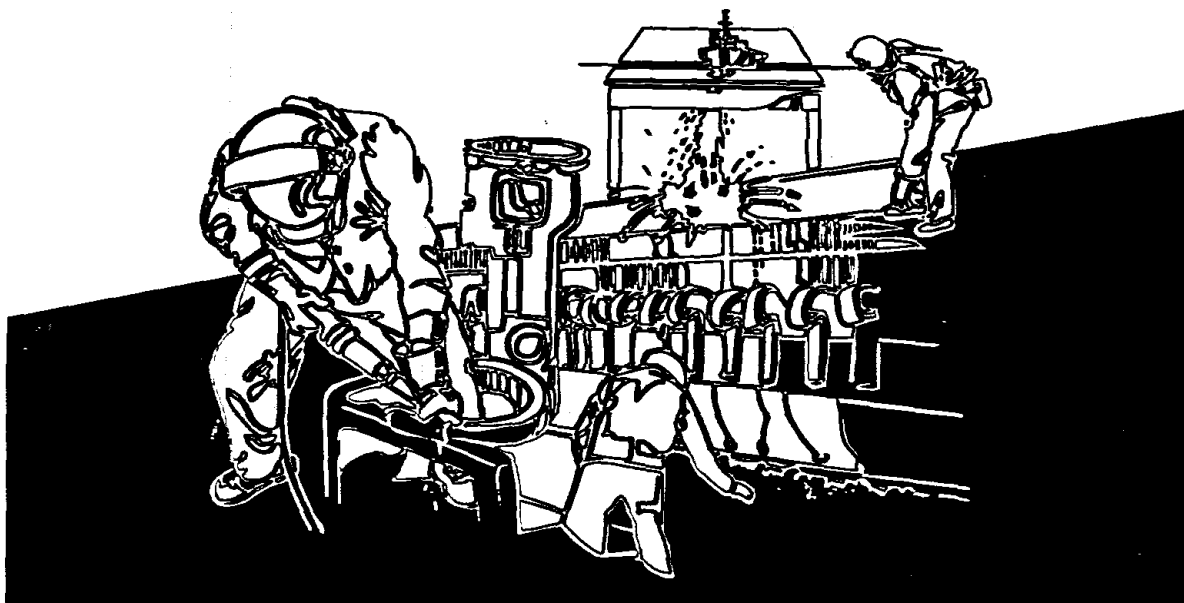


This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional HHE reports are available at <http://www.cdc.gov/niosh/hhe/reports>



NIOSH HEALTH HAZARD EVALUATION REPORT

**HETA 91-0292-2467
MAGNETICS DIVISION OF
SPANG & COMPANY
BUTLER, PENNSYLVANIA**



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



PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazard 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 Evaluation 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

**HETA 91-0292-2467
NOVEMBER 1994
MAGNETICS DIVISION OF
SPANG & COMPANY
BUTLER, PENNSYLVANIA**

**NIOSH INVESTIGATORS:
LEO M. BLADE, C.I.H.
FAYE T. BRESLER, M.D.**

SUMMARY

On January 11-13, 1993, National Institute for Occupational Safety and Health (NIOSH) representatives conducted a health hazard evaluation (HHE) at the Magnetics Division of Spang & Company, East Butler, Pennsylvania, in response to a confidential request submitted by three current employees. The requestors asked NIOSH to evaluate the Tape Core Paint Room (Paint Room) and adjacent areas. The employees expressed concern about the potential exposures to paints, paint thinners (Cellosolve® acetate and FD-81 Solvent), and Freon®. Their concerns were raised in part by a physician's diagnosis of lightheadedness or fainting episodes in at least three employees employed in the Tape Core Department. Ventilation measurements were made and personal breathing-zone (PBZ) and general-area (GA) air sampling was conducted for xylene, ethyl acetate, 1,1,1-trichloroethane, methylene chloride, 2-ethoxyethyl acetate, Freon® TF [1,1,2-trichloro-1,2,2-trifluoroethane]), respirable and total particulate, and metals (including lead and chromium). In addition, bulk-material samples were analyzed and observations made of the operations and work practices.

Air concentrations of xylene, ethyl acetate, 1,1,1-trichloroethane, and Freon® TF were well below their respective PBZ exposure criteria. Methylene chloride was detected in both full-shift and short-term (approximately 53 minutes) PBZ and GA air samples, ranging up to 35 parts per million (ppm). NIOSH considers methylene chloride a potential occupational carcinogen, so exposures should be reduced to their lowest feasible concentrations. The compound 2-ethoxyethyl acetate was only quantifiably measurable in one sample (a PBZ sample collected on a tape-core painter). However, this one sample had 0.25 ppm, a concentration which is one-half of the NIOSH Recommended Exposure Limit (REL) for full-shift, time-weighted average (TWA) exposure. Furthermore, 2-ethoxyethyl acetate can be absorbed through the unprotected skin.

Of the 26 elements analyzed for in the air samples, 15 were not detectable (the minimum detectable concentration [MDC] for these 15 elements was 0.8 micrograms per cubic meter [$\mu\text{g}/\text{m}^3$]). One PBZ sample collected on a tape-core painter had 36 $\mu\text{g}/\text{m}^3$ of lead, a concentration which exceeds the Occupational Safety and Health Administration (OSHA) action level for lead of 30 $\mu\text{g}/\text{m}^3$, TWA; the OSHA Permissible Exposure Limit (PEL) for lead for a full-shift TWA exposure is 50 $\mu\text{g}/\text{m}^3$.

Ventilation measurements indicated that the two spray booths in the Paint Room exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) spray booth performance recommendations of 100 to 150 cubic feet per minute per square foot (with the operator outside the booth). Good work practices among the painters were observed;

for example, they did not lean into the booths during painting. Paint Room workers also wore rubber gloves at the time of the NIOSH survey.

A review of the OSHA Injury and Illness records (OSHA Form 200) for 1990-1992 revealed that all entries were for injuries, strains, tendinitis, lacerations, and low back pain. One entry in 1990 was recorded as "light head and dizzy, not work-related" and was check-marked as an injury. No other entries listed symptoms consistent with dizziness, syncope, or central neurotoxicity. A review was also performed of the medical and company records concerning four employees from Magnetics who had experienced symptoms ranging from dizziness to syncopal episodes. Medical records were from the period of February 1991 to August 1992, and included all documentation regarding office visits, laboratory test results (including blood-work, electrocardiograms, pulmonary function tests, etc.). Information from the four medical records was consistent with "Type 1 Solvent Neurotoxicity," defined by the World Health Organization (WHO) as the presence of headaches, dizziness, and difficulty concentrating after solvent exposure.

Workers in the Paint Room were exposed to levels of methylene chloride, a potential carcinogen. Since NIOSH considers methylene chloride to be potential occupational carcinogen, concentrations should be reduced to the lowest feasible level. One PBZ air sample collected for 2-ethoxyethyl acetate was one-half of the NIOSH REL for this compound. Another PBZ air sample exceeded the OSHA action level for lead. Since exposures can vary from day-to-day, higher exposures to 2-ethoxyethyl acetate and lead may occur among Paint Room employees. Finally, although the exposures measured in this evaluation were under the OSHA PELs, some workers may still experience symptoms such as dizziness or mucous membrane irritation when working near paints and solvents. Recommendations have been made to: (1) conduct additional air monitoring to more fully characterize worker exposures to lead; (2) replace the methylene chloride and Freon® TF used in the vapor degreaser with less hazardous solvents; (3) provide additional personal protective equipment for Paint Room workers; and (4) institute ventilation and administrative changes to further reduce exposures.

Keywords: SIC 3679 (Electronic Components, Not Elsewhere Classified), methylene chloride, Freon® TF, 2-ethoxyethyl acetate, lead, 1,1,2-trichloro-1,2,2-trifluoroethane

INTRODUCTION AND BACKGROUND

On January 11-13, 1993, National Institute for Occupational Safety and Health (NIOSH) representatives made a site visit to the Magnetics Division of Spang & Company, in East Butler, Pennsylvania. This visit was performed in response to a confidential request for a health hazard evaluation (HHE) submitted by three current employees. The requestors asked NIOSH to evaluate the workroom environment of the Tape Core Paint Room (Paint Room) and areas adjacent to this department. The employees expressed concern about the potential exposures to paints, paint thinners (Cellosolve® acetate and FD-81 Solvent), and Freon®. Their concerns were raised in part by a physician's diagnosis of lightheadedness or fainting episodes in at least three employees employed in the Tape Core Department prior to this NIOSH evaluation.

An opening conference was held on January 11, 1993, which was attended by representatives of management and by the International Brotherhood of Electrical Workers (IBEW), Local 1957. NIOSH representatives presented an overview of the NIOSH HHE program and discussed plans for the initial investigation. Following this meeting, a tour of the Tape Core Department, including the Paint Room, was conducted. Subsequent activities on January 12, 1993, included ventilation measurements, personal-breathing-zone (PBZ) and general-area (GA) air sampling in the Tape Core Department, the collection of bulk-material samples for qualitative and quantitative analyses, and observations of the operations and work practices.

DESCRIPTION OF THE FACILITY AND OPERATIONS

The Magnetics Division plant, located in a two-story building in East Butler, Pennsylvania, employed approximately 450 people as of September 1992. This facility manufactures two types of magnetic cores (a high-nickel alloy type and an iron oxide [ferrite] type). These cores are used in a variety of electronic devices. Thin gauge strips of high nickel alloy are wound to make a tape core.

The Tape Core Department and the adjacent Tape Core Paint Room were situated on the second floor. Approximately 50 employees (predominately female) worked in the Tape Core Department in September 1992, over three work shifts. There were two painters and one painter's helper assigned to the Paint Room. As shown in Figure 1, the approximately 350 square foot (ft²) Paint Room is adjacent to the Tape Core Department. The two painters and one painter's helper who worked in this room typically rested at a table located in a corridor immediately outside the Paint Room when they were between tasks.

At the time of the NIOSH visit, a vapor degreaser was located across the corridor from the painters' table, along the outside wall. This degreaser, used to clean parts, contained

Freon[®] TMC, a mixture of 54% methylene chloride and 46% Freon[®] TF.¹ Reportedly, this degreaser was scheduled to be replaced to comply with environmental regulations governing the emission of chlorofluorocarbons into the atmosphere. In addition to a local exhaust ventilation system, this degreaser was equipped with a metal lid that was closed whenever the tank was not in use. Degreasing was conducted by placing racks containing numerous parts into the degreaser. This operation was reportedly conducted early in the day, typically before the painters arrived.

Tape Core Department employees performed a variety of assembly, cleaning, or inspection operations while seated at numerous workstations. Small quantities of two substances, ethyl acetate and 1,1,1-trichloroethane, were intermittently used in this area (away from the Paint Room) for manual parts cleaning using paper towels. Two paint spray booths were located in the Paint Room -- the tape-core spray booth and the bobbin-core spray booth (bobbin cores arrive from the Bobbin Core Department, an area not included in this NIOSH evaluation). A painter was assigned to either the bobbin-core or the tape-core spray booth. Also used in the Paint Room, as paint thinners, are Cellosolve[®] acetate and FD-81, a solvent containing approximately 90% petroleum distillates and 10% naphthalene.

Tape cores are placed on racks, pre-heated in tape-core dispatch oven #1, and then moved to the tape-core spray booth where they are manually spray painted with G4347 Thermelec Orange paint. The painted cores are then transferred to tape-core dispatch oven #2 for curing. This painting and curing process is repeated to apply a second coat of paint.

Bobbin cores are handled in a similar manner, except that there is only one bobbin-core oven and the paint is slightly different (G4369 Thermelec Orange). The compositions of these orange paints, however, are similar. Each contain xylene, 2-ethoxyethyl acetate (Cellosolve[®] acetate), and Moly Orange Pigment Red 104 (a pigment containing lead, chromium [including chromium VI], and molybdenum). A small amount (2.7%) of amorphous silica is present in G4347 Thermelec Orange, while G4369 contains no amorphous silica.

Both spray booths and all three ovens in the Paint Room are equipped with local exhaust ventilation systems exhausting through the roof of the building. The "roof exhaust" shown in Figure 1 was a dilution ventilation unit which was not in use at the time of this survey.

Make-up air (to replace the air exhausted from this area) is supplied to the Paint Room from two sources. The diffuser labelled "Air Makeup #1" in Figure 1 provides supply-air from one of the two general heating, ventilating, and air conditioning (HVAC) air-handling units (AHUs) that serve the second-floor Tape Core Department areas. This AHU serves about half of the second-floor area. A similar AHU provides ventilation for the remainder of

¹ The chemical formula for Freon TF[®], also called Freon 113, is 1,1,2-trichloro-1,2,2-trifluoroethane.

the second floor. Both of these AHUs filter and heat or cool a mixture of outside air and return (recirculated) air, and supply it to the work areas at a constant volumetric flow rate. However, no air is recirculated from the Paint Room. The introduction of outside air by these AHUs provides dilution ventilation for the general areas of these departments not equipped with dilution exhaust ventilation.

The diffuser labelled "Air Makeup #2" in Figure 1 transfers conditioned, relatively uncontaminated room air, from an adjacent department into the Paint Room at a constant flow rate (designed to be 3150 cubic feet per minute [cfm]). The total exhaust from the Paint Room is designed to exceed the total make-up air, so that negative static pressure is maintained in the Room compared to the adjacent corridor. Therefore, potentially contaminated air should not flow out from the Paint Room into the rest of the Tape Core Department.

Personal protective equipment used by Paint Room workers include organic vapor respirators and hair and body coverings.

EVALUATION METHODS

Environmental

The ventilation systems serving the Paint Room were assessed by using smoke powder to visualize airflow patterns, and by estimating the average air velocities, using a TSI VelociCALC Plus electronic heated-wire anemometer, across the faces of the various inlets and outlets and then measuring the physical dimensions of the faces. The TSI VelociCALC can automatically calculate the average velocity from multiple individual velocities measured at representative points traversing an opening or duct.

Air samples were collected and analyzed for the following substances: organic compounds (for qualitative analyses); specific organic compounds (xylene, ethyl acetate, 1,1,1-trichloroethane, methylene chloride, 2-ethoxyethyl acetate, and Freon® TF [1,1,2-trichloro-1,2,2-trifluoroethane]), selected based upon the screening results and knowledge of the substances used in the Tape Core Department); metals (including lead, elemental chromium, chromium VI, lead, and molybdenum); and respirable and total particulates.² Details about each sampling and analytical method used are provided in Table 1.

² Since the NIOSH Method for air sampling and analysis of amorphous silica is not reliable, air sampling was instead conducted for both respirable and total particulates. These results were then used to estimate the maximum airborne concentrations of amorphous silica in the G4347 paint (based on the percentage reported in its Material Safety Data Sheet [MSDS]).

Personal breathing-zone air samples were collected by attaching the air-inlet parts of the battery operated sampling apparatuses to the workers' clothing in their breathing zones, and the pumps to the workers' belts. General-area air samples were collected by simply setting the sampling apparatuses in the workrooms. Air samples of both full-shift and short-term durations were collected. The latter were collected to assess airborne contaminant concentrations during or shortly after specific operations of interest.

Bulk-material samples of the G4347 and G4369 Thermelec Orange paints and of the FD-81 Solvent were collected. The paints were analyzed quantitatively for metals and chromium VI, and qualitatively for organic compounds, while the FD-81 Solvent was analyzed qualitatively for organic compounds. Generally, small aliquots of the bulk-material samples were prepared and analyzed using the methods detailed in Table 1, and the few minor changes are noted therein. The industrial hygiene samples collected during the environmental survey were submitted for chemical analyses on January 20 and 21, 1993.

Medical

The medical evaluation included interviews with 11 employees, review of the Occupational Safety and Health Administration (OSHA) Injury and Illness Logs for 1990-1992, and observation and analysis of the work practices of the employees. Pertinent medical records of four interviewed employees were reviewed.

EVALUATION CRITERIA

To assess the hazards posed by workplace exposures, NIOSH investigators use a variety of environmental evaluation criteria. These criteria suggest exposure levels to which most workers may be exposed for a working lifetime without experiencing adverse health effects. However, because of wide variation in individual susceptibility, some workers may experience occupational illness even if exposures are maintained below these limits. The evaluation criteria do not take into account individual hypersensitivity, pre-existing medical conditions, or possible interactions with other workplace agents, medications being taken by the worker, or ambient environmental conditions.

Evaluation criteria for chemical substances are usually based on the average personal breathing-zone exposure to the airborne substance over an entire 8- to 10-hour workday, expressed as a time-weighted average (TWA). To supplement the 8-hr TWA where there are recognized adverse effects from short-term exposures, some substances have a short-term exposure limit (STEL) for 15-minute peak periods, or a ceiling limit which is not to be exceeded at any time. The concentrations of substances in air are usually expressed in parts of air contaminant per million parts of air (parts per million, or ppm), milligrams per cubic meter of air (mg/m^3), or micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Additionally, the evaluation

criteria for some chemicals have a "skin" notation to indicate that the substance may be absorbed through direct contact of the material with the skin and mucous membranes.

The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),¹ the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs),² and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).³ These criteria typically change over time as new information on the toxic effects of an agent become available.

The OSHA PELs reflect the economic feasibility of controlling exposures in various industries, public notice and comment, and judicial review, whereas the NIOSH RELs are based primarily on concerns related to the prevention of occupational disease. An additional complication is due to the fact that a U.S. Circuit Court of Appeals decision vacated the OSHA 1989 Air Contaminants Standard in *AFL-CIO v OSHA*, 965F.2d 962 (11th cir., 1992), and OSHA is now enforcing the previous 1971 standards (listed as Transitional Limits in 29 CFR 1910.1000, Table Z-1-A).⁴ However, some states which have OSHA-approved State Plans will continue to enforce the more protective 1989 limits. NIOSH encourages employers to use the 1989 limits or the RELs, whichever are lower.

Based on the results of the PBZ and GA air monitoring conducted in this evaluation, detailed evaluation criteria sections pertaining to methylene chloride, 2-ethoxyethyl acetate, and lead are included in this report. All occupational exposure criteria relevant to this evaluation are summarized in Table 2.

Methylene Chloride

Methylene chloride is a chlorinated organic compound that has been commonly used as a solvent, paint remover, and degreaser. It may be absorbed into the body by inhalation of vapors and by absorption of liquid through the skin. Rats and mice have developed tumors and cancers after exposure to methylene chloride under specific experimental conditions.⁵ NIOSH recommends that methylene chloride be regarded as a potential occupational carcinogen and that exposure be controlled to the lowest feasible level.⁵

If inhaled in high concentrations, methylene chloride may affect the nervous system, leading to symptoms such as mental confusion, lightheadedness, nausea, vomiting, and headache.⁶ Continued exposure to very high concentrations may cause increased lightheadedness, staggering, unconsciousness, and death.⁷ High vapor concentrations may cause irritation of the eyes and respiratory tract. Chronic (long-term) neurotoxic (nervous system) effects among workers who have been exposed to methylene chloride for several years have also been reported. Symptoms reported from chronic exposure have included forgetfulness, insomnia, headache, fatigue, and hallucinations.⁸

Exposure to methylene chloride may aggravate the symptoms of angina pectoris (heart pain), which may be accompanied by feelings of suffocation and palpitations. If the liquid is held in contact with the skin, it may cause irritation or skin burns. Splashes of the liquid into the eyes may cause irritation.

2-Ethoxyethyl Acetate

Commonly referred to as Cellosolve[®] acetate, this colorless liquid is used as a solvent in electronic component manufacturing and in the coatings industry (especially the semiconductor industry). This material is irritating to the eyes, nose, and throat and at high concentrations can cause central nervous system depression.⁹ 2-ethoxyethyl acetate has caused reproductive toxicity in male mice equivalent to the glycol ethers 2-methoxyethanol and 2-ethoxyethanol.¹⁰ This compound also appears to have fetotoxicity and teratogenicity effects in rats.¹⁰ Based on these findings, NIOSH recommends that exposure to 2-ethoxyethyl acetate in the workplace be limited to 0.5 ppm as a TWA for up to a 10-hour workday.¹⁰ Dermal contact must be prohibited since 2-ethoxyethyl acetate is readily absorbed through the skin.

Lead

Lead is ubiquitous in U.S. urban environments due to its widespread use during the past century. Occupational exposure to lead is generally through inhalation of dust and fume, and ingestion through hand-to-mouth contact with lead-contaminated food, cigarettes, clothing, and other objects. Once absorbed, lead accumulates in the soft tissues and bones. Lead is stored in the bones for decades, and may cause health effects long after exposure as it is slowly released in the body.

An individual's blood lead level (BLL) is a good indication of recent exposure to, and current absorption of lead.¹¹ The frequency and severity of symptoms associated with lead exposure generally increase with increasing BLL. These symptoms include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort, colic, anemia, high blood pressure, irritability or anxiety, fine tremors, and "wrist drop."^{12,13,14} Overexposure to lead may also result in damage to the kidneys, gastrointestinal tract, peripheral and central nervous systems, and the blood-forming system (bone marrow), infertility and reduced sex drive in both sexes, and impotence. The overall mean BLL for the U.S. adult population (ages 20-74 yrs) declined significantly between 1976 and 1991, from 13.1 to 3.0 micrograms per deciliter of blood ($\mu\text{g}/\text{dL}$)—this decline is most likely due to the reduction of lead in gasoline.¹⁵

Under the OSHA general industry lead standard (29 CFR 1910.1025), the PEL-TWA for lead is 50 $\mu\text{g}/\text{m}^3$, over an 8-hour shift.¹⁶ The standard requires lowering the PEL for shifts exceeding 8 hours, medical monitoring for employees exposed to airborne

lead at or above the Action Level of $30 \mu\text{g}/\text{m}^3$ (8-hour TWA), medical removal of employees whose average BLL is $50 \mu\text{g}/\text{dL}$ or greater, and provides economic protection for medically removed workers. Medically removed workers cannot return to jobs involving lead exposure until their BLL is below $40 \mu\text{g}/\text{dL}$. ACGIH has proposed a TLV-TWA for lead of $50 \mu\text{g}/\text{m}^3$, with worker BLLs to be controlled to at or below $20 \mu\text{g}/\text{dL}$, and designation as an animal carcinogen.¹⁷ The U.S. Public Health Service has established the goal for workers exposed to lead to eliminate, by the year 2000, all exposures that result in BLLs greater than $25 \mu\text{g}/\text{dL}$.¹⁸ Overt symptoms of lead poisoning in adults generally begin at BLLs above $50 \mu\text{g}/\text{dL}$.

The occupational exposure criteria (above) are not protective for all the known health effects of lead. For example, studies have found neurological symptoms in workers with BLLs of 40 to $60 \mu\text{g}/\text{dL}$, and decreased fertility in men at BLLs as low as $40 \mu\text{g}/\text{dL}$. BLLs are associated with increases in blood pressure, with no apparent threshold through less than $10 \mu\text{g}/\text{dL}$. Fetal exposure to lead is associated with reduced gestational age, birthweight, and early mental development with maternal BLLs as low as 10 to $15 \mu\text{g}/\text{dL}$.¹⁹ Men and women who are planning on having children should limit their exposure to lead.

RESULTS

Environmental Evaluation

Bulk Samples

The results of the quantitative analyses of the bulk-material samples of the G4347 and G4369 Thermelec Orange paints for elemental metals are provided in Table 3. These results confirm the presence of lead, chromium, and molybdenum in the paints, along with several other metals. Lead is the most prevalent metal in both paints, followed by chromium, barium, molybdenum, and aluminum. Very small proportions of magnesium, sodium, calcium, and lanthanum were also detected. Totalling the measured proportions of the metals reported in Table 3 indicates that they account for 8.7% of the G4347 Thermelec Orange paint and 22.2% of the G4369 Thermelec Orange. These values are reasonably consistent with the proportions of 13.5% and 22.1%, respectively, of the two paints (reported in their MSDSs).

Quantitative analyses of the paint bulk-material samples for chromium VI indicate that the G4347 Thermelec Orange paint contains 16 mg of chromium VI per gram of paint, while the G4369 Thermelec Orange contains 27 mg of chromium VI per gram. A comparison of these concentrations reveals that the relative prevalences parallel the relative proportions of the pigment in the two paints.

The results of the qualitative analyses of the bulk-material samples of the two paints and the FD-81 Solvent for organic compounds confirm that the major organic constituents of both paints are xylenes and ethoxyethyl acetate. Also detected in the G4347 Thermelec Orange paint were isopropanol, C₇ to C₁₀ alkanes, ethoxyethanol, and some C₉H₁₂ alkyl benzenes. Similarly, some C₉H₁₂ to C₁₀H₁₄ alkyl benzenes, toluene, and traces of C₈ to C₁₁ alkanes, ethoxyethanol, and alkyl naphthalenes were detected in the G4369 Thermelec Orange paint. The FD-81 Solvent was found to consist entirely of naphthalene and alkyl-substituted naphthalene derivatives; this finding is consistent with the information in the MSDS for this solvent.

Air Samples

A GA air sample was collected in the Paint Room (outside of the bobbin-core spray booth) and qualitatively analyzed for organic compounds. Xylene isomers, ethyl acetate, 1,1,1-trichloroethane, methylene chloride, and 2-ethoxyethyl acetate were identified as the major components collected on this sample. This sample and the remaining PBZ and GA air samples were subsequently analyzed quantitatively for these specific organic compounds. The compounds which were detected are reported in Table 4. In addition to the samples shown in Table 4, six "side-by-side" air samples were collected specifically for 2-ethoxyethyl acetate, at the same sampling locations. This compound was not detected on any of these air samples (the minimum detectable concentration [MDC] for this sample set was 0.2 ppm).

The results for short-term PBZ and GA samples collected and analyzed for methylene chloride and Freon® TF (1,1,2-trichloro-1,2,2-trifluoroethane) are shown in Table 5. Higher exposures to methylene chloride occurred during and immediately following use of the parts degreaser, near the door into the Paint Room. NIOSH recommends reducing exposure to this compound to the lowest feasible concentration. The removal of this degreaser to comply with environmental regulations, which was already scheduled at the time of the survey, will eliminate exposures to methylene chloride and Freon® TF. Freon® TF concentrations were well below all relevant evaluation criteria.

The results for full-shift, GA air samples collected and analyzed for chromium VI, respirable particulates, and total particulates are provided in Table 6. Chromium VI was not present in the air at detectable concentrations at the times and locations the samples were collected, despite its presence in the paints. Using the measured airborne particulate concentrations and the 2.7% amorphous silica content of the G4347 Thermelec Orange paint (as reported in its MSDS), the estimated maximum airborne concentrations of amorphous silica are 0.0046 mg/m³ total and 0.0019 mg/m³ respirable fraction, based on the unlikely assumption that 100% of the collected particulate is composed of G4347 Thermelec Orange paint mist. These estimated concentrations are still well below all relevant evaluation criteria.

Six full-shift air samples, including both PBZ and GA, were collected "side-by-side" with the samples reported in Table 4 and were analyzed for 26 elemental metals. The results for these samples, for 11 of the metallic elements, are provided in Table 7. The other 15 elements (silver, barium, beryllium, cadmium, cobalt, copper, lanthanum, lithium, phosphorous, selenium, strontium, titanium, vanadium, yttrium, and zirconium) were not detectable in the air at the times and locations the samples were collected. The minimum detectable concentration in each sample, for all 15 of these elements, was $0.8 \mu\text{g}/\text{m}^3$. The concentrations reported in Table 7 are well below the relevant evaluation criteria for all these elements, except for lead; the personal exposure of the tape-core painter to lead (see sample AA-5), at $36 \mu\text{mg}/\text{m}^3$, exceeds the OSHA action level for lead of $30 \mu\text{g}/\text{m}^3$ for full-shift TWA exposure.

Ventilation Assessment

The ventilation measurements indicate that both the tape-core spray booth and the bobbin-core spray booth exceeded ACGIH performance recommendations. The tape-core booth had a front opening measuring 47 by 43 inches (giving 14.0 ft^2 of open area at the face). Since the average face velocity at this booth was 200 ft/min, air was exhausted at an estimated rate of 2800 cfm. This equates to approximately 200 cfm per ft^2 . The ACGIH recommends at least 100 to 150 cfm per ft^2 for spray booths with the operator outside the booth. Likewise, the bobbin-core spray booth, with an opening size of 42 in by 39 in (giving 11.4 ft^2 of open area at the face), had an estimated average face velocity of 196 ft/min, exhausting air at a rate of approximately 2230 cfm. Therefore, approximately 196 cfm per ft^2 are exhausted, a level which also exceeds the ACGIH recommendation for spray booths.

The bobbin-core oven, with a 18 by 24 inch opening, and an estimated average face velocity of 220 ft/min, exhausts air at an estimated rate of 660 cfm. The tape-core oven exhaust rates could not be measured due to the configurations of the ovens and openings. The total exhaust flow rate from the Paint Room exceeded 5700 cfm, based on the estimated exhaust rates of the paint booths and the bobbin-core oven and the fact that the two tape-core oven exhaust flowrates are not known. Transfer air entered the Paint Room from the 8-in high, 32-in wide Air Makeup #2 diffuser (see Figure 1) at an estimated rate of 1610 cfm (the average face velocity was 905 ft/min). It should be noted that the damper on the Air Makeup #1 diffuser was closed during this evaluation.

Using these estimates, the total exhaust flowrate from the Paint Room substantially exceeded the reported, design-specified delivery rate of make-up air, so that negative static pressure is maintained in the Paint Room compared to the adjacent corridor. This means that relatively uncontaminated air is thereby induced to flow into the Paint Room rather than potentially contaminated air flowing out of this area and into the

Tape Core Department. Smoke-powder observations confirmed this airflow into the Paint Room.

Medical Evaluation

A review of OSHA 200 logs for 1990-1992 revealed that all entries were for injuries, strains, tendinitis, lacerations, and low back pain. One entry in 1990 was recorded as "light head and dizzy, not work-related" and was check-marked as an injury. No other entries listed symptoms consistent with dizziness, syncope, or central neurotoxicity.

A review was performed of the medical and company records concerning four employees from Magnetics who had experienced symptoms ranging from dizziness to syncopal episodes. Medical records were obtained from February 1991 to August 1992, and included all documentation regarding office visits, laboratory test results (including blood-work, electrocardiograms, pulmonary function tests, etc.). Information from the four medical records was consistent with "Type 1 Solvent Neurotoxicity," defined by the World Health Organization (WHO) as the presence of headaches, dizziness, and difficulty concentrating after solvent exposure.²⁰

DISCUSSION

- ▶ The compound 2-ethoxyethyl acetate was only quantifiably measurable in one sample (No. CT-18, a PBZ sample collected on the tape-core painter.) However, this one sample measured 0.25 ppm, a concentration which is one-half of the NIOSH REL for full-shift TWA exposure. Furthermore, 2-ethoxyethyl acetate can be absorbed through the unprotected skin. Although not quantifiably measurable, the bobbin-core painter was exposed to a detectable amount of 2-ethoxyethyl acetate (between 0.02 and 0.75 ppm). The measured levels of the remaining organic compounds such as xylene, ethyl acetate, and 1,1,1-trichloroethane were all well below the relevant evaluation criteria.
- ▶ Since NIOSH considers methylene chloride a potential occupational carcinogen, exposures should be reduced to their lowest feasible concentrations. Methylene chloride was detected in all but one of the air samples collected in this survey and short-term exposures (for approximately 53 minutes) ranged up to 35 ppm.
- ▶ The concentrations of metals on the day of this evaluation were all below their respective evaluation criteria. One PBZ air sample, collected on the tape-core painter, had a lead concentration of 36 $\mu\text{g}/\text{m}^3$, which exceeds the OSHA action level for lead of 30 $\mu\text{g}/\text{m}^3$, TWA for an 8-hour exposure.

- ▶ Workers operating the parts degreaser removed parts from the rack before all the liquid degreasing mixture, Freon TMC, had drained or evaporated. This mixture contains both methylene chloride and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon® TF), both of which are known to cause symptoms consistent with mild neurotoxicity, although measured exposure to Freon® TF were at least two orders of magnitude less than those associated with neurotoxicity. It should be noted that the removal of this degreaser to comply with environmental regulations, which was already scheduled at the time of the survey, will eliminate exposures to methylene chloride and Freon® TF.
- ▶ Visual observations of the performance of the Tape Core Paint Room paint booth exhaust systems suggest that their capture effectiveness is good. The booths apparently provided good capture of paint overspray particulates and vapors and good movement of these contaminants away from the painters' breathing zones without noticeable eddy (back) currents; these factors are likely to help minimize the painters' exposures to the potentially harmful components of the paints. Also, certain good work practices among the painters were observed; for example, they were not observed leaning into the booths during painting.
- ▶ Paint Room workers wore rubber gloves at the time of the NIOSH survey, and some workers mentioned a risk of burns on the hands, wrists, and lower forearms when moving racks of parts in and out of the ovens.
- ▶ The symptoms experienced by some Magnetics employees (dizziness, syncopal episodes), while unexpected with the concentrations of methylene chloride measured during this evaluation, are not inconsistent with exposure to this substance.⁹
- ▶ Based on a review of the health effects associated with Freon® TF, it would appear unlikely the solvent concentrations measured during this evaluation would elicit the dizziness and syncopal episodes experienced by some of the Magnetics workers. For example, in a study involving human volunteers exposed six hours per day to Freon® TF concentrations ranging from 500 to 1000 ppm, only mild throat irritation was observed and no adverse changes were seen in the performance of complex mental tasks by the participants.⁶

CONCLUSIONS

- ▶ Workers in the Paint Room were exposed to levels of methylene chloride, a potential carcinogen. Since NIOSH considers methylene chloride to be potential occupational carcinogen, concentrations should be reduced to the lowest feasible level.

- ▶ One PBZ air sample collected for 2-ethoxyethyl acetate was one-half of the NIOSH REL for this compound. Another PBZ air sample exceeded the OSHA action level for lead. Since exposures can vary from day-to-day, higher exposures to 2-ethoxyethyl acetate and lead could occur among Paint Room employees.
- ▶ Although the concentrations of solvents measured in this evaluation were under the OSHA PELs, some workers may still experience symptoms such as dizziness or mucous membrane irritation when working near paints and solvents.
- ▶ Four employees had symptoms consistent with "Type 1 Solvent Neurotoxicity" as defined by the World Health Organization.

RECOMMENDATIONS

1. Because the tape-core painter's full-shift TWA exposure on the day of the survey to 2-ethoxyethyl acetate was one-half of the NIOSH REL, and this exposure may be lower or higher on other days, appropriate steps should be taken to assure that exposures of the painters to the paint mists and/or vapors and the thinner vapors are kept to a minimum. Respiratory-protection program procedures should be re-evaluated and improved if necessary; any skin contact with the paint or 2-ethoxyethyl acetate thinner that occurs during current operations should be reduced or eliminated through work practices changes or protective gloves and clothing. Work practices should be reviewed to determine if handling and use of the 2-ethoxyethyl acetate thinner could be reduced, or carried out only in or near the spray booths. Finally, administrative controls should be made which includes minimizing the time spent in the Paint Room to minimize exposures to the paints and solvents.

According to the OSHA General Industry Standard (29 Code of Federal Regulations Part 1910.1025), since the tape-core painter's lead exposure exceeded the OSHA action level of 30 $\mu\text{g}/\text{m}^3$, PBZ air monitoring shall be continued at least every 6 months until at least two consecutive measurements (taken at least 7 days apart) are below the action limit.

2. To reduce eddy-created back flows of potentially contaminated air out of the Paint Room through the doorway to the corridor, the door should be firmly anchored with a door stop to the floor or ceiling in a slightly-opened position (except when persons are entering or exiting) so that the entering air is moving quickly through the remaining opening. Alternatively, a door equipped with a grille could be used.
3. The removal of the parts degreaser near the door to the Paint Room to comply with environmental regulations, which was already scheduled at the time of the survey, should be completed if it has not yet been done. Replacement with a degreaser using

methylene chloride is not recommended. Regardless of what type of degreaser may be used in its place, removing racks of parts from the device before all of the liquid degreasing mixture drains and/or evaporates should be avoided to minimize worker exposures to the vapors of degreasing compounds, mixtures, or solutions.

4. **Paint Room workers should wear heat-resistant gloves to prevent burns on the hands, wrists, and lower forearms when moving racks of parts in and out of the ovens.**

REFERENCES

1. **CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. MMWR 37(suppl S-7): pp 1-29.**
2. **ACGIH [1993]. Threshold limit values for chemical substances and physical agents and biological exposure indices for 1993-1994. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.**
3. **58 Fed. Reg. 124 [1993]. Occupational Safety and Health Administration: air contaminants, final rule. (To be codified at 29 CFR, Part 1910.1000).**
4. **Code of Federal Regulations [1992]. OSHA Table Z-1, air contaminants-permissible exposure limits. 29 CFR, Part 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.**
5. **NIOSH [1986]. Current intelligence bulletin 46: methylene chloride. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS Publication No.86-114.**
6. **ACGIH [1986]. Documentation of threshold limit values and biological exposure indices, 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.**
7. **NIOSH [1981]. NIOSH/OSHA occupational health guidelines for chemical hazards. 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 Publication No. 81-123.**
8. **NIOSH [1976]. Criteria for a recommended standard: occupational exposure to methylene chloride. Cincinnati, OH: U.S. Department of Health, Education, and**

Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW Publication No. 76-138.

9. **Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1991]. Proctor and Hughes' chemical hazards of the workplace, 3rd edition. New York, NY: Van Nostrand Reinhold.**
10. **NIOSH [1991]. Criteria for a recommended standard: occupational exposure to ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and their acetates. 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 Publication No. 91-119.**
11. **NIOSH [1978]. Occupational exposure to inorganic lead. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-158.**
12. **Hernberg S, et al [1988]. Lead and its compounds. In: Occupational medicine. 2nd ed. Chicago, IL: Year Book Medical Publishers.**
13. **Landrigan PJ, et al [1985]. Body lead burden: summary of epidemiological data on its relation to environmental sources and toxic effects. In: Dietary and environmental lead: human health effects. Amsterdam: Elsevier Science Publishers.**
14. **Proctor NH, Hughes JP, Fischman ML [1991]. Lead. In: Chemical hazards of the workplace. 3rd ed. Philadelphia, PA: J.B. Lippincott Company, Philadelphia, pp 353-357.**
15. **Pirkle JL, et al [1994]. The decline in blood lead levels in the United States. JAMA 272:284-291.**
16. **Code of Federal Regulations [1992]. OSHA lead standard. 29 CFR, Part 1910.1025. Washington, DC: U.S. Government Printing Office, Federal Register.**
17. **ACGIH [1993]. 1993-1994 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.**
18. **DHHS [1990]. Healthy people 2000: national health promotion and disease objectives. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, DHHS Publication No. (PHS) 91-50212.**

19. **ATSDR [1990]. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, DHHS (ATSDR) Publication No. TP-88/17.**
20. **WHO [1975]. Early detection of health impairment in occupational exposure to health hazards. World Health Organization, Division of Environmental Health, Geneva, Switzerland, WHO TRS.571.**

AUTHORSHIP AND ACKNOWLEDGMENTS

Evaluation Conducted By:

**Faye T. Bresler, M.D.
Medical Officer
Medical Section**

**Leo M. Blade, C.I.H.
Industrial Hygiene Engineer
Industrial Hygiene Section**

Field Assistance By:

**Anthony T. Zimmer, C.I.H.
Industrial Hygiene Engineer**

Originating Office:

**Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies**

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-address mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

Page 18 - Health Hazard Evaluation Report No. 91-0292

Copies of this report have been sent to:

- 1. Magnetics Division of Spang and Company**
- 2. Confidential Employee Requesters**
- 3. International Brotherhood of Electrical Workers (IBEW), Local 1957**
- 4. OSHA Region III**

For the purpose of Informing affected workers, 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
Air Sampling and Analytical Methods Used
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Analyte(s)	NIOSH Method No.	Air Sampling Medium	Nominal Air-Sampling Flowrate	Sample Preparation and Analytical Techniques	Comments
Organic compounds, for qualitative (screening) analyses	--	CT	200 mL/min	CS ₂ extraction; GC/FID screening; GC-MS confirmation	Chromatographic column used was 30-meter DB-1 fused-silica capillary column. Bulk samples were extracted with CS ₂ , then filtered.
Five specific organic compounds (quantitative analyses)	1003/1005/1450/1501/949	CT	50 mL/min or 200 mL/min	CS ₂ extraction; GC/FID	The five NIOSH Methods listed are similar, and a combination of all five was used. Separation of the analytes was achieved using two different fused-silica capillary columns for chromatography.
2-Ethoxyethyl acetate (only)	1450	CT	20 mL/min	CS ₂ (and 5% methanol) extraction; GC/FID	Analytical technique modified to include addition of methanol to extraction solution, and use of fused-silica capillary column in chromatography.
Elemental metals	7300	MCE-membrane filter	3 L/min	Nitric- and perchloric-acid ashing; inductively-coupled argon-plasma AES	
Chromium VI (only)	7600	PVC-membrane filter	2 L/min	Sodium hydroxide and sodium carbonate extraction; colorimetric reaction and determination (visible-light spectroscopy)	
Methylene chloride (only)	1005	2 CTs in series	20 mL/min	CS ₂ extraction; GC/FID	Analytical technique modified to include use of fused-silica capillary column in chromatograph.
1,1,2-Trichloro-1,2,2-trifluoroethane	1020	CT	20 mL/min	CS ₂ extraction; GC/FID	
Particulates (respirable fraction)	0600	PVC-membrane filter	1.7 L/min	Gravimetric determination	Respirable fraction selected upstream of collection medium with 10-mm Dorr-Oliver cyclone.
Particulates (total)	0500	PVC-membrane filter	2 L/min	Gravimetric determination	

CT = Charcoal tube (glass tube packed with activated charcoal).
 GC = Gas chromatography
 MS = Mass spectrometry
 AES = Atomic emission spectroscopy
 CS₂ = Carbon disulfide
 FID = Flame-ionization detector
 MCE = Mixed cellulose-ester
 PVC = Polyvinyl chloride

Table 2

Evaluation Criteria for Occupational Exposures to Air Contaminants
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HEHA 91-0292
January 12, 1993

Substance	NIOSH REL _s	OSHA PEL _s		ACGIH TLV _s
		1989 Standard (not enforceable)	"Transitional" (enforceable)	
Xylene (total of all isomers)	100 ppm TWA 150 ppm STEL	100 ppm TWA 150 ppm STEL	100 ppm TWA	100 ppm TWA 150 ppm STEL
Ethyl acetate	400 ppm TWA	400 ppm TWA	400 ppm TWA	400 ppm TWA
1,1,1-Trichloroethane	350 ppm (15-min ceiling)	350 ppm TWA 450 ppm STEL	350 ppm TWA	350 ppm TWA 450 ppm STEL
Methylene chloride	"Lowest feasible concentration," treat as potential occupational carcinogen	500 ppm TWA 1000 ppm ceiling 2000 ppm peak for 5 min per 2-hr period	500 ppm TWA 1000 ppm ceiling 2000 ppm peak for 5 min per 2-hr period	50 ppm TWA (suspected human carcinogen)
2-Ethoxyethyl acetate	0.5 ppm TWA ("skin")	100 ppm TWA ("skin")	100 ppm TWA ("skin")	5 ppm TWA ("skin")
1,1,2-Trichloro-1,2,2-trifluoroethane	1000 ppm TWA 1250 ppm STEL	1000 ppm TWA 1250 ppm STEL	1000 ppm TWA	1000 ppm TWA 1250 ppm STEL
Chromium VI	1 µg/m ³ TWA, treat as potential occupational carcinogen	100 µg/m ³ ceiling (measured as chromium trioxide)	100 µg/m ³ ceiling (measured as chromium trioxide)	50 µg/m ³ TWA (with certain water-insoluble compounds designated "confirmed human carcinogen")†
Chromium, other forms	500 µg/m ³ TWA	500 µg/m ³ TWA (in compounds) 1000 µg/m ³ TWA (metal)	500 µg/m ³ TWA (in compounds) 1000 µg/m ³ TWA (metal)	500 µg/m ³ TWA
Amorphous fumed silica	6 mg/m ³ TWA	6 mg/m ³ TWA	80 mg particulate/m ³ per % silica TWA	2 mg/m ³ TWA (respirable fraction)
Manganese	1000 µg/m ³ TWA 3000 µg/m ³ STEL	1000 µg/m ³ TWA 3000 µg/m ³ STEL	5000 µg/m ³ ceiling	1000 µg fume/m ³ TWA 3000 µg fume/m ³ STEL**
Molybdenum, present in soluble compounds*	-----	5000 µg/m ³ TWA	5000 µg/m ³ TWA	5000 µg/m ³ TWA

Table 2 (Continued)
Evaluation Criteria for Occupational Exposures to Air Contaminants
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HEHA 91-0292
January 12, 1993

Substance	NIOSH REL	OSHA PEL		ACGIH TLVs
		1989 Standard (not enforceable)	"Transitional" (enforceable)	
Nickel	15 µg/m ³ TWA, treat as potential occupational carcinogen	100 µg/m ³ TWA (present in soluble compounds*)	1000 µg/m ³ TWA	100 µg/m ³ TWA (present in soluble compounds*)††
Lead, inorganic	<100 µg/m ³ TWA	50 µg/m ³ TWA	50 µg/m ³ TWA	150 µg/m ³ TWA†††

- NIOSH REL - National Institute for Occupational Safety and Health -- Recommended Exposure Limit
- OSHA PEL - Occupational Safety and Health Administration -- Permissible Exposure Limit
- ACGIH TLV - American Conference of Governmental Industrial Hygienists -- Threshold Limit Value
- TWA - Time-weighted average, full-shift (10-hr for NIOSH RELs and 8-hr for OSHA PELs and ACGIH TLVs, unless noted)
- STEL - Short-term exposure limit (15-min sampling period, unless noted)
- ppm - parts (of contaminant) per million (parts of air)
- µg/m³ - micrograms (of contaminant) per cubic meter (of air)
- "skin" - substance may be absorbed by direct contact, in addition to inhalation exposure
- mg/m³ - milligrams (of contaminant) per cubic meter (of air)
- * - Other common forms of this element have less-restrictive criteria
- † - Notice of Intended Change: 50 µg/m³ TWA in water-soluble compounds, 10µg/m³ TWA in water-insoluble compounds, both designated "confirmed human carcinogen"
- †† - Notice of Intended Change: 50 µg/m³ TWA, and designated "confirmed human carcinogen"
- ** - Notice of Intended Change: 200 µg/m³ TWA (all forms)
- ††† - Notice of Intended Change: 50 µg/m³ TWA, and designated "animal carcinogen"

Table 3
Results of Analyses, for 26 Elemental Metals,
of Bulk-Material Samples of Paints
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Element	Composition of Sample	
	G4369 Thermelec Orange Paint (%)	G4347 Thermelec Orange Paint (%)
Silver	*	*
Aluminum	0.383	0.114
Barium	0.816	0.359
Beryllium	*	*
Calcium	0.0430	0.0119
Cadmium	*	*
Cobalt	*	*
Chromium	3.58	0.748
Copper	*	*
Iron	*	*
Lanthanum	0.00568	0.00250
Lithium	*	*
Magnesium	0.0830	0.0361
Manganese	*	*
Molybdenum	0.569	0.250
Sodium	0.0518	0.0231
Nickel	*	*
Phosphorus	*	*
Lead	16.7	7.16
Selenium	*	*
Strontium	*	*
Titanium	*	*
Vanadium	*	*
Yttrium	*	*
Zinc	*	*
Zirconium	*	*

* = The percent composition was less than the limit of quantification for these analytes in that sample. Limit of quantification for each analyte in the G4369 paint was 0.00510%, and limit of quantification for each analyte in the G4347 paint was 0.00238%.

Table 4
Results of Full-Shift Air Samples for Five Specific Organic Compounds
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Sample No.	Job Title	Location	Air Sampling Flow Rate (mL/min)	Time (Military)		Airborne Concentration (ppm)				
				Start	Stop	Methylene Chloride	Ethyl Acetate	1,1,1-Trichloroethane	2-Ethoxyethyl Acetate	Xylene (total, all isomers)
CT-18	Tape Core Painter	Tape Core Paint Room	200	0735	1447	≥ 1.4*	0.86	0.28	0.25	0.84
CT-21	Bobbin Core Painter	Tape Core Paint Room	50	0740	1450	≥ 3.2*	0.72	0.26	Trace†	0.19
CT-25	AREA SAMPLE	Tape Core Painters' table, outside the Tape Core Paint Room	200	0745	1459	≥ 1.3*	1.0	0.37	Trace††	0.051
CT-26	Boxer	Tape Core Department	200	0805	1501	≥ 0.49*	1.0	0.42	Trace††	0.037
CT-29	AREA SAMPLE	Outside the Tape Core spray booth, in the Tape Core Paint Room	200	0755	1504	≥ 1.3*	0.57	0.26	Trace††	0.44
CT-31	AREA SAMPLE	Outside the bobbin core spray booth, in the Tape Core Paint Room	50	0751	1510	≥ 3.3*	≥ 0.78*	≥ 0.32*	Trace* †	≥ 0.27*

* = Concentration should be considered a minimum due to "breakthrough" of methylene chloride past the collection medium, leading to incomplete collection from the air, and/or due to prior desorption of sample CT-31 (for use in the qualitative analyses described in the text).
Trace = Indicates that the measured concentration is below the minimum quantifiable concentration (MQC), but above the minimum detectable concentration (MDC); i.e., compound was detected but concentration cannot be reliably quantified.
† = The measured concentration of 2-ethoxyethyl acetate is between 0.02 ppm and 0.75 ppm, the MDC and MQC, respectively, for this compound in this sample.
†† = The measured concentration of 2-ethoxyethyl acetate is between 0.004 ppm and approximately 0.20 ppm, the MDC and MQC, respectively, for this compound in this sample.

Table 5
Results of Short-Term Air Samples for Methylene Chloride
and 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon® TF)
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Sample No.	Job Title	Location	Time (Military)		Substance and Airborne Concentration	Comments
			Start	Stop		
CT-1	Tape Core Expeditor (boxing)	Degreaser	0705	0757	Freon® TF 13 ppm	Worker spent approximately the first 25 minutes of the sampling period doing one degreasing operation.
CT-2	Tape Core Expeditor (boxing)	Degreaser	0705	0757	Methylene Chloride 35 ppm	
CT-4	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	0710	0914	Methylene Chloride 6.0 ppm	Two degreasing batch operations performed during the sampling period.
CT-14	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	0710	1003	Freon® TF 2.1 ppm	
CT-15	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	0914	1106	Methylene Chloride ND*	No degreasing was performed during the sampling period
CT-17	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	1106	1312	Methylene Chloride ND*	

Table 5 (Continued)
Results of Short-Term Air Samples for Methylene Chloride
and 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon® TF)
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Sample No.	Job Title	Location	Time (Military)		Substance and Airborne Concentration	Comments
			Start	Stop		
CT-23	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	1312	1455	Methylene Chloride ND*	No degreasing was performed during the sampling period
CT-16	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	1003	1310	Freon® TF ND**	
CT-22	AREA SAMPLE	Tape Core Painters' table, near degreaser and Tape Core Paint Room	1310	1455	Freon® TF ND**	

ND = None Detected
 * = The minimum detectable concentration for these methylene chloride samples was 1 ppm.
 ** = The minimum detectable concentration for Freon® TF was 0.4 ppm for sample CT-16 and 0.6 ppm for sample CT-22.

Table 6
Results of Full-Shift, General-Area Air Samples for Chromium VI,
Total Particulate, and Respirable Particulate
Magnetics Division of Spang & Company
East Butler, Pennsylvania
HETA 91-0292
January 12, 1993

Sample No.	Location	Time (Millary)		Substance and Airborne Concentration
		Start	Stop	
PVC 92-572	Tape Core Painter's table, near Tape Core Paint Room	0830	1454	Chromium VI ND
PVC 92-547	Tape core spray booth, in Tape Core Paint Room	0832	1506	Chromium VI ND
PVC 92-542	Tape core spray booth, in Tape Core Paint Room	0832	1513	Respirable Particulate 0.07 mg/m ³
PVC 92-571	Tape core spray booth, in Tape Core Paint Room	0833	1505	Total Particulate 0.17 mg/m ³

ND = None detected. The minimum detectable concentration of Chromium VI was approximately 0.7 µg/m³ for these samples.

Table 7
 Results of Full-Shift Air Samples for Elemental Metals
 Magnetica Division of Spang & Company
 East Butler, Pennsylvania
 HETA 91-0292
 January 12, 1993

Sample Number; Job Title; Location	Time (Military)		Airborne Concentration, micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)												
	Start	Stop	Al	Ca	Cr	Fe	Mg	Mn	Mo	Na	Ni	Pb	Zn		
AA-3 AREA SAMPLE Tape Core Painters' table	0745	1455	ND	1.5	ND	6.2	2.7	ND	4.3	0.85	1.1	ND	2.4		
AA-4 Boxer Tape Core Department	0805	1501	ND	0.92	ND	6.9	2.8	ND	5.0	0.2	1.4	ND	0.5		
AA-5 Tape Core Painter Tape Core Paint Room	0735	1447	1.8	1.5	8.5	8.0	2.6	ND	5.2	2.2	1.4	36.	ND		
AA-6 Bobbin Core Painter Tape Core Paint Room	0740	1450	ND	1.6	ND	6.3	2.3	ND	4.3	0.92	1.0	0.85	ND		
AA-7 AREA SAMPLE Outside the Bobbin Core Spray Booth, Tape Core Paint Room	0751	1505	ND	ND	ND	5.4	ND	ND	3.5	0.7	0.85	ND	ND		
AA-8 AREA SAMPLE Outside the Tape Core Spray Booth, Tape Core Paint Room	0755	1512	ND	ND	ND	7.6	0.2	0.85	4.6	0.6	0.85	ND	ND		

Abbreviations:

ND = Not detected. The minimum quantifiable concentration for these samples is $0.8 \mu\text{g}/\text{m}^3$ for all elements (except for magnesium, sodium, and zinc, for which values as low as $0.2 \mu\text{g}/\text{m}^3$ are reported due to field-blank adjustments).

Al = Aluminum
 Ca = Calcium
 Mo = Molybdenum
 Na = Sodium
 Cr = Chromium
 Ni = Nickel
 Fe = Iron
 Pb = Lead
 Mg = Magnesium
 Zn = Zinc
 Mn = Manganese

Comments:

The following elements were not detected in any of these air samples:

Barium	Beryllium	Cadmium	Lithium
Copper	Selenium	Strontium	Zirconium
Yttrium	Vanadium	Silver	
		Cobalt	
		Titanium	
		Lanthanum	
		Phosphorus	

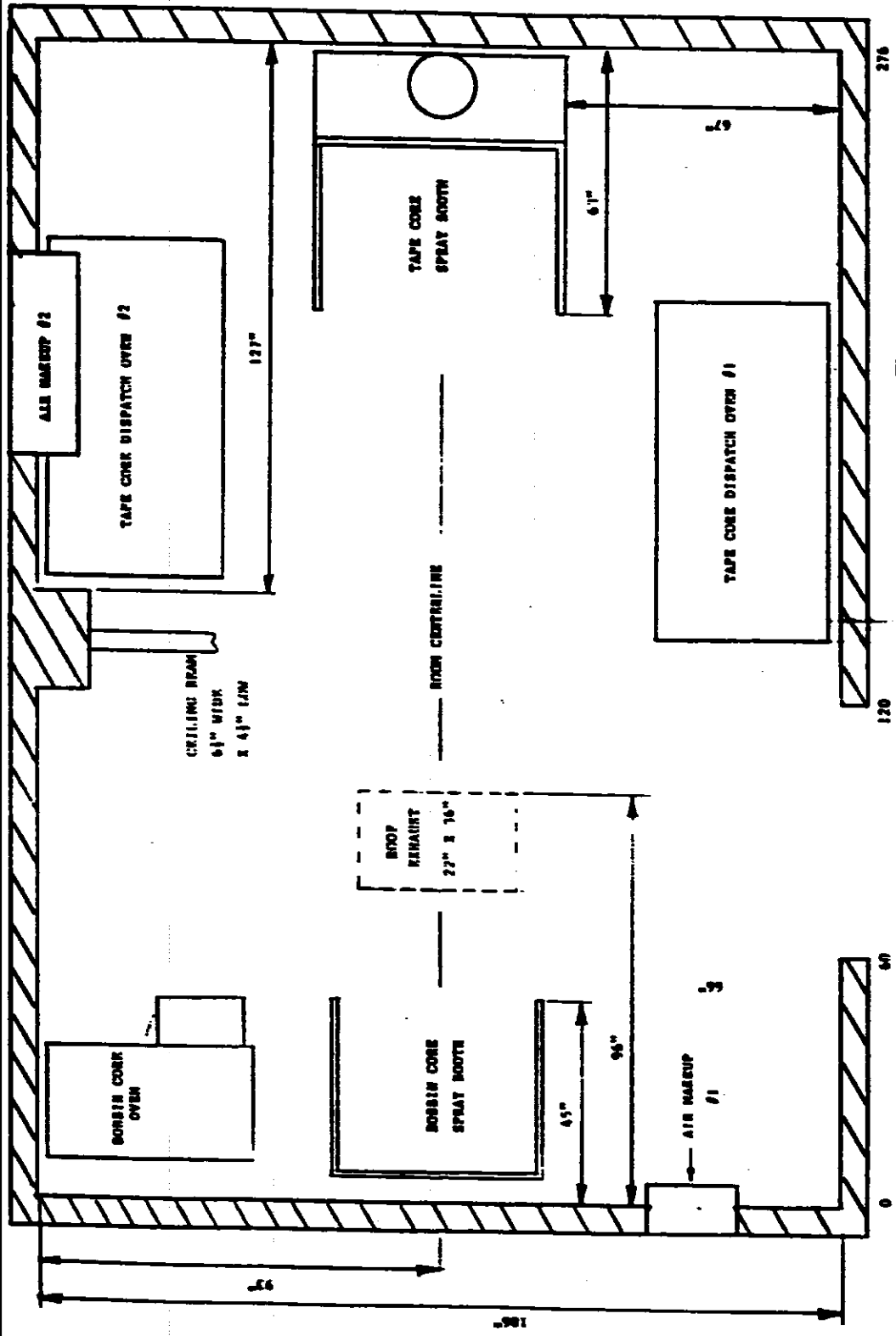


Figure 1
Tape Core Paint Room Plan
 Magnetics Division of Spang & Company
 East Butler, Pennsylvania
 HIETA 91-0292

ROOM SIZE
 LENGTH - 23 FT.
 WIDTH - 15.5 FT.
 HEIGHT - 8.3 FT.
 VOLUME - 2,970 CU. FT.