RETEC

# FINAL REPORT

# PERFORMANCE MONITORING OF THE VAPOR CONTROL SYSTEM LOCATED AT THE UNISYS GREAT NECK FACILITY

RECEIVED
NOV 1 - 1993
HAZARDOUS WASTE REMEDIATION
NYSDEC REGION 1

*Prepared for:*

Unisys Corporation
365 Lakeville Road, MS 1P10
Great Neck, New York 11020

*Prepared by:*

Remediation Technologies, Inc
Damonmill Square
9 Pond Lane
Concord, Massachusetts 01742

Project # 8-1153-200

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# 1.0 INTRODUCTION

Remediation Technologies, Inc. (RETEC) was contracted to conduct a performance monitoring program on a newly installed soil vapor off-gas control system located at the Unisys Great Neck, New York facility. The monitoring program was designed to validate the effectiveness of the system, which was designed to achieve an organic destruction efficiency for the compounds of concern of 95 to 99 percent. Compounds of concern for this program are presented in Table 1-1.

The Unisys vapor control system was comprised of two major components: a catalytic oxidizer to control volatile organic compounds (VOCs); and a spray chamber scrubber to control hydrogen chloride (HCL). Details of the vapor control system are presented in Section 2.0.

RETEC performed simultaneous sampling of the inlet and outlet vapor stream of the catalytic oxidizer to determine the efficiency of the vapor control system. Outlet sampling was performed on the HCL scrubber to determine its emission rate. Three sample test runs were performed as part of the emission monitoring program. Sampling procedures followed the methods presented in the RETEC Work Plan (September, 1993). Results from the sampling and analytical programs are presented in Sections 3.0 and 5.0 of this document.

## Table 1-1

## Compounds of Concern
## For the Vapor Monitoring Program
## Unisys Corporation
## Great Neck, New York

| Compounds |
|---|
| Benzene |
| 2-Butanone (MEK) |
| Chloroform |
| 1,2-Dichlorobenzene |
| 1,2-Dichloroethane |
| 1,1-Dichloroethene |
| 1,2-Dichloroethene (total) |
| Ethylbenzene |
| Methylene Chloride |
| Tetrachloroethene |
| Toluene |
| 1,1,1-Trichloroethane |
| Trichloroethene |
| Xylene |
| Freon 113 |
| Naphthalene |
| Hydrochloric Acid |

# 2.0 SITE HISTORY

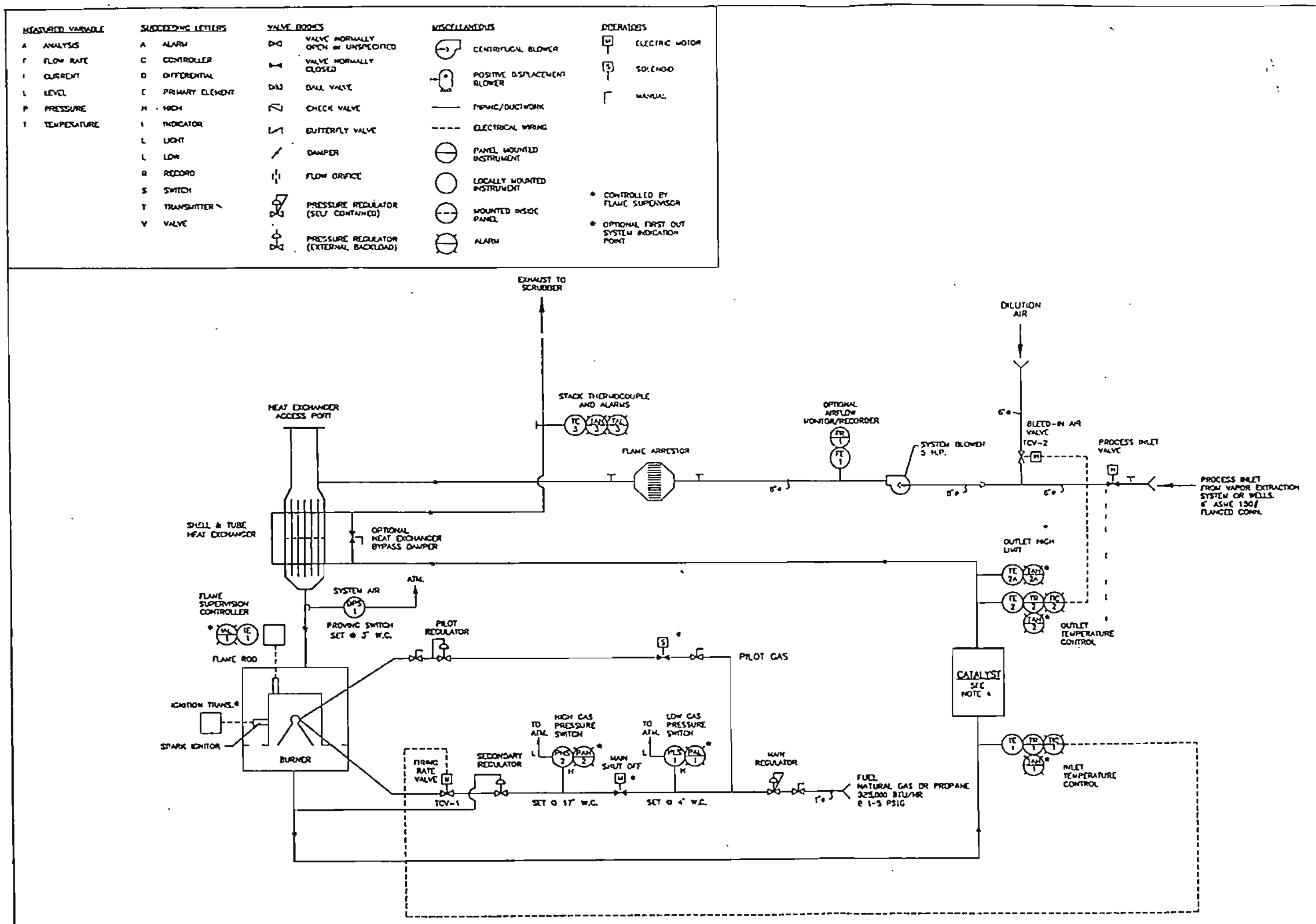
In December 1991, a pilot soil vapor extraction (SVE) test was performed by Unisys at their Great Neck facility. Data collected during the program was used to estimate organic levels in the vapor stream to evaluate and select an appropriate vapor control system. Based on the results of the SVE program test, Unisys chose catalytic oxidation as the vapor control system.

## 2.1 VAPOR CONTROL SYSTEM

Treatment of the extracted vapors was achieved by catalytic oxidation. Unisys chose a Chloro-Cat oxidizer, manufactured by Global Technologies, Inc., for the thermal oxidizer. A schematic of the system is presented in Figure 2-1.

Organic laden air is drawn into the system by way of a soil vapor vacuum blower and then through a heat exchanger prior to the natural gas fired burner. The burner raises the temperature of the vapors to the catalyzing temperature of approximately $650^{\circ\mathrm{F}}$. The organics in the stream are converted to carbon dioxide, water vapor and inorganic acids. A spray chamber scrubber is used to neutralize the inorganic acids prior to the release to the atmosphere. A schematic of the scrubber system is presented in Figure 2-2.

The treated vapors leave the scrubber and enter the discharge stack at a temperature of approximately 135°F. The stack is eight inches in diameter, thirty-five feet high, and terminates ten feet above the roof of the building.



NOTES
1. THE PROCESS INLET VALVE IS HELD CLOSED AND THE DILUTION AIR VALVE IS HELD OPEN UNTIL THE CATALYST OUTLET TEMPERATURE REACHES A PRESET LEVEL.
2. THE DILUTION AIR VALVE IS CONTROLLED BY THE EXOTHERM CAUSED BY THE LEVEL OF SOLVENT LOADING. AS THE OUTLET TEMPERATURE RISES THE DILUTION AIR VALVE WILL OPEN TO KEEP THE UNIT FROM SHUTTING DOWN ON HIGH OUTLET TEMPERATURE.
3. THE STACK TEMPERATURE IS MONITORED TO PREVENT HCl CONDENSATION. IF A LOW STACK TEMPERATURE IS DETECTED THE INLET VALVE CLOSES AND THE DILUTION AIR VALVE OPENS.
4. SYSTEM CATALYST VOLUME REQUIREMENT IS DEPENDENT UPON SPECIFIC PROCESS VOLUME AND CONSTITUENTS AS WELL AS CATALYST MANUFACTURER GUARANTEES FOR THE SPECIFIC STREAM. CATALYST CAPACITY IS AS FOLLOWS:
   MODEL 7 CHLOOCAT – 3 CU.FT.

GLOBAL
Global Technologies, Inc.
Milwaukee, Wisconsin

| | | | | |
|---|---|---|---|---|
| SCALE N.T.S. | | CUSTOMER UNISYS CORP. | | |
| DRAWN JPW | DATE 10-7-92 | | | |
| CHECKED | DATE | JOB NO. 72 | DRAWING NO. 72-1 | REV. |
| APPROVED | DATE | DWG TO DRTI-CO | PAGE 1 OF 1 | – |
| TITLE 300 SCFM CATALYTIC OXIDIZER – CHLOROCAT<br>PROCESS AND INSTRUMENTATION DIAGRAM | | | | |

Figure 2-1 VOC Control Schematic

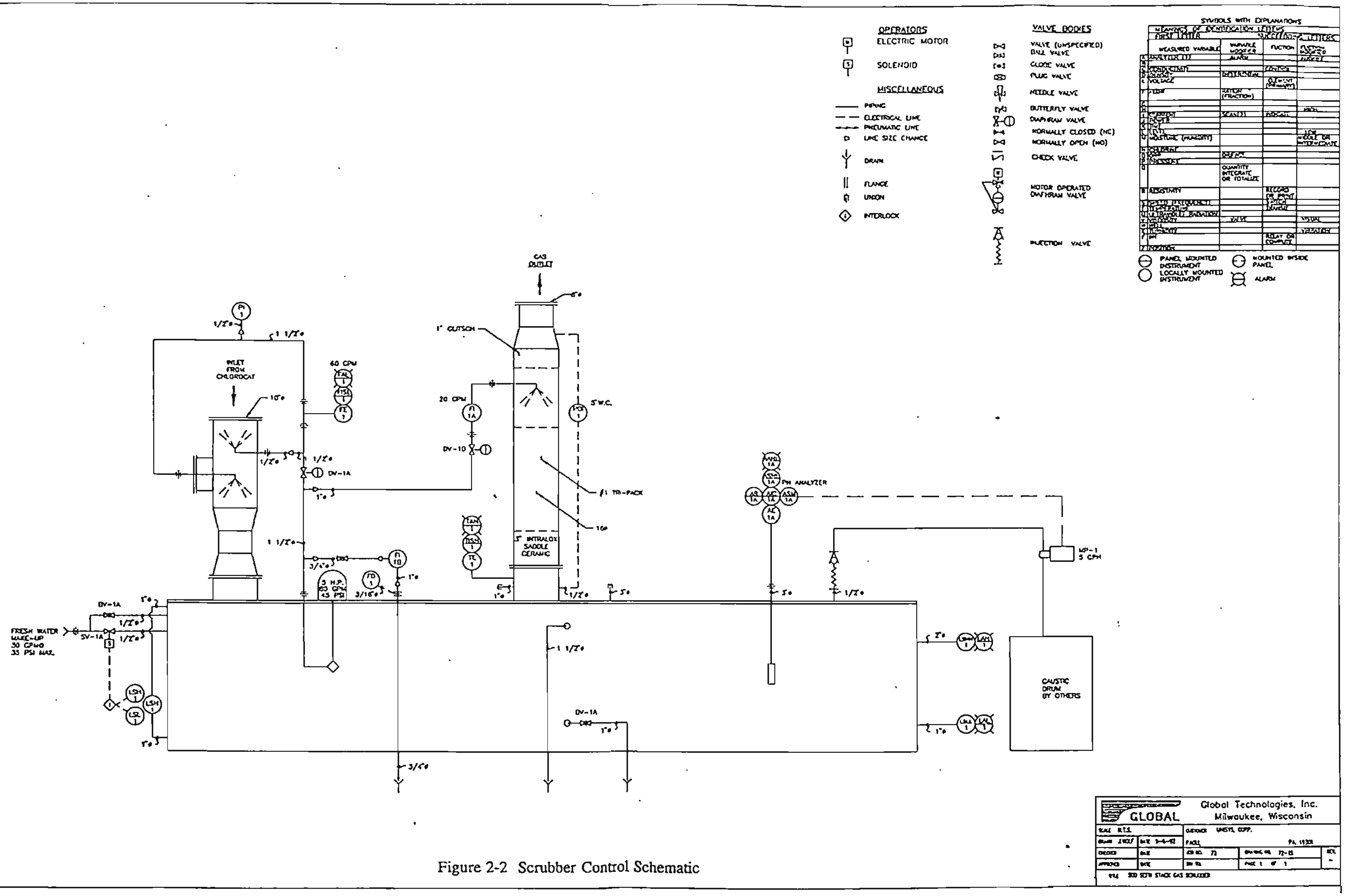


Figure 2-2 Scrubber Control Schematic

# 3.0 SCOPE OF WORK

RETEC performed an emission test on the vapor control system to measure the destruction efficiency for selected organics and the emission rate of HCL. Sampling procedures followed methods detailed in the RETEC Work Plan (September 1993). This section details the sampling methodologies followed during the emission testing program.

## 3.1 GAS STREAM SAMPLING LOCATIONS AND CHARACTERIZATION

RETEC located gas sampling ports on the vapor control system following the guidelines established by the U.S. EPA. A schematic of the sampling ports on the vapor control system used during the program are presented in Figures 3-1 and 3-2.

### 3.1.1 Inlet Sample Location

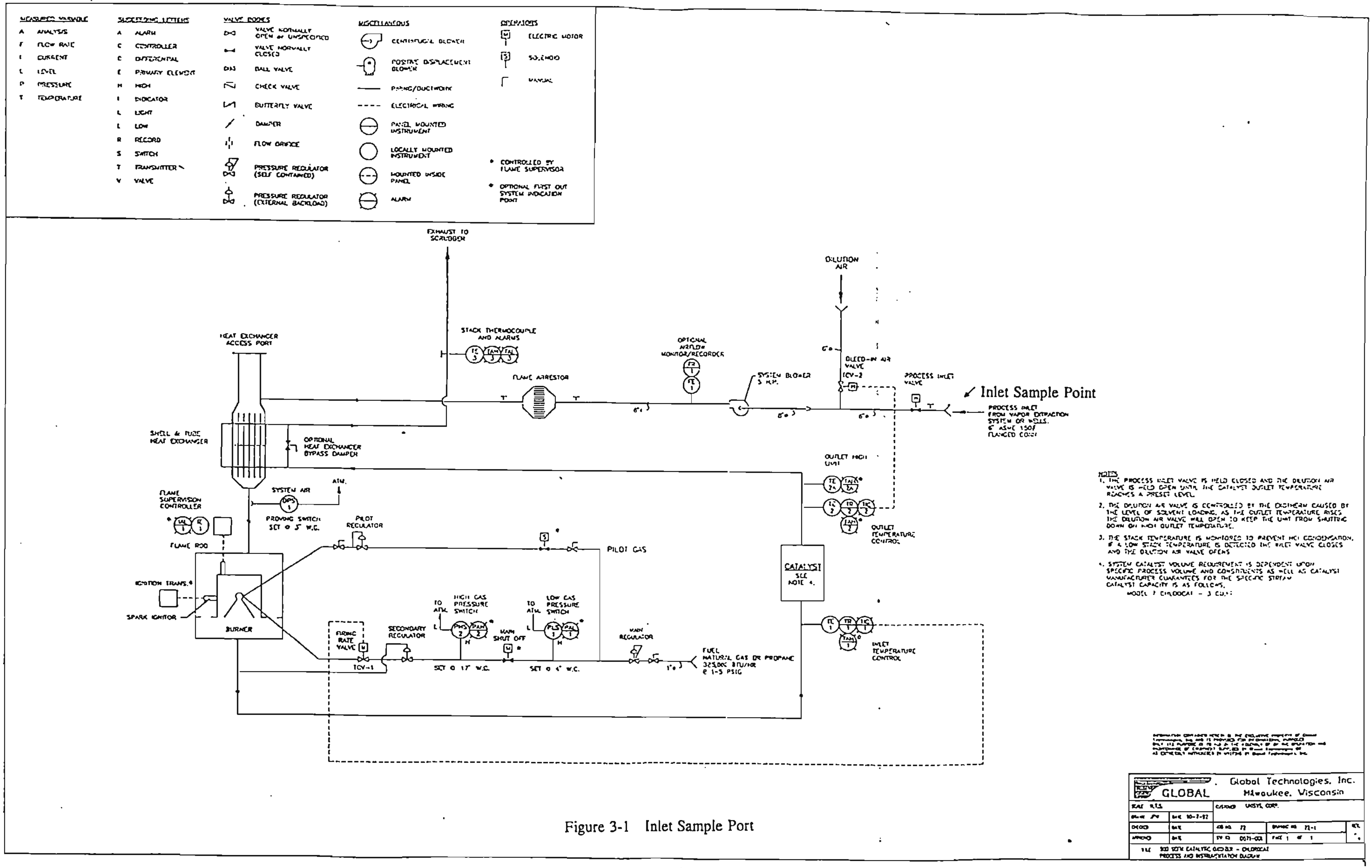
The inlet sampling port for organic measurement was located in a four inch diameter pipe, leading from the soil vapor system, to the catalytic oxidizer. The sample port was located before the soil vapor vacuum blower, so the stream was under negative pressure during the monitoring program.

### 3.1.2 Outlet Sample Location

The combined outlet sampling port for organic and HCL measurement was located in the exhaust stack (8-inch diameter) from the inorganic gas scrubber. The port was accessible by way of the building roof and was approximately eight feet from the end of the stack.

### 3.1.3 Gas Stream Characterization

Gas velocity measurements were performed on the inlet and outlet gas streams with a standard pitot tube and inclined manometer. The number of traverse points and the verification of absence of cyclonic flow was performed following the procedures presented in the RETEC Work Plan.



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| TITLE 300 SCFM CATALYTIC OXIDIZER – CHLOROCAT PROCESS AND INSTRUMENTATION DIAGRAM | | | | |

Figure 3-1 Inlet Sample Port

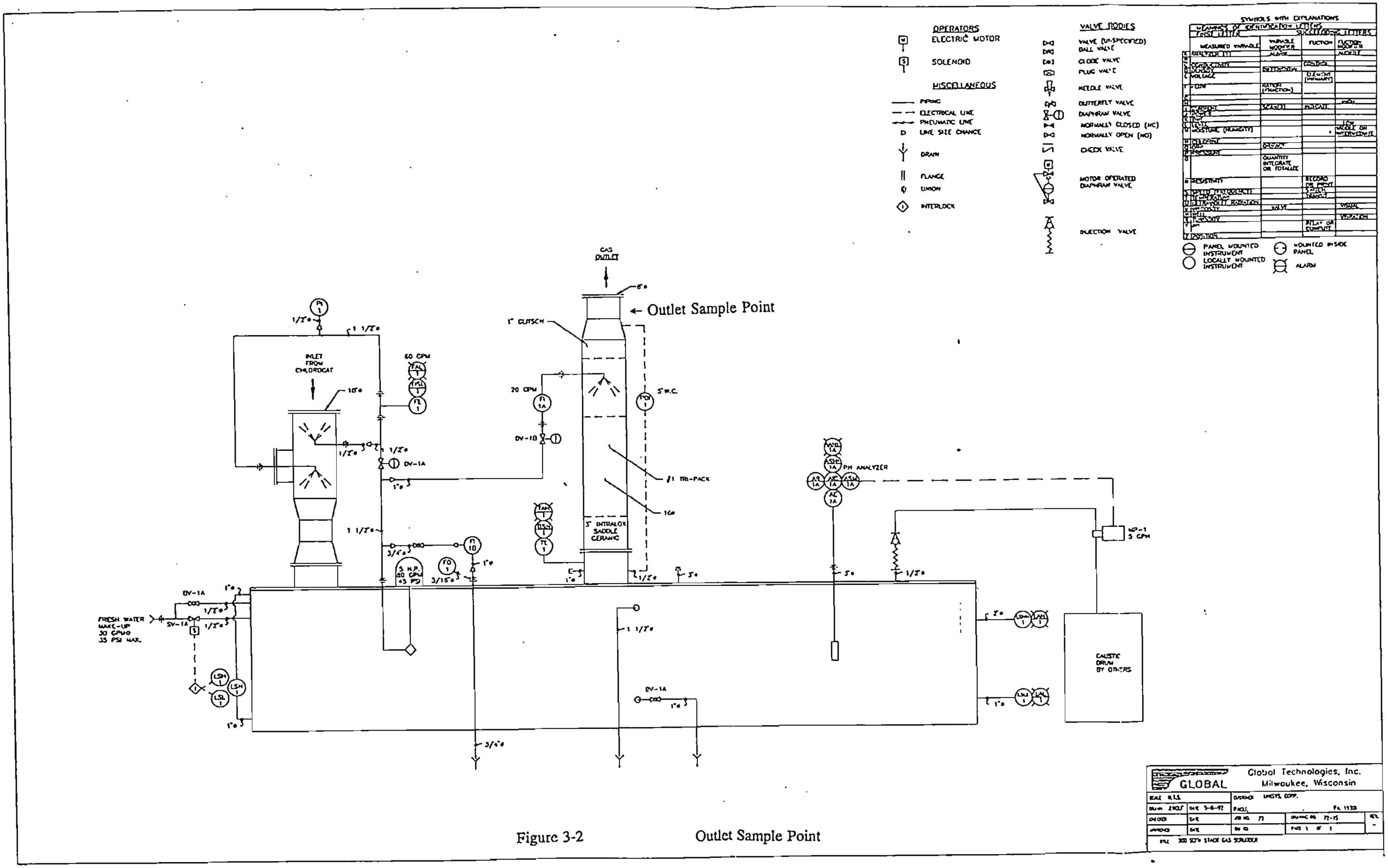

Figure 3-2 Outlet Sample Point

Gas velocities were measured before and after each inlet and outlet sampling run. Initial and final gas velocities are reported separately, but were averaged to calculate the final gas flow for each sample run.

Temperature of the inlet and outlet gas streams were also measured during the sample program using a thermocouple capable of measuring temperatures to within 1.5 percent of the minimum absolute stack temperature. Barometric pressure was obtained from the National Weather Service, corrected for elevation.

## 3.2 DETERMINATION OF ORGANIC CONCENTRATIONS

Samples of organics in the inlet and outlet gas streams from the catalytic oxidizer were collected using a leak-less sample pump and carbon adsorption tubes in accordance with the RETEC Work Plan. The carbon tubes were sent to the analytical laboratory, subsequently desorbed, and analyzed for the specific organics of interest by gas chromatography and mass spectrometry.

A preliminary sample analysis survey was performed on the inlet gas stream with a portable organic vapor analyzer before and during each sample run with the carbon adsorption tubes. The analyzer measured total organics in the gas stream, on a ppmv basis, using a photo ionization detector (PID). The portable analyzer was calibrated prior to use with a standard concentration of 100 ppmv isobutylene mixed with air. This qualitative analysis provided an appropriate loading rate and subsequent total sample volume for the charcoal adsorbent tubes to prevent constituent break-through. The measured concentration (ppmv) was converted to a $mg/m^3$ concentration using the relationship of 1 ppmv of isobutylene is equal to 2.29 $mg/m^3$ (at standard conditions).

### 3.2.1 Sampling Train

The sampling trains used for inlet and outlet sampling consisted of a stainless steel probe (approximately ¼ inches in diameter), midget glass impingers to condense water vapor, inert (Teflon) flexible tubing to connect the probe to the midget impingers, and carbon adsorption tubes. Sample gas to the oxidizer was pulled through the sampling system using a battery operated personnel pump. Samples from the exhaust stream were collected using electric vacuum pumps equipped with critical flow orifices.

The personnel pump, equipped with a pressure sensitive flow control needle valve, had a sample rate of 1.5 liters per minute (±5%). The electric vacuum pump, equipped with the critical flow orifice, had a flow setting of 2 liters per minute (±15%).

The flow rate for each sample train was calculated using the following formula:

$$Q_T = \frac{M_C \times 0.20}{(2.5 \times C_A) \times 2.29 \times \theta}$$

where:

$Q_T$ = Sample train flow rate ($m^3$/min)
$M_C$ = Mass of carbon (mg)
$C_A$ = Concentration of gas stream (ppmv)
$\theta$ = Total run time (minutes)

The mass of carbon in the tubes were assumed to be only 20% efficient in collecting organics, so the mass of carbon in the formula is multiplied by 0.20. A relative response factor of 2.5 was also used to account for photo ionization detector sensitivity.

The calibration of the pump flow rate through the adsorption tubes was performed with a bubble tube flow meter prior to and at the conclusion of each sample run. The flow rate used during the organic sample run was corrected to dry standard conditions following the formula:

$$V_{sb}(std) = V_{sb}\left(\frac{TstdP_s}{Ts\ Pstd}\right)$$

and,

$$Q_{std} = \left(\frac{V_{sb}(std)}{\theta}\right)$$

where:

$V_{sb}(std)$ = Volume of gas as measured by the soap bubble meter corrected to standard conditions (scf)
$V_{sb}$ = Volume of gas as measured by the soap bubble meter ($ft^3$)
$Q_{std}$ = Volumetric flow rate through critical orifice (scf/min)
$\Theta$ = Time (minutes)
$P_s$ = Ambient pressure (in Hg)
$P_{std}$ = Standard pressure (29.92 in Hg)

Sample probes were located in the centroid of both the inlet and outlet pipes. Midget impingers were placed in an ice bath and allowed to cool prior to sampling. Total sample times, sample flow rates, barometric pressure and temperatures were recorded for each run.

### 3.2.2 Adsorbent Tubes

The adsorbent tubes, activated charcoal, were obtained commercially and had the following general specifications: glass tube, 11 cm long, 1 cm OD, 8 mm ID, flamed sealed ends, containing two sections of activated (60°C) coconut shell charcoal (front = 800 mg, back = 200 mg) separated by a 4 mm urethane foam plug. A glass wool plug preceded the front section and a 4 mm urethane foam plug followed the back section.

Two tubes were used in series during the monitoring program to detect possible constituent break-through. The back tube was connected in the reverse direction such that the 200 mg section was first. This configuration allowed the contents of the first tube (1,000 mg) and the back-half of the second tube (200 mg) to be combined as one sample (1,200 mg). The remaining 800 mg of charcoal in the back tube was analyzed for break-through. Results are presented in Section 5.0

### 3.2.3 Condensates

Liquid condensates collected in the impingers during the sample run were poured into 20 ml VOA vials. Any available space in the vials was filled with distilled water before sealing. Samples were stored and shipped at $4^{\circ C}$.

## 3.3 DETERMINATION OF HCL CONCENTRATIONS

The concentration of hydrogen chloride in the outlet gas stream from the spray chamber scrubber was performed following the RETEC Work Plan. The method involved the passage of sample gas through a dilute sulfuric acid solution by means of a midget impinger. The solution was then measured for chloride ions using ion chromatography. Three sample runs were conducted on the outlet gas stream during the monitoring program.

### 3.3.1 Sampling Train

The sampling train included a probe lined with borosilicate glass, six 30 ml midget impingers with leak free glass connectors, sample line, and a sampling pump equipped with a 2 lpm limiting flow orifice.

The impingers were connected in series with a knockout impinger first. The next two impingers contained 15 ml of absorbing solution (0.1 N sulfuric acid). The fourth and fifth impingers contained 15 ml of scrubber solution (0.1 N sodium hydroxide). The sixth impinger acted as the drying tube.

The probe was placed at the centroid of the duct. Sample run times were 60 minutes each. Total sample time, flow rate, barometric pressure, and atmospheric temperature were recorded for each run.

Sample recovery was performed by quantitatively transferring the contents of the first three impingers (knockout impinger and the two absorbing solution impingers) to a leak-free storage bottle. Water rinses of each of these impingers and connecting glassware (probe) were added to the same storage bottle. The sample bottles were labeled and the fluid level marked so that if any sample was lost during shipment, a correction proportional to the lost volume could be applied.

# 4.0 LABORATORY ANALYSIS

Samples collected in the field were shipped back to the analytical laboratory at the conclusion of the sampling program. The following sections detail the analytical procedures used on the samples to analyze for the constituents of concern.

## 4.1 ORGANIC ANALYSIS

Upon receipt at the laboratory, the charcoal adsorbent tubes were desorbed using either carbon disulfide or toluene in accordance with the RETEC Work Plan. The use of toluene as a desorption solvent enabled the laboratory to detect the following compounds without the elution interference caused by carbon disulfide:

- 2-Butanone (MEK);
- Chloroform; and
- Methylene Chloride

The resulting extract was analyzed by GC/MS for the organic constituents of concern.

### 4.1.1 Desorption Efficiency Test

The laboratory performed a desorption efficiency (DE) test on the activated carbon for the constituents of concern using carbon disulfide or toluene. The desorption efficiency test followed the guidelines detailed in NIOSH Method 1501. The DE was determined by preparing three carbon tubes at five organic levels plus three media blanks. The desorption test was performed using the same batch of activated charcoal that was used in the field.

Results form the test are presented in the laboratory report, which is included in this report as Appendix A.

### 4.1.2 Analytical Procedure

In general, the contents of both sorbent tubes were combined in a single vial for analysis. Samples submitted for constituent breakthrough analysis, however, required a different preparation scheme. In these instances, the contents of the first tube (1,000 mg) and the primary section of the second tube (200mg), were combined and analyzed. The remaining portion of the second tube (800mg) was analyzed separately to detect breakthrough.

An appropriate volume of solvent (1-3 ml) was added to the contents of the vial(s) which were sealed immediately using a crimp cap. The covered vial was set aside for a minimum of thirty minutes, with occasional agitation.

The extracted samples were analyzed by GC/MS. The GC was calibrated daily with a minimum of five working standards over the range of anticipated constituent concentrations. The results of these analysis provided concentration data (ug/ml) for the specific indicator compounds. Detection limits for the compounds are presented in the laboratory report.

Liquid condensates were analyzed by GC/MS following the procedures detailed in U.S EPA SW-846: Method 8240. Organic compounds were introduced into the gas chromatography by purge and trap method. An inert gas was bubbled through the solution at ambient temperature were the organic components are efficiently transferred from the aqueous phase to the vapor phase. The vapors are swept through a sorbent column where the organic components are trapped. After the purging was completed, the sorbent column was heated and backflushed with inert gas to desorb the components into the GC. The gas chromatograph separates the components of interest which are quantified by the mass spectrometer. The final results are presented in $\mu$g/L.

The detected organics in the sample charcoal tube and any corresponding condensate were summed to obtain a total organic and compound specific concentration in milligrams (mg) for the sample run. A final concentration, in mg/m$^3$, was calculated by dividing the detected mass by the total volume sampled, corrected to dry standard conditions as detailed in Section 3.

## 4.2 HCL ANALYSIS

Samples received for HCL analysis were performed using ion chromatography. The instrument was calibrated with standards covering an appropriate concentration range, starting with the lowest concentration standard. Duplicate injections of a QC sample, followed by a water blank and the field sample was performed. A final injection of the calibration standard was made to allow for compensation of any drift in the instrument during analysis of the field samples.

The peak $Cl^-$ area was measured for all sample injections. The average response from duplicate samples was used to determine the field sample concentrations by comparing it to a linear calibration curve generated from the standards. The concentration of $Cl^-$ in the sample is reported in $\mu$g/L.

The mass of HCl in the sample ($\mu$g) was calculated by multiplying the $Cl^-$ concentration (blank corrected) by the molecular weight of HCl ($\mu$g/$\mu$g-mole) and then dividing the product by the atomic weight of Cl ($\mu$g/$\mu$g-mole). A final concentration, in mg/$m^3$, was calculated by dividing the mass of HCL by the total volume of gas sampled, corrected to dry standard conditions.

# 5.0 RESULTS

This section details the results of the compliance emission monitoring program conducted on the Unisys thermal catalytic oxidizer on September 16, 1993. The analytical laboratory report is presented in Appendix A. Field data sheets are presented in Appendix B.

## 5.1 CALCULATION OF GAS VELOCITY

The calculation to determine the gas velocities within the inlet and outlet gas streams are as follows:

$$V_s = 5130 \times C_p \times SDE \times \left(\frac{1}{PS \times MW}\right)^{0.5}$$

where:

$V_s$ = Average stack velocity (ft/sec)
$C_p$ = Pitot tube constant (.99)
MW = Molecular weight of stack gas (lb/lb mole)
SDE = $\Delta$Pressure x $\Delta$Temperature
PS = Absolute stack pressure (inches Hg)

SDE was calculated as:

$$SDE = (\sqrt{\Delta P_{AV}}) \times (\sqrt{TS_{AV} + 460})$$

### 5.1.1 Inlet Gas Velocities

Three sample runs were performed on the inlet gas stream for organic compounds of concern. Gas pressure readings were taken before (initial) and after (finial) each sample run. Results are recorded on the filed data sheets presented in Appendix B.

The average initial and final gas pressure readings for sample run one was 0.053 and 0.052 inches of $H_2O$, respectively, with an average sample run pressure of 0.052. Run two had average initial and finial pressure readings of 0.066 and 0.062 inches of $H_20$, with an average sample pressure of 0.064. Run three had average initial and finial pressure readings of 0.058 and 0.060 inches of $H_20$, with an average pressure of 0.059. The pressure readings recorded during each sample run indicated that inlet velocities remained constant during each sampling run and during the sampling program as a whole.

Using the above formulas, the gas velocity during sample Run 1 was calculated to be 905.4 afpm. Sample Run 2 had a gas velocity of 1,005 afpm and Run 3 had a recorded velocity of 961.6 afpm.

### 5.1.2 Exhaust Gas Velocities

Three sample runs performed on the outlet gas stream for organic compounds of concern and HCL, recorded gas velocities before and after each sample run. Results are recorded on the field data sheets, which are presented in Appendix B.

The average initial and final gas pressure readings for sample Run 1 was 0.230 and 0.232 inches of $H_2O$, respectively, with an average sample run pressure of 0.231. Run 2 had average initial and finial pressure readings of 0.232 and 0.237 inches of $H_20$, with an average sample run pressure of 0.234. Run three had an average initial pressure reading of 0.232, but the final pressure was not recorded. The oxidizer was turned off prior to the final flow measurement.

The pressure readings indicate that the outlet velocities remained constant during individual sampling runs and the sampling program as a whole.

Using the above formulas, the gas velocity out the stack during sample Run 1 was calculated to be 2,049.4 afpm. Sample Run 2 had a gas velocity of 2,053.6 afpm and Run 3 had a recorded velocity of 2,054.8 afpm, using the initial measured velocity.

## 5.2 CALCULATION OF GAS FLOW RATES

The equation used to determine the gas flow rates is as follows:

$$Q = (\frac{V_S}{A_S})$$

where:

Q = Volumetric stack gas flow rate at actual conditions (acfm)
$V_s$ = Average actual stack velocity (afpm)
$A_s$ = Cross sectional area of stack (ft$^2$)

Using the calculated velocities presented in Section 6.1, the flow rates for the inlet gas stream was calculated by dividing the velocity by the area of the inlet pipe, which was 4 inches in diameter ( $\pi(r)^2$ or 0.087 ft$^2$). The gas flow rate during Run 1 was 78.9 acfm. Run 2 was calculated to be 87.6 acfm and Run 3 was 83.8 acfm. Flows were consistent between sample runs, as to be expected from the results of the gas velocity measurements.

Calculated flow rates for the exhaust stream (8 inch pipe) were: 715.0 acfm for Run 1; 716.5 acfm for Run 2; and 716.9 acfm for Run 3 (using the initial velocity reading).

## 5.3 CALCULATION OF SAMPLE TRAIN VOLUMES

Battery powered sample pumps used at the inlet sample location were calibrated using a primary calibration standard: a gas bubble tube. Electric vacuum pumps used to sample the exhaust stream were equipped with critical flow orifices. Recorded flow rates from the bubble tube and critical flow orifices, presented on field data sheets in Appendix B, were converted to dry standard conditions using the formula present in Section 3.2.2.

Sample duration for the inlet and outlet locations lasted 60 minutes. Two sample trains were used to sample the inlet and outlet gas streams at the oxidizer to provide sample tubes for carbon disulfide and toluene extraction procedure.

The average, actual flow rate recorded for inlet sample train 1 was 1,500 cm$^3$/min. The corresponding standard flow was calculated to be 1,468 cm$^3$/min. The actual flow recorded from inlet sample train 2 was 1,630 cm$^3$/min, which corresponds to a standard flow rate of

1,595 $cm^3$/min. Tubes collected using sample train 1 were desorbed using carbon disulfide. Tubes from sample train 2 were desorbed with toluene.

The actual recorded flow rate from the critical flow orifices during the exhaust sampling program was 2,000 $cm^3$/min. Three pumps were used: two pumps to collect organic compounds onto carbon tubes, the other pump to pull a sample of stack gas through the HCL train. The flow rates were corrected to standard conditions at a rate of 1,957 $cm^3$/min.

Total volume sampled over each sample period was computed as:

$$(Q_{std}) \times (run\ time)$$

Total times for each of the three sampling runs were recorded at 60 minutes. Inlet sample volumes for sample train 1, for each of the three sample runs, was calculated to be 0.090 $m^3$. Inlet sample volumes for sample train 2, for each of the three sample runs, was calculated to be 0.098 $m^3$.

Exhaust sample volumes for organic sample trains 1, 2 and the HCL train, for each of the three sample runs, was calculated to be 0.117 $m^3$.

## 5.4 ORGANIC ANALYTICAL RESULTS

Results from the desorption efficiency test indicated percent recoveries for organic constituents of concern from 55 to 120 percent. 1,2-Dichloroethene had the lowest recovery with 55%, trichloroethene had the highest at 120%.

Previous sample results from the Unisys oxidizer for organic concentrations reported initial results in units of ug/tube. Concerns over this unit value by NYDEC were acknowledged by RETEC and was corrected prior to this final monitoring program. Analytical results presented in the laboratory report, Appendix A, report the detected levels of organics in units of ug/ml, ug/g, and ug/tube.

To obtain the mass of carbon in the sampling tube, RETEC advised the laboratory to obtain an average carbon weight by measuring the weight of blank carbon tubes from the same batch used for the gas sampling. An average weight of carbon for the front and back sections were calculated. The weight of the front tube, or the primary section, was measured to be 1.27 grams. The weight of the back tube, or the secondary section, was measured to be 0.84 grams. These masses were used to calculate a constituent concentration on the carbon tubes in units of ug/g.

Constituent breakthrough analysis was conducted on every carbon tube. Problems of constituent breakthrough were not detected in any of the inlet gas stream samples, all detected constituent concentrations in the back section of the tubes were less than 10%.

Constituent breakthrough did occur on run 1 and run 3 for the effluent sampling runs. Sample run 1 detected breakthrough for 1,2-dichloroethene (12.6%), tetrachlorethane (80%), and trichloroethene (17.1%). Sample run 3 detected breakthrough for freon 113 (14.6%). Sample run 2 had no breakthrough concentrations.

The ability of carbon to absorb the compounds was proven during the analysis of the inlet carbon tubes. High concentrations of organic constituents did not breakthrough the primary section of the tube. Low outlet concentrations would also indicate no breakthrough for the constituents. The only difference between the inlet and outlet organic sampling trains was in their flow rates. Constituent breakthrough on sample runs 1 and 3 may be explained by too low of a constituent concentration and too high of a sampling flow rate. A high moisture content of the exhaust stream may have also contributed to the breakthrough concentrations, however an impinger was used prior to the carbon tube to knockout any moisture in the sample gas stream.

### 5.4.1 Measured Concentrations of Organics

Table 5-1 presents the results of the three organic sample runs on the inlet gas stream to the catalytic oxidizer on September 16, 1993. Thirteen out of the sixteen organic compounds of concern were detected during the monitoring program. 2-Butanone, 1,1-dichloroethene, and naphthalene were the three organic compounds which were not detected in any of the three inlet sampling runs.

Three compounds made up the majority of the organic concentration in the inlet stream, approximately 88.8%. They are: tetrachloroethene at 38.4%; trichloroethene at 25.7%; and 1,2-

# TABLE 5-1

# DETECTED INFLUENT ORGANIC RESULTS
## COMPLIANCE MONITORING PROGRAM
## UNISYS CORPORATION
## GREAT NECK, NEW YORK

| Compounds | Detection Limit ug/ml | Detected Compounds Run 1 | | | Detected Compounds Run 2 | | | Detected Compounds Run 3 | | | Average Levels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ug/sample | ug/$m^3$ | lbs/hr | ug/sample | ug/$m^3$ | lbs/hr | ug/sample | ug/$m^3$ | lbs/hr | ug/sample | ug/$m^3$ | lbs/hr |
| Benzene | 0.5 | 116 | 1,317 | 0.00039 | 109.1 | 1,240 | 0.00041 | 129.5 | 1,472 | 0.00046 | 118.2 | 1,343 | 0.00042 |
| 2-Butanone | 5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Chloroform | 0.5 | 42 | 476 | 0.00014 | 41.0 | 466 | 0.00015 | 48.5 | 551 | 0.00017 | 43.8 | 498 | 0.00016 |
| 1,2-Dichlorobenzene | 0.5 | 39 | 443 | 0.00013 | 35.1 | 398 | 0.00013 | 42.9 | 487 | 0.00015 | 39.0 | 443 | 0.00014 |
| 1,2-Dichloroethane | 0.5 | 21 | 236 | 0.00007 | 20.8 | 236 | 0.00008 | 24.2 | 275 | 0.00009 | 21.9 | 249 | 0.00008 |
| 1,1-Dichloroethene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,2-Dichloroethene (total) | 0.5 | 109,091 | 1,239,669 | 0.36699 | 96,000.0 | 1,090,909 | 0.35755 | 145,636.4 | 1,654,959 | 0.52055 | 116,909.1 | 1,328,512 | 0.41503 |
| Ethylbenzene | 0.5 | 248 | 2,821 | 0.00084 | 251.7 | 2,861 | 0.00094 | 265.5 | 3,017 | 0.00095 | 255.2 | 2,900 | 0.00091 |
| Methylene Chloride | 0.5 | 29 | 332 | 0.00010 | 55.8 | 634 | 0.00021 | 53.1 | 603 | 0.00019 | 46.0 | 523 | 0.00017 |
| Tetrachloroethene | 0.5 | 100,000 | 1,136,364 | 0.33640 | 85,714.3 | 974,026 | 0.31924 | 100,000.0 | 1,136,364 | 0.35743 | 95,238.1 | 1,082,251 | 0.33769 |
| Toluene | 0.5 | 21,935 | 249,267 | 0.07379 | 26,580.6 | 302,053 | 0.09900 | 24,838.7 | 282,258 | 0.08878 | 24,451.6 | 277,859 | 0.08719 |
| 1,1,1-Trichloroethane | 0.5 | 546 | 6,205 | 0.00184 | 492.1 | 5,592 | 0.00183 | 569.7 | 6,473 | 0.00204 | 536.0 | 6,090 | 0.00190 |
| Trichloroethene | 0.5 | 55,250 | 627,841 | 0.18586 | 57,500.0 | 653,409 | 0.21416 | 55,000.0 | 625,000 | 0.19659 | 55,916.7 | 635,417 | 0.19887 |
| Xylene | 0.5 | 448 | 5,087 | 0.00151 | 438.1 | 4,978 | 0.00163 | 452.4 | 5,141 | 0.00162 | 446.0 | 5,069 | 0.00158 |
| Freon 113 | 0.5 | 3,600 | 40,909 | 0.01211 | 5,640.0 | 64,091 | 0.02101 | 5,730.0 | 65,114 | 0.02048 | 4,990.0 | 56,705 | 0.01787 |
| Naphthalene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Total | | 291,365 | 3,310,968 | 0.98 | 272,879 | 3,100,894 | 1.02 | 332,791 | 3,781,714 | 1.19 | 299,012 | 3,397,858 | 1.06 |

ND = Not Detected
NC = Not Calculated

1,2-dichloroethene (total) at 24.7%. Two other compounds, toluene (8.7%) and freon 113 (1.9%) make up an additional 10.6% of the organic concentration for the inlet gas stream. These five organic compounds comprise 99.4% of the inlet gas concentrations to the catalytic oxidizer. The remaining eight compounds make up less than 0.20% of the organic concentration.

Inlet sampling results also indicate a very low organic loading rate to the catalytic oxidizer. An average mass of organic measured during the program was 0.299 grams. With an average flow rate of 83.4 acfm, this relates to a loading rate of only 1.06 lbs/hr.

Table 5-2 presents the results from the sampling of the exhaust stream. Table 5-3 presents the organic results for the collected liquid condensates and Table 5-4 details the calculated destruction efficiencies.

Six out of the thirteen organic compounds detected in the inlet gas stream were detected in the exhaust gas. The detected organic compounds of concern and their average concentrations (ug/m$^3$) in the exhaust gas stream are:

- benzene (13);
- 1,2-dichloroethene (194, total);
- methylene chloride (9);
- tetrachloroethene (204);
- trichloroethene (262); and
- freon 113 (1,403).

The detection of 1,2-dichloroethene, tetrachloroethene, and trichloroethene represents a destruction efficiency greater than 97% for 88.8% of the total detected organics in the inlet gas stream. Toluene, which made up 8.7% of the inlet gas organic concentration, was below the detection limit of the exhaust sampling train, subsequently a destruction efficiency was not calculated. The other compound Freon 113, which made up 1.9% of the inlet organic stream, was reduced in concentration from 55,444 ug/m$^3$ to 11,583 ug/m$^3$, but increased in emission rate from 0.02 to 0.032 lbs/hr. This indicates that the reduction in freon 113 concentration was caused by sample stream dilution with ambient air and not by the oxidizer. Methylene chloride also showed an increase in emission rate between the inlet and outlet gas streams, from 0.00019 to 0.00021 lbs/hr.

## TABLE 5-2

## DETECTED EFFLUENT ORGANIC RESULTS
## COMPLIANCE MONITORING PROGRAM
## UNISYS CORPORATION
## GREAT NECK, NEW YORK

| Compounds | Detection Limit ug/ml | Detected Compounds Run 1 | | | Detected Compounds Run 2 | | | Detected Compounds Run 3 | | | Average Levels | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ug/sample | $ug/m^3$ | lbs/hr | ug/sample | $ug/m^3$ | lbs/hr | ug/sample | $ug/m^3$ | lbs/hr | ug/sample | $ug/m^3$ | lbs/hr |
| Benzene | 0.5 | 1.7 | 14.6 | 0.00004 | 1.7 | 14.6 | 0.00004 | 1.7 | 14.6 | 0.00004 | 1.7 | 14.6 | 0.00004 |
| 2-Butanone | 5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Chloroform | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,2-Dichlorobenzene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,2-Dichloroethane | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,1-Dichloroethene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,2-Dichloroethene (total) | 0.5 | 336.4 | 2874.9 | 0.0077 | 392.7 | 3356.6 | 0.0090 | 327.3 | 2797.2 | 0.0075 | 352.1 | 3,010 | 0.0081 |
| Ethylbenzene | 0.5 | ND | NC | NC | ND | ND | ND | ND | NC | NC | ND | NC | NC |
| Methylene Chloride | 0.5 | 13.8 | 118.0 | 0.0003 | 9.6 | 81.7 | 0.0002 | 1.6 | 15.4 | 0.00004 | 8.3 | 72 | 0.0002 |
| Tetrachloroethene | 0.5 | 259.0 | 2214.1 | 0.0059 | 151.4 | 1294.3 | 0.0035 | 171.4 | 1465.2 | 0.0039 | 194.0 | 1,658 | 0.0044 |
| Toluene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| 1,1,1-Trichloroethane | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Trichloroethene | 0.5 | 211.7 | 1809.1 | 0.0048 | 225.0 | 1923.1 | 0.0052 | 217.5 | 1859.0 | 0.0050 | 218.1 | 1,864 | 0.0050 |
| Xylene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Freon 113 | 0.5 | 2010.0 | 17179.5 | 0.0460 | 1770.0 | 15128.2 | 0.0406 | 428.0 | 3658.1 | 0.0098 | 1,402.7 | 11,989 | 0.0321 |
| Naphthalene | 0.5 | ND | NC | NC | ND | NC | NC | ND | NC | NC | ND | NC | NC |
| Total | | 2,833 | 24,210 | 0.065 | 2,550 | 21,798 | 0.058 | 1,147 | 9,809 | 0.026 | 2,177 | 18,606 | 0.050 |

ND = Not Detected
NC = Not Calculated

26-Oct-93

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## TABLE 5-3

## DETECTED IMPINGER ORGANIC RESULTS
## COMPLIANCE MONITORING PROGRAM
## UNISYS CORPORATION
## GREAT NECK, NEW YORK

| Compounds | Detection Limit ug/L | Detected Compounds Run 1 |  |  | Detected Compounds Run 2 |  |  | Detected Compounds Run 3 |  |  | Average Levels |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Vol. (L) | ug/L | ug/samp. | Vol. (L) | ug/L | ug/samp. | Vol. (L) | ug/L | ug/samp. | Vol. (L) | ug/L | ug/samp. |
| Benzene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| 2-Butanone | 10 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| Chloroform | 1 | 0.067 | 2.2 | 0.15 | 0.065 | 3.0 | 0.20 | 0.064 | 2.7 | 0.17 | 0.065 | 2.63 | 0.17 |
| 1,2-Dichlorobenzene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| 1,2-Dichloroethane | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| 1,1-Dichloroethene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| 1,2-Dichloroethene (total) | 1 | 0.067 | 2.9 | 0.19 | 0.065 | 2.9 | 0.19 | 0.064 | 3.8 | 0.24 | 0.065 | 3.20 | 0.21 |
| Ethylbenzene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| Methylene Chloride | 1 | 0.067 | 7.3 | 0.49 | 0.065 | 10.0 | 0.65 | 0.064 | 8.1 | 0.52 | 0.065 | 8.47 | 0.55 |
| Tetrachloroethene | 1 | 0.067 | 1.3 | 0.09 | 0.065 | 1.4 | 0.09 | 0.064 | 1.5 | 0.10 | 0.065 | 1.40 | 0.09 |
| Toluene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| 1,1,1-Trichloroethane | 1 | 0.067 | 2.1 | 0.14 | 0.065 | 1.2 | 0.08 | 0.064 | ND | ND | 0.065 | 1.10 | 0.07 |
| Trichloroethene | 1 | 0.067 | 2.1 | 0.14 | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | 0.70 | 0.05 |
| Xylene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| Freon 113 | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| Naphthalene | 1 | 0.067 | ND | ND | 0.065 | ND | ND | 0.064 | ND | ND | 0.065 | ND | ND |
| Chloride | 100 | 0.067 | 4,000 | 268.0 | 0.065 | 4,900 | 318.5 | 0.064 | 2,300 | 147.2 | 0.065 | 3,733.3 | 244.6 |
| Total Organics |  |  | 17.9 | 1.20 |  | 18.5 | 1.20 |  | 16.1 | 1.03 |  | 17.5 | 1.14 |

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## TABLE 5-4

## ORGANIC DESTRUCTION EFFICIENCY
## COMPLIANCE MONITORING PROGRAM
## UNISYS CORPORATION
## GREAT NECK, NEW YORK

| Compounds | Influent Average Levels | | | Effluent Average Levels | | | Destruction Efficiency |
|---|---|---|---|---|---|---|---|
| | ug/sample | ug/m$^3$ | lbs/hr | ug/sample | ug/m$^3$ | lbs/hr | |
| Benzene | 118 | 1,343 | 0.00042 | 1.70 | 14.6 | 0.00004 | 90.7% |
| 2-Butanone | ND | NC | NC | ND | NC | NC | NC |
| Chloroform | 44 | 498 | 0.00016 | <1.5 | <12.8 | <0.00003 | >78.0% |
| 1,2-Dichlorobenzene | 39 | 443 | 0.00014 | <1.5 | <12.8 | <0.00003 | >75.2% |
| 1,2-Dichloroethane | 22 | 249 | 0.00008 | <1.5 | <12.8 | <0.00003 | >56.0% |
| 1,1-Dichloroethene | ND | NC | NC | ND | NC | NC | NC |
| 1,2-Dichloroethene (total) | 116,909 | 1,328,512 | 0.41503 | 352.12 | 3009.6 | 0.00807 | 98.1% |
| Ethylbenzene | 255 | 2,900 | 0.00091 | <1.5 | <12.8 | <0.00003 | >96.2% |
| Methylene Chloride | 46 | 523 | 0.00017 | 8.32 | 71.7 | 0.00019 | -16.2% |
| Tetrachloroethene | 95,238 | 1,082,251 | 0.33769 | 193.97 | 1657.8 | 0.00444 | 98.7% |
| Toluene | 24,452 | 277,859 | 0.08719 | <1.5 | <12.8 | <0.00003 | 100.0% |
| 1,1,1-Trichloroethane | 536 | 6,090 | 0.00190 | <1.5 | <12.8 | <0.00003 | >98.2% |
| Trichloroethene | 55,917 | 635,417 | 0.19887 | 218.06 | 1863.7 | 0.00499 | 97.5% |
| Xylene | 446 | 5,069 | 0.00158 | <1.5 | <12.8 | <0.00003 | >97.8% |
| Freon 113 | 4,990 | 56,705 | 0.01787 | 1402.67 | 11988.6 | 0.03212 | -79.8% |
| Naphthalene | ND | NC | NC | ND | NC | NC | NC |
| Total | 260,339 | 2,892,660 | 1.0619 | 2,006 | 16,716 | 0.05 | >93.9% |

ND = Not Detected (0.5 ug/ml)
NC = Not Calculated

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27-Oct-93

Freon 113, or 1,1,2-trichloro-1,2,2-trifluoroethane, has a very low heat of combustion value and is rated by the US EPA as one of the hardest organic compounds to oxidize. Methylene chloride in the off-gas may be a product of incomplete combustion (PIC) of tetrachloroethene.

Benzene emission rate was reduced from 0.0004 to 0.00004 lbs/hr, indicating a destruction efficiency of 90.7%. Problems obtaining an appropriate destruction efficiency for benzene, as well as methylene chloride, may be attributed to insufficient loading on the inlet gas stream. Published reports[1] of incinerator testing indicate that low inlet loading rates can contribute to poor destruction efficiencies.

## 5.5 HCL RESULTS

Samples for $Cl^-$ ions in the outlet gas stream were collected by RETEC. Sample results were calculated to represent hydrochloric acid concentrations by multiplying the $Cl^-$ concentration by the molecular wight of HCL (36.46 ug/ug-mole) and dividing by the atomic weight of $Cl^-$ (35.453 ug/ ug-mole). Results are presented in Table 5-5.

Results indicate HCL emissions to be less than 1 lb/hr, specifically 0.006 lbs/hr.

## 5.6 CONCLUSIONS

Results from the compliance emission monitoring program show an ability of the oxidizer to destroy organic constituents of concern at the Unisys Great Neck, New York facility. Inlet compounds, with a high enough loading rates, indicated greater than 97% destruction efficiency. This includes the organic compounds which make up 88% of the inlet organic concentration to the oxidizer. Hydrochloric acid emissions were less than 1 lb/hr.

Problems occurred from the fact that insufficient organic loading to the oxidizer took place during the monitoring program. Destruction efficiencies for chloroform, 1,2-dichlorobenzene, 1,2-dichloroethane were reported with a greater than sign since they were all calculated using their specific detection limit. Ethylbenzene, 1,1,1-trichloroethane and xylene

# TABLE 5–5

## HCL EMISSIONS
## COMPLIANCE MONITORING PROGRAM
## UNISYS CORPORATION
## GREAT NECK, NEW YORK

| Compound | Detection Limit (ug/L) | Detected Compounds Run 1 | | | Detected Compounds Run 2 | | | Detected Compounds Run 3 | | | Average Levels | | | Emission Rate (lbs/hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ug/L | ug/samp. | $mg/m^3$ | ug/L | ug/samp. | $mg/m^3$ | ug/L | ug/samp. | $mg/m^3$ | ug/L | ug/samp. | $mg/m^3$ | |
| Chloride | 100 | 4,000 | 268.00 | | 4,900 | 318.50 | | 2,300 | 147.20 | | 3,733 | 244.57 | | |
| Hydrogen Chloride | | | 275.61 | 2.36 | | 327.55 | 2.80 | | 151.38 | 1.29 | | 251.51 | 2.15 | 0.0058 |

destruction efficiencies were reported above 96%, calculated using their detection limit concentrations as well. Low loading rates for benzene and methylene chloride in the inlet stream may have caused inefficient destruction efficiencies for benzene, as well as methylene chloride in the exhaust stream.

Concentrations of freon 113 detected in the exhaust stream may be attributed to its low heat of combustion or its high resistance to thermal oxidation. The US EPA rates freon 113 as one of the lowest organic compounds for heat of combustion potential and subsequently the hardest to oxidize.

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[1] Trenholm, A, Hathaway, R, Oberacker, D Products of Incomplete Combustion From Hazardous Waste Incinerators, 1988

# Appendix A

# Analytical Laboratory Report

# REPORT OF ANALYTICAL RESULTS

Case Numbers: D0923-15
D0923-16
D0923-17

Prepared for:

Remediation Technologies, Inc.
9 Pond Lane
Concord, MA 01742
Attn: Rich Roat

Prepared by:

New England Testing Laboratory, Inc.
1254 Douglas Avenue
North Providence, RI 02904

Date Reported: October 3, 1993

Reviewed By: Mark H. Bishop
Mark H. Bishop
Laboratory Director

**NEW ENGLAND TESTING LABORATORY, INC.**
1254 Douglas Avenue, North Providence, Rhode Island 02904-5392 • 401-353-3420

## Sample Description

The following samples were submitted to New England Testing Laboratory on 23 SEPT 1993:

"Unisys, NY - Air"

| **D0923-15** | **D0923-16** | **D0923-17** |
|---|---|---|
| Carbon tubes:<br>"Effluent" | Carbon tubes<br>"Influent" | Impinger/Rinse<br>Composite Sol'ns |
| 1. Run-1 P-1 | 1. Run-1 P-1 | 1. Run-1 |
| 2. Run-1 S-1 | 2. Run-1 S-1 | 2. Run-2 |
| 3. Run-1 P-2 | 3. Run-1 P-2 | 3. Run-3 |
| 4. Run-1 S-2 | 4. Run-1 S-2 | |
| 5. Run-2 P-1 | 5. Run-2 P-1 | |
| 6. Run-2 S-1 | 6. Run-2 S-1 | |
| 7. Run-2 P-2 | 7. Run-2 P-2 | |
| 8. Run-2 S-2 | 8. Run-2 S-2 | |
| 9. Run-3 P-1 | 9. Run-3 P-1 | |
| 10. Run-3 S-1 | 10. Run-3 S-1 | |
| 11. Run-3 P-2 | 11. Run-3 P-2 | |
| 12. Run-3 S-2 | 12. Run-3 S-2 | |
| 13. Field Blank | 13. Field Blank | |

Custody records are included in this report. The samples were assigned internal identification codes (case numbers) for laboratory information management purposes. The case numbers for this sample submission appear in bold face type in the column headings above.

## Sample Description

The following samples were submitted to New England Testing Laboratory on 23 SEPT 1993:

"Unisys, NY - Air"

**D0923-15**

Carbon tubes:
"Effluent"

1. Run-1 P-1
2. Run-1 S-1
3. Run-1 P-2
4. Run-1 S-2
5. Run-2 P-1
6. Run-2 S-1
7. Run-2 P-2
8. Run-2 S-2
9. Run-3 P-1
10. Run-3 S-1
11. Run-3 P-2
12. Run-3 S-2
13. Field Blank

**D0923-16**

Carbon tubes
"Influent"

1. Run-1 P-1
2. Run-1 S-1
3. Run-1 P-2
4. Run-1 S-2
5. Run-2 P-1
6. Run-2 S-1
7. Run-2 P-2
8. Run-2 S-2
9. Run-3 P-1
10. Run-3 S-1
11. Run-3 P-2
12. Run-3 S-2
13. Field Blank

**D0923-17**

Impinger/Rinse
Composite Sol'ns

1. Run-1
2. Run-2
3. Run-3

Custody records are included in this report. The samples were assigned an internal identification codes (case numbers) for laboratory information management purposes. The case numbers for this sample submission appear in bold face type in the column headings above.

## Analysis/Methods

### Carbon tubes:

Carbon tubes were prepared for analysis by NIOSH Method 1500. A carbon disulfide desorption was used for all compounds except those which elute before or during the elution of the carbon disulfide solvent. The remaining compounds were desorbed with toluene.

After desorption, the extracts were analyzed by EPA Method 8240.

### Impinger composite solutions:

The impinger solutions were analyzed for chloride content by EPA Method 26 and for volatile organic compounds by EPA Method 8240.

### Average carbon charge in sampling tubes:

In addition to performing the analysis detailed above seven random carbon tubes were selected from the batch of tubes used in collecting the samples. The carbon loading in both sections of these tubes was weighed. The results are tabulated in Table #1.

## Quality Assurance/Control Statements

All samples were found to be properly preserved/cooled upon receipt. Procedure/calibration checks required by the designated protocols were within control limits.

**New York Laboratory ID: 11382**

## Desorption Efficiency Evaluation

A desorption efficiency evaluation was performed for both the carbon disulfide and toluene extraction/analysis sequences. The results of this evaluation are presented in the following table.

**Desorption efficiency**

Subject: Volatile Organic Compounds

| Compound | Recovery, % |
|---|---|
| Benzene | 88 |
| 2-Butanone | 68 |
| Chloroform | 68 |
| 1,2-Dichlorobenzene | 77 |
| 1,2-Dichloroethane | 62 |
| 1,2-Dichloroethene (total) | 55 |
| Ethylbenzene | 87 |
| Methylene chloride | 113 |
| Tetrachloroethane | 105 |
| Toluene | 93 |
| 1,1,1-Trichloroethene | 89 |
| Trichloroethene | 120 |
| Xylene, Total | 63 |

# ANALYTICAL RESULTS

# TABLE 1

## Carbon tube sectional weights

| | Front | Back |
|---|---|---|
| Replicate | 0.8761 | 0.2214 |
| 1 | 0.8397 | 0.2097 |
| 2 | 0.8454 | 0.2135 |
| 3 | 0.7962 | 0.2094 |
| 4 | 0.8431 | 0.2105 |
| 5 | 0.8712 | 0.2131 |
| 6 | 0.809 | 0.2119 |
| 7 | | |
| **Average** | 0.8401 | 0.212785714 |
| **Standard deviation** | 0.027139934 | 0.001745566 |
| **Weight for Primary Section** | 1.27 | |
| **Weight for Secondary Sectio** | 0.84 | |

## Detection Limits:

Subject: Volatile Organic Compounds

Primary section (Entire P tube + 200 mg section of S tube)

Ave Primary section carbon weight=1.27g

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 0.5 | 3 | 1.18 | 1.5 |
| 2-Butanone | 5 | 3 | 11.81 | 15 |
| Chloroform | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichlorobenzene | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichloroethane | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichloroethene (total) | 0.5 | 3 | 1.18 | 1.5 |
| Ethylbenzene | 0.5 | 3 | 1.18 | 1.5 |
| Methylene chloride | 0.5 | 3 | 1.18 | 1.5 |
| Tetrachloroethane | 0.5 | 3 | 1.18 | 1.5 |
| Toluene | 0.5 | 3 | 1.18 | 1.5 |
| 1,1,1-Trichloroethene | 0.5 | 3 | 1.18 | 1.5 |
| Trichloroethene | 0.5 | 3 | 1.18 | 1.5 |
| Xylene, Total | 0.5 | 3 | 1.18 | 1.5 |
| Freon 113 | 0.5 | 3 | 1.18 | 1.5 |
| Naphthalene | 0.5 | 3 | 1.18 | 1.5 |

## Detection Limits:

Subject: Volatile Organic Compounds

Secondary section ( 800 mg section of S tube)

Ave Secondary section carbon weight=0.84g

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 0.5 | 2 | 1.19 | 1 |
| 2-Butanone | 5 | 2 | 11.90 | 10 |
| Chloroform | 0.5 | 2 | 1.19 | 1 |
| 1,2-Dichlorobenzene | 0.5 | 2 | 1.19 | 1 |
| 1,2-Dichloroethane | 0.5 | 2 | 1.19 | 1 |
| 1,2-Dichloroethene (total) | 0.5 | 2 | 1.19 | 1 |
| Ethylbenzene | 0.5 | 2 | 1.19 | 1 |
| Methylene chloride | 0.5 | 2 | 1.19 | 1 |
| Tetrachloroethane | 0.5 | 2 | 1.19 | 1 |
| Toluene | 0.5 | 2 | 1.19 | 1 |
| 1,1,1-Trichloroethene | 0.5 | 2 | 1.19 | 1 |
| Trichloroethene | 0.5 | 2 | 1.19 | 1 |
| Xylene, Total | 0.5 | 2 | 1.19 | 1 |
| Freon 113 | 0.5 | 2 | 1.19 | 1 |
| Naphthalene | 0.5 | 2 | 1.19 | 1 |

## Analytical Results:

Run-1 Effluent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichloroethene (total) | 57 | 3 | 134.65 | 171 |
| Methylene chloride | 5.2 | 3 | 12.28 | 15.6 |
| Tetrachloroethane | 50 | 3 | 118.11 | 150 |
| Trichloroethene | 76 | 3 | 179.53 | 228 |
| Freon 113 | 670 | 3 | 1582.68 | 2010 |

Run-1 Effluent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| 1,2-Dichloroethene (total) | 7.2 | 2 | 17.14 | 14.4 |
| Tetrachloroethane | 61 | 2 | 145.24 | 122 |
| Trichloroethene | 13 | 2 | 30.95 | 26 |

**Analytical Results:**

Run-2 Effluent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichloroethene (total) | 72 | 3 | 170.08 | 216 |
| Methylene chloride | 3.6 | 3 | 8.50 | 10.8 |
| Tetrachloroethane | 53 | 3 | 125.20 | 159 |
| Trichloroethene | 90 | 3 | 212.60 | 270 |
| Freon 113 | 590 | 3 | 1393.70 | 1770 |

Run-2 Effluent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Tetrachloroethane | 0.6 | 2 | 1.43 | 1.2 |

## Analytical Results:

Run-3 Effluent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 0.5 | 3 | 1.18 | 1.5 |
| 1,2-Dichloroethene (total) | 60 | 3 | 141.73 | 180 |
| Methylene chloride | 0.6 | 3 | 1.42 | 1.8 |
| Tetrachloroethane | 60 | 3 | 141.73 | 180 |
| Trichloroethene | 87 | 3 | 205.51 | 261 |
| Freon 113 | 130 | 3 | 307.09 | 390 |

Run-3 Effluent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Tetrachloroethane | 0.6 | 2 | 1.43 | 1.2 |
| Freon 113 | 19 | 2 | 45.24 | 38 |

## Analytical Results:

Run-1 Influent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 34 | 3 | 80.31 | 102 |
| Chloroform | 9.5 | 3 | 22.44 | 28.5 |
| 1,2-Dichlorobenzene | 10 | 3 | 23.62 | 30 |
| 1,2-Dichloroethane | 4.3 | 3 | 10.16 | 12.9 |
| 1,2-Dichloroethene (total) | 20000 | 3 | 47244.09 | 60000 |
| Ethylbenzene | 72 | 3 | 170.08 | 216 |
| Methylene chloride | 11 | 3 | 25.98 | 33 |
| Tetrachloroethane | 35000 | 3 | 82677.17 | 105000 |
| Toluene | 6800 | 3 | 16062.99 | 20400 |
| 1,1,1-Trichloroethene | 162 | 3 | 382.68 | 486 |
| Trichloroethene | 22100 | 3 | 52204.72 | 66300 |
| Xylene, Total | 94 | 3 | 222.05 | 282 |
| Freon 113 | 1200 | 3 | 2834.65 | 3600 |

Run-1 Influent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| 1,2-Dichloroethene (total) | 0.8 | 2 | 1.90 | 1.6 |
| Tetrachloroethane | 16 | 2 | 38.10 | 32 |
| Trichloroethene | 7.5 | 2 | 17.86 | 15 |

## Analytical Results:

Run-3 Influent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 38 | 3 | 89.76 | 114 |
| Chloroform | 11 | 3 | 25.98 | 33 |
| 1,2-Dichlorobenzene | 11 | 3 | 25.98 | 33 |
| 1,2-Dichloroethane | 5 | 3 | 11.81 | 15 |
| 1,2-Dichloroethene (total) | 26700 | 3 | 63070.87 | 80100 |
| Ethylbenzene | 77 | 3 | 181.89 | 231 |
| Methylene chloride | 20 | 3 | 47.24 | 60 |
| Tetrachloroethane | 35000 | 3 | 82677.17 | 105000 |
| Toluene | 7700 | 3 | 18188.98 | 23100 |
| 1,1,1-Trichloroethene | 169 | 3 | 399.21 | 507 |
| Trichloroethene | 22000 | 3 | 51968.50 | 66000 |
| Xylene, Total | 95 | 3 | 224.41 | 285 |
| Freon 113 | 1910 | 3 | 4511.81 | 5730 |

Run-3 Influent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| 1,2-Dichloroethene (total) | 6.3 | 2 | 15.00 | 12.6 |
| Tetrachloroethane | 15 | 2 | 35.71 | 30 |
| Trichloroethene | 6.7 | 2 | 15.95 | 13.4 |

## Analytical Results:

Run-2 Influent, Primary Section:

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Benzene | 32 | 3 | 75.59 | 96 |
| Chloroform | 9.3 | 3 | 21.97 | 27.9 |
| 1,2-Dichlorobenzene | 9 | 3 | 21.26 | 27 |
| 1,2-Dichloroethane | 4.3 | 3 | 10.16 | 12.9 |
| 1,2-Dichloroethene (total) | 17600 | 3 | 41574.80 | 52800 |
| Ethylbenzene | 73 | 3 | 172.44 | 219 |
| Methylene chloride | 21 | 3 | 49.61 | 63 |
| Tetrachloroethane | 30000 | 3 | 70866.14 | 90000 |
| Toluene | 8240 | 3 | 19464.57 | 24720 |
| 1,1,1-Trichloroethene | 146 | 3 | 344.88 | 438 |
| Trichloroethene | 23000 | 3 | 54330.71 | 69000 |
| Xylene, Total | 92 | 3 | 217.32 | 276 |
| Freon 113 | 1880 | 3 | 4440.94 | 5640 |

Run-2 Influent, Secondary Section

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| 1,2-Dichloroethene (total) | 9 | 2 | 21.43 | 18 |
| Tetrachloroethane | 8 | 2 | 19.05 | 16 |
| Trichloroethene | 3 | 2 | 7.14 | 6 |

## Analytical Results:

Sample

**Field Bias Blank-Effluent:** No compounds detected

**Field Bias Blank-Influent**

| | Concentration, ug/ml | Desorbtion volume, ml | Carbon Conc. ug/g | Loading, ug/sample |
|---|---|---|---|---|
| Tetrachloroethane | 0.8 | 2 | 1.52 | 1.6 |

Note: Carbon Conc. based on 1.05 g carbon per tube

## Detection Limits

Impinger solutions:

| | Conc. ug/l | Vol, l (nominal) | Loading ug/sample |
|---|---|---|---|
| Benzene | 1 | 0.065 | 0.065 |
| 2-Butanone | 10 | 0.065 | 0.65 |
| Chloroform | 1 | 0.065 | 0.065 |
| 1,2-Dichlorobenzene | 1 | 0.065 | 0.065 |
| 1,2-Dichloroethane | 1 | 0.065 | 0.065 |
| 1,2-Dichloroethene (total) | 1 | 0.065 | 0.065 |
| Ethylbenzene | 1 | 0.065 | 0.065 |
| Methylene chloride | 3 | 0.065 | 0.195 |
| Tetrachloroethane | 1 | 0.065 | 0.065 |
| Toluene | 1 | 0.065 | 0.065 |
| 1,1,1-Trichloroethene | 1 | 0.065 | 0.065 |
| Trichloroethene | 1 | 0.065 | 0.065 |
| Xylene, Total | 1 | 0.065 | 0.065 |
| Freon 113 | 1 | 0.065 | 0.065 |
| Naphthalene | 1 | 0.065 | 0.065 |
| | | | |
| Chloride | 100 | 0.065 | 6.5 |

## Analytical Results

Impinger solutions:

| Run-1 | Conc. ug/l | Vol, l | Loading ug/sample |
|---|---|---|---|
| Chloroform | 2.2 | 0.067 | 0.1474 |
| 1,2-Dichloroethene (total) | 2.9 | 0.067 | 0.1943 |
| Methylene chloride | 7.3 | 0.067 | 0.4891 |
| Tetrachloroethane | 1.3 | 0.067 | 0.0871 |
| 1,1,1-Trichloroethene | 2.1 | 0.067 | 0.1407 |
| Trichloroethene | 2.1 | 0.067 | 0.1407 |
| | | | |
| Chloride | 4000 | 0.067 | 268 |

## Analytical Results

Impinger solutions:

| Run-2 | Conc. ug/l | Vol, 1 | Loading ug/sample |
|---|---|---|---|
| Chloroform | 3 | 0.065 | 0.195 |
| 1,2-Dichloroethene (total) | 2.9 | 0.065 | 0.1885 |
| Methylene chloride | 10 | 0.065 | 0.65 |
| Tetrachloroethane | 1.4 | 0.065 | 0.091 |
| 1,1,1-Trichloroethene | 1.2 | 0.065 | 0.078 |
| | | | |
| Chloride | 4900 | 0.065 | 318.5 |

## Analytical Results

Impinger solutions:

| Run-3 | Conc. ug/l | Vol, l | Loading ug/sample |
|---|---|---|---|
| Chloroform | 2.7 | 0.064 | 0.1728 |
| 1,2-Dichloroethene (total) | 3.8 | 0.064 | 0.2432 |
| Methylene chloride | 8.1 | 0.064 | 0.5184 |
| Tetrachloroethane | 1.5 | 0.064 | 0.096 |
| | | | |
| Chloride | 2300 | 0.064 | 147.2 |

# CUSTODY RECORDS

D0923-15

# CHAIN OF CUSTODY RECORD

**PROJ. NO.**

**PROJECT NAME** UNISYS - AIR

**SAMPLERS:** *(Signature)* Ben Dowd

| SAMPLE NO. | ~~DATE~~ I.D. | TIME | SAMPLE LOCATION | NO. OF CONTAINERS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-1 | P-1 | | EFFLUENT | | | | | | | | CHARCOAL TUBES |
| RUN-1 | S-1 | | | | | | | | | | |
| RUN-1 | P-2 | | | | | | | | | | |
| RUN-1 | S-2 | | | | | | | | | | |
| RUN-2 | P-1 | | | | | | | | | | |
| RUN-2 | S-1 | | | | | | | | | | |
| RUN-2 | P-2 | | | | | | | | | | |
| RUN-2 | S-2 | | | | | | | | | | |
| RUN-3 | P-1 | | | | | | | | | | |
| RUN-3 | S-1 | | | | | | | | | | |
| RUN-3 | P-2 | | | | | | | | | | |
| RUN-3 | S-2 | | | | | | | | | | |
| | | | | | | | | | | | P= PRIMARY TUBE |
| | | | | | | | | | | | S= SECONDARY TUBE |
| | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* | **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* |
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* | **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* |
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received for Laboratory by:** *(Signature)* Lynn Smith | **Date / Time** 9/23/93 | | |

**REMARKS:**

RETEC
REMEDIATION TECHNOLOGIES INC

**REMEDIATION TECHNOLOGIES**
Damonmill Square
9 Pond Lane
Concord, MA 01742

D0923-16

# CHAIN OF CUSTODY RECORD

| | |
|---|---|
| **PROJ. NO.** | |
| **PROJECT NAME** | UNISYS - AIR |
| **SAMPLERS:** *(Signature)* | Ben Dowd |

| SAMPLE NO. | [redacted] ID | TIME | SAMPLE LOCATION | NO. OF CONTAINERS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-1 | P-1 | | INFLUENT | 1 | | | | | | | CHARCOAL TUBES |
| RUN-1 | S-1 | | | 1 | | | | | | | |
| RUN-1 | P-2 | | | 1 | | | | | | | [redacted] |
| RUN-1 | S-2 | | | 1 | | | | | | | |
| RUN-2 | P-1 | | | 1 | | | | | | | |
| RUN-2 | S-1 | | | 1 | | | | | | | |
| RUN-2 | P-2 | | | 1 | | | | | | | |
| RUN-2 | S-2 | | | 1 | | | | | | | |
| RUN-3 | P-1 | | | 1 | | | | | | | |
| RUN-3 | S-1 | | | 1 | | | | | | | |
| RUN-3 | P-2 | | | 1 | | | | | | | |
| RUN-3 | S-2 | | | 1 | | | | | | | |
| | | | FIELD BIAS BLANK | 1 | | | | | | | |
| | | | | | | | | | | | P= PRIMARY TUBE |
| | | | | | | | | | | | S= SECONDARY TUBE |

| | | | | | |
|---|---|---|---|---|---|
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* | **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* |
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* | **Relinquished by:** *(Signature)* | **Date / Time** | **Received by:** *(Signature)* |
| **Relinquished by:** *(Signature)* | **Date / Time** | **Received for Laboratory by:** *(Signature)* Lynn Smith | **Date / Time** 9/23/93 | | |

**REMARKS:**

REIEC
REMEDIATION TECHNOLOGIES INC

**REMEDIATION TECHNOLOGIES**
Damonmill Square
9 Pond Lane
Concord, MA 01742

№

# CHAIN OF CUSTODY RECORD

D0923-1

**PROJ. NO.**

**PROJECT NAME** UNISYS-AIR

**SAMPLERS:** *(Signature)*

| SAMPLE NO. | ~~DATE~~ ID | TIME | SAMPLE LOCATION | NO. OF CONTAINERS | | Chloride by | ion chromatography | VOC's | | | REMARKS<br>$H_2SO_4$ CATCH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN-1 | | | EFFLUENT 67ml | | | X | | X | | | IMPINGER |
| RUN-1 | | | | | | | | | | | RINSE |
| RUN-2 | | | 65ml | | | X | | X | | | IMPINGER |
| RUN-2 | | | | | | | | | | | RINSE |
| RUN-3 | | | 64ml | | | X | | X | | | IMPINGER |
| RUN-3 | | | | | | | | | | | RINSE |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
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| Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* | Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* |
|---|---|---|---|---|---|
| | | | | | |

| Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* | Relinquished by: *(Signature)* | Date / Time | Received by: *(Signature)* |
|---|---|---|---|---|---|
| | | | | | |

| Relinquished by: *(Signature)* | Date / Time | Received for Laboratory by: *(Signature)* | Date / Time |
|---|---|---|---|
| | | Lynn Smith | 9/23/93 |

**REMARKS:**

RETEC
REMEDIATION TECHNOLOGIES INC

**REMEDIATION TECHNOLOGIES**
**Damonmill Square**
**9 Pond Lane**
**Concord, MA 01742**

# Appendix B

# Field Data Sheets

# REMEDIATION TECHNOLOGIES, INC
# FIELD DATA SHEET

## INLET GAS STREAM RECORD

Facility Name: Unisys
Date: 9/16/93
Run Number: 1

Ambient Temp: $72^{oF}$
Barametric Pressure: 29.29 inches
Stactic Pressure :PST −0.25 inches

## GAS FLOW READINGS

Dry Bulb Reading: ND
Wet Bulb Reading: ND
Impinger Volume (moisture: MD)
Start zero
End zero

Stack Gas Temp: TS
Start 55 oF
End 55 oF

Pitot Tube Type: standard
Stack Dimensions: 4 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.050 |
| 2 | 14.7% | 0.6 | 0.055 |
| 3 | 29.5% | 1.2 | 0.050 |
| 4 | 70.5% | 2.8 | 0.045 |
| 5 | 85.3% | 3.4 | 0.055 |
| 6 | 95.6% | 3.8 | 0.060 |
| Average | | | 0.053 |

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^a \times C_D \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_D$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
$PS = PB +- \text{avg.PST}$
$MW = MWD^b \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_a$
$Q_a = VS/A_s$
$A_s$ = Area of Stack ($ft^2$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.045 |
| 2 | 14.7% | 0.6 | 0.050 |
| 3 | 29.5% | 1.2 | 0.055 |
| 4 | 70.5% | 2.8 | 0.050 |
| 5 | 85.3% | 3.4 | 0.050 |
| 6 | 95.6% | 3.8 | 0.060 |
| Average | | | 0.052 |

| Results: | |
|---|---|
| Gas Velocity Run 1 | 905.44 afpm |
| Gas Flow Rate: | 78.97 acfm |
| Gas Flow Rate: | 2.24 $m^3$/min |

| | |
|---|---|
| Run Avg. | 0.052 |
| AvgSTD | 5.179 |
| PS | 29.27 |
| MW | 28.83 |

# REMEDIATION TECHNOLOGIES, INC
# FIELD DATA SHEET

## OUTLET GAS STREAM RECORD

|  |  |  |  |
|---|---|---|---|
| Facility Name: Unisys |  | Ambient Temp: | 62 $^{o}F$ |
| Date: 9/16/93 |  | Barametric Pressure: | 29.29 inches |
| Run Number: 1 |  | Stactic Pressure :PST | 0.2 inches |

### GAS FLOW READINGS

Dry Bulb Reading: ND
Wet Bulb Reading: ND
Impinger Volume (moisture: MD)
Start zero
End zero

Pitot Tube Type: standard
Stack Dimensions: 8 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.200 |
| 2 | 14.7% | 1.2 | 0.230 |
| 3 | 29.5% | 2.4 | 0.240 |
| 4 | 70.5% | 5.6 | 0.240 |
| 5 | 85.3% | 6.8 | 0.240 |
| 6 | 95.6% | 7.6 | 0.230 |
| Average |  |  | 0.230 |

Stack Gas Temp: TS
Start 136 $^{o}F$
End 136 $^{o}F$

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^{a} \times C_{D} \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_{D}$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
$PS = PB +- \text{avg.PST}$
$MW = MWD^{b} \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_{a}$
$Q_{a} = VS/A_{s}$
$A_{s}$ = Area of Stack (ft$^{2}$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.220 |
| 2 | 14.7% | 1.2 | 0.240 |
| 3 | 29.5% | 2.4 | 0.240 |
| 4 | 70.5% | 5.6 | 0.230 |
| 5 | 85.3% | 6.8 | 0.230 |
| 6 | 95.6% | 7.6 | 0.230 |
| Average |  |  | 0.232 |

| Results: |  |
|---|---|
| Gas Velocity Run 2 | 2049.43 afpm |
| Gas Flow Rate: | 715.02 acfm |
| Gas Flow Rate: | 20.25 m$^{3}$/min |

|  |  |
|---|---|
| Run Avg. | 0.231 |
| AvgSTD | 11.729 |
| PS | 29.30 |
| MW | 28.83 |

REMEDIATION TECHNOLOGIES, INC
FIELD DATA SHEET

## INLET GAS STREAM RECORD

Facility Name: Unisys
Date: 9/16/93
Run Number: 2

Ambient Temp: 72 oF
Barametric Pressure: 29.29 inches
Stactic Pressure :PST −0.2 inches

## GAS FLOW READINGS

Dry Bulb Reading: ND
Wet Bulb Reading: ND
Impinger Volume (moisture: MD)
Start zero
End zero

Stack Gas Temp: TS
Start 55 oF
End 55 oF

Pitot Tube Type: standard
Stack Dimensions: 4 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.070 |
| 2 | 14.7% | 0.6 | 0.070 |
| 3 | 29.5% | 1.2 | 0.065 |
| 4 | 70.5% | 2.8 | 0.055 |
| 5 | 85.3% | 3.4 | 0.070 |
| 6 | 95.6% | 3.8 | 0.070 |
| Average | | | 0.067 |

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^a \times C_D \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_D$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
PS = PB +− avg.PST
$MW = MWD^b \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_a$
$Q_a = VS/A_s$
$A_s$ = Area of Stack (ft$^2$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.060 |
| 2 | 14.7% | 0.6 | 0.070 |
| 3 | 29.5% | 1.2 | 0.060 |
| 4 | 70.5% | 2.8 | 0.060 |
| 5 | 85.3% | 3.4 | 0.055 |
| 6 | 95.6% | 3.8 | 0.065 |
| Average | | | 0.062 |

| Results: | |
|---|---|
| Gas Velocity Run 2 | 1004.93 afpm |
| Gas Flow Rate: | 87.65 acfm |
| Gas Flow Rate: | 2.48 m$^3$/min |

| | |
|---|---|
| Run Avg. | 0.064 |
| AvgSTD | 5.749 |
| PS | 29.28 |
| MW | 28.83 |

# REMEDIATION TECHNOLOGIES, INC
# FIELD DATA SHEET

## OUTLET GAS STREAM RECORD

Facility Name: Unisys
Date: 9/16/93
Run Number: 2

Ambient Temp: 68 oF
Barametric Pressure: 29.29 inches
Stactic Pressure :PST 0.25 inches

### GAS FLOW READINGS

Dry Bulb Reading: ND
Wet Bulb Reading: ND
Impinger Volume (moisture: MD)
Start zero
End zero

Stack Gas Temp: TS
Start 130 oF
End 130 oF

Pitot Tube Type: standard
Stack Dimensions: 8 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.210 |
| 2 | 14.7% | 1.2 | 0.230 |
| 3 | 29.5% | 2.4 | 0.230 |
| 4 | 70.5% | 5.6 | 0.230 |
| 5 | 85.3% | 6.8 | 0.240 |
| 6 | 95.6% | 7.6 | 0.250 |
| Average | | | 0.232 |

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^{a} \times C_{D} \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_{D}$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
PS = PB +− avg.PST
$MW = MWD^{b} \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_a$
$Q_a = VS/A_s$
$A_s$ = Area of Stack (ft$^2$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.240 |
| 2 | 14.7% | 1.2 | 0.240 |
| 3 | 29.5% | 2.4 | 0.230 |
| 4 | 70.5% | 5.6 | 0.230 |
| 5 | 85.3% | 6.8 | 0.240 |
| 6 | 95.6% | 7.6 | 0.240 |
| Average | | | 0.237 |

Results:
Gas Velocity Run 2: 2053.63 afpm
Gas Flow Rate: 716.49 acfm
Gas Flow Rate: 20.29 m$^3$/min

| | |
|---|---|
| Run Avg. | 0.234 |
| AvgSTD | 11.754 |
| PS | 29.31 |
| MW | 28.83 |

# REMEDIATION TECHNOLOGIES, INC
# FIELD DATA SHEET

## INLET GAS STREAM RECORD

Facility Name: Unisys
Date: 9/16/93
Run Number: 3

Ambient Temp: 72 °F
Barametric Pressure: 29.29 inches
Stactic Pressure :PST −0.22 inches

## GAS FLOW READINGS

Dry Bulb Reading: ND
Wet Bulb Reading: ND
Impinger Volume (moisture: MD)
Start zero
End zero

Stack Gas Temp: TS
Start 55 °F
End 55 °F

Pitot Tube Type: standard
Stack Dimensions: 4 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.060 |
| 2 | 14.7% | 0.6 | 0.060 |
| 3 | 29.5% | 1.2 | 0.055 |
| 4 | 70.5% | 2.8 | 0.050 |
| 5 | 85.3% | 3.4 | 0.060 |
| 6 | 95.6% | 3.8 | 0.060 |
| Average | | | 0.058 |

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^{a} \times C_{p} \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_{p}$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
PS = PB +− avg.PST
$MW = MWD^{b} \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_a$
$Q_a = VS/A_s$
$A_s$ = Area of Stack (ft$^2$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.2 | 0.055 |
| 2 | 14.7% | 0.6 | 0.065 |
| 3 | 29.5% | 1.2 | 0.065 |
| 4 | 70.5% | 2.8 | 0.060 |
| 5 | 85.3% | 3.4 | 0.055 |
| 6 | 95.6% | 3.8 | 0.060 |
| Average | | | 0.060 |

Results:

| | |
|---|---|
| Gas Velocity Run 1: | 961.61 afpm |
| Gas Flow Rate: | 83.87 acfm |
| Gas Flow Rate: | 2.38 m$^3$/min |

| | |
|---|---|
| Run Avg. | 0.059 |
| AvgSTD | 5.501 |
| PS | 29.27 |
| MW | 28.83 |

# REMEDIATION TECHNOLOGIES, INC
# FIELD DATA SHEET

## OUTLET GAS STREAM RECORD

Facility Name: Unisys
Date: 9/16/93
Run Number: 3

Ambient Temp: 72$^{oF}$
Barametric Pressure: 29.29 inches
Stactic Pressure :PST 0.22 inches

## GAS FLOW READINGS

| | |
|---|---|
| Dry Bulb Reading: | ND |
| Wet Bulb Reading: | ND |
| Impinger Volume (moisture: MD) | |
| Start | zero |
| End | zero |

Stack Gas Temp: TS

| | |
|---|---|
| Start | 137 $^{oF}$ |
| End | 0 $^{oF}$ |

Pitot Tube Type: standard
Stack Dimensions: 8 inches

| Initial Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.210 |
| 2 | 14.7% | 1.2 | 0.220 |
| 3 | 29.5% | 2.4 | 0.240 |
| 4 | 70.5% | 5.6 | 0.250 |
| 5 | 85.3% | 6.8 | 0.240 |
| 6 | 95.6% | 7.6 | 0.230 |
| Average | | | 0.232 |

Formulas:

Gas Velocity (afpm) = VS
$VS = 5130^{a} \times C_D \times \text{avg SDE} \times [1/PS \times MW]^{0.5}$
$C_D$ = pitot tube coefficient
$\text{avgSDE} = [\text{avg.pressure}]^{0.5} \times [TS + 460]^{0.5}$
$PS = PB +- \text{avg.PST}$
$MW = MWD^{b} \times MD + 18(1-MD)$

Gas Flow Rate (acfm) = $Q_a$
$Q_a = VS/A_s$
$A_s$ = Area of Stack (ft$^2$)

| Final Traverse Points | % Distance of diameter | Measurement Δ point (inch) | Pressure Readings |
|---|---|---|---|
| 1 | 4.4% | 0.4 | 0.000 |
| 2 | 14.7% | 1.2 | 0.000 |
| 3 | 29.5% | 2.4 | 0.000 |
| 4 | 70.5% | 5.6 | 0.000 |
| 5 | 85.3% | 6.8 | 0.000 |
| 6 | 95.6% | 7.6 | 0.000 |
| Average | | | 0.000 |

| Results: | |
|---|---|
| Gas Velocity Run 3 | 2054.80 afpm |
| Gas Flow Rate: | 716.90 acfm |
| Gas Flow Rate: | 20.30 m$^3$/min |

| | |
|---|---|
| Run Avg. | 0.232 |
| AvgSTD | 11.760 |
| PS | 29.31 |
| MW | 28.83 |