REPORT ON AIR AND WIPE SAMPLING

1829 CLEMENT AVENUE

BUILDING EVALUATION

Prepared for:

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Prepared by:

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1.0 Introduction

This report addresses the air monitoring and wipe sampling conducted at the building at 1829 Clement Avenue in Alameda, California on April 26, 1990. The monitoring program was conducted in order to characterize the potential exposure of future occupants of the building to chemical constituents known to be used in various processes by former tenants of the building. These chemicals were known to exist in the materials beneath the building. However, it was not known to what extent they were present inside the building, and what exposure pathways may exist for future tenants. Through the sampling it was found that the site constituents are present inside the building at very low levels, if at all, and then only on uncovered or unpainted surfaces. No airborne constituents were found at any amount above detectable levels.

2.0 Sampling Strategy

In order to characterize the average concentrations present in the building, a strategy was chosen in which the existing site chemical data and site observations were used to determine the most likely potential constituents for exposure. Appropriate sampling/analysis methods were then chosen, samples collected and analyzed, and results matched with their respective building locations.

3.0 Selection of Analytes

Analytes for the samples were chosen according to: their prevalence on site; the likelihood of exposure of building occupants; and chemical volatility, toxicity, and carcinogenicity.

Metals (specifically arsenic, beryllium, chromium, copper, molybdenum, and lead), and cyanides were chosen as parameters because site data showed that both were used by the former tenants of the building during the plating and etching operations, and that both are present in the materials beneath the building.

4.0 Sampling Protocol

4.1 Sampling and Analytical Methods

The sampling was conducted in accordance with standardized NIOSH and OSHA methods for sampling and analysis, or a suitable equivalent. Specifically, the methods used for the sampling were: NIOSH Method 7300 for airborne metals; NIOSH Method 7904 for airborne cyanides; and a modified OSHA method for wipe sampling using the appropriate wetting solution. These methods specify QA/QC provisions for instrument calibration, sample media, collection parameters, packaging, storage, preparation for analysis, and analytical procedures. Both air and wipe metals samples were analyzed via inductively-coupled argon plasma spectrophotometry. All cyanide samples were analyzed via ion-specific electrode. A copy of the NIOSH methods cited above are included in Appendix A.

4.2 Recordkeeping

Detailed sample documentation is an integral part of the overall sampling program. This documentation is necessary in order to demonstrate the accuracy and validity of sample data. All sampling data was recorded in ink in the sampling log. Any problems encountered during the sample period were recorded in the log. The following information was also recorded for the samples;

1. Date of sampling;
2. Sample location;
3. Sample identification number;
4. Start and stop times, total minutes sampled, and sample volume (air samples);
5. Pump number (air samples);
6. Pump calibration data and sample flow rate (air samples);

In addition to preserving accurate sampling data, shipping and handling of the samples were documented through the use of a chain-of-custody form which accompanied the samples to the laboratory.

4.3 Sample Media

Several types of media were utilized for the sampling. These media included mixed cellulose ester fiber (MCEF) filters for airborne metals; MCEF filters in conjunction with sodium hydroxide (NaOH) solution in an impinger for airborne cyanides; and Watman ashless filter paper for the wipe sampling. The Watman filters were pre-wetted by the laboratory with NaOH for the cyanides analysis, and were wetted in the field with purified distilled water for the metals analysis.

4.4 Air Sample Collection

4.4.1 Pump Calibration

All sample pumps were calibrated before and after use to verify the accuracy of the flowrate at which the samples were collected. Pumps were calibrated utilizing a precision rotameter, which was in turn calibrated to a Gilibrator primary standard. The lowest of the pre- and post-calibration flowrates was used in the volume determination. The use of the lower air volume results in a higher calculated airborne concentration, and is therefore more conservative.

4.4.2 Sample Placement

The air samples were collected by placing the sample at a location near the middle of each room, attached to a stanchion which allowed the sample to be collected at a height of approximately three feet above the floor. These locations were chosen in order to obtain the average as far as airborne chemical constituents in

the breathing zone throughout the building. Air sample locations are shown on Figure 1. Samples were collected for cyanides at all locations. Metals samples were taken at locations 1, 3, 5, 6, 8, and 9.

4.4.3 Sample Collection

For both the metals and the cyanides air samples, the sampling pump was operated in the high-flow configuration. The pump senses changes in resistance across the filter and adjusts its speed correspondingly, thus assuring a consistent flow rate. The metals samples were collected at a flow rate of approximately two liters/minute (l/min.), while the cyanides samples were run at one l/min. The plastic plugs were removed from the filter cassette and saved for resealing it after the sampling event. For the cyanides samples, the bubbler impinger was put in-line between the filter and the pump. The sampling trains were attached to the pump by a length of tubing such that the air sample was drawn in through the port on the cassette marked "INLET".

4.4.4 Sampling Control

The sample start and stop times were recorded in order to calculate the total sample volume. The pumps were observed periodically throughout the sampling period to verify the consistency of the flowrate, and any problems which arose were noted. No tampering with the samples was tolerated. All samples ran for a period of 480 minutes, except Sample A-4.26C-3. On this sample, the pump faulted out after 317 minutes due to battery failure. Another battery was installed and the pump restarted. The total sampling time, and hence the sample volume, was adjusted to reflect the period during which the pump was not operating. At the end of the sampling period, the shut-off time and the pump timer reading were recorded for all the pumps. The total air volume for each ambient air sample was calculated by multiplying the flowrate by the total

number of minutes sampled.

4.4.5 Sample Handling

The MCEF filter samples for metals were left in the filter cassette for shipment to the laboratory. The cassette plugs were replaced, and the cassettes were placed in a Ziplock bag and stored in a safe location until shipment. The filters for the cyanides samples were removed from the cassettes with tweezers, transferred to a vial supplied by the laboratory, and labelled with the label from the cassette. The impinger solution was transferred to a separate vial, and the impinger was rinsed into the vial with a small amount of fresh NaOH solution. The label was then placed on the vial.

4.5 Wipe Sample Collection

4.5.1 Sample Locations

Sample locations were chosen in order to obtain an average characterization of concentrations of chemicals on exposed surfaces within the building. An effort was made to obtain a worst-case scenario by sampling only those areas which had not recently been painted or covered with new materials. As such, the areas sampled were the sections of original flooring throughout the building, with nearly every room that was used in the former operations being sampled. Both cyanides and metals samples were taken at every location.

4.5.2 Sample Collection

At each location, two adjacent 10-centimeter (cm) by 10-cm squares were marked on the surface to be sampled, one square for the cyanides sample and one for the metals. A clean pair of latex gloves was used for each sample location in order to prevent cross-contamination of samples.

4.5.3 Sample Handling

After each wipe sample was collected, it was placed in a separate pre-labelled vial and the lid was securely fastened. At the end of the sampling, the vials were placed in the cooler for shipment to the laboratory.

4.6 Field Blanks

One field blank was prepared for each type of sample collected. One of each of the sample media was handled as though it were being used to sample. The plugs from the filter cassettes for the metals samples were removed and then replaced. The MCEF filter for a cyanide air sample was removed from the cassette and placed in a vial. An amount of NaOH solution was poured directly into another vial as a blank for the cyanides impinger samples. The Watman filter for the wipe samples for cyanides was briefly taken from its vial and placed back in the same vial. A wipe filter for metals was moistened with the same distilled water used for the other metals samples and placed in a vial. The blank samples were labelled, stored, and shipped in the same manner as the other samples.

4.7 Chain of Custody and Shipment

Each sample number was listed on the chain-of-custody form with the analysis to be performed, along with other pertinent information.

The samples were shipped via overnight delivery to the laboratory. The samples and chain-of-custody were placed in a cooler with blue ice and packing material (the metals samples do not require blue ice.) The cooler was then taped shut to assure evidence of any tampering, and to prevent accidental loss of the samples from the cooler. All samples were sent to Clayton Environmental Consultants, Inc., for analysis. Clayton is a laboratory

accredited by the American Industrial Hygiene Association (AIHA). Chain-of-custody forms for the samples are included in Appendix B.

5.0 Analytical Results

All sample data was reviewed for the sampling procedures followed, recordkeeping, and validity and accuracy of the data. The actual analytical results reported by Clayton are included in Appendix C. The number at the end of each sample identification number corresponds to the location numbers delineated on Figure 1.

Volumes for the air samples ranged from 434 to 480 liters for the cyanides samples, and all metals samples volumes were 960 liters. Detection limits for metals ranged from 1 to 5 micrograms of metal per cubic meter of air (ug/m^3), and for cyanides from 13 to 14 ug/m^3. All of these detection levels are well below the current OSHA Permissible Exposure Limits (PEL)s.

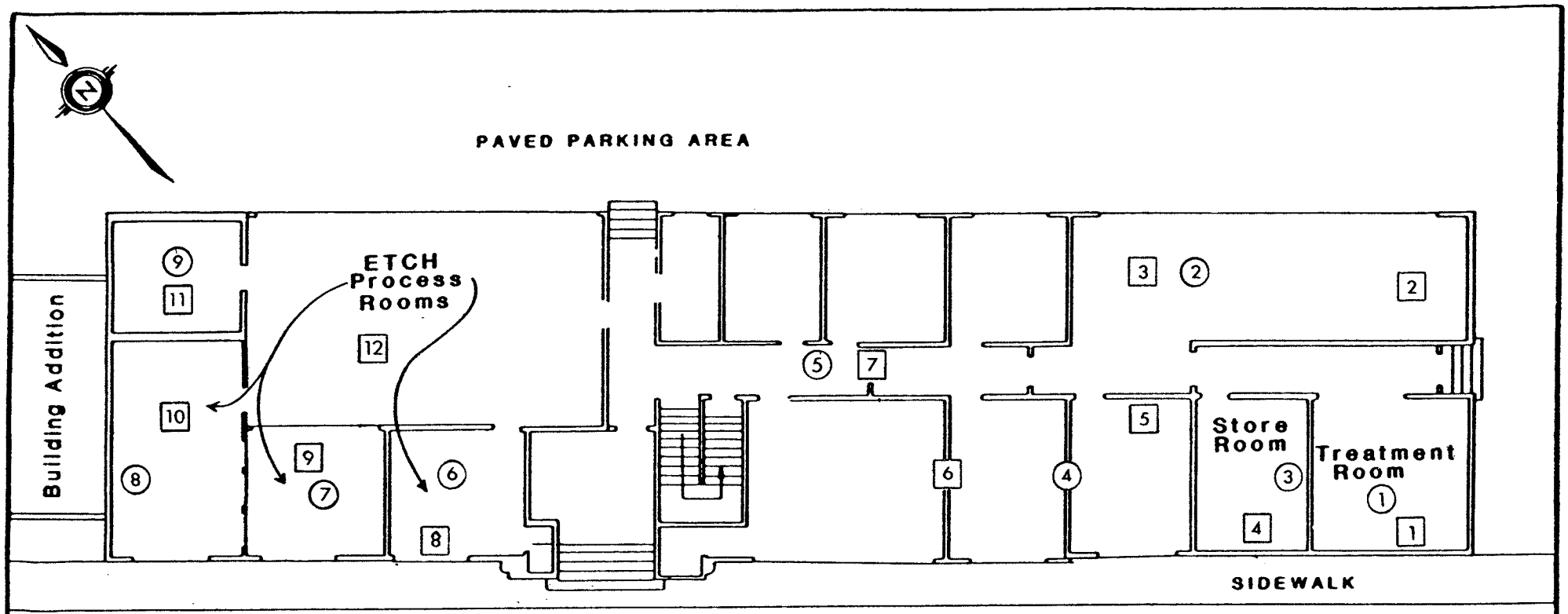
The detection limits for the wipe samples for metals ranged from 2 to 7 ug, while the cyanides detection level was 3 ug.

All of the results for the air samples for both cyanides and metals were below the detection limits, as were all of the cyanides wipe samples. Two of the wipe samples for metals contained amounts just at or above the detection level. The wipe sample from the "Treatment Room", Location 1, contained copper at 7 ug, right at the detection level. The sample from the corner storage room, Location 11, contained lead at 4 ug, just above the detection level of 3 ug.

6.0 Recommendations

As of the writing of this document, the intended use for the building at 1829 Clement Avenue is for business office space. The walls have been painted, some of the floors have been replaced, and other floors have been or are going to be covered over with plywood and carpet. All of these measures will tend to reduce or eliminate any potential exposures which may occur to the occupants through a contact route of exposure. Because of the non-detectable to low concentrations found on the building surfaces, and because the samples were taken as a worst-case example, such measures should be sufficient.

Air quality is not of concern, since the samples were all below the limits of detection, which are all well below OSHA permissible levels.



APPROXIMATE SCALE IN FEET

0 15 30

LEGEND

□ Wipe

○ Air

Kaldveer Associates
Geoscience Consultants
A California Corporation

SITE PLAN

1829 CLEMENT AVENUE
Alameda, California

PROJECT NO	DATE	
KE1179-1	March 1990	Figure 1

APPENDIX A

NIOSH ANALYTICAL METHODS

FORMULA: HCN and salts

M.W.: 27.03 (HCN); 65.11 (KCN)

CYANIDES, aerosol and gas

METHOD: 7904
ISSUED: 2/15/84

OSHA: 11 mg/m³; skin (HCN)
5 mg/m³; skin (cyanides, as CN^-)
NIOSH: 5 mg/m³/10 min (as CN^-) [1]
ACGIH: C 10 mg/m³; skin (HCN);
5 mg/m³; skin (cyanides, as CN)

PROPERTIES: HCN: gas, BP 26 °C
KCN: solid, d 1.52 g/mL, MP 634 °C

SYNONYMS: HCN: hydrocyanic acid, prussic acid, formonitrile, CAS #74-90-8.
cyanides: CAS #151-50-8; CAS #143-33-9.

SAMPLING

SAMPLER: FILTER + BUBBLER
(0.8-µm cellulose ester membrane
+ 10 mL 0.1 N KOH)

FLOW RATE: 0.5 to 1 L/min

VOL-MIN: 10 L @ 5 mg/m³ (as CN^-)
-MAX: 180 L @ 11 mg/m³ (as CN^-)

SHIPMENT: routine

SAMPLE STABILITY: HCN stable in 0.1 N KOH at least 1 week [1]; particulate on filter may liberate HCN gas [2]

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 5 to 21 mg/m³ (HCN) [3];
2.6 to 10 mg/m³ (KCN) [2]

BIAS: not significant [2,3]

OVERALL PRECISION (s_r): 0.081 (HCN) [3];
0.103 (KCN) [2]

MEASUREMENT

TECHNIQUE: ION-SPECIFIC ELECTRODE

ANALYTE: cyanide ion (CN^-)

EXTRACT FILTER: 25 mL 0.1 N KOH; 30 min

RINSE BUBBLER: 2 mL 0.1 N KOH; dilute to 25 mL with 0.1 N KOH

MEASURE: mV reading of cyanide ion electrode vs. reference electrode

CALIBRATION: solutions of KCN in 0.1 N KOH

RANGE: 0.05 to 2 mg CN^-

ESTIMATED LOD: 2.5 µg CN^- [2]

PRECISION (s_r): 0.043 (HCN) [3];
0.038 (KCN) [2]

APPLICABILITY: The working range (as CN^-) is 0.5 to 15 mg/m³ for a 90-L air sample or 5 to 20 mg/m³ for a 10-L air sample.

INTERFERENCES: Sulfide, chloride, iodide, bromide, cadmium, zinc, silver, nickel, cuprous iron and mercury interfere. In humid atmospheres, some particulate cyanide collected on the filter will liberate hydrogen cyanide which will be trapped in the bubbler [2]. The method cannot distinguish between HCN formed in this manner and HCN originally present in air.

OTHER METHODS: This method combines and replaces Methods S288 [4], S250 [5], and P&CAM 116 [6].

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REAGENTS:

1. Double distilled (d.d.) water.
2. Potassium cyanide.*
3. Calibration stock solution, 1000 µg CN^-/mL. Dissolve 0.250 g KCN in 0.1 N KOH to make 100 mL solution. Stable for at least 1 week in polyethylene bottle.
4. Potassium hydroxide (KOH), 0.1 N. Dissolve 5.6 g KOH in d.d water; dilute to 1000 mL.
5. Lead acetate paper.
6. Cadmium carbonate (if sulfide present).
7. Hydrogen peroxide, 30% (if sulfide present).
8. Sodium sulfite, 1 M (if sulfide present).

*See Special Precautions.

EQUIPMENT:

1. Sampler: mixed cellulose ester membrane filter, 37-mm diameter, 0.8-µm pore size, followed by a glass midget bubbler containing 15 mL 0.1 N KOH.
2. Personal sampling pump, 0.5 to 1 L/min, with splashover protection and flexible connecting tubing.
3. Vials, polyethylene, with screw caps, 20-mL, and plastic tape for sealing.
4. Cyanide ion electrode, (Orion 94-06 or equivalent).
5. Reference electrode.
6. pH meter, readable to 0.1 mV.
7. Magnetic stirrer and stirring bars.
8. Jars, ointment, 60-mL, squat-form with aluminum-lined screw caps.
9. Pipets, 0.05- to 2-and 25-mL, with pipet bulb.
10. Volumetric flasks, 25-mL.
11. Beakers, 50-mL.
12. Analytical balance, readable to 0.1 mg.

SPECIAL PRECAUTIONS: Hydrogen cyanide gas and the cyanide particulates may be fatal if swallowed, inhaled or absorbed through the skin. Work in a hood.

Amyl nitrite is the antidote for cyanide poisoning [1].

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at 0.5 to 1 L/min for a total sample size of 10 to 180 L.
   NOTE: Maintain bubblers in a vertical position during sampling. Do not allow the solution level to fall below 10 mL.
3. Remove the bubbler stem and tap it gently against the inside wall of the bubbler. Rinse the bubbler stem with 1 to 2 mL of unused 0.1 N KOH. Add the rinse to the bubbler.
4. Quantitatively transfer the contents of the bubbler to a 20-mL vial. Close cap tightly and wrap with plastic tape to avoid sample loss during transit. Label each vial.

SAMPLE PREPARATION:

5. Transfer the filter from the cassette filter holder to a 60-mL ointment jar.
6. Pipet 25.0 mL 0.1 N KOH into the jar. Cap and allow to stand for at least 30 min with occasional shaking to complete extraction. Analyze within 2 hrs after extraction.
7. Empty the contents of the vial into a 25-mL volumetric flask using 0.1 N KOH to rinse the vial. Add rinse to the volumetric flask. Dilute to the mark with 0.1 N KOH.
   NOTE: Sulfide ion irreversibly poisons the cyanide ion specific electrode and must be removed if present. Check for the presence of sulfide ion by touching a drop of sample to a piece of lead acetate paper; the paper will discolor in the presence of sulfide ion. If this test is positive, remove sulfide by one of the following methods:
   a. Add 1 mL 1 M H_2O_2 and 1 mL 1 M Na_2SO_3 to sample solutions prior to diluting to volume; or

b. Add a small amount (spatula tip) of powdered cadmium carbonate to the sample. Swirl to disperse the solid and recheck the liquid with lead acetate paper. If sulfide ion has not been removed completely, add more cadmium carbonate. Avoid a large excess of cadmium carbonate and long contact time with the solution. When a drop of liquid no longer discolors a strip of lead acetate paper, filter the sample through a small plug of glass wool in a Pasteur pipette and proceed with the analysis.

CALIBRATION AND QUALITY CONTROL:

8. Prepare at least five working standards fresh daily to cover the range 50 to 2000 µg CN^- per sample by diluting aliquots of 1000 µg/mL calibration stock solution with 0.1 N KOH (e.g., 0.05 to 2.0 mL calibration stock solution diluted to 25 mL).
9. Analyze the working standards according to steps 11 and 12 together with the samples and blanks.
10. Prepare a calibration graph on semilog paper by plotting cyanide ion concentration on the logarithmic axis and mV on the linear axis.

MEASUREMENT:

11. Transfer the solution to be measured to a 50-mL beaker. Immerse the cyanide ion electrode and reference electrode in the sample and start the magnetic stirrer.
12. With the magnetic stirrer on, allow the potential reading to stabilize. Record the mV reading.

NOTE 1: Potential readings are a function of temperature. Measure samples and working standards at the same temperature (± 2 °C).

NOTE 2: The cyanide electrode will malfunction if chloride, iodide and bromide ions, which form insoluble silver salts, are present in sufficient quantity. Several metal ions are also known to complex with cyanide such as cadmium, zinc, silver, nickel, cuprous iron and mercury. Consult the electrode instruction manual for the procedure to use when such ions are present.

CALCULATIONS:

13. Read the mass, µg, of cyanide ion present in the sample filter (W_f), sample bubbler (W_b), average media blank filter (B_f) and media blank bubblers (B_b) from the calibration graph.
14. Calculate the concentration (mg/m³) of particulate cyanide, Cp, and hydrogen cyanide, C_{HCN}, in the air volume sampled, V (L):

$$Cp = \frac{W_f - B_f}{V}, \text{ mg/m}^3 \text{ and } C_{HCN} = \frac{(W_b - B_b) \cdot 1.04}{V}, \text{ mg/m}^3$$

where 1.04 is the stoichiometric conversion factor from CN^- to HCN.

NOTE: Particulate cyanides will be collected on the filter. In humid atmospheres, however, it has been observed that during the collection of particulate cyanide, HCN is gradually liberated [2]; therefore, particulate cyanide interference is not completely removed.

EVALUATION OF METHOD:

HCN: Method S288 was issued on September 2, 1977 [4]. Test atmospheres of HCN were generated by calibrated flow from a compressed mixture of HCN in nitrogen [3,7]. The range of HCN concentrations in air was 5 to 21 mg/m³ for 12-L air samples. Eighteen HCN samples collected at 0.2 L/min for 60 min indicated overall precision of 6.2%, with a 96.7% recovery. An eight-day storage stability study involving six samples at the OSHA standard concentration

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level indicated a 92.4% average recovery for the one-day old samples and a 92.6% for eight-day old samples. A collection efficiency study at twice the OSHA standard level, which included backup bubblers, indicated that an average of 99.8% of HCN was collected in the first bubbler. The HCN air generated concentrations were independently confirmed by a titration method [3].

KCN: Method S250 was issued on January 30, 1976 [5]. A set of six weighed KCN samples in the range of 1.8 to 2.5 mg KCN per filter indicated a 97% recovery and a 3.8% measurement precision [2]. Spiking with aqueous or basic solutions of KCN proved unsuccessful (low recovery) because of the cyanide instability in the presence of water and CO_2. Test atmospheres of KCN were generated by atomization of an aqueous solution (162 g/L) of KCN into a dry airstream. Eighteen KCN samples collected in 0.1 N NaOH at 1.5 L/min for 60 min indicated overall precision, s_r, of 0.09. Collection was accomplished with cellulose ester membrane filters followed with backup bubblers. The collection efficiency at twice the OSHA level was 100.0% on the filters. Cyanide salts are known to decompose in moist air with liberation of HCN. This instabilty was determined with two sets of six samples at the one and two times the OSHA level. Each of the samples which were twice the OSHA level were connected with two backup bubblers. Both sets indicated a loss of 16.5%.

REFERENCES:

[1] Criteria for a Recommended Standard...Occupational Exposure to Hydrogen Cyanide and Cyanide Salts, 5-9, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-108 (1976).
[2] Documentation of the NIOSH Validation Tests, S250, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185 (1977).
[3] Backup Data Report for Hydrogen Cyanide, S288, available as "Ten NIOSH Analytical Methods, Set 5," Order No. BP 287-499 from NTIS, Springfield, VA 22161.
[4] NIOSH Manual of Analytical Methods, 2nd. ed., V. 4, S288, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 78-175 (1978).
[5] Ibid, V. 3, S250, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).
[6] Ibid, V. 1, P&CAM 116, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).
[7] NIOSH Research Report-Development and Validation of Methods for Sampling and Analysis of Workplace Toxic Substances, U.S. Department of Health and Human Services, Publ. (NIOSH) 80-133 (1980).

METHOD REVISED BY: J. Palassis, NIOSH/DPSE; S250 and S288 originally validated under NIOSH Contracts CDC-99-74-45 and 210-76-0123, respectively.

ELEMENTS (ICP)

METHOD: 7300
ISSUED: 2/15/84

M.W.: Table 1

OSHA/NIOSH/ACGIH: Table 1

PROPERTIES: Table 1

ELEMENTS:	aluminum	cobalt	manganese	silver	tungsten
	arsenic	copper	molybdenum	sodium	vanadium
	beryllium	iron	nickel	tellurium	yttrium
	cadmium	lead	phosphorus	thallium	zinc
	calcium	lithium	platinum	tin	zirconium
	chromium	magnesium	selenium	titanium	

SYNONYMS: vary depending upon the compound.

SAMPLING

SAMPLER: FILTER
(0.8-µm, cellulose ester membrane)

FLOW RATE: 1 to 4 L/min

VOL-MIN: Table 1
-MAX: Table 1

SHIPMENT: routine

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: not studied

BIAS: none identified

OVERALL PRECISION (s_r): not evaluated

MEASUREMENT

!
!TECHNIQUE: INDUCTIVELY COUPLED ARGON PLASMA,
! ATOMIC EMISSION SPECTROSCOPY
!
!ANALYTE: elements above
!
!ASHING REAGENTS: conc. HNO_3, 4 mL;
! and conc. $HClO_4$, 1 mL
! CONDITIONS: room temperature, 30 min;
! 150 °C to near dryness
!
!FINAL SOLUTION: 4% HNO_3, 1% $HClO_4$, 10 mL
!
!WAVELENGTH: depends upon element; Table 2
!
!BACKGROUND CORRECTION: spectral wavelength shift
!
!CALIBRATION: elements in 4% HNO_3, 1% $HClO_4$
!
!RANGE: 2.5 to 1000 µg per sample [1]

!ESTIMATED LOD: 1 µg per sample [1]
!
!PRECISION (s_r): Table 2
!

APPLICABILITY: The working range of this method is 0.005 to 2.0 mg/m³ for each element in a 500-L air sample. This is simultaneous elemental analysis, not compound specific. Verify that the types of compounds in the samples are soluble with this ashing procedure.

INTERFERENCES: Spectral interferences are the primary interferences encountered in ICP-AES analysis. These are minimized by judicious wavelength selection, interelement correction factors and background correction [1,2].

OTHER METHODS: This method replaces P&CAM 351 [2] for trace elements. Atomic absorption spectroscopy (e.g., Methods 70XX) is an alternate analytical technique for many of these elements.

ELEMENTS (ICP) METHOD: 7300

REAGENTS:
1. Nitric acid, conc.
2. Perchloric acid, conc.*
3. Ashing acid: 4:1 (v/v) HNO_3:$HClO_4$. Mix 4 volumes conc. HNO_3 with 1 volume conc. $HClO_4$.
4. Calibration stock solutions, 1000 µg/mL. Commercially available, or prepared per instrument manufacturer's recommendation (see step 12).
5. Dilution acid, 4% HNO_3, 1% $HClO_4$. Add 50 mL ashing acid to 600 mL water; dilute to 1 L.
6. Argon.
7. Distilled,deionized water.

*See Special Precautions.

EQUIPMENT:
1. Sampler: cellulose ester membrane filter, 0.8-µm pore size, 37-mm diameter; in cassette filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Inductively coupled plasma-atomic emission spectrometer, equipped as specified by the manufacturer for analysis of elements of interest.
4. Regulator, two-stage, for argon.
5. Beakers, Phillips, 125-mL, or Griffin, 50-mL, with watchglass covers.*
6. Volumetric flasks, 10- and 100- mL.*
7. Assorted volumetric pipets as needed.*
8. Hotplate, surface temperature 150 °C.

*Clean all glassware with conc. nitric acid and rinse thoroughly in distilled water before use.

SPECIAL PRECAUTIONS: Perform all perchloric acid digestions in a perchloric acid hood.

SAMPLING:
1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for a total sample size of 200 to 2000 L (see Table 1) for TWA measurements. Do not exceed a filter loading of approximately 2 mg total dust.

SAMPLE PREPARATION:
3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 5 mL ashing acid. Cover with a watchglass. Let stand 30 min at room temperature.
   NOTE: Start a reagent blank at this step.
5. Heat on hotplate (120 °C) until ca. 0.5 mL remains.
   NOTE: Some species of Li, Mn, Mo, Sn, W, and Zr will not be completely solubilized by this procedure. Alternative solubilization techniques for most of these elements can be found elsewhere [2,3,4,5,6,7].
6. Add 2 mL ashing acid and repeat step 5. Repeat this step until the solution is clear.
7. Remove watchglass and rinse into the beaker with distilled water.
8. Increase the temperature to 150 °C and take the sample to dryness.
9. Dissolve the residue in 2 to 3 mL dilution acid.
10. Transfer the solutions quantitatively to 10-mL volumetric flasks.
11. Dilute to volume with dilution acid.

CALIBRATION AND QUALITY CONTROL:
12. Calibrate the spectrometer according to the manufacturers recommendations.
    NOTE: Typically, an acid blank and 10 µg/mL multielement working standards are used. The following multielement combinations are chemically compatible in 4% HNO_3/1% $HClO_4$:
    a. Ag, Ca, Co, Mn, Pb, V, Zn;
    b. Al, Be, Cd, La, Li, Ni, Tl;
    c. As, B, Ba, Mg, Mo, P, Sn;

d. Cu, Fe, Na, Pt, Sr, Te, Y;
e. Cr, K, Sb, Se, Ti, Zr; and
f. Si, W (distilled water only)

13. Analyze a standard for every ten samples.
14. Check recoveries with at least two spiked media blanks per ten samples.

MEASUREMENT:

15. Set spectrometer to conditions specified by manufacturer.
16. Analyze standards and samples.
    NOTE: If the values for the samples are above the range of the standards, dilute the solutions with dilution acid, reanalyze and apply the appropriate dilution factor in the calculations.

CALCULATIONS:

17. Obtain the solution concentrations for the sample, C_s (µg/mL), and the average media blank, C_b (µg/mL), from the instrument.
18. Using the solution volumes of sample, V_s (mL), and media blank, V_b (mL), calculate the concentration, C (mg/m³), of each element in the air volume sampled, V (L):

$$C = \frac{C_s V_s - C_b V_b}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Method P&CAM 351 was evaluated in 1981 [1,2]. The precision and recovery data were determined at 2.5 and 1000 µg of each element per sample on spiked filters. The precision and recovery data, instumental detection limits, sensitivity, and analytical wavelengths are listed in Table 2. The values in Table 2 were determined with a Jarrell-Ash Model 1160 ICP operated according to manufacturer's instructions.

REFERENCES:

[1] Hull, R.D. "Multielement Analysis of Industrial Hygiene Samples," NIOSH Internal Report, presented at the American Industrial Hygiene Conference, Portland, Oregon (May 1981).
[2] NIOSH Manual of Analytical Methods, 2nd ed., V. 7, P&CAM 351, U.S. Department of Health and Human Services, Publ. (NIOSH) 82-100 (1981).
[3] Ibid, S341 (Lead).
[4] Ibid, V. 2, S5 (Manganese), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).
[5] Ibid, V. 4, P&CAM 271 (Tungsten), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 78-175 (1978).
[6] Ibid, V. 5, P&CAM 173 (Metals by Atomic Absorption), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-141 (1979).
[7] Ibid, V. 3, S183 (Tin), S185 (Zirconium), and S376 (Molybdenum), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).

METHOD REVISED BY: R. DeLon Hull and Mark Millson, NIOSH/DPSE.

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Table 1. Properties and sampling volumes.

Element (Symbol)	Properties: Atomic Weight	Properties: MP, °C	Permissible Exposure Limits, mg/m³ TWA OSHA/NIOSH/ACGIH	Air Volume @ OSHA, L: MIN	Air Volume @ OSHA, L: MAX
Silver (Ag)	107.87	961	0.01/ -- / 0.1	250	2000
Aluminum (Al)	26.98	660	-- / -- / 10.	5 (g)	100 (g)
Arsenic (As)	74.92	817*	0.5/C 0.002/ 0.2	5	2000
Beryllium (Be)	9.01	1278	0.002/ 0.0005/ 0.002	1250	2000
Calcium (Ca)	40.08	842	5 (b)/ -- / 2 (b)	5	200
Cadmium (Cd)	112.40	321	0.2/ 0.04/ 0.05	13	2000
Cobalt (Co)	58.93	1495	0.1/ -- / 0.1	25	2000
Chromium (Cr)	52.00	1890	1.0 (c)/ 0.025/ 0.5 (c)	5	1000
Copper (Cu)	63.54	1083	1.0/ -- / 1.0	5	1000
Iron (Fe)	55.85	1535	10 (b)/ -- / 5 (b)	5	100
Lithium (Li)	6.94	179	0.025 (d)/ -- / 0.025 (d)	100	2000
Magnesium (Mg)	24.31	651	15 (b)/ -- / 10 (b)	5	67
Manganese (Mn)	54.94	1244	C 5/ -- / C 5	5	200
Molybdenum (Mo)	95.94	651	15 (e)/ -- / 10 (e)	5	67
Sodium (Na)	22.99	98	2 (f)/ C 2 (f)/ C 2 (f)	13	2000
Nickel (Ni)	58.71	1453	1/ 0.015/ 1 (c)	5	1000
Phosphorus (P)	30.97	44	-- / -- / 0.1	25 (g)	2000 (g)
Lead (Pb)	207.19	328	0.05/ 0.1/ 0.15	50	2000
Platinum (Pt)	195.09	1769	0.002 (a)/ -- / 1 (c)	1250	2000
Selenium (Se)	78.96	217	0.2/ -- / --	13	2000
Tin (Sn)	118.69	232	2/ -- / 2 (c)	5	500
Tellurium (Te)	127.60	450	0.1/ -- / 0.1	25	2000
Titanium (Ti)	47.90	1675	-- / -- / 10 (b)	5	100
Thallium (Tl)	204.37	304	0.1 (a)/ -- / 0.1 (a)	25	2000
Vanadium (V)	50.94	1890	C 0.5/ 1 (c)/ 0.05 (V_2O_5)	5	2000
Tungsten (W)	183.85	3410	-- / 5 (e)/ 5 (e)	5 (g)	200 (g)
Yttrium (Y)	88.91	1495	1/ -- / 1	5	1000
Zinc (Zn)	65.37	419	5 (b)/ 5 (b)/ 5 (b)	5	200
Zirconium (Zr)	91.22	1852	5/ -- / 5	5	200

(a) soluble
(b) oxide
(c) metal
(d) hydride
(e) insoluble
(f) hydroxide
(g) at the ACGIH TLV

Table 2. Measurement procedures and data (a).

Element	Wavelength (nm)	Instrumental LOD (ng/mL)	Sensitivity (Intensity/ µg/mL)	Recovery (%) @ 2.5 µg/ filter (b)	Recovery (%) @ 1000 µg/ filter	Precision (s_r) (N = 3) @ 2.5 µg/ filter	Precision (s_r) (N = 3) @ 1000 µg/ filter
Ag	328.3	26	0.65	111	91	0.02	0.075
Al	308.2	14	0.23	93	100	0.092	0.023
As	193.7	13	0.57	103	99	0.062	0.026
Be	313.0	1.5	1.29	107	90	0.040	0.034
Ca	315.9	10	0.49	99	95	0.036	0.014
Cd	226.5	1.6	0.83	107	99	0.032	0.020
Co	231.2	7.4	0.38	101	95	0.040	0.005
Cr	205.6	1.3	0.50	98	106	0.053	0.016
Cu	324.8	2.1	0.72	98	99	0.036	0.022
Fe	259.9	3.9	0.13	94	97	0.068	0.016
Li	670.8	2.8	0.48	89	95	0.171	0.043
Mg	279.6	24	0.22	105	106	0.084	0.027
Mn	257.6	0.4	0.74	84	93	0.062	0.035
Mo	281.6	7.0	0.18	94	88	0.023	0.049
Na	589.0	10	0.76	(c)	101	(c)	0.045
Ni	231.6	3.4	0.41	105	97	0.027	0.020
P	214.9	22	0.17	(c)	91	(c)	0.056
Pb	220.4	17	0.42	105	95	0.060	0.011
Pt	203.7	15	0.6°	106	91	0.041	0.075
Se	190.6	21	0.28	105	97	0.068	0.049
Sn	190.0	64	0.43	74	67	0.33	0.16
Te	214.3	29	0.41	102	94	0.050	0.063
Ti	334.9	1.2	0.55	96	108	0.051	0.029
Tl	190.9	17	0.22	103	99	0.043	0.017
V	310.2	3.2	0.88	99	94	0.043	0.014
W	207.9	13	2.58	35	23	0.053	0.60
Y	371.0	0.8	2.35	99	100	0.015	0.013
Zn	213.9	0.6	0.60	101	94	0.013	0.013
Zr	339.2	1.9	0.88	75	98	0.049	0.008

(a) Values reported were obtained with a Jarrell-Ash Model 1160 ICP; performance may vary with instrument and should be independently verified.

(b) 2.5 µg/filter corresponds to 5 µg/m^3 for a 500-L air sample.

(c) Blank levels too high to make accurate determinations

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APPENDIX B

CHAIN-OF-CUSTODY FORMS

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 1 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | **Client Job No.** 89-055

SEND INVOICE TO
- Name: Mary Agnes Nabors
- Company: Environmental Health Cons. | Dept.
- Address: 22955 Caminito Luz
- City, State, Zip: Laguna Hills CA 92653

REPORT RESULTS TO
- Name: Irene Napoli | Title: President
- Company: Environmental Health Consultants | Dept.
- Mailing Address: P.O. Box 117910
- City, State, Zip: Burlingame, CA 94011-7910
- Telephone No.: 347-9805 | Telefax No.: Same

Date Results Required:

Rush Charges Authorized? ~~X~~ Yes ☐ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)
* denotes 48-hour TAT, otherwise normal TAT

*** Explanation of Preservative:**

CLIENT SAMPLE IDENTIFICATION		DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	ANALYSIS REQUESTED: Ni labs (TCP)	FOR LAB USE ONLY
A-4.26M-1	*	4-26-90	MCE	Will Call	1	X	
-3	*		(Air)				
-5	*						
-6							
-8							
-9							
- Please add + analyze a blank of the appropriate lot.							

CHAIN OF CUSTODY (if required)
- Relinquished by: [signature] | Date/Time 4/26/90 - 3:30p
- Relinquished by: | Date/Time
- Method of Shipment:

Received by: | Date/Time

Received at lab by: | Date/Time

Sample condition upon receipt:

Authorized by: [signature] - EHC Date 4-26-90
(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive Novi, MI 48050 (313) 344-1770	Raritan Center 160 Fieldcrest Ave. Edison, NJ 08837 (201) 225-6040	400 Chastain Center Blvd., N.W. Suite 490 Kennesaw, GA 30144 (404) 499-7500	1252 Quarry Lane Pleasanton, CA 94566 (415) 426-2600

DISTRIBUTION:
- WHITE - Clayton Laboratory
- YELLOW - Clayton Accounting
- PINK - Client Retains

7/89 20K

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 2 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | **Client Job No.** 89-055

SEND INVOICE TO
- Name: Mary Agnes Keferos
- Company | Dept.
- Address: See Page 1
- City, State, Zip

REPORT RESULTS TO
- Name: Irene Fanelli | Title
- Company | Dept.
- Mailing Address
- City, State, Zip: See Page 1
- Telephone No. | Telefax No.

Date Results Required:

Rush Charges Authorized? ☒ Yes ☐ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)

* 48-hour TAT for all samples on this page

*** Explanation of Preservative:**

ANALYSIS REQUESTED
(Enter an 'X' in the box below to indicate request; Enter a 'P' if Preservative added*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	Metals (TCLP)	FOR LAB USE ONLY
W-4.26M-1	4-26-90	Whatman	Wipe	1		
-2	"	Ashless	100 cm²			
-3	"	Filter	"			
-4	"	"	"			
-5	"	"	"			
-6	"	"	"			
-7	"	"	"			

CHAIN OF CUSTODY (if required)

Relinquished by: [signature] Date/Time 4/26/90-6.30p

Relinquished by: Date/Time

Method of Shipment:

Received by: Date/Time

Received at lab by: Date/Time

Sample condition upon receipt:

Authorized by: [signature] - FAC **Date** 4-26-90

(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive
Novi, MI 48050
(313) 344-1770

Raritan Center
160 Fieldcrest Ave.
Edison, NJ 08837
(201) 225-6040

400 Chastain Center Blvd., N.W.
Suite 490
Kennesaw, GA 30144
(404) 499-7500

1252 Quarry Lane
Pleasanton, CA 94566
(415) 426-2600

DISTRIBUTION:
WHITE - Clayton Laboratory
YELLOW - Clayton Accounting
PINK - Client Retains

7/89 20K

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 3 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | **Client Job No.** 89-055

SEND INVOICE TO
- Name: Mary Agnes Nefouros
- Company: See page 1 | Dept.
- Address:
- City, State, Zip:

REPORT RESULTS TO
- Name: Irene Fanelli | Title
- Company | Dept.
- Mailing Address: See page 1
- City, State, Zip
- Telephone No. | Telefax No.

Date Results Required:

Rush Charges Authorized? ☐ Yes ☒ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)

Normal TAT for all samples on this page

*** Explanation of Preservative:**

ANALYSIS REQUESTED
(Enter an 'X' in the box below to indicate request; Enter a 'P' if Preservative added*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	Metals (ICP)	FOR LAB USE ONLY
W-4.26M-8	4-26-90	Whatman	Wipe	1	X	
-9		Acetate Filter	100 cm²			
-10						
-11						
-12						
-Blank						

CHAIN OF CUSTODY (If required)

Relinquished by: [signature] Date/Time 4/26/90 1:30p — Received by: — Date/Time

Relinquished by: — Date/Time — Received at lab by: — Date/Time

Method of Shipment:

Sample condition upon receipt:

Authorized by: [signature] **Date** 4-26-90

(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive Novi, MI 48050 (313) 344-1770	Raritan Center 160 Fieldcrest Ave. Edison, NJ 08837 (201) 225-6040	400 Chastain Center Blvd., N.W. Suite 490 Kennesaw, GA 30144 (404) 499-7500	1252 Quarry Lane Pleasanton, CA 94566 (415) 426-2600

DISTRIBUTION:
WHITE - Clayton Laboratory
YELLOW - Clayton Accounting
PINK - Client Retains

7/89 20K

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 1 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | Client Job No. 89-055

SEND INVOICE TO
Name Mary Agnes Notaros
Company Environmental Health Consultants | Dept.
Address 22955 Cancinto Luz
City, State, Zip Laguna Hills, CA 92653

REPORT RESULTS TO
Name Irene Fanelli | Title President
Company Environmental Health Consultants | Dept.
Mailing Address P.O. Box 117910
City, State, Zip Burlingame CA 94011-7910
Telephone No. 415-347-9205 | Telefax No. Send

Date Results Required: | Rush Charges Authorized? ☒ Yes ☐ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)
* denotes 48-hour TAT.

* Explanation of Preservative: otherwise, normal TAT.

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME* (specify units)	Number of Containers	ANALYSIS REQUESTED (Enter an 'X' in the box below to indicate request; Enter a 'P' if Preservative added*) Cyanide	FOR LAB USE ONLY
AA104291 / A-4.26C-1 *	4-26-90	MCE/	Will Call	2	X	
AA10984-1 / -2 *		NaOH				
-845 / -3 *		Hydrogen Peroxide				
-840 / -4 *						
-849 / -5 *						
-842 / -6						
-843 / -7						
848 / -8						
-846 / -9						
-847 / -Blank			Blank			

CHAIN OF CUSTODY (if required)

Relinquished by: [signature] | Date/Time 4/26/90 - 6:30p | Received by: | Date/Time
Relinquished by: | Date/Time | Received at lab by: | Date/Time
Method of Shipment:

Sample condition upon receipt:

Authorized by: [signature] - EHC Date 4-26-90
(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive, Novi, MI 48050, (313) 344-1770
Raritan Center, 160 Fieldcrest Ave., Edison, NJ 08837, (201) 225-6040
400 Chastain Center Blvd., N.W., Suite 490, Kennesaw, GA 30144, (404) 499-7500
1252 Quarry Lane, Pleasanton, CA 94566, (415) 426-2600

DISTRIBUTION:
WHITE - Clayton Laboratory
YELLOW - Clayton Accounting
PINK - Client Retains

7/89 20K

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 2 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | **Client Job No.** 89-055

SEND INVOICE TO
- Name: ~~[redacted]~~ MaryAgnes Nikoros
- Company: See page 1 | Dept.
- Address: See page 1
- City, State, Zip

REPORT RESULTS TO
- Name: Irene Fanelli | Title
- Company | Dept.
- Mailing Address: See Page 1
- City, State, Zip
- Telephone No. | Telefax No.

Date Results Required:

Rush Charges Authorized? ☒ Yes ☐ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)
* 48-hour TAT for all Samples on this page.

*** Explanation of Preservative:**

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	ANALYSIS REQUESTED: Cyanide	FOR LAB USE ONLY
W-4.26C-1 *	4-26-90	Filter	Wipe	1	X	
-2			100cm²			
-3						
-4						
-5						
-6						
-7						

CHAIN OF CUSTODY (if required)
- Relinquished by: [signature] | Date/Time 4/26/90 6:30p
- Relinquished by: | Date/Time
- Method of Shipment:

Received by: | Date/Time

Received at lab by: | Date/Time

Sample condition upon receipt:

Authorized by: [signature] - EMC **Date** 4-26-90

(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive Novi, MI 48050 (313) 344-1770	Raritan Center 160 Fieldcrest Ave. Edison, NJ 08837 (201) 225-6040	400 Chastain Center Blvd., N.W. Suite 490 Kennesaw, GA 30144 (404) 499-7500	1252 Quarry Lane Pleasanton, CA 94566 (415) 426-2600

DISTRIBUTION:
- WHITE - Clayton Laboratory
- YELLOW - Clayton Accounting
- PINK - Client Retains

7/89 20K

Clayton ENVIRONMENTAL CONSULTANTS

A Marsh & McLennan Company

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Clayton Use Only	Page 3 of 3
Project No.	
Batch No.	
Client No.	
Date Received	By
Date Logged In	By

Purchase Order No. | **Client Job No.** 89-055

SEND INVOICE TO
- Name: Mary Agnes Neforos
- Company: | Dept.
- Address: See page 1
- City, State, Zip:

REPORT RESULTS TO
- Name: Irene Farelli | Title
- Company | Dept.
- Mailing Address: See Page 1
- City, State, Zip:
- Telephone No. | Telefax No.

Date Results Required:

Rush Charges Authorized? ☐ Yes ☒ No

Special Instructions: (method, limit of detection, phone results, rush results, etc.)
- Normal TAT for all samples on this page

*** Explanation of Preservative:**

ANALYSIS REQUESTED
(Enter an 'X' in the box below to indicate request; Enter a 'P' if Preservative added*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	Cyanide	FOR LAB USE ONLY
W-4.26C-8	4.26-90	Filter	Wipe	1	X	
-9			100 cm^2			
-10						
-11						
-12						
-Blank						

CHAIN OF CUSTODY (if required)
- Relinquished by: [signature] Date/Time 4/26/90 6:30p
- Relinquished by: Date/Time
- Method of Shipment:

Received by: Date/Time

Received at lab by: Date/Time

Sample condition upon receipt:

Authorized by: [signature] IHC Date 4.26-90
(Client Signature Must Accompany Request)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

22345 Roethel Drive Novi, MI 48050 (313) 344-1770	Raritan Center 160 Fieldcrest Ave. Edison, NJ 08837 (201) 225-6040	400 Chastain Center Blvd., N.W. Suite 490 Kennesaw, GA 30144 (404) 499-7500	1252 Quarry Lane Pleasanton, CA 94566 (415) 426-2600

DISTRIBUTION:
- WHITE - Clayton Laboratory
- YELLOW - Clayton Accounting
- PINK - Client Retains

7/89 20K

APPENDIX C

LABORATORY ANALYTICAL REPORTS

Western Operations

1252 Quarry Lane
Pleasanton, CA 94566
(415) 426-2600
Fax (415) 426-0106

Clayton
ENVIRONMENTAL
CONSULTANTS

May 1, 1990

Ms. Irene Fanelli
ENVIRONMENTAL HEALTH CONSULTANTS. INC.
P.O. Box 117910
Burlingame, CA 94011-7910

Client Ref. No. 89-055
Work Order No. 9004182
Lab Client Code 100662

Dear Ms. Fanelli:

Attached is our analytical laboratory report for the samples received on April 27, 1990. A copy of the Chain-of-Custody form acknowledging receipt of these samples is attached.

Please note that any unused portion of the samples will be disposed of 30 days after the date of this report, unless you have requested otherwise.

We appreciate the opportunity to be of assistance to you. If you have any questions, please contact Maryann Gambino, Client Services Representative, at (415) 426-2657.

Sincerely,

Mary D. Beck for
Ronald H. Peters, CIH
Manager, Laboratory Services
Western Operations

RHP/dt
Attachments

INDUSTRIAL HYGIENE
METALS ANALYSIS

Sample I.D.: See below

Client: ENVIRONMENTAL HEALTH CONS.INC

Sample Received: 04/27/90

Client Ref. No.: 89-055

Samples Analyzed: 04/27/90

Lab Client Code: 100662

Sample Matrix: FILTER

Project No.: 9004182

Lab No.	Sample I.D.	Volume (Liters)	Analyte	Amount (mg)	Conc. (mg/m3)	Detection Limit (mg)
-01	A-4.26M-1	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-02	A-4.26M-3	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-03	A-4.26M-5	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-04	A-4.26M-6	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001

< = Less than the indicated limit of detection (LOD)
-- = Information not available or not applicable

INDUSTRIAL HYGIENE
METALS ANALYSIS

Sample I.D.: See below

Client: ENVIRONMENTAL HEALTH CONS.INC

Sample Received: 04/27/90

Client Ref. No.: 89-055

Samples Analyzed: 04/27/90

Lab Client Code: 100662

Sample Matrix: FILTER

Project No.: 9004182

Lab No.	Sample I.D.	Volume (Liters)	Analyte	Amount (mg)	Conc. (mg/m3)	Detection Limit (mg)
-05	A-4.26M-8	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-06	A-4.26M-9	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-20	BLANK	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001
-21	METHOD BLANK	--	Arsenic	<0.001	--	0.001
			Beryllium	<0.0005	--	0.0005
			Chromium	<0.002	--	0.002
			Copper	<0.002	--	0.002
			Molybdenum	<0.001	--	0.001
			Lead	<0.001	--	0.001

< = Less than the indicated limit of detection (LOD)
-- = Information not available or not applicable

METHOD REFERENCE: NIOSH 7300

INORGANIC LABORATORY ANALYSES

Sample I.D.:	See below	Client:	ENVIRONMENTAL HEALTH
Sample Received:	04/27/90	Client Ref. No.:	89-055
Sample Analyzed:	05/01/90	Lab Client Code:	100662
Sample Matrix:	Wipe	Lab No.:	9004182

Batch Sub. No.	Sample Identification	Arsenic (mg/wipe)	Beryllium (mg/wipe)	Chromium (mg/wipe)
-07A	W-4.26M-1	<0.003	<0.002	<0.007
-08A	W-4.26M-2	<0.003	<0.002	<0.007
-09A	W-4.26M-3	<0.003	<0.002	<0.007
-10A	W-4.26M-4	<0.003	<0.002	<0.007
-11A	W-4.26M-5	<0.003	<0.002	<0.007
-12A	W-4.26M-6	<0.003	<0.002	<0.007
-13A	W-4.26M-7	<0.003	<0.002	<0.007
-14A	W-4.26M-8	<0.003	<0.002	<0.007
-15A	W-4.26M-9	<0.003	<0.002	<0.007
Limit of Detection:		0.003	0.002	0.007
Method Reference:		NIOSH 7300 (Modified)		

< = less than, below limit of detection

INORGANIC LABORATORY ANALYSES

Sample I.D.:	See below	Client:	ENVIRONMENTAL HEALTH
Sample Received:	04/27/90	Client Ref. No.:	89-055
Sample Analyzed:	05/01/90	Lab Client Code:	100662
Sample Matrix:	Wipe	Lab No.:	9004182

Batch Sub. No.	Sample Identification	Arsenic (mg/wipe)	Beryllium (mg/wipe)	Chromium (mg/wipe)
-16A	W-4.26M-10	<0.003	<0.002	<0.007
-17A	W-4.26M-11	<0.003	<0.002	<0.007
-18A	W-4.26M-12	<0.003	<0.002	<0.007
-19A	W-4.26M-Blank	<0.003	<0.002	<0.007
-21B	Method Blank	<0.003	<0.002	<0.007
Limit of Detection:		0.003	0.002	0.007
Method Reference:		NIOSH 7300 (Modified)		

< = less than, below limit of detection

INORGANIC LABORATORY ANALYSES

Sample I.D.:	See below	Client:	ENVIRONMENTAL HEALTH
Sample Received:	04/27/90	Client Ref. No.:	89-055
Sample Analyzed:	05/01/90	Lab Client Code:	100662
Sample Matrix:	Wipe	Lab No.:	9004182

Batch Sub. No.	Sample Identification	Copper (mg/wipe)	Molybdenum (mg/wipe)	Lead (mg/wipe)
-07A	W-4.26M-1	0.007	<0.003	<0.003
-08A	W-4.26M-2	<0.007	<0.003	<0.003
-09A	W-4.26M-3	<0.007	<0.003	<0.003
-10A	W-4.26M-4	<0.007	<0.003	<0.003
-11A	W-4.26M-5	<0.007	<0.003	<0.003
-12A	W-4.26M-6	<0.007	<0.003	<0.003
-13A	W-4.26M-7	<0.007	<0.003	<0.003
-14A	W-4.26M-8	<0.007	<0.003	<0.003
-15A	W-4.26M-9	<0.007	<0.003	<0.003
Limit of Detection:		0.007	0.003	0.003
Method Reference:		NIOSH 7300 (Modified)		

< = less than, below limit of detection

INORGANIC LABORATORY ANALYSES

Sample I.D.:	See below	Client:	ENVIRONMENTAL HEALTH
Sample Received:	04/27/90	Client Ref. No.:	89-055
Sample Analyzed:	05/01/90	Lab Client Code:	100662
Sample Matrix:	Wipe	Lab No.:	9004182

Batch Sub. No.	Sample Identification	Copper (mg/wipe)	Molybdenum (mg/wipe)	Lead (mg/wipe)
-16A	W-4.26M-10	<0.007	<0.003	<0.003
-17A	W-4.26M-11	<0.007	<0.003	0.004
-18A	W-4.26M-12	<0.007	<0.003	<0.003
-19A	W-4.26M-Blank	<0.007	<0.003	<0.003
-21B	Method Blank	<0.007	<0.003	<0.003
Limit of Detection:		0.007	0.003	0.003
Method Reference:		NIOSH 7300 (Modified)		

< = less than, below limit of detection

CLAYTON ENVIRONMENTAL CONSULTANTS, INC.
22345 Roethel Drive Novi, Michigan 48050

Ms. Irene Fanelli
President
ENVIRONMENTAL HEALTH CONSULTANTS
P.O. Box 117910
Burlington, CA 94011-7910

Date Reported: 7-MAY-90
Date Received: 28-APR-90
Clayton Project No. 65309-17
Client Job No. 89-055

Dear Ms. Fanelli:

The following is our report on the samples submitted for analysis.

Table 1

Lab Number	Sample Description	Cyanide Filter (mg)	Cyanide Impinger (mg)	Cyanide Total (mg)
819325	AA-104291/A-4.26C-1	<0.003	<0.003	<0.006
819326	AA-109841/A-4.26C-2	<0.003	<0.003	<0.006
819327	AA-109845/A-4.26C-3	<0.003	<0.003	<0.006
819328	AA-109840/A-4.26C-4	<0.003	<0.003	<0.006
819329	AA-109849/A-4.26C-5	<0.003	<0.003	<0.006
819330	AA-109842/A-4.26C-6	<0.003	<0.003	<0.006
819331	AA-109843/A-4.26C-7	<0.003	<0.003	<0.006
819332	AA-109848/A-4.26C-8	<0.003	<0.003	<0.006
819333	AA-109846/A-4.26C-9	<0.003	<0.003	<0.006
819334	AA-109847/A-4.26C-BLANK	<0.003	<0.003	<0.006
Limit of Detection:		0.003 mg	0.003 mg	0.006 mg
Analytical Method (NIOSH):		7904	7904	7904

ENVIRONMENTAL HEALTH CONSULTANTS
Clayton Project No. 65309-17

Table 2

Lab Number	Sample Description	Cyanide (mg)
819335	W-4.26C-1	<0.003
819336	W-4.26C-2	<0.003
819337	W-4.26C-3	<0.003
819338	W-4.26C-4	<0.003
819339	W-4.26C-5	<0.003
819340	W-4.26C-6	<0.003
819341	W-4.26C-7	<0.003
819342	W-4.26C-8	<0.003
819343	W-4.26C-9	<0.003
819344	W-4.26C-10	<0.003
819345	W-4.26C-11	<0.003
819346	W-4.26C-12	<0.003
819347	W-4.26C-BLANK	<0.003

Limit of Detection: 0.003 mg
Analytical Method (NIOSH): 7904

We appreciate the opportunity to be of assistance to you. Please call our Client Services Department at (313) 344-2650 or me if you have any questions.

Robert Lieckfield Jr., C.I.H.
Manager, Laboratory Services