GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. A-3327 DATE 8/24/82

Project Director: ~~James L. Burson~~ EWING ~~School~~/Lab EDL/SHS

Sponsor: U.S.Department of Agriculture, U.S.Forest Service

Type Agreement: Purchase Order No. 40-43ZP-2-1244 dated 7/20/82

Award Period: From 9/1/82 To 12/10/82 (Performance) 12/10/82 (Reports)

Sponsor Amount: $1,850 (fixed price) Contracted through:

Cost Sharing: GTRI/~~GIT~~

Title: Industrial Hygiene Survey of USFS Print Shop

ADMINISTRATIVE DATA

OCA Contact Faith G. Costello x-4820

1) Sponsor Technical Contact:

Mr. Charles Hoffman
U. S. Forest Service
Room 812 - Pers. Mgmt. Safety
1720 Peachtree Road, N.W.
Atlanta, GA 30367

2) Sponsor Admin/Contractual Matters:

Mr. Charles Hoffman
Purchasing Agent
U. S. Forest Service
Room 802 Purchasing
1720 Peachtree Road, N.W.
Atlanta, GA 30367
Phone: 881-2003

Defense Priority Rating: N/A

Security Classification: N/A

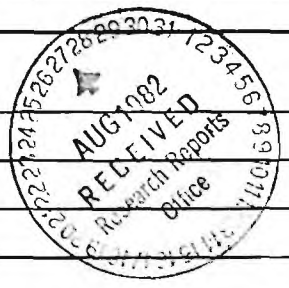
RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with N/A

COMMENTS:



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FORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 12/15/82

Project Title: Industrial Hygiene Survey of USFS Print Shop

Project No: A-3327

Project Director: W. M. Ewing

Sponsor: U. S. Department of Agriculture, U. S. Forest Service

Effective Termination Date: 12/10/82

Clearance of Accounting Charges: 12/10/82

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and ~~Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: EDL/SHS (School/Laboratory)

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A-3327

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

November 24, 1982

Mr. Richard Ames
USDA/USFS
Room 812
1720 Peachtree Street, N.W.
Atlanta, Georgia 30309

Subject: Print Shop Industrial Hygiene Survey, Project No. A-3327

Dear Mr. Ames:

Enclosed are two copies of the final report of the Industrial Hygiene Study conducted at the Print Shop of your facility. The only deficiencies found were with regard to methylene chloride, ventilation and waste disposal. Each of these items are addressed in the report, and I would be happy to discuss them further with you.

It has been a pleasure to provide this service to you and the U. S. Forest Service. The cooperation of the employees in the print shop during the course of the survey was greatly appreciated. Should you have any questions concerning the report please do not hesitate to contact us.

Sincerely,

William M. Ewing
Industrial Hygienist

WME:sek

Enclosures

INDUSTRIAL HYGIENE SURVEY

U. S. Department of Agriculture
U. S. Forest Service
1720 Peachtree Street
Atlanta, Georgia 30367

Project No. A-3327
Final Report

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety and Health Division
Atlanta, Georgia 30332

November 24, 1982

INDUSTRIAL HYGIENE SURVEY

U. S. Department of Agriculture
U. S. Forest Service
1720 Peachtree Street
Atlanta, Georgia 30367

Project No. A-3327

1.0 INTRODUCTION

The Georgia Tech Research Institute was retained by the U. S. Forest Service to conduct an industrial hygiene survey of the print shop located at 1720 Peachtree Street, Atlanta, Georgia. The survey was performed at the request of Mr. Richard Ames of the U. S. Forest Service. This survey was conducted by Messrs. William M. Ewing and William H. Spain on October 26, 1982. They were accompanied by Mr. Ames while at the facility.

The purpose of the survey was to evaluate employee exposure to selected chemical and physical stresses. The chemical compounds included organic solvents used in the print shop and particulate matter (dusts) created at this facility. Also of concern was an evaluation of solvent vapor migration into the adjacent Office Management Department and the supply room. The physical stress agents evaluated were temperature, relative humidity, illumination, and noise. In addition, ventilation measurements were taken to identify and evaluate airflow patterns in the workplace (print shop).

The following report summarizes the results of the industrial hygiene survey and includes conclusions and recommendations, where necessary. The results of air sampling and noise monitoring are included in Appendix A. Descriptions of the sampling methodologies employed are found in Appendix B. Toxicological information about the contaminants monitored is included in Appendix C.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Area air sampling results indicated concentrations of total dust below the current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 15 milligrams per cubic meter (mg/m^3), determined as an 8-hour, time-weighted average (TWA). The highest 8-hour, TWA concentration of total dust found was 1.49 mg/m^3.

2.2 Personal sampling results indicated employee exposure to methylene chloride and perchloroethylene below the current OSHA PEL, determined as 8-hour, TWAs. The values measured were also below the recommended PEL by the National Institute for Occupational Safety and Health (NIOSH) and the threshold limit value (TLV) adopted by the American Conference of Governmental Industrial Hygienists (ACGIH).

2.3 Recent evidence has determined that methylene chloride can cause cancer in laboratory animals. Accordingly, every effort should be made to

minimize employee exposure to methylene chloride until further information is available. This topic is discussed further in section 4.1 of this report.

2.4 Most of the employee exposure to methylene chloride occurs during cleaning of TCS Systems 4 and 5. Exposure during normal operation of the machines is minimal.

2.5 Based on the results of area sampling, there does not appear to be any significant solvent vapor migration from the print shop into adjacent areas.

2.6 General ventilation in the print shop was estimated to be below the American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) recommended air volumes for office environments. This is addressed in greater detail in section 4.2 of this report.

2.7 Employee 8-hour, TWA exposure to noise was determined to be below the current OSHA PEL of 90 dBA and "action level" of 85 dBA.

2.8 Illumination levels throughout the print shop were found to be adequate to perform most tasks. Illumination in an adjacent office (Office Management Department) was determined to be inadequate due to a blue filter placed in the overhead light fixture.

2.9 Measurements of temperature and relative humidity indicated no major deviations from ASHRAE recommended standards.

2.10 Housekeeping and personal hygiene practices appeared adequate throughout the print shop.

2.11 Waste solvent disposal at this facility is inadequate. The practice of permitting an employee to burn the organic wastes at home should be discontinued immediately. Wastes generated at the print shop should be disposed of properly where it will not present a hazard to employees or the environment.

3.0 DESCRIPTION OF OPERATIONS

The U. S. Forest Service operates a print shop which employs four full-time employees. The print shop performs all the functions required to produce bound documents for the Forest Service. The entire shop, including the paper storage room and the supervisor's office encompasses approximately 1900 square feet (sq. ft.) of floor space. Figure 3.0-1 is a sketch of the facility depicting the various machines present in the shop.

4.0 DISCUSSION OF FINDINGS

4.1 AIR SAMPLING

Personal and area air samples were collected and analyzed for a variety of chemical contaminants including total dust (particulate matter), total hydrocarbons (as n-hexane), methylene chloride, and perchloroethylene. The results of individual samples have been compiled in Tables A-1 and A-2 of Appendix A.

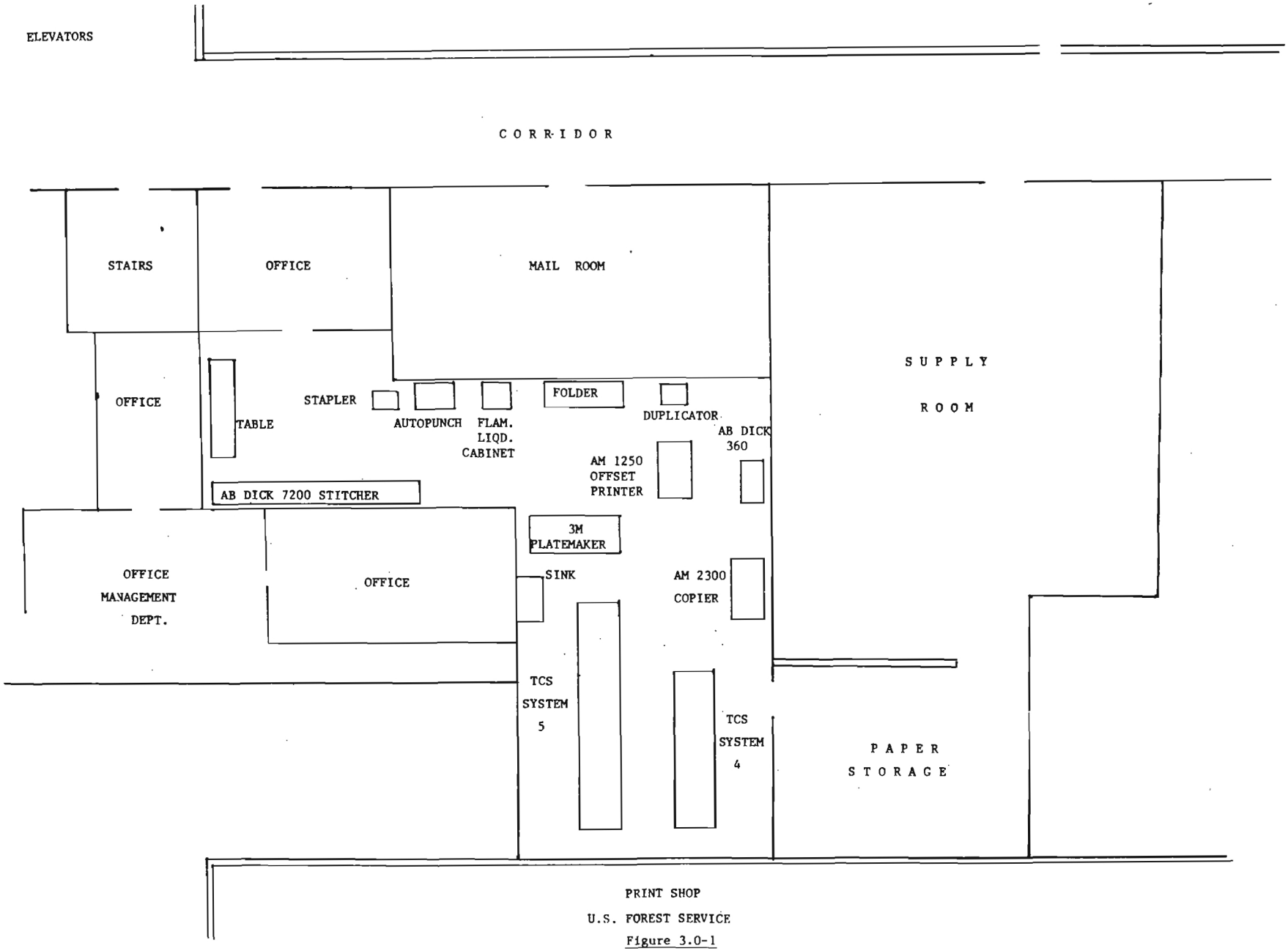

ELEVATORS
CORRIDOR
STAIRS
OFFICE
MAIL ROOM
SUPPLY ROOM
OFFICE
TABLE
STAPLER
AUTOPUNCH
FLAM. LIQD. CABINET
FOLDER
DUPLICATOR
AB DICK 360
AM 1250 OFFSET PRINTER
AB DICK 7200 STITCHER
3M PLATEMAKER
OFFICE MANAGEMENT DEPT.
OFFICE
SINK
AM 2300 COPIER
TCS SYSTEM 5
TCS SYSTEM 4
PAPER STORAGE
PRINT SHOP
U.S. FOREST SERVICE

Figure 3.0-1

Three area samples were collected and analyzed gravimetrically for total dust. The results indicated 8-hour, TWA concentrations of 0.07-1.49 milligrams per cubic meter of air sampled (mg/m^3). These values are below the current OSHA PEL of 15 mg/m^3 (8-hour, TWA) and the ACGIH TLV of 10 mg/m^3 (8-hour, TWA). It should be noted that personal sampling was not attempted since each employee in the print shop was asked to wear two pieces of sampling equipment for other measurements. Based on these findings there is little evidence to suggest that print shop employees would exceed or approach the OSHA PEL or the ACGIH TLV. Further, a review of the chemicals used at this facility did not indicate the use of any highly toxic dusts (particulate matter).

Five personal samples were collected and analyzed for selected organic vapors to determine employee exposure. These samples were analyzed for total hydrocarbons (as n-hexane). The data indicated a range of exposures of 1.8-15.4 ppm. It should be noted that this analysis is not specific for any one compound, but rather, measures the total quanitity of carbon and hydrogen atoms only. Subsequently, each sample was analyzed for methylene chloride and perchloroethylene.

The range of methylene chloride concentrations found was from less than 3 ppm to 74 ppm. The highest concentrations were detected in samples collected during cleaning of TCS systems 4 and 5. These concentrations were 73 and 74 ppm, respectively, during this activity. During the remainder of the workday these employees were exposed to a concentration below 3 ppm. The 8-hour, TWA methylene chloride exposures calculated for the TCS System 4 and 5 operators were 11.9 ppm and 17.8 ppm, respectively. The current OSHA PEL for methylene chloride is 500 ppm, determined as an 8-hour, TWA. The current NIOSH recommended PEL is 75 ppm averaged over a work shift up to 10 hours per day, 40 hours per week. The current ACGIH TLV is 100 ppm, determined as an 8-hour, TWA concentration.

It should be noted that methylene chloride has recently been found to cause cancer in laboratory animals, according to the National Toxicology Program (Chemical and Engineering News, October 4, 1982, p. 13). The OSHA standard and other recommended limits stated above were promulgated before this information was available. As of this writing, further information regarding recommended actions has not been released by NIOSH or OSHA. Accordingly, every effort should be made to minimize employee exposure to methylene chloride until further information is available.

All personal samples were also analyzed for perchloroethylene. The 8-hour, TWA range of concentrations was from less than 0.5 ppm to 0.6 ppm. The current OSHA PEL for perchloroethylene is 100 ppm, determined as an 8-hour, TWA. This same value was also adopted by the ACGIH. The NIOSH recommended PEL is 50 ppm average concentration for up to a 10-hour workday, 40-hour work week.

Two area samples were collected outside the print shop in adjacent office areas. These areas included the supply room and the Office Management Department. The results of analyses for total hydrocarbons (as n-hexane) was 1.1 ppm in the Office Management Department and 0.8 ppm in the supply room. Both of these values are representative of 8-hour, TWA

determinations. Methylene chloride and perchloroethylene were not detected in either sample. Accordingly, a limit of detection of less than 3 ppm is reported for methylene chloride and less than 0.5 ppm for perchloroethylene. Based on the above findings there does not appear to be any significant solvent vapor migration from the print shop into surrounding office areas.

4.2 VENTILATION

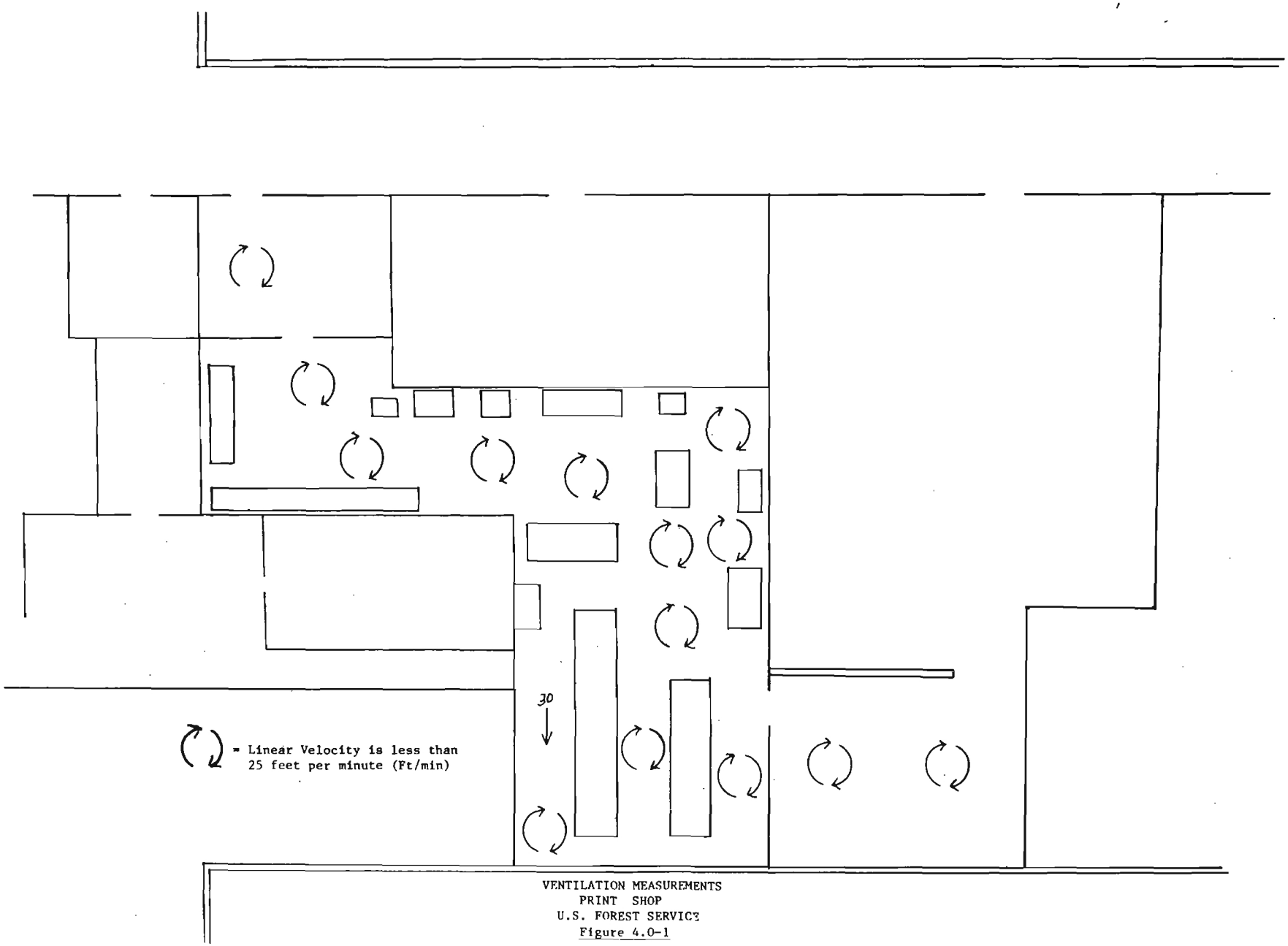
Air flow measurements were conducted throughout the print shop in an effort to characterize air flow patterns. These results are indicated on Figure 4.0-1 with arrows indicating flow rate in linear feet per minute (fpm). From these measurements it is evident that the print shop contains many areas of air stagnation. Stagnant air has been defined by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) as any air mass with a linear velocity less than 25 fpm. A subsequent investigation was made to determine the reason for the reduced air flow.

The air supply system for this floor is divided into two equal halves. One system serves the south tower and the other serves the north tower. On each floor is located two fans to provide air flow in each of these areas. The print shop is on the south tower system. Thirty-two face velocity measurements were made at the return air filter located in the mechanical room. From these measurements it was determined that the total air volume handled by this fan approximates 7,300 cubic feet per minute (cfm). The square footage of floor space handled by this system was calculated at 10,600 square feet (ft^2). This results in an air exchange rate of approximately 0.7 cfm per square feet of floorspace. It should be noted that leakage was not included in this figure. Leakage would be minimal since the building is sealed (no open windows, etc.) with the only appreciable amounts occuring at elevators, stairwells, and bathroom vents. The calculated value (0.7 cfm/ft^2) falls below the ASHRAE recommended air volume per square foot of 0.75-2.0 cfm.* In order to meet the recommended exchange rate the capacity of the system for the south tower would need to be increased to 8,000-21,000 cfm. Alternatively, a supplemental system could be installed to service the print shop alone.

4.3 NOISE

Both noise dosimetry and A-weighted sound level measurements were used to determine employee's exposure to noise. The results of the hand-held, A-weighted sound level measurements are included on Figure 4.0-2. Briefly, the measurements show the noise level throughout the print shop to be at or below 80 dBA, with certain exceptions. These exceptions include employee exposure to noise above 80 dBA but below 85 dBA when operating the AB Dick 7200 Stitcher, the AB Dick 360, and TCS Systems 4 and 5. Of the above-mentioned machines, only TCS Systems 4 and 5 are used continuously during the workday.

*Recommended value obtained from American Society for Heating, Refrigeration and Air-Conditioning Engineers Handbook, 1978 Applications, Section 3.7, "Design Criteria for Office Buildings."



VENTILATION MEASUREMENTS
PRINT SHOP
U.S. FOREST SERVICE
Figure 4.0-1

When industrial noise is transient and variable, a reasonably accurate determination of employees' daily noise exposure can be made using an audio dosimeter. These dosimeter measurements are also used to determine compliance with the OSHA noise standard and was conducted for all four employees in the print shop.

The new amendment to the OSHA Noise standard actually requires that two noise level exposures be determined. One is an "action level" of 85 dBA and the other is a 90 dBA permissible exposure level. Both of these levels are time-weighted averages over an eight-hour work shift.

The ranges of noise levels used to make the two determinations are different. For the "action level" of 85 dBA, all noise impulses between 80 and 130 dBA are included in the calculation. For the 90 dBA permissible exposure level, only those noise impulses between 90 and 130 dBA are included in the calculation. Consequently, the employee exposure results determined by the "action level" measurement criteria should be a higher value than the employee exposure results determined by the 90 dBA permissible exposure level criteria. This is because of the fact that any readings between 80 and 89 are included in the "action level" calculation but those readings would simply represent zero noise levels when calculating the 90 dBA permissible exposure level, and would therefore lower the average value.

Major hearing loss studes show 85 dBA as the level where the risk of hearing impairment becomes fairly significant. While exposure to 80 dBA indicate a 0 to 5% risk, exposures at 85 dBA indicate a 10 to 15% risk of hearing impairment. At 90 dBA, this risk jumps to 21 to 29%.

The audio dosimetry results, presented in Appendix A, Table A-3, indicated that employees monitored were not exposed to noise in excess of the current OSHA action level or the PEL. The range of exposures found for compliance with the OSHA PEL (90 dBA) was 62-66 dBA, determined as 8-hour, TWAs. The range of exposures determined for compliance with the OSHA action level (85 dBA) was 64-76 dBA, determined as 8-hour, TWAs.

4.4 ILLUMINATION

Levels of illumination were measured (in footcandles) using a hand-held light meter throughout the print shop and several adjacent areas. The results of these measurements are included in Figure 4.0-3. It should be noted that the higher readings found at the east end of the print shop are due to sunlight entering windows along the wall. From this data, it appears that illumination levels within the print shop proper are satisfactory. The illumination level of 10 footcandles found in the adjacent office (in the Office Management Department) is inadequate. The blue filter covering the light fixture is responsible for the reduced illumination level. Table 4.0-1 lists current recommended illumination levels for various tasks in an office environment.

ILLUMINATION (in Footcandles)
PRINT SHOP
U. S. FOREST SERVICE
Figure 4.0-3

Table 4.0-1

LEVELS OF ILLUMINATION

	Currently Recommended Illumination* Footcandles
OFFICES	
Cartography, designing, detailed drafting	200
Accounting, auditing, tabulating, bookkeeping, business machine operation, reading poor reproductions, rough layout drafting	150
Regular office work, reading good reproductions, reading or transcribing handwriting in hard pencil or on poor paper, active filling, index references, mail sorting	100
Reading or transcribing handwriting in ink or medium pencil on good quality paper, intermittent filing	70
Reading high contrast or wel-printed material, tasks and areas not involving critical or prolonged seeing such as conferring, interviewing, inactive files, and washrooms	30
Corridors, elevators escalors stairways	20
	(or not less than 1/8 level in adjacent areas)

*From Illuminating Engineering Society

4.5 MISCELLANEOUS

Measurements of temperature and relative humidity were taken throughout the print shop and surrounding areas using a sling psychrometer. The range of temperature was 72-76 degress F. The range of relative humidity (rh) determinations was 25-30 percent rh. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) recommendation for relative humidity in office buildings is 40-50 percent (summer) and 30-40 percent (winter). Figure 4.0-4 depicts the location of the measurements taken to determine temperature and relative humidity.

Housekeeping and personal hygiene by the employees appeared adequate and consistent. Employees frequently wash their hands to remove inks or use towelettes supplied by the Forest Service for this purpose. Most employees were aware of the hazards associated with chemicals they work with and the proper precautions for handling and storage. One exception to this was their use of Multigraphics Electrostatic Solution (used for TCS Systems 4 and 5) which contains ferrocyanide. Although ferrocyanides are not as toxic as

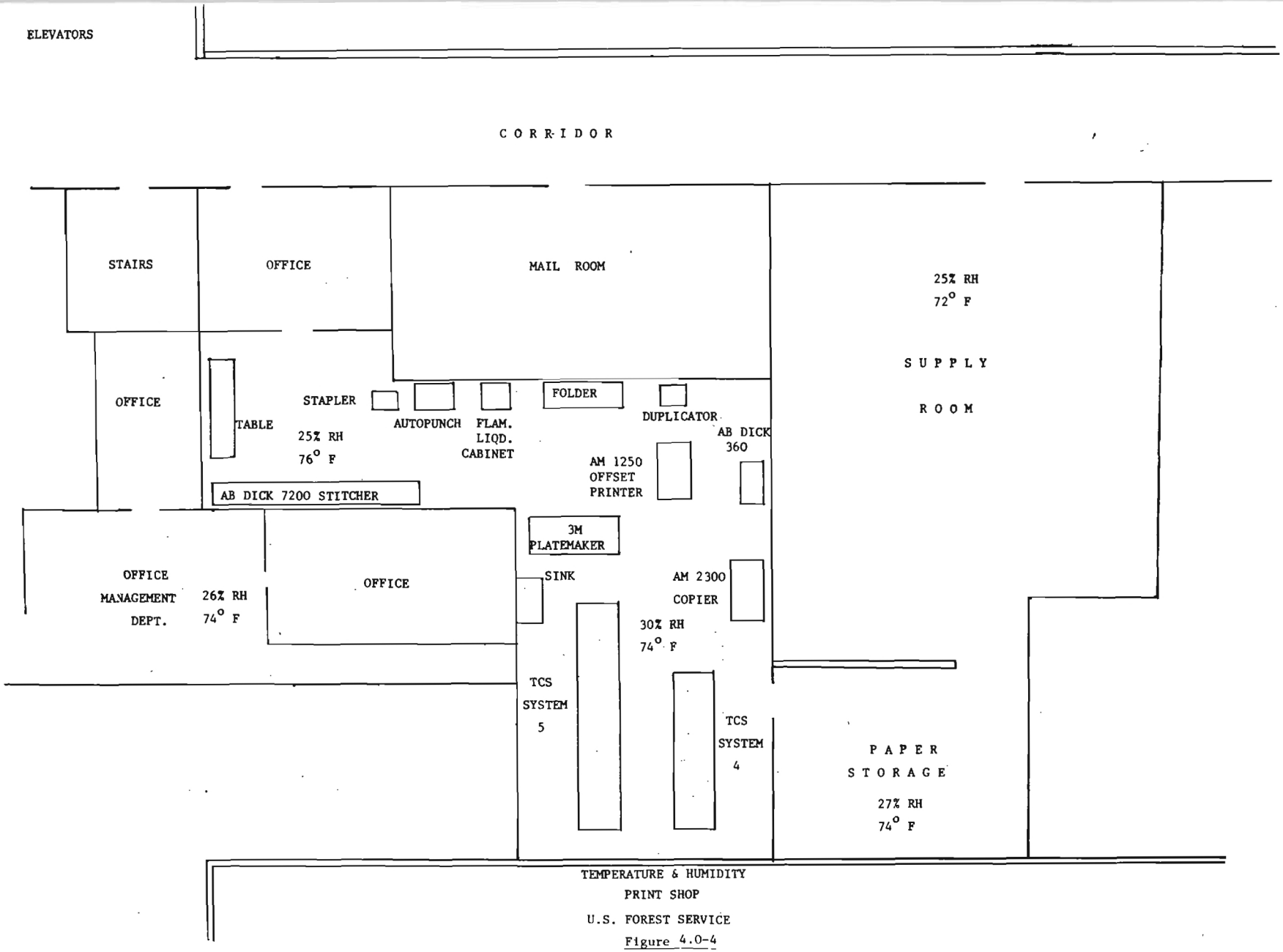

ELEVATORS
CORRIDOR
STAIRS
OFFICE
MAIL ROOM
25% RH
72° F
SUPPLY
ROOM
OFFICE
TABLE
STAPLER
AUTOPUNCH
FLAM.
LIQD.
CABINET
FOLDER
DUPLICATOR
AB DICK
360
25% RH
76° F
AM 1250
OFFSET
PRINTER
AB DICK 7200 STITCHER
3M
PLATEMAKER
OFFICE
MANAGEMENT
DEPT.
26% RH
74° F
OFFICE
SINK
AM 2300
COPIER
30% RH
74° F
TCS
SYSTEM
5
TCS
SYSTEM
4
PAPER
STORAGE
27% RH
74° F
TEMPERATURE & HUMIDITY
PRINT SHOP
U.S. FOREST SERVICE

Figure 4.0-4

simple cyanide they should be handled with caution and any skin contact kept minimal.

Waste disposal is an area of concern at this location. Waste solvents are drained into 5 gallon cans for temporary storage. These cans are taken home by an employee where they are used as an accelerator to burn domestic garbage. The waste contains chlorinted hydrocarbons including methylene chloride and perchloroethylene, along with the flammable alcohols. Upon combustion, the chlorinated hydrocarbons would permit the production of the highly toxic compound, phosgene (OSHA PEL = 0.1 ppm). Further, should ferrocyanides be present in the waste, highly toxic hydrogen cyanide gas would be produced during decomposition (OSHA PEL = 10 ppm). Waste generated at the print shop should be disposed of properly where it will not present a hazard to employees or the environment.

This report prepared by:

William M. Ewing
Industrial Hygienist

This report reviewed by:

William H. Spain, CIH
Industrial Hygienist

This report approved by:

James L. Burson, CIH, CSP
Chief, Safety and Health Division

WME:sek

APPENDIX A

RESULTS OF SAMPLING

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

Report No. A-3527

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant U. S. Forest Service
Print Shop

Materials Total Dust (TD)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TD (mg/m^3)		
10/26	PVC-285-08	Area Sample, at Control Panel of TCS System 5	0714	1453	909	459	0.09		
10/26	PVC-285-11	Area Sample, 2 feet from Auto-punch Machine	0714	1453	920	459	0.07		
10/26	PVC-285-12	Area Sample, 2 feet from AB Dick 360 Duplicator	0714	1453	923	459	1.49		

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

Report No. A-3327

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant U. S. Forest Service
Print Shop

Materials Total Hydrocarbons as n-hexane (THC),
Methylene Chloride (McCl), Perchloroethylene (Perc)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			THC (ppm*)	MeCl (ppm*)	Perc (ppm*)
10/26	31	C. Chisley, TCS System 5, Operator, Normal Operation	0653	1334	19.4	401	1.8	<3.	<0.5
10/26	33	C. Chisley, TCS System 5, Operator, Cleaning Procedure	1334	1520	5.1	106	11.6	74.	<0.5
10/26	29	G. Spearman, TCS System 4, Operator, Normal Operation	0737	1440	21.7	423	2.1	<3.	0.6
10/26	34	G. Spearman, TCS System 4, Operator, Cleaning Procedure	1440	1542	3.2	62	15.4	73.	<0.5
10/26	30	W. Denton, Operating AB Dick 360 and Other Machines	0703	1458	24.9	475	2.0	4.1	<0.5
10/26	28	Area Sample, Office Management Department, Top of Bookcase	0730	1509	26.0	459	1.1	<3.	<0.5
10/26	32	Area Sample, Supply Room, Above Sign-In Desk	0733	1508	22.1	455	0.8	<3.	<0.5

*parts per million

TABLE A-3

Georgia Institute of Technology
Engineering Experiment Station

Report No. A-3327

NOISE EXPOSURE DATA SHEET

Company U. S. Forest Service, Print Shop

Date 10/26/82

Test by William Ewing

Dosimeter Model No. Metrologger

Operating Conditions Normal

Calibrator Model No. Metroreader

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Start/Stop	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
2752	N/A	Connie Chisley TCS System 5 Operator	0654 1520	506	70	66
2751	N/A	Wayne Denton, Worked Throughout Print Shop	0702 1458	476	71	62
2888	N/A	Ray Kobaly, Print Shop Supervisor	0705 1529	504	64	63
2890	N/A	Gene Spearman TCS System 4 Operator	0737 1531	474	76	64

APPENDIX B

SAMPLING AND ANALYTICAL METHODS

NOISE

Sound pressure level measurements were taken with Type II Sound Level Meters manufactured in accordance with the American National Standards Institute (ANSI) SI.4 - 1971 "Specifications for Sound Level Meters". General area and operator station sound pressure levels were measure on the "A-weighted slow response" integrating network, which approximates the response of the normal human ear to sound, at the workers' ear level as specified in ANSI SI.13 - 1971 "Methods for the Measurement of Sound Pressure Levels".

When industrial noise is transient and variable, a reasonably accurate determination of compliance with existing standards can be made with an Audio Dosimeter which automatically time-weights and integrates the various exposure conditions. Readings from this devise are reported as a percentage of the current allowable exposure limit and have been corrected to reflect eight-hour, time-weighted averages. A representative number of sound level readings are taken while the dosimeters are being used in order to verify the dosimetry percentage readings.

The first step in the engineering control of industrial noise requires a comprehensive characterization of all major sources of noise, including an analysis of the individual sound pressure levels in the 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 using approved Octave Band Analyzers.

All noise instruments were calibrated in accordance with the manufacturers' recommendations prior to and immediately following use. Sound level meters were calibrated using the appropriate Sound Level Calibrators.

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

ORGANIC VAPORS

Samples were collected by using battery-powered, portable pumps to draw air at measured flowrates through:

1. Charcoal Sample Collection Tubes, containing 450-milligram (front) and 150-milligram (back) sections of activated charcoal, or

2. Charcoal Tubes containing 100-milligrams (front) and 50-milligram (back) sections of activated charcoal.

Immediately after sampling, the ends of tubes were sealed with polyethylene caps for transport to the laboratory, where they were refrigerated until analysis.

In the laboratory, front and back sections of each tube were desorbed separately in appropriate volumes of carbon disulfide, and aliquots of the resultant solutions injected into a gas chromatograph. Quantites of each analyte present were determined by comparison of areas under the sample chromatogram peaks with areas under chromatogram peaks for standards prepared in carbon disulfide. Analytical results, which include any necessary corrections for parallel blank and recovery determinations, were used in conjunction with sampling data (volume of air sampled) to calculate the concentrations of airborne analytes represented by each sample, expressed in parts analyte per million parts of air, by volume (ppm).

TOTAL DUST

Samples to be analyzed for total dust were collected by drawing air at measured flowrates through cassetted polyvinyl filters, using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibrium to balance room conditions.

Analytical results, which include any necessary corrections for blank determinations, were used in conjunction with the measure flowrates and sampling durations to calculate the concentrations of airborne analyte, expressed in unit of milligrams of analyte per cubic meter of air (mg/m^3).

APPENDIX C

TOXICOLOGICAL INFORMATION ON CONTAMINANTS MONITORED

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)	Duration Hours/Day
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\text{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\text{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be conducted and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m^3 of total dust containing less than 1% quartz, or 5 mg/m^3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m^3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m^3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

PERCHLOROETHYLENE

Perchloroethylene (1,1,2,2-tetrachloroethylene) is a colorless solvent with an odor like ether or chloroform. Human exposure to high concentrations of the vapor in air may result in maladies of the liver, kidneys, eyes, upper respiratory system, and the central nervous system. Skin contact with liquid perchloroethylene may result in skin burns, blistering, erythema. Skin effects due to chronic perchloroethylene exposure (in air) may result in eczema.

Symptoms of exposure to perchloroethylene vapors vary depending on the concentration. At relatively low concentrations (75-100 ppm) one may experience lightheadedness, slight eye irritation, throat irritation, and frontal headache. At higher concentrations symptoms of fatigue, vertigo, nausea, and vomiting may become apparent. Prolonged exposure to high concentrations may lead to liver dysfunction, pulmonary edema, kidney failure, neurological disorders, coma, and eventually death.

The current Occupational Safety and Health Administration Permissible Exposure Limit for perchloroethylene is 100 ppm based on a 8-hour, time-weighted average (TWA). The National Institute for Occupational Safety and Health's recommended standard is 50 ppm based on a 10-hour, TWA.