HETA 92-0028-2501
CTL AEROSPACE, INC.
CINCINNATI, OHIO

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 92-0028-2501
APRIL 1995
CTL AEROSPACE, INC.
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
Kenneth F. Martinez, M.S.E.E
Yvonne Boudreau, M.D.
Stephen S. Smith, M.S.
Ann Krake, M.S.

I. SUMMARY

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at CTL Aerospace, Inc., in Cincinnati, Ohio. This investigation was performed in response to a confidential employee request. The health concerns listed on the request included skin rashes, burning eyes and throat, and tunnel vision among workers in the fabrication department who reported exposure to fibrous glass containing materials, 2-butanone, also called methyl ethly ketone (MEK), Frekote®, and spray adhesives.

On February 20, 1992, NIOSH investigators performed a walk-through inspection of the CTL Aerospace facility. Private medical interviews were conducted with seven (88%) of the eight employees who worked in Clean Room D, the area of concern as identified by the workers (activities were later relocated to Clean Room A). The most commonly reported health concern was skin rashes. This symptom was reportedly related to direct skin contact with sealants, epoxy resins, MEK, and a Kevlar® containing material. Most of those interviewed reported that the use of gloves decreased the occurrence of skin rashes. Other reported health concerns included fatigue, headaches, nose and throat irritation, sinus congestion, soreness of neck, shoulders and wrists, and finger stiffness. None of the interviewed workers reported tunnel vision (a health effect listed on the original request).

A follow-up investigation was conducted on April 20, 1993. This site visit was conducted to assess ergonomic issues related to the application of fabric to the mold and to collect personal breathing zone (PBZ) air samples for MEK on workers in Clean Room A. The ergonomic evaluation identified employee activities (awkward static postures and the application, repetition, and duration of significant forces to musculoskeletal tissue) that could result in stress and eventual strain to upper extremities. All of the PBZ air samples showed time-weighted average MEK exposures were below the NIOSH Recommended Exposure Limit, the American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Value, and the Occupational Safety and Health Administration Permissible Exposure Limit of 200 parts per million (ppm). One short-term sample was above the NIOSH and ACGIH 15-minute short-term exposure limit of 300 ppm. Methyl ethyl ketone was observed to be liberally applied to clean tools and molds prior to the fabrication of parts during worker activities outside Clean Room A.

Based on the data collected in this evaluation, the NIOSH investigators conclude that direct skin exposure to epoxy resins, MEK, and fibrous glass-containing materials could be causing skin irritation and/or sensitization in employees. Additionally, a short-term MEK over-exposure and potential biomechanical hazards were identified. Recommendations are made in the report for engineering solutions and personal protective equipment to reduce potential biomechanical hazards and solvent exposures.

KEYWORDS: SIC 3728 (aircraft parts and auxiliary equipment, not elsewhere classified) and 3769 (guided missile and space vehicle parts and auxiliary equipment, not elsewhere classified), 2-butanone, methyl ethyl ketone, MEK, ergonomics, skin irritation.

II. INTRODUCTION

On October 21, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees at CTL Aerospace, Inc., Cincinnati, Ohio, to conduct a Health Hazard Evaluation (HHE) of operations in Clean Room D. Specific concerns focused on symptoms believed by employees to be associated with exposures to materials used in the fabrication of composite aerospace parts. "Possible" chemical agents cited in the request included fibrous glass, methyl ethyl ketone (MEK), Frekote®, and a spray adhesive. Symptom descriptions include "some tunnel vision," burning eyes and nose, headaches, occasional dizziness, a "sick feeling," and skin rashes.

On February 20, 1992, NIOSH investigators (including an industrial hygiene engineer and a medical officer) conducted an initial site visit at the CTL Aerospace facility. The site visit consisted of a facility walk-through inspection and private medical interviews with employees who worked in Clean Room D. A follow-up investigation was conducted on April 20, 1993, to assess ergonomic issues related to the application of fabric to the mold and to collect personal breathing zone (PBZ) air samples for MEK on workers in Clean Room A (relocated from Clean Room D). MEK is used primarily as a solvent to clean fabrication tools and surfaces. An interim letter reporting the results of the PBZ air samples (along with recommendations) was sent to a CTL management representative and the confidential requestors on August 20, 1993.

III. BACKGROUND

CTL Aerospace, Inc. primarily manufactures composite components for clients in the aerospace industry. CTL also repairs and overhauls composite and metal aerospace parts. Materials used in the manufacturing process include thermal plastics, ceramics, high temperature polyamides, PMR-15, epoxies, and phenolics. Additionally, reinforcement agents used in the manufacturing process include Kevlar®, graphite, and fibrous glass. In 1988, CTL moved its manufacturing operations to a newly constructed 96,000 square foot concrete building. At the time of the investigation, employment reports indicated a total work population of 162 people, of which approximately two-thirds are directly responsible for manufacturing.

The "lay-up" of composite parts is conducted in four clean rooms (Clean Rooms A, B, C, and D). Between the time of the initial request and the second site visit, operations in Clean Room D had relocated to a newly constructed room (Clean Room A) on the opposite side of the facility (Figure 1). Lay-up production occurs on two work shifts (70% during the first shift), which operate eight hours per day, five days per week. In Clean Room A, 11 to 15 employees cut resin fabric materials impregnated with fibrous glass, graphite, or Kevlar®, and "mold" them to aluminum "tools" (gusset fitting cable shield covering). Tasks within the lay-up process include: preparatory cleaning of tools with MEK; cutting resin fabric to customers' specifications utilizing a template; application and molding of the

resin fabric to the tool; applying heat to the molded piece as an initial cure treatment; and vacuum packaging prior to final curing in autoclaves.

On November 15, 1991, the Occupational Safety and Health Administration's (OSHA) Cincinnati office received an employee complaint concerning chest pains and other respiratory problems believed to be caused by formaldehyde and other chemical exposures. These exposures were believed to be the result of inadequate ventilation and lack of respiratory protection. According to the report, an OSHA inspection was conducted on October 23-28, 1991, it included air monitoring for hexane and MEK. Air sample results did not indicate over-exposures to the chemicals sampled; however, the OSHA investigation revealed violations of the OSHA hazard communication standard; specifically, the absence of appropriate labels, tags or marks identifying hazardous chemicals, and failure to train all employees on the hazards of chemicals with which they worked. During the February 20, 1992, NIOSH investigation, CTL indicated they were developing a hazard communication program.

IV. EVALUATION METHODS

Medical Evaluation

Seven of the eight Clean Room D first shift employees were present on the day of the first NIOSH visit. These employees were interviewed privately by the NIOSH medical officer. All interviews were done on a voluntary basis, and no one refused to be interviewed.

Environmental Evaluation

PBZ samples for MEK were collected on the four employees in Clean Room A who were identified by observation during the initial site visit as those with the highest potential exposure. PBZ air samples used to estimate time-weighted average (TWA) exposures were collected on employees in Clean Room A; PBZ air samples used to estimate short-term exposures were collected on employees outside Clean Room A conducting tool clean-up (MEK is used in greater quantity during tool clean-up than for any other observed use). Each employee wore a Gilian®, Model No. LFS 113 DC, low-flow personal sampling pump attached to a solid sorbent tube (Orbo™ 90 molecular sieve) via flexible tubing. All sampling pumps were operated at a calibrated flow rate of 50 cubic centimeters per minute (cc/min) with the exception of the pump used to collect two short-term samples, which was operated at a calibrated flow rate of 200 cc/min. Sorbent tube analysis was conducted according to NIOSH Method 2500.[1] Each sorbent tube was desorbed in 1 milliliter (mL) of carbon disulfide containing 1 microliter (µL) per mL of benzene as an internal standard. MEK analysis was conducted on a gas chromatograph with a flame ionization detector.

Ergonomic evaluation

During the second NIOSH site visit, investigators observed workers in Clean Room D to evaluate areas of potential ergonomic stress upon musculoskeletal tissue. Activities were monitored during the cutting of fabric and the application of the fabric to molds.

V. EVALUATION CRITERIA

Methyl ethyl ketone

MEK is a colorless, flammable organic solvent with a characteristic odor similar to acetone. MEK is typically used as a solvent in the surface coating and synthetic resin industries.[2,3] MEK is absorbed primarily through inhalation and, at high concentrations, may cause central nervous system depression. Short duration inhalation exposure to 100 ppm of MEK was reported to cause slight nose and throat irritation, 200 ppm caused mild eye irritation, and 300 ppm was associated with headaches, throat irritation, and an objectional odor.[4] Additional studies indicate that MEK by itself does not cause neurologic toxicity of the extremities (peripheral neuropathy), but it may potentiate the toxic effects of substances known to cause peripheral neuropathy, such as n-hexane.[5,6,7] Many industrial solvents are primary skin irritants and can cause defatting of the skin and dermatitis (i.e., continued or prolonged skin contact with MEK liquid).[3] Solvents are among the leading causes of occupational skin disease.[8] MEK is not known to be a carcinogen.[9] The NIOSH Recommended Exposure Limit (REL), the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for MEK are 200 ppm as a full-shift (for NIOSH REL up to 10 hours) TWA. NIOSH and ACGIH have established a 15-minute short-term exposure limit (STEL) of 300 ppm.[10,11,12]

Occupational Skin Disease

Skin disease accounts for 15-20% of all occupational illnesses, excluding injuries and accidents.[13] The skin is particularly vulnerable to occupationally induced disease because large areas of this organ are directly exposed to the environment. Approximately 95% of all types of occupational skin disease may be classified as contact dermatitis, while the other 5% is due to infection. There are two types of contact dermatitis, irritant and allergic. Approximately 80% of all cases of contact dermatitis are believed to be irritant.[14]

Virtually any substance, under the right set of circumstances, is capable of causing irritant contact dermatitis. Among the most common skin irritants are detergents, solvents (including MEK), and fibrous glass. Irritant contact dermatitis often results from multiple exposures to several potential skin irritants rather than from just a single substance. Irritant dermatitis generally remains confined to the primary areas of skin exposure and does not

spread to other parts of the body where direct exposure has not occurred. If the irritant substance comes into contact with damaged (i.e., dry or chapped) skin, irritation is more likely to develop. The eyelids, face, and genital area (where skin is thinnest) are most susceptible to irritation.

The development of allergic contact dermatitis requires sensitization to the offending substance. This sensitization process involves mechanisms which require a period of at least one to three weeks following first exposure, but development of allergic contact dermatitis may take longer, depending on the frequency and severity of exposure. Once sensitized, if an affected individual is exposed to even extremely low concentrations of the offending substance, he/she will have a reaction within several hours to a few days. Unlike irritant contact dermatitis, allergic contact dermatitis frequently extends to parts of the body away from the primary site of direct skin contact with the allergen. Plastic resins (e.g., epoxy resin) and metallic compounds (e.g., nickel, chromate) are examples of causes of allergic contact dermatitis.

Medical management is the same for both irritant and allergic contact dermatitis. The causative exposures should be minimized or eliminated, and the affected worker should see a physician for evaluation and treatment (typically consideration of topical corticosteroid use). Allergic contact dermatitis usually requires complete elimination of exposure to the allergen.

VI. RESULTS

Medical Evaluation

Four of the seven interviewed employees reported a skin rash, and two each reported fatigue and headaches (refer to Figure 2). These symptoms (nose bleeds, sore throats, sinus congestion, finger stiffness, wrist pains, sore shoulders, sore neck) were reported by only one person each. The rashes were reportedly related to direct skin contact with MEK, epoxy resins, and a Kevlar® material containing fibrous glass. Skin rashes were reportedly limited to exposed areas of the skin. None of the workers had a rash on the day of the interviews.

Environmental Evaluation

The results of the PBZ air samples are summarized in Table I as TWA exposures (air samples were collected over a time period of approximately 7 hours) and as short-term exposures (15 minutes). All of the samples for TWA exposures were well below the NIOSH REL, OSHA PEL, and ACGIH TLV of 200 ppm. The low TWA exposure sampling results are not unexpected since MEK is used infrequently inside Clean Room A (only for periodic cleaning of the fabrication tools and work surfaces). One of the short-term exposure samples collected outside Clean Room A (MEK concentration of 362 ppm) was above the NIOSH and ACGIH STEL of 300 ppm. MEK was observed to be liberally applied by workers outside Clean Room A during tool clean-up.

Ergonomic Evaluation

NIOSH investigators observed areas of potential ergonomic stress upon musculoskeletal tissue. For example, tables and chairs used during work did not adjust to accommodate employees of different height and with different functional reach capabilities. Potential problems to musculoskeletal tissue may occur when employees must assume awkward postures due to the location of the point of operation. Such awkward postures were apparent while employees were using the tables and sitting in the chairs when cutting and applying fabric to an aluminum mold. The fabric was brought to the table in sheets and was manually cut into specific sizes and shapes. Templates and small industrial knives were used to cut the fabric for certain mold shapes. Due to the degree of cutting precession necessary, workers placed themselves in position where they could be most effective. However, the height of the chairs appeared to be too high for tall workers, requiring them to maintain a flexed neck and hunched back posture, which was not alleviated by switching to a standing position. Correspondingly, the orientation of the table along with the size and shape of the specified cuts required short workers to reach and maintain that posture while working at the point of operation. Awkward postures have been considered as on of the risk factors for musculoskeletal stress and strain.[15, 16] Additionally, when pressing the mold into place, workers had to manipulate an aluminum piece and hold it with one hand (or arm or side of the body) while forcefully pressing with the free hand. The aluminum pieces are lightweight but are not of standard shape and size. An awkward shaped piece could result in an awkward posture during the attempt to achieve an adequate mold fit.

Once the fabric was applied, it was fitted to the aluminum mold. The procedure for pressing the fabric into place required the worker to hold the mold stationary with one hand (or arm or pressed against the body) while forcefully pressing with the other hand. Although the aluminum pieces were lightweight, they were not of standard size and shape. The shapes and sizes of the pieces also made it necessary for workers to assume awkward postures to apply enough pressure for an adequate mold fit.

The employees use a piece of Teflon® (machined in-house to the employee's specifications) to press the fabric into shape. Often an employee has a few differently shaped Teflon® pieces for reaching and fitting fabric into difficult areas. Although the Teflon® is shaped uniquely according to the task, a problem may occur as a result of external mechanical stress on the hand from forcefully pressing with the piece of Teflon®. In a discussion between various investigators of occupational related upper extremity musculoskeletal disorders, a common contributing factor was identified as internal and external mechanical stress.[17, 18] The combination of these factors (awkward static posture and the application of significant force) along with task repetition and duration may result in stress and eventual strain to an employees' upper extremity musculoskeletal tissue.[19]

VII. CONCLUSIONS AND RECOMMENDATIONS

Medical interviews revealed predominant work-related health problems to be skin rashes. MEK, fibrous glass, and epoxy resins can cause contact dermatitis, so direct skin contact with these materials should be prevented. The short-term over-exposure to MEK indicates the need for appropriate controls. Some of the employee health complaints (i.e., sore neck, sore shoulders, and wrist pain) identified during the medical interviews may be related to awkward postures assumed during the lay-up process. Specific recommendations include:

1. The replacement of toxic workplace chemicals with less toxic, yet still effective, substitutes should be considered. This is always a prudent course of action, even when exposure criteria are not exceeded.

2. Where material substitution is not practical, modification of work practices may provide a reasonable alternative. The one short-term over-exposure may have been the result of inappropriate work practices during the clean-up operation (e.g., over application of MEK) or, alternatively, the result of clean-up procedures specific to a particular mold (exclusive of the practices of the worker). Further exposure monitoring should be conducted to evaluate various clean-up techniques.

3. If exposures continue to exceed STELs, then local exhaust ventilation can be applied. Local exhaust ventilation is preferred over general dilution ventilation because it removes the contaminant at the source. General dilution ventilation is an inefficient method of dealing with a short-term localized exposure. Until the appropriate controls can be implemented, personal protective equipment is warranted as an interim solution (i.e., respiratory protection in accordance with 29 CFR 1910.134).

4. Any worker who has skin contact with MEK, epoxy resins, or Kevlar® impregnated materials should wear gloves that are impermeable to the substance (i.e., butyl rubber or Teflon® gloves for MEK and polyethylene gloves for epoxy resins). If a skin rash occurs after exposure to one or more of these compounds, the rash should be evaluated by a physician who is knowledgeable about occupational skin disorders.

5. During the April 20, 1993, NIOSH investigation, an employee was observed applying a release agent (composed of chlorodifluoromethane, trichlorotrifluoroethane, dibutyl ether, and aliphatic naphtha) to various molds on the spray table (as shown in Figure 1). In an attempt to control exposures to the aerosol, CTL installed an upright stationary fan directed across the spray table. Although the stationary fan might provide some dilution ventilation, a more effective control strategy would be to install a small paint-spray booth to remove aerosols from the employee work environment.

6. Engineering controls are the preferred method for prevention of work-related musculoskeletal disorders. The focus of engineering controls is to make the job fit the person, not the person fit the job. The engineering recommendations discussed below focus on workstation design, work methods, or use of specific tools to reduce identified physical stress risk factors.

    a. Provide new adjustable tables and chairs or modify existing equipment. The tables should have tilt as well as height adjustability. Tilting the table would help bring the point of operation closer and alleviate some of the reaching and bending associated with the job.

    b. Attach an adjustable piece holder or vise to the table. Fastening the piece in the vise should relieve the employee of having to manually hold the piece in place while simultaneously attempting to fit the fabric to the mold. An adjustable or maneuverable vise may assist in preventing the employee from having to maneuver around the vise while working on the piece. This may also reduce the awkward postures assumed by the employee to gain access to certain areas while applying the fabric.

    c. Provide a handle (preferably adjustable) in which the Teflon® plastic could be inserted and removed when necessary. An adjustable handle would enable positioning of the Teflon® to emulate a pistol grip, in-line grip, or possibly other tool grip shapes. Since the sizes and shapes of the pieces are not consistent, an adjustable handle may allow an employee to maintain the wrists and arms in a neutral position.

7. Although engineering control is the preferred method of preventing work related musculoskeletal disorders, administrative controls can be used as a temporary measure until engineering controls are implemented or when engineering controls are not technically feasible. Training, job rotation, and rest pauses are reasonable administrative measures to help prevent work related musculoskeletal disorders. At this particular facility and for this particular area, the training and rest breaks appear adequate.

VIII. REFERENCES

1. NIOSH [1984]. NIOSH manual of analytical methods. Vol 3. Cincinnati, OH: National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

2. ACGIH [1986]. Documentation of threshold limit values and biological exposure indices for chemical substances and physical agents. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. NIOSH [1978]. Criteria for a recommended standard: occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

4. Proctor NH, Hughes JP, Fischman ML [1991]. Chemical hazards of the workplace. 3rd ed. Philadelphia, PA: J.B. Lippincott.

5. Ellenhorn MJ, Barceloux DG [1988]. Medical toxicology: diagnosis and treatment of human poisoning. New York, NY: Elsevier, pp 1000-1001.

6. Dyro FM [1978]. Methyl ethyl ketone polyneuropathy in shoe factory workers. Clin Toxicol 13:371-376.

7. NIOSH [1978]. Criteria for a recommended standard: occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

8. Cone JE [1986]. Health hazards of solvents. In: State of the art reviews: occupational medicine. *1*(1):69-87.

9. NTP [1994]. Seventh annual report on carcinogens: 1994 summary. Research Triangle Park, NC: U.S. Department of Health and Human Services, National Toxicology Program.

10. NIOSH [1992]. NIOSH recommendations for occupational safety and health. Compendium of policy documents and statements. 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) Publication No. 92-100.

11. ACGIH [1992]. Threshold limit values and biological exposure indices for 1992-93. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

12. Code of Federal Regulations [1989]. OSHA Table Z-1. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

13. Occupational Injury and Illness in the United States. United States Department of Labor, Bureau of Labor Statistics, Bulletin 2424, May 1993.

14. Mathias, CGT. Occupational Dermatoses, In Occupational Medicine: Principles and Practical Applications, second edition. C. Zen, ed. Chicago, Year Book Medical Publishers, Inc. pp. 132-165, 1998.

15. Aaras A, Westgard RH, Stranden E [1988]. Postural angles as an indicator of postural load and muscular injury in occupational work situations. Ergonomics *31*(6):915-933.

16. Sommerich CM, McGlothlin JD, Marras WS [1993]. Occupational risk factors associated with soft tissue disorders of the shoulder: a review of recent investigations in the literature. Ergonomics *36*(6):697-717.

17. Silverstein BA, Fine LJ, Armstrong TJ [1986]. Carpal tunnel syndrome: causes and a preventive strategy. Seminars in Occupational Medicine *1*(3):213-221.

18. Armstrong TJ, Silverstein BA, Blair S, Buckle P, Fine LJ, Hagberg M, Jonsson B, Kilbom A, Hogstedt C, Kuorinka I, Viikari-Juntura E, Sjoigaard G [1988]. Work related neck and upper limb disorders: a discussion. Ergonomics International 88 (the musculoskeletal system at work), pp:404-406.

19. Putz-Anderson V [1988]. Cumulative trauma disorders: a manual for musculoskeletal disease of the upper limbs. Bristol, PA: Taylor and Francis.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:	Kenneth F. Martinez, M.S.E.E. Industrial Hygiene Engineer Industrial Hygiene Section
	Yvonne Boudreau, M.D. Medical Officer Medical Section
	Stephen S. Smith, M.S. Mechanical Engineer Division of Physical Sciences and Engineering
Field Assist:	Ann Krake, M.S. Industrial Hygienist Industrial Hygiene Section
Analytical Support:	DataChem Laboratories Salt Lake City, Utah
Report Formatted By:	Caren B. Day Office Automation Assistant Industrial Hygiene Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report may be freely reproduced and are not copyrighted. Single copies of this report will be available for a period of 90 days from the date of this report from the NIOSH Publications Office, 4676 Columbia Parkway, Cincinnati, Ohio 45226. To expedite your request, include a self-addressed mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Confidential Requestors
2. Management Representative
3. OSHA Region V, Chicago, Illinois

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

Table I. Results of Environmental Air Samples for MEK
CTL Aerospace, Inc., Cincinnati, Ohio
HETA 92-0028
April 20, 1993

LOCATION	WORKER	SAMPLE TIME (min)	SAMPLE VOLUME (L)	CONCENTRATION (ppm)
Time Weighted Average				
Clean Room A	A	426	21.3	18
Clean Room A	B	426	21.3	8
Clean Room A	C	414	20.7	8
Clean Room A	D	414	20.7	17
Short-Term				
Outside Clean Room	A	15	0.8	362
Outside Clean Room	B	15	1.7	42
Outside Clean Room	D	11	2.2	2
Outside Clean Room	D	15	3	93
Evaluation Criteria				
OSHA NIOSH ACGIH	*8-hour TWA*	200 ppm 200 ppm 200 ppm	*15-minute STEL*	300 ppm 300 ppm

NOTE: Similar job descriptions exist for all sampled employees.

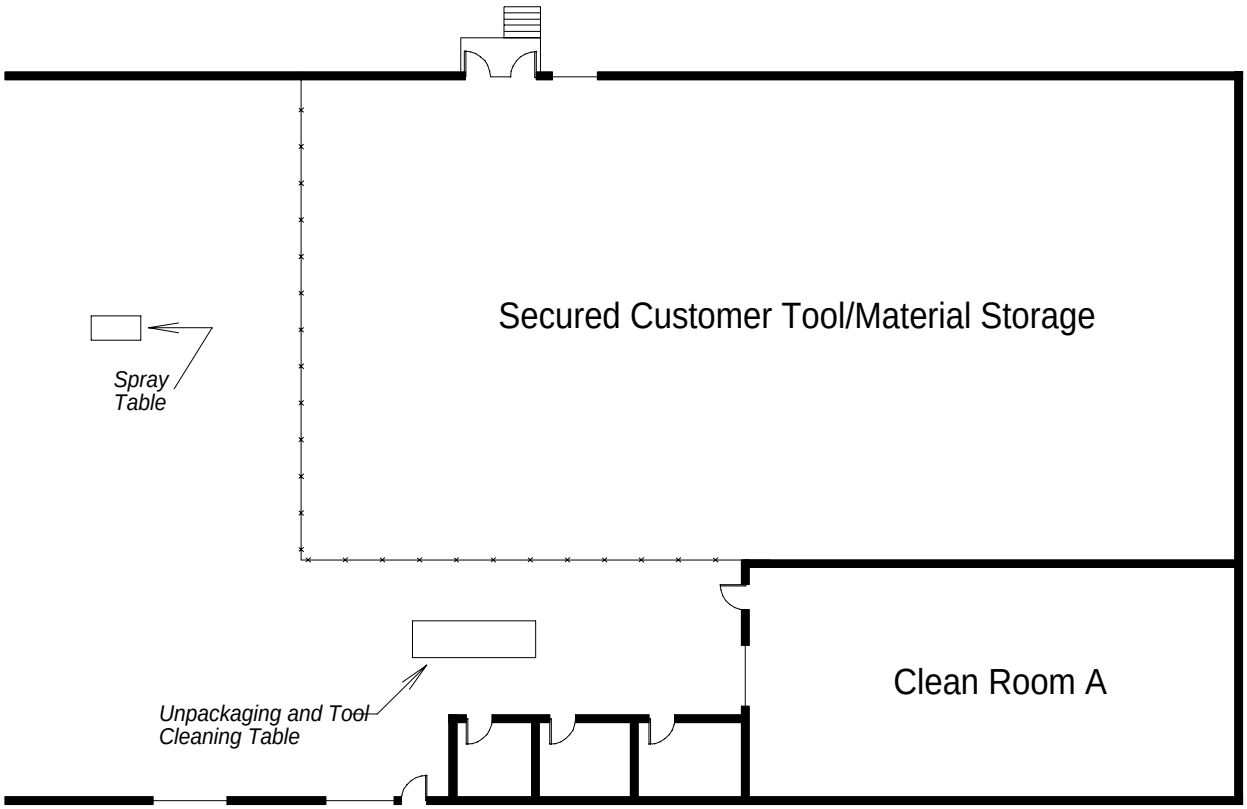

Figure 1. Plan View of Evaluated Area, CTL Aerospace, Inc., Cincinnati, Ohio, HETA 92-0028

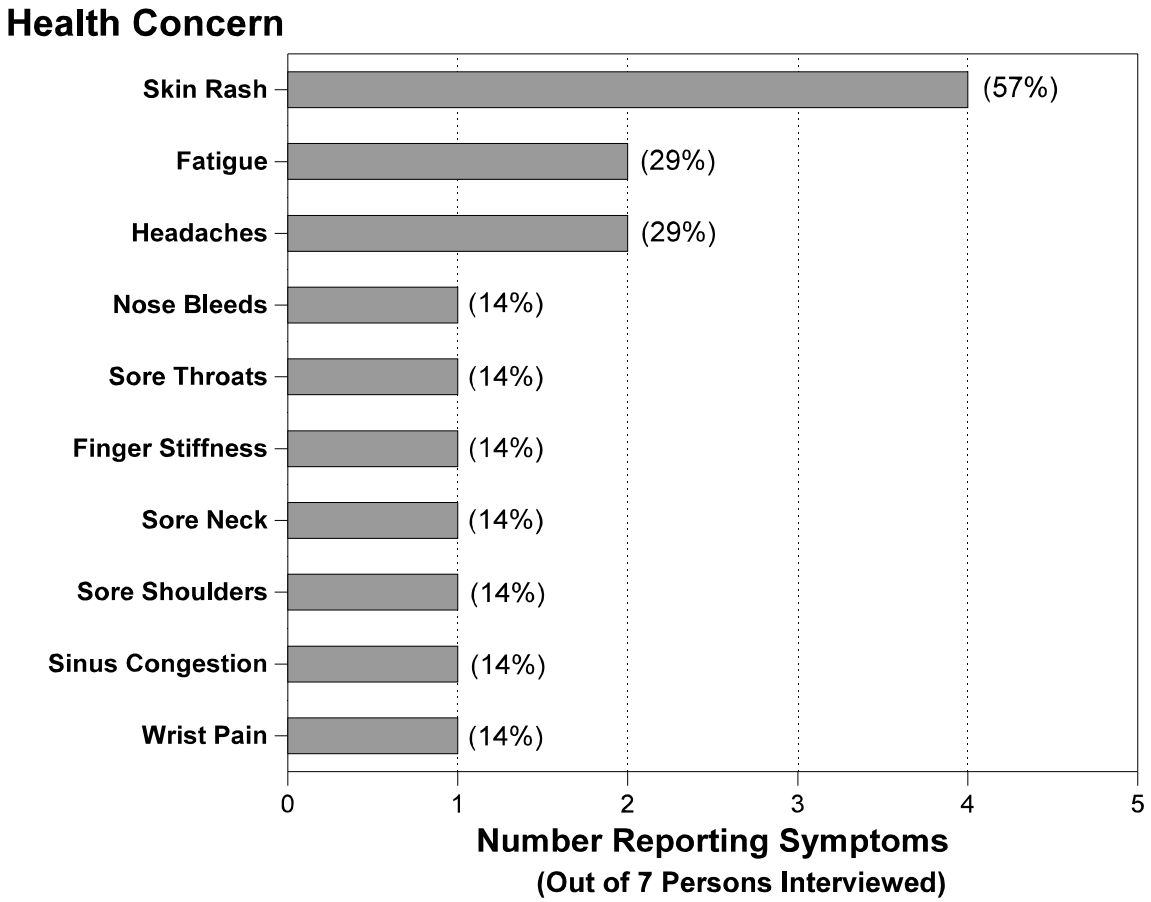

Figure 2. Health Concerns of Seven CTL Aerospace, Inc. Employees Based on Medical Interview, February 20,1994, HETA 92-0028