HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 89-276-L2093
LOCKHEED AERONAUTICAL SYSTEMS COMPANY
MARIETTA, GEORGIA
JANUARY 1991

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

In June 1989, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from an authorized representative of the International Association of Machinists and Aerospace Workers, Aeronautical Machinists Lodge 709. The request asked that NIOSH conduct a health hazard evaluation (HHE) at the Lockheed Aeronautical Systems Company in Marietta, Georgia. The union was concerned about health hazards from possible exposures to epoxy and polyurethane paints being sprayed in open areas on the C-130 aircraft assembly line. The request mentioned that some assembly line workers had reported breathing difficulties and other respiratory problems. Responding to this request, NIOSH medical and industrial hygiene investigators visited the Lockheed facility on September 6-7, 1989 to conduct an initial walk-through survey. Confidential interviews with potentially exposed workers confirmed that their main concern was the spray painting done in open areas along the C-130 assembly line. Two areas identified during the walk-through were where dry-bay wing panels are painted with white polyurethane, and the "mid-fuselage" assembly area where fairings and de-ice shields are painted. Following the release of an October 11, 1989 interim NIOSH report documenting preliminary findings from the initial survey, NIOSH industrial hygiene investigators completed a follow-up environmental survey of dry-bay painting operations on October 25, 1989. NIOSH investigators collected air samples to evaluate potential exposures to diisocyanates, organic vapors, and trace metals released during wing panel spraying. A preliminary air sampling results report was sent to company and union representatives on June 29, 1990.

BACKGROUND

The Lockheed Aeronautical Systems Company manufactures military cargo aircraft for the U.S. Military and many foreign countries. The C-130, C-141, and C-5 aircraft were built at this plant. At the time of the NIOSH survey, the company had about 10,500 employees. The company has manufactured various models of the C-130 since 1953, and now produces an average of two aircraft per month. C-130 manufacturing functions, which include fabrication, sub-assembly, and final assembly are located in Building B-1. Approximately 1100 employees were assigned to C-130 assembly operations, with 350 persons working on the final assembly line. The company operates three staggered day shifts (shifts 2, 3, and 4), a #5 swing shift from 3:45 p.m. to 12:15 a.m., and a #1 graveyard shift from midnight to 7:00 a.m. Of the 350 final assembly workers, most were assigned to the day shifts. Less than 100 worked the swing shift. No C-130 production workers, except two painters from the Paint Department, were used on the #1 shift.

In Building B-1, aircraft are located in each of six positions along the final assembly line. The most completed aircraft occupies Position 1 (see Figure 1). Although the main body of the aircraft is painted in a separate paint hanger, touch-up painting is done out in the open at various locations within and near the final assembly line. These painting jobs are normally done by the same two workers. At the time of the initial NIOSH survey, touch-up painting was done during swing shift when other employees were working in the building. Although these painting tasks are normally completed in less than an hour, some C-130 production workers felt they were being exposed to potentially harmful concentrations of paint overpray and solvent vapors.

Assembly workers were especially concerned about the dry bay wing panel spraying. The work was done on an upper-level deck located in the middle of Building B-1. The white spray paint drifting overhead from the deck was clearly visible from most locations in the building. According to union representatives, one person working in position 6 of the final assembly line suffered an allergic reaction to the paint and was taken to the hospital. The incident prompted local union representatives to ask management to move all touch-up painting operations to the #1 shift, when the building was mostly unoccupied. Two of the ten painting tasks were moved to shift 1, as requested. However, the remaining jobs, including wing panel painting, continued during swing shift. In response to worker concerns, the union asked NIOSH to conduct a health hazard evaluation.

EVALUATION PROCEDURES

On September 6-7, 1989, NIOSH investigators conducted an initial survey of the C-130 production areas. Following an opening conference, NIOSH investigators conducted a walk-through to observe manufacturing processes and specific painting operations. Material safety data sheets (MSDSs) for all paints and coatings applied during C-130 assembly in Building B-1 were compiled and reviewed by the NIOSH industrial hygiene investigator. NIOSH medical investigators reviewed OSHA 200 Logs, and discussed medical problems with the plant's Medical Director. Selected workers were confidentially interviewed to obtain health information pertinent to the evaluation. A closing conference was held to summarize walk-through survey findings and provide interim recommendations.

Preliminary Findings

The walk-through inspection revealed several areas where overspray from the painting process could drift into the breathing zone of other C-130 production workers. Two areas identified were: (1) where wing panel dry-bays are painted with a white polyurethane, and (2) the mid-fuselage area where fairings and de-ice shields are painted.

The two painters doing touch-up painting in Building B-1 were interviewed by the NIOSH industrial hygiene investigator to determine what paint jobs they performed and what painting products they used. After the interview, copies of MSDSs for all these products were obtained from the Lockheed Hazard Communications Coordinator. The components for all the paints and coatings used are listed in Attachment A.

NIOSH medical investigators conducted confidential interviews with 28 employees randomly chosen from the areas of complaint. The mean age of those interviewed was 46 years (range 29-61). Those interviewed had worked an average of 9.6 years at the Lockheed plant. Sixteen of these 38 workers complained of irritative symptoms, including nasal irritation (9), cough (6), headaches (4), and nausea (3). Employees experiencing symptoms identified wing panel dry-bay spray painting operations as the source of their complaints. Symptoms were reported to occur within seconds of perceived exposure to the white polyurethane overspray. Workers reported that their symptoms would last until the overspray dissipated, or until they left the area. One worker reported symptoms consistent with diisocyanate sensitization, including shortness of breath and wheezing upon exposure to the paint.

Follow-up Environmental Survey

On October 25, 1989, NIOSH industrial hygienists collected air samples to evaluate potential exposures to diisocyanates, organic vapors, and airborne metals released during painting of C-130 wing panel dry-bays. After the initial walk-through and in response to the initial NIOSH survey, this painting operation was now being done on the #1 shift. On the night of the NIOSH survey two wing panels had been prepared for painting. Two painters, wearing disposable coveralls, full-face cartridge respirators, and head covers did the spraying. Painting was done on an upper deck located in the center of Building B-1. Although no local exhaust ventilation was used, painters set up venturi air blowers to dissipate and push the paint cloud to the north side of the building. After wiping down the surface of the dry-bay sections to be painted, painters began applying a light coat of Code 54 epoxy primer (see Attachment A) to each dry-bay. Primer spraying was complete within 15 minutes. After mixing, two coats of white polyurethane were then applied. Final applications were completed within 35 minutes.

To monitor personal exposures to paint aerosols and vapors, air sampling equipment was worn by each painter. Area samples were also collected. Area samples were placed at ground floor locations surrounding the painting operation. Samples were placed in positions or locations where workers had complained of potential overspray exposures (see Figure 1). A personal breathing zone sample was collected from each painter by attaching sample collection devices to each painter's shirt collar.

1. Organic Vapor Monitoring

Organic vapors released during spray painting operations were collected by drawing air through glass tubes packed with vapor-adsorbing activated charcoal. The charcoal tubes were connected via plastic tubing to pre-calibrated battery powered air sampling pumps operating at a flow rate of 200 cubic centimeters (cc) per minute. After sampling, the charcoal tubes were capped and shipped to the NIOSH contract laboratory for analysis. Based on information obtained from MSDSs, the samples were analyzed for methyl ethyl ketone (MEK), methyl isobutyl ketone, xylene, 2-ethoxyethyl acetate, ethyl acetate, butyl acetate, and cyclohexanone. The samples were analyzed by gas chromatography and flame ionization detection (GC-FID) according to NIOSH Methods 1300, 1450, and 1501 with modifications.[1]

2. Trace Metals Monitoring

Trace metals contained in the primer and polyurethane paint aerosols were identified and quantitated by collecting personal breathing zone and area samples on 0.8-micrometer, cellulose ester membrane filters mounted in three-piece plastic cassettes. The cassettes were attached via plastic tubing to pre-calibrated battery powered air sampling pumps operated at a flow rate of 2 liters of air per minute (Lpm). Paint aerosols collected on the filters were analyzed by inductively coupled argon plasma, atomic emission spectroscopy (ICP/AES), according to NIOSH method 7300.[1] Of the 29 trace elements detectable by ICP/AES, the metals aluminum, barium, chromium, iron, magnesium, titanium, and zinc were identified and quantitated.

3. Hexamethylene Diisocyanate (HDI) Monitoring

Because the white polyurethane activator was known to contain (30%) HDI polyisocyanate, sampling for HDI monomer and HDI oligomers (prepolymers containing unreacted isocyanate groupings) was done according to NIOSH Sampling and Analytical Method 5521.[1] Air samples were collected using spill-proof midget impingers. Each impinger contained 15-milliliters (mL) solution of 1-(2-methoxyphenyl)-piperazine in toluene. The impingers were connected via plastic tubing to battery powered pre-calibrated air sampling pumps operating at a flow rate of 1 Lpm. Area sample locations are identified in Figure 1. To collect personal breathing zone samples from each painter, each impinger was mounted in a leather holster that was pinned to the front of the worker's shirt. After sampling, the impinger solutions were placed in glass vials and shipped to the NIOSH contract laboratory for analysis by high performance liquid chromatography, using electrochemical and UV detection. An attempt to analyze the samples for HDI prepolymers was not successful because of difficulty in identifying the prepolymer peaks. Only HDI monomer was quantitated.

RESULTS AND DISCUSSION

Organic Vapors

As expected, the highest concentrations of organic vapors detected during the two-hour painting operation were found in the two personal breathing zone samples of the spray painters (see Table 1). MEK was the greatest component of the mixture of organic vapors released. However, MEK levels were still well below the recommended exposure limit of 200 parts per million (ppm). Average MEK levels detected in the breathing zones of the painters were 35.9 and 33.3 ppm. Only trace amounts of MIBK, xylene, ethyl acetate, 2-ethoxyethyl acetate, butyl acetate, and cyclohexanone were found in the personal samples. Area samplers detected little or no organic vapors. NIOSH investigators noted that because wing panel painting was done atop an elevated platform, paint overspray was clearly visible throughout most areas of Building B-1. Paint aerosol was seen drifting upward into the ceiling of the building, and slowly to the northeast of the platform. It was being pulled into the return air vents of the heating, ventilating, and air-conditioning (HVAC) mechanical rooms located above the forward and aft fuselage areas. NIOSH investigators monitored production floor areas under the drifting paint cloud for organic vapors using a direct reading organic vapor detector. The instrument response was negative in all areas checked except one location. Slight fluctuations above background levels were noted near column G77.

Trace Metals

The concentrations of airborne metals in personal breathing zone samples were considerably higher for one of the two painters monitored (see Table 2). Excluding chromium, trace element concentrations were well below occupational exposure limits. Area samplers collected little or no airborne metals during the painting operation. Metals found in the area sample collected at the final assembly line, position six may not have originated from any airborne paint aerosols because no chromium or titanium was detected in the sample.

Chromium, as strontium chromate, is contained in Code 54 primer. Although strontium chromate is probably used to replace lead chromate in the primer formulation, both strontium chromate and lead chromate are classified as water-insoluble hexavalent chromium compounds. Based on animal studies and epidemiological investigations of workers, certain hexavalent chromium compounds are now recognized as human carcinogens. The ACGIH Documentation of the TLVs[2] states that exposures to water-insoluble hexavalent chromium compounds appear related to an increased risk of lung cancer. Except chromic acid anhydride and monochromates and bichromates of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, NIOSH considers all hexavalent chromium compounds to be potential carcinogens, whether water-soluble or water-insoluble.[3] Hexavalent chromium compound exposures have been associated with effects such as ulcerated nasal mucosa, perforated nasal septum, rhinitis, nose-bleeds, perforated eardrum, pulmonary edema, asthma, kidney damage, erosion and discoloration of the teeth, primary irritant dermatitis, sensitization dermatitis, and skin ulceration.[4]

NIOSH recommends reducing exposures to occupational carcinogens to the lowest feasible level and suggests establishing a goal to reduce exposures to below concentrations detectable by the most sensitive sampling and analytical methods published by NIOSH. For hexavalent chromium, this concentration is now 0.001 mg/m^3 for an 8-hour time-weighted average (TWA) or 0.05 mg/m^3 as 15-minute ceiling limit.[5] The Occupational Safety and Health Administration (OSHA) has not yet adopted a specific permissible exposure limit (PEL) for hexavalent chromium. OSHA now enforces a 0.1 mg/m^3 ceiling limit for chromic acid and chromates. A ceiling limit should not be exceeded at any time.[6] For practical monitoring applications, compounds with established ceiling limits are usually sampled for 15 minutes during worse-case exposure situations. The personal air monitoring results obtained during wing dry-bay painting operations show painters are working in atmospheres containing airborne chromates that would likely exceed the OSHA and NIOSH ceiling limits.

HDI Monitoring Results

Results of the analysis of impinger samples showed that airborne HDI monomer levels were just above the detection limit of the NIOSH sampling and analytical method (see Table 3). Had sampling times been limited to ten minutes, HDI probably would not have been detected in the samples. It is highly unlikely that all the HDI monomer was collected by the samples within a 10-minute period. Yet, if this did occur, the results from the sample collecting the greatest amount of HDI monomer (3.4 micrograms) would only represent a peak concentration of about 0.35 mg/m^3 (0.05 ppm) HDI.

Medical

Studies have found that all diisocyanates can cause irritation to the skin, mucous membranes, and respiratory tract. HDI-induced irritation is observed in most people at airborne concentrations of 0.05 to 0.1 ppm. Symptoms include burning and tearing of the eyes, burning of the nose and throat, tightness of the chest, and cough. The extent of irritation depends upon the concentration of HDI, type of body tissue exposed, and individual susceptibility. These symptoms are reversible upon removal of the worker from the exposure area.[7,8]

Respiratory hypersensitization can develop in people working with HDI-containing materials. Sensitized people can react to low levels of airborne HDI and develop symptoms that include difficulty in breathing, chest tightness, wheezing, and coughing. Other effects may include chills, fever, general feelings of bodily discomfort, headache, a burning sensation in the chest, and pains in the joints. These reactions may occur immediately after exposure to HDI, or several hours after exposure, or both. Effects may subside after a few hours or persist for up to two weeks. People with severe reactions may require hospitalization. Sensitized people with continued exposure to HDI may develop symptoms sooner after each exposure. The number and severity of symptoms may increase. Recovery may take longer and longer after removal from exposure. Some sensitized people have continued to suffer respiratory problems for at least 18 months after cessation of exposure to HDI. Information on HDI levels, which can cause sensitization, is lacking. It appears that the lower the exposure to HDI, the less chance there is of becoming sensitized. Yet, even non-allergy-prone people can become sensitized to HDI.

The mechanism of HDI sensitivity is not completely understood. It may involve a response of the body's immune system. Cross-sensitization between different isocyanates have been found to occur. One person sensitized to HDI-containing enamel showed sensitization to polymethylene polyphenyl isocyanate (PMPPI) with no previous exposure to this material.[9] Certain symptomatic people will develop a generalized airway hypersensitivity causing shortness of breath and chest tightness. With exposure to many other irritating chemicals, dusts or vapors, and not just to isocyanates alone.[10] Although NIOSH now concludes that data on carcinogenicity give sufficient evidence to warrant concern about the potential consequences of occupational exposure to toluene diisocyanate (TDI), there is not sufficient evidence for classifying HDI as potentially carcinogenic.[11]

NIOSH recommends that 10-minute HDI exposures not exceed 0.02 ppm (0.14 mg/m^3). The American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour time-weighted average (TWA) Threshold Limit Value (TLV)[12] and NIOSH Recommended 8-hour TWA exposure limit for HDI monomer[4] is 0.005 ppm (0.035 mg/m^3). The current ACGIH TLV for HDI is based on the assumption that HDI toxicity is similar to TDI. There is no OSHA PEL or STEL for HDI monomer.

CONCLUSIONS

The environmental monitoring data from this survey show minimal risk of exposure for non-painters to organic vapors, HDI monomer, and toxic metals released into the open atmosphere of Building B-1 during first-shift painting of wing panel dry bays. Area monitors set up around the painting operation showed airborne concentrations of organic vapors and hazardous particulates were either not detectable or well below current occupational health exposure limits. Exposure risks to hexavalent chromium compounds were shown for one of the painters spraying primer containing strontium chromate. The large interior volume of Building B-1 and the rapid dispersion and upward drift of paint overspray may tend to reduce the chance of floor-level exposures. The practice of open spraying of polyurethane paints when the Building is mostly unoccupied should prevent new cases of respiratory sensitization to diisocyanates among C-130 production workers.

RECOMMENDATIONS

1. If feasible, spraying of paints and other surface coatings containing diisocyanates or hexavalent chromium compounds should be done under local-exhaust enclosed hoods or inside paint booths. Larger items, which must be painted out in open areas of Building B-1, should be painted on Shift 1 when the building is mostly unoccupied. If Shift 1 painting is not possible, then extra precautions should be taken to ensure production workers (non-painters) are well away from the painting operations. Based on MSDS information supplied to NIOSH during this survey (see Attachment A), use restrictions should apply to spraying of the following coatings:

   Code 611 primer (zinc chromate)
   B12 sealer (pro-seal 870, polysulfide rubber)
   Laminar X-500 (with 10-C-32 catalyst)
   Laminar X-500 (with 8-W-24 catalyst)
   Code 54 epoxy primer
   Code 36 white poly (white super desothane activator)
   Code 46 polyurethane primer
   Code 19 epoxy primer (corrosion inhibiting)
   Cellulose nitrate lacquer
   Gunship gray SD AL polyester #36118

2. For work in atmosphere containing up to 1 ppm of any diisocyanate, NIOSH recommends use of Type C supplied-air respirator with full-facepiece, operated in pressure-demand or other positive pressure mode; or use of a full-facepiece helmet or hood operated in continuous-flow mode. Because of the low exposure limits for diisocyanates, the use of cartridge type respirators is not recommended. The NIOSH respiratory selection guide for protection against carcinogenic hexavalent chromium calls for a full-face, positive pressure, self-contained breathing apparatus, or a combination supplied air respirator with auxiliary self-contained air supply, operated in the positive-pressure mode.

3. Lockheed industrial hygienists should develop and carry out an exposure monitoring program to evaluate other potential exposure hazards through out the facility.

4. Periodic medical examinations should be made available at least annually to workers potentially exposed to paint aerosols and vapors containing diisocyanates. This exam should include interim medical and work

histories and clinical examination, giving particular attention to the respiratory tract and measurements of FEV1 (forced expiratory volume in one minute) and FVC (forced vital capacity). Spirometry should be done according to American Thoracic Society guidelines. During examinations, employees found to have medical conditions that could be directly or indirectly aggravated by exposure to diisocyanates (*e.g.*, respiratory allergy, chronic upper or lower respiratory irritation, chronic obstructive pulmonary disease, or evidence of sensitization to diisocyanates) should be counseled on their risk from working with or around these substances. Chronic bronchitis, emphysema, disabling pneumoconiosis, or cardiopulmonary disease with significantly impaired ventilatory capacity similarly suggests an increased risk to health from exposures to diisocyanates. All employees also should be informed that exposure to diisocyanates may cause delayed effects, such as coughing or difficulty in breathing during the night.

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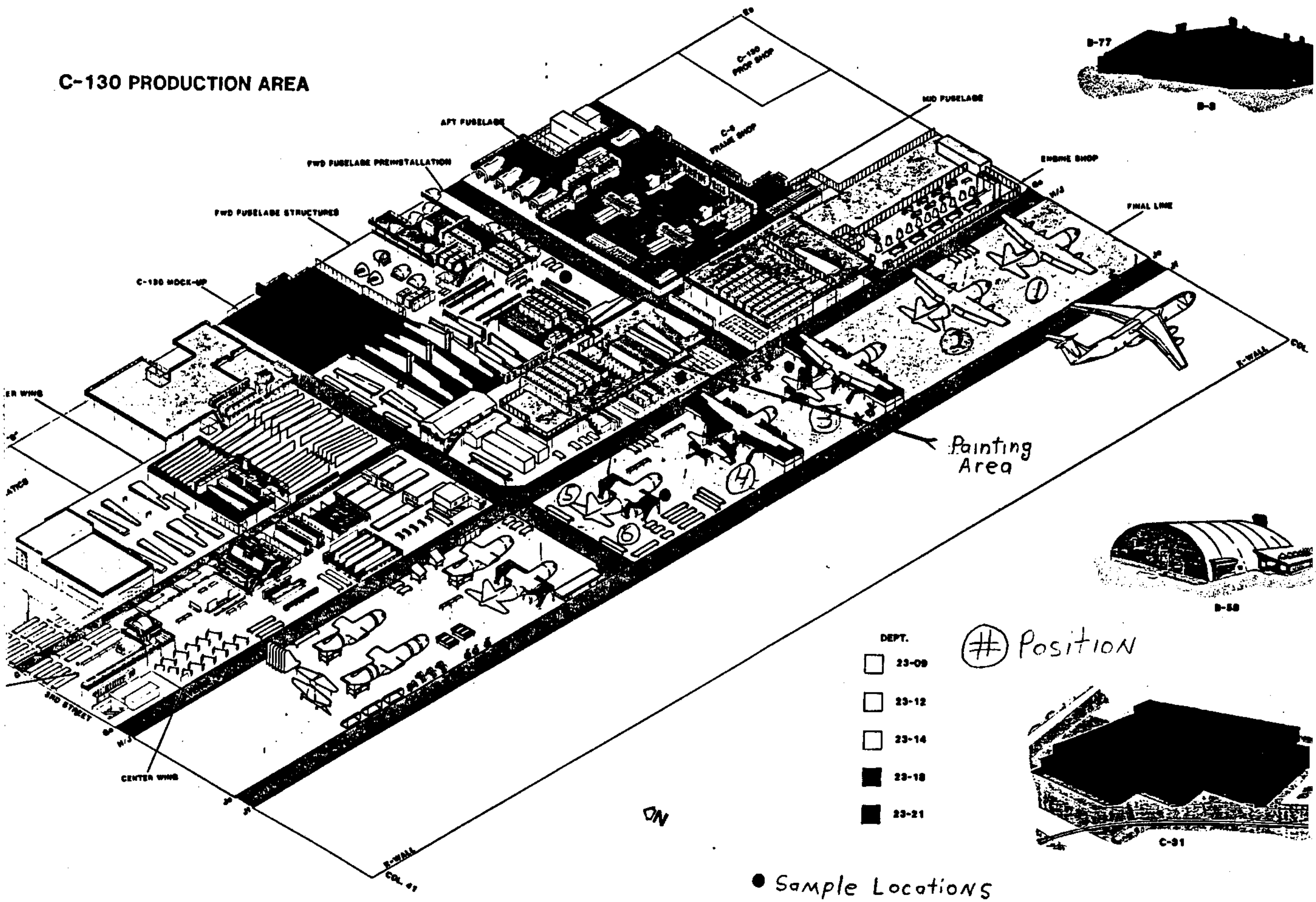
FIGURE 1



C-130 PRODUCTION AREA
C-130 PROP SHOP
C-5 FRAME SHOP
AFT FUSELAGE
MID FUSELAGE
FWD FUSELAGE PREINSTALLATION
FWD FUSELAGE STRUCTURES
ENGINE SHOP
FINAL LINE
C-130 MOCK-UP
CENTER WING
3RD STREET
E-WALL
COL. 41
B-77
B-8
B-58
C-31
Painting Area
DEPT.
23-09
23-12
23-14
23-18
23-21
Position
● Sample Locations

TABLE 1 - ORGANIC VAPOR CONCENTRATIONS

HETA 89-276
LOCKHEED AERONAUTICAL SYSTEMS
MARIETTA GEORGIA
October 25, 1989

SAMPLE NUMBER	SAMPLE DESCRIPTION	TYPE SAMPLE	START TIME	STOP TIME	MEK ppm	MIBK ppm	Xylene ppm	EEA ppm	Eth Ace ppm	But Ace ppm	Cyclohex ppm
OV-1	Near Column F-71	Area	00:56	1:56	0.3	nd	nd	nd	2.3	nd	nd
OV-2	High Value Crib	Area	00:58	1:59	nd	nd	nd	nd	nd	nd	nd
OV-3	Pos. 3 Qual Station	Area	00:59	1:58	nd	nd	nd	nd	nd	nd	nd
OV-4	Pos 6 Dist. Box	Area	00:31	1:56	nd	nd	nd	nd	nd	nd	nd
OV-5	Painting Wing Panels	Personal	00:51	1:54	35.9	7.6	4.5	1.1	0.2	4.8	nd
OV-6	Painting Wing Panels	Personal	00:35	1:51	33.3	1.9	1.7	0.9	0.2	2.6	nd
Evaluation Criteria:											
<u>8-hr TWA</u>											
NIOSH Recommended Exposure Limits					200.0	50.0	100.0	LFL	--	--	25.0
OSHA Permissible Exposure Limits					200.0	50.0	100.0	100.0	400.0	150.0	25.0
ACGIH Threshold Limit Values					200.0	50.0	100.0	5.0	400.0	150.0	25.0
<u>SHORT TERM or CEILING LIMITS</u>											
NIOSH Recommended Ceiling Limit (15-min)					--	--	200	LFL	--	--	--
OSHA Short Term Exposure Limit (STEL)					300	75	150	--	--	200	--
ACGIH Short Term Exposure Limit (STEL)					300	75	150	--	--	200	--
Analytical limits of detection					0.3	0.2	0.2	0.2	0.2	0.2	1.6
Analytical limits of quantitation					0.8	0.6	0.6	0.5	0.7	0.5	4.1

MEK = methyl ethyl ketone
MIBK = methyl isobutyl ketone
EEA = 2-ethoxyethyl acetate
TWA = time weighted average

Eth Ace = ethyl acetate
But Ace = butyl acetate
Cyclohex = cyclohexanone
ppm = parts per million

LFL = lowest feasible level
ND = None Detected

TABLE 2 - AIRBORNE METALS CONCENTRATION

HETA 89-276
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SAMPLE NUMBER	SAMPLE DESCRIPTION	TYPE SAMPLE	START TIME	STOP TIME	TIME minutes	Aluminum mg/m³	Barium mg/m³	Cr (vi) mg/m³	Iron mg/m³	Mg mg/m³	Titanium mg/m³	Zr mg/m³
AA-1	Near Column F-71	Area	00:56	1:56	60	0.00	0.00	0.000	0.00	0.00	0.00	0.00
AA-2	High Value Crib	Area	00:58	1:59	61	0.00	0.00	0.000	0.00	0.00	0.00	0.00
AA-3	Pos. 3 Qual Station	Area	00:59	1:58	59	0.00	0.00	0.000	0.00	0.00	0.00	0.00
AA-4	Pos 6 Dist. Box	Area	00:31	1:56	85	1.21	0.00	0.000	0.02	0.01	0.00	0.06
AA-5	Painting Wing Panels	Personal	00:51	1:54	63	0.69	0.02	0.308	0.00	0.11	3.47	0.00
AA-6	Painting Wing Panels	Personal	00:35	1:51	76	0.00	0.00	0.012	0.00	0.02	0.80	0.00
Evaluation Criteria												
8-hr TWA												
NIOSH Recommended Exposure Limits (REL)						--	--	0.001	--	--	--	--
OSHA Permissible Exposure Limits (PEL)						5.00	0.50	--	10.00	10.00	10.00	5.00
ACGIH Threshold Limit Values (TLV)						10.00	0.50	0.050	5.00	10.00	10.00	5.00
SHORT TERM or CEILING LIMITS												
NIOSH Recommended Ceiling Limit (15-min)						--	--	0.05	--	--	--	--
OSHA Short Term or Ceiling (c) Limits						--	--	(c) 0.1	--	--	--	10.00
ACGIH Short Term Exposure Limit (STEL)						--	--	--	--	--	--	10.00
Analytical limits of detection						0.08	0.01	0.008	0.01	0.02	0.08	0.08

Mg = magnesium
Zr = zirconium
Cr (vi) = hexavalent chromium
mg/m³ = milligrams per cubic meter

Eval. Crit. for water insoluble Cr (vi)
Includes: lead chromate
strontium chromate
zinc chromate
calcium chromate
barium chromate
sintered chromium trioxide

TABLE 3 - HEXAMETHYLENE DIISOCYANATE (HDI) CONCENTRATIONS

HETA 89-276
LOCKHEED AERONAUTICAL SYSTEMS
MARIETTA, GEORGIA
October 25, 1989

SAMPLE NUMBER	SAMPLE DESCRIPTION	P/A	TIME START	TIME STOP	TIME minutes	µg HDI	HDI mg/m³	HDI ppm
I-1	Fwd Fusalage	A	00:56	01:56	60	1.9	0.031	0.005
I-2	High Value Crib	A	00:58	01:59	61	0.9	0.014	0.002
I-3	Position 3	A	00:59	01:58	59	1.2	0.020	0.003
I-4	Position 6	A	00:31	01:56	85	2.1	0.024	0.003
I-5	Painting Wing Panels	P	00:53	01:54	61	3.4	0.054	0.008
I-6	Painting Wing Panels	P	00:55	01:51	56	1.1	0.019	0.003
Evaluation Criteria:								
8-hr TWA								
NIOSH Recommended Exposure Limit							0.035	0.005
OSHA Permissible Exposure Limit								--
ACGIH Threshold Limit Value							0.035	0.005
SHORT TERM or CEILING LIMITS								
NIOSH Recommended Ceiling Limit (10-min)							0.140	0.020
OSHA Short Term Exposure Limit (15 min)								--
ACGIH Short Term Exposure Limit (15-min)								--
Analytical limits of detection						0.4	0.01	0.001
Analytical limits of quantitation						1.1	0.02	0.003

P = personal sample
A = area sample
µg = micrograms
mg/m³ = milligrams of HDI per cubic meter of air
ppm = parts per million

ATTACHMENT A
LOCKHEED C-130 PAINTING OPERATIONS
HETA 89-276
LOCKHEED AERONAUTICAL SYSTEMS
MARIETTA, GEORGIA

MID FUSELAGE AREA

1. <u>Fairings and wheel well fitings (shift 5)</u>

Code 611 primer (zinc chromate)

- zinc tetroxy chromate	<15%
- lead naphthenate solution	<1%
- xylene	35%
- toluene	<20%
- silicon dioxide	<5%

2. <u>Inside wheel well (shift 5)</u>

GS 140 aluminized (corrosion resistant)

- methyl ethyl ketone (MED)	8%
- toluene	30%
- n-butyl acetate	20%
- methyl-n-butyl ketone	20%

3. <u>De-ice shields (shift 5)</u>

Code 611 primer (zinc chromate)

- zinc tetroxy chromate	<15%
- lead naphthenate solution	<1%
- xylene	35%
- toluene	<20%
- silicon dioxide	<5%

B12 sealer (pro-seal 870, polysulfide rubber)

Part A:

- magnesium chromate	25%
- 1,3-diphenyl guanadine (CAS 102-06-7)	<5%
- manganese dioxide	40%

Part B:

- toluene	<5%
- phenol polymer with formaldehyde	<5%

Laminar X-500 (with 10-C-32 catalyst)

- 2-ethoxyethyl acetate	45%
- toluene	20%
- pentoxone (CAS 107-70-0)	10%
- TDI	0.5%

(or)

Laminar X-500 (with 8-W-24 catalyst)

- HDI	0.3%
- ethylene glycol monoethyl ether acetate	20%
- n-butyl acetate	5%
- MEK	5%
- toluene	5%

4. Cargo Floor (end bays only) (shift 5)

Code 611 primer (zinc chromate)

- zinc tetroxy chromate	<15%
- lead naphthenate solution	<1%
- xylene	35%
- toluene	<20%
- silicon dioxide	<5%

Code 27 L-917 lacquer (acid resistant)

- toluene	26.9%
- butyl cellosolve	5.5%
- methyl isobutyl ketone	22%

OUTER WING

1. Wing Panel Dry Bay (moved to shift 1)

Code 54 epoxy primer

Typical Composition:

- strontium chromate	20%
- titanium dioxide	4%
- MIBK	25%
- MEK	24%
- toluene	4%
- xylene	2%

Code 36 white poly (white super desothane)

- 2-ethoxyethyl acetate	20%
- ethyl acetate	5%
- butyl acetate	15%

Code 36 white poly (white super desothane activator)

- 2-ethoxyethyl acetate	30%
- cyclohexanone	5%
- methyl ethyl ketone	30%
- xylene	5%
- HDI (aliphatic polyisocyanate)	30%

2. <u>Nacelle (shift 5)</u>

Code 46 polyurethane primer

base component:

- epoxy resin	<10%
- titanium dioxide	<5%
- strontium chromate	<5%
- chrome yellow (lead chromate)	<5%
- talc	<10%
- mica	<5%
- 2-ethoxyethylacetate	<10%
- MEK	<20%

curing solution:

- MDI	<10%
- toluene	<5%
- MEK	<20%

thinner:

- toluene	<10%
- 2-ethoxyethylacetate	<15%
- MEK	<20%

3. <u>Forward Beams (shift 5)</u>

Code 19 epoxy primer (corrosion inhibiting)

base component:

- epoxy resin	<15%
- titanium dioxide	<5%
- lead chromate (pb 59%, cr 26%)	<5%
- strontium chromate	<5%
- talc	<15%
- toluene	<10%
- xylene	<15%
- methyl isobutyl ketone (MIBK)	<5%
- cyclohexanone	<10%

curing solution:

- organic amine complex	<5%
- xylene	<10%
- n-butyl alcohol	<15%
- MEK	<15%
- MIBK	<10%
- cyclohexanone	<10%

Code 24 aluminized epoxy enamel

- MIBK	3%
- 2-ethoxyethyl acetate	5%
- xylene	13%
- butyl alcohol	1%
- toluene	5%

FINAL ASSEMBLY LINE

1. Body Mate Area, position 5 & 6 (shift 5)

Cellulose nitrate lacquer

Typical Composition:

- di-octyl phthalate	5%
- isopropyl alcohol	10%
- n-butyl alcohol	5%
- n-butyl acetate	10%
- 2-butoxyethanol	10%
- methyl isobutyl ketone	5%
- toluene	15%
- iron oxide (as Fe)	10%
- xylene	5%
- titanium dioxide	5%
- lead chromate (as Pb)	10%
- lead chromate (as Cr)	5%
- talc	15%
- amorphous silica	5%

2. Cargo deck, under floor, position 3 (shift 1)

Code 611 primer (zinc chromate)

- zinc tetroxy chromate	<15%
- lead naphthenate solution	<1%
- xylene	35%
- toluene	<20%
- silicon dioxide	<5%

3. Pylons, under wing, position 1 & 2 (shift 1)

Code 54 epoxy primer

Typical Composition:

- strontium chromate	20%
- titanium dioxide	4%
- MIBK	25%
- MEK	24%
- toluene	4%
- xylene	2%

Gunship gray SD AL polyester #36118

base components:	
- n-butyl acetate	15%
- MIBK	5%
- glycol ether acetate	10%
- titanium dioxide	10%
- carbon balck	<5%
- resin and pigments	30%
- crystalling silica	5%
- talc (not-asbestiform)	<5%
- amorphous silica	10%
- MEK	10%
activator:	
- methyl n-amyl ketone	30%
- cyclohexanone	5%
- MEK	25%
- xylene	5%
- toluene	<5%
- aliphatic polyisocyanate (HDI)	30%