USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 020
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INDOOR AIR MONITORING PLAN
OCCUPIED BUILDING AREAS
STRATFORD ARMY ENGINE PLANT
Stratford, Connecticut

February 4, 2000

Prepared for

TACOM-SAEP
U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

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Prepared by

Foster Wheeler Environmental Corporation
Boston, MA

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Portland, Maine

Revision	Date	Prepared By	Approved By	Pages Affected
0	02/04/00	Borkland	All N. Walter	

INDOOR AIR MONITORING PLAN
OCCUPIED BUILDING AREAS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

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1.0 INTRODUCTION

This monitoring plan has been prepared to outline the requirements and methods to be used to monitor indoor air quality in Buildings B-1, B-2, B-9, B-12, and B-65 of the former Stratford Army Engine Plant. The purpose of the indoor air monitoring program is to document indoor air quality in currently occupied areas of the facility and evaluate the air quality for continued occupancy. Air quality will be compared to the limits established under the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) and previous sample results. A screening level human health risk assessment will be performed for sample results that significantly exceed previous results.

In August 1999, a soil vapor survey with on-site analysis was conducted beneath the majority of buildings at SAEP. Exceedances of CTDEP RSRs for soil vapor were observed at the facility. In September 1999 two rounds (rounds 1 and 2) of indoor air monitoring were performed in Building B-2 (HLA/FWENC, 1999). Results indicated some exceedances of CTDEP RSRs for indoor air and two additional rounds (rounds 3 and 4) of indoor air samples were collected in occupied portions of the facility. Rounds 3 and 4 indicated indoor air quality in some of the occupied areas exceeds the CTDEP RSRs for indoor air. A screening level human health risk assessment was completed for these results which indicated that for a five year exposure period, excess cancer risks did not exceed $1x10^{-5}$ of rounds 1, 2 and 3. The results of indoor air monitoring for Rounds 1 through 4 along with the screening level human health risk assessment are presented in detail in Appendix B and C.

The air monitoring described in this workplan is a continuation of the air monitoring conducted during Rounds 3 and 4 for occupied areas of the facility.

The air quality objectives of this monitoring plan are outlined below:

1. Document indoor air quality concentrations in occupied areas of the facility of target contaminants of concern for averaging periods that correspond to the CTDEP "Industrial/Commercial Target Indoor Air Concentration" standards.
2. Evaluate background air quality as measured by samples collected outside of buildings within the facility. Background samples may be collected near air intake locations for use in evaluating the potential benefit of changing air exchange rates within the buildings.
3. Document the variability of indoor air quality concentrations under different weather conditions and seasons and estimate average concentrations by over a six-month period.

2.0 MONITORING LOCATIONS AND SCHEDULE

Indoor air monitoring will be conducted at ten interior building locations and two outside background locations within the SAEP facility. Each monitoring location will be placed, where possible, according to the following criteria:

- Minimum of 35 feet from any wall or other obstruction to airflow; or,
- Minimum unrestricted airflow of at least 270 degrees around the sample inlet; and
- Sample inlet height of 5 feet above grade. This will be achieved either through placement of the monitoring canister on a platform, or extending the inlet from the monitoring canister to 5 feet through use of ¼" teflon tubing.

Indoor air sampling locations will be located as follows (see Figure 1):

Designation	Building	Location Descripton
IAB102	B-1	Second Floor
IAB103	B-1	Third Floor
IAB101	B-2	Main Entrance/Guard Area
IAB201	B-2	Boiler Room
IAML01	B-2	Meyer's Lease, second floor office
IAML02	B-2	Meyer's Lease, storage area
IAB901	B-9	
IAB1201	B-12	Maintenance Area
IAB1202	B-12	Office Area
IAB6501	B-65	Index Lease Area
IABKGD08	Background	50' North of B-12
IABKGD09	Background	Roof of B-12

[1]Background locations may be moved for each sampling event.

Monitoring will begin during the first week of February and will continue for six months. The last monthly samples will be collected in July.

3.0 MONITORING AND ANALYTICAL METHODS

All air samples will be collected and analyzed in accordance with a modified EPA TO-14 method. The TO-14 method uses gas chromatography/mass spectrometry (GC/MS) to analyze for a select series of volatile organic compounds. The monitoring and analysis procedures will follow the EPA TO-14 method, with the exception that the samples will be analyzed for the COCs, not the full TO-14 analyte list. The level of detection of the analytical method will be approximately 0.1 to 10 parts per billion (ppb) for most compounds analyzed. The target list of COCs, based on the data from the soil gas sampling program, is listed below:

Contaminants of Concern (COCs)
1,1,1-Trichloroethane
1,1-Dichloroethene
Perchloroethylene
Trichloroethylene
Vinyl Chloride

Monitoring will be conducted over an 8-hour period, approximately from 7 am to 3 pm. This period corresponds to the Industrial/Commercial Target Indoor Air Concentrations under the CTDEP regulations, and corresponds to the expected work schedule of workers that are likely to use this building space. The EPA TO-14 method uses an evacuated SUMMA©canister to draw an air sample for subsequent analysis. The use of a SUMMA© canister eliminates the need for pumps and sampling media and associated equipment calibration activities. A 6-liter SUMMA© canister will be used over the 8-hour monitoring period. The 6-liter volume has proven adequate during previous indoor air monitoring. Standard operating procedures for collecting canister samples are outlined in Appendix A.

At the conclusion of the monitoring event, the SUMMA© canisters will be removed from the monitoring location, canister pressure checked and recorded, flow controller removed and valve closed and covered to prevent contamination during shipping. The canisters will then be labeled with the monitoring location ID number, date and total monitoring time, and placed into a shipping container. Chain-of-custody forms will also be filled out and placed with the samples for shipment to the analytical laboratory. When filling out the chain-of-custody forms, the sampling technician will identify the analytes to be analyzed using the EPA TO-14 method.

Weather observations will be recorded at the start and finish of the monitoring program. These data will be used to interpret the monitoring data, as necessary. Local wind directions will be recorded based on visual observations, since winds are strongly influenced by site-specific conditions. All other meteorological data will be obtained from the closest National Weather Service (NWS) Station or from a local weather report. Meteorological data to be recorded will include: wind speed, wind direction, temperature, relative humidity, and atmospheric pressure.

Air Toxics Limited (ATL) in Folsom, California or an equivalent laboratory will be used for all sample analysis. ATL is a laboratory specializing in the analysis of toxic air samples, and is

certified through various State environmental laboratory approval programs. ATL also participates in the USEPA's Superfund Special Analytical Services (SAS) National Standards Institute (NSI) audit canister program.

Field Monitoring Data Logs will be used to record all data on sampling times and canister readings. A map will be marked up to identify the actual monitoring locations selected in the field. Distances from property boundaries, walls, beams, etc. will be recorded in order to verify locations in the future, if necessary.

4.0 QUALITY ASSURANCE/QUALITY CONTROL MEASURES

Quality assurance (QA) and quality control (QC) checks will be performed to evaluate the accuracy and precision of both the monitoring and analytical methods. The QA/QC checks will include the following standard procedures:

- batch certification of Summa canisters
- method spikes/method spike duplicates (one each per sampling event);
- field blanks (one per sampling event); and
- duplicate field samples (one per sampling event).

In order to provide a quality assurance check on the canister cleaning procedures, blanks are performed on each canister prior to shipment. The canister blank is performed by analyzing ultrapure air evacuated into the canister. Method spikes/method spike duplicates will be analyzed by the laboratory for each monitoring event. The method spike and method spike duplicate are performed by analyzing a known concentration of each COC, which is injected into a clean canister, then extracted for subsequent analysis. The method spikes measure the efficiency of recovery of the analyte during the TO-14 SUMMA© canister extraction procedure. Canister blanks and method spikes will be generated and conducted by the laboratory. They do not require additional sample collection.

A field blank will be analyzed for the sample canisters to identify potential contamination during shipping and/or handling of the samples. The field blank will be obtained by simulating monitoring through testing the canister pressure, installing and removing the flow controller, capping and sealing the canister, then packing the canister for shipment with the actual field samples. The field blank includes all sample-handling activities with the exception that air is not drawn into the canister. One field blank will be obtained for each sample event.

To test the precision of the monitoring and analytical methods, a duplicate co-located sample will be obtained at one monitoring location from either the indoor or background air samples. The results of the primary and secondary (duplicate) samples will be compared to determine the variation in the COC concentrations measured. A duplicate sample will be obtained during each monitoring event.

5.0 DATA REPORTING

5.1 Reporting Schedule

A brief letter report will be completed for each sampling round. The summary report will also include a screening level human health risk assessment. If the results of a monthly sampling event significantly exceed the currently available results, an interim screening level risk assessment will be prepared and included with the monthly letter report..

A summary report will be completed following the six rounds of sampling, summarizing all data collected, and reporting on trends in data, with recommendations for future actions.

5.2 Data Report Format

All data results will be tabulated for each monitoring location. If the COCs are detected in the outdoor ambient air samples, these concentrations will not be subtracted from the indoor air results. However, if significant concentrations are found in the ambient air that cause an exceedance of the CTDEP Industrial/Commercial Target Indoor Air Concentrations, then external air emission sources will need to be investigated. The CTDEP standards are outlined below for each of the COCs:

Chemical of Concern	Industrial/Commercial Target Indoor Air Conc. ($\mu g/m^3$)
1,1,1-Trichloroethane	1,460
1,1-Dichloroethene	0.0818
Perchloroethylene	11
Trichloroethylene	5
Vinyl Chloride	0.0487

EPA Method TO-14 provides a measurement of the COC concentrations in ppmv. Because the analytical instrumentation is calibrated at standard temperature and pressure, the laboratory results do not require any temperature and pressure correction for comparison to the CTDEP Industrial/Commercial Target Indoor Air Concentrations. However, to adjust the concentrations to obtain common units as the standards, the following equation must be used:

$$\text{Conc } (\mu g/m^3) = \text{Conc (ppmv)} \times \text{Molecular Weight} / 0.02404$$

Average and maximum concentrations will be tabulated for each COC at each monitoring location. The average indoor concentrations will be computed for comparison to the CTDEP Industrial/Commercial Target Indoor Air Concentrations. Monitoring methods will be summarized in the report and any specific conditions encountered during the monitoring event will be documented in the report to assist in evaluating the final data results. All QA/QC results will be summarized in the report with discussions on the data validity based on the QA/QC results. All field monitoring logs, chain-of-custody logs, and analytical laboratory reports will be

included in an appendix to the final data report. The final laboratory report will provide all backup equipment calibration data and gas chromatographs along with the results of the QA/QC checks.

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FIGURE 1
AIR QUALITY SAMPLING LOCATIONS
INDOOR AIR SAMPLING PLAN, OCCUPIED BOILDING AREAS
STRATFORD ARMY ENGINE PLANT
Harding Lawson Associates

Standard Operating Procedures for Monitoring with EPA Method TO-14

1.0 APPLICABILITY

This document describes the procedures to be used for the routine operation of SUMMA© passivated canisters. The canisters are used to sample ambient air for the determination of volatile organic compounds (VOCs) by EPA Method TO-14.

2.0 DOCUMENTATION REQUIRED

The following documentation should be completed by the field personnel:

AQ Form 1: Canister Sampling Data Sheet

AQ Form 2: Chain of Custody Form

3.0 EQUIPMENT REQUIRED

6 or 15L SUMMA© passivated canisters
30 PSIG Vacuum gauge
9/16" wrench or adjustable wrench
Flow controller
Flow meter (rotometer or digital flow meter) and connecting plumbing (only required if adjusting flowrate in the field)
Tripod
1/4" OD Teflon (3-5 ft)
1/4" Swagelock nuts
Packing tape

Note: for 24 hour samples, a 15 L canister may be preferred. The larger canister volume allows the use of a higher flow rate, which will maintain a more stable flow. A critical flow orifice is also recommended for 24 hour sampling, to avoid unstable flows.

4.0 SAMPLING METHOD

Method TO-14 is based on the collection of whole air samples in SUMMA© passivated stainless steel canisters. A 6 Litre (L) or 15 L canister is used that has been certified cleaned and evacuated to a pressure of -30 pounds per square inch gauge (psig) prior to sampling. During sampling, the canister collects a sample by regulating the flow rate into the canister through a stainless steel precleaned flow controller. The canister vacuum is checked periodically during sampling to maintain a flow rate that will result in a final vacuum pressure between -5 and -15 psig. The canister should never be evacuated to atmospheric pressure. Figure 1 is a diagram of a typical canister based sampling system.

4.1 Equipment Setup

The following steps should be followed when setting up the canister for sampling:

Step 1: Check the initial vacuum of the labeled canister by removing the brass cap from the canister and connecting the vacuum gauge to the canister, then opening the valve. The pressure should read -30 psi, ± 2 psi. Record the canister starting pressure in AQ Form 1. *Make sure the pressure gauge is capped off on the outlet or the canister will evacuate immediately and cannot be used.*

Step 2: Record the vacuum on the canister label and the canister sampling data sheet, AQ Form 1.

Step 3: Close the canister valve (hand tight) and remove the vacuum gauge. Do not overtighten the valve, but ensure the valve is closed. *Make sure the valve is closed before removing the gauge or the canister will evacuate immediately and cannot be used.*

Step 4: Remove the brass cap and plastic plug from the flow controller. If the flow controller has not been preset in the laboratory, it will need to be adjusted to the proper flowrate setting. The flowrate setting should be established by dividing 75% of the canister volume (maximum fill level) by the total sampling time (ltr/min).

Step 5: Connect the flow controller outlet, "LP" to the canister. Using the 9/16" wrench tighten the nut (on the flow controller) 1/4 turn beyond finger tight. Verify the tightness of the connection by attempting to rotate the flow controller. It should not be possible to rotate the controller.

Step 6: Connect the filter to the flow controller inlet ("HP"). Tighten the filter to the flow controller using the 9/16" wrench. The filter prevents dust or particulates from entering the flow controller.

Step 7: Connect the inlet of the filter to a length of teflon tubing using a 1/4" swagelock nut fitting. Fasten the tubing to a tripod or other device to ensure the inlet is located at the appropriate sampling height. For outdoor sampling, the teflon tubing should be angled downward to avoid precipitation from entering the sampling line.

Step 8: Once the sampling system is placed at the sampling location, open the canister valve to initiate sampling. Record the sample start time on AQ Form 1. If a critical flow orifice is used to control the sampling flowrate, the canister pressure does not need to be tested during the sampling period.

4.2 Equipment Teardown

After sampling is complete, perform the following procedures:

Step 1: Close the valve on the canister, remove the tripod, and remove the canister from the sample location.

Step 2: Check the final pressure of the labeled canister by removing the flow controller and filter, connecting the vacuum gauge to the canister, and opening the valve. The pressure should be between -5 and -15 psig (optimal pressure is -10 psig). Record the final vacuum on the canister label and in AQ Form 1. *Make sure the pressure gauge is capped off on the outlet or the canister will evacuate immediately and cannot be used.*

Step 3: Close the canister valve and then remove the vacuum gauge. Make sure the valve is closed or the sample will be lost. Do not overtighten the valve.

Step 4: Send the labeled canister accompanied with a chain-of-custody form (AQ Form 2) to the laboratory for analysis. Indicate on the chain-of-custody form the sample ID number, the date and time of sampling, the sampling location, the analytical method to be used, and the compounds to be analyzed for. Sign the form in the first "reliquished by" signature box.

AQ FORM 1
CANISTER SAMPLING DATA SHEET

Network:			Sampled By:			
Site Location:			Sampling Date:			
Sample ID No.	Sampling Location	Start Time	End Time	Total Sample Time	Canister Start Pressure (psig)	Canister End Pressure (psig)
Comments:						

AQ FORM 2
CHAIN OF CUSTODY FORM

Network					ANALYSES (List analytical method and compounds to be analyzed)						
Site Location											
Sampled By:											
Sample No./ Identification	Date	Time	Sampling Location	Lab Sample Number							

Relinquished by: (*Signature*)	Date	Time	Received by: (*Signature*)	Date	Time
Relinquished by: (*Signature*)	Date	Time	Received for Laboratory: (*Signature*)	Date	Time
Sample Disposal Method:			Disposed of by: (*Signature*)	Date	Time

SAMPLE COLLECTOR	ANALYTICAL LABORATORY	

Technical Memorandum: Rounds 1 through 3 Results

December 1, 1999

Mr. John Burleson
BRAC Environmental Coordinator
Stratford Army Engine Plant
550 Main Street
Stratford, CT 06615

SUBJECT: Summary of Indoor Air Quality Sample Analyses
Stratford Army Engine Plant
Stratford, Connecticut

Dear Mr. Burleson,

The purpose of this technical memorandum is to summarize results of indoor air quality monitoring conducted at the Stratford Army Engine Plant (SAEP) by Harding Lawson Associates (HLA) between September 1, 1999 and October 22, 1999. Three rounds of monitoring were conducted, the results of which are presented in the following paragraphs. In addition, a risk screening of detected indoor air contaminants is presented to further assess potential risks to workers and provide perspective as to the likelihood of potential risks.

ROUND 1 (SEPT. 2, 1999) SAMPLING AND RESULTS

In August of 1999, HLA was asked to conduct indoor air monitoring for a potential lease area inside Building 2. On September 2, 1999, the first round of indoor air monitoring was conducted inside Building 2 at locations IA-99-01 through IA-99-05 (see Figure 1). In addition, two background samples were collected at locations IABKGD01 and IABKGD02. Samples were collected over an 8-hour period from approximately 7:30AM to 3:30PM to approximate the standard work day at SAEP. Samples were analyzed by Quanterra in Santa Anna, CA for trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), vinyl chloride, tetrachloroethene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA). Weather conditions during the sampling round were clear, relative humidity between 37% and 69%, with a temperature ranging from 67 to 78 degrees Fahrenheit during the sampling period. Winds were relatively steady at 6 to 8 knots from the east and southeast. The average barometric pressure for the day was 30.02 inches of mercury (in. hg).

Analytical results indicated concentrations of TCE and 1,1-DCE exceeding Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) for commercial/industrial indoor air quality in all five sample locations, IA-99-01 through IA-99-05 (see Table 1). 1,1-DCE exceeded the CTDEP RSR by a factor of 36 times at sample location IA-99-03, and TCE exceeded the CTDEP RSR by a factor of 12 at sample location IA-99-04. Vinyl chloride concentrations exceeded the CTDEP RSR at sample locations IA-99-03 and IA-99-05. Duplicate sample results for IA-99-01 indicate good agreement for the compounds 1,1-DCE and TCE, but not for vinyl chloride (see Table 1). Review of sampling protocol and laboratory records did not disclose the source of this discrepancy for vinyl chloride concentrations.

Background samples IABKGD01 and IABKGD02 both contained TCE at concentrations exceeding the CTDEP RSR by a factor of up to 4.8. Vinyl chloride also exceeded the CTDEP RSR by a factor of 17 in sample IABKGD02.

ROUND 2 (SEPT. 21, 1999) SAMPLING AND RESULTS

Based on Round 1 analytical results, HLA was asked to conduct an additional round of indoor air monitoring at the same locations inside Building 2, IA-99-01 through IA-99-05 (see Figure 1). In addition, two background samples were collected at locations IABKGD02 and IABKGD03. Background sample location IABKGD03 was favored over location IABKGD01 to provide a better chance of upwind conditions from Building 2. Samples were collected over an 8-hour period from approximately 7:00AM to 3:00PM to approximate the standard work day at SAEP. Samples were analyzed by Quanterra in Santa Anna, CA for TCE, 1,1- DCE, vinyl chloride, PCE and 1,1,1-TCA. Weather conditions during the sampling round were overcast with rain and mist, relative humidity between 93% and 100%, with a temperature ranging from 64 to 66 degrees Fahrenheit during the sampling period. The average wind speed for the day was approximately 13 knots, from the northeast. The average barometric pressure for the day was 29.76 in. hg.

Analytical results indicated concentrations of 1,1-DCE, TCE, and vinyl chloride exceeding Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) for commercial/industrial indoor air quality in all five sample locations, IA-99-01 through IA-99-05 (see Table 2). At sample location IA-99-04, 1,1-DCE concentrations exceeded the CTDEP RSR by a factor of 32 times, TCE concentrations exceeded the CTDEP RSR by a factor of 2, and vinyl chloride concentrations exceeded the CTDEP RSR by a factor of 3.5. Duplicate sample results for IA-99-05 indicate generally good agreement (see Table 2).

Background samples IABKGD02 and IABKGD03 contained vinyl chloride, TCE, and 1,1,1-TCA, all at concentrations less than or equal to the CTDEP RSRs.

SUMMARY OF ROUND 1 AND ROUND 2 RESULTS

Round 1 and Round 2 analytical results indicate that the interior air of Building 2 contains concentrations of chlorinated volatile organic compounds (VOCs) exceeding CTDEP RSRs for Industrial/Commercial workspaces. Concentrations of TCE decreased significantly between Rounds 1 and 2 (some of the TCE detected in Round 1 samples may have originated from an aquifer pumping test occurring at the Chromium Plating Facility during this round). Following a review of these two rounds of data, the U.S. Army requested that HLA perform additional indoor air quality sampling in occupied buildings at SAEP to evaluate potential exposure of workers to indoor air contamination.

ROUND 3 (OCT. 21, 1999) SAMPLING AND RESULTS

Based on Rounds 1 and 2 analytical results, HLA was asked to conduct additional indoor air monitoring in occupied buildings to evaluate potential exposure of workers to indoor air contamination. Eleven indoor air samples were collected at various locations on October 21, 1999 during sampling Round 3. Three indoor air samples were collected in Building 1 at IA-B1-01 (first floor), IA-B1-02 (second floor), and IA-B1-03 (third floor). Two samples were collected in the leased section of Building 2 at IA-ML-01 and IA-ML-02 (both on the second floor). An additional sample was collected in the unleased section of Building 2 near the boiler plant at IA-B2-01. Two samples were collected in Building 12 at IA-B12-01 and IA-B12-02. Additional indoor air samples were also collected at IA-B9-01 (Building 9), IA-B-48-01 (Building 48), and IA-B65-01 (Building 65). Two field duplicates were collected for IA-B12-01 and IA-B65-01. Two background samples (IABKDG04 and IABKDG05) were also collected (see Figure 1).

Samples were collected over an 8-hour period from approximately 7:00AM to 3:00PM to approximate the standard work day at SAEP. Samples were analyzed by Air Toxics, Ltd. of Folsom, CA for TCE, 1,1-DCE, vinyl chloride, PCE and 1,1,1-TCA. Weather conditions during the sampling round were clear, relative humidity between 44% and 86%, with a temperature ranging from 44 to 58 degrees Fahrenheit during the sampling period. Winds were relatively steady at 6 to 10 knots from the northwest. The average barometric pressure for the day was 29.98 in. hg.

Analytical results indicated concentrations of 1,1-DCE and vinyl chloride exceeding Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) for commercial/industrial indoor air quality in a number of sample locations (see Table 3) in the following buildings:

- B-1 (outside security headquarters)
- B-2 (Meyers lease area, and near the boiler room)
- B-9
- B-12
- B-48
- B-65

VOC concentrations did not exceed CTDEP RSRs on samples from the 2nd and 3rd floors of Building 1.

Duplicate sample results for IA-B65-01 and IA-B12-01 indicate generally good agreement (see Table 2). Background samples IABKGD04 and IABKGD05 did not contain VOC concentrations exceeding the CTDEP RSRs.

RISK SCREENING OF INDOOR AIR CONTAMINANTS

To further assess potential risks to workers and provide perspective as to the likelihood of potential risks, HLA performed a preliminary risk screening associated with worst case exposures via the indoor air pathway for workers at the Stratford Army Engine Plant in Stratford, Connecticut. This worst case exposure scenario assumes that indoor workers are exposed onsite to maximum detected concentrations of VOCs throughout the workday. This preliminary risk screening is performed in accordance with the CTDEP RSRs, and is based on the risk assessment principles and guidance provided in USEPA's Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989).

To supplement this preliminary risk evaluation, indoor air concentrations were also compared to workplace exposure standards published by the American Conference of Governmental and Industrial Hygienists (ACGIH). The ACGIH publishes time-weighted average (TWA) exposure concentrations and Short-Term Exposure Limits (STELs) (ACGIH, 1998). The TWA is protective for long-term exposures (i.e., the conventional 8-hour workday) to workers. STELs represent a 15-minute TWA appropriate for evaluating short-term exposures.

Several important conclusions of this preliminary risk evaluation are identified below.

- No short-term or long-term workplace exposure standards are exceeded.
- Maximum detected concentrations of three compounds (vinyl chloride, TCE, and 1,1-DCE) exceed CTDEP industrial/commercial indoor air target levels.
- A preliminary screening level risk evaluation showed that the cumulative excess cancer risk met the CTDEP RSR criteria of $1x10^{-5}$.

- Cancer risks for three compounds calculated based on maximum concentrations exceed the CTDEP cancer risk limit for individual compounds. However, if exposures to these levels of contaminants are limited to 5 years, risk levels are not exceeded.
- Maximum concentrations likely overestimate risks.

The remainder of this memorandum is organized as follows:

- Current Site Layout
- Building Interior Data Collection and Analysis
- Exposure Assessment and Assumptions
- Exposure Points
- Exposure Point Concentrations
- Toxicity Assessment
- Risk Characterization Results and Discussion
- References

Current Site Layout

The Stratford Army Engine Plant consists of a large complex of 49 buildings as shown in Figure 1 – Air Quality Sampling Locations. Six buildings, including Building 1, 2, 9, 12, 48, and 65, are currently occupied with office workers and/or maintenance workers. The other buildings are empty. However, maintenance workers may visit these empty buildings occasionally.

Building 1 is a three-story building used as office space. Building 12 has offices and shop space and is occupied eight hours per day by office workers in the area of the building represented by location IA-B12-02 and occupied four to six hours per day by maintenance workers in the area represented by sample IA-B12-01. Building 2 is the largest building onsite and contains the former chromium plating facility. It is currently unused and is occupied at most two hours per day, primarily by maintenance workers from B-12 passing through or performing brief periods of maintenance. Building 9 is used for shop space and may be occupied approximately four hours per day by workers from B-12 for tasks such as painting. Building 48 is also used as shop space and may be occupied up to four hours per day by workers performing carpentry activities and machining. Building 65 is occupied for eight hours per day; this building is leased to a private company that performs electronics manufacturing. The area of Building 2 represented by samples IA-ML-01 and IA-ML-02 is leased by Meyers trucking company for office space and is occupied for eight hours per day.

Building Interior Data Collection and Analysis

Building 2 was selected for indoor air monitoring in 1999 as part of a potential leasing transaction for warehouse space. HLA collected indoor air samples in Building 2 at five locations (IA-99-01 through IA-99-05) during sampling Rounds 1 and 2 in September 1999. Eleven indoor air samples were collected in October 1999 during sampling Round 3 at various locations. Five indoor air background samples (IABKDG01 through IABKDG05) were collected during sampling Rounds 1 through 3, but were not factored into this worst case evaluation which focuses on exposure to maximum detected concentrations in occupied buildings. However, for further risk evaluations for the SAEP site, background data would likely be considered.

All samples were analyzed for vinyl chloride, 1,1-DCE, 1,1,1-TCA, TCE, and PCE. Analytical results for all samples are provided in Table 4. Results for the unleased portion of Building 2 (where workers are only present intermittently throughout the day) are provided separately from the results for the other plant buildings, which are occupied full-time by office and/or maintenance workers.

Exposure Assessment and Assumptions

Office and maintenance workers (including security personnel) are the only people who are present at the site frequently. Receptors may potentially be exposed to VOCs via inhalation that may migrate from soil gas to indoor air of occupied buildings. The presence of the building complex overlying the affected vadose zone soils suggests that workers could potentially be exposed to the VOCs migrating from soil and/or groundwater to soil gas if it migrates through cracks in the building foundations or building slabs to the air inside.

Two worst case scenarios have been evaluated. For Worst Case Scenario 1, it is assumed that the indoor maintenance worker is present at the unleased portion of Building 2 intermittently throughout the day (assume 2 hours/day). The remaining workday is assumed to be spent in the other portions of the facility (assume 6 hours/day). For Worst Case Scenario 2, a full-time indoor worker is assumed to spend the entire workday in portions of the facility other than the unleased portion Building 2. For the purposes of this preliminary risk screening, it is assumed that an indoor plant worker works a total of 8 hours per day, 250 days per year, for 25 years.

Exposure Points

As shown in Figure 1 – Air Quality Sampling Locations, the plant is composed of Building 2 and 48 other buildings of varying sizes. As discussed earlier, only six buildings are currently occupied. Environmental and exposure conditions likely differ between the smaller areas and the larger manufacturing areas within the building complex. However, to streamline this assessment, Building 2 will represent one exposure point and the remaining building complex will represent another exposure point.

Exposure Point Concentrations

Maximum concentrations were used as exposure point concentrations (EPCs) for the worst case scenarios. Duplicate results were averaged with primary results prior to calculating the average EPCs. The maximum may represent an overly conservative estimate of concentrations of analytes that are present in building indoor air, but will serve to represent the worst-case scenario for workers at the SAEP site. Some estimate of average concentrations would better represent the concentrations of VOCs at the exposure points, because the average indoor air concentrations would likely represent a composite of the potential contributions from each sampling location, and may help account for the fact that compound concentrations will dilute and mix with the building air. Maximum EPCs for VOCs detected in indoor air samples are provided in the risk spreadsheets (Tables 7 through 12).

Toxicity Assessment

The main source of dose-response values is the USEPA Integrated Risk Information System (IRIS), which is a data base established by USEPA containing all validated data for many substances. This database was used to identify the unit risks (URs) and reference concentrations (RfCs) used in this evaluation. The UR is defined as the upper 95% Confidence Limit of the mean incremental lifetime cancer risk estimated to result from lifetime exposure to an agent if it is in the air at a concentration of 1 ug/m3. RfCs represent air concentrations (in mg/m3) at which adverse or deleterious effects are unlikely (i.e., an air concentration corresponding to a Hazard

Index (HI) = 1.0). Non-carcinogenic risks due to inhalation exposures are estimated by comparing the environmental air concentration to the inhalation RfC.

Where no information was found in IRIS, USEPA Health Effects Assessment Summary Tables (HEAST) were consulted. When toxicity values from IRIS or HEAST were not available, alternative toxicity values available from USEPA were used. Appropriate dose-response values are provided in the risk calculation spreadsheets.

Risk Characterization Results and Discussion

Risk characterization involves the integration of the exposure and toxicity assessment into quantitative expressions of potential human health risks associated with exposure to compounds. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each compound. Quantitative estimates of cancer and non-cancer health risk were calculated by combining the quantitative intake estimates for compounds with the toxicity data.

Evaluation of Cancer Risks

To evaluate cancer risks associated with inhalation exposures, average air concentrations over a lifetime are calculated and are multiplied by inhalation toxicity values (URs). The product of these two values is an estimate of the excess lifetime cancer risk, which is defined as the excess probability that an individual will develop cancer over a lifetime due to exposure to the compound of potential concern. In accordance with Section 22a-133k-3 (c)(4)(B) of the CTDEP remediation regulations (CTDEP, 1996), the target excess lifetime cancer risk level for each compound is one in one-million (1×10^{-6}). Cancer risks for all detected compounds are summed to yield the cumulative receptor cancer risk. Each cumulative receptor cancer risk is compared to the target cumulative receptor cancer risk limit of one in one-hundred thousand (1×10^{-5}).

Evaluation of Noncancer Risks

To evaluate noncancer risks associated with inhalation exposures, average air concentrations over a specific time period are calculated and are compared to inhalation toxicity values (RfCs). The hazard quotient (HQ) is calculated for each chemical for inhalation exposure by dividing the average air concentration by the RfC. For a mixture of chemicals, a screening hazard index (HI) is estimated by summing the individual HQs for all compounds. A screening HI of less than 1 indicates that noncarcinogenic toxic effects are not expected to occur due to the exposure. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring, but the circumstances must be evaluated on a case-by-case basis. Generally, as the HI increases, so does the likelihood that adverse effects might be associated with exposure.

Results

Risks for a maintenance worker (Worst Case Scenario 1) and full-time office worker (Worst Case Scenario 2) were estimated for possible inhalation exposures to VOCs in indoor air. A summary of risk estimates associated with potential inhalation exposures over a 25-year period are provided in Table 13. As shown in Table 13, the total cancer risk for the maintenance worker under Worst Case Scenario 1 is equal to, but does not exceed, the cumulative excess lifetime cancer risk limit of 1×10^{-5} required by CTDEP. The cancer risk for the office worker (7×10^{-6}) is below the cumulative excess lifetime cancer risk limit of 1×10^{-5}. However, the cancer risk calculated for the following compounds exceed the excess lifetime cancer risk limit for individual compounds of 1×10^{-6}: vinyl chloride (Worst Case Scenarios 1 and 2), 1,1-DCE (Worst Case Scenarios 1 and 2), and TCE (Worst Case Scenario 1, Building 2 only). Total non-cancer risks for workers under both worst case scenarios are all below an HI of 1.

Assuming continuous exposure to maximum detected concentrations during the workday, the exposure duration that would be associated with cancer risks meeting regulatory limits have been calculated. For Worst Case Scenario 1, an exposure duration of up to five years yields risk estimates that meet regulatory requirements. For Worst Case Scenario 2, an exposure duration of up to seven years yields risk estimates that meet regulatory requirements. Table 14 shows excess lifetime cancer risk estimates by OHM using these modified durations. Given the conservative nature of this assessment, longer exposures are likely to meet regulatory requirements. Risks based on average air concentrations would likely indicate that longer-term exposures meet regulatory limits. Further evaluation of background conditions may indicate that one or more buildings have typical background conditions.

To supplement the worst case risk evaluation, maximum detected indoor air concentrations were compared to screening criteria. As shown in Table 6, all concentrations of VOCs detected in indoor air samples are below ACGIH TLVs.

References

California Environmental Protection Agency (CAEPA), 1994. California Environmental Protection Agency Criteria for Carcinogens. November.

CTDEP, 1996. State of Connecticut Department of Environmental Protection Remediation Standard Regulations (22a-133k-1 through 22a-133k-3).

USEPA, 1989. Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part A), Interim Final: Office of Emergency and Remedial Response, EPA/540/1-89/002.

USEPA, 1997. Health Effects Assessment Summary Tables (HEAST), Annual Update: Office of Solid Waste and Emergency Response, EPA 540/R/95/036, PB94-921199.

USEPA, 1999. Integrated Risk Information System (IRIS). On-line data base. November.

CONCLUSIONS AND RECOMMENDATIONS

- Exceedances of CTDEP RSRs for indoor air quality are widespread in buildings at SAEP.
- No short-term or long-term workplace exposure standards are exceeded.
- Maximum detected concentrations of three compounds (vinyl chloride, TCE, and 1,1-DCE) exceed CTDEP industrial/commercial indoor air target levels.
- A preliminary screening level risk evaluation showed that the cumulative excess cancer risk met the CTDEP RSR criteria of $1x10^{-5}$.
- Cancer risks for three compounds calculated based on maximum concentrations exceed the CTDEP cancer risk limit for individual compounds. However, if exposures to these levels of contaminants are limited to 5 years, risk levels are not exceeded.
- Maximum concentrations likely overestimate risks.
- Additional sampling should be performed to continue to assess indoor air contamination levels.

If you have any issues concerning the enclosed material, please contact me at (207) 775-5401.

Sincerely,

HARDING LAWSON ASSOCIATES

Nelson Walter, P.E.
Project Manager

enclosures

cc: J. Burleson (TACOM)
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R. Pendleton (HLA)
File

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
INTERMITTENT INDOOR WORKER - USING ROUND 1 & 2 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1A

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	2	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	MADEP, 1995
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	MADEP, 1995
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

MADEP, 1994 Background Documentation for the Development of the MCP Numerical Standards April
MADEP, 1995 Guidance for Disposal Site Risk Characterization, Interim Final Policy WSC/ORS-95-141 July
USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03

EQUATIONS

CANCER RISK = AVG. CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1
HAZARD QUOTIENT = AVG CONC (ug/m3)/REF. CONC. (ug/m3)

$$\text{AVG. EXPOSURE CONC} = \frac{[\text{OHM}]_{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects. AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
INTERMITTENT INDOOR WORKER - USING ROUND 1 & 2 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1A

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	2 55E+00	4 9E-02	8 40E-05	4 1E-06
1,1-Dichloroethene	2 88E+00	5 5E-02	5 00E-05	2 7E-06
Trichloroethene	5 95E+01	1 1E+00	2 00E-06	2 3E-06
Tetrachloroethene	7 50E+00	1 4E-01	4 80E-07	6 9E-08
			SUMMARY CANCER RISK	9E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
INTERMITTENT INDOOR WORKER - USING ROUND 1 & 2 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1A

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	2 55E+00	1 5E-01	ND	
1,1-Dichloroethene	2 88E+00	1 6E-01	ND	
1,1,1-Trichloroethane	1 37E+01	7 8E-01	1 00E+03	7 8E-04
Trichloroethene	5 95E+01	3 4E+00	ND	
Tetrachloroethene	7 50E+00	4 3E-01	4 90E+02	8 7E-04
		SUMMARY HAZARD INDEX		2E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
INTERMITTENT INDOOR WORKER - USING ROUND 1 & 2 AVERAGE CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1B

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	2	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	MADEP, 1995
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	MADEP, 1995
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

MADEP, 1994. Background Documentation for the Development of the MCP Numerical Standards April
MADEP, 1995 Guidance for Disposal Site Risk Characterization, Interim Final Policy WSC/ORS-95-141 July
USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors." OSWER Directive 9285 6-03

EQUATIONS

CANCER RISK = AVG. CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1
HAZARD QUOTIENT = AVG.CONC.(ug/m3)/REF. CONC. (ug/m3)

$$\text{AVG. EXPOSURE CONC} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
INTERMITTENT INDOOR WORKER - USING ROUND 1 & 2 AVERAGE CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1B

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m3)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	2 14E-01	4 1E-03	8 40E-05	3 4E-07
1,1-Dichloroethene	1 19E+00	2 3E-02	5 00E-05	1 1E-06
Trichloroethene	2 95E+01	5 6E-01	2 00E-06	1 1E-06
Tetrachloroethene	2 99E+00	5 7E-02	4 80E-07	2 7E-08
		SUMMARY CANCER RISK		3E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
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STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 1B

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	2 14E-01	1 2E-02	ND	
1,1-Dichloroethene	1 19E+00	6 8E-02	ND	
1,1,1-Trichloroethane	8 97E+00	5 1E-01	1 00E+03	5 1E-04
Trichloroethene	2 95E+01	1 7E+00	ND	
Tetrachloroethene	2 99E+00	1 7E-01	4 90E102	3 5E-04
		SUMMARY HAZARD INDEX		9E-04

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2A

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	MADEP, 1995
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	MADEP, 1995
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

MADEP, 1994 Background Documentation for the Development of the MCP Numerical Standards April
MADEP, 1995 Guidance for Disposal Site Risk Characterization, Interim Final Policy WSC/ORS-95-141 July
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03.

EQUATIONS

CANCER RISK = AVG. CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1
HAZARD QUOTIENT = AVG CONC.(ug/m3)/REF. CONC (ug/m3)

$$\text{AVG EXPOSURE CONC} = \frac{[OHM]air * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2A

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	5 67E-01	4 3E-02	8 40E-05	3 6E-06
1,1-Dichloroethene	8 39E-01	6 4E-02	5 00E-05	3 2E-06
Trichloroethene	1 41E+00	1 1E-01	2 00E-06	2 1E-07
Tetrachloroethene	3 82E+00	2.9E-01	4 80E-07	1 4E-07
		SUMMARY CANCER RISK		7E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2A

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m3)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	5 67E-01	1 3E-01	ND	
1,1-Dichloroethene	8 39E-01	1 9E-01	ND	
1,1,1-Trichloroethane	6 59E+00	1 5E+00	1 00E+03	1 5E-03
Trichloroethene	1 41E+00	3 2E-01	ND	
Tetrachloroethene	3 82E+00	8 7E-01	4 90E+02	1 8E-03
		SUMMARY HAZARD INDEX		3E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 AVERAGE CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2B

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	MADEP, 1995
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	MADEP, 1995
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

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USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03

EQUATIONS

CANCER RISK = AVG CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1
HAZARD QUOTIENT = AVG CONC (ug/m3)/REF CONC. (ug/m3)

$$\text{AVG. EXPOSURE CONC} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 AVERAGE CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2B

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	9 54E-02	7 3E-03	8 40E-05	6 1E-07
1,1-Dichloroethene	2 28E-01	1 7E-02	5 00E-05	8 7E-07
Trichloroethene	6 71E-01	5 1E-02	2 00E-06	1 0E-07
Tetrachloroethene	9 07E-01	6 9E-02	4 80E-07	3 3E-08
			SUMMARY CANCER RISK	2E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR
FULL-TIME INDOOR WORKER - USING ROUND 3 AVERAGE CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 2B

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	9 54E-02	2.2E-02	ND	
1,1-Dichloroethene	2 28E-01	5 2E-02	ND	
1,1,1-Trichloroethane	2 23E+00	5 1E-01	1 00E+03	5 1E-04
Trichloroethene	6 71E-01	1 5E-01	ND	
Tetrachloroethene	9 07E-01	2 1E-01	4 90E+02	4 2E-04
		SUMMARY HAZARD INDEX		9E-04

TABLE 4

INDOOR AIR ANALYTICAL RESULTS

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Data from B-1, the leased area of B-2, B-9, B-12, B-48, and B-65

SITE ID:	IA-B1-01	IA-B1-02	1A-B1-03	IA-ML-01	IA-ML-02	IA-B12-01	IA-B12-01D	IA-B12-01risk	IA-B12-02	IA-B9-01
SAMPLE ID:	419	23988	10790	94945	20947	9549	12333	12333	13847	12952
DATE SAMPLED:	10/21/99	10/21/99	10/21/99	10/21/99	10/21/99	10/21/99	10/21/99 Duplicate Sample	10/21/99	10/21/99	10/21/99
Compound	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.022	0.020 U	0.020 U	0.032	0.020 U	0.041	0.020	0.031	0.020 U	0.022
1,1-Dichloroethene	0.027	0.020 U	0.020 U	0.020 U	0.020 U	0.210	0.077	0.144	0.140	0.023
1,1,1-Trichloroethane	0.510	0.140	0.110	0.350	0.340	0.540	0.460	0.500	0.420	0.480
Trichloroethene	0.260	0.055	0.043	0.180	0.180	0.095	0.120	0.108	0.065	0.180
Tetrachloroethene	0.089	0.081	0.055	0.082	0.097	0.096	0.110	0.103	0.120	0.560

Data from B-2 (not including the leased area at the SE corner of the building)

SITE ID:	IA-99-01	IA-99-01	IA-99-01RISK	IA-99-02	IA-99-03	IA-99-04	IA-99-05	IA-99-01	IA-99-02	IA-99-03
SAMPLE ID:	GL0054	0090	GL0054	92062	802	0071	93208	GL0054	92062	802
DATE SAMPLED:	9/2/99	9/2/99 DUPLICATE	9/2/99	9/2/99	9/2/99	9/2/99	9/2/99	9/22/99	9/22/99	9/22/99
Compound	**ppbv**	**ppbv**		**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.016	0.99	0.50	0.024 U	0.025	0.025 U	0.036	0.043	0.023	0.048
1,1-Dichloroethene	0.18	0.23	0.21	0.15	0.72	0.18	0.14	0.32	0.24	0.29
1,1,1-Trichloroethane	0.25	1.0	0.63	1.1	1.8	1.1	1.0	2.10	1.8	2.1
Trichloroethene	7.8	8.1	7.95	8.2	8.2	11.0	10.0	1.8	1.7	1.8
Tetrachloroethene	0.25	0 31	0.28	0.031 U	0.91	1.10	0.46 U	0.33	0.22	0.36

TABLE 4

INDOOR AIR ANALYTICAL RESULTS

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Data from B-1, the leased area of B-2, B-9, B-12, B-48, and B-65

SITE ID:	IA-B48-01	IA-B65-01	IA-B65-01D	Maximum
SAMPLE ID:	12703	12954	12954	Concentration
DATE SAMPLED:	10/21/99	10/21/99	10/21/99 Duplicate Sample	
Compound	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.033	0.210	0.22	**0.22**
1,1-Dichloroethene	0.020 U	0.038	0.039	**0.21**
1,1,1-Trichloroethane	1.200	0.190	0.19	**1.2**
Trichloroethene	0.100	0.110	0.11	**0.26**
Tetrachloroethene	0.160	0.047	0.046	**0.56**

Data from B-2 (not including the leased area at the SE corner of the building)

SITE ID:	IA-99-04	IA-99-05	IA-99-05	IA-B2-01	Maximum
SAMPLE ID:	0071	93208	0090	25246	Concentration
DATE SAMPLED:	9/22/99	9/22/99	9/22/99 Duplicate Sample	10/21/99	
Compound	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.063	0.063	0.066	0.010	**0.99**
1,1-Dichloroethene	0.30	0.26	0.63	0.210	**0.72**
1,1,1-Trichloroethane	2.5	2.0	2.4	0.240	**2.5**
Trichloroethene	2.0	1.7	2.0	0.078	**11**
Tetrachloroethene	0.41	0.35	0.43	0.065	**1.1**

TABLE 5
INDOOR AIR DATA CONVERSION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Chemical of Concern	MAXIMUM OHM CONCENTRATION FROM B-2 (LEASED), B-9, B-12, B-48, AND B-65 (ppbv)	Mol. Formula	Mol. Wt.	CONVERTED OHM CONCENTRATION (ug/m^3)
Vinyl Chloride	0.22	C_2ClH_3	62	0.57
1,1-Dichloroethene	0.21	$C_2Cl_2H_2$	96	0.84
1,1,1-Trichloroethane	1.2	$C_2Cl_3H_3$	132	6.6
Trichloroethylene	0.26	C_2Cl_3H	130	1.4
Tetrachloroethylene	0.56	C_2Cl_4	164	3.8

Chemical of Concern	MAXIMUM OHM CONCENTRATION FROM B-2 (UNLEASED) (ppbv)	Mol. Formula	Mol. Wt.	CONVERTED OHM CONCENTRATION (ug/m^3)
Vinyl Chloride	0.99	C_2ClH_3	62	2.6
1,1-Dichloroethene	0.72	$C_2Cl_2H_2$	96	2.9
1,1,1-Trichloroethane	2.5	$C_2Cl_3H_3$	132	14
Trichloroethylene	11	C_2Cl_3H	130	59
Tetrachloroethylene	1.1	C_2Cl_4	164	7.5

Conversion of ppbv to ug/m^3:

Conc (ug/m^3) = Conc (ppbv) / 1000 x Mol. Wt./ 0.02404

TABLE 6
COMPARISON OF MAXIMUM INDOOR AIR CONCENTRATIONS TO STANDARDS

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Data from Building B-2 (Unleased) - Used in the Assessment of Short-Term Exposures at B-2 for Maintenance Workers

OHM	Max Indoor Air Concentration (mg/m^3)	Industrial/Commercial Target Indoor Air Conc. (mg/m^3)*	Indoor Air Concentrations Exceeds Target?	TLV-STEL (mg/m^3)**	Indoor Air Concentrations Exceeds TLV?
Vinyl chloride	2.55E-03	4.87E-05	Yes	NA	NA
1,1-Dichloroethene	2.88E-03	8.18E-05	Yes	79	No
1,1,1-Trichloroethane	1.37E-02	1.46E+00	No	2429	No
Trichloroethene	5.95E-02	5.00E-03	Yes	532	No
Tetrachloroethene	7.50E-03	1.10E-02	No	671	No

Data from Buildings B-1, the leased area of B-2, B-9, B-12, B-48, and B-65 - Used in the Assessment of Longer -Term Exposures for Maintenance Workers and Office Workers

OHM	Max Indoor Air Concentration (mg/m^3)	Industrial/Commercial Target Indoor Air Conc. (mg/m^3)*	Indoor Air Concentrations Exceeds Target?	TLV-TWA (mg/m^3)**	Indoor Air Concentrations Exceeds TLV?
Vinyl chloride	5.67E-04	4.87E-05	Yes	13	No
1,1-Dichloroethene	8.39E-04	8.18E-05	Yes	20	No
1,1,1-Trichloroethane	6.59E-03	1.46E+00	No	1890	No
Trichloroethene	1.41E-03	5.00E-03	No	266	No
Tetrachloroethene	3.82E-03	1.10E-02	No	168	No

Notes:

TLV in mg/m^3 = (TLV in ppm) * (gram MW) / 24.45

* Obtained from CTDEP, 1996. *State of Connecticut Department of Environmental Protection Remediation Standard Regulations* (22a-133k-1 through 22a-133k-3).

** Obtained from ACGIH, 1998. *Threshold Limit Values for Chemical Substances and Physical Agents.* Based on "adopted values" and not "intended changes."

TLV - threshold limit value

TWA - time-weighted average; appropriate for conventional 8-hr workday.

STEL - short-term exposure limit; appropriate for short-term exposures (15-minute TWA). Only short-term exposures are likely to occur in Building B-2.

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 7

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	2	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors. EPA/600/P-95/002Fa

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC. (ug/m3) * CANCER UNIT RISK (ug/m3)^-1

HAZARD QUOTIENT = AVG CONC.(ug/m3)/REF CONC. (ug/m3)

$$\text{AVG EXPOSURE CONC.} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects: AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 7

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	2 55E+00	4 9E-02	8 40E-05	4 1E-06
1,1-Dichloroethene	2 88E+00	5 5E-02	5 00E-05	2 7E-06
Trichloroethene	5 95E+01	1 1E+00	2 00E-06	2 3E-06
Tetrachloroethene	7 50E+00	1 4E-01	4 80E-07	6 9E-08
		SUMMARY CANCER RISK		9E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 7

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC (1) (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	2 55E+00	1 5E-01	ND	
1,1-Dichloroethene	2 88E+00	1 6E-01	ND	
1,1,1-Trichloroethane	1 37E+01	7 8E-01	1 00E+03	7 8E-04
Trichloroethene	5 95E+01	3 4E+00	ND	
Tetrachloroethene	7 50E+00	4 3E-01	4 90E+02	8 7E-04
		SUMMARY HAZARD INDEX		2E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 8

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	6	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors EPA/600/P-95/002Fa

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance. "Standard Default Exposure Factors " OSWER Directive 9285 6-03

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1

HAZARD QUOTIENT = AVG CONC (ug/m3)/REF CONC (ug/m3)

$$\text{AVG EXPOSURE CONC} = \frac{[\text{OHM}]air * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects: AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 8

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	5 67E-01	3 2E-02	8 40E-05	2 7E-06
1,1-Dichloroethene	8 39E-01	4 8E-02	5 00E-05	2 4E-06
Trichloroethene	1.41E+00	8 0E-02	2 00E-06	1 6E-07
Tetrachloroethene	3 82E+00	2 2E-01	4 80E-07	1 0E-07
		SUMMARY CANCER RISK		5E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 1
MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 8

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	5.67E-01	9 7E-02	ND	
1,1-Dichloroethene	8 39E-01	1 4E-01	ND	
1,1,1-Trichloroethane	6 59E+00	1 1E+00	1 00E+03	1 1E-03
Trichloroethene	1.41E+00	2.4E-01	ND	
Tetrachloroethene	3 82E+00	6 5E-01	4 90E+02	1 3E-03
		SUMMARY HAZARD INDEX		2E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 2
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 9

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	25	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	25	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors EPA/600/P-95/002Fa

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03.

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC. (ug/m3) * CANCER UNIT RISK (ug/m3)^-1
HAZARD QUOTIENT = AVG.CONC.(ug/m3)/REF CONC. (ug/m3)

$$\text{AVG EXPOSURE CONC} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects. AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 2
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 9

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	5 67E-01	4 3E-02	8 40E-05	3 6E-06
1,1-Dichloroethene	8 39E-01	6 4E-02	5 00E-05	3 2E-06
Trichloroethene	1 41E+00	1 1E-01	2 00E-06	2 1E-07
Tetrachloroethene	3 82E+00	2 9E-01	4 80E-07	1 4E-07
			SUMMARY CANCER RISK	7E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - WORST CASE SCENARIO 2
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 9

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC (1) (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	5 67E-01	1 3E-01	ND	
1,1-Dichloroethene	8 39E-01	1 9E-01	ND	
1,1,1-Trichloroethane	6 59E+00	1 5E+00	1 00E+03	1 5E-03
Trichloroethene	1 41E+00	3 2E-01	ND	
Tetrachloroethene	3 82E+00	8 7E-01	4 90E+02	1 8E-03
		SUMMARY HAZARD INDEX		3E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 10

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	2	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	5	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	5	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors EPA/600/P-95/002Fa.

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC. (ug/m3) * CANCER UNIT RISK (ug/m3)^-1

HAZARD QUOTIENT = AVG CONC (ug/m3)/REF CONC. (ug/m3)

$$\text{AVG EXPOSURE CONC.} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects· AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 10

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	2.55E+00	9 7E-03	8 40E-05	8 2E-07
1,1-Dichloroethene	2 88E+00	1 1E-02	5 00E-05	5 5E-07
Trichloroethene	5.95E+01	2 3E-01	2 00E-06	4 5E-07
Tetrachloroethene	7 50E+00	2 9E-02	4 80E-07	1 4E-08
			SUMMARY CANCER RISK	2E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
MAINTENANCE WORKER VISITING BUILDING 2 - USING B-2 (UNLEASED) MAXIMUM CONCENTRATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 10

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	2 55E+00	1 5E-01	ND	
1,1-Dichloroethene	2 88E+00	1 6E-01	ND	
1,1,1-Trichloroethane	1 37E+01	7 8E-01	1 00E+03	7 8E-04
Trichloroethene	5 95E+01	3 4E+00	ND	
Tetrachloroethene	7 50E+00	4 3E-01	4 90E+02	8 7E-04
		SUMMARY HAZARD INDEX		2E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 11

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	6	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	5	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	5	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors EPA/600/P-95/002Fa

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors " OSWER Directive 9285 6-03

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC (ug/m3) * CANCER UNIT RISK (ug/m3)^-1

HAZARD QUOTIENT = AVG CONC.(ug/m3)/REF. CONC. (ug/m3)

$$\text{AVG. EXPOSURE CONC.} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 11

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	5 67E-01	6 5E-03	8 40E-05	5 4E-07
1,1-Dichloroethene	8 39E-01	9 6E-03	5 00E-05	4 8E-07
Trichloroethene	1 41E+00	1.6E-02	2 00E-06	3 2E-08
Tetrachloroethene	3 82E+00	4 4E-02	4 80E-07	2 1E-08
			SUMMARY CANCER RISK	1E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM MAINTENANCE WORKER IN OTHER BUILDINGS - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED), B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 11

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC (1) (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	5.67E-01	9 7E-02	ND	
1,1-Dichloroethene	8 39E-01	1 4E-01	ND	
1,1,1-Trichloroethane	6 59E+00	1.1E+00	1 00E+03	1 1E-03
Trichloroethene	1 41E+00	2 4E-01	ND	
Tetrachloroethene	3 82E+00	6 5E-01	4 90E+02	1 3E-03
		SUMMARY HAZARD INDEX		2E-03

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 12

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION IN AIR	[OHM]air	Calculated	ug/m^3	
CONVERSION FACTOR 1	CF1	24	hours/day	
EXPOSURE TIME DAILY	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption [a]
EXPOSURE DURATION	ED	7	years	USEPA, 1991
CONVERSION FACTOR 2	CF2	365	days/year	
AVERAGING TIME CANCER	AT	75	years	USEPA, 1997
AVERAGING TIME NONCANCER	AT	7	years	USEPA, 1991

USEPA, 1997 Exposure Factors Handbook, Volume I, General Factors EPA/600/P-95/002Fa

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors " OSWER Directive 9285 6-03

[a] 5 days per week for 50 weeks (assuming 2 weeks vacation)

EQUATIONS

CANCER RISK = AVG CONC. (ug/m3) * CANCER UNIT RISK (ug/m3)^-1

HAZARD QUOTIENT = AVG.CONC (ug/m3)/REF CONC (ug/m3)

$$\text{AVG EXPOSURE CONC} = \frac{[\text{OHM}]\text{air} * EF * ET * ED}{AT * CF1 * CF2}$$

*For noncarcinogenic effects. AT = ED

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 12

CARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m3)	INHALATION CANCER UNIT RISK (ug/m3)^-1	CANCER RISK
Vinyl chloride	5 67E-01	1 2E-02	8 40E-05	1 0E-06
1,1-Dichloroethene	8 39E-01	1 8E-02	5 00E-05	8 9E-07
Trichloroethene	1 41E+00	3 0E-02	2 00E-06	6 0E-08
Tetrachloroethene	3 82E+00	8 1E-02	4 80E-07	3 9E-08
		SUMMARY CANCER RISK		2E-06

INHALATION EXPOSURE TO VOLATILE OHM IN INDOOR AIR - USING ED THAT RESULTS IN ACCEPTABLE RISKS FOR EACH OHM
FULL-TIME INDOOR WORKER - USING MAXIMUM CONCENTRATIONS FROM B-1, B-2 (LEASED) B-9, B-12, B-48, AND B-65
STRATFORD ARMY ENGINE PLANT
STRATFORD, CT
TABLE 12

NONCARCINOGENIC EFFECTS

COMPOUND	OHM AIR CONCENTRATION (ug/m³)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m3)	CHRONIC INHALATION RfC [1] (ug/m3)	HAZARD QUOTIENT
Vinyl chloride	5 67E-01	1.3E-01	ND	
1,1-Dichloroethene	8 39E-01	1 9E-01	ND	
1,1,1-Trichloroethane	6 59E+00	1 5E+00	1 00E+03	1 5E-03
Trichloroethene	1 41E+00	3 2E-01	ND	
Tetrachloroethene	3 82E+00	8 7E-01	4 90E102	1 8E-03
		SUMMARY HAZARD INDEX		3E-03

TABLE 13
SUMMARY OF CANCER AND NON-CANCER RISKS FOR THE INDOOR WORKER

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Exposure Scenario	Exposure Point	Receptor	Exposure Route	ELCR	HI
Worst-Case Scenario 1 [a]	Data from B-2 (Unleased)	Maintenance Worker	Vapor inhalation	9 E-06	0 002
	Data from B-1, B-2 (Leased), B-9, B-12, B-48, and B65	Maintenance Worker	Vapor inhalation	5.E-06	0 002
			Total Risk for Receptor	**1.E-05**	**0.004**
Worst-Case Scenario 2 [a]	Data from B-1, B-2 (Leased), B-9, B-12, B-48, and B65	Full-Time Indoor Worker	Vapor inhalation	7.E-06	0.003
			Total Risk for Receptor	**7.E-06**	**0.003**

Notes:
ELCR = Excess Lifetime Cancer Risk
HI = Hazard Index
[a] Maximum concentrations used as exposure point concentrations for estimating risks For Scenario 1, it is assumed that a maintenance worker may be present at Building B-2 (unleased) intermittently throughout the day (assume 2 hours/day). The remaining workday is assumed to be spent in the other portions of the facility (assume 6 hours/day) For Scenario 2, a full-time indoor worker is assumed to spend the entire workday in portions of the facility other than Building B-2 (unleased)

TABLE 14
EXPOSURE DURATIONS THAT CORRESPOND TO ACCEPTABLE CANCER RISK LEVELS BY OHM

STRATFORD ARMY ENGINE PLANT
STRATFORD, CT

Exposure Scenario	Exposure Point	OHM	ELCR
Worst Case Scenario 1 [a]	Data from B-2 (Unleased)	Vinyl chloride	8 E-07
"Acceptable Duration" - 5 years		1,1-Dichloroethene	5.E-07
		Trichloroethene	5.E-07
		Tetrachloroethene	1.E-08
	Data from B-1, B-2 (Leased), B-9, B-12, B-48, and B65	Vinyl chloride	5.E-07
		1,1-Dichloroethene	5.E-07
		Trichloroethene	3.E-08
		Tetrachloroethene	2.E-08
	Total OHM Risk	**Vinyl chloride**	**1.E-06**
		1,1-Dichloroethene	**1.E-06**
		Trichloroethene	**5.E-07**
		Tetrachloroethene	**3.E-08**
Worst Case Scenario 2 [a]	Data from B-1, B-2 (Leased), B-9, B-12, B-48, and B65	Vinyl chloride	1.E-06
"Acceptable Duration" - 7 years		1,1-Dichloroethene	9.E-07
		Trichloroethene	6 E-08
		Tetrachloroethene	4.E-08

Notes:
ELCR = Excess Lifetime Cancer Risk
HI = Hazard Index
[a] Maximum concentrations used as exposure point concentrations for estimating risks For Scenario 1, it is assumed that workers may be present at Building B-2 intermittently throughout the day (assume 2 hours/day). The remaining workday is assumed to be spent in the other portions of the facility (assume 6 hours/day)
For Scenario 2, the worker is assumed to spend the entire workday in portions of the facility other than Building B-2

Rounds 1 through 4 Air Data

ROUND 1
INDOOR AIR QUALITY SAMPLING ANALYTICAL RESULTS
STRATFORD ARMY ENGINE PLANT

SITE ID:		IA-99-01	IA-99-01	IA-99-02	IA-99-03	IA-99-04	IA-99-05
SAMPLE ID:		GL0054	0090	92062	802	0071	93208
DATE SAMPLED:		9/2/99	9/2/99 DUPLICATE	9/2/99	9/2/99	9/2/99	9/2/99
Compound	RSR*	ppbv	ppbv	ppbv	ppbv	ppbv	ppbv
Vinyl chloride	0.019	0.016	0.99	0.024 U	0.025	0.025 U	0.036
1,1-Dichloroethen	0.02	0.18	0.23	0.15	0.72	0.18	0.14
1,1,1-Trichloroeth	266	0.25	1.0	1.1	1.8	1.1	1.0
Trichloroethene	0.92	7.8	8.1	8.2	8.2	11.0	10.0
Tetrachloroethene	1.61	0.25	0.31	0.31 U	0.91	1.10	0.46 U

SITE ID:		IABKGD01	IABKGD02
SAMPLE ID:		9707-B	12442
DATE SAMPLED:		9/2/99	9/2/99
Compound	RSR*	ppbv	ppbv
Vinyl chloride	0.019	0.15 U	0.33
1,1-Dichloroethen	0.02	0.19 U	0.17 U
1,1,1-Trichloroeth	266	2.1 U	1.9 U
Trichloroethene	0.92	4.3	4.4
Tetrachloroethene	1.61	1.90 U	1.70 U

Shaded values indicate exceedance of RSR

RSR = CTDEP Remediation Standard Regulation (RSR) for Industrial/Commercial

U - Not Detected at a concentration above the detection limit

ROUND 2
INDOOR AIR QUALITY SAMPLING ANALYTICAL RESULTS
STRATFORD ARMY ENGINE PLANT

SITE ID:		IA-99-01	IA-99-02	IA-99-03	IA-99-04	IA-99-05	IA-99-05
SAMPLE ID:		GL0054	92062	802	0071	93208	0090
DATE SAMPLED:		9/21/99	9/21/99	9/21/99	9/21/99	9/21/99	9/21/99
							DUPLICATE
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.043	0.023	0.048	0.063	0.063	0.066
1,1-Dichloroethen	0.02	0.32	0.24	0.29	0.30	0.26	0.63
1,1,1-Trichloroeth	266	2.10	1.8	2.1	2.5	2.0	2.4
Trichloroethene	0.92	1.8	1.7	1.8	2.0	1.7	2.0
Tetrachloroethene	1.61	0.33	0.22	0.36	0.41	0.35	0.43

SITE ID:		IABKGD03	IABKGD02
SAMPLE ID:		9707-B	12442
DATE SAMPLED:		9/21/99	9/21/99
Compound	**RSR***	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.018	0.019
1,1-Dichloroethen	0.02	0.01 U	0.01 U
1,1,1-Trichloroeth	266	0.14	0.27
Trichloroethene	0.92	0.29	0.34
Tetrachloroethene	1.61	0.33	0.38 U

Shaded values indicate exceedance of RSR

RSR = CTDEP Remediation Standard Regulation (RSR) for Industrial/Commercial

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ROUND 3
INDOOR AIR QUALITY SAMPLING ANALYTICAL RESULTS
STRATFORD ARMY ENGINE PLANT

SITE ID:		IA-B1-01	IA-B1-02	1A-B1-03	IA-ML-01	IA-ML-02	IA-B2-01
SAMPLE ID:		419	23988	10790	94945	20947	25246
DATE SAMPLED:		10/21/99	10/21/99	10/21/99	10/21/99	10/21/99	10/21/99
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.022	0.020 U	0.020 U	0.032	0.019 U	0.020 U
1,1-Dichloroethen	0.02	0.027	0.020 U	0.020 U	0.019 U	0.019 U	0.210
1,1,1-Trichloroeth	266	0.510	0.140	0.110	0.350	0.340	0.240
Trichloroethene	0.92	0.260	0.055	0.043	0.180	0.180	0.078
Tetrachloroethene	1.61	0.089	0.081	0.055	0.082	0.097	0.065

SITE ID:		IA-B12-01	IA-B12-01D	IA-B12-02	IA-B9-01	IA-B48-01	IA-B65-01
SAMPLE ID:		9549	12333	13847	12952	12703	12954
DATE SAMPLED:		10/21/99	10/21/99 Duplicate Sample	10/21/99	10/21/99	10/21/99	10/21/99
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.041	0.020	0.019 U	0.022	0.033	0.210
1,1-Dichloroethen	0.02	0.210	0.077	0.140	0.023	0.019 U	0.038
1,1,1-Trichloroeth	266	0.540	0.460	0.420	0.480	1.200	0.190
Trichloroethene	0.92	0.095	0.120	0.065	0.180	0.100	0.110
Tetrachloroethene	1.61	0.096	0.110	0.120	0.560	0.160	0.047

SITE ID:		IA-B65-01D	IA-BKGD-04	IA-BKGD-05	IA-BTB-03
SAMPLE ID:		12954	30842	1054	9936
DATE SAMPLED:		10/21/99 Duplicate Sample	10/21/99	10/21/99	10/21/99 Trip Blank
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.22	0.018 U	0.019 U	0.010 U
1,1-Dichloroethen	0.02	0.039	0.018 U	0.019 U	0.010 U
1,1,1-Trichloroeth	266	0.19	0.092 U	0.019 U	0.050 U
Trichloroethene	0.92	0.11	0.037 U	0.042	0.020 U
Tetrachloroethene	1.61	0.046	0.084	0.063	0.020 U

Shaded values indicate exceedance of RSR

RSR = CTDEP Remediation Standard Regulation (RSR) for Industrial/Commercial

U - Not Detected at a concentration above the detection limit

ROUND 4
INDOOR AIR QUALITY SAMPLING ANALYTICAL RESULTS
STRATFORD ARMY ENGINE PLANT

SITE ID:		IA-ML-01	IA-ML-02	IA-B1-01	IA-B1-02	IA-B1-03	IA-B9-01
SAMPLE ID:		9912135A-04A	9912135A-05A	9912135B-01A	9912135B-02A	9912135B-03A	9912135B-06A
DATE SAMPLED:		12/7/99	12/7/99	12/7/99	12/7/99	12/7/99	12/7/99
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.021 U	0.021 U	0.020 U	0.020 U	0.020 U	0.021 U
1,1-Dichloroethene	0.02	0.021 U	0.021 U	0.020 U	0.020 U	0.020 U	0.021 U
1,1,1-Trichloroethane	266	0.200	0.120	0.180	0.140	0.150	0.530
Trichloroethene	0.92	0.200	0.085	0.047	0.075	0.120	0.042 U
Tetrachloroethene	1.61	0.140	0.049	0.072	0.063	0.110	0.380

SITE ID:		IA-B65-01	IA-B12-01	IA-B12-01D	IA-B12-02	IA-B2-01	IA-BKGD-06
SAMPLE ID:		9912135B-07A	9912135B-08A	9912135A-05A	9912135B-10A	9912135B-11A	9912135B-12A
DATE SAMPLED:		12/7/99	12/7/99	12/7/99 Duplicate Sample	12/7/99	12/7/99	12/7/99
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	**0.130**	0.020 U	0.021 U	**0.023**	0.021 U	0.019 U
1,1-Dichloroethene	0.02	**0.076**	**0.370**	**0.380**	**0.320**	**0.086**	0.019 U
1,1,1-Trichloroethane	266	0.230	0.660	0.670	0.690	0.550	0.096 U
Trichloroethene	0.92	0.290	0.180	0.160	0.130	0.630	0.038 U
Tetrachloroethene	1.61	0.071	0.100	0.064	0.080	0.075	0.041

SITE ID:		IA-BKGD-06D	IA-BKGD-07	IA-TB-01
SAMPLE ID:		9912135A-05A	9912135B-13A	9912135B-14A
DATE SAMPLED:		12/7/99 Duplicate Sample	12/7/99	12/7/99 Trip Blank
Compound	**RSR***	**ppbv**	**ppbv**	**ppbv**
Vinyl chloride	0.019	0.019 U	0.020 U	0.010 U
1,1-Dichloroethene	0.02	0.019 U	0.020 U	0.010 U
1,1,1-Trichloroethane	266	0.096 U	0.100 U	0.050 U
Trichloroethene	0.92	0.038 U	0.040 U	0.020 U
Tetrachloroethene	1.61	0.041	0.042	0.020 U

Shaded values indicate exceedance of RSF

RSR = CTDEP Remediation Standard Regulation (RSR) for Industrial/Commer

U - Not Detected at a concentration above the detection limit