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Project Summary

Audit of the Vulcanus Incineration Ship Prior to the August 1982 PCB Burn Mobile, Alabama

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Systems and performance audits were conducted of instrumentation aboard the incinerator ship MT Vulcanus, August 12-13, 1982. Instrumentation audited included the continuous emission monitoring system (CEMS) which measured the concentrations of oxygen (O_2), carbon monoxide (CO), and carbon dioxide (CO_2) in the incinerator effluent. Also audited were four thermocouples (which measured incinerator wall temperatures) and a Method 5 sampling system (operated by TRW, Inc.).

The audit disclosed that the CO monitor produced measurements which were 35.4 percent lower than expected; performance of the O_2 and CO_2 monitors was satisfactory. A leak, detected by the auditors in the starboard incinerator sampling system, was corrected by the ship's personnel. The combustion thermocouple readout meters performed satisfactorily; however, the portside Plastomatic* thermocouple readout meter averaged 7.2 percent less than expected, and the starboard Plastomatic thermocouple readout meter averaged 15.7 percent greater than expected. Differences at 1200°C were -5.2 and 9.7 percent, respectively. Results of the Method 5 dry gas meter audit originally indicated that TRW's meter was 11 percent less than expected. Recalculations by TRW reduced the differences to less than 3 percent.

*Plastomatic 2000 system, provided by Withoff-Phillips, Bremen, West Germany.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Vulcanus is a Singapore-registered tanker which has been converted for incinerating industrial waste at sea. This ship has been operating for several years, disposing of various chemical wastes generated mainly in the European community. Industrial waste disposal by incineration at sea is also an option for American waste management systems and thus is of interest to the U.S. Environmental Protection Agency (EPA).

In August 1982, the EPA had an opportunity to study (at sea) the incineration (by the Vulcanus) of transformer oil containing polychlorinated biphenyls. Merrill D. Jackson, head of the EPA investigative team, was assisted in this study by others from EPA and by TRW contract personnel experienced in source testing and fugitive emission evaluation.

Because of the special interest in this project, the quality assurance officer for EPA's Industrial Environmental Research Laboratory at Research Triangle Park (IERL-RTP) directed the Research Triangle Institute (RTI) to independently evaluate the ship's continuous emission monitoring system, incinerator temperature mea-

surement system, and the TRW sampling train prior to the test burn. The RTI audit team performed this evaluation August 11-13, 1982 while the Vulcanus was docked at Chickasaw Harbor near Mobile, AL.

Results

The audit results are reported separately for the three systems audited.

Continuous Emission Monitoring System (CEMS)

The CEMS was audited by supplying known concentrations of the pollutants of interest directly to the CEMS' ceramic probe, inside the incinerator. Table 1 summarizes the results. The results show only the CO analyzer to be producing unsatisfactory data. (Subsequent investigation determined that CO_2 produced a positive response in the CO analyzer.) Also of note is the positive intercept for the O_2 analyzer: the analyzer produced positive readings while sampling the audit cylinder containing nitrogen only. Examination of the starboard sampling system disclosed a leak between the Teflon sample line and the incinerator wall mounting device. The leak was subsequently corrected. No such leak was detected in the portside sampling system.

Temperature Measurement System

The temperature of the incinerator wall is monitored by a temperature measurement system consisting of thermocouples and readout meters. An audit of four meters was conducted by delivering known millivolt currents to the meters. Results of the audit are presented in Table 2. The results show the starboard Plastomatic thermocouple readout meter (in the camera box) read 15.7 percent higher on the average than the input voltages. The calculated error at a simulated temperature of 1200°C would be 9.7 percent for this meter. Similarly, the portside Plastomatic thermocouple readout meter read 7.2 percent lower on the average than the input voltages. The calculated error at a simulated temperature of 1200°C at the portside Plastomatic would be -5.2 percent for this meter.

TRW Dry Gas Meter

TRW used two Research Appliance Corporation Method 5 sampling trains to sample emissions from the starboard incinerator. One of the two sampling systems was audited to determine the accuracy of the train's dry gas meter. The audit results are presented in Table 3. Note that preliminary results show the TRW values to be approximately 11 percent lower than the RTI audit values. Examination of the preliminary calculations determined that TRW used an incorrect temperature conversion when calculating standard volume, and incorrectly applied the meter box correction to the volume equation. Recalculating the data increased TRW's standard volume 7.6 percent.

Audit data were recalculated using 20°C (as opposed to 25°C) as standard temperature and eliminating a water vapor correction from the standard volume equation.

Final results show that the TRW dry gas meter reads 3.1 percent lower than the audit meter.

Table 1. Summary of the Continuous Emission Monitoring System's Audit Results

Monitor S/N	Parameter	Average Difference (ppm)	Average Difference (%)[a]	Regression of monitor response (Y) on audit conc. (X); Y = mX + b: Slope (m)	Intercept (b)	Corr. Coeff. (r)
MO4-478	O_2	3,900	7.6	0.883	0.74[b]	0.9997
MO3-949	CO_2	6,200	8.5	1.025	0.34	0.9969
MO4-54	CO	-38.7	-35.4	0.750	-6.6	0.9938

[a]Values reported are the averages of the percent differences calculated by: (Analyzer Response - Audit Conc.)/Audit Conc. X 100 = Percent Difference.

[b]A leak in the starboard sampling system was identified and corrected.

Table 2. Summary of Temperature Measurement System Audit Results

Thermocouple Identity	Average Difference (°C)	Average Difference (%)[a]
Portside Combustion TC		
Camera Box Meter	64[b]	5.5[b]
Combustion Room Meter	39[b]	3.8[b]
Portside Plastomatic TC		
Camera Box Meter	-52	-7.2
Starboard Combustion TC		
Camera Box Meter	59[b]	5.2[b]
Combustion Room Meter	66[b]	5.6[b]
Starboard Plastomatic TC		
Camera Box Meter	+104	+15.7

[a]Values reported are the averages of the percent differences calculated by: (Analyzer Response - Audit Value)/Audit Value X 100 + Percent Difference.

[b]The value reported is an absolute average, comprising positive and negative data points.

Table 3. Summary of TRW Dry Gas Meter (DGM) Audit Results

Parameter	Average Difference (ft^3)	Average Difference (%)[a]	Linear Regression of TRW DGM Volume (Y) on Audit Volume (X); Y = mX + b: Slope (m)	Intercept (b)	Corr. Coeff. (r)
Volume (Preliminary)	-0.183	-10.7	0.890	0.00	0.9997
Volume (Final)	-0.057	-3.1	0.956	0.02	0.9997

[a]Values reported are the averages of the percent differences calculated by: (TRW DGM Volume - Audit Volume)/Audit Volume X 100 = Percent Difference

Recommendations

Recommendations are given separately for two of the three systems audited.

Continuous Emission Monitors

The discrepancy in the CO audit should be resolved. To do this and to increase the

accuracy of calibration of the remaining two monitors, it is recommended that:

1. Maintenance be performed on the CO analyzer, if possible, to "filter-out" the positive interference of CO_2. If electronic adjustments are not possible, a chemical CO_2 scrubber such as Ascarite may be necessary for scrubbing sample gases and calibration gases immediately before they enter the CO monitor.
2. The calibration system plumbing be modified so that the calibration gases pass through the scrubbers and dryers exactly the same as do the samples from the incinerators. The existing plumbing should be retained to permit two options: routing calibration gases directly to the monitors or through the scrubbers and dryers. Such a check will verify that the scrubbing system is not altering the sample gas.
3. The monitors be activated at least 5 days before a test burn to allow the detectors and associated electronics to stabilize. Calibration responses should be checked twice daily and results logged. During a burn, calibration should continue twice daily, with results and time of calibration logged.
4. The calibration standard be recertified to verify the concentration of CO.

Thermocouple

The audit disclosed discrepancies between meters of the same thermocouple as well as errors in accuracy. To correct these discrepancies, it is recommended that:

1. All meters of a given thermocouple be checked for similar readings during an actual burn or during calibration when a known voltage is passed to the readout meters.
2. The voltmeter used by the ship's electrician be recertified. During the audit, the ship's voltmeter read input voltages about 1 mV less than the audit voltmeter. Certification of the *audit* voltmeter to a National Bureau of Standards traceable voltmeter after the audit verified the meter to be accurate and thus still traceable to NBS standards.

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***Merrill D. Jackson** is the EPA Project Officer (see below).*
The complete report, entitled "Audit of the Vulcanus Incineration Ship Prior to the August 1982 PCB Burn, Mobile, Alabama," (Order No. PB 83-193 698; Cost: $8.50, subject to change) will be available only from:
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