

upon individual instrument sensitivity and levels of monitored analytes expected to be found at the sampling location.

9.2.2 Thermal desorption of soil directly: The analyst must weigh out ~1.00-g of dried soil/sediment sample into a Pyrex petri dish. To this sample is injected 5- μ L of 200-ng/ μ L pyrene-d₁₀ internal standard. The soil is then mixed thoroughly using a scoopula. The probe is then placed on the sample and the PCB's are thermally desorbed by the thermal desorption head of the TDGC. Internal standard concentration will vary dependent upon individual instrument sensitivity and levels of monitored analytes expected to be found at the sampling location.

9.3 TDGC Conditions

9.3.1 For soil and extract thermal desorption, the sample analytes are thermally desorbed off of the Pyrex petri dish by heating the sample head of the GC probe isothermally at 260°C. The sample is introduced at the head of the capillary column by volatilization at 260°C, the carrier gas flow rate through the probe, and the temperature gradient between the thermal desorption head and the initial column temperature. The column temperature is held at 120°C for 40 seconds followed by linear temperature programmed heating to 233°C at 38°C/minute. Follow the temperature program with an isothermal heating period of 80 seconds at 233°C, and then cool the column to 70°C. The total analysis time is 220 seconds. Alternatively, an isothermal TDGC program can be used for introduction of the PCB analytes into the MS system. In this mode of operation, the precision of the measurement falls to 40%, and therefore the QC requirements must be altered accordingly. In this mode of operation, elution time for the octachlorinated biphenyl analytes is achieved in under 120 seconds with minimal instrument thermal cleaning required after the analysis.

9.4 MS Conditions: MS data is collected in the selected ion monitoring (SIM) mode. The SIM mode of the TDGC/MS allows the analysis of up to 12 analytes (one must be reserved for the internal standard) simultaneously. By employing analyte-specific MS algorithms (SiteWorks, Inc. owns the proprietary rights to these algorithms) the targeted PCB's can be detected using up to four representative ions/analyte. Four ions will be selected to monitor each analyte or chlorination (for PCB's), internal standard, and surrogates as needed. Table 2 shows some of the relative target ions for these analytes as well as their relative abundance criteria. Additionally impossible ion, with relative intensity set to 0.0%, is used to filter non-selected PCB ions from those that correspond to the targeted compounds for PCB analysis. Compound identity will be reported when the selected ions normalized to 100% are above background signal at the peak maxima and on either side of one-half the peak maxima on three consecutive scans through the chromatographic peak. The mass filter algorithms incorporate such descriptors as reliability level, warning level, alarm level, and interference which are all described below. When operating in the SIM mode coupled with the rapid GC temperature programming (400 seconds/analysis) TDGC/MS detection limits are improved up to 5 times, and, due to the unique EI fragmentation patterns of the PCB analytes due to the chlorine atoms, interferences are minimal. Details concerning the SIM MS algorithms and detection schemes have been cited elsewhere¹⁻⁴.

9.4.1 The reliability level of the mass spectrometer refers to the difference of the normalized ion current signal abundances and the established ion monitoring designation between the selected ions current signals monitored for each analyte. This parameter has arbitrary units between 0 and 20. Practically, this means that when the signal intensities of the four ions are normalized to approximately the same levels then the instrument reports that the desired compound has been detected. This instrument identifies the presence of such compounds by indicating an alarm to the operator. Smaller values mean that the measured intensities for all ions must be within a small degree of error to their established criteria for positive detection. Typical values for reliability lie between R = 1 and 5 and must be determined from experience. For the reliability criteria to be met, $(d_1 + d_2 + d_3) < 0.3 \times 5$ where d₁, d₂, and d₃ are the differences when the lowest normalized ion current signal difference is subtracted from the three higher normalized ion currents signal differences for the four ions.

9.4.2 The instrument provides so-called warning levels with the presence of potential target compounds. Alarm and warning levels are set in logarithmic intensity units. In general, alarm levels should be at least 0.5 log units above their associated warning levels. These values must be established by experience. If the alarm level is not set higher than the warning level after entering a value for the latter, the alarm level will be automatically set at 0.1 log units higher than the warning level. These settings simply indicate to the operator that the compound has been detected at a predetermined signal intensity level and can be set at the detection limit of the instrument to ensure that low levels are not precluded from compound detection.

9.4.3 The interference parameter has units of log amount and typical values are between 0.5 and 2.0; the best values must be determined from experience. In general, the function of the interference parameter is to suppress alarms when large amounts of interfering substances are present. Larger values mean a higher concentration of an interfering compound is required to suppress an alarm. There is no interfering substance if the maximum ion current for substance A (if substance A has the highest single ion current) minus the average ion current for substance B (average of all four ion currents) in logarithmic values less than the interference number.

10.0 COMPOUND IDENTIFICATION

10.1 Since rapid GC temperature programming devaluates the use of retention time data for compound identification purposes, analyte identification must be based primarily upon the MS data. Through the use of analyst derived MS algorithms, up to four characteristic ions for each target analyte will be monitored during each analysis. Post-analysis ion current amount versus time curves allow for the analyst to positively verify the instrument response by monitoring the normalization of the individual ion current signals over the length of the analysis and to assign a relative retention time window for compound elution with respect to the internal standard.

10.2 Chlorination level isomers that have very similar mass spectra and less than 20 seconds difference in retention time, can be explicitly identified only if the resolution between authentic isomers in a standard mixture is acceptable. Acceptable resolution is achieved if the baseline to valley height between the isomers is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

11.0 CALCULATIONS

11.1 The quantitation of an identified compound should be based on the integrated abundance from the SIM ion response currents of the normalized four characteristic ions given in Table 2.

11.2 Thermal desorption of soil directly.

11.2.1 Calculate the concentration of the PCB analytes directly desorbed from the soil using the response factor generated by direct soil-injected standards analysis and by using the internal standard calculation procedure described in section 8 and Eq. 2:

$$\text{Concentration (ng/g)} = (A_s)(C_{is})/(A_{is})(RF)(W_s)(D)(E) \quad \text{where, [2]}$$

W_s = Weight of the sample (g)

D = (100-% moisture in the sample)/100 where appropriate

The remaining parameters are described in Section 8

11.3 Thermal desorption of solvent extracted analytes.

11.3.1 Calculate the concentration of each identified analyte in the sample as follows:

$$\text{concentration (ng)} = (A_s)(C_s)/(A_d)(RF)(W_s)(D)(E) \quad \text{where,} \quad [2]$$

W_s = Weight of the sample (g)

D = (100-% moisture in the sample)/100 where appropriate

E = extraction efficiency derived from recovery experiments.

12.0 METHOD PERFORMANCE

12.1 Details for the performance of the method are provided in the Appendices that follow as well as the cited references.

13.0 APPENDICES

13.1 APPENDIX I

On-column injection vs. thermal desorption

To compare the difference in MS response between direct on-column injection and thermal desorption using the sampling probe, the following experiment was performed. ERA soils (0.4-g) containing 25 ppm of Aroclor 1254 or 35 ppm of Aroclor 1242 were extracted with 2-mL of hexane. From these solutions, a 10- μ L of internal standard were placed on a Pyrex petri dish and thermally desorbed and analyzed as in Section 9.0 (experiment 1). In contrast, a 3- μ L aliquot of extract and 3- μ L of internal standard were injected on-column and the MS response measured (experiment 2). Comparison (n=5) of the measured relative PCB concentrations from experiments 1 and 2 revealed 92% MS response when the samples were introduced by sample probe desorption versus on-column injection. Importantly, the standard error in the thermal desorption measurement was 3.5% (n=5) and somewhat less (3%) for on-column injection.

13.2 APPENDIX II

PCB recovery rates vs. extraction time

Soil extraction experiments were performed to determine optimum extraction times and corresponding PCB recovery rates. For example, either 0.4-g of back yard soil spiked with 50 ppm of Aroclor 1254 or 0.4-g of standard PCB/ERA soil were added to separate vials containing 2-mL of hexane and shaken for different periods of time. The organic fraction was removed from the vial and analyzed by TDGC/MS. Sample components were separated by the 3.5-m GC column under the experimental conditions stated above. Extraction times were varied between 15 seconds and 1 hour. Two minutes was found to be the optimum time required for both the backyard and ERA soils. The average recovery of PCB's from the soils was about $75 \pm 3\%$ (n=5) after a single extraction. To obtain greater PCB recovery, multiple 2-mL extractions can be performed with diminishing returns. It should be noted that PCB/soil recovery efficiencies may vary from one soil/sediment sample to the next due to different matrix adsorption characteristics. Thus, optimum extraction times may also vary depending upon the composition of the soils and sediments studied. Results of this experiment are shown in Table 3.

13.3 APPENDIX III

PCB recovery rates vs. solvent composition

Three different solvent compositions were tested for PCB extraction efficiency from soil. As shown in Table 4, hexane and methylene chloride yielded the same results. A 50:50 hexane:methylene chloride

mixture resulted in lower recovery rates, about 13% less than when hexane and methylene chloride were used separately. Standard ERA soil (35 ppm in Aroclor 1242) was used for this evaluation. Two grams of the soil extracted with 2-mL of each one of the three solvents for two minutes and the extracts were separated from the soil. A 10- μ L aliquot from the extracts together with 5- μ L of the internal standard were put in a Pyrex petri dish. The compounds were then thermally desorbed and analyzed by TDGC/MS as described in Sections 9.0. The calculated amounts of PCB's were compared to the actual known amounts contained in the extracted soils. A $69 \pm 5\%$ recovery was calculated for hexane and methylene chloride while the 50:50 mixture resulted in recoveries of $60 \pm 5.5\%$. Hexane was used throughout the development of the method.

13.4 APPENDIX IV

PCB recovery rates vs. amount of solvent

The optimum amount of solvent used for the extraction of PCB's from soil was evaluated. Separate 2-g of standard ERA soil (35 ppm in Aroclor 1242) samples were extracted for 2 min with varying volumes of hexane as illustrated in Table 5. The extracts were separated from the soil. A 10- μ L aliquot of extract plus 5- μ L of internal standard were placed on the Pyrex dish. The compounds were thermally desorbed and analyzed by GC/MS as described in Section 9.0. The optimum amount of hexane for 2-g of the specific soil used was found to be 2-mL, which gave a 69% recovery, consistent with the findings from other experiments in the method evaluation. It is understood that this value might differ with different soil matrices and different concentrations of PCB's.

13.5 APPENDIX V

PCB recovery rates vs. soil concentration

The effect of the concentration on the extraction recovery of PCB's from soil was also evaluated. For this, backyard soil was spiked with PCB calibration standard to produce seven different concentration soils, from 5 to 200 ppm. An amount of 2-g of each soil was extracted with 2-mL of hexane for 2 minutes and the extracts were separated from the soil. The same procedure was followed as described above for thermal desorption and analysis of the extracts. Experimental data has shown that the PCB extraction recovery was $75 \pm 4\%$ in the range between 10 and 100 ppm. The higher recovery for the 200 ppm standard soil was expected due to PCB saturation of the soil. The results of this experiment are shown in Table 6.

13.6 APPENDIX VI

PCB TDGC measurement vs. amount injected on dish

Experiments were performed to evaluate the amount of PCB's which could be thermally desorbed through the stainless-steel mesh into the sampling probe. Different amounts of PCB calibration standard covering the range between 15 and 7,500-ng were placed on the Pyrex petri dish and thermally desorbed and analyzed as before. Table 7 illustrates the results of these experiments. The recovery of the PCB's from the dish was found to be constant in the range between 37.5 and 3,750-ng. The reduced measurement for the 7,500-ng injection is due primarily to column overload. The lower measurement for the 15-ng injection was anticipated because the amount injected for some of the chlorination levels is below the minimum detectable amount that passed through the steel mesh membrane (see Appendix 13.7).

13.7 APPENDIX VII

Dynamic ranges of PCB's and pyrene-d₁₀

The mass spectrometer was found to be linear in the concentration range between 7 and 2100-ng total PCB's (standard solution) injected on-column (after removing the sampling head). Table 8 illustrates the

corresponding dynamic range plot for total PCB. The minimum detectable amount of total PCB in the standard solution was found to be 7-ng for those compounds detected. Additionally, chlorination level ion signal measurement precision was evaluated at two different spiked soil concentrations. All measurement precision values were found to be within 20% RSD for all chlorination levels as shown in Table 9. Another experiment was performed to evaluate the linearity of the instrument for pyrene-d₁₀. Different concentration solutions of pyrene-d₁₀ were prepared and injected (n=5) onto the Pyrex petri dish. The instrument was found to be linear in the concentration range between 12 and 4000-ng, and the minimum detectable amount for pyrene-d₁₀ was 12-ng. Results of this experiment are shown in Table 10.

13.8 APPENDIX VIII

Comparison between EPA methods 8080 and 608 and TDGC/MS field method

The method for the fast on-site analysis of PCB's was tested for reliability with the cooperation of EPA, Region 1. Sediment samples from dredged materials from the New Bedford Harbor (MA) Superfund Site were analyzed for PCB's. SF systems (Waltham, MA) developed a remediation method for liquid extraction of soils contaminated with PCB's. Split samples of raw harbor sediment and remediated sediment were analyzed by EPA contractors and the authors. TDGC/MS was performed on-site using the methods described in this paper. The results are presented in Tables 11 and 12.

13.9 APPENDIX IX

Method Detection Limit Studies of Aroclor Mixtures

Method detection limit (MDL) studies were performed according to USEPA procedure 40 CFR part 136 Appendix B. These calculated method detection limits are compared to the CLP contractor required detection limits (CRDL) and the EPA Region IX preliminary remediation goals (PRG's) for risk based assessment as shown in Table 13. Please note that the COP MDL values are based upon electron capture detector response which is inherently more sensitive toward chlorinated biphenyls than MS.

REFERENCES

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3. Robbat, A., Jr., and Abraham, B.M., "Thermal Desorption Gas Chromatography/Mass Spectrometry Fast Field Methods for the Detection of Organic Compounds", the Second International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals, February 12-24, 1991, Las Vegas, NV.
4. Abraham, B.M., Liu, T.Y., and Robbat, A., Jr., *Hazardous Waste & Hazardous Materials Journal*, Volume 9 Number 4, (1993), pp. 461-473.

Table 1. Representative response factors for PCB chlorination levels 1-8.

<u>Chlorination level</u>	<i>Quantitative Method¹</i>		<i>Screening Method²</i>	
	<u>Ave RF</u>	<u>%s</u>	<u>Ave RF</u>	<u>%s</u>
mono-	0.472	20	13.439	19
di-	0.264	17	3.747	25
tri-	0.265	17	3.912	23
tetra-	0.160	15	2.545	16
penta-	0.148	12	2.021	16
hexa-	0.101	15	1.606	16
hepta-	0.056	17	1.036	23
octa-	0.034	10	0.356	19

¹Thermal desorption of standard PCB solution

²Direct PCB/soil thermal desorption

Table 2. Selected ions and relative abundances for PCB chlorination levels and internal standards.

<u>m/z</u>	<u>Relative Intensity</u>	<u>m/z</u>	<u>Relative Intensity</u>	<u>m/z</u>	<u>Relative Intensity</u>
Monochlorobiphenyls		Pentachlorobiphenyls		Pyrene-d₁₀	
188	100.0	324	64.7	212	100.0
190	33.5	326	100.0	211	55.9
152	31.1	328	69.6	210	31.1
189	0.0	325	0.0		
Dichlorobiphenyls		Hexachlorobiphenyls		Phenanthrene-d₁₀	
222	100.0	358	51.9	188	100.0
224	69.6	360	100.0	189	15.0
226	11.2	362	91.8		
223	0.0	359	0.0		
Trichlorobiphenyls		Heptachlorobiphenyls		Chrysene-d₁₂	
256	100.0	392	44.8	240	100.0
258	100.0	394	100.0	241	20.1
260	33.5	396	100.0		
257	0.0	395	0.0		
Tetrachlorobiphenyls		Octachlorobiphenyls			
290	80.5	356	31.1		
292	100.0	358	51.9		
294	51.9	360	35.9		
291	0.0	357	0.0		

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Table 3. Amount of PCB's detected after extraction of two soil compositions for different periods of time (n=5 at each extraction time).

A. ERA soil

<u>Time of Extraction (sec)</u>	<u>Soil Concentration (theoretical, ppm)</u>	<u>% Det</u>	<u>%s</u>
15	35	57	4
30	35	61	5
60	35	70	6
120	35	70	5
300	35	70	9
600	35	74	5
1800	35	74	4
3600	35	76	8

B. Backyard soil

<u>Time of Extraction (sec)</u>	<u>Soil Concentration (theoretical, ppm)</u>	<u>% Det</u>	<u>%s</u>
15	50	10	10
30	50	23	9
60	50	43	12
120	50	72	8
300	50	70	10
600	50	74	7
1800	50	72	9
3600	50	70	12

Table 4. Amount of PCB's* detected after two minute extraction with three solvent compositions (n=5 for each solvent composition).

<u>Solvent</u>	<u>Soil Concentration (theoretical, ppm)</u>	<u>% Det</u>	<u>%s</u>
hexane	35	69	5
methylene chloride	35	69	5
meth. chlor./hexane 50:50	35	60	6

*ERA soil, 35ppm in Aroclor 1242

Table 5. Amount of PCB's^a detected after two minute extraction with three solvent volume compositions (n=5 for each solvent volume).

<u>Hexane Volume (mL)</u>	<u>Soil Concentration (theoretical, ppm)</u>	<u>% Det</u>	<u>%s</u>
2	35	69	16
4	35	50	4
6	35	40	4
8	35	34	5
10	35	32	4

^aERA soil, 35ppm in Aroclor 1242

Table 6. Amount of PCB's^a detected after thermal desorption vs. concentration of PCB's spiked into soil (n=5) for each PCB concentration).

<u>Soil Concentration</u> <u>(theoretical, ppm)</u>	<u>%Det</u>	<u>%s</u>
5	69	3
10	75	9
20	71	2
50	77	5
75	76	6
100	76	4
200	92	8

PCB calibration standard

Table 7. Amount of PCB's^a detected after thermal desorption vs. amount injected on dish (n=5 at each amount).

<u>Theoretical Amount (ng)</u>	<u>% Det</u>	<u>%s</u>
15	56	14
37.5	89	17
75	90	10
375	90	9
750	95	13
2250	89	8
3750	85	11
7500	61	8

^aPCB calibration standard

Table 8. Dynamic range for total PCB (n=5), r = 0.997.

<u>Amount injected^a(ng)</u>	<u>Ave signal</u>	<u>%s</u>
7 ^b	1,262	5
28	3,465	16.5
70	32,178	8.5
140	63,771	6.7
210	90,098	12.8
700	673,393	4.4
1400	1,127,366	4.2
2100	1,751,639	2.8

^aPCB calibration standard injected on-column
^bMinimum Detection Limit

Table 9. Average signal by chlorination level for different PCB amounts injected on-column.

A. 70 ng total PCB

<u>Chlorination level</u>	<u>Ave signal</u>	<u>%s</u>
mono-	6,718	12.2
di-	5,444	13.8
tri-	3,572	13.2
tetra-	3,572	13.2
penta-	3,367	12.2
hexa-	3,000	10.8
hepta-	3,777	10.8
octa-	2,674	12.2

B. 28 ng total PCB

<u>Chlorination level</u>	<u>Ave signal</u>	<u>%s</u>
mono-	ND	ND
di-	ND	ND
tri-	605	9.6
tetra-	696	12.9
penta-	970	19.8
hexa-	877	12.8
hepta-	399	12.3
octa-	ND	ND

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Table 10. Dynamic range for pyrene-d₁₀ (n=5), r = 0.9998.

<u>Amount injected (ng)</u>	<u>Ave signal</u>	<u>%s</u>
12*	2,642	11
40	7,535	11
100	71,264	13
400	398,107	3
1000	1,258,925	5
4000	5,011,872	4

*Minimum Detection Limit

Table 11. Comparison of Results for New Bedford Harbor Superfund Site Demonstration: CF Systems (Waltham, MA).

<u>Test #4</u>	<u>Method 8080</u>		<u>Field TDGC/MS</u>		<u>Method 608</u>	
	<u>conc (ppm)</u>	<u>*</u>	<u>conc (ppm)</u>	<u>%s (n=7)</u>	<u>conc(ppm)</u>	<u>**</u>
Raw Feed	2553	-	8200	6.5	8700	-
Pass 1	1000	-	1444	8.0	NP	-
Pass 2	990	-	447	6.0	NP	-
Pass 3	672	-	89	4.8	NP	-
Pass 4	325	-	43	10.6	350	-

NP = not performed

* 21% fell within defined acceptance criteria relative % difference between calculated MS/MSD

** recoveries of congeners and surrogates for some isomer groups fell outside the defined acceptance criteria

Table 12. Chlorination level comparison results between EPA method 608 and field TDGC/MS for Test #4, Raw Feed from New Bedford Harbor Superfund Site Demonstration.

<u>PCB Congener Group</u>	<i>EPA Method 608</i>	<i>Field TDGC/MS (n=7)</i>	
	<u>Concentration (ppm)</u>	<u>Concentration (ppm)</u>	<u>%s</u>
Mono-	39	ND	-
Di-	1150	999	12
Tri-	2800	3670	9
Tetra-	3000	2460	11
Penta-	1400	899	10
Hexa-	260	175	11

ND = not detected

Table 13. Comparison of TDGC/MS method detection limits (MDL^a) with the EPA Region IX preliminary risk assessment remediation goals (PRG) and CLP Contract Required Quantitation Limits (CRQL's) for and PCB's.

<u>Aroclor</u>	<u>PRG Residential (ug/kg)</u>	<u>CLP CRQL (ug/kg)</u>	<u>TDGC/MS MDL (ug/kg)</u>
Aroclor 1248	110	33.0 ^b	75
Aroclor 1254	110	33.0	76
Aroclor 1260	110	33.0	61

^a according to EPA CFR 40, Part 136 Appendix B

^b please note that the CLP MDL is based upon GC/ECD analysis and the ECD is inherently more sensitive to chlorinated biphenyls than an MS detector, however, the TDGC/MS MDL is still lower than the Region IX PRG.

Appendix C

**MARINE CORPS AIR STATION EL TORO
PHASE II REMEDIAL INVESTIGATION/
FEASIBILITY STUDY DRAFT HEALTH AND
SAFETY PLAN ADDENDUM**

**MARINE CORPS AIR STATION EL TORO
EL TORO, CALIFORNIA
INSTALLATION RESTORATION PROGRAM
PHASE II REMEDIAL
INVESTIGATION/FEASIBILITY STUDY
HEALTH AND SAFETY PLAN FINAL ADDENDUM**

16 May 1994

REVISION 0

PREPARED BY:
Southwest Division, Naval Facilities
Engineering Command
1220 Pacific Highway
San Diego, California 92132-5190

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Jacobs Engineering Group Inc.
3655 Nobel Drive, Suite 200
San Diego, California 92122

In association with:
International Technology Corporation
CH2M HILL

1.0 INTRODUCTION

This addendum must accompany the Health and Safety Plan (HSP) for Marine Corps Air Station El Toro Installation Restoration (IR) Program Phase II Remedial Investigation/ Feasibility Study (RI/FS) Draft HSP approved on 8 November 1993. The purpose of the HSP addendum is to add supplementary information as it becomes available. Depending on the type of new information, the addendum may be more or less restrictive than the original plan. In the event that the addendum contains different information than the HSP, the addendum will take precedence. Sections that are not addressed in the addendum do not have changes and, therefore, the HSP will be followed. The information in the HSP is applicable unless identified below. All employees working under the HSP must read this addendum and agree to abide by its provisions as addressed below.

1.3 Description of Field Activities

Soil Gas Survey

A soil gas survey will be conducted in Site 24 and portions of Site 25 prior to the initiation of Phase II RI field activities. Site 24, as described in the Draft HSP, encompasses Sites 7, 8, 9, 10, 11, and 22, and Solid Waste Management Units and Areas of Concern (SWMUs/AOCs) investigated by the Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) where volatile organic compounds (VOCs) were detected. Areas to be investigated within Site 25 (described in the Draft

HSP) are segments of the Bee Canyon Wash and Agua Chinon Wash, which run immediately outside the perimeter of Site 24. Potential VOC source areas identified in the soil gas survey will be investigated further during the Phase II Remedial Investigation (RI).

Utility clearance of approximately 500 soil gas survey locations will be completed using utility maps and geophysical methods. Prior to drilling or direct push activities, the borings will be drilled to 7 feet below ground surface (bgs) with a nondestructive drilling technique (air knife) or hand auger. Soil gas samples will be collected from depths of 12 and 20 feet bgs for a total of 1,000 samples. Approximately 200 subsurface soil samples will be collected.

Surfaces that restrict the driving of soil gas probes include: concrete, asphalt, and Marsden metal aircraft matting. The concrete (approximately 14 inches thick) will have to be cored and the metal matting will have to be cut. After collecting soil gas samples, concrete and asphalt will be patched.

Air knife and soil gas survey work will begin in Level D or Level D (modified) protection as indicated in the Personal Protective Equipment table in Section 6.0 of this Addendum. A Photoionization detector (PID) with an 11.7 eV probe or flame ionization detector (FID) is recommended to measure the potential chemicals of concern, including carbon tetrachloride and hydrocarbon residual.

2.1 Project Organization

The following personnel have been added:

Soil Gas Survey Project Manager:

John Lovenburg/CH2M HILL, SCO

Regional Health and Safety Representative (RHSR):

Lisa Martin, CIH/CH2M HILL, SCO

2.4 Employee Medical Surveillance and Training

Soil Gas Survey

All subcontractor employees shall provide written documentation of their methods of compliance with Title 8 California Code of Regulations (T8CCR) Sections 1509 and 3203 "Injury and Illness Prevention Program." Additionally, air knife and direct push rig subcontractors shall provide documentation of current certification of their medical fitness, training, and respirator fit in accordance with T8CCR Section 5144 "Respiratory Protective Equipment" and 5192 "Hazardous Waste Operations and Emergency Response" (40-hour HAZWOPER training).

3.1 Chemical Hazards and Control

Soil Gas Survey

Build-up of diesel exhaust contaminants while operating heavy equipment in Buildings 296 and 297 shall be controlled by opening high bay doors to provide cross ventilation and placement of explosion-proof fans, as necessary.

3.3 Physical (Safety) Hazards and Controls

Procedures for Locating Buried Utilities

Utility clearance of approximately 500 soil gas survey locations will be completed using utility maps and geophysical methods. Geophysical methods may include ground penetrating radar (GPR), electromagnetic (EM) methods, and magnetic surveys. Geophysical utility clearance will not be conducted on metal matting. Prior to drilling or direct push activities, the borings will be drilled to 7 feet bgs with a nondestructive drilling technique (air knife) or hand auger.

Concrete Coring and Air Knife Activities

The safety hazards and controls for concrete coring shall be provided by the specialty subcontractor performing the work, and is included as Attachment 1 to this Addendum.

The safety hazards and controls for air knife activities shall be provided by the specialty subcontractor performing the work, and is included as Attachment 2 to this Addendum.

5.1.2 Equipment Specification

The equipment listed in the table below shall be utilized during air knife and soil gas survey activities in the sites identified:

Instrument	Tasks	Action Levels	Frequency	Calibration
Dust Monitor: Mini-Ram	Air knife	0-5 mg/m ³ (ab) ¹ >5-10 mg/m ³ (ab) >10 mg/m ³ (ab) Level D Level C Stop work: reevaluate	When visible dust is present in worker's breathing zone, and at 15-minute intervals while elevated readings are sustained.	Zero Daily Pre- and Post-Use
Photoionization Detector (PID): HNu with 11.7 eV lamp for all sites except Site 10; HNu with 10.2 eV lamp for Site 10	Air knife; soil gas sampling	<p>Site 25: 0-1 ppm^{ab} Level D >1.0-10 ppm^{ab} Level C >10-100 ppm^{ab} Level B >100 ppm^{ab} Stop work: reevaluate</p> <p>NOTE: If confirmed that reading is NOT BENZENE, use Action Levels listed below for Site 24.</p> <p>Sites 7, 8, 9, and 22: 0-2 ppm^{ab} Level D >2-20 ppm^{ab} Level C >20-100 ppm^{ab} Level B >100 ppm^{ab} Stop work: reevaluate</p> <p>NOTE: If confirmed that reading is NOT CARBON TETRACHLORIDE, use Action Levels listed below for Site 24.</p> <p>Site 24 (Excluding Sites 7, 8, 9, and 22): 0-5 ppm^{ab} Level D >5-25 ppm^{ab} Level C >25-100 ppm^{ab} Level B >100 ppm^{ab} Stop Work: reevaluate</p>	<p>Air knife activities: Continuously in the employee breathing zone.</p> <p>Soil gas sampling: At the beginning of operations and at 15-minute intervals, in the employee breathing zone.</p>	Daily and Pre-use

Instrument	Tasks	Action Levels	Frequency	Calibration
Flame Ionization Detector (FID): OVA-128 or equivalent	Air knife; soil gas sampling - as a substitute for PID	<p>Site 25: 0-1ppm^{ab} (non-methane)³ Level D >1-10 ppm^{ab} " Level C >10-100 ppm^{ab} " Level B >100 ppm^{ab} " Stop work; reevaluate</p> <p>NOTE: If confirmed that reading is NOT BENZENE, use Action Levels listed below for Site 24.</p> <p>Sites 7, 8, 9, and 22: 0-2 ppm^{ab} (non-methane) Level D >2-20 ppm^{ab} " Level C >20-100 ppm^{ab} " Level B >100 ppm^{ab} " Stop work; reevaluate</p> <p>NOTE: If confirmed that reading is NOT CARBON TETRACHLORIDE, use Action Levels listed below for Site 24.</p> <p>Site 24 (Excluding Sites 7, 8, 9, and 22): 0-5ppm^{ab} (non-methane) Level D >5-25 ppm^{ab} " Level C >25-100 ppm^{ab} " Level B >100 ppm^{ab} " Stop Work; reevaluate</p>	<p>Air knife activities: Continuously in the employee breathing zone.</p> <p>Soil gas sampling: At the beginning of operations and at 15-minute intervals, in the employee breathing zone.</p>	Daily and Pre-use
Colorimetric Tubes: Benzene	Site 25 only: Air knife and soil gas sampling.	0-1 ppm as Benzene Level D >1-10ppm " " Level C >10-100ppm " " Level B >100 ppm " " Stop work; reevaluate	When HNu or OVA readings exceed 1.0 ppm in the breathing zone and every 15 minutes while readings are sustained.	Pump Calibration: Daily, Pre- and Post-Use
Colorimetric Tubes Carbon Tetrachloride (CCl ₄)	Sites 7, 8, 9, and 22 only: Air Knife and soil gas sampling	0-2 ppm as CCl ₄ Level D >2-20 ppm " Level C >20-100 ppm " Level D >100 ppm " Stop work; reevaluate	When HNu or OVA readings exceed 2.0 ppm in the breathing zone and every 15 minutes while readings are sustained.	Pump Calibration: Daily, Pre- and Post-use
Heat Stress Monitor	All tasks	Refer to Subsection 3.4.1 of HSP	Per Subsection 3.4.1 of HSP	Daily
Noise Level Monitor	All tasks (see next column: Action Levels)	Noise measurements are required when voice must be raised to communicate at a distance of 3 feet or less.	Initial measurement and at 30-minute intervals while readings are above 85 dB(A).	Daily
<p>NOTES: 1: ab = above background 2: expl = explosive limit 3: If above background level is detected, with the FID, insert the instrument charcoal filter and take a second reading. Subtract second reading from first reading to determine actual "non-methane" organic vapor concentration. Apply Action Levels as indicated.</p>				

6.0 Personal Protective Equipment (PPE)

The table below summarizes the PPE requirements for Levels D, C, and B for concrete coring, air knife, and soil gas sampling activities. Table 6.3, "Reasons to Upgrade or Downgrade Level of Protection" in the HSP, has not been changed and shall also apply to air knife and soil gas sampling activities.

Task	Level	Body	Foot (ANSI Z 41.1)	Head (ANSI Z 89.1)	Eye (ANSI Z 87)	Hand	Respirator (ANSI Z 88.2)
Concrete coring, air knife, soil gas sampling	D D (modified)	Sites 7, 8, 9, 10, 22, 24, and 25: Disposable Tyvek Coveralls Site 11: Disposable Saranex, Saran Coated Tyvek Coveralls	Steel toe/shank leather safety shoes/boots with neoprene or nitrile shoe/boot covers OR neoprene or nitrile boots with steel toe/shank	Hard hat	Safety glasses or goggles	Inner Gloves: N-Dex or Latex Rubber Site 11: Neoprene Gloves	None required
Air knife, soil gas sampling	C	Same as Level D for Sites listed above	Steel toe/shank leather safety shoes/boots with neoprene or nitrile shoe/boot covers OR neoprene or nitrile boots with steel toe/shank	Hard hat	Safety glasses or goggles, full-face air-purifying respirator (APR)	Inner gloves: N-Dex or Latex Rubber Outer gloves: Nitrile	Full-face APR, Mine Safety Appliance, Inc. (MSA), Ultratwin or equivalent, equipped with GMC-H cartridges for protection against organic vapors, acid gases, dusts, fumes, and mists. (Optional) Full-face Powered Air-Purifying Respirator (PAPR) with the same cartridges as above.

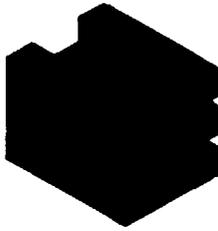
Task	Level	Body	Foot (ANSI Z 41.1)	Head (ANSI Z 89.1)	Eye (ANSI Z 87)	Hand	Respirator (ANSI Z 88.2)
Air knife, soil gas sampling	B	Same as Level D for Sites listed above	Steel toe/shank leather safety shoes/boots with neoprene or nitrile shoe/boot covers OR neoprene or nitrile boots with steel toe/shank	Hard hat	Self- contained breathing apparatus (SCBA) facepiece certified for impact resistance	Inner Gloves: N-Dex or Latex Rubber Outer Gloves: Nitrile	Full-face air-supplied respirator with 30- minute air tank or 5- minute bottle with airline. Each large air bottle is available for 4 person- hours.

9.3 Plan Addenda

Attachment 3 to this addendum is the Health and Safety Plan Addendum Approval.

Attachment 1

CONCRETE CORING SAFETY HAZARDS AND CONTROLS



INDUSTRIAL CONTRACTING ENGINEERS INC.

CORE DRILLING

All electrical cords should be inspected every day before operating equipment.

Below grade investigation should be complete or X-Ray decks for post tension cable before commencement of work.

Base should be securely mounted to deck before commencement of work, unless a architectural finish is required, then a vacuum base is acceptable.

Core driller should never tap segments of core drill bit if diamond glaze over and bit seems not to cut.

Place a small amount of silica sand over the top of the hole.

This should increase the cutting ability of the blade.

Exercise common sense if a problem arises, in this case call the office or Steve Parsons.

C:\WP60\ATHRUG\COR.DRIL

Attachment 2

AIR KNIFE ACTIVITY SAFETY HAZARDS AND CONTROLS

NON-DESTRUCTIVE DRILL (III) OPERATION & SAFETY PROCEDURES

SAFETY

1. Check fluid levels in the air compressor and vacuum pump.
2. Check all hoses for connections and safety tie all compressor hose fittings.
3. As a minimum wear the following personal protective equipment:

Safety toe boots, ear plugs, safety glasses, hard hat and gloves. Additional safety gear may be necessary depending upon site conditions.
4. If you are operating in noise sensitive areas use an exhaust muffler on the venturi.
5. If high levels of VOC's are encountered a carbon filtration system may be necessary.
6. Never allow the air jets to blow against any part of your body or clothing as compressed air can cause injury or death if improperly used.
7. Always use your safety equipment when using air tools. This air drill may propel debris at supersonic speeds so always wear your safety glasses.

OPERATION

1. Turn on the vacuum equipment first (air compressor with venturi and/or vacuum pump).
2. Turn on air supply to tool but make sure that the air valve on the tool is in the off position.
3. Position the tool at the location where you want to drill the hole.
4. Turn on the air valve to allow the compressed air to "blast" the soil away.
5. Rotate the tool in full 360 degree rotations allowing the air jets to cut through the soil.

6. If the tool fails to descend into a hole, shut off the air and inspect the hole for rocks or other debris and clear the hole or reposition if necessary.
7. After the tool has descended all the way down to the quick release coupling, shut off the air and reposition the tool for the next hole.
8. After several holes have been drilled the cyclo-cone separator may need to be emptied. Pull on the handle at the bottom of the cone to open the valve and shovel the soil to a designated receptacle.

Holes deeper than four feet may be drilled by using an extension. To change extensions shut off the air supply, release the camloc type coupling on the tool, remove the extension, line up the internal air fittings on the new extension and lock in place with the camloc levers.

Attachment 3

HEALTH AND SAFETY PLAN ADDENDUM APPROVAL

Addendum Prepared By: *Lisa Martin* Date: April 1994

Lisa Martin, CIH
CH2M HILL Regional Health and Safety Representative

Plan Approved By: *Robert Nash* Date: April 1994

Robert Nash, CIH
CH2M HILL District Health and Safety Manager

Concurrence By: *John Dolegowski* Date: April 1994

John Dolegowski
CH2M HILL Project Manager

Concurrence By: *Ken Tomeo* Date: April 1994

Ken Tomeo
CH2M HILL CLEAN Resource Center Manager

Plan Approved By: *David R. Smith* Date: April 1994

David Smith, CIH, CSP, REA, CHMM
CLEAN Program Health and Safety Manager
Jacobs Engineering Group Inc.

Appendix D

AIR KNIFE FACT SHEET

AIR KNIFE FACT SHEET
(Distributed at the 23 March 1994 RPM Meeting)

Use for the MCAS El Toro Soil Gas Survey

Jacobs Engineering Group Inc. (Jacobs) standard operating procedure (SOP) 7.7 requires that in addition to geophysical utility clearance, "borings will be hand augered to a minimum of 7 feet within developed areas where there is a potential to impact buried utilities. The hole will be reamed by hand auger to at least the diameter of the drill rig auger or bit prior to drilling."

Because hand augering to 7 feet is time consuming and labor intensive, it has been considered cost prohibitive by the Navy. The air knife has been successfully used for utility clearance in lieu of hand augering at the Barstow and Yuma military facilities.

Air Knife Description and Operation

The air knife is a nondestructive drilling system designed by Ventura Petroleum Services, Inc. (VPS) for utility clearance purposes. The air knife will be used to drill a 3- or 4-inch diameter hole to a depth of 7 feet at MCAS El Toro during the Soil Gas Survey for the purpose of clearing soil gas sampling locations for the presence of buried utilities.

The following paragraph is paraphrased from VPS literature:

"The air knife is a drilling implement that delivers compressed air under high pressure to drill soil holes from 2 1/2 to 8 inches in diameter and to depths of 10 feet. A special feature of the equipment is that the displaced dirt is simultaneously vacuumed through a shroud into DOT-17H drums and not left on the surface or blown into the environment. The drilling method will not drill through fiberglass or PVC."

Based on conversations with VPS Senior Engineer Joe Bentley (air knife designer) on 2 March and 21 March 1994, the following additional operational information was gathered.

- **Drilling Times.** For a 7-foot hole, the average drilling time is about 5 to 10 minutes per hole. Sandy soils are drilled very rapidly. Clays and cobbles are slower; where large cobbles are encountered a hand auger may be used to get past a particular depth.

- **Air Circulation.** For the 3-inch diameter unit, air is delivered through a small tube attached to the side wall inside the 3-inch drill casing. The cuttings are vacuumed up through the drill casing.
- **Air Volumes and Pressures.** In order to avoid blowing dust, the vacuumed air volume is greater than the injected air volume, thus creating a net negative pressure. The injected and vacuumed volumes can be adjusted to ensure that cuttings do not blow out the annulus of the borehole, yet the net negative pressure is minimized. The following are the injection and extraction volumes, which can be used to minimize the net volume removed.

Pressures:

Injected - 100 to 125 pounds per square inch (psi)

Vacuumed - Up to 15 inches of mercury (Hg)

Flow Rates:

Injected - Less than 250 cubic feet per minute (cfm)

Vacuumed - Approximately 300 cfm

Make Up Flow Rate = Extracted Flow Rate - Injected Flow Rate

50 cfm = 300 cfm - 250 cfm

Note that 50 cfm of make up air is needed, which may be drawn along the air knife from the ground surface or may be extracted as soil gas from the formation.

The net make up flow rate is supplied down the annulus of the borehole from the surface and from the formation. Since the borehole annulus is potentially the most permeable pathway, the majority of air is likely supplied from the surface. The proportion of air extracted from the formation is of interest, because of the potential of this extraction to affect the measured soil gas concentrations.

In lower permeability formations, the flow rate of make up air from the ground surface is probably much greater than from the formation; in higher permeability formations, the soil gas flow rate may be more comparable. Higher permeability soils drill more quickly, thus reducing the difference between high and low permeability soils in terms of the total volume of soil gas pumped from the formation (flow rate x time =

volume). In general, soils at MCAS El Toro have low permeabilities (mostly sandy silts, silts, silty sands, and clays); therefore, the air knife is expected to draw only a small portion of the make up flow from the formation, but because of the speed of drilling, the formation may be exposed to vacuum for a relatively longer period.

The effect on the formation, and specifically on soil gas measurements to be obtained following the use of the air knife, can be thought of as the movement of soil vapors from beyond the zone to be sampled toward the zone to be sampled. To the extent the soil gas concentrations in these two zones are different, the soil gas in the zone to be sampled may be temporarily out of equilibrium with the VOCs in the soil moisture and other phases. Over a relatively short distance (i.e., several feet), soil gas concentrations are not expected to vary significantly, because of the balancing effect of soil gas diffusion between adjacent soil zones.

The parameters that can be managed to obtain relatively representative soil gas concentrations include: the ability of the air to pass along the annulus (good practice would be to keep from using the air knife when surface soils are moist or wet); minimizing the duration of the air knife drilling; backfilling the borehole with extracted soil following use of the air knife; waiting for a defined period before obtaining a soil gas sample; and providing a buffer zone between the air knife depth and the first soil gas sampling depth.

Assessment of the Affects of the Air Knife on Soil Gas Concentrations in Permeable Soils

The affect of the air knife on permeable soils are addressed below.

Assumptions:

- 50 cfm of make up air is discharged
- 50 percent of the make up air is supplied from the formation
- 5 minutes of drilling time to a depth of 7 feet
- A vadose zone air porosity of 25 percent

In a permeable soil, a total of 250 cubic feet of air would be purged (5 minutes x 50 cfm). Approximately 125 cubic feet of the air is assumed to be supplied by the formation (250 cfm x 50 percent). Approximately 500 cubic feet (approximately 8 x 8

x 8 feet) of formation could be affected (125 cubic feet divided by 25 percent porosity). This volume is approximate by a sphere approximately 10 feet in diameter.

Therefore, even with a 5-foot buffer between the bottom of the air knife hole and the first sample, there is a potential soil gas displacement affect for the sampling zone in permeable soils. (This analysis assumes vertical permeability is equal to horizontal permeability; however, the horizontal permeability is frequently greater [anisotropic conditions]). If the soil is anisotropic, then the affected subsurface zone would be shallower, but wider.

In order to minimize the impact of extracted soil gas on sampled soil gas VOC concentrations, subsequent to drilling to 7 feet with the air knife, the hole will be filled back in with the soil cuttings and allowed to re-equilibrate for a recommended period of 2 days. Soil gas in less permeable soils (silts and clays) will not be as affected by the air knife, so will be sampled without an explicit re-equilibration time. For permeable units, it is proposed to maximize the re-equilibration times. Using these guidelines, representative soil gas concentrations are anticipated.