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8. Authors:

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11. Title: WRAIR CHEMICAL DECOMMISSIONING, BUILDING 500 PHASE 1 PILOT PROJECT, WRAMC, FOREST GLEN CAMPUS, 1-5 DECEMBER 1997 VOLUME I

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U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

HAZARDOUS WASTE STUDY NO. 37-EF-6209-98
WRAIR CHEMICAL DECOMMISSIONING
BUILDING 500 PHASE I PILOT PROJECT
WALTER REED ARMY MEDICAL CENTER
FOREST GLEN CAMPUS
1-5 DECEMBER 1997

VOLUME I

Distribution limited to U.S. Government agencies only; protection of privileged information evaluating another command; May 98. Requests for this document must be referred to Commander, Walter Reed Army Institute of Research, Washington, DC 20307-5100.

Readiness Thru Health

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
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REPLY TO
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MCHB-TS-EHM (40)

26 MAY 1998

MEMORANDUM FOR Commander, Walter Reed Army Institute of Research,
ATTN: COL Robert Gifford, Executive Officer,
Washington, DC 20307-5100

SUBJECT: Hazardous Waste Study No. 37-EF-6209-98, WRAIR Chemical Decommissioning, Building 500 Phase I Pilot Project, Walter Reed Army Medical Center, Forest Glen Campus, 1-5 December 1997

Two copies of this report are enclosed. The point of contact for this report is Mr. James Sheehy. He may be reached at DSN 584-5211 or commercial (410) 671-5211. Additional comments or concerns may be directed to the undersigned at DSN 584-3651 or commercial (410) 671-3651.

FOR THE COMMANDER:

Linda K Baetz

Encl

LINDA L. BAETZ
Program Manager
Hazardous and Medical Waste

CF (w/encl):
HFPO, ATTN: LTC BOND
CDR, MEDCOM, ATTN: MCHO-CL-W (exec sum only)
CDR, NORTH ATLANTIC RMC, ATTN: PVNTMED SVC
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REPLY TO
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EXECUTIVE SUMMARY
HAZARDOUS WASTE STUDY NO. 37-EF-6209-98
WRAIR CHEMICAL DECOMMISSIONING
BUILDING 500 PHASE I PILOT PROJECT
WALTER REED ARMY MEDICAL CENTER
FOREST GLEN CAMPUS
1-5 DECEMBER 1997

1. PURPOSE. The primary purpose of this project was to determine whether construction workers can perform demolition and remodeling activities and future occupants can work in the Phase I construction area at the Walter Reed Army Institute of Research's (WRAIR's) Forest Glen Building 500 without an unsafe exposure to residual chemicals on or in the building materials. This project generated the necessary data to perform human health risk assessments based on the worker scenarios identified above. The secondary purpose of this project was to use the Phase I construction area as a Pilot Project to determine the best and most efficient methods of sampling for the chemical decommissioning of the rest of the WRAIR laboratory facilities. This pilot project also identified areas of possible economies in future sample collection that will reduce the overall cost of the chemical decommissioning. The biological and radiological decommissioning were not covered in this effort, but will be covered by separate documents produced by WRAIR and the U.S. Army Center for Health Promotion and Preventive Medicine's (USACHPPM) Medical Health Physics Program, respectively.

2. CONCLUSIONS.

a. The demolition and renovation of the Phase I Area of Building 500 is safe as shown in the human health risk assessment (HRA). The HRA used extremely conservative assumptions; e.g., that the maximum contaminant level detected was present at uniform concentrations on all interior surfaces and that all of the risk was additive to produce an upper bound estimate of risk. Provided that workers wear standard safety gear (such as shirts, gloves, and dust masks as deemed appropriate by a trained Industrial Hygienist), there is virtually no increased risk from the demolition and remodeling of the WRAIR facilities. Since there is minimal risk to the construction workers, and the surfaces responsible for that slight risk will be removed during the demolition, there will be no adverse risks to future occupants of the Phase I Area.

b. Assuming the remainder of the WRAIR laboratory spaces in Building 500 are similar to the Phase I area, the level of sampling that was conducted in the Phase I Area will not be required in the rest of Building 500. Some sampling could be conducted for verification purposes at the rate of one sample per 700 - 800 square feet of floor space. However, these data would be of limited use. The data could be used to locally verify the previous findings; but, the data could not be used for additional risk assessment since it would be too limited and not representative enough. This is because the distribution of the contamination throughout the building is not normal (equally distributed). Finally, the evaluation of the remainder of the WRAIR facilities for "hot spots" is infeasible. The level of effort and high number of samples that would be required would make this approach cost prohibitive and cannot be justified based on the results of the Phase I sampling.

c. Based on the results from Building 500, there are several alternatives that may be considered for the chemical decommissioning of WRAIR. The least conservative approach would be to assume that additional sampling at Building 500 may not be required. This assumption would be appropriate if the same types of activities were conducted in all of the WRAIR labs. If WRAIR would like to be more conservative and assume that laboratories in different buildings (Buildings 500 and 40) are dissimilar, another sampling event could be conducted in a wing of Building 40 in a manner similar to the Phase I Area of Building 500. This would determine the level of contamination present in a representative section of Building 40 and possibly verify that laboratory facilities at the WRAIR are similar irrespective of the actual building that they are located. The assumption that the laboratories in the same building or in different buildings that belong to the same command are similar is based on the length of time that research activities have been conducted. Over the years, some type of normalization should occur as different activities are conducted in different labs until, over time, many different activities have been conducted in the same lab.

d. If there is evidence of persistent chemical contamination/spills in a particular area, samples could be collected to establish the level of chemical contamination at that location. If this evidence exists, these samples could be collected to determine if chemical decontamination will be required. An example of an area that would be suited to this type of sampling would be the "Blob Room," where unknown materials were stored for an indefinite period prior to being disposed.

e. The costs of these different options are also variable. They would range from no additional cost by taking no more samples to over an additional $250,000 to perform verification sampling at the rate of one sample every 800 to 850 square feet of floor space. Sampling the rest of the WRAIR facilities in the same manner as the Pilot Project would cost over $1 million; and the benefits gained from the additional sampling do not justify this level of effort in order to complete the chemical decommissioning. An additional round of sampling

at Building 40 with a level of effort similar to the Pilot Project. This is a reasonable approach since the information gathered would be worth the additional cost of between $55,000 and $65,000 depending on the area involved.

f. No additional chemical decommissioning samples will be collected by USACHPPM personnel until the biological decontamination of the WRAIR facilities are accomplished. If no biological decontamination is necessary, this should be stated in writing with justification. The USACHPPM personnel are not familiar with the aspects of biological research that are being conducted, and neither are the construction personnel performing demolition and renovation. Exposure to biological pathogens or toxins cannot be risked as the demolition and remodeling progress to laboratories with more hazardous pathogens or toxins. This decontamination is necessary whether or not any additional sampling is conducted in order to avoid future liability to WRAIR from real or perceived exposures.

g. Weighting factors were used in determining the number of samples to collect in each type of surface found in Building 500 Phase I Area. The weighting factors shifted sampling emphasis to areas with more potential for spills and splashes. The weighting factors that were assigned were oversimplified, and the population polled to determine if the factors should be expanded to include at least two laboratory personnel in the future. A more sophisticated method of determining the weighting factors than assigning integers between 11 and 1 will be applied in any future sampling to allow for better representation of actual preferences.

3. RECOMMENDATIONS.

a. Proceed with the Phase I demolition and renovation of Building 500 as planned.

b. Conduct and document biological decontamination after laboratory spaces have been completely emptied.

c. Conduct a second round of sampling in the first wing of Building 40 to be emptied in a manner similar to the Pilot Project to determine if another wing of laboratories has as little future risk as Building 500. Further sampling in Building 500 is not recommended.

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BUILDING 500 PHASE I PILOT PROJECT
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FOREST GLEN CAMPUS
1-5 DECEMBER 1997

1. REFERENCES. Appendix A contains a list of references used while preparing this report.

2. AUTHORITY. Scope of Work Approval Meeting, 20 May 1997, between COL Martin Crumrine, Walter Reed Army Institute of Research (WRAIR) Deputy Commander; COL Jeff Davies, WRAIR Executive Officer; Mr. Thomas Runyon, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Hazardous and Medical Waste Program (HMWP); and Mr. James Sheehy, USACHPPM HMWP.

3. PURPOSE. The primary purpose of this project was to determine whether construction workers can perform demolition and remodeling activities and future occupants can work in the Phase I construction area at the WRAIR's Forest Glen Building 500 without an unsafe exposure to residual chemicals on or in the building materials. This project generated the necessary data to perform human health risk assessments based on the worker scenarios identified above. The secondary purpose of this project was to use the Phase I construction area as a Pilot Project to determine the best and most efficient methods of sampling for the chemical decommissioning of the rest of the WRAIR laboratory facilities. This pilot project also identified areas of possible economies in future sample collection that will reduce the overall cost of the chemical decommissioning. The biological and radiological decommissioning were not covered in this effort, but will be covered by separate documents produced by WRAIR and the USACHPPM Medical Health Physics Program, respectively.

4. GENERAL.

a. Personnel. The Project Officer for this study is Mr. James Sheehy of the USACHPPM, HMWP. Mr. Charles Pitrat, USACHPPM, Environmental Health Risk Assessment and Risk Communication Program, conducted the Health Risk Assessment portion of the study and assisted with the sampling. Mr. Mark Pippen, USACHPPM, Ground Water and Solid Waste Program, also assisted with the sampling.

b. Personnel Contacted. The following personnel were contacted during this study: COL Martin Crumrine, Commander, WRAIR; COL Robert Gifford, Executive Officer, WRAIR; CPT Morford and Mr. Edward Keiper, WRAIR Facilities; Mr. Bert Mueck and SSG Tim Mensing, WRAIR Safety; COL Scovil and Mr. Mel Heiffer, WRAIR Building 500; LTC Rick Bond and 1LT James Goetschius, U.S. Army Health Facilities Project Office; and Ms. Tracy Porter and Dr. Winston Williams, Walter Reed Army Medical Center (WRAMC) Department of Public Works.

c. Background.

(1) Walter Reed Army Institute of Research. The mission of WRAIR is biomedical research focused on soldier health and readiness. The Institute fulfills its mission by conducting innovative research in naturally occurring infectious diseases, combat casualty care, operational health hazards, and medical biological and chemical warfare defense. The WRAIR is the largest laboratory within the U.S. Army Medical Research and Materiel Command. It is currently in the process of constructing a new research facility at the WRAMC Forest Glenn Campus that will allow it to consolidate research activities.

(2) Chemical Decommissioning. The WRAIR intends to ensure the safety of both construction workers and future occupants from the effects of chemical exposures by performing chemical decommissioning of all WRAIR buildings that have housed research laboratories or chemical storage before any construction begins or new occupants move into these buildings. This chemical decommissioning involves the sampling of WRAIR facilities with past laboratory chemical usage, analyzing the data, determining the potential risks to construction workers and future occupants, and identifying any decontamination that must be performed in order to mitigate excessive risks as determined in the human health risk assessment (HRA).

(3) Building 500. Building 500 is one of the many small buildings other than the main WRAIR building (Building 40 at WRAMC) occupied by WRAIR personnel. Some of the research groups currently in the building include the Departments of Pharmacology, Parasitology, Medical Chemistry, and Biology. Building 500 is being renovated concurrently with the construction of the new WRAIR facility to house the WRAIR Biometrics Division. The renovations in Building 500 will change the primary use of the building from laboratory space to administrative/office space. The research facilities currently in the building will ultimately be relocated to the new WRAIR building currently being constructed near Building 500. These renovations to Building 500 are being completed in two phases: Phase I, the west wing of the building; and Phase II, the remainder of the building (see Figure 1).

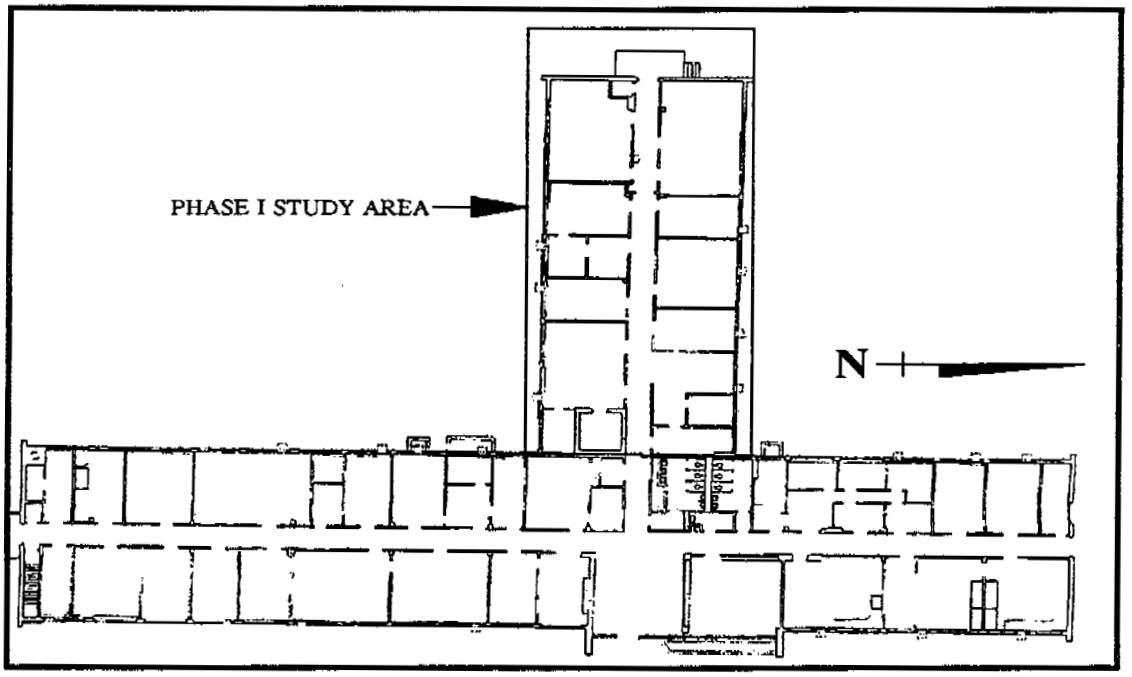

Figure 1. WRAIR Building 500.

5. DISCUSSION OF FINDINGS.

a. Evaluation Framework. There are no specific standards associated with determining acceptable levels of chemical contamination in research laboratories. Therefore, the decision of whether the Phase I area of Building 500 requires decontamination has been based on a HRA. This was accomplished through data collection, data evaluation, and the HRA (See Appendix B) as discussed in the following sections.

b. Data Collection. Samples were collected to determine if contamination was present and, if so, at what levels. The protocol for the sampling effort is described in the Sampling Protocol (Appendix C). Modifications to the Sampling Protocol are discussed in paragraph 5e below. The Site Safety and Health Plan for this project is located in Appendix D.

(1) Number of Samples. A total of 72 samples was collected and analyzed for metals and semivolatile organic compounds. This was the maximum number of samples that could be collected with the budget available for the study. The samples were collected from the 13 different surface types identified in the Phase I area, shown in Table 1 below. The number of samples collected from each surface type was based on two considerations. First, all (100 percent) of the 10 sinks and 2 ventilation hoods in the area were to be sampled due to the

Table 1. Surface Types, Weighting Factors, and Number of Samples Collected by Surface Type

Surface Type	Rank	Weighting Factor	Surface Area (ft^2)	Weighted Surface Area (ft^2)	% of Total Area	Number of Samples
sink	N/A	N/A	N/A	N/A	N/A	10
hood	N/A	N/A	N/A	N/A	N/A	2
type 1a - uncovered floor (lab)	T4	6.5	2549	16567	17%	10
type 1b - uncovered floor (office/hall)	6	3	1209	3626	4%	2
type 2 - covered floor (lab)	T4	6.5	692	4497	5%	3
type 3 - counter top	1	11	850	9346	9%	6
type 4 - wall shelves	T3	8.5	673	5723	6%	3
type 5 - floor cabinet shelves and drawers	T3	8.5	1748	14861	15%	9
type 6 - floor cabinet fronts	2	10	998	9976	10%	6
type 7a - exposed wall area (lab)	T5	4.5	5139	23125	23%	15
type 7b - exposed wall area (office/hall)	7	2	2786	5573	6%	3
type 8a - covered wall area (lab)	T5	4.5	1136	5111	5%	3
type 8b - covered wall area (office/hall)	8	1	38	38	0%	0
		Total	17817	98442	100.00%	72

Note: N/A - Not Applicable.
T3, T4, and T5 - Surface types that were ranked equally, and tied for third, fourth, and fifth respectively.
Covered floor and wall areas were those areas obscured by permanently installed cabinetry or shelving units.

high probability of chemical contact. Second, the surface areas of the remaining 11 surface types were measured in all of the rooms in the Phase I area, tabulated, and weighted, since some surfaces have more potential to have received leaks and spills than others. The weighting factors were assigned by ranking the surfaces, from highest leak/spill potential to lowest. The rank was then multiplied by the measured areas to yield a weighted surface area. The number of samples to be collected in each media was then determined by multiplying the total number of samples available (60) by the percentage of the weighted surface area to the total weighted surface area (see Table 1).

(2) Sample Types. Two types of samples were collected during the study: wipe samples and bulk samples. Wipe samples were collected from non-porous surfaces, and bulk samples were collected from porous surfaces. Of the 72 samples, 64 were wipe samples and 8 were bulk samples. An additional four samples were collected for quality assurance/quality

control (QA/QC) purposes. These four QA/QC samples consisted of two duplicate wipe samples and two split bulk samples. Their use is discussed in the data evaluation portion of this report.

(3) Sample Location. After the number of samples to be collected by each surface type was determined, specific rooms in which to sample each type of surface and the location of each sample within that room had to be selected. To determine which samples were to be collected in each room, the rooms were first divided by type: laboratory or office/hallway, and any surfaces that did not exist in a particular room were removed from consideration. A random number generator was then used for each sample type as shown in Table 2. The rooms in which specific samples of a surface type were to be sampled were determined by selecting the room with the lowest number first, then additional rooms in ascending order. If there were more samples than rooms with eligible surfaces, the order for room selection was repeated from lowest to highest. Table 2 shows which rooms were selected for a sample by room and surface type. The number in the table is the number of samples to be collected from that room and surface type. Rooms 62, 63A, 64, and the hallway were considered to be office/hallway space, and the remainder of the rooms were considered to by laboratories. Figure 2 shows the sample locations for this project. The only modification to this process was to move one exposed wall (type 7b) sample from Room 64 to Room 63A so that there would be at least one sample in every room. Sample locations in the rooms were selected by the sampler. Samples were collected from various places in the room in an effort to make the samples representative of the whole laboratory space. Samples were collected from areas where spills and occupation were likely to bias the sampling towards worst-case exposure scenarios.

(4) Analytical Results.

(a) Semivolatile Organic Compounds. Both wipe and bulk samples were analyzed for the standard U.S. Environmental Protection Agency (USEPA) suite of semivolatile organic compounds (SVOCs) (reference 1). In the wipe samples, the only detected SVOCs were phthalate compounds. Phthalates are used as plasticizers and are very common in the environment due to the amounts of plastics and tile used. The same phthalates were also detected in the bulk samples collected. One of the eight bulk samples, WR-621, collected from Room 62 also contained phenol and two polynuclear aromatic hydrocarbons (PAHs) at low levels. This sample was collected in a wall constructed of drywall and covered with a wallpaper of some sort. The phenol and the PAHs could have come from either the wallpaper or the adhesive used to attach it to the wall. Since Room 62 was an office, it does not seem likely that the phenol or the PAHs were the result of laboratory contamination. Table 3 shows the maximum detected of concentration of the SVOCs in both the wipe and bulk samples and the surfaces on which they were detected.

Table 2. Sample Location Determination Table

	Surface Type										
Room	type 1a	type 1b	type 2	type 3	type 4	type 5	type 6	type 7a	type 7b	type 8a	type 8b
Room 62	--	0	--	--	0	--	--	--	1	--	--
Room 63	1	--	0	1	1	1	0	2	--	1	--
Room 63A	--	0	--	--	0	--	--	--	0	--	0
Room 64	--	1	--	--	0	--	--	--	1	--	--
Room 66	1	--	1	0	1	0	1	1	--	0	--
Room 67	1	--	0	1	1	1	1	1	--	0	--
Room 69	1	--	--	0	0	--	--	1	--	0	--
Room 69A	1	--	0	1	0	1	1	2	--	0	--
Room 71	0	--	0	0	0	1	0	2	--	0	--
Room 72	1	--	0	1	0	1	1	1	--	0	--
Room 72A	1	--	0	0	0	1	0	1	--	0	--
Room 74	1	--	1	0	0	1	0	1	--	0	--
Room 76	1	--	1	1	0	1	1	1	--	1	--
Hallway	--	1	--	--	--	--	--	--	1	--	--
Cold Room	1	--	0	1	0	1	1	2	--	1	--

Note: "--" denotes those rooms that did not have that surface type.

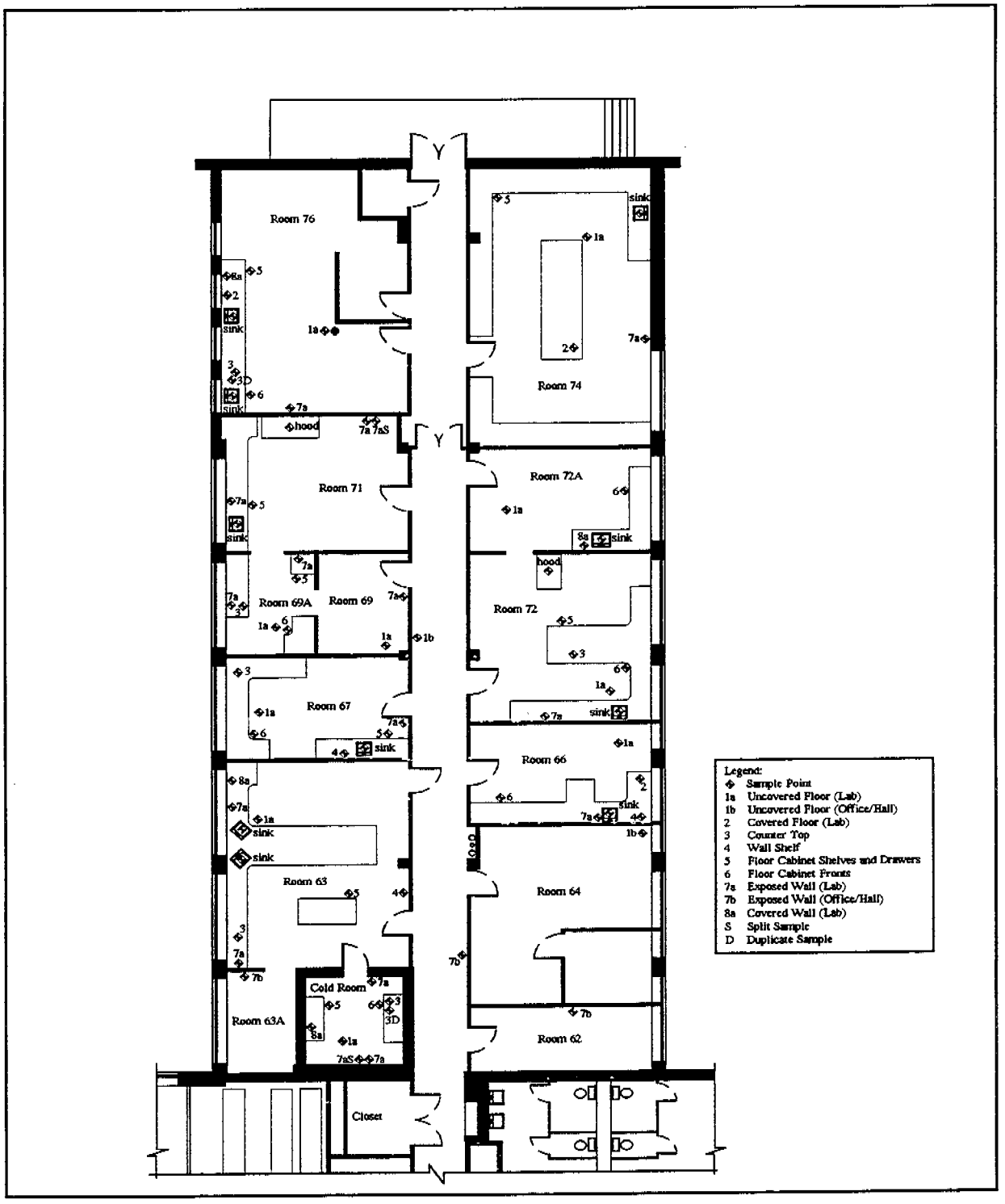

Figure 2. Building 500 Phase I Area, Sample Locations, and Surface Types.

Table 3. Maximum Detected Concentration of SVOCs

	Wipe samples		Bulk Samples	
Compound	Concentration ($\mu g/100cm^2$)	Surface Sampled	Concentration (mg/kg)	Surface Sampled
phenol	nd	--	5.7	exposed office wall
diethylphthalate	10	exposed laboratory floor	0.85	exposed office wall
phenanthrene	nd	--	0.45	exposed office wall
fluoranthene	nd	--	0.40	exposed office wall
di-n-butylphthalate	14	exposed laboratory floor	12	exposed office wall
butylbenzylphthalate	310	exposed laboratory floor	3,300	exposed office wall
bis(2-Ethylhexyl)phthalate	210	sink	1.7	laboratory wall

Note: nd - contaminant not detected in any sample.

(b) Metals. Wipe and bulk samples were analyzed for eight different metals. The eight metals were those with the potential to be regulated as hazardous waste by the Resource Conservation and Recovery Act: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Analysis of the metals samples revealed the presence of seven of the eight metals that were of concern. Selenium was not detected in any of the wipe or bulk samples. Additionally, arsenic was not detected in any of the wipe samples, and silver was not detected in any of the bulk samples. The presence of these metals in trace amounts on surfaces and in construction materials is not unexpected, because some are commonly used in laboratory settings (barium, mercury, lead, siiver), and the others are either may have been used in research or are often present in building materials. Table 4 shows the maximum detected concentration of the metals in both the wipe and bulk samples and the surfaces on which they were detected.

Table 4. Maximum Detected Concentration of metals

	Wipe samples		Bulk Samples	
Compound	Concentration ($\mu g/100cm^2$)	Surface Sampled	Concentration (mg/kg)	Surface Sampled
arsenic	nd	--	3.3	covered laboratory wall
barium	170	lower cabinet shelf/drawer	61	exposed laboratory wall
cadmium	40	sink	5.5	office wall
chromium	10	sink	17	covered laboratory wall
mercury	170	hood	0.66	exposed laboratory wall
lead	290	covered laboratory floor	20	exposed laboratory wall
silver	40	counter top	nd	--

Note: nd - contaminant not detected in any sample.

(c) Tentatively Identified Compounds. A screen was run on all of the SVOC samples for tentatively identified compounds (TICs). The software used by the analytical equipment has a larger database of compounds than are commonly used and will tentatively identify compounds in addition to the standard list of analytes. These TICs are compounds that the analytical equipment identified and reported as being present in the samples. The TICs cannot be positively identified since the analytical equipment is not calibrated for them, and standards of the TICs have not been run through the equipment. By screening the samples for TICs, the presence of other organic chemicals could be looked for without the additional cost of adding suites of analytes such as polychlorinated biphenols or pesticides. These compounds would manifest themselves in a TIC screen, and if detected in significant quantities, additional sampling could have been conducted to verify their presence and concentration. Table 5 shows the maximum detected concentration of the TICs used in the HRA in both the wipe and bulk samples and the surfaces on which they were detected. Not all of the TICs that were identified were used in the HRA, since the required toxicity data does not exist for every compound, or the amount of risk posed by the TIC did not contribute a significant amount to the risk posed to construction workers and future occupants. A complete listing of the TICs detected in the analysis are contained in Volume II of this report.

Table 5. Maximum Detected Concentration of HRA Evaluated TICs

	Wipe samples		Bulk Samples	
Compound	Concentration ($\mu g/100cm^2$)	Surface Sampled	Concentration (mg/kg)	Surface Sampled
phosphoric acid	nd	--	43	exposed office wall
butyl ester butanoic acid	nd	--	50	exposed laboratory wall
ethanol; 2-2 butoxy ethoxy	nd	--	14	exposed laboratory wall
o-p' DDE	nd	--	5.9	exposed laboratory wall
o-p' DDT	nd	--	4.9	exposed laboratory wall
DDT	nd	--	13	covered laboratory wall

Note: nd - contaminant not detected in any sample.

c. Data Evaluation.

(1) Statistical Evaluation. A statistical evaluation was used to assess the quality of the data collected as related to the number and location of samples collected. The data were grouped by sample type (wipe/bulk) and surface type. The results of the statistical analysis revealed little about the data however. One result of the statistical evaluation was that, with very few exceptions, the chemical contamination that was detected was not normally distributed for any surface type. This shows that the distribution of the contaminants is not classifiable. Neither was the contamination spread normally throughout the building when all of the surface types were combined for analysis. This may be a result of two factors. First, the weighting of the surface areas skewed the proportion of surface areas from their actual distributions. Second, contamination might be present as a result of spills and splashes and would result in "hot spots" of contamination, not a normally distributed level of contamination. The results of the statistical evaluation are contained in Appendix E. The data sets with very few samples numbers were combined with other similar surfaces for analysis, and there was no attempt to statistically analyze several of the data sets due to the extremely low frequency of detection of analytes in those samples.

(2) Quality Assurance/Quality Control. There were two types of QA/QC samples evaluated during this project. These were field and laboratory QA/QC samples. Both are discussed below.

(a) Field QA/QC Samples. Field QA/QC samples consisted of two each field split and field duplicate. Field split samples of bulk samples were collected by gathering two times the quantity of necessary bulk sample, mixing thoroughly, placing in two different containers, and submitted as independent samples. This is a blind QA/QC check of the laboratory. The results of the two samples should be similar since they were two aliquots from the sample original sample. Field duplicate samples of wipe samples were collected by taking two wipe samples adjacent to each other. This provides a QA/QC check of the sampling methods, since the surface contamination on adjacent surfaces should be relatively similar. A review of the relative percent difference (RPD) for the field split samples showed that the results were acceptable (less than 50 percent) (references 2 and 3) for all of the parameters in all of the samples except bis (2-Ethylhexyl) phthalate in sample WR-713 and WR-716. The results for that parameter and sample were 53 percent, which is not significantly greater than 50 percent and, when combined with the results of the other field splits, is acceptable. There is no specific guidance on the acceptable RPD for field duplicates, but all of the field duplicates were within 100 percent of each other and this is acceptable. A greater RPD is acceptable on field duplicates, since the samples are taken adjacent to one another and the variability due to varying levels of contamination on the surfaces should be taken into account due to a localized, random pattern of contaminant distribution (use, storage, settlement, etc). The calculations showing the RPD are located in Appendix E.

(b) Laboratory QA/QC Samples. The laboratories also perform internal QA/QC checks as part of the standard analytical methods used. Most of the laboratory QC checks were within the acceptable limits. While some of the QC results were outside of the methods limits, the laboratories reported that they had minimal impact on the data since they were just outside of the acceptable limits, and other QA/QC data for the same samples were within acceptable limits. Specific QA/QC narratives are contained with the analytical data in Volume II.

d. Human Health Risk Assessment. There are two groups of people with the potential to be exposed to any chemical contamination in Building 500. These are the construction workers performing the demolition and remodeling and the office workers that will occupy Building 500 after the renovation. There will be no remaining areas of the original Building 500 for office workers to be exposed to following the renovation. Therefore, this pathway may be bypassed at this time. Since the renovation of Building 500 involves extensive demolition of the building down to the structural members, the construction workers would have the greatest exposures of any current or future workers and the greatest risk from any

chemical contamination present in the building. The HRA concentrated on determining the risk faced by construction workers during the demolition and renovation as the most conservative exposure. The HRA accounted for three types of potential risk: dermal risk, or risk from skin contact; ingestion risk, or risk from the incidental ingestion of dust; and the occupational inhalation risk, or the risk from breathing the dust. As a conservative, preliminary screen, the maximum level of contaminant detected in any sample was assumed to be present in a uniform concentration on all of the surfaces in the Phase I Area. The dermal risk and ingestion risk were calculated and compared to the USEPA standard for risk assessment (reference 4). The additional risk presented by exposure to these levels of contamination were within the acceptable levels of risk established by the USEPA for the dermal and ingestion exposures (reference 5). This is represented by a Hazard Index (HI) of less than 1 for noncarcinogenic risk or a carcinogenic risk of between $1x10^{-4}$ and $1x10^{-6}$. For the inhalation exposure, the calculated risk is below the maximum allowable limits for the inhalation exposure by the American Conference of Governmental Industrial Hygienists (reference 6). This is also represented by a HI. Again, a HI of less than 1 is considered acceptable. The total noncarcinogenic risk for all pathways (dermal, inhalation, and ingestion) was 0.1, and the total carcinogenic risk for all pathways was $2x10^{-7}$. These are both well within the limits of acceptable risk. Since the risk levels calculated in the HRA using the most conservative assumptions were acceptable, no further modifications to the assumptions used were made. The entire HRA, to include the assumptions, calculations, and narrative, is contained in Appendix B.

The calculated risk from exposures to the surfaces in Building 500, Phase I Area were almost equally divided between the SVOCs and metals that were detected. The TICs did not contribute a significant amount to the negligible risks that were detected.

e. Data Analysis.

(1) Additional Sampling of Building 500. Assuming the remainder of the WRAIR laboratory spaces are similar to the Building 500 Phase I area, further sampling of Building 500 may not be necessary. The risk to construction workers is almost negligible, and the costs of additional sampling are not justified from the benefits provided. Some sampling could be conducted for verification purposes at the rate of one sample per 700 - 800 square feet of floor space within the cost estimates originally provided to WRAIR by USACHPPM. However, these data would be of limited use. The data could not be used for additional risk assessment since it would be too limited and not representative enough. This is because the distribution of the contamination throughout the building is not normal. The only likely source of chemical contamination would be spill sites with highly concentrated amounts of chemicals or "hot spots." The evaluation of the remainder of the Building 500 or of any of the other

WRAIR facilities for hot spots would be infeasible. The level of effort and high number of samples that would be required would make this approach cost prohibitive and cannot be justified based on the results of the Phase I area sampling.

(2) Additional Sampling of WRAIR Facilities. If the research activities that were conducted in different WRAIR facilities was similar in terms of the chemicals used over the years, it may be possible to apply the results of the Phase I area to the remainder of the WRAIR facilities. A more conservative approach would be to assume that laboratories in different buildings (Buildings 500 and 40) are dissimilar. Based on this assumption, another sampling event could be conducted in a wing of Building 40 in a manner similar to the Phase I Area of Building 500. This would determine the level of contamination present in a representative section of Building 40. It may also demonstrate that laboratory facilities at the WRAIR are similar irrespective of the actual building in which they are located. The assumption that the laboratories in the same building or in different buildings that belong to the same command are similar is based on the length of time that research activities have been conducted. Over the years, some type of normalization should occur as different activities are conducted in different labs until, over time, many different activities have been conducted in the same lab.

(3) "Hot Spots". The data evaluation and HRA are based on the worst-case scenarios that were discovered during the Phase I area sampling. The HRA uses the assumption that the level of contamination is uniform throughout the area at the highest concentration discovered. None of the samples found an area with high levels of contamination that would significantly increase the level of risk encountered by construction workers. As discussed previously, sampling to determine the presence of "hot spots" is not feasible. However, if there is evidence of persistent chemical contamination/spills in a particular area, additional samples could be collected to establish the level of chemical contamination at that location as needed. The assumption that all research areas are similar due to normalized usage may not be appropriate in areas like the "Blob Room" where unknown materials were stored for an indefinite period prior to being disposed. If areas like this are identified, they can be sampled on a case-by-case basis.

(4) Costs of Additional Sampling. The costs of the different options are variable. They would range from no additional cost by taking no more samples to over an additional $250,000 to perform verification sampling at the rate of one sample every 800 to 850 square feet of floor space. Sampling the rest of the WRAIR facilities in the same manner as the Pilot Project would cost over $1 million; and the benefits gained from the additional sampling do not justify this level of effort in order to complete the chemical decommissioning. Sampling the rest of Building 500 at a rate similar to this Pilot Project would cost an additional $120,000, which was not included in the original cost estimate. The best alternative for continued

sampling is an additional round of sampling at Building 40 with a level of sampling similar to the Pilot Project. This additional effort is a reasonable amount of additional sampling and would be worth the cost of between $55,000 and $65,000, depending on the area involved.

f. Modifications to the Sampling Protocol.

(1) Location of Samples. As the study personnel moved throughout the Phase I Area of Building 500, obvious staining and discoloration of surfaces was observed. Instead of selecting a totally random sample location on surface areas to be sampled, biased sampling was performed to collect some samples in these areas of staining or discoloration. This was appropriate since the HRA was to be based on the worst-case exposure scenarios. Staining seemed to indicate that spills may have occurred in that location. For data evaluation purposes it was desirable to have samples collected from both stained and unstained areas.

(2) Types of Surfaces. The Sampling Plan listed a slightly different series of surface areas than were sampled and evaluated during data collection. Return air vents were not sampled since they do not exist in Building 500. The air used in the heating system is 100 percent outside air. Differentiating between laboratory spaces and office/hall spaces was not discussed in the Sampling Plan. This differentiation was added prior to sampling, after the weighting factors were added. In this report, wall shelves were separated from floor cabinets, since it was determined that they may have had differing usage patterns. Finally, floor shelves and drawers, and cabinet doors and drawer fronts were combined due to usage similarities.

(3) Weighting Factors. When the initial determination of surface-area ratios was calculated without the weighting factors, floors and walls would have received most of the samples. This was determined to be unacceptable since one of the purposes of this report was to determine the actual level of sampling that would be necessary throughout all of the WRAIR facilities. In order to determine which surfaces may have significant levels of contamination present, additional samples would have to be collected in surface areas other than walls and floors. This was accomplished by applying weighting factors. The weighting factors were determined by ranking the potential of surface areas to have been involved in spills and splashes using a poll of USACHPPM study personnel (reference 7). The weighting factors assigned are explained in paragraph 5b(1) above. Weighting factors from 11 to 1 were selected for their ease of use on the site; however, they did not allow for enough accentuation on the more significant surface areas. In the future, a more sophisticated ranking system will be used to allow more discrimination between surface type variation.

(4) Sampling Delays. Sample collection was delayed at the start of the Pilot Project when it was discovered that many of the laboratories had not been emptied. This resulted in 12 man hours (over $300) being spent in identifying the owners of the materials still remaining

and supervising the removal of the materials. In addition to this delay, there had been no evidence of any type of biological decommissioning prior to the start of the chemical decommissioning.

6. PILOT STUDY.

a. Study Cost. The primary driver of costs in a study such as this one is the cost of the sample analysis. The cost of analyzing the 76 samples for this project was $51,000 at an approximate cost of $671 per sample for metals and SVOCs. In addition, the TIC analysis by the laboratory on this project will cost an additional $64/sample. There are two ways of reducing this cost. One would be to reduce the number of samples analyzed and the other would be to reduce the parameters that are sampled. The only parameter that could be dropped in any continued sampling would be the TICs, since they did not substantially contribute to the negligible risk that was compiled. The SVOC and metals samples will still have to be collected. That leaves reducing the number of samples collected as the only method for reducing the study cost.

b. Sample Locations. The samples that were collected are representative of both laboratories, as a whole. Since they are weighted, they are considered representative of the sites in the laboratories that may have had the most potential for splashes and spills. The methods developed to determine the sample locations for the Pilot Study will also be used in any further sampling along with modified weighting factors.

c. Sample Parameters. As discussed in the section above for study costs, the only sample parameter that can be dropped completely is the analysis for TICs. Additionally, selenium will no longer need to be analyzed for since it was not detected in any of the wipe or bulk samples collected. This will result in a total cost for any future samples of $652.

d. Number of Samples. Selecting the actual number of samples will be determined by any future objectives of the chemical decommissioning. The number of samples is determined by two factors: objective of the sampling and the allowable budget. If the desire of any future sampling is just to do some minor verification sampling, a very small number of samples would need to be collected. However, if the objective of future sampling is similar to the Pilot Study by being able to determine the potential risk faced by construction workers, a large number of samples will need to be collected. Since determining the number of samples based on a statistical analysis of the data already collected would result in a very large number of samples, the budget would actually regulate the number of samples that could be collected. Something similar to the Pilot Project would have to be done where the maximum number of sample allowed by the budget would be collected.

7. CONCLUSIONS.

a. The demolition and renovation of the Phase I Area of Building 500 is safe as shown in the HRA. The HRA used extremely conservative assumptions; e.g., that the maximum contaminant level detected was present at uniform concentrations on all interior surfaces and that all of the risk was additive to produce an upper bound estimate of risk. Provided that workers wear standard safety gear (such as shirts, gloves, and dust masks as deemed appropriate by a trained Industrial Hygienist), there is virtually no increased risk from the demolition and remodeling of the WRAIR facilities. Since there is minimal risk to the construction workers, and the surfaces responsible for that slight risk will be removed during the demolition, there will be no adverse risks to future occupants of the Phase I Area.

b. Assuming the remainder of the WRAIR laboratory spaces in Building 500 are similar to the Phase I area, the level of sampling that was conducted in the Phase I Area will not be required in the rest of Building 500. Some sampling could be conducted for verification purposes at the rate of one sample per 700 - 800 square feet of floor space. However, these data would be of limited use. The data could be used to locally verify the previous findings, but the data could not be used for additional risk assessment since it would be too limited and not representative enough. This is because the distribution of the contamination throughout the building is not normal (equally distributed). Finally, the evaluation of the remainder of the WRAIR facilities for "hot spots" is infeasible. The level of effort and high number of samples that would be required would make this approach cost prohibitive and cannot be justified based on the results of the Phase I sampling.

c. Based on the results from Building 500, there are several alternatives that may be considered for the chemical decommissioning of WRAIR. The least conservative approach would be to assume that additional sampling at Building 500 may not be required. This assumption would be appropriate if the same types of activities were conducted in all of the WRAIR labs. If WRAIR would like to be more conservative, and assume that laboratories in different buildings (Buildings 500 and 40) are dissimilar, another sampling event could be conducted in a wing of Building 40 in a manner similar to the Phase I Area of Building 500. This would determine the level of contamination present in a representative section of Building 40 and possibly verify that laboratory facilities at the WRAIR are similar irrespective of the actual building that they are located. The assumption that the laboratories in the same building or in different buildings that belong to the same command are similar is based on the length of time that research activities have been conducted. Over the years, some type of normalization should occur as different activities are conducted in different labs until, over time, many different activities have been conducted in the same lab.

d. If there is evidence of persistent chemical contamination/spills in a particular area, samples could be collected to establish the level of chemical contamination at that location. If this evidence exists, these samples could be collected to determine if chemical decontamination will be required. An example of an area that would be suited to this type of sampling would be the "Blob Room" where unknown materials were stored for an indefinite period prior to being disposed.

e. The costs of these different options are also variable. They would range from no additional cost by taking no more samples to over an additional $250,000 to perform verification sampling at the rate of one sample every 800 to 850 square feet of floor space. Sampling the rest of the WRAIR facilities in the same manner as the Pilot Project would cost over $1 million; and the benefits gained from the additional sampling do not justify this level of effort in order to complete the chemical decommissioning. An additional round of sampling at Building 40 with a level of sampling similar to the Pilot Project. This is a reasonable approach since the information gathered would be worth the additional cost of between $55,000 and $65,000 depending on the area involved.

f. No additional chemical decommissioning samples will be collected by USACHPPM personnel until the biological decontamination of the WRAIR facilities are accomplished. If no biological decontamination is necessary, this should be stated in writing with justification. The USACHPPM personnel are not familiar with the aspects of biological research that are being conducted, and neither are the construction personnel performing demolition and renovation. Exposure to biological pathogens or toxins cannot be risked as the construction and demolition progress to laboratories with more hazardous pathogens or toxins. This decontamination is necessary whether or not any additional sampling is conducted in order to avoid future liability to WRAIR from real or perceived exposures.

g. Weighting factors were used in determining the number of samples to collect in each type of surface found in Building 500 Phase I Area. The weighting factors shifted sampling emphasis to areas with more potential for spills and splashes. The weighting factors that were assigned were oversimplified, and the population polled to determine if the factors should be expanded to include at least two laboratory personnel in the future. A more sophisticated method of determining the weighting factors than assigning integers between 11 and 1 will be applied in any future sampling to allow for better representation of actual preferences.

8. RECOMMENDATIONS.

a. Proceed with the Phase I demolition and renovation of Building 500 as planned.

b. Conduct and document biological decontamination after laboratory spaces have been completely emptied.

c. Conduct a second round of sampling in the first wing of Building 40 to be emptied in a manner similar to the Pilot Project to determine if another wing of laboratories has as little future risk as Building 500. Further sampling in Building 500 is not recommended.

9. TECHNICAL ASSISTANCE/FURTHER INFORMATION. Any questions or comments related to this study may be directed to any of the undersigned at commercial (410) 671-3652.

JAMES R. SHEEHY
Environmental Engineer
Hazardous and Medical Waste Program

REVIEWED BY:

for THOMAS R. RUNYON
Team Leader, Special Studies & Technologies
Hazardous and Medical Waste Program

APPROVED BY:

LINDA L. BAETZ
Program Manager
Hazardous and Medical Waste

APPENDIX A

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4. Risk Assessment Guidance for Superfund; Volume 1; Human Health Evaluation Manual (Part A), USEPA, 1989.

5. Region III Risk-Based Concentration Table, USEPA, 22 October 1997.

6. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, 1997.

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APPENDIX B

HUMAN HEALTH RISK ASSESSMENT

1. PURPOSE. The purpose of this evaluation is to determine if significant health risks exist for future demolition workers from the presence of residual chemicals in Building 500.

2. BACKGROUND.

a. This evaluation was performed to support the USACHPPM report 37-E-6209-98 and is the quantitative risk assessment performed for demolition workers working at Building 500 at WRAIR. It specifically calculates the human heath risks to demolition workers from chemicals that may be present in laboratory materials that will be demolished prior to renovation of the building.

b. The WRAIR plans to completely renovate the building into space for office and administrative workers. Only the floor, load-bearing structures, and exterior walls will remain of the original structure. Since the building was a laboratory, WRAIR requested that USACHPPM determine if workers performing the renovation would be at significant health risk from the presence of residual chemicals.

3. CONCEPTUAL SITE MODEL.

a. Building Characterization.

(1) Figure 2 of the basic report shows the floor plan for Building 500 as is it existed 1-5 December 1997. The building is approximately 4,500 square feet. Most of the space was laboratory space, with about a fifth of the space used as offices. A hallway ran the entire length of the building. Most of the laboratory interior spaces were walled with painted drywall. The interior and exterior laboratory walls facing the length of the hallway were a laminate of painted stainless steel and insulation. The walls facing the exterior of the buildings were windowed above bench level (34 inches) and contained the service chase.

(2) The general layout of each laboratory is shown in Figure 2. The laboratories contained metal cabinets covered with laminated countertop polymer composite bench tops. The floor was a concrete base covered with industrial tile. Offices had concrete floors with covered carpet, and the walls were papered drywall. Room 63 is a cold room, with a bare, sealed concrete floor and ceramic tile walls and ceiling. The walls for the cold room are insulated with cork. The floor in the hallway is concrete covered with tile.

(3) At the time of sampling, laboratories had been emptied of all chemicals and equipment and had been cleaned somewhat. There were noticeable stains in many places, generally around sinks, refrigerators, and chemical storage areas. Following the exit of researchers, the sampled portion of the building was isolated from the Heating, Ventilation, and Air Conditioning (HVAC) system and sealed, which will significantly reduce the ventilation rate of the building.

b. Development of Exposure Pathways.

(1) During this operation chemicals which are present can be contacted several ways. Table B-1, Annex B, shows the pathways that were considered in this analysis. The three direct primary pathways by which chemicals can enter a receptor are: inhalation of chemicals from the air; either as dust or vapor, dermal absorption after direct contact, or contact with generated dust which contains residual chemicals, or ingestion of soil from poor hygienic practices.

(2) A significant amount of dust is generated during renovation operations (reference 1). This dust may contact receptors through all three mechanisms. As this generated dust is inhaled, any chemicals present in the dust will enter the body. In addition, the free dust on the surface of non-destructible materials, which may contain some chemicals, will be resuspended because of mechanical agitation or through air movement (reference 2). The chemical present in this resuspended dust will then be inhaled. Chemicals with appreciable volatility will evaporate from the surface of these materials and then be inhaled by receptors.

(3) Dermal absorption can result as generated dust contacts the skin (analogously to soil loading) and upon direct contact with material on which chemicals are present. As with soil loading, chemicals in the dust may be transferred from the dust to the skin, then consequently absorbed. On surfaces where chemicals are present (e.g., on a bench top), if a receptor contacts this material as it is being carried, then the chemicals present on that material will pass through the skin and into the body. Since the amount of dust generated will be much greater than the amount of resuspended dust, the chemical intake due to loading of resuspended dust will not be considered.

(4) Dermal absorption of a chemical through the skin from free airborne concentrations was not considered because none of the chemicals detected on surfaces have a "skin" notation according to the American Conference of Governmental Industrial Hygienists (reference 3). Phenol, the only chemical considered that did have a skin notation, was found only in bulk samples, and thus only considered in the dermal absorption pathway for contaminated dust.

4. SAMPLING AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN (COPC).

a. The detailed sampling and analysis plan is contained in the basic report. A summary of sampling results is shown in Table B-2. The basic report also discusses quality control and sample location selection. Sampling locations were selected to create a representative sample of surface types for the building.

b. This assessment is based on wipe and bulk sampling. There is currently no accepted method to screen chemicals detected with these types of sampling. As a result, no chemicals were screened out of the assessment based on acceptable surface concentrations (no risk based screening occurred). However, several of the chemicals that were detected did not have toxicity reference data - either in the documentation of the ACGIH TLV's (reference 3) or in the USEPA's Integrated Risk Information System (reference 4). These were excluded from further due to the lack of adequate toxicity data. The final list of COPC is shown in Table B-3.

5. EXPOSURE ASSESSMENT.

a. Identification of Receptor. The receptor of interest is a demolition worker. Based on a conversation with the primary contractor, the demolition phase of the renovation of Building 500 is expected to take no longer than to 30 days. For purposes of this assessment, workers will be assumed to be present for all 30 of those days and will work 8 hours per day.

b. Use of Sampling Data for the Risk Assessment.

(1) Cost and feasibility limited the amount of sampling data. As a result, concentration distributions were not always available. Where multiple samples were taken from a surface or material type, the maximum concentration was used. Since this is a screening assessment, the result of this assumption will bias the results of the risk to higher values.

(2) Dust will be generated as friable materials (e.g., concrete block and drywall) are destroyed during demolition of the interior of Building 500. The chemical concentration in generated dust will be assumed to be the same as the chemical concentration in this material. Materials that are not expected to produce dust are steel/metal structures (cabinets and shelves) and ceramic materials (bench tops). For these, surface chemical concentrations will be used to estimate exposures.

c. Calculation of Intake.

(1) Inhalation.

(a) Estimation Of Airborne Chemical Concentrations.

- Airborne chemical concentrations result from three mechanisms. Chemicals will: be generated in dust as materials are destroyed; resuspended as surface dust containing chemicals becomes airborne through mechanical disturbance or air movement over the surface; and they

will evaporate directly into the air. Receptors take chemicals into the lungs as either a chemical in the resuspended dust or as vapor. Equation 1 is the general equation for calculating the inhaled dose resulting from airborne contaminates.

$$ADI_{air} = \frac{IRxEDxC_{air}}{BWxAT} \qquad \text{Equation 1}$$

Where:
ADI_{air} = average daily intake of airborne chemicals
IR = inhalation rate (20 m^3/day)
BW = body weight (70 kg)
AT = averaging time (25,550 days for carcinogenic risk, 30 days for noncancer risk)
ED = Exposure duration
C_{air} = chemical concentration in air

- The total airborne chemical concentration is the sum of the three sources mentioned above. To calculate the total intake from these sources, average daily intakes were calculated for each term in equation 2. In this equation: ADI_{air} is the total average daily intake from airborne contaminates, ADI_{gen} is the average daily intake from generated dust, ADI_{resp} is the average daily intake from resuspended dust, and ADI_{evap} is the average daily intake from direct evaporation.

$$ADI_{air} = ADI_{gen} + ADI_{resp} + ADI_{evap} \qquad \text{Equation 2}$$

- The estimation of chemical intake due to the inhalation of generated dust will be calculated differently than for the intake due to the inhalation of resuspended dust or evaporated chemicals. Because the bulk sampling was limited, a weighted airborne concentration (based on the amount and type of material that is present) was determined. The details of this calculation are presented in paragraph 5c(1)(b).

- The estimation of the average airborne concentration due to resuspended dust or direct evaporation is slightly different. The general equation for estimating these values is based on the general dilution ventilation equation (equation 3, reference 5), which relates the steady state concentration of a chemical in a room to ventilation rate and the emission rate of the chemical in the room.

$$C = \frac{G}{Q} = \frac{G}{V_{room} x Q^{'}} \qquad \text{Equation 3}$$

where:
G = generation (emission) rate of a chemical
Q = ventilation rate
V_{room} = volume of the room
Q' = air changes per hour

In equation 3, the concentration is related to the room volume, and to calculate the concentration the room volume must be known. However, as the demolition of the interior of the building progresses, the room volume will change as walls are removed. How this affects the concentration resulting from chemicals on a surface is hard to determine. What is known is that as the walls are removed, the volume of the building will increase and thus decrease the concentration. As a result, the concentration will be highest at the point when each room is smallest (all the walls are intact). As a conservative estimate of exposure, the concentration used to determine intake will be this maximum concentration.

- Receptors are assumed to be exposed at this concentration as long as they are in the room, which will be some fraction of the project duration. To calculate the average daily dose for a chemical present in a room, the daily intake equation must be modified to reflect the amount of time spent in a room. It will be assumed that the proportion of time spent in a room during the project will be the same as the proportional size of the room in the building (less time in smaller rooms, more time in larger rooms).

$$ED_{room} = \left(\frac{SA_{room}}{SA_{Total}}\right) ED_{Total} \qquad \text{Equation 4}$$

Where:
ED_{room} = Estimated time spent in a room during the project
SA_{room} = floor surface area of the room
SA_{Total} = total building surface area
ED_{Total} = project duration (30 days)

Equation 4 will be used to determine the adjusted exposure duration for each room. It calculates the proportional exposure duration for a specific room. This will effectively time-weight the chemical concentration over the project duration. Substituting this equation into equation will result in the average dose for the duration of the project.

- The dose calculation for all three mechanisms relies on a time-weighted average (TWA) over the duration of the project. It does not evaluate for elevated single exposures. As a result, the maximum airborne concentration for each chemical (irrespective of where or when that concentration occurred) was added to determine the maximum concentration of a chemical

that might exist in the building. These values were compared to the ACGIH Threshold Limit Values (TLVs) (reference 3). The results are shown with the risk assessment results for the inhalation pathway (Table B-8).

(b) Intake from Generated Dust.

- Dust will result from friable material that has been destroyed during renovation. Estimates of the amount of dust generated during building renovation were sought in the industrial hygiene literature. One study (reference 1) reported an 8-hour TWA range of 6.0 to 15.6 mg/m^3 for total dust during the "demolition of interior walls, elevated floors and mechanical work" in an office building. The mean of this range (10 mg/m^3) was selected to represent the worst-case dust exposure experienced by the receptors that will be present. This value is the "total particulate not otherwise classified" exposure limit established by Occupational Safety and Health Administration (OSHA) and recommended by the ACGIH (reference 3), and it is expected that at an exposure level above this workers would wear some form of breathing protection.

- This value will be assumed to be the average dust exposure over the entire exposure period. It must be noted, however, that because the activities performed by these receptors will vary as the project progresses, this may represent a significant overestimate of the average exposure for the period of the project.

- All the dust that is generated will be assumed to result from the friable material in all of the rooms in the building. The amount of dust generated for each room will be dependent on the amount of friable material in each room. To estimate the contribution to the concentration that results from each room, the concentration term is modified to reflect the contribution for the amount of material in each room. Equation 5 is used to calculate the average airborne chemical concentration for a chemical resulting from the destruction of a particular material within a room. It represents (for each chemical) the average airborne chemical concentration (weighted by material type and bulk concentration within an individual room) resulting from the destruction of material during renovation.

$$C_{gen} = C_{part} \sum_{rooms} P_{DSA} \left(\sum_{surf\ type} P_{DST} C_{bulk} \right) \qquad \text{Equation 5}$$

Where:
C_{gen} = airborne chemical concentration in the generated dust
C_{part} = airborne dust concentration (10 mg/m^3)
P_{DSA} = proportion of the total destructible material originating in a particular room
P_{DST} = proportion of a particular destructible material type in the room (see Table B-5)
C_{bulk} = bulk chemical concentration in a particular material in a particular room

(c) Resuspended Dust.

- Mechanical agitation or air movement can resuspend chemicals bound to dust located on a surface (reference 2). Resuspension factors have been developed to which can be used to estimate the amount of chemical that will become airborne for various indoor activities. This factor, when multiplied by the surface concentration, will give an emission rate that can be used to determine the concentration in air.

- Equation 6 (reference 6) relates the resuspension factor ($F_{resuspension}$) to the airborne concentration due to resuspension of the surface bound chemicals, and can be sued to estimate the resulting airborne concentration.

$$C_{resp} = \frac{C_{Surface} x F_{resusension} x A_{Surface}}{V_{Room} x Q'} \qquad \text{Equation 6}$$

Where:
C_{resp} = airborne concentration of a chemical due to resuspension
$C_{surface}$ = surface concentration
$F_{resuspension}$ = resuspension factor
A = total area of the contaminated surface
V = room volume, and
Q' = air exchange rate for the room

Sanstone (reference 6) summarized resuspension factors for several activities. The range of these factors spans 8 orders of magnitude (1.0E-9 to 1.5E-2). The most applicable resuspension factor (4.3E-5) to this scenario was for active work in a confined space. However, because this value was not derived specifically for demolition work, it was roughly doubled to 1E-4.

- Portions of Building 500 will continue to be used during renovation. To prevent dust from contaminating nearby research labs, the building was sealed. As a result, the air exchange rate was assumed to be much lower than would be expected in normal industrial operations. Normally, air exchange rates of 0.5 air changes per hour are assumed (reference 6) for poorly ventilated areas. However, because the building is sealed, an air exchange rate of 0.1 air changes per hour was used.

(d) Evaporation.

- There is limited information on calculating an emission rate from a contaminated surface indoors. In soil, this rate is generally modeled as a first order process that is dependent on a first order rate constant and the surface concentration. Researchers at DOW

(reference 7) developed equation 7, which relates a soil surface concentration change with time to a first order rate constant (k) that is a function of the vapor pressure (P_{VP}), the soil adsorption coefficient (K_{oc}) and the water solubility (S).

$$C(t) = C_o e^{-kt} \text{ where } k = 4.4x10^7 \left(\frac{P_{VP}}{K_{oc} S}\right) day^{-1} \qquad \text{Equation 7}$$

In this equation:
C(t) = the time dependant surface concentration
C_o = the initial surface concentration
P_{VP} = Vapor pressure
K_{oc} = Soil adsorption constant
S = Water solubility of the chemical

- Although the emission rate varies with time (dC/dt is not constant), the average emission rate during a short time period can be approximated as the change in concentration during the project divided by the project duration, in days. Equation 8 follows from equation 7 and can be used to estimate the emission rate of a chemical from a contaminated surface. The airborne concentration can then be calculated using equation 9. Where C_{evap} is the airborne chemical concentration due to evaporation, and G_{surf} is the surface emission rate from equation 8.

$$G_{surf} \approx \frac{\Delta C}{\Delta t} \simeq \frac{C_o\left(1 - e^{-k(ED)}\right)}{ED} \qquad \text{Equation 8}$$

$$C_{evap} = \frac{G_{surf} xSA}{VxQ'} \qquad \text{Equation 9}$$

Equation 9, used with equation 4 in equation 1, will estimate the weighted average dose over the period of the project.

(2) Soil Ingestion.

- An average daily ingestion rate for industrial workers of 480 mg/day (reference 7) was assumed for this assessment. This value was reported for outdoor workers performing heavy physical activity. This number was selected due to the nature of the work and the amount of

dust that will be generated. The dust will result primarily from the destruction of construction materials and, as a result, only the chemicals contained in the bulk sampling will be considered.

- As with the airborne concentrations of chemicals in generated dust, the proportional intake was assumed to originate from each material as in equation 5, where the average particulate concentration (C_{part}) can be replace by the ingestion rate. The resulting intake equation is analogous to equation 4 and is shown in equation 10, below.

$$ADI_{ingestion} = \frac{ED}{BWxAT}\left(IR\sum_{rooms} P_{DSA}\left(\sum_{surf\ type} P_{DST}\, C_{bulk}\right)\right) \qquad \text{Equation 10}$$

Where:
ADI = average daily intake
IR = ingestion rate (480 mg/day) (reference 7)
ED = exposure duration (30 days)
BW = body weight, (70 kg)
AT = averaging time, (25,550 days for carcinogenic risk, 30 days for noncancer risk)
P_{DSA} = proportion of the total destructible material originating in a particular room
P_{DST} = proportion of a particular destructible material type in the room

(3) Dermal Absorption. Two types of dermal exposures were evaluated: dermal contact from soil loading and direct contact with contaminated surfaces.

(a) Soil Loading. A dermal soil loading value of 0.06 mg/cm^2 was assumed. This number was measured on the arms of farmers performing outdoor work while wearing heavy clothing. The available surface area used was the 95th percentile default available surface are recommended for outdoor work. As with equation 9 above, the average daily intake was calculated using proportionate dust concentrations based on the amount of destructible material in the building. (Equation 11)

$$ADI_{soil\ loading} = \frac{SAxEDxABS}{BWxAT}\left(AF\sum_{rooms} P_{DSA}\left(\sum_{surf\ type} P_{DST}\, C_{bulk}\right)\right) \qquad \text{Equation 11}$$

Where:
SA = surface area available for contact (5800 cm^2)(reference 7)
AF = Adherence factor (0.06 mg/cm^2) (reference 7)

ABS = absorption factor [0.01 for inorganics, 0.1 for organics (reference 8)]
ED = exposure duration (30 days)
BW = body weight, (70 kg)
AT = averaging time, (25,550 days for carcinogenic risk, 30 days for noncancer risk)
C_{bulk} = bulk contamination concentration
P_{DSA} = proportion of the total destructible material originating in a particular room
P_{DST} = proportion of a particular destructible material type in the room

(b) Direct Contact.

- This measure is the most difficult to assess. To estimate the contact rate each type of material, the potential for contact for each material was evaluated and a contact proportion was assigned. This was an arbitrary assignment approximately based on the ratio of the sum of the surface area of the chest, arms, and hands for an adult male to the surface area available for contact on the material. These values are presented in Table B-6.

- Workers will be assumed to contact all nonfriable material in the building. However, since there will be several workers performing the demolition, each worker will only contact a fraction of the material. In conversations with the primary contractor, it was estimated that six to eight personnel will work during the demolition. As a result, the total dose will be calculated using equation 11, and then divided by the number of workers. To estimate the worst case, six workers will be assumed.

The average daily intake will be calculated using equation 12. This equation will estimate the dose for one worker who contacts all materials in the buildings. As above, materials will be segregated within a room, and chemical surface concentrations will be uniform on the materials within the room. The exposure is then be summed over all materials in a room and then over all rooms.

$$ADI_{direct} = \left(\frac{1}{W}\right)\frac{1}{BWxAT}\sum_{Room}\left(\sum_{Surf\ Type} ABSxTFxC_{surf}\,xSA_{surf}\,xCF_{surf}\right) \qquad \text{Equation 12}$$

Where:
W = number of workers
BW = body weight (70 kg)
AT = averaging time, (25,550 days for carcinogenic risk, 30 days for noncancer risk)
ABS = absorption factor [0.01 for inorganics, 0.1 for organics (reference 8)]
TF = transfer factor (unitless, 0.1) (reference 9)
C_{surf} = surface concentration
SA_{surf} = contaminated surface area in room i.
CF_{surf} = contacted fraction of surface (Table B-6).

6. TOXICITY ASSESSMENT.

a. The toxicity information used in this analysis was collected for each chemical from USEPA's Integrated Risk Information System (reference 4). Table B-3 is the list of the chemicals considered in the analysis, along with the carcinogenic classification and confidence in the reference dose. These are standard reference doses provided by the USEPA and are designed to provide a method to relate exposure and risk for the general population.

b. Table B-8 contains the results of the risk assessment for airborne chemicals. This table also compares the standard occupational reference values (reference 3) with the modeled airborne concentrations that may be present during demolition. The ACGIH TLVs are derived for occupational exposures are not applicable to the general population. They are universally recognized as the "gold standard" for evaluating occupational exposure and for use as guides in controlling potential exposure. However, in conditions where exposures other than inhalation are present, they are difficult to apply without some modification.

c. For general environmental exposures, standard methods have been developed to estimate chemical intake from other types of exposures - primarily dermal (reference 8 and 9). These methods are based on estimating a chemical intake, and then using that dose to estimate the risk to an individual. The toxicity data used to estimate this risk are, by necessity, protective of the general population - including sensitive populations (children etc.). As a result, their use in assessing occupational risks may significantly overestimate health risks for the general working population.

d. On one hand the occupational reference doses (TLVs) are designed to be protective of workers but are not conducive to quantitative use with dermal and ingestion exposure assessments. On the other hand, the toxicity data used with standard dermal and ingestion exposure models are not specific to occupational exposures and greatly overestimate risk to workers. However, if the risks calculated using the USEPA toxicity values are safe by USEPA standards, then the risks to the average worker should also be considered safe. Because the dose estimation will be more appropriate within the context of the USEPA risk assessment, the risks will be calculated using the USEPA toxicity data. In addition, the TLVs will be reported with the modeled airborne concentrations and the estimated risks for airborne chemicals.

e. For the calculation of dermal reference doses, the oral reference dose was used with an adjustment factor. Initially, IRIS was consulted to determine if the oral absorption efficiency was used in the calculation of the RfD_o or CSF_o. If this was not used, the oral absorption efficiency was found in the Agencey for Toxic Substance Disease Registry (ATSDR) toxicological profile for the specific chemical. The RfD_o was adjusted by dividing by the oral

absorption efficiency. The CSF_o was adjusted by multiplying by the absorption efficiency (see Table B-9). The adjusted reference doses and adjustment factors are shown in Table B-6. These values were used in the dermal portion of the risk assessment.

7. RISK CHARACTERIZATION.

a. The USEPA recommended a safe range of carcinogenic risk to be 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}) for humans. The acceptable noncarcinogenic risk to humans is a hazard quotient below 1. The carcinogenic risk is calculated for each chemical by determining the chemical intake and then multiplying by the appropriate cancer slope factor. The cancer risk is then summed across all chemicals for each pathway and then across all pathways within an exposure scenario. The noncarcinogenic risk is determined by dividing the average daily intake for each chemical by the appropriate reference dose. These are also summed across all chemicals and pathways within an exposure scenario.

b. Table B-7 contains the results of the risk assessment. Both the carcinogenic and noncarcinogenic risks are in the range that the USEPA has determined is acceptable. The highest contributor to the carcinogenic risk is the dermal pathway, which is primarily driven by cadmium exposure. The noncarcinogenic risk is also primarily a result of the dermal exposure pathway, although about a third of the risk is due to incidental ingestion of dust. The inhalation pathway did not contribute significantly to either the carcinogenic or noncancer risk. In addition, from Table B-7, estimated airborne chemical concentrations are well below the ACGIH recommended TLV for each chemical. The TLV for the mixture of chemicals present is also below ACGIH's recommended TLV_{mix} of 1.

c. Based on the results of this risk assessment, there is not a discernible risk to the demolition workers performing demolition of Building 500. These risks were calculated with very conservative assumptions and should represent an upper bound of the risk that may exist due to the presence of residual chemicals.

8. DISCUSSION OF UNCERTAINTY.

a. Characterization of human exposure to chemicals based on wipe and bulk sampling data is a difficult task. Airborne concentrations were estimated both from direct evaporation of chemicals and resuspension of dust containing these chemicals. The science used to estimate these exposure parameters is uncertain. The equation used to estimate the airborne concentration resulting from surface evaporation was developed for surface applied pesticides and was accurate to within an order of magnitude for the chemicals considered (reference 7). Although pesticides were not found at Building 500, the chemical properties of the residual chemicals were not dissimilar to these pesticides. As a result, the estimated exposures should be similarly accurate.

b. The equation used to estimate the airborne chemical concentrations resulting from resuspended dust were based on early studies to estimate radioactivity resuspension during rescue operations following a nuclear accident (reference 2). The resuspension factor selected for this assessment was similar to that measured during heavy activity (digging etc.) indoors and is appropriate for this scenario. However, this factor has been shown to consistently vary by an order of magnitude, which will introduce significant uncertainty into the results. The direction of this bias cannot be determined.

c. Estimated dust concentrations used to estimate the amount of dust generated during renovation were based on a very limited study. The measured dust exposure was near the TLV for total dust and may represent an overestimate of the average exposures experienced by workers. This would result in an overestimate of the resulting airborne chemical concentration.

d. The soil ingestion rate used in this study is based on estimates of soil intake during heavy outdoor work. This number represents the highest estimated intake by an adult and significantly higher than the default adult soil intake used by the EPA (EPA, 1997). As a result, this should be a conservative estimate of exposure and represent an intake that would not be found under normal circumstances.

e. The dermal soil loading factor used was the maximum soil loading found for farmers performing manual work (shoveling, moving equipment etc.) while wearing heavy clothing. Of the soil loading studies discussed in reference 7, this scenario represented the most similar type of exposure to the demolition workers. As a result, significant difference between these two groups will result in a proportional difference in risk. Again, the bias would be indeterminate.

f. Since limited sampling data was obtained, the maximum surface and bulk concentration were used to determine exposure concentrations. In addition, sampling was performed in areas where contamination was suspected to occur. The combination of these two factors will tend to bias exposure estimates significantly higher. This will also result in an overestimate of risk. However, contamination that was not detected will not be characterized, and the risk from these chemicals will not be estimated. This will result in an underestimate in the risk.

9. CONCLUSIONS. Based on a health risk assessment conducted using the data collected from 1-5 December 1997, both carcinogenic and non-carcinogenic risks for construction personnel during demolition and construction from any chemicals found in the Phase I area are

considered safe using the assumptions outlined in this report. It is expected that this work will be performed under applicable OSHA and DA/DoD regulations, and under the guidance of a qualified safety professional.

CHARLES A. PITRAT
Environmental Scientist
Environmental Health Risk Assessment and Risk Communication Program

REVIEWED BY:

for Dennis E. Druck
KEITH HODDINOTT
Team Chief, Risk Response Team
Environmental Health Risk Assessment and Risk Communication Program

APPROVED BY:

Dennis E. Druck
DENNIS DRUCK
Acting Program Manager
Environmental Health Risk Assessment and Risk Communication Program

ANNEX A

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ANNEX B

TABLES

Table B-1. Exposure Pathways Considered

	Inhalation	Dermal Absorption	Ingestion
Resuspended Chemical	X	NE[a]	NE[a]
Generated Dust	X	X	X
Evaporated Chemical	X	NE[a]	---

[a] NE= pathway not evaluated (see text)

Table B-2. Summary of Sampling Results (WIPE)

	Number Detected	Number Sampled	Detection Frequency	Maximum Concentration Detected	Detection Type
(1-Butyloctyl)-Benzene	2	64		59	TIC
(1-Pentylheptyl)-Benzene	2	64		20	TIC
Ag	4	64	0.06	290	Norm
Ba	30	64	0.47	210	Norm
Benzotriazole	1	64		16	TIC
Bis (2-Ethylhexyl) Phthalate	30	64	0.47	310	Norm
Butylbenzyl Phthalate	14	64	0.22	310	Norm
Cd	2	64	0.03	170	Norm
Cr	12	64	0.19	40	Norm
Diethyl Phthalate	1	64	0.02	10	Norm
Diisononyl Phthalate	1	64		9	TIC
Di-N-Butyl Phthalate	2	64	0.03	14	Norm
Dodecanoic Acid	2	64		19	TIC
Ethanol	4	64		550	TIC
Hg	29	64	0.45	170	Norm
Mono(2-Ethylhexyl) Hexanedioate	1	64		20	TIC
Napthalene, CASN 26137-53-1	1	64		550	TIC
N-Dotriacontane	1	64		15	TIC
Palmitic Acid	1	64		29	TIC
Pb	42	64	0.66	290	Norm
Stearic Acid	1	64		29	TIC
Triphenyl Phosphate	1	64		16	TIC
Tris(2-Butoxyethyl) Phosphate	3	64		40	TIC

Table B-2 (Cont). Summary of Sampling Results (Bulk)

	Number Detected	Number Sampled	Detection Frequency	Maximum Concentration Detected	Detection Type
Ag	0	8		0	Norm
As	8	8	1.0	3300	Norm
Ba	8	8	1.0	60000	Norm
Bis(2-Ethylhexyl) Phthalate	7	8	0.87	170000	Norm
Butyl Ester Butanoic Acid	1	1		50000	TIC
Butylbenzyl Phthalate	4	8	0.50	3400	Norm
Cd	1	8	0.13	5500	Norm
Cr	7	8	0.88	17000	Norm
DDT	2	2		13000	TIC
Diethyl Phthalate	4	8	0.50	850	Norm
Di-N-Butyl Phthalate	5	8	0.62	12000	Norm
Ethanol, 2-2 Butoxy Ethoxy	1	1		14000	TIC
Fluoranthene	1	8	0.12	400	Norm
Hg	4	8	0.50	660	Norm
Octicizer	1	1		29000	TIC
o-p' DDE	2	2		5900	TIC
o-p' DDT	2	2		4900	TIC
Pb	8	8	1	20000	Norm
Phenanthrene	1	8	0.13	450	Norm
Phenol	1	8	0.13	5700	Norm
Phosphoric Acid	1	1		43000	TIC

Table B-3. Chemicals of Potential Concern and USEPA's Evaluation of Toxicity Data

Chemical	Carcinogenicity Assessment	Confidence In RfD_o
Ag	D – Not Classifiable	Low
As	A - Human Carcinogen	Med
Ba	NE – Not Evaluated	Med
Bis(2-Ethylhexyl) Phthalate	B2- Suspected Human Carcinogen	Med
Butylbenzyl Phthalate	C- Possible Human Carcinogen	Low
Cd	B1 – Probable Human Carcinogen	High
Cr -as Cr(VI)	A – Human Carcinogen	Low
DDT	B2- Suspected Human Carcinogen	Med
Diethyl Phthalate	D – Not Classifiable	Low
Di-N-Butyl Phthalate	D – Not Classifiable	Low
Fluoranthene	D – Not Classifiable	Low
Hg	D – Not Classifiable	High (RfD_i)
o-p' DDE	B2- Suspected Human Carcinogen	
o-p' DDT	B2- Suspected Human Carcinogen	Med
Pb	B2- Suspected Human Carcinogen	
Phenathrene	D – Not Classifiable	No Data
Phenol	D – Not Classifiable	Low
Phosphoric Acid	NE – Not Evaluated	Med (RfC_i)

Table B- 4. Room Surface Areas

	Total Floor Surface Area (SF)	P_{SA}
Room 62	141	0.03
Room 63	460	0.10
Room 63A	86	0.02
Room 64	375	0.08
Room 66	216	0.05
Room 67	237	0.05
Room 69	117	0.03
Room 69A	111	0.02
Room 71	279	0.06
Room 72	380	0.09
Room 72A	225	0.05
Room 74	580	0.13
Room 76	522	0.12
Hallway	607	0.14
Cold Room	114	0.03
Type Totals	4449	

Table B-5. Destructible Material Proportions; Total Building and Room

	P_{DST} Proportion of Destructible Surface Type In Room			P_{STA} Total Proportion of Destructible Surface Type
	exposed wall (lab)	Exposed wall (office/hall)	covered wall (lab)	
Room 62	0	0.15	0	0.05
Room 63	0.09	0	0.09	0.07
Room 63A	0	0.09	0	0.03
Room 64	0	0.33	0	0.10
Room 66	0.07	0	0.12	0.05
Room 67	0.08	0	0.07	0.06
Room 69	0.12	0	0.04	0.07
Room 69A	0.04	0	0.07	0.03
Room 71	0.07	0	0.14	0.06
Room 72	0.08	0	0.14	0.07
Room 72A	0.07	0	0.12	0.05
Room 74	0.13	0	0.13	0.09
Room 76	0.19	0	0.05	0.11
Hallway	0	0.43	0	0.13
Cold Room	0.05	0	0.01	0.03
Total Proportion	0.70	0.29	0.01	

Table B-6. Fraction Of Material Contacted, By Surface Type

Fraction Of Total SA	Contacted Fraction
Cabinet Area Covering Floor (Lab)	0.25
Counter Tops	0.25
Wall Shelves	0.25
Lower Cabinet Shelves & Drawers	0.15
Lower Cabinet Front Area	0.15
Uncovered Floor Area (Lab)	0.10
Covered Floor Area (Lab)	0.10
Exposed Wall Area(Lab)	0.10
Exposed Wall Area(Office/Hall)	0.10
Covered Wall Area(Lab)	0.10
Hood	0.05
Sink	0.05
Covered Wall Area(Office/Hall)	0.10

Table B-7. Risk Assessment Results

Summary of Risk
Demolition Worker Scenario, Walter Reed Army Institute For Research

Chemical	Carc. Assmt.	Dermal		Ingestion		Inhalation		TOTAL	
		Non-cancer Risk	Carcinogenic Risk	Non-cancer Risk	Carcinogenic Risk	Non-cancer Risk	Carcinogenic Risk	Non-cancer Risk	Carcinogenic Risk
Phosphoric Acid	NE					8.2E-07		8.2E-07	
Ag	D	1.7E-04						1.7E-04	
As	A	3.0E-04	2.E-12	1.5E-02	8.E-09		2.E-11	1.5E-02	8.E-09
Ba	NE	7.6E-05		1.6E-03		1.8E-04		1.9E-03	
Cd	B1	3.2E-04	1.E-07	1.7E-05		5.2E-06	2.E-12	3.4E-04	1.E-07
Cr	A	1.5E-03		4.0E-03		7.5E-03		1.3E-02	
Hg	D	1.5E-02		6.5E-03		1.8E-06		2.2E-02	
Pb	B2	1.5E-04		8.3E-04				9.8E-04	
Bis(2-Ethylhexyl) Phthalate	B2	3.8E-02	4.E-08	3.6E-03	1.E-09			4.2E-02	4.E-08
Butylbenzyl Phthalate	C	4.8E-03						4.8E-03	
DDT	B2		6.E-13		2.E-09		9.E-13		2.E-09
Diethyl Phthalate	D	1.9E-05		1.2E-06				2.0E-05	
Di-N-Butyl Phthalate	D	1.6E-04		6.5E-05				2.2E-04	
Fluoranthene	D	2.0E-07		4.0E-06				4.2E-06	
O-P' DDE	B2		4.E-13		2.E-09				2.E-09
O-P' DDT	B2		2.E-13		9.E-10		3.E-13		9.E-10
Phenanthrene	D								
Phenol	D	1.1E-07		3.8E-06				3.9E-06	
Total		6.1E-02	2.E-07	3.1E-02	1.E-08	7.7E-03	2.E-11	1.0E-01	2.E-07

NE = Not evaluated

Table B-8. Risk Assessment Results, Inhalation Pathway

Inhalation Risk Assessment, Combined Sources

	Comparison with ACGIH TLVs								
	Estimated Airborne Conc. ($\mu g/m^3$)	TLV ($\mu g/m^3$) (ACGIH, 1997)	C/TLV	Average Daily Dose	RfD_i	Non-Cancer Risk	Lifetime Average Daily Dose	CSF_i	Carcinogenic Risk
Phenol	1.81E-06	1.90E+01	9.52E-08	3.10E-07			3.64E-10		
Diethyl Phthalate	1.05E-06	5.00E+00	2.11E-07	1.81E-07			2.12E-10		
Phenanthrene	1.43E-07	1.50E-01	9.52E-07	2.45E-08			2.87E-11		
Fluoranthene	1.27E-07	2.00E-01	6.35E-07	2.18E-08			2.55E-11		
Di-N-Butyl Phthalate	5.87E-06	5.00E+00	1.17E-06	1.01E-06			1.18E-09		
Butylbenzyl Phthalate	5.89E-06	5.00E+00	1.18E-06	1.01E-06			1.19E-09		
Bis(2-Ethylhexyl) Phthalate	5.86E-05	5.00E+00	1.17E-05	1.00E-05			1.18E-08		
As	5.88E-06	1.00E-02	5.88E-04	1.01E-06			1.18E-09	1.51E+01	1.79E-11
Ba	1.47E-04	5.00E-01	2.93E-04	2.51E-05	1.43E-04	1.76E-04	2.95E-08		
Cd	1.75E-06	2.00E-03	8.73E-04	2.99E-07	5.71E-05	5.24E-06	3.51E-10	6.30E+00	2.21E-12
Cr	2.50E-05	5.00E-02	5.01E-04	4.29E-06	5.71E-07	7.51E-03	5.04E-09	4.20E+01	
Hg	8.76E-07	2.50E-02	3.50E-05	1.50E-07	8.57E-05	1.75E-06	1.76E-10		
Pb	1.91E-05	1.50E-01	1.27E-04	3.27E-06			3.84E-09		
Phosphoric Acid	1.36E-05	1.00E+00	1.36E-05	2.34E-06	2.86E-03	8.18E-07	2.75E-09		
Ethanol, 2-2 Butoxy Ethoxy	2.01E-05			3.45E-06			4.05E-09		
Butyl Ester Butanoic Acid	4.99E-05	2.00E+01	2.49E-06	8.55E-06			1.00E-08		
O-P' DDE	5.89E-06	1.00E+00	5.89E-06	1.01E-06			1.18E-09		
O-P' DDT	4.89E-06	1.00E+00	4.89E-06	8.38E-07			9.84E-10	3.40E-01	3.34E-13
DDT	1.30E-05	1.00E+00	1.30E-05	2.22E-06			2.61E-09	3.40E-01	8.87E-13
Total	TLV_{mix} = 2.47E-03					7.70E-03			2.13E-11

Table B-9. Risk Assessment Results; Dermal Pathway

Dermal Exposure (Both Direct Contact and Dust Loading)

	Average Daily Contact Rate mg/kg/day	Dermal Absorption Factor Unitless	Chronic Average Daily Dose mg/kg/day	RfDo mg/kg/day	Dose Adjustment Fact Unitless	Non-cancer risk	Life Ave. Daily Absorbed Dose mg/kg/day	CSFo $(mg/kg/day)^{-1}$	Carcinogenic. Risk
Ag	4.35E-04	0.01	4.35E-06	0.005	0.2	1.74E-04	5.11E-09		
Ba	2.20E-03	0.01	2.20E-05	0.07	0.05	1.57E-05	2.58E-08		
Cd	8.55E-05	0.01	8.55E-07	0.0005	0.046	7.87E-05	1.00E-09	6.30E+00	1.38E-07
Cr	2.26E-04	0.01	2.26E-06	0.005	0.005	2.26E-06	2.65E-09		
Hg	5.29E-03	0.01	5.29E-05	0.0003	0.085	1.50E-02	6.21E-08		
Pb	7.01E-03	0.01	7.01E-05	0.037	0.06	1.14E-04	8.23E-08		
Bis (2-Ethylhexyl) Phthalate	1.39E-02	0.1	1.39E-03	0.02	0.55	3.81E-02	1.63E-06	1.40E-02	4.14E-08
Butylbenzyl Phthalate	1.76E-02	0.1	1.76E-03	0.2	0.55	4.84E-03	2.06E-06		
Diethyl Phthalate	2.75E-04	0.1	2.75E-05	0.8	0.55	1.89E-05	3.23E-08		
Di-N-Butyl Phthalate	3.11E-04	0.1	3.11E-05	0.1	0.5	1.55E-04	3.65E-08		
Total						5.85E-02			1.79E-07

Table B-10. Risk Assessment Results; Incidental Ingestion

Incidental Ingestion of Chemical Contaminated Dust

	Total Chemical Ingested mg/day	Chronic Average Daily Dose mg/kg/d	RfDo mg/kg/d	Non-Cancer Risk Unitless	Ave. Lifetime Daily Dose mg/kg/d	CSFo $(mg/kg/day)^{-1}$	Carcinogenic Risk unitless
As	3.10E-04	4.4E-06	3.00E-04	1.48E-02	5.20E-09	1.50E+00	7.80E-09
Ba	7.94E-03	1.1E-04	7.00E-02	1.62E-03	1.33E-07		
Cd	1.54E-04	2.2E-06	5.00E-04	4.41E-03	2.59E-09	6.30E+00	1.63E-08
Cr	1.40E-03	2.0E-05	5.00E-03	3.99E-03	2.34E-08		
Hg	4.54E-05	6.5E-07	1.00E-04	6.49E-03	7.62E-10		
Pb	1.08E-03	1.5E-05	1.85E-02	8.31E-04	1.80E-08		
Bis(2-Ethylhexyl) Phthalate	4.98E-03	7.1E-05	2.00E-02	3.56E-03	8.36E-08	1.40E-02	1.17E-09
Butyl Ester Butanoic Acid	2.25E-03	3.2E-05			3.78E-08		
Butylbenzyl Phthalate	2.36E-04	3.4E-06	2.00E-01	1.69E-05	3.97E-09		
Diethyl Phthalate	6.47E-05	9.2E-07	8.00E-01	1.15E-06	1.08E-09		
Di-N-Butyl Phthalate	4.58E-04	6.5E-06	1.00E-01	6.55E-05	7.69E-09		
Ethanol, 2-2 Butoxy Ethoxy	6.70E-04	9.6E-06			1.12E-08		
Fluoranthene	1.12E-05	1.6E-07	4.00E-02	4.01E-06	1.88E-10		
O-P' DDE	2.70E-04	3.9E-06			4.54E-09	3.40E-01	1.54E-09
O-P' DDT	1.57E-04	2.2E-06			2.64E-09	3.40E-01	8.98E-10
DDT	3.99E-04	5.7E-06			6.69E-09	3.40E-01	2.27E-09
Phenanthrene	1.26E-05	1.8E-07			2.12E-10		
Phenol	1.60E-04	2.3E-06	6.00E-01	3.81E-06	2.68E-09		
Total				3.57E-02			3.00E-08

APPENDIX C

SAMPLING PROTOCOL

SAMPLING PROTOCOL
HAZARDOUS WASTE STUDY NO. 37-EF-6209-98
WRAIR CHEMICAL DECOMMISSIONING
BUILDING 500 PHASE I PILOT PROJECT
WALTER REED ARMY MEDICAL CENTER
FOREST GLEN CAMPUS
1-5 DECEMBER 1997

1. Purpose. The primary purpose of this project is to determine whether the buildings from which Walter Reed Army Institute of Research (WRAIR) are moving are safe for both construction workers to perform demolition and remodeling activities and future occupants of the buildings to work in without an unsafe exposure to residual chemicals on or in the building materials. To determine the best and most appropriate method of sampling to achieve this purpose, the Phase I construction area at Forest Glen Building 500 will be extensively sampled. This sampling will generate the necessary data to perform human health risk assessments based on various worker scenarios. A secondary objective of this pilot project will be to identify areas of possible economies in future sample collection that will reduce the overall cost of the decommissioning. The biological and radiological decommissioning will not be covered in this effort, but will be covered by separate documents.

2. References.

a. Walter Reed Army Institute of Research, Hazardous Chemical Inventory, 6 January 1997.

b. Soil Sampling Quality Assurance User's Guide, EPA/600/8-89/046, March 1989.

3. General.

a. Background. The WRAIR occupies a series of buildings at the Walter Reed Army Medical Center (WRAMC) at both the Main and Forest Glen campuses. At the present time a new building to house all of the research being conducted at many separate locations is being constructed with a completion date of January of 1999 projected. As soon as this facility is completed, WRAIR activities will begin to move. WRAIR intends to limit liability from the effects of chemical exposures to both construction workers and future occupants by performing a chemical decommissioning of these buildings before any construction begins or new occupants move into these buildings. Since there are no specific standards associated with determining acceptable levels of chemical contamination in research laboratories, the decision criteria for determining whether a facility is contaminated and needs decontamination will be based on a human health risk assessment. The chemical decommissioning involves the sampling of WRAIR facilities with past laboratory chemical usage, analyzing the data, determining the potential risks to construction workers and future occupants, and identifying any decontamination that must be performed in order to mitigate excessive risks as determined in the health risk assessment.

b. Building 500. Building 500 is one of the many small buildings other than Building 40 occupied by small groups of WRAIR personnel. Some of the research groups currently in the building include the Departments of Pharmacology, Parasitology, Medical Chemistry, and Biology. Building 500 will be renovated concurrently with the construction of the new WRAIR facility and will be used by WRAIR personnel when remodeling is completed. This renovation allows for the sampling to be completed in the Phase I area prior to any

4. Data Quality Objectives.

a. Overview. The cost of sampling every surface in every laboratory would be prohibitively expensive. In order to keep the overall cost of the chemical decommissioning of WRAIR within the proposed budget, a sample population will be selected from the total area of the Phase I construction at Building 500. This sample population will have to be small enough to control costs, but large enough to provide statistically significant data.

b. Sample Parameters. The parameters to be evaluated during the sampling include semi-volatile organic compounds (SVOCs) and the 8 heavy metals listed as characteristic hazardous wastes in the Resource Conservation and Recovery Act since these comprise the predominant chemicals used by the laboratories at WRAIR (reference a). There is also significant usage of volatile organic compounds (VOCs) at WRAIR, but these compounds will not persist in the materials to be sampled. The conditions in the laboratories are such that the VOCs will evaporate readily and be removed by the air handling system. The usage of other classes of chemicals by research activities such as herbicides, pesticides, or explosives is unlikely because herbicides and pesticides are incompatible with the type of research being conducted (i.e., would prove deleterious to the organisms being studied), and explosives are not part of the research mission. The specific analytes, analytical detection limits, and analytical methods are listed in Annex A. While many of the chemicals used at WRAIR are not included in the standard SVOC listing, they may be identified as Tentatively Identified Compounds (TICs). The top five TICs, as identified in the spectrogram will be identified by the USACHPPM Laboratories. They can not be positively quantified since the equipment is not calibrated for the TICs, and it would be cost prohibitive to do so.

c. Number of Samples. The number of samples to be collected during this sampling is affected by the available funding. A total of 76 samples will be collected including 5% split samples and 5% duplicate samples (4 of each). The sample locations will be detailed below.

d. Quality Assurance/Quality Control. Quality Assurance/Quality Control (QA/QC) will be assured in two ways during this project. There will be field split and duplicate samples (4 of each) collected during the sampling. This is within the 5-10% required by the U.S. Environmental Protection Agency during environmental sampling (reference b). The splits will be used as a field control of the laboratories, and the duplicates will be used as a field control of the field sampling techniques. In addition to the field QA/QC, the USACHPPM Laboratories will conduct different QA/QC checks during their analysis. The QA/QC package from the laboratory will be provided in the final report.

e. Statistical Analysis. After the data are returned, a statistical analysis will be performed for each type of surface area described below. This statistical analysis will perform two functions. First, the data and the amount of statistical variation in the sample population will be used in the health risk assessment. During this process the confidence level and power of the data will be determined. Second, the amount of variance and the minimum relative detectable difference in the sample populations will show where it will be possible to reduce the number of samples collected to further reduce costs in the rest of the chemical decommissioning.

5. Sampling Strategies

a. Sampling Techniques.

(1) Overview. There are two possible methods of sampling for the WRAIR buildings: destructive and non-destructive. Destructive sampling involves actually destroying the material to be sampled using one of several means to include scarification or scraping, taking a core sample with a drill, or removing material with a hammer and chisel. Non-destructive sampling is accomplished by the wipe sampling of surfaces. The type of sampling used will be determined by the material to be sampled.

(2) Destructive Sampling. Destructive sampling is performed on materials such as concrete, drywall, or wood that are porous and have the potential to absorb contaminants. In drywall or wood materials this sampling will be conducted by removing a bulk sample of the material using an electric drill and a one inch spade bit. The sample will be collected into a clean plastic bag with a clean paper funnel device. Enough aliquots will be collected in the sample location to give the proper mass of sample. If the material is concrete, the sample will be collected using an electric hammer-drill and a one inch masonry bit. For samples to be analyzed for semivolatile organic compounds, the sample will be transferred from the plastic bag to a glass jar for shipment to the USACHPPM Laboratory.

(3) Non-Destructive Sampling. Non-destructive sampling is performed on non-porous materials such as lab benches or sheet metal that are unlikely to absorb contaminants. The contaminants remain on the surface of the material where a wipe sample will remove them. The wipe sample solvent facilitates this removal. The non-destructive sampling will be conducted by collecting wipe samples using a wipe with the specified solvents for each parameter in a 10 cm by 10 cm square. The templates used to perform this sampling have been fabricated from thin stainless steel stock. A clean template will be used for each sample location. The wipes will then be placed into clean glass jars for shipment to the USACHPPM Laboratories. The solvents to be used to collect each parameter are listed in Annex A.

b. Material Sampling Methodology.

(1) Overview. As stated in paragraph 4.a. above, the type of sample collected will depend on the material. A destructive sample of an impermeable material or a wipe sample of a very permeable material will not generate appropriate data for this project. The type of sample for each identified building material is listed below.

(2) Painted Gypsum Board/Plaster/Drywall or Concrete Walls. These types of walls will be sampled using destructive sampling. Due to the thinness (<1 inch) of these walls, multiple aliquots will need to be collected for each analyzed sample. These will be collected within a 12-inch diameter of the identified sample location.

(3) Wooden Cabinets/Cabinet Doors/Drawer Fronts/Walls. These types of materials will be sampled using destructive sampling. If these materials are thinner that 1 inch, multiple aliquots will be collected in a manner similar to painted gypsum board walls. If these materials are thicker than 1 inch, the depth of each sample hole will be limited to 1.5 inches and multiple aliquots will be collected as in the thinner material.

(4) Laboratory Benches. These lab benches (counter tops) are constructed of a durable, impermeable material designed to resist the damaging affects of laboratory chemicals. For this reason, wipe samples will be collected from these benches.

(5) Metal Cabinets/Cabinet Doors/Drawer Fronts/Walls/Hoods/Sinks. These materials have been used in some places instead of the more permeable materials. Due to the impermeable nature of these metal objects, they will generally resist penetration by laboratory chemicals. For this reason, wipe samples will be collected from these objects.

(6) Floors. The floors in the buildings are usually constructed of some type of floor tile with carpet over the tile in some places. This tile will be treated as an impermeable surface, if intact. If the flooring is intact wipe samples will be taken. If the flooring is loose or damaged, or if the flooring is bare concrete, a destructive sample will be collected in a manner similar to concrete walls. If the flooring is carpet over another material, the carpet will be cut out of the way, and the material below the carpet will be sampled. This is because none of the active laboratories so far identified have had carpet on the floors. The carpet is apparently added to the floors when spaces have been converted to office space.

(7) Installed Cabinetry. There is the potential for permanently installed cabinetry to have had contamination migrate around the backs or down to the floor under the cabinets. To account for the potential exposures to these surfaces during the demolition, the surface area of the backs of the cabinets and the floors under the cabinets will be recorded and sampled as separate materials. This will ensure that a representative number of sample will be collected from these surfaces. This sampling will be done by removing fasteners if possible to remove cabinetry and expose obscured surfaces, otherwise the materials will be demolished to remove them as necessary using hand or power tools.

(8) Other. If materials other than those described are identified, they will be classified as a permeable or impermeable material, and then sampled using the appropriate technique.

c. Sample Location.

(1) General. Since there are as many potential configurations of laboratories as there are laboratories at WRAIR, and many of the rooms being used as offices have been laboratories in the past, the entire Phase I Area will be considered during the sampling. This space is currently all laboratories with the exception of rooms 62 and 64. Since the exact history of the different spaces is not known, any room in the Phase I Area could have been a laboratory at one time; however, the walls and floors in rooms 62 and 64 will be the only surfaces considered for sampling. This is because the current furnishings in the rooms are office furniture, not laboratory equipment, and are unlikely to have been used in for any chemical processes or storage and should not be contaminated.

(2) Surface Area Determination. The areas of all identified surfaces will be measured and recorded on a Physical Data Collection Sheet (see Annex B). The ratio of these surface areas will be compared to the total surface area, and the number of samples to be collected in each surface will be determined by these ratios. For example, if floor space is 15% of the total surface area then 15% of the available samples will be collected at random from the floors. The method used to randomly distribute these samples will be determined on site, and then described in the final report. In addition to these randomly distributed samples, every fume hood interior and every sink interior will be sampled since these are areas with a high probability of chemical contamination; however, the location of the sample will be determined randomly. The surfaces that will be sampled are listed in Table 1 below.

Table 1. Laboratory Surfaces to be Sampled.

Surface Type	Surface Type
Floor Cabinet Doors	Floors
Floor and Wall Cabinet Interiors	Exposed Walls
Drawer Fronts	Bench Tops
Drawer Interiors	Interior of Hood Ventilation Ductwork
Sinks	Return Air Vent Grates
Chemical Ventilation Hoods	Walls Covered with Cabinets
Cabinet Backs	Floors Covered with Cabinets

d. Decontamination Procedures. Decontamination will be performed to protect workers and offsite personnel from chemical exposure, and to limit the spread of contamination in the study areas. Personnel will decontaminate equipment and themselves. Personal protective equipment will be properly removed and disposed. Personnel will further decontaminate themselves by cleaning and washing their hands. Personnel will be advised to shower at the end of each work day and properly segregate contaminated clothing (if any).

(1) Excess dirt/dust will be brushed off equipment and clothing.

(2) Reusable equipment will then be rinsed and scrubbed using soapy water followed by rinses with tap water and deionized water.

e. Record Keeping. Detailed notes will be maintained by the project officer to record the exact location, sample number, date and time for each sample collected as well as any appropriate observations. An inventory of samples will accompany each cooler of samples delivered to the USACHPPM laboratories identifying sample numbers, date and time of collection, analyses to be performed, and any other appropriate instructions.

f. Safety. A site safety and health plan has been prepared for this study under separate cover.

6. SCHEDULE. This study is planned to occur between 1 and 5 December 1997. Analytical results should be received by the project officer not later than thirty days after their submission to the laboratory. A preliminary report determining the level of chemical decontamination, if any, will be prepared by 26 January 1998.

7. TECHNICAL ASSISTANCE/FURTHER INFORMATION. Any questions or comments related to this study may be directed to any of the undersigned at commercial (410) 671-3652.

JAMES R. SHEEHY
Environmental Engineer
Project Officer
Hazardous and Medical Waste

Reviewed By:

THOMAS R. RUNYON
Team Leader
Special Studies and Technologies
Hazardous and Medical Waste

Approved By:

LINDA L. BAETZ
Acting Program Manager
Hazardous and Medical Waste

ANNEX A

ANALYTICAL PARAMETERS AND WIPE SAMPLE SOLVENTS

TABLE A-1. METALS.

Analyte	Analytical Detection Limit (mg/kg or µg/wipe)	Analytical Method
arsenic	0.5	EPA 7060
barium	2.0	EPA 6010A
cadmium	2.0	EPA 6010A
chromium	5.0	EPA 6010A
lead	1.0	EPA 7421
mercury	0.1	EPA 7471A
selenium	40	EPA 6010A
silver	2.0	EPA 6010A

Wipe sample media for metals are standard baby wipes with no alcohol, aloe, or lanolin added (the lanolin will degrade the sample containers). The media are provided by the USACHPPM Laboratories with no on-site preparation.

TABLE A-2. SEMI-VOLATILE ORGANIC COMPOUNDS.

Analyte	Analytical Detection Limit (µg/kg or µg/wipe)	Analytical Method
Acenaphthene	340	EPA 8270B
Acenaphthylene	340	EPA 8270B
Anthracene	340	EPA 8270B
Benzo(a)anthracene	340	EPA 8270B
Benzo(a)pyrene	340	EPA 8270B
Benzo(a)fluoranthene	340	EPA 8270B
Benzo(g,h,i)perylene	340	EPA 8270B
Benzo(k)fluoranthene	340	EPA 8270B
Benzyl alcohol	340	EPA 8270B
bis(2-choroethoxy)methane	340	EPA 8270B
bis(2-Chloroethyl)ether	340	EPA 8270B
bis(2-Chloroisopropyl)ether	340	EPA 8270B
bis(2-Ethylhexyl)phthalate	340	EPA 8270B
4-bromodiphenylether	340	EPA 8270B
Butylbenzylphthalate	340	EPA 8270B
4-Chloroaniline	340	EPA 8270B
4-Chlorodiphenylether	340	EPA 8270B
Chloro-3-methylphenol	340	EPA 8270B
2,4-Dinitrophenol	670	EPA 8270B
2,4-Dinitrotoluene	340	EPA 8270B
2,6-Dinitrotoluene	340	EPA 8270B
Dimethylphthalate	340	EPA 8270B
Fluoranthene	340	EPA 8270B
Fluorene	340	EPA 8270B
Hexachlorobenzene	340	EPA 8270B
Hexachlorobutadiene	340	EPA 8270B
Hexachloropentadiene	340	EPA 8270B
Hexachloroethane	340	EPA 8270B
Indeno(1,2,3-cd)pyrene	340	EPA 8270B
Isophorone	340	EPA 8270B
2-Chloronaphthalene	340	EPA 8270B
2-Chlorophenol	340	EPA 8270B
Chrysene	340	EPA 8270B

TABLE A-2. SEMI-VOLATILE ORGANIC COMPOUNDS, CONTINUED.

Analyte	Analytical Detection Limit (µg/kg or µg/wipe)	Analytical Method
Dibenz(a,h)anthracene	340	EPA 8270B
Dibenzofuran	340	EPA 8270B
1,3-Dichlorobenzene	340	EPA 8270B
1,4-Dichlorobenzene	340	EPA 8270B
1,2-Dichlorobenzene	340	EPA 8270B
2,4-Dichlorophenol	340	EPA 8270B
Diethylphthalate	340	EPA 8270B
2,4-Dimethylphenol	340	EPA 8270B
Di-n-butylphthalate	340	EPA 8270B
Di-n-octylphthalate	340	EPA 8270B
4,6-Dinitro-2-methylphenol	670	EPA 8270B
2-Methylnaphthalene	340	EPA 8270B
2-Methylphenol	340	EPA 8270B
4-Methylphenol	340	EPA 8270B
Naphthalene	340	EPA 8270B
2-Nitroaniline	340	EPA 8270B
3-Nitroaniline	670	EPA 8270B
4-Nitroaniline	670	EPA 8270B
Nitrobenzene	340	EPA 8270B
2-Nitrophenol	340	EPA 8270B
4-Nitrophenol	670	EPA 8270B
N-Nitroso-dimethylamine	340	EPA 8270B
N-Nitroso-diphenylamine	340	EPA 8270B
N-Nitroso-di-n-propylamine	340	EPA 8270B
Pentachlorophenyl	670	EPA 8270B
Phenanthrene	340	EPA 8270B
Phenol	340	EPA 8270B
Pyrene	340	EPA 8270B
1,2,4-Trichlrobenzene	340	EPA 8270B
2,4,5-Trichlorophenol	340	EPA 8270B
2,4,6-Trichlorophenol	340	EPA 8270B

Wipe sample media will be provided by the USACHPPM Laboratories. Equal parts hexane and acetone solvent will be added to the media on site immediately prior to the sample being collected.

ANNEX B

PHYSICAL DATA COLLECTION SHEET

Room Number _____

Room Sketch.

Surface Type	Surface Area (in^2)	% of Total
Floor Cabinet Doors		
Floor and Wall Cabinet Interiors		
Drawer Fronts		
Drawer Interiors		
Sinks	(Y/N) Quantity_____	
Chemical Ventilation Hoods	(Y/N) Quantity_____	
Cabinet Backs		
Floors		
Exposed Walls		
Bench Tops		
Return Air Vent Grates	(Y/N) Quantity_____	
Walls Covered with Cabinets		
Floors Covered with Cabinets		
Other(specify)		
Other(specify)		
Other(specify)		
Other(specify)		
Total Area		100

APPENDIX D

SITE SAFETY AND HEALTH PLAN

SITE SAFETY AND HEALTH PLAN
HAZARDOUS WASTE STUDY NO. 37-EF-6209-98
WRAIR CHEMICAL DECOMMISSIONING
BUILDING 500 PHASE I PILOT PROJECT
WALTER REED ARMY MEDICAL CENTER
FOREST GLEN CAMPUS
1-5 DECEMBER 1997

1. Introduction.

a. Plan Purpose. The purpose of this site safety and health plan (SSHP) is to identify the activities to be performed during the study and to identify the necessary precautions and activities to protect study personnel.

b. Study Purpose. The primary purpose of this project is to determine whether the buildings from which Walter Reed Army Institute of Research (WRAIR) are moving are safe for both construction workers to perform demolition and remodeling activities and future occupants of the buildings to work in without an unsafe exposure to residual chemicals on or in the building materials. To determine the best and most appropriate method of sampling to achieve this purpose, the Phase I construction area at Forest Glen Building 500 will be extensively sampled. This sampling will generate the necessary data to perform human health risk assessments based on various worker scenarios. A secondary objective of this pilot project will be to identify areas of possible economies in future sample collection that will reduce the overall cost of the decommissioning.

c. Summary of Proposed Activities.

(1) Destructive Sampling. Destructive sampling will be performed on materials such as concrete, drywall, or wood that are porous and have the potential to absorb contaminants. In drywall or wood materials this sampling will be conducted by removing a bulk sample of the material using an electric drill and a one inch spade bit. The sample will be collected into a clean plastic bag with a clean paper funnel device. Enough aliquots will be collected in the sample location to give the proper mass of sample. If the material is concrete, the sample will be collected using an electric hammer-drill and a one inch masonry bit.

(2) Non-Destructive Sampling. Non-destructive sampling is performed on impermeable materials such as lab benches or sheet metal that are unlikely to absorb contaminants. The contaminants remain on the surface of the material where a wipe sample will remove them. The wipe sample solvent facilitates this removal. The non-destructive wipe sampling will be conducted by using a wipe with the specified solvents for each parameter in a 10 cm by 10 cm square. The templates used to perform this sampling have been fabricated from thin stainless steel stock. A clean template will be used for each sample location. The wipes will then be placed into clean glass jars for shipment to the USACHPPM Laboratories.

(3) Building Demolition. In order to collect samples on some of the surfaces, some installed cabinetry will have to be removed. This will include removing any fasteners that are holding the cabinetry in place, breaking the cabinets away from the wall or floor if they are glued down, and possibly cutting cabinets into smaller pieces to ease removal.

2. Personnel and Responsibilities.

a. Creighton Jacobson, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Safety and Occupational Health Manager. Ensures all USACHPPM personnel are aware of the safety concerns related to

their specific duties and are enrolled in an appropriate medical surveillance program.

b. Linda Baetz, Acting Program Manager, Hazardous and Medical Waste Program (HMWP), USACHPPM. Provides Program oversight including assurance that all legal and safety issues are addressed.

c. Thomas Runyon, Team Leader, Special Studies and Technologies Team (SSTT), HMWP. Ensures all SSTT personnel are covered by the medical surveillance program and receive all safety training required for job performance. Ensures team personnel prepare and staff project specific SSHPs.

d. James Sheehy, Project Officer and Site Safety Manager, SSTT, HMWP. Identifies project safety hazards and prepares a comprehensive plan to preclude hazardous exposures and physical accidents. Ensures that all study team members are aware of the potential hazards, follow established protocols, and are familiar with emergency procedures. Stops work in the event of exposures or increased work site hazards.

e. Charles Pitrat, Environmental Scientist, Health Risk Assessment and Risk Communication Program, USACHPPM. Conducts Health Risk Assessment on data, helps determine appropriate sample locations and techniques, provides sampling assistance.

f. Mark Pippen, Engineering Technician, Ground Water and Solid Waste Program, USACHPPM. Provides sampling assistance.

g. Bert J. Mueck, Safety Manager, WRAIR. Is aware of USACHPPM activities on site and ensures all site specific safety threats and procedures are considered prior to site activities.

3. Personnel Training.

a. All study personnel have successfully completed an accredited 40-hour hazardous waste operations and emergency response (HAZWOPER) course, along with requisite 8-hour annual refresher training. Each individual should carry a copy of their current certification during site operations. All site visitors must have completed appropriate training to be on the study site. In addition, the Project Safety Manager has completed the 8-hour basic HAZWOPER supervisor's course.

b. A minimum of two onsite personnel will have received first aid and cardiopulmonary resuscitation (CPR) training. Current certification from an accredited organization/program will be available.

c. Safety meetings will be conducted prior to each day's activities. These meetings are mandatory for all study personnel. Topics will include, but are not limited to, study activities and procedures, associated health and safety issues, and required personnel protective equipment (PPE).

4. Medical Surveillance. All USACHPPM personnel involved in field activities participate in the medical surveillance program operated through the U.S. Army Health Clinic, Aberdeen Proving Ground-Edgewood Area. Personnel are re-assessed on an annual basis.

5. Hazard Assessment.

a. Chemical Hazards.

(1) The most significant chemical hazard associated with this study is associated with solvents used on the wipe sample media to collect the semivolatile organic compounds (SVOCs). The two solvents used to collect the SVOC samples are acetone and hexane. Material Safety Data Sheets for these two chemicals are at Annex A.

(2) The other contaminants of concern for this study - SVOCs and heavy metals - are not expected to be present in sufficient quantities to create an air-borne/inhalation hazard. To prevent dermal contact, incidental ingestion, and removal of site contaminants to other areas, Tyvek®[1] suits and latex gloves will be worn during sampling activities. Gloves will be changed between sampling locations; Tyvek® will be changed between each site and at the end of each day. There will be no smoking and no food will be consumed onsite.

b. Physical Hazards. Numerous physical hazards are associated with this sampling project. The most significant will be from the operation of the power tools necessary for collecting destructive samples or for assisting in building demolition. Care will be taken to avoid potentially dangerous situations. In addition, steel-toed boots will be worn at all times. Hearing protection, safety glasses, leather gloves, and hard hats will be worn during power tool operation. Safety glasses, leather gloves, and hard hats will be worn when doing any building demolition. All utilities that may be encountered during the destructive sampling or demolition will be identified by WRAIR Facilities Engineers so they will not be damaged. Electricity will be shut off and tagged out in the Phase I area, and electric power will be supplied by generator. If tag out is impossible without shutting power off to all of Building 500, the circuit breakers will still be deactivated and labeled to alleviate the possibility of someone reactivating the circuit.

c. Biological Hazards. WRAIR laboratories have been used extensively in research with Biosafety Level 1 and 2 etiological agents. WRAIR is responsible for all biological decommissioning of the laboratory facilities. The level of decommissioning is dependent on the agent used and will vary from laboratory to laboratory. To prevent exposure from any residual biological materials, dust masks will be worn during destructive sampling. The latex gloves worn during all sampling will also provide a barrier to dermal exposure. There will be no smoking or food consumed on the site, and all personnel will wash their hands after sampling.

6. Personal Protective Equipment. Based on site history and the hazard assessment completed above, the level of personal protective equipment (PPE) to be worn is a modified level D. The PPE to be worn by all personnel while conducting this study (as described in the hazard assessment) follows: disposable, Tyvek® coveralls; steel-toed work boots; hearing protection; safety glasses; and latex gloves.

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[1]Tyvek® is a Registered Trademark of E.I. DuPont de Nemours & Co., Inc., Wilmington, Delaware.

7. Site Control Measures. The study sites to be sampled during this investigation are not "uncontrolled hazardous waste sites" as defined by relevant regulations. Therefore, exclusionary zones will not be established nor maintained during site activities. However, no personnel, beyond those listed in the SSHP, will be permitted to handle sampling equipment or the samples themselves, and a log will be kept of all personnel that enter the Phase I area during the sampling.

8. Decontamination Procedures.

a. Decontamination involves the controlled removal of chemical contamination from equipment and PPE. It is an essential step to protect worker health, prevent the spread of contamination offsite, and to preclude the cross-contamination of equipment and samples onsite.

b. Latex gloves will be changed between sample collection locations using care not to touch the glove exteriors during doffing and placed in a plastic bag. Tyvek® suits will be discarded at lunch, at the end of each day, and any time personnel are leaving Building 500 using care not to touch the suit exterior during doffing and placed in a plastic bag. Sampling equipment will be decontaminated by rinsing with potable water, scrubbing with Alconox®[2] soap, and finally rinsing with distilled water.

c. The determination had been made that the potential for exposure to contamination by study personnel is low. Therefore, the protection offered to work boots by the Tyvek® suit is deemed sufficient to prevent contamination of upper surfaces of the boot. Shoe soles will be brushed off as each site is exited. Finally, hands will be washed prior to eating and at the end of each day. Disposable cups will be used for drinking during study activities.

9. Emergency Procedures. Emergency notification procedures will be obtained from installation personnel before site activities. These procedures will include the proper responses to emergencies. A map showing the directions to the site of the nearest medical facility will be obtained from installation personnel at the time of arrival. Emergency notification procedures and a map to the medical facility will be attached to this plan and available to personnel at the site. Since the Phase II areas of Building 500 are still occupied with workers, telephones will be available.

10. Personnel Certification. A pre-entry briefing will be held prior to all sampling activities. This briefing will consist of the familiarization of project personnel with the sample locations and methodologies, site safety procedures, and emergency response procedures. The following individuals acknowledge that they have been notified of the contents of this SSHP,

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[2] Alconox® is a Registered Trademark of Alconox Incorporated, New York, New York.

understand its requirements, and agree to comply with the identified procedures:

Name	Signature	Date
James R. Sheehy		11/26/97
Charles Pitrat		12/1/97
Mark Pippen		12/1/97

PREPARED BY:

11/26/97
JAMES R. SHEEHY — DATE
Project Officer
Site Safety Manager

REVIEWED BY:

Thomas R. Runyon 26 Nov 1997
THOMAS R. RUNYON — DATE
Team Leader
Special Studies/Technology Team

CONCURRENCE BY:

Linda L. Baetz 26 Nov 97
LINDA L. BAETZ — DATE
Acting Program Manager
Hazardous and Medical Waste
USACHPPM

Thomas R. Runyon 26 Nov 1997
CREIGHTON P. JACOBSON — DATE
Safety and Occupational Health Manager
USACHPPM

1 Dec 97
BERT J. MUECK — DATE
Safety Manager
WRAIR

ANNEX A
MATERIAL SAFETY DATA SHEETS

MATERIAL SAFETY DATA SHEET

CORPORATE RESEARCH & DEVELOPMENT
120 ERIE BOULEVARD
SCHENECTADY, N.Y. 12305

MATERIALS INFORMATION SERVICES

NO. 397
n-HEXANE
Revision B
DATE August 1983

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: [redacted]
DESCRIPTION: n-Hexane or a mixed isomer solvent with substantial levels of n-hexane
OTHER DESIGNATIONS: Hexane, $CH_3(CH_2)_4CH_3$, C_6H_{14}, ASTM D1836, CAS# 000 110 543

MANUFACTURER: Available from many sources.

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Typical Composition:		
n-Hexane (major component)	>98	8-hr TWA 50 ppm* or 180 mg/m^3
Other Hexanes (minor component or nil)	Trace	
Other Saturated Hydrocarbons (C_5 to C_7)	Trace	
Olefinic Hydrocarbons (C_5 to C_7)	<0.1	Human, Inhalation TCLo 5000 ppm/10M CNS Effects
		Mouse, Inhalation LCLo 120 gm/m^3

*ACGIH (1983) TLV. Level set to prevent possible nerve cell damage (peripheral neuropathy). Current OSHA 8-hr TWA is 500 ppm.

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F --- ca 152-156*	Specific gravity (20/4C) -- ca 0.66*
Vapor pressure at 60 F, mm Hg - ca 100*	Volatiles, % ---------- 100
Vapor density (Air=1) --------- 3	Melting point, deg F ------ -139
Water Solubility ---------- Insoluble	Molecular weight ---------- 86.20

Appearance & Odor: A clear, colorless, mobile fluid. Mild hydrocarbon odor.

*Precise values depend on the grade of the hexane.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
<0 F (TCC)	500 F	Approx. % by volume	1.2	7.5

Extinguishing media: Use carbon dioxide, dry chemical or foam. Water may be ineffective in putting out fire and a water stream will spread flames; but a water spray should be used to cool fire-exposed containers to prevent pressure build-up and rupture.
This flammable liquid is a dangerous fire hazard, and a dangerous explosion hazard when heated. Fight fire from a safe distance. (Hexane burns like gasoline.)
Firefighters should wear self-contained breathing apparatus and proper eye and skin protection.

SECTION V. REACTIVITY DATA

This is a stable liquid in a closed container at room temperature. It does not polymerize.
This highly flammable liquid (OSHA Class 1B) must be kept away from heat, and sources of ignition. It is incompatible with oxidizing agents.
Thermal-oxidative decomposition products in air can include carbon monoxide.

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GENERAL ELECTRIC

NO. 397

SECTION VI. HEALTH HAZARD INFORMATION

TLV 50 ppm n-Hexane (See Sect. II)

Excessive exposure to n-hexane vapors can cause upper respiratory tract irritation and CNS depression. Symptoms can include dizziness, numbness of extremities, giddiness, and intoxication, depending on exposure level and time. In the body n-hexane can be metabolized (partially oxidized) to (2,5 - hexanedione) neurotoxin which causes nerve damage (peripheral polyneuropathy) in individuals repeatedly exposed above 1000 ppm over a period of months. (See N. Engl. J. Med 285:82-85, 1971.) The liquid is a defatting agent. Eye contact can be irritating, skin contact can cause irritation and dermatitis when repeated or prolonged. Ingestion may cause GI tract discomfort. Aspiration hazard if vomiting occurs.

FIRST AID:

Eye Contact: Flush eyes well with running water for 15 minutes. Get medical help if irritation persists.

Skin Contact: Wash contact area with soap and water. Remove contaminated clothing promptly. Replace skin oils with lotions or creams.

Inhalation: Remove to fresh air. Restore breathing if required. Get medical help.

Ingestion: Get medical help immediately! (Aspiration hazard! Do not induce vomiting! If spontaneous vomiting occurs lower head to knee level.) Give several ounces of edible oil to drink.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Establish plans and provide training prior to any emergency situation. When spills occur exclude workers from area except those assigned to clean-up who must have proper protection against inhalation of vapors or contact with liquid (see Sect. VIII). Provide maximum explosion-proof ventilation. Eliminate ignition sources. Flush hexane away from sensitive areas with a cold water spray. (Flush to ground not to the sewer!) Small amounts of liquid (or absorbed liquid) can be allowed to evaporate with good ventilation or in a hood or open area; large spills should be picked up in a safe and appropriate manner for disposal.

DISPOSAL: Scrap material can be burned with skill and caution in an approved incinerator in accordance with Federal, State and local regulations.

Aquatic Toxicity: TLm 96: > 1000 ppm

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation which is explosion proof and adequate to meet the action level or TLV requirements. For emergency or nonroutine exposures above the TLV use an approved or organic vapor cartridge respirator or self-contained breathing apparatus (SCBA) below 1000 ppm. Higher levels require a SCBA with full facepiece.

Prevent skin contact by use of impermeable gloves, aprons, boots, suits, etc as needed by the circumstances of use. Prevent eye contact by use of safety glasses, goggles, or face shield with googles or glasses as the workplace circumstances may require.

Eyewash stations and safety showers should be readily available to areas of handling and use.

Subneurotoxic level of hexane can be potentiated to neurotoxicity by the presence of MEK. Crit. Rev. of Tox. 7, 279 ff (1980)

Preemployment and periodic medical examinations should emphasize the skin and the nervous system.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers in a cool, well-ventilated area, away from oxidizing agents and sources of heat and ignition. Protect containers from physical damage. Ground and bond containers for transfers to prevent static sparks. Use non-sparking tools. Use metal safety cans for handling small amounts. Storage and handling must be suitable for an OSHA Class 1B flammable liquid. No smoking in areas of storage or use.

Avoid breathing vapors! Prevent contact with skin and eyes! Do not ingest!

Exposure monitoring and recordkeeping requirements which have been proposed by NIOSH for alkanes should be instituted.

DOT Classification: FLAMMABLE LIQUID I.D. No. UN 1208 Label: FLAMMABLE LIQUID

DATA SOURCE(S) CODE: 1-12,14,19,23,25,26,31,37,18,43,45,49

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, General Electric Company extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY 11-21-83

MEDICAL REVIEW: 1 August 1983

GENERAL ELECTRIC

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SOLVENT

MATERIAL SAFETY DATA SHEET OHS00140

OCCUPATIONAL-HEALTH SERVICES, INC.
450 SEVENTH AVENUE, SUITE 2407
NEW YORK, NEW YORK 10123
(800) 445-MSDS (212) 967-1100

EMERGENCY CONTACT:
JOHN S. BRANSFORD, JR. (615) 292-1180

SUBSTANCE IDENTIFICATION

CAS-NUMBER 67-64-1
RTEC-NUMBER AL3150000

SUBSTANCE: ACETONE

TRADE NAMES/SYNONYMS:
DIMETHYLFORMALDEHYDE; DIMETHYLKETAL; DIMETHYL KETONE; BETA-KETOPROPANE; PROPANONE; 2-PROPANONE; PYROACETIC ETHER; B-KETOPROPANE; RCRA U002; STCC 4908105; UN 1090; A-949; A-40; A-20; A-19; A-946; A-18; A-18-S; A-18-SK; A-11; A-11-S; A-16-P; A-16-S; C3H6O; OHS00140

CHEMICAL FAMILY:
KETONE, ALIPHATIC

MOLECULAR FORMULA: C-H3-C-O-C-H3 MOLECULAR WEIGHT: 58.08

CERCLA RATINGS (SCALE 0-3): HEALTH=1 FIRE=3 REACTIVITY=0 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=3 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: ACETONE PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
ACETONE:
1000 PPM (2400 MG/M3) OSHA TWA
750 PPM (1780 MG/M3) ACGIH TWA; 1000 PPM (2375 MG/M3) ACGIH STEL
250 PPM (590 MG/M3) NIOSH RECOMMENDED 10 HOUR TWA

5000 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO SARA SECTION 313 ANNUAL TOXIC CHEMICAL RELEASE REPORTING

PHYSICAL DATA

DESCRIPTION: CLEAR, COLORLESS, VOLATILE LIQUID WITH A CHARACTERISTIC, SWEETISH, FRAGRANT, MINT-LIKE ODOR AND PUNGENT, SWEETISH TASTE.

BOILING POINT: 133 F (56 C) MELTING POINT: -139 F (-95 C)

SPECIFIC GRAVITY: 0.7899 EVAPORATION RATE: (BUTYL ACETATE=1) 14.4

VOLATILITY: 100% SOLUBILITY IN WATER: VERY SOLUBLE

VAPOR DENSITY: 2.0 VAPOR PRESSURE: 180 MMHG @ 20 C

PH: NEUTRAL IN SOLUTION ODOR-THRESHOLD: 20 PPM

OTHER SOLVENTS - (SOLVENT - SOLUBILITY):
SOLUBLE IN ETHANOL, ETHER, CHLOROFORM, BENZENE, MOST OILS, DIMETHYLFORMAMIDE

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
DANGEROUS FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK.

VAPOR-AIR MIXTURES ARE EXPLOSIVE.

FLASH POINT: -4 F (-20 C) (CC) UPPER EXPLOSION LIMIT: 13%

LOWER EXPLOSION LIMIT: 2.5% AUTOIGNITION TEMP.: 869 F (465 C)

FLAMMIBILITY CLASS (OSHA): IB

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, HALON, WATER SPRAY OR ALCOHOL FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. COOL FIRE-EXPOSED CONTAINERS WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM STORAGE TANK ENDS. FOR MASSIVE FIRE IN STORAGE AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES, ELSE WITHDRAW FROM AREA AND LET FIRE BURN. WITHDRAW IMMEDIATELY IN CASE OF RISING SOUND FROM VENTING SAFETY DEVICE OR ANY DISCOLORATION OF STORAGE TANK DUE TO FIRE (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 26).

EXTINGUISH ONLY IF FLOW CAN BE STOPPED. USE FLOODING AMOUNTS OF WATER AS A FOG; SOLID STREAMS MAY BE INEFFECTIVE. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING VAPORS; KEEP UPWIND. IF FIRE IS UNCONTROLLABLE OR CONTAINERS ARE EXPOSED TO DIRECT FLAME, EVACUATE TO A RADIUS OF 1500 FEET. CONSIDER EVACUATION OF DOWNWIND AREA IF MATERIAL IS LEAKING.

WATER MAY BE INEFFECTIVE (NFPA FIRE PROTECTION GUIDE ON HAZARDOUS MATERIALS, EIGHTH EDITION).

ALCOHOL FOAM (NFPA FIRE PROTECTION GUIDE ON HAZARDOUS MATERIAL, EIGHTH EDITION).

TRANSPORTATION

D-10

EPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION: 49CFR172.101
LAMMABLE LIQUID

EPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS: 49CFR172.101 AND 172.400
LAMMABLE LIQUID

EPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49CFR173.119(A)
XCEPTIONS: 49CFR173.118

TOXICITY

CETONE:
00 PPM EYE-HUMAN IRRITATION; 395 MG OPEN SKIN-RABBIT MILD IRRITATION; 3950 UG
YE-RABBIT SEVERE IRRITATION; 20 MG/24 HOURS EYE-RABBIT MODERATE IRRITATION;
40 MG/24 HOURS SKIN-RABBIT MILD IRRITATION; 500 PPM INHALATION-HUMAN TCLO;
2000 PPM/4 HOURS INHALATION-MAN TCLO; 10 MG/M3/6 HOURS INHALATION-MAN TCLO;
40 UG/M3/6 MINUTES INHALATION-MAN TCLO; 2857 MG/KG ORAL-MAN TDLO; 1159 MG/KG
NREPORTED-MAN LDLO; 5800 MG/KG ORAL-RAT LD50; 8 GM/KG ORAL-DOG LDLO;
000 MG/KG ORAL-MOUSE LD50; 5340 MG/KG ORAL-RABBIT LD50; 20 GM/KG SKIN-RABBIT
D50; 110 GM/M3/1 HOUR INHALATION-MOUSE LCLO; 1297 MG/KG INTRAPERITONEAL-MOUSE
D50; 8 GM/KG INTRAPERITONEAL-DOG LDLO; 500 MG/KG INTRAPERITONEAL-RAT LDLO;
576 MG/KG INTRAVENOUS-RABBIT LDLO; 5500 MG/KG INTRAVENOUS-RAT LD50; 4 GM/KG
NTRAVENOUS-MOUSE LDLO; 5000 MG/KG SUBCUTANEOUS-GUINEA PIG LDLO; 5 GM/KG
UBCUTANEOUS-DOG LDLO; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA
RTECS);
ANCINOGEN STATUS: NONE.
ACETONE IS A SKIN, EYE AND MUCOUS MEMBRANE IRRITANT AND CENTRAL NERVOUS
YSTEM DEPRESSANT. THE USE OF ALCOHOLIC BEVERAGES MAY ENHANCE THE TOXIC
FFECTS. PERSONS WITH CHRONIC RESPIRATORY OR SKIN DISEASES MAY BE AT AN
NCREASED RISK FROM EXPOSURE.

HEALTH EFFECTS AND FIRST AID

INHALATION:
CETONE:
RRITANT/NARCOTIC. 20,000 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.
ACUTE EXPOSURE- VAPOR CONCENTRATIONS AROUND 1000 PPM MAY CAUSE SLIGHT TRANSIENT IRRITATION OF THE UPPER RESPIRATORY TRACT. EXPOSURE TO 12,000 PPM HAS CAUSED THROAT IRRITATION AND CENTRAL NERVOUS SYSTEM DEPRESSION WITH WEAKNESS OF THE LEGS, HEADACHE, DIZZINESS, DROWSINESS, NAUSEA AND A GENERAL FEELING OF MALAISE. OTHER POSSIBLE EFFECTS FROM EXPOSURE TO HIGH CONCENTRATIONS INCLUDE DRYNESS OF THE MOUTH AND THROAT, INCOORDINATION OF MOTION AND SPEECH, RESTLESSNESS, ANOREXIA, VOMITING, SOMETIMES FOLLOWED BY HEMATEMESIS, HYPOTHERMIA, DYSPNEA, SLOW, IRREGULAR RESPIRATION, SLOW, WEAK PULSE, PROGRESSIVE COLLAPSE WITH STUPOR, AND IN SEVERE CASES, COMA. LIVER DAMAGE MAY BE INDICATED BY HIGH UROBILIN LEVELS AND JAUNDICE. KIDNEY DAMAGE MAY BE INDICATED BY ALBUMIN AND RED AND WHITE BLOOD CELLS IN THE URINE. BLOOD GLUCOSE LEVELS MAY BE AFFECTED AND FATAL KETOSIS IS POSSIBLE.
CHRONIC EXPOSURE- WORKERS EXPOSED TO 500 PPM/6 HOURS/6 DAYS EXPERIENCED MUCOUS MEMBRANE IRRITATION, AN UNPLEASANT SMELL, HEAVY EYES, OVERNIGHT HEADACHE, AND GENERAL WEAKNESS ACCOMPANIED BY HEMATOLOGIC CHANGES. RECOVERY OCCURRED IN SEVERAL DAYS. WORKERS EXPOSED TO 1000 PPM FOR 3 HOURS/DAY FOR 7-15 YEARS REPORTED CHRONIC INFLAMMATION OF THE

RESPIRATORY TRACT, STOMACH AND DUODENUM, DIZZINESS, LOSS OF STRENGTH, AND ASTHENIA. DROWSINESS, VERTIGO, SENSATION OF HEAT, AND COUGHING HAVE ALSO BEEN REPORTED FROM CHRONIC EXPOSURE TO LOW CONCENTRATIONS. ANIMAL STUDIES SHOW ADVERSE EFFECTS ON FERTILITY WHEN FEMALES WERE EXPOSED CHRONICALLY DURING PREGNANCY.
FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
ACETONE:
IRRITANT.
ACUTE EXPOSURE- CONTACT WITH THE LIQUID CAUSED MILD IRRITATION IN RABBITS. CELLULAR DAMAGE TO THE OUTER LAYERS OF THE EPITHELIUM WITH MILD EDEMA AND HYPEREMIA HAS BEEN DEMONSTRATED IN HUMANS, BUT WAS READILY REVERSIBLE. SMALL AMOUNTS MAY BE ABSORBED THROUGH INTACT SKIN.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE DERMATITIS WITH DRYING, CRACKING, AND ERYTHEMA DUE TO THE DEFATTING ACTION. THE AMOUNT ABSORBED THROUGH THE SKIN INCREASES DIRECTLY WITH THE FREQUENCY AND EXTENT OF THE EXPOSURE. 2 OF 3 GUINEA PIGS EXPOSED BY SKIN CONTACT FOR 3 WEEKS DEVELOPED CATARACTS BY THE END OF THREE MONTHS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
ACETONE:
IRRITANT.
ACUTE EXPOSURE- IN HUMANS, VAPORS PRODUCE ONLY SLIGHT IRRITATION WHEN THE CONCENTRATION IS AT OR BELOW 1000 PPM. HOWEVER, HIGH VAPOR CONCENTRATIONS HAVE CAUSED CORNEAL EPITHELIAL AND CONJUNCTIVAL INJURY IN ANIMALS. LIQUID SPLASHED IN HUMAN EYES CAUSES AN IMMEDIATE STINGING SENSATION AND, IF WASHED PROMPTLY, DAMAGE ONLY TO THE CORNEAL EPITHELIUM CHARACTERIZED BY MICROSCOPIC GRAY DOTS AND A FOREIGN BODY SENSATION, WHICH HEALS COMPLETELY IN 1-2 DAYS.
CHRONIC EXPOSURE- PROLONGED OR REPEATED EXPOSURE TO THE VAPORS MAY CAUSE IRRITATION OR CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
ACETONE:
NARCOTIC.
ACUTE EXPOSURE- MAY CAUSE A FRUITY ODOR OF THE BREATH AND MUCOUS MEMBRANE AND GASTROENTERIC IRRITATION. IN ACUTE CASES, A LATENT PERIOD MAY BE FOLLOWED BY RESTLESSNESS AND VOMITING PROCEEDING TO HEMATEMESIS AND PROGRESSIVE COLLAPSE WITH STUPOR. HEPATORENAL LESIONS HAVE BEEN REPORTED. THE BLOOD GLUCOSE LEVEL MAY BE AFFECTED AND KETOSIS MAY BE FATAL. 10-20 MILLILITERS HAVE BEEN TOLERATED WITHOUT ILL EFFECTS. 200 MILLILITERS HAVE CAUSED STUPOR WITHIN A HALF HOUR, FLUSHED CHEEKS, SHALLOW RESPIRATION, AND COMA WHICH LASTED FOR 12 HOURS. RENAL GLUCOSURIA PERSISTED FOR 9 MONTHS.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- REMOVE BY GASTRIC LAVAGE OR EMESIS USING ACTIVATED CHARCOAL. DO NOT

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PERFORM GASTRIC LAVAGE OR EMESIS ON AN UNCONSCIOUS PERSON. MAINTAIN BLOOD PRESSURE AND RESPIRATION. GIVE OXYGEN IF RESPIRATION IS DEPRESSED. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.) TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE AND OXYGEN SHOULD BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
ACETONE:
- ACIDS: INCOMPATIBLE.
- AMINES (ALIPHATIC): INCOMPATIBLE.
- BROMINE: VIOLENT REACTION WITH EXCESS AMOUNTS OF BROMINE.
- BROMINE TRIFLUORIDE: EXPLOSION ON CONTACT.
- BROMOFORM: VIOLENT REACTION IN PRESENCE OF BASES (E.G. POTASSIUM HYDROXIDE).
- CHLOROFORM: VIOLENT REACTION IN PRESENCE OF A BASE.
- CHROMIUM TRIOXIDE: IGNITION ON CONTACT AT AMBIENT TEMPERATURE.
- CHROMYL CHLORIDE: INCANDESCENT REACTION.
- DIOXYGEN DIFLUORIDE + SOLID CARBON DIOXIDE: EXPLOSION AT -78 C.
- HEXACHLOROMELAMINE: POSSIBLE EXPLOSION.
- HYDROGEN PEROXIDE: EXPLOSION.
- NITRIC ACID: IGNITION.
- NITRIC + ACETIC ACID MIXTURE: POSSIBLE EXPLOSION.
- NITRIC + SULFURIC ACID MIXTURE: VIOLENT OXIDATION.
- NITROSYL CHLORIDE: EXPLOSIVE REACTION.
- NITROSYL PERCHLORATE: IGNITION AND EXPLOSION.
- NITRYL PERCHLORATE: IGNITION AND EXPLOSION.
- OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.
- PERMONOSULFURIC ACID: EXPLOSION.
- PLASTICS: INCOMPATIBLE.
- PLATINUM + NITROSYL CHLORIDE: POSSIBLE EXPLOSION.
- POTASSIUM-TERT-BUTOXIDE: IGNITION.
- RAYON: INCOMPATIBLE.
- SODIUM HYPOBROMITE: EXPLOSION.
- SODIUM HYPOIODITE: POSSIBLE EXPLOSION.
- SULFUR DICHLORIDE: VIOLENT REACTION.
- SULFURIC ACID AND POTASSIUM DICHROMATE: IGNITION.
- THIODIGLYCOL + HYDROGEN PEROXIDE: POSSIBLE EXPLOSION.
- THIOTRIAZYL PERCHLORATE: POSSIBLE EXPLOSION.
- 1,1,1-TRICHLOROETHANE: EXOTHERMIC CONDENSATION BY A BASIC CATALYST.
- TRICHLOROMELAMINE: POSSIBLE EXPLOSION.

SEE ALSO KETONES.

KETONES:
- ACETALDEHYDE: VIOLENT CONDENSATION REACTION.
- NITRIC ACID + HYDROGEN PEROXIDE: FORMATION OF EXPLOSIVE PRODUCT.
- PERCHLORIC ACID: VIOLENT DECOMPOSITION.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE IN ACCORDANCE WITH 29 CFR 1910.106.

BONDING AND GROUNDING: SUBSTANCES WITH LOW ELECTROCONDUCTIVITY, WHICH MAY BE IGNITED BY ELECTROSTATIC SPARKS, SHOULD BE STORED IN CONTAINERS WHICH MEET THE BONDING AND GROUNDING GUIDELINES SPECIFIED IN NFPA 77-1983, RECOMMENDED PRACTICE ON STATIC ELECTRICITY.

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

CONDITIONS TO AVOID

MAY BE IGNITED BY HEAT, SPARKS OR FLAMES. CONTAINER MAY EXPLODE IN HEAT OF FIRE. VAPOR EXPLOSION HAZARD INDOORS, OUTDOORS OR IN SEWERS. RUN-OFF TO SEWER MAY CREATE FIRE OR EXPLOSION HAZARD.

SPILLS AND LEAKS

OCCUPATIONAL-SPILL:
SHUT OFF IGNITION SOURCES. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA! KEEP UNNECESSARY PEOPLE AWAY; ISOLATE HAZARD AREA AND DENY ENTRY.

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS OR NIOSH CRITERIA DOCUMENTS; OR DEPARTMENT OF LABOR,

D-12

29CFR1910 SUBPART I.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION.

1000 PPM- ANY CHEMICAL CARTRIDGE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE(S).
ANY POWERED AIR-PURIFYING RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE(S).
ANY SUPPLIED-AIR RESPIRATOR.
ANY SELF-CONTAINED BREATHING APPARATUS.

4250 PPM- ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS FLOW MODE.

12,500 PPM- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE.
ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.

20,000 PPM- ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE AND OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE MODE.

SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE. CONTACT LENSES SHOULD NOT BE WORN.

AUTHORITED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 09/06/84 REVISION DATE: 11/09/88

NOTICE

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ANNEX B

INSTALLATION EMERGENCY PHONE NUMBERS
AND MAP TO NEAREST MEDICAL TREATMENT
FACILITY

WALTER REED ARMY INSTITUTE OF RESEARCH
WRAMC Wash DC Area Code (202) (DSN 662)
Forest Glen Area Code (301) (DSN 295)
(FOREST GLEN)

EMERGENCY RESPONSE:

1. IN THE EVENT OF FIRE, I would:

R- RESCUE persons in immediate danger
A- ALARM; sound the alarm
C- CONFINE fire by closing doors, etc.
E- EXTINGUISH or EVACUATE

2. TO USE EXTINGUISHER, I would:

P- PULL the pin
A- AIM at base of fire
S- SQUEEZE the trigger
S- SWEEP side to side to cover area

EMERGENCY NUMBER 295-7543/7544

CHEMICAL SPILL: Consult MSDS
1. USE proper PPE
2. SMALL SPILL: USE ABSORBENT & CLEAN
3. LARGE SPILL: EVACUATE & SECURE AREA

REPORT SPILL FOR HELP CALL:

FIRE DEPARTMENT	295-7543/7544
WRAIR SAFETY	782-3019/0955
OCC HEALTH CLIN	782-3611/3668
INDUST. HYGIENE	356-0072

RADIOACTIVE MATERIAL SPILL, CALL

HEALTH PHYSICS 356-0058

3/97

WALTER REED ARMY INSTITUTE OF RESEARCH
Courtesy: SAFETY Office, WRAIR
(FOREST GLEN)

BLOODBORNE PATHOGENS

1. "UNIVERSAL PRECAUTIONS" means:
Treat all blood and body fluids as if infected with HBV/HIV or other pathogen

2. Wear proper PPE
3. Use Sharps containers
4. Dispose of waste appropriately
5. Decontaminate spills and work-areas

LABORATORY SAFETY

Good housekeeping, keep lab clean.
No eating, drinking or makeup in labs.
Use appropriate PPE.
Check Fire Extinguisher, Eye-wash.

IMPORTANT PHONE NUMBERS

WRAIR Director	782-3551/3552
WRAIR HQ's & CQ	782-7209/3333
WRAIR Safety	782-3019/0955
WRAIR ORDERLY RM	782-7696/4110

WRAMC

FIRE DEPARTMENT	295-7543/7544
AMBULANCE	295-7543/7544
MILITARY POLICE	295-7554/7545
INDUSTR. HYGIENE	356-0072
HEALTH PHYSICS	356-0058
RED CROSS	782-6362/6365


PLYERS MILL ROAD
METROPOLITAN AVE
KENSINGTON
MORMON TEMPLE
ARMY MEDICAL CENTER
PARK
MANOR ROAD
JONES BRIDGE ROAD
Coquelin Run
WEST EAST
MONTGOMERY HILLS
MONTGOMERY COUNTY
CONNECTICUT
185
495
97
390
186
37
62

APPENDIX E

STATISTICAL ANALYSIS OF SAMPLING DATA

DATA ANALYSIS FORMULAS AND SUMMARY TABLES

1. FORMULAS.

a. Mean. The mean is an estimate of the central tendency of a data set. The mean of a data set is represented by the symbol $\bar{x}$ and is the sum of all values divided by the number of data points (n).

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

b. Variance. The variance is the most fundamental way of expressing data spread; however, it is not very easily interpreted. The variance of a data set is represented by s^2 and it is calculated by the following formula.

$$s^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$$

c. Standard Deviation. The standard deviation is represented by the square root of the variance, termed the standard deviation (s).

d. The Shapiro-Wilk W test for Normality. For the W test, the null hypothesis is that the population has a normal distribution; the alternative hypothesis is that the population does not have a normal distribution. To conduct the test, the data set is first ordered from smallest to largest, so that x_1 is the smallest value and x_n is the largest value. The test statistic (W_{calc}) is then computed as follows:

$$W_{calc} = \frac{\left[\sum_{i=1}^{k} a_i * (x_{|n-i+1|} - x_{|i|})\right]^2}{s^2 * (n-1)}$$

where:

n = the number of data values (sampling points)

$k = \frac{n}{2}$ if n is even or $\frac{(n-1)}{2}$ if n is odd

Σ = a summation of all values where the index i ranges from 1 to k

a_i = W test coefficients (reference 4, Table 2)

s^2 = the variance of the data set.

(1) To determine whether to accept or reject the null hypothesis, W_{calc} is compared to the value in reference 4, Table 3 which matches the n and the α of the study (where α is the type I error rate equal to 0.05 for this test). If W_{calc} is greater than W_α, the null hypothesis is accepted and it is concluded that the data are normally distributed with 1- α confidence. If W_{calc} is less than W_α , the null hypothesis is rejected and it is concluded that the data are not normally distributed with 1- α confidence.

(2) If the data set is not normal, the next step is to determine if the data are lognormally distributed. This same W test is applied. However, instead of using the data values x_i , each datum is transformed as $y_i = \ln(x_i)$ and the mean, variance and standard deviation are recalculated. Now, the null hypothesis is that the data are lognormally distributed and the alternative hypothesis is that the data are not lognormally distributed. The decision to accept or reject the null hypothesis is exactly the same as described above.

(3) If the data set does not pass either test, it should be considered lognormal. This is because the EPA has stated that environmental data are usually lognormally distributed in their *Supplemental Guidance to RAGS: Calculating the Concentration Term.*

e. The 95th Percentile. The 95th percentile of a set of data, which has been sorted from smallest to largest, is the value that has 95 percent of all data below it and 5 percent of all data above it. For normally distributed data, the mean plus 1.645 times the standard deviation gives the 95th percentile for the data set, as shown below. For lognormally distributed data, the same calculation is completed on the transformed data statistics, followed by taking the exponential of the result. This provides the 95th percentile in original units.

$$95th\ percentile = \bar{x} + (1.645 * s)$$

f. The 80 percent Upper Confidence Limit. The 80 percent Upper Confidence Limit (UCL) on the mean is computed as follows for normal data. The value of $t_{0.20}$ is found in reference 4, Table 1.

$$80\%UCL = \bar{x} + t_{0.20} * \left[\frac{s}{\sqrt{n}}\right]$$

$$80\%UCL = e^{(\bar{y}+0.5*s_y^2+(s_y*H_{1-0.20})/\sqrt{n-1})}$$

For lognormal data, the 80% UCL on the mean is calculated as
where $\bar{y}$ and s_y are the mean and standard deviation of the transformed data and $H_{(1-0.20)}$ is determined from reference 4, Table 4, based on the values of s_y and n.

g. Relative Percent Difference. The Relative Percent Difference (RPD) is an estimate of the variability between split or co-located (duplicate) samples and is used to determine the extent to which heterogeneous media, field and laboratory techniques contribute to data variation beyond that seen on the site as a whole. The RPD is calculated as the difference between the two results divided by their average and expressed as a percentage. With x_1 and x_2 as the results from an original and duplicate sample respectively, the RPD is calculated as shown below.

$$RPD = \frac{x_1 - x_2}{\frac{1}{2}(x_1 + x_2)}$$

h. Summary Tables. Summary tables are contained on the following pages.

Surface Types 1a and 2: Covered and Uncovered Floor Areas, Laboratory

	diethyl-phthalate	di-n-butylphthalate	butylbenzyl-phthalate	ln(butyl)	bis(2-Ethylhexyl) phthalate	ln(bis)	barium	ln(ba)	cadmium	chromium	ln(cr)	mercury	ln(hg)	lead	ln(pb)	silver
	5	5	4	1.386	6	1.792	2	0.693	1.25	0.5	-0.693	0.1	-2.303	1.6	0.470	1
	5	5	5	1.609	8	2.079	3.4	1.224	1.25	0.5	-0.693	0.22	-1.514	3.1	1.131	1
	5	5	5	1.609	8	2.079	3.4	1.224	1.25	0.5	-0.693	0.25	-1.386	3.1	1.131	1
	5	5	5	1.609	9	2.197	3.6	1.281	1.25	0.5	-0.693	0.27	-1.309	4.1	1.411	1
	5	5	6	1.792	11	2.398	3.6	1.281	1.25	0.5	-0.693	0.28	-1.273	5	1.609	1
	5	5	9	2.197	16	2.773	3.6	1.281	1.25	0.5	-0.693	0.36	-1.022	9.2	2.219	1
	5	5	9	2.197	18	2.890	3.7	1.308	1.25	1.2	0.182	0.51	-0.673	11	2.398	1
	5	5	32	3.466	18	2.890	4	1.386	1.25	1.3	0.262	0.99	-0.010	12	2.485	1
	5	5	33	3.497	56	4.025	5.5	1.705	1.25	1.5	0.405	2	0.693	14	2.639	1
	5	5	52	3.951	61	4.111	6.7	1.902	1.25	3.2	1.163	4	1.386	31	3.434	1
	5	5	110	4.700	130	4.868	10	2.303	1.25	3.7	1.308	69	4.234	120	4.787	1
	5	5	120	4.787	140	4.942	11	2.398	1.25	4.8	1.569	140	4.942	280	5.635	1
	10	14	310	5.737	180	5.193	15	2.708	15	8.3	2.116	150	5.011	290	5.670	2.3
Mean	5.385	5.692	53.846	2.965	50.846	3.249	5.808	1.592	2.308	2.077	0.219	28.306	0.521	60.315	2.694	1.100
Standard Error	0.385	0.692	24.021	0.409	16.683	0.338	1.069	0.160	1.058	0.654	0.283	15.289	0.719	28.998	0.477	0.100
Median	5.000	5.000	9.000	2.197	18.000	2.890	3.700	1.308	1.250	1.200	0.182	0.510	-0.673	11.000	2.398	1.000
Mode	5.000	5.000	5.000	1.609	8.000	2.079	3.600	1.281	1.250	0.500	-0.693	#N/A	#N/A	3.100	1.131	1.000
Standard Deviation	1.387	2.496	86.609	1.474	60.151	1.217	3.855	0.577	3.814	2.357	1.022	55.126	2.593	104.553	1.719	0.361
Sample Variance	1.923	6.231	7501.141	2.173	3618.141	1.482	14.862	0.333	14.543	5.555	1.044	3038.879	6.723	10931.411	2.954	0.130
Range	5.000	9.000	306.000	4.350	174.000	3.401	13.000	2.015	13.750	7.800	2.809	149.900	7.313	288.400	5.200	1.300
Minimum	5.000	5.000	4.000	1.386	6.000	1.792	2.000	0.693	1.250	0.500	-0.693	0.100	-2.303	1.600	0.470	1.000
Maximum	10.000	14.000	310.000	5.737	180.000	5.193	15.000	2.708	15.000	8.300	2.116	150.000	5.011	290.000	5.670	2.300
Sum	70.000	74.000	700.000	38.539	661.000	42.237	75.500	20.694	30.000	27.000	2.848	367.980	6.775	784.100	35.020	14.300
Count	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000
d	23.077	74.769	90013.692	26.081	43417.692	17.783	178.349	4.001	174.519	66.663	12.529	36466.544	80.673	131176.937	35.446	1.560
k	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
w	0.332	0.332	0.668	0.908	0.777	0.909	0.818	0.926	0.332	0.764	0.859	0.592	0.851	0.622	0.927	0.332
w.10	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889

Surface Type 3: Counter Tops

	bis(2-Ethylhexyl)phthalate	barium	mercury	ln(hg)	lead	ln(pb)	silver	ln(ag)
	5	0.75	0.2	-1.61	0.5	-0.69	1	0
	5	1.125	0.2	-1.61	3	1.099	1	0
	5	1.125	0.2	-1.61	3.5	1.253	1	0
	5	1.5	0.22	-1.51	2.3	0.833	1	0
	5	2	0.22	-1.51	2.3	0.833	1	0
	5	2	0.43	-0.84	10	2.303	40	3.688879
Mean	5	1.416666667	0.279166667	-1.45	4.933333333	0.938	7.5	0.614813
Standard Error	0	0.208333333	0.043135768	0.123	1.352199854	0.395	6.5	0.614813
Median	5	1.3125	0.225	-1.56	4.9	0.966	1	0
Mode	5	1.125	0.2	-1.61	6.3	0.833	1	0
Standard Deviation	0	0.510310363	0.10566062	0.301	3.312199672	0.966	15.92168333	1.505979
Sample Variance	0	0.260416667	0.011164167	0.09	10.97066667	0.934	253.5	2.267972
Minimum	5	0.75	0.2	-1.61	0.5	-0.69	1	0
Maximum	5	2	0.43	-0.84	10	2.303	40	3.688879
Sum	30	8.5	1.675	-8.7	29.6	5.627	45	3.688879
Count	6	6	6	6	6	6	6	6
d	0	1.302083333	0.055820833	0.452	54.85333333	4.67	1267.5	11.33986
k	3	3	3	3	3	3	3	3
a1		0.6431	0.6431	0.643	0.6431	0.643	0.6431	0.6431
a2		0.2806	0.2806	0.281	0.2806	0.281	0.2806	0.2806
a3		0.0875	0.0875	0.088	0.0875	0.088	0.0875	0.0875
w		0.899469231	0.431923427	0.616	0.614971059	0.706	0.496293132	0.496293
w.10		0.826	0.826	0.826	0.826	0.826	0.826	0.826

Surface Types 4 and 5: Wall Shelves and Lower Cabinet Shelves and Drawers

	bis(2-Ethylhexyl)phthalate	ln(bis)	barium	ln(ba)	cadmium	ln(cd)	chromium	ln(cr)	mercury	ln(hg)	lead
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	0.5
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	0.5
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	0.5
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	1.3
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	1.4
	5	1.609	0.75	-0.288	1.25	0.223	0.5	-0.693	0.1	-2.303	2
	5	1.609	2	0.693	1.25	0.223	0.5	-0.693	0.1	-2.303	2.3
	5	1.609	2	0.693	1.25	0.223	0.5	-0.693	0.1	-2.303	3
	5	1.609	11	2.398	1.25	0.223	0.5	-0.693	0.29	-1.238	3.9
	8	2.079	14	2.639	1.25	0.223	0.5	-0.693	0.36	-1.022	4.1
	14	2.639	26	3.258	1.25	0.223	0.5	-0.693	0.47	-0.755	5.8
	120	4.787	170	5.136	6.4	1.856	1.6	0.470	0.62	-0.478	9.3
Mean	15.583	1.999	19.125	1.091	1.679	0.359	0.592	-0.596	0.212	-1.826	2.883
Standard Error	9.523	0.269	13.903	0.529	0.429	0.136	0.092	0.097	0.052	0.209	0.754
Median	5.000	1.609	1.375	0.203	1.250	0.223	0.500	-0.693	0.100	-2.303	2.150
Mode	5.000	1.609	0.750	-0.288	1.250	0.223	0.500	-0.693	0.100	-2.303	0.500
Standard Deviation	32.989	0.932	48.162	1.831	1.487	0.471	0.318	0.336	0.181	0.725	2.612
Sample Variance	1088.265	0.869	2319.563	3.353	2.210	0.222	0.101	0.113	0.033	0.525	6.825
Range	115.000	3.178	169.250	5.423	5.150	1.633	1.100	1.163	0.520	1.825	8.800
Minimum	5.000	1.609	0.750	-0.288	1.250	0.223	0.500	-0.693	0.100	-2.303	0.500
Maximum	120.000	4.787	170.000	5.136	6.400	1.856	1.600	0.470	0.620	-0.478	9.300
Sum	187.000	23.991	229.500	13.091	20.150	4.311	7.100	-7.155	2.540	-21.913	34.600
Count	12	12	12	12	12	12	12	12	12	12	12
d	11970.917	9.558	25515.188	36.882	24.312	2.445	1.109	1.240	0.361	5.774	75.077
k	6	6	6	6	6	6	6	6	6	6	6
w	0.371	0.503	0.440	0.785	0.327	0.327	0.327	0.327	0.689	0.681	0.851
w.10	0.883	0.883	0.883	0.883	0.883	0.883	0.883	0.883	0.883	0.883	0.883

Surface Type 6: Lower Cabinet Front Area

	bis(2-Ethylhexyl) phthalate	ln(bis)	mercury	ln(hg)	lead
	5	1.609	1	0	0.5
	5	1.609	1	0	0.5
	5	1.609	1	0	0.5
	5	1.609	1	0	1.2
	5	1.609	1	0	1.4
	6	1.792	24	3.178054	1.8
Mean	5.167	1.640	4.833	0.530	0.983
Standard Error	0.167	0.030	3.833	0.530	0.230
Median	5	1.609	1	0	0.85
Mode	5	1.609	1	0	0.5
Standard Deviation	0.408	0.074	9.390	1.297	0.564
Sample Variance	0.167	0.006	88.167	1.683	0.318
Range	1	0.182	23	3.178	1.3
Minimum	5	1.609	1	0	0.5
Maximum	6	1.792	24	3.178	1.8
Sum	31	9.839	29	3.178	5.9
Count	6	6	6	6	6
d	0.833	0.028	440.833	8.417	1.588
k	3	3	3	3	3
w	0.496	0.496	0.496	0.496	0.832
w.10	0.826	0.826	0.826	0.826	0.826

Surface Type 7a and 8a: Covered and Exposed Laboratory Walls - Destructive Samples

	Diethy-lphthalate	ln(ethyl)	di-n-butylphthalate	butylbenzyl-phthalate	ln(butyl)	bis(2-Ethylhexyl) phthalate	arsenic	ln(as)	barium	ln(ba)	chromium	ln(cr)	mercury	ln(hg)	lead	ln(pb)
	140	4.942	170	165	5.106	170	1200	7.090	32500	10.389	5900	8.683	60	4.094	2900	7.972
	170	5.136	170	170	5.136	205	1300	7.170	33000	10.404	6500	8.780	60	4.094	4050	8.306
	170	5.136	170	170	5.136	750	1500	7.313	37000	10.519	6600	8.795	60	4.094	4300	8.366
	170	5.136	580	170	5.136	790	1500	7.313	41000	10.621	8100	9.000	125	4.828	4700	8.455
	170	5.136	590	170	5.136	1500	2800	7.937	58000	10.968	15500	9.649	470	6.153	14000	9.547
	400	5.991	670	390	5.966	1500	2800	7.937	58000	10.968	17000	9.741	520	6.254	17000	9.741
	585	6.372	965	3400	8.132	1700	3300	8.102	60000	11.002	17000	9.741	660	6.492	20000	9.903
Mean	257.857	5.407	473.571	662.143	5.678	945.000	2057.143	7.552	45642.857	10.696	10942.857	9.198	279.286	5.144	9564.286	8.899
Standard Error	63.993	0.206	117.659	457.371	0.426	238.864	330.121	0.160	4731.750	0.104	1989.599	0.185	98.479	0.422	2717.069	0.302
Median	170.000	5.136	580.000	170.000	5.136	790.000	1500.000	7.313	41000.000	10.621	8100.000	9.000	125.000	4.828	4700.000	8.455
Mode	170.000	5.136	170.000	170.000	5.136	1500.000	1500.000	7.313	58000.000	10.968	17000.000	9.741	60.000	4.094	#N/A	#N/A
Standard Deviation	169.309	0.545	311.297	1210.089	1.126	631.974	873.417	0.423	12519.033	0.276	5263.984	0.489	260.551	1.116	7188.690	0.799
Sample Variance	28665.476	0.297	96905.952	1464315.476	1.268	399391.667	762857	0.179	156726190	0.076	27709523	0.239	67886.905	1.245	51677261	0.638
Range	445.000	1.430	795.000	3235.000	3.026	1530.000	2100.000	1.012	27500.000	0.613	11100.000	1.058	600.000	2.398	17100.000	1.931
Minimum	140.000	4.942	170.000	165.000	5.106	170.000	1200.000	7.090	32500.000	10.389	5900.000	8.683	60.000	4.094	2900.000	7.972
Maximum	585.000	6.372	965.000	3400.000	8.132	1700.000	3300.000	8.102	60000.000	11.002	17000.000	9.741	660.000	6.492	20000.000	9.903
Sum	1805.000	37.848	3315.000	4635.000	39.747	6615.000	14400.00	52.86	319500.00	74.872	76600.000	64.387	1955.000	36.010	66950.000	62.292
Count	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
d	171992.85	1.783	581435.714	8785892.857	7.606	2396350.000	4577142	1.072	940357142	0.458	166257142	1.435	407321.429	7.472	310063571	3.828
k	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
w	0.700	0.743	0.857	0.494	0.601	0.879	0.827	0.843	0.814	0.828	0.775	0.799	0.800	0.795	0.820	0.850
w.10	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838

Relative Percent Difference Calculations

Sample Numbers	Sample Type	Parameter	x1	x2	RPD
WR-713 WR-716	split	diethylphthalate	570	600	-5
		di-n-butyl phthalate	990	940	5
		butylbenzylphthalate	160	170	-6
		bis(2-Ethylhexyl)phthalate	1000	580	53
		arsenic	1100	1300	-17
		barium	32000	33000	-3
		chromium	7500	8700	-15
		mercury	130	120	8
		lead	3900	4200	-7
WR-CR6 WR-CR8	split	bis(2-Ethylhexyl)phthalate	240	170	34
		arsenic	2700	2900	-7
		barium	61000	55000	10
		chromium	16000	15000	6
		lead	17000	17000	0
WR-763 WR-7610	duplicate	barium	1.5	0.75	67
		mercury	0.3	0.1	100
		lead	2.6	3.2	-21
WR-CR2 WR-CR9	duplicate	mercury	0.24	0.55	-78
		lead	1.4	0.5	95