± 4.0	± 15.6	± 5.0	± 6.1	± 12.7	± 7.1
Number with a Significant Decrease in Pulmonary Function (Severity Code 0 0)		9	2	0	1	1	0	1	2	16
Number with Symptoms Identified as Work Related		5	4	0	1	1	4	1	1	17
Number with Symptoms NOT Identified as Work Related		16	0	1	4	1	1	1	3	27

* Numbers are: Production Assembly - 38; Other - 5; Total - 86.
** See Table IA for job titles included in this category.
See Table IA for Statistical Analysis.

TABLE IA

Notes on Table I
Age, Years in Plant, Pulmonary Function,
and Complaints by Job Classification.

Siemens Components, Inc.
Broomfield, CO

June 23 & 24, 1983

Selected Statistical Analysis

Analysis of Variance Characteristic	F Value	Significance
Age	0.9182	Not significant
Years in Plant	3.7845	p less than 0.01
FEV_1	0.6794	Not significant
FVC	0.8297	Not significant
MMEF	1.0395	Not significant
FEV_1/FVC	0.8367	Not significant

Significant Difference in Means (using L statistic at 95% Confidence Level)
Years in Plant - "Other" vs. Rest of group $+4.46 \pm 3.90$

Correlation Coefficients for Job Classification Means
% Men vs. % Current Smokers -0.7562

Job Titles Included in Selected Job Classifications

Facilities & Maintenance:	
Electricians	2
Machinist	1
Plumber	1
Repair Crew	3
Tool & Die Maker	1
Other Manufacturing:	
Final Test	2
Inspector	2
Lead (not otherwise specified)	1
Schottky Assembly	2
Supervisor(not otherwise specified)	1
Voltage Tester	1
Other:	
Cafeteria Manager	1
Production Manager	1
Personnel Secretary	1
Research & Development Laboratory	1
Director, Human Resources	1
Material Manager	1

Pulmonary Function and Respiratory Complaints by Sex and Current Smoking Status

Siemens Components, Inc.
Broomfield, CO

June 23 & 24, 1983

Sex / Smoking Status / Characteristic	Male: Current Smokers	Male: Ex& Non-Smokers	Male: Total	Female: Current Smokers	Female: Ex& Non-Smokers	Female: Total	Total: Current Smokers	Total: Ex& Non-Smokers	Total
Number	15	17	32	38	20	58	53	37	90

TABLE III

BREATHING ZONE AIR CONCENTRATIONS OF
1-1-1-TRICHLOROETHANE AND ISOPROPYL ALCOHOL

Siemens Components, Inc.
Broomfield, Colorado
July 13, 1983

SAMPLE #	JOB DESCRIPTION	SAMPLING TIME	Mg/M^3 1,1,1 Trichlorethene	ISOPROPYL ALCOHOL
1	Etching	8:57-1:10	*	*
2	Chemical Shed	9:17-1:10	40	3
3	Tin Dipping	9:10-2:30	*	*
5	Etching	10:30-2:30	*	*
7	Research & Development	11:20-2:30	*	14
Evaluation Criteria			1900	980
Laboratory Limit of Detection			0.01	0.01

mg/M^3 = milligrams of substance per cubic meter of air
* = Below Laboratory limit of detection

TABLE IV

BREATHING ZONE AIR CONCENTRATIONS OF
TOTAL PARTICULATE AND ALUMINUM PARTICULATE

Siemens Components, Inc.,
Broomfield, Colorado
July 13, 1983

SAMPLE #	JOB DESCRIPTION	SAMPLING TIME	mg/m^3 TOTAL PARTICULATE	ALUMINUM
P5-399	Lead Setup	8:32-11:00	0.45	0.04
P5-395	Glass abrader	8:14-12:20	0.16	*
P5-380	Sandblast	8:19-1:15	0.38	*
P5-384	Sandblast	8:16-1:10	0.16	*
P5-379	Sandblast	8:22-12:50	0.22	*
Evaluation Criteria			10	10
Laboratory limit of detection			.005	.005

mg/M^3 = milligrams of substance per cubic meter of air
* below laboratory limit of detection

POSTAGE AND FEES PA
U.S. DEPARTMENT OF H
HHS 396