RESEARCH TRIANGLE INSTITUTE

STATUS REPORT #7

STABILITY OF ORGANIC AUDIT MATERIALS AND RESULTS OF SOURCE TEST ANALYSIS AUDITS

by

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EPA Contract No.: 68-02-3767

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NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

Source measurement and monitoring efforts are designed to anticipate potential environmental problems, to support regulatory actions by developing data bases needed in developing regulations and to provide means of monitoring compliance with regulations. The Environmental Monitoring Systems Laboratory, Research Triangle Park, North Carolina, has the responsibility for implementation of agency-wide Quality Assurance programs for air pollution measurement systems; and supplying technical support to other groups in the Agency including the Office of Air and Radiation, the Office of Toxic Substances, and the Office of Enforcement.

The need for reliable standards for auditing and documenting the accuracy of source emission measurement of gaseous hydrocarbons, halocarbons, and sulfur compounds is well established. The Quality Assurance Division of EPA's Environmental Monitoring Systems Laboratory has responded to this need through the development of an extensive repository of gaseous compounds. The primary objectives of this ongoing project are (1) to provide accurate gas mixtures to EPA, state/local agencies, or their contractors for performance audits to assess the accuracy of source emission measurements in certain organic chemical manufacturing industries, (2) to verify the vendor's certified analysis of the gas mixtures, (3) to determine the stability of the gas mixtures with time, and (4) to develop new audit materials as requested by EPA. This report describes the current status of this project. Included in the report are (1) a description of the experimental procedures used for the analyses of gas mixtures, (2) a description of the audit procedure, and (3) currently available audit results and stability data.

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ABSTRACT

A repository of 45 gaseous compounds including hydrocarbons, halocarbon, and sulfur species has been established under contract with the U.S. Environmental Protection Agency (USEPA). The main objectives of this on-going project are (1) to provide gas mixtures to EPA, state/local agencies, or their contractors, as performance audits to assess the accuracy of source emission measurements in certain organic chemical manufacturing industries, (2) to corroborate the vendor's certified analysis of the gas mixtures by in-house analysis, (3) to determine the stability of the gas mixtures with time by in-house analysis, and (4) to explore the feasibility of new audit materials as requested by EPA.

Thus far, 31 compounds have been used to conduct 149 different audits. The results of these audits and a description of the experimental procedures used for analyses and available stability data are presented in the status report. Generally the audit results are within 15 percent of the expected values.

Compound stabilities have been determined through multiple analyses of the cylinders containing them. Stability data for up to 7 years is available for many compounds and over 4 years for most compounds. Compounds that are unstable and not suitable for use as an audit material are identified.

CONTENTS

TABLES

ACKNOWLEDGEMENTS

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SECTION 1
INTRODUCTION

OBJECTIVES

The need for reliable standards for auditing source emission measurement of gaseous hydrocarbons, halocarbons and sulfur compounds is well established. The Research Triangle Institute (RTI), under contract to the U.S. Environmental Protection Agency (USEPA), has responded to this need through the development of an extensive repository of 39 gaseous compounds. The primary objectives of this ongoing project are (1) to provide accurate gas mixtures to EPA, state/local agencies, or their contractors for performance audits to assess the relative accuracy of source emission measurements in certain organic chemical manufacturing industries, (2) to examine the vendor's certified analysis of the gas mixtures by in-house analysis, (3) to determine the stability of the gas mixtures with time by in-house analysis, and (4) to develop new audit materials, as requested by EPA.

This report describes the current status of this project. Included in the report are (1) a description of the experimental procedures used for initial cylinder analyses and collection of stability data, (2) a description of the audit procedure, and (3) currently available audit results and stability data. Complete details of the study with statistical analyses for ten (10) halocarbons and eight (8) other organics are presented in two journal publications (1,2). Statistical analysis for the remaining compounds will be presented in a future report.

AUDIT MATERIALS CONTAINED IN THE REPOSITORY

Currently, 45 gaseous compounds have been investigated as audit materials. Six of these gaseous compounds have been found to be unstable in cylinders and not suitable as audit materials. The other 39 gaseous compounds in the repository are suitable for conducting performance audits during source testing. The compounds were selected based on the anticipated needs of the Emission Measurement Branch, Office of Air Quality Planning and Standards, USEPA. Table 1 lists the 45 compounds, the concentration ranges, the number of cylinders of each compound currently in the repository, and the cylinder construction material. In Table 1, the audit materials fall into two concentration ranges. The low concentration range between 5 and 50 parts per million (ppm) simulates possible emission standard levels. The high concentration range between 50 and 700 ppm simulates expected source emission levels. The balance gas for all gas mixtures is nitrogen.

TABLE 1. AUDIT MATERIALS CURRENTLY IN THE REPOSITORY

Compound	Low Concentration Range			High Concentration Range		
	No. of Cylinders	Concentration Range (ppm)	Cylinder Construction*	No. of Cylinders	Concentration Range (ppm)	Cylinder Construction*
Benzene	7	5 - 20	S	11	60 - 400	S
Ethylene	4	5 - 20	Al	4	300 - 700	Al
				6	3000 - 20,000	Al
Propylene	3	5 - 20	Al	3	300 - 700	Al
Methane/Ethane	-	------	--	4	1000 - 6000(M), 200 - 700(E)	Al
Propane	4	5 - 20	Al	4	300 - 700	Al
				4	1000 - 20,000	Al
Toluene	5	5 - 20	S	4	100 - 700	LS
Hydrogen Sulfide	7	5 - 50	Al	7	100 - 700	Al
Meta-Xylene	1	5 - 20	S	2	300 - 700	LS
Methyl Acetate	2	5 - 20	S	2	300 - 700	S
Chloroform	2	5 - 20	S	1	300 - 700	S
Carbonyl Sulfide	1	5 - 20	S	3	100 - 300	S
Methyl Mercaptan	3	3 - 10	Al	-	---------	-
Hexane	2	20 - 80	Al	1	1000 - 3000	LS
1,2-Dichloroethane	4	5 - 20	Al	4	100 - 600	Al
Cyclohexane	-	------	--	1	80 - 200	S
Methyl Ethyl Ketone	1	30 - 80	S	-	---------	-
Methanol	2	30 - 80	Al	-	---------	-
1,2-Dichloropropane	2	5 - 20	Al	2	300 - 700	Al
Trichloroethylene	2	5 - 20	Al	2	100 - 600	Al
1,1-Dichloroethylene	2	5 - 20	Al	2	100 - 600	Al
**1,2-Dibromoethylene	-	------	--	-	---------	--
Perchloroethylene	2	5 - 20	S	2	300 - 700	LS
Vinyl Chloride	9	5 - 30	S	-	---------	--
1,3-Butadiene	1	5 - 30	S	-	---------	--
Acrylonitrile	1	5 - 20	Al	1	300 - 500	Al
**Aniline	-	------	--	-	---------	--
Methyl Isobutyl Ketone	1	5 - 20	Al	-	---------	--

*Cylinder constructions: Al = Aluminum, S = Steel, LS = Low-Pressure Steel

**Cylinders are no longer available; the compounds were found to be unstable in the cylinders.

TABLE 1. AUDIT MATERIALS CURRENTLY IN THE REPOSITORY (Continued)

Compound	Low Concentration Range			High Concentration Range		
	No. of Cylinders	Concentration Range (ppm)	Cylinder Construction*	No. of Cylinders	Concentration Range (ppm)	Cylinder Construction*
**Para-dichlorbenzene	-	---	S	-	---------	--
**Ethylamine	-	---	Al	-	---------	--
**Formaldehyde	-	---	-	-	---------	--
Methylene Chloride	3	1 - 20	Al	-	---------	--
Carbon Tetrachloride	1	5 - 20	Al	-	---------	--
Freon 113	1	5 - 20	Al	-	---------	--
Methyl Chloroform	1	5 - 20	Al	-	---------	--
Ethylene Oxide	5	5 - 20	Al	-	---------	--
Propylene Oxide	1	5 - 20	Al	1	75 - 200	Al
Allyl Chloride	1	5 - 20	S	1	75 - 200	S
Acrolein	1	5 - 20	Al	-	---------	--
Chlorobenzene	3	5 - 20	Al	-	---------	--
Carbon Disulfide	-	---	Al	1	75 - 200	Al
**Cyclohexanone	-	---	Al	-	---------	--
***EPA Method 25 Gas	6	100 - 200	Al	3	750 - 2000	Al
Ethylene Dibromide	2	5 - 20	S	2	100 - 300	S
Tetrachloroethane	1	5 - 20	S	-	---------	--

*Cylinder construction: Al = Aluminum, S = Steel, LS = Low Pressure Steel

**Cylinders are no longer available; the compounds were found to be unstable in the cylinders.

***The gas mixture contains an aliphatic hydrocarbon, an aromatic hydrocarbon, and carbon dioxide in nitrogen. Concentrations shown are reported in ppmC.

SECTION 2

EXPERIMENTAL PROCEDURES

Analysis of the cylinder gases is required to corroborate the concentrations reported by the company which prepared the gas mixtures and also to measure concentration changes with time, that is, estimate stability of the compounds.

INSTRUMENTATION

Analyses are presently performed with (1) a Perkin-Elmer Sigma 4 Gas Chromatograph with a flame ionization detector, and (2) a Tracor 560 Gas Chromatograph with a flame photometric detector. The flame photometric detector has been used principally for measurement of the sulfur-containing species. The gaseous samples are injected onto the columns by means of gas sampling valves constructed of Hastalloy C (high nickel content and low adsorptive properties). These valves are equipped with interchangeable sample loops to allow the injection of variable volumes of gas. A thermal oxidation system consisting of a 3/8 inch O.D. stainless steel tube heated to 1350°F in a tube furnace is used to oxidize calibration mixtures to CO_2 for verification of concentration. The CO_2 concentration is measured with a Byron Model 401 equipped with a nickel based reduction catalyst and flame ionization detector.

The gas chromatographic parameters used in the measurement of individual compounds and any problems with the analysis are listed in Attachment 1.

CALIBRATION

Calibration of the gas chromatographs has involved measurement of known concentrations of gases in air or nitrogen. The source or method of preparation of calibration standards varies depending on the gas involved.

National Bureau of Standards, Standard Reference Materials (NBS-SRMs) of methane and propane were used for the calibration of the GC for the measurement of methane, ethane, propane, ethylene, and propylene audit materials. NBS-SRM of benzene was used for the calibration of the GC for the measurement of low concentration benzene audit cylinders.

A second method for preparation of calibration standards involves the use of permeation tubes. For example, the calibration gases for vinyl chloride and ethylene oxide have been generated in this manner. The permeation tube is placed in a temperature-controlled chamber and nitrogen is passed over the permeation tube at a known flow rate. The resultant gaseous mixture is further diluted, if necessary, using additional nitrogen in a glass dilution bulb. The final mixture is collected in a gas sampling syringe and analyzed by GC-FID. The permeation rates of the tubes are determined periodically by weight loss.

A third method for developing a calibration standard is the pressure-dilution technique. A known volume of the compound, either gas or liquid, is injected into an evacuated glass bulb or stainless steel sphere of known volume. The volume of the bulb or sphere is determined gravimetrically. The bulb or sphere is then pressurized with a balance gas of choice. If a pure liquid is injected, total vaporization is assumed and the concentration is calculated by using the ideal gas law. Additional dilutions are also made, if necessary, by partially evacuating to a known pressure and pressurizing with a balance gas to a known pressure.

With each of these approaches, multipoint calibration curves are prepared each time a sample is analyzed.

QUALITY CONTROL

Replicate injections of both audit cylinder gases and calibration standards are performed until no trends in the detector response are observed and the relative standard deviation of replicate injections is less than 1 percent.

Instead of depending totally upon the pressure-dilution technique for the determination of calibration mixture concentrations, an internal quality control has been implemented to allow verification of the calibration mixture concentration. This involves passing a portion of the lowest concentration calibration mixture of a particular compound prepared in a bulb or sphere through the thermal oxidizer described in

Section 2.1 and analysis of the CO_2 produced with a Byron 401 analyzer. The CO_2 response is calibrated with a primary standard (± 1%) mixture of CO_2 in air. The concentration determined by this technique was then assigned to the lowest concentration calibration mixture and the concentrations of higher calibration mixtures were calculated by assuming quantitative dilution. This procedure was used for those organics listed in Table 2. The lowest standard calibration mixtures were only verified with this technique in order to limit the production of corrosive by-products of halogenated organics by the oxidizer.

TABLE 2. ORGANIC CALIBRATION MIXTURES VERIFIED BY BYRON 401 ANALYZER

Toluene
M-xylene
Methyl acetate
Chloroform
1,1-dichloroethane
Methanol
1,2-dichloropropane
1,1-dichloroethylene
Perchloroethylene
Methyl isobutyl ketone
Methylene chloride
Carbon tetrachloride
Freon 113
Allyl chloride
Acrolein
Chlorobenzene
EPA Method 25 gas mixture

SECTION 3
PERFORMANCE AUDITS

RTI supplies repository cylinders for audits upon request from the EPA, state or local agencies or contractors. A contractor must be performing source emission tests at the request of EPA or a state or local agency in order to qualify for the performance audit. When a request is received, the contents of the cylinders are analyzed, the tank pressures are measured and the cylinders are shipped by overland carrier. Tank regulators are also provided when requested. A letter is included with the cylinders which provides general instructions for performance of the audit. The audit material concentration and cylinder pressure are provided to the requesting agency audit coordinator.

To date, 149 individual audits have been initiated, and 140 are complete. The audit results currently available are presented in Table 2. Generally, the results of the audits show agreement of ± 15 percent with the audit material concentrations measured by RTI.

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
1	A	Ethylene oxide production	Ethylene in N_2	3,240	-22.5	E
			Ethylene in N_2	21,200	-20.0	
2	A	Ethylene oxide production	Methane/ethane in N_2	1,710Me/220Et	+9/-20	E
			Methane/ethane in N_2	8,130Me/597Et	+9/-1.00	
3	A	Ethylene oxide production	Methane/ethane in N_2	1,021Me/315Et	+21.5/-4.50	E
			Methane/ethane in N_2	6,207Me/773Et	+23.5/-4.50	
4	A	Acetone production	Benzene in N_2	79.0	-19.0	E
			Benzene in N_2	374.0	-11.0	
5	A	Maleic anhydride production	Benzene in N_2	138	-9.40	E
			Benzene in N_2	300	+4.70	
6	A	Ethylene oxide production	Ethylene in N_2	5,440	-27.0	E
			Ethylene in N_2	18,900	-33.0	
7	B	Maleic anhydride production	Benzene in N_2	80.0	+2.30	E
			Benzene in N_2	355	+27.5	
8	C	Maleic anhydride production	Benzene in N_2	101	+12.9	E
			Benzene in N_2	387	+14.5	
9	D	Ethyl benzene styrene manufacturer	Benzene in N_2	71.0	-2.80	E
			Benzene in N_2	229	-3.90	
10	E	Gasoline bulk terminal	Benzene in N_2	62.0	+3.80	E
			Benzene in N_2	80.0	+3.40	
11	F	Gasoline transfer terminal	Benzene in N_2	142	-3.50	E
			Benzene in N_2	294	+3.20	
12	F	Gasoline transfer terminal	Benzene in N_2	268	-11.8	E
			Benzene in N_2	343	-1.00	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI Audit conc. (ppm)	Client Audit % bias (Avg.)*	Status of audit**
13	F	Gasoline transfer terminal	Benzene in N_2	129	+4.70	E
			Benzene in N_2	318	+8.70	
14	F	Gasoline transfer terminal	Benzene in N_2	10.7	+2.60	E
15	C	Nitrobenzene manufacturing	Benzene in N_2	9.73	-4.60	E
			Benzene in N_2	269	-2.60	
16	F	Gasoline bulk terminal	Benzene in N_2	8.20	-2.30	E
			Benzene in N_2	140	-1.80	
17a	F	Gasoline bulk terminal	Benzene in N_2	9.50	+10.4	E
			Benzene in N_2	127	-2.80	
17b	F	Gasoline bulk terminal	Benzene in N_2	9.50	+12.5	E
			Benzene in N_2	127	-6.30	
18	G	Coke oven	Hydrogen sulfide in N_2	7.05	-24.8	E
			Hydrogen sulfide in N_2	9.73	-22.9	
19	F	Gasoline bulk terminal	Benzene in N_2	12.0	-0.80	E
			Benzene in N_2	218	+7.30	
20	F	Gasoline bulk terminal	Benzene in N_2	7.65	+16.3	E
			Benzene in N_2	396	+1.50	
21	F	Linear alkyl-benzene manufacturing	Benzene in N_2	98.0	+5.70	E
			Benzene in N_2	294	+6.80	
			Benzene in N_2	331	+4.50	
22	F	Gasoline bulk terminal	Benzene in N_2	9.85	-4.10	E
			Benzene in N_2	81.0	-6.80	
23	F	Gasoline bulk terminal	Benzene in N_2	10.2	+4.60	E
			Benzene in N_2	61.0	-9.50	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
24	H	Industrial surface coating process	Toluene in N_2	14.8	-1.90	E
			Propylene in N_2	474	+0.20	
			Propane in N_2	20.3	-2.30	
			Methane/ethane in N_2	1,640Me/195et	-13.5(as methane)	
25	C	Acrylic acid and ester Production	Propane in N_2	10.1	+8.60	E
			Propane in N_2	710	+5.60	
26	C	Acrylic acid and ester Production	Propane in N_2	5.1	+17.6	E
			Propane in N_2	607	-3.60	
27	E	Maleic anhydride	Benzene in N_2	10.2	NA	F
			Benzene in N_2	218	NA	
28A	A	Carbon adsorber	Toluene in N_2	8.55	-6.40	E
			Toluene in N_2	405	-1.00	
28B	A	Carbon adsorber	Toluene in N_2	8.55	+4.10	E
			Toluene in N_2	405	NA	
28C	A	Carbon adsorber	Toluene in N_2	8.55	-8.80	E
			Toluene in N_2	405	NA	
29	EPA, QAD	Instrument check-out	Ethylene in N_2	4.75	+4.00	E
			Ethylene in N_2	19.6	+3.10	
			Ethylene in N_2	312	-0.80	
			Ethylene in N_2	3020	+5.30	
			Ethylene in N_2	20400	-8.60	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI Audit conc. (ppm)	Client Audit % bias (Avg.)*	Status of audit**
30	EPA, QAD	Instrument	Benzene in N_2	8.20	+0.30	E
		check-out	Benzene in N_2	78.0	-0.90	
			Benzene in N_2	133	-4.00	
			Benzene in N_2	348	-0.90	
31	EPA, QAD	Instrument	Toluene in N_2	405	+3.20	E
		check-out	Toluene in N_2	579	+1.00	
32	EPA, QAD	Instrument	Methyl acetate in N_2	6.80	-2.60	E
		check-out	Methyl acetate in N_2	17.2	+1.70	
			Methyl acetate in N_2	326	-1.50	
			Methyl acetate in N_2	455	-1.30	
33	EPA, QAD	Instrument	Propylene in N_2	4.90	-22.4	E
		check-out	Propylene in N_2	19.7	-7.80	
			Propylene in N_2	300	+1.00	
			Propylene in N_2	685	-1.80	
34	EPA, QAD	Instrument	Propane in N_2	14.6	-0.70	E
		check-out	Propane in N_2	303	+7.60	
			Propane in N_2	439	+6.20	
35a	I	Vegetable oil	Hexane in N_2	82.2	+8.10	E
		plant	Hexane in N_2	1980	+3.00	
35b	I	Vegetable oil	Hexane in N_2	82.2	-1.20	E
		plant	Hexane in N_2	1980	-1.30	
36	A	Carbon adsorber	Toluene in N_2	8.20	-2.40	E

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
37	B	Coke oven	Benzene in N_2	12.1	+0.80	E
			Benzene in N_2	105	+2.90	
38	D	Ethylbenzene/ styrene	Benzene in N_2	9.90	+5.70	E
			Benzene in N_2	77.9	+3.60	
			Benzene in N_2	345	+1.50	
39	B	Coke oven Byproduct	Benzene in N_2	8.20	-2.60	E
			Benzene in N_2	85.4	-8.70	
40	D	Coke oven Byproduct	Benzene in N_2	10.9	+20.0	
			Benzene in N_2	147	+6.80	
41	H	Paint spray	Benzene in N_2	10.8	NA	F
			m-Xylene in N_2	16.4	NA	
42	H	Tire manufacturing	Cyclohexane in N_2	93.4	-11.1	E
43	B	Coke oven	Benzene in N_2	7.54	+0.10	D
			Benzene in N_2	225	+0.40	
44	D	Ethylbenzene/ styrene	Benzene in N_2	8.20	-3.40	D
			Benzene in N_2	74.5	-0.20	
			Propane in N_2	10.6	-3.00	
45	F	Industrial surface coating	Propane in Air	316	-3.20	E
			Propane in Air	450	-2.00	
46	EPA, QAD	Tire manufacturing	Propane in Air	15.0	NA	F
			Propane in Air	316	NA	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
47	EPA, QAD	Tire manufacturing	Propane in air	20.8	-18.4	E
			Propane in air	453	+13.4	
48	D	Dimethyl terephthalate production	Meta-xylene in N_2	487	-2.10	E
49	EPA, QAD	Instrument check-out	Toluene in N_2	61.5	NA	F
			Methanol in N_2	55.2	NA	
50	EPA, QAD	Tire oven manufacturing	Propane in air	4.90	-48.8	E
			Propane in air	613	+16.9	
			Propane in air	718	+16.8	
51	EPA, QAD	Instrument check-out	Propane in air	20.8	+20.0	E
			Propane in air	316	-9.20	
52	D	Styrene manufacturing	Benzene in N_2	106	-4.90	E
			Benzene in N_2	358	-3.70	
			1,3-Butadiene in N_2	20.9	+23.8	
53	I	Veg. oil manufacturing	Cyclohexane in N_2	99.0	-3.50	E
54	M	Research	Chloroform in N_2	16.5	NA	F
			Chloroform in N_2	531	NA	
55	J	Research	Ethylene in N_2	300	+1.40	E

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
56	K	Reactivity of vent activated charcoal	Chloroform in N_2	8.11	NA	F
57	EPA, QAD	Instrument check-out	Hydrogen sulfide in N_2	16.2	NA	F
58	C	Coil coating	Propane in Air	5.20	NA	E
			Propane in Air	472	-8.40	
59	L	Maleic anhydride	Benzene in N_2	9.45	NA	F
			Benzene in N_2	341	NA	
60	M	Research	Audit not initiated	--	--	--
61	EPA (State of Conn.)	Maleic anhydride	Benzene in N_2	133	NA	F
62	O		Meta-xylene in N_2	760	NA	F
			Hexane in N_2	1990	NA	
63	M	Paper and pulp	Methyl mercaptan in N_2	4.44	NA	F
64	P	Research	Benzene in N_2	13.4	NA	F
			Methyl ethyl ketone in N_2	44.5	NA	
65	E	Coke oven Byproduct Recovery	Benzene in N_2	7.93	-2.90	E
			Benzene in N_2	132	+1.39	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
66	D	Rubber manufacturing	Benzene in N_2	12.0	+14.2	E
			Benzene in N_2	10.2	0	
			Benzene in N_2	100	+6.40	
			Benzene in N_2	335	+6.00	
			Hexane in N_2	79.8	+1.80	
			Hexane in N_2	3080	-7.50	
			Propane in Air	9.97	-3.20	
			Propane in Air	314	-10.8	
67	E	Coke oven Byproduct Recovery	Benzene in N_2	8.29	-2.20	E
			Benzene in N_2	75.7	-2.50	
68	EPA, Region II	Vinyl chloride manufacturing	Vinyl chloride in N_2	5.74	NA	F
			Vinyl chloride in N_2	28.3	NA	
69	EPA, QAD	Instrument Check	Propylene in N_2	328	-7.00	E
			Propylene in N_2	725	-8.30	
70	EPA, Region I	Vinyl chloride manufacturing	Vinyl chloride in N_2	7.50	NA	F
71	E	Degreasing vent	Trichloroethylene in N_2	14.9	-0.40	E
			Trichloroethylene in N_2	566	-8.70	
72	EPA, QAD	Instrument check-out	Hexane in N_2	3080	NA	F
73	EPA, QAD	Combustion efficiency test	Hydrogen sulfide in N_2	16.2	-7.50	E
			Methyl mercaptan in N_2	8.22	-8.90	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
74	E	Vinyl chloride manufacturing	1,2-Dichloroethane in N_2	9.30	+6.00	E
			1,2-Dichloroethane in N_2	462	+3.70	
75	N	Coil coating	Propane in air	10.0	NA	F
			Propane in air	309	NA	
76	F	Coil coating	Propane in air	10.0	NA	F
			Propane in air	309	NA	
77	D.	Maleic anhydride	Benzene in N_2	9.46	-6.60	E
			Benzene in N_2	66.9	-11.7	
78	EPA, Region VII	Instrument checkout	Benzene in N_2	120	NA	F
			Hexane in N_2	30.2	NA	
79	D	Maleic anhydride	Benzene in N_2	9.46	-4.60	E
			Benzene in N_2	128	+12.5	
80	F	Plywood/veneer drying	Propylene in N_2	14.8	-4.70	E
			Propylene in N_2	328	+4.40	
			Toluene in N_2	430	-0.80	
81	P	Plywood/veneer drying	Propylene in N_2	20.3	+18.2	E
			Propylene in N_2	479	-22.5	
			Toluene in N_2	487	+32.5	
82	J	Polypropylene manufacturing	Propylene in N_2	9.63	-0.35	E
			Propane in N_2	19.7	+0.84	
			Propane in N_2	296	+0.45	
83	I	Coke oven	Hydrogen sulfide in N_2	437	+4.90	E
			Hydrogen sulfide in N_2	647	-16.5	
			Carbonyl sulfide	101	+1.98	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
84	J	Compliance testing	Benzene in N_2	7.45	23.0	E
			Hexane in N_2	72.6	0.6	
			Toluene in N_2	15.0	-8.7	
			Methyl mercaptan in N_2	5.40	NA	
85	I	Steel manufacturing	Hydrogen sulfide in N_2	647	5.0	E
			Carbonyl sulfide in N_2	9.08	1.0	
86	I	Oil shale	Hydrogen sulfide in N_2	437	-3.0	E
			Carbonyl sulfide in N_2	117	-4.6	
			Methyl mercaptan in N_2	8.42	-13.3	
87	Q	Maleic Anhydride Production	Benzene in N_2	55.7	+528.4	E
			Hexane in N_2	324	+20.5	
88	R	Refining	Hydrogen sulfide in N_2	17.5	21.1	E
			Hydrogen sulfide in N_2	437	22.0	
89	Air Quality Bureau, New Mexico	Refining	Hydrogen sulfide in N_2	647	NA	F
90	S	Oil shale	Carbonyl sulfide in N_2	117	-29.1	E
			Methyl mercaptan in N_2	8.42	-14.8	
			Hydrogen sulfide in N_2	437	-3.65	
91	F	Compliance testing & demonstration	Trichlorethylene in N_2	94.6	NA	E
			Propane in N_2	10.0	NA	
			Propane in N_2	309	-54.0	
			Propane in N_2	73.8	8.7	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
92	EPA, Region I	Research Method Development	Toluene in N_2	347	NA	F
93	D	Method Validation	Hydrogen sulfide in N_2	8.32	NA	F
94	USEPA, Region I	Research-Method Development	Vinyl chloride in N_2	8.39	-20.2	E
			1,1-dichloroethylene in N_2	14.2	+10.6	
			Trichloroethylene in N_2	13.5	+55.6	
			Perchloroethylene in N_2	7.94	+48.1	
95	E	Acrylonitrile Production	Acrylonitrile in N_2	413	NA	E
			Acrylonitrile in N_2	10.8	6.94	
96	USEPA, Region I	Resource Recovery Garbage Burning Emissions	Propane in N_2	10.0	-35.0	E
			Propane in N_2	296	-17.2	
97	Tewksbury State Hospital, MA	Research-Method Development	Vinyl chloride in N_2	8.39	+57	E
			1,1-dichloroethylene in N_2	14.2	-9.9	
			Trichloroethylene in N_2	13.5	-4.4	
			Tetrachloroethylene in N_2	7.94	+48.6	
98	T	Plywood Veneer	Method 25 gas in N_2	102 as C	NA	F
			Method 25 gas in N_2	1940 as C	NA	
99	U	Hazardous Materials Incineration	Trichloroethylene in N_2	8.91	NA	F
			Perchloroethylene in N_2	7.94	NA	
			Chloroform in N_2	16.5	NA	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
100	USEPA, Region I	Research Method Development	Chlorobenzene in N_2	9.20	NA	F
			Benzene in N_2	128	NA	
			Hexane in N_2	30.2	NA	
			Meta-xylene in N_2	6.82 (cold bulb)	NA	
				2.68 (warm bulb)		
101	U	Hazardous Materials Incineration	Trichloroethylene in N_2	13.5	NA	F
			Perchloroethylene in N_2	14.5	NA	
102	Allegheny County	Source Testing	Toluene in N_2	8.51	NA	F
			Methyl ethyl ketone in N_2	38.7	NA	
			Acrylonitrile in N_2	11.6	NA	
			Methyl isobutyl ketone in N_2	9.49	NA	
103	I	Hazardous Waste Incineration	Vinylidiene chloride in N_2	14.2	12.3	E
104	I	Hazardous Waste Incineration	Vinylidiene chloride in N_2	9.00	10.0	E
105	USEPA, Region VI	Plastics	Vinyl chloride in N_2	8.41	NA	F
106	USEPA, Region VI	Vinyl Chloride Manufacturing	Vinyl chloride in N_2	8.44	NA	F
107	V	Instrument Check	Methyl chloroform in N_2	10.2	+7.8	E
			Perchloroethylene in N_2	7.94	+15.9	
108	Q	Gasoline Terminal	Propane in air	1.18%	-4.2	E
109	P	Chemicals Manufacturing	Toluene in N_2	16.4	17.3	E
			Benzene in N_2	7.3	NA	
			1,2-dichloroethane in N_2	8.1	NA	
110	MD Dept. of Health	Instrument Check	Benzene in N_2	9.64	-6.6	E
			Perchloroethylene in N_2	14.5	+60.1	

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
111	V	Instrument Check	Chloroform in N_2	16.5	+3	E
			Carbon tetrachloride in N_2	10.5	+33.0	
			Trichloroethylene in N_2	13.5	+4.0	
			Freon 113 in N_2	9.76	0	
112	J	Research, Method Development	Propane in N_2	628	+0.6	E
			Toluene in N_2	347	+2.0	
113	GA State EPA	Plastics	Vinyl chloride in N_2	8.44	+10.2	E
114	Sacremento County, California	Instrument Check	Ethylene oxide in N_2	10.1	NA	F
115	W	Instrument Check	Benzene in N_2	389	-35.7	E
			Chlorobenzene in N_2	9.20	-43.1	
116	V	Instrument Check	Methanol in N_2	55.2	NA	F
117	X	Carbon Adsorption	Toluene in N_2	16.1	NA	F
			Methyl ethyl ketone in N_2	38.7	NA	
			Methylene chloride in N_2	9.67	NA	
118	F	Surface Coating	Method 25 gas in N_2	96.8 as C	+127.3	E
119	K	Source Testing	Freon 113 in N_2	9.76	NA	F
120	Z	Source Testing	Toluene in N_2	8.51	+38.8	E
			Toluene in N_2	558	-3.1	
121	K	Source Testing	Perchloroethylene in N_2	7.94	NA	F
122	LA State EPA	Source Testing	Benzene in N_2	9.64	-30.5	E
			Vinyl chloride in N_2	8.44	191.5	
			1,2-dichloroethane in N_2	13.8	-37.0	
			Carbon tetrachloride in N_2	10.5	-40.0	
123	C	Paper Manufacturing	Vinyl chloride in N_2	6.60	NA	F

TABLE 3. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
124	LA State EPA	Instrument Check	Toluene in N_2	8.51	-34.2	E
			Methylene chloride in N_2	9.67	96.8	
125	Y	Surface Coating	Method 25 gas in N_2	107 as C	80.4	E
			Method 25 gas in N_2	775 as C	39.5	
126	I	Oil Shale	Carbonyl sulfide in N_2	10.7	NA	F
			Carbonyl sulfide in N_2	116	NA	
			Hydrogen sulfide	627	NA	
			Methyl mercaptan	8.42	NA	
127	F	Surface Coating	Method 25 gas in N_2	775 as C	-26.5, -18.7	E
128	Y	Surface Coating	Method 25 gas in N_2	205 as C	21.5	E
			Method 25 gas in N_2	1040 as C	18.9	
129	J	Research, Method Development	Methyl ethyl ketone in N_2	38.7	NA	F
130	Region VII	Source Testing	Acrylonitrile in N_2	11.6	-29.3	E
131A	South Coast Air Quality Management District	Hazardous Waste Landfill	Benzene in N_2	134	-28	E
			Methane in N_2	6460	+0.6	
131B	South Coast Air Quality Management District	Hazardous Waste Landfill	Methane in N_2	6460	-2.5	E
132	Maryland Dept. of Health	Instrument Check	Benzene in N_2	7.9	-11.1	E
			Trichloroethylene in N_2	9.4	-31.6	
			Hexane in N_2	32.8	-18.5	
			Methyl isobutyl ketone in N_2	8.4	+15.4	
			1,2-Dichloroethane in N_2	13.9	-2.1	
133	State of California Air Resources Board	Quality Assurance Audit of Standards	Methylene chloride in N_2	9.2	+7.6	E
			Chloroform in N_2	4.6	+2.2	
			Perchloroethylene in N_2	10.5	+14.3	
			Carbon tetrachloride in N_2	9.6	+1.0	
			Trichloroethylene in N_2	14.0	+7.1	
			Freon-113 in N_2	11.0	-9.1	

TABLE 2. SUMMARY OF PERFORMANCE AUDIT RESULTS (Continued)

Audit No.	Client***	Industry	Audit material	RTI audit conc. (ppm)	Client audit % bias (Avg.)*	Status of audit**
134	AA	Source Testing	Benzene in N_2	310	+5.2	E
135	FF	Source Testing	Method 25 gas in N_2	103.8 as C	+28.1	E
136	J	Instrument Check	Benzene in N_2 Benzene in N_2	10.3 121	+12.2 +6.2	E
137	I	Source Testing	Method 25 gas in N_2	195 as C		A
138	F	Compliance Testing	Methanol in N_2	48.8	+10.7	E
139	BB	Source Testing	Methyl ethyl ketone in N_2 Method 25 gas in N_2	40.4 1060		A
140	EPA Region II	Metal Refining	Benzene in N_2	376	-11.2	E
141	Commonwealth of Massachusetts	Instrument Check	Benzene in N_2 Trichloroethylene in N_2 Methyl ethyl ketone in N_2	7.9 14.0 40.4	+5.1 -4.3 +31.2	E
142	EPA Region II	Source Testing	Benzene in N_2	7.8	-5.1	D
143	State of Delaware	Plastic Manufacturing	Vinyl chloride in N_2 Vinyl chloride in N_2	7.75 20.3	-11.0 -10.3	E
144	EE	Plastic Manufacturing	Method 25 gas in N_2 Propane in air	96.1 as C 10.9	-24.5 -4.6	E
145	DD	Paper Coating	Toluene in N_2	546		A
146	State of Delaware	Instrument Check	Benzene in N_2	7.9	-20.6	E
147	CC	Gasoline Terminal	Propane in N_2	2052		A
148	F	Vinyl Coating	Propane in N_2	308		A
149	BB	Plastic Manufacturing	Methyl ethyl ketone in N_2 Method 25 gas in N_2	40.4 1017 as C		A

NA = Not analyzed

$$\text{*Client \% Bias} = 100 \times \frac{\text{Client-Measured Concentration} - \text{RTI-Measured Concentration}}{\text{RTI-Measured Concentration}}$$

**Status Codes:
A = Cylinder shipped; audit results not yet received;
B = Audit results received;
C = Audit report submitted to EPA;
D = Audit results received, audit report submitted to EPA, cylinder not yet returned by client;
E = Audit complete;
F = Audit completed without analysis of audit materials by client.

***Whenever the auditee is known, an alphabetical letter is shown. Whenever the auditee is unknown, the name of the agency requesting the audit is shown.

1977 - Audits 1-8	1982 - Audits 83-86
1978 - Audits 9-28	1983 - Audits 87-106
1979 - Audits 29-49	1984 - Audits 107-130
1980 - Audits 50-75	1985 - Audits 131-149
1981 - Audits 76-82	

SECTION 4

STABILITY STUDIES

An ideal calibration standard or audit material should be stable over its total time of usage. The stabilities of the compounds in the repository were studied through periodic analysis of the cylinder contents. In this project, the gas mixtures in the repository are initially analyzed upon receipt from the specialty gas vendor to corroborate the vendor's analysis. If the RTI analysis result differs from the vendor's value by more than 10 percent, the cylinder is given to a third party (EPA or NBS) for analysis. The gas mixtures are again analyzed at 1 month, at 2 months, and at one year following the initial analysis to determine the stability of the gas mixtures. In some cases, analyses are not performed on the dates specified above; however, every attempt is made to acquire the data on this schedule. Cylinder concentrations are also usually determined prior to each performance audit, providing additional data for use in stability studies.

As the number of analyses per cylinder increases, statistical stability analyses will be performed. The results will be presented in a future report. Statistical stability analyses for ten (10) halocarbons and eight (8) other organics were recently published in the open literature (1,2).

Absolute accuracies of the cylinder analyses have not been determined due to lack of NBS standards for most of the organic gas mixtures above one ppm. Recently NBS has issued SRMs for tetrachloroethylene and benzene and is in the process of certifying a 4-component SRM containing aromatic species (benzene, toluene, chlorobenzene, and bromobenzene) and a 4-component SRM containing halocarbons (chloroform, carbon tetrachloride, tetrachloroethylene and vinyl chloride). Once these NBS-SRMs are available, they will be used in the future to estimate the absolute accuracy. An examination of the data in Attachment 1 shows values for individual cylinder analyses usually vary by less than 10 percent for 4-8 analyses over 2-6 years. This variation indicates changes in cylinder contents (i.e., instability) and the imprecision of the measurement process. The possible sources of experimental error that could result in apparent differences in concentrations include (1) the variability of the analytical technique used for analysis, (2) stability of and/or accuracy of calibration standards, and (3) the accuracy of reproducing standards for which NBS-SRMs do not exist. Each of these sources of variability contributes to the net uncertainty of the resulting data presented in Attachment 1. Estimates of day-to-day measurement uncertainty (repeatability) for all compounds have not been performed. However, the measurement uncertainties for ten halocarbons were recently published (2). The measurement uncertainty varied from <1 to 10 percent depending on the compound, and the major portion of the uncertainty was attributed to the method of preparation of the calibration standard. The uncertainty for the gas chromatographic analysis was determined to be less than 2 percent by multiple injections of the gas during same day analysis. For some recent analyses of those organics listed in Table 2, the uncertainty in the concentration has been estimated. These estimates are based on consideration of the uncertainties of several parameters involved in the measurement and calibration standard preparation procedures. For example, for those analyses involving the use of the thermal oxidizer and Byron 401, the estimated uncertainties (percent coefficient of variation) were determined to be as follows:

- o CO_2 standard response uncertainty - 2%
- o CO_2 standard concentration uncertainty - 1%
- o CO_2 analyzer response linearity uncertainty - 1%
- o oxidized organic calibration mixture response uncertainty - 1%
- o organic calibration mixture GC response uncertainty - 1%
- o repository mixture GC response uncertainty - 1%.

The equation below was then used to estimate the total uncertainty based on the above individual uncertainties.

$$\text{Total Uncertainty} = 2\left(\sum_{i=1}^{n} e_i^2\right)^{1/2}$$

Where:

2 = two standard deviations (95 percent confidence limit)

e_i = individual component error, (percent coefficient of variation)

n = total number of error components.

Thus, a total uncertainty of 7.0 percent was obtained for all the compounds listed in Table 2. For those analyses involving the use of NBS-SRM's for calibration, the total uncertainty was determined to be 3.5 percent.

SECTION 5

SUMMARY AND CONCLUSIONS

Cylinder gases of hydrocarbons, halocarbons, and sulfur containing organic species have been used successfully as audit materials to assess the relative accuracy of gas chromatographic systems used to measure source emissions. Absolute accuracy has not been determined due to the lack of NBS standards for most of the organic gas mixtures above 1 ppm; instead an estimated interlaboratory bias has been reported for the performance audits conducted during source testing. This interlaboratory bias has been generally within 15 percent for both low and high concentration gases (Table 3).

Of the 45 gaseous compounds studied or currently under study, 39 have demonstrated sufficient stability in cylinders to be used further as audit materials. Five compounds (ethylamine, paradichlorobenzene, cyclohexanone, 1,2-dibromoethylene, and aniline) are not recommended as audit materials for various reasons as discussed in Attachment 1. One gaseous compound (formaldehyde) was ordered but the speciality gas manufacturer indicated that cylinder gases of this compound could not be prepared. Detailed statistical analyses which would separate statistical deviations from true concentration changes with time for 18 gaseous compounds have been published in a journal publication, and statistical analyses for the remaining compounds will be presented in a future report.

REFERENCES

1. R. K. M. Jayanty, C. Parker, C. E. Decker, W. F. Gutknecht, J. E. Knoll and D. J. VonLehmden, "Quality Assurance for Emissions Analysis Systems," *Environmental Science and Technology*, *17* (6), 257-263A (1983).

2. G. B. Howe, R. K. M. Jayanty, A. V. Rao, W. F. Gutknecht, C. E. Decker and D. J. VonLehmden, "Evaluation of Selected Gaseous Halocarbons for Use in Source Test Performance Audits," *J. of Air Pollution Control Association*, *33* (9), 823-826 (1983).

ATTACHMENT 1

Stability Data
as of
July 1985

1.0 BENZENE STABILITY STUDY

2.0 ETHYLENE STABILITY STUDY

3.0 PROPYLENE STABILITY STUDY

4.0 METHANE/ETHANE STABILITY STUDY

5.0 PROPANE STABILITY STUDY

6.0 TOLUENE STABILITY STUDY

7.0 HYDROGEN SULFIDE STABILITY STUDY

8.0 META-XYLENE STABILITY STUDY

9.0 METHYL ACETATE STABILITY STUDY

10.0 CHLOROFORM STABILITY STUDY

11.0 CARBONYL SULFIDE STABILITY STUDY

12.0 METHYL MERCAPTAN STABILITY STUDY

13.0 HEXANE STABILITY STUDY

14.0 1,2-DICHLOROETHANE STABILITY STUDY

15.0 CYCLOHEXANE STABILITY STUDY

16.0 METHYL ETHYL KETONE STABILITY STUDY

17.0 METHANOL STABILITY STUDY

18.0 1,2-DICHLOROPROPANE STABILITY STUDY

19.0 TRICHLOROETHYLENE STABILITY STUDY

20.0 1,1-DICHLOROETHYLENE STABILITY STUDY

21.0 1,2-DIBROMOETHYLENE STABILITY STUDY

22.0 PERCHLOROETHYLENE STABILITY STUDY

23.0 VINYL CHLORIDE STABILITY STUDY

24.0 1,3-BUTADIENE STABILITY STUDY

25.0 ACRYLONITRILE STABILITY STUDY

26.0 ANILINE STABILITY STUDY

27.0 METHYL ISOBUTYL KETONE STABILITY STUDY

28.0 CYCLOHEXANONE STABILITY STUDY

29.0 PARADICHLOROBENZENE STABILITY STUDY

30.0 ETHYLAMINE STABILITY STUDY

31.0 FORMALDEHYDE STABILITY STUDY

32.0 METHYLENE CHLORIDE STABILITY STUDY

33.0 CARBON TETRACHLORIDE STABILITY STUDY

34.0 FREON 113 STABILITY STUDY

35.0 METHYL CHLOROFORM STABILITY STUDY

36.0 ETHYLENE OXIDE STABILITY STUDY

37.0 PROPYLENE OXIDE STABILITY STUDY

38.0 ALLYL CHLORIDE STABILITY STUDY

39.0 ACROLEIN STABILITY STUDY

40.0 CHLOROBENZENE STABILITY STUDY

41.0 CARBON DISULFIDE STABILITY STUDY

42.0 METHOD 25 GAS MIXTURE

43.0 ETHYLENE DIBROMIDE

44.0 1,1,2,2-TETRACHLOROETHANE

NOTE: PPM concentrations shown in Attachment 1 are expressed on a mole/mole basis, except for EPA Method 25 mixture which is on a mole carbon/mole basis.

1.0 BENZENE STABILITY STUDY

Cylinder No.		1A	1B	1C	1D	1E	1F	1G
Cylinder Construction*		Al	Al	Al	Al	S	S	S
Manufacturer Concentration	ppm	65.4	324	200	117	61.0	71.0	80.0
	Date	7/27/77	7/27/77	7/27/77	7/27/77	2/10/78	2/10/78	2/10/78
	ppm	(79.0)	(374)	(241)	(138)	(62.0)	(71.0)	(80.0)
	Day	136	136	247	29	78	232	78
	ppm	(74.0)	(337)	(216)	(144)	(62.0)	(73.0)	(81.0)
	Day	156	156	252	157	216	385	216
	ppm	(78.0)	(350)	(215)	(134)	(61.0)	(75.0)	(81.0)
	Day	167	167	381	252	385	586	385
	ppm	(80.0)	(355)	(218)	(129)	(65.0)	(74.5)	(84.0)
	Day	630	402	**	290	722	882	504
	ppm	(77.9)	(331)		(127)	(66.9)	(75.7)	(85.4)
RTI	Day	**	433		414	1337	1292	1292
Concentration	ppm		(343)		(127)	(55.7)	(65.7)	(74.0)
	Day		969		1247	1858	2246	2246
	ppm		(358)		(132)	(58.7)	(70.0)	(78.3)
	Day		1274		2438	2246		
	ppm		(348)		(121)	(60.4)		
	Day		1491					
	ppm		(324)					
	Day		2056					
	ppm		(305)					
	Day		2438					
	ppm		(319)					

*Al = Aluminum; S = Steel; LS = Low-Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 60°C.

CALIBRATION: Reagent-grade "Benzene" liquid is used as a standard. Pressure-dilution technique is used for making the series of standards for calibration.

1.0 BENZENE STABILITY STUDY (Continued)

Cylinder No.		1H	1I	1J	1K	1L	1M	1N
Cylinder Construction*		S	S	S	S	S	S	S
Manufacturer Concentration	ppm	100	139	232	265	296	326	344
RTI Concentration	Date	2/8/78	2/9/78	2/9/78	2/9/78	2/9/78	2/9/78	2/9/78
	ppm	(101)	(139)	(229)	(264)	(295)	(319)	(332)
	Day	65	49	233	49	49	49	49
	ppm	(102)	(139)	(237)	(261)	(292)	(316)	(327)
	Day	206	50	386	50	51	51	54
	ppm	(98.0)	(142)	(243)	(268)	(294)	(318)	(342)
	Day	237	96	557	69	93	96	69
	ppm	(101)	(139)	(225)	(254)	(298)	(323)	(335)
	Day	434	127	**	84	205	433	809
	ppm	(105)	(140)		(269)	(294)	(345)	(342)
	Day	773	205		**	237	830	**
	ppm	(106)	(138)			(302)	(335)	
	Day	831	505			809	1294	
	ppm	(100)	(147)			(295)	(320)	
	Day	1294	1293			1294	2379	
	ppm	(92.0)	(128)			(290)	(310)	
	Day	2380	1338			2379		
	ppm	(96.0)	(128)			(285)		
	Day		2380					
	ppm		(134)					

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

1.0 BENZENE STABILITY STUDY (Continued)

Cylinder No.		1O	1P	1Q	1R	1S	1T	1U
Cylinder Construction*		S	S	S	S	S	S	S
Manufacturer Concentration	ppm	389	8.04	9.85	9.89	9.93	10.0	10.9
RTI Concentration	Date	2/9/78	4/21/78	4/21/78	4/21/78	4/21/78	4/21/78	4/21/78
	ppm	(387)	(8.37)	(9.99)	(10.0)	(10.0)	(10.7)	(11.5)
	Day	64	4	5	4	4	25	4
	ppm	(369)	(8.33)	(9.88)	(10.1)	(10.1)	(10.2)	(10.7)
	Day	205	25	25	13	26	146	25
	ppm	(396)	(8.20)	(10.1)	(9.73)	(9.80)	(9.20)	(10.8)
	Day	809	26	332	332	56	362	332
	ppm	(396)	(8.34)	(9.71)	(9.77)	(9.50)	(9.90)	(10.7)
	Day	1294	56	**	1018	146	1222	434
	ppm	(389)	(8.19)		(9.46)	(8.90)	(9.56)	(10.9)
	Day	2247	134		1270	628	**	759
	ppm	(376)	(7.81)		(9.64)	(9.57)		(10.2)
	Day		434			738		1222
	ppm		(8.21)			(9.45)		(9.69)
	Day		766			**		2175
	ppm		(7.93)					(9.90)
	Day		1222					
	ppm		(7.68)					
	Day		2175					
	ppm		(7.90)					

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

1.0 BENZENE STABILITY STUDY (Continued)

Cylinder No.		1V	1W	1X	1Y	1Z	1AA	1AB
Cylinder Construction*		S	S	S	S	S	S	S
Manufacturer Concentration	ppm	12.2	8.09	11.0	11.2	8.09	9.14	270
RTI Concentration	Date	4/25/78	5/19/78	5/4/78	5/4/78	5/4/78	5/4/78	7/27/77
	ppm	(12.7)	(8.10)	(11.2)	(10.9)	(8.20)	(9.10)	(300)
	Day	1	105	132	132	132	132	29
	ppm	(12.5)	(7.70)	(10.2)	(9.90)	(7.04)	(7.80)	(319)
	Day	21	287	**	302	302	302	157
	ppm	(12.3)	(8.10)		(10.7)	(7.70)	(8.50)	(312)
	Day	109	488		393	473	1005	2056
	ppm	(12.0)	(8.20)		(10.8)	(7.54)	(8.17)	(305)
	Day	358	784		2162	**	1209	**
	ppm	(12.1)	(8.30)		(10.3)		(8.42)	
	Day	755	1194				2162	
	ppm	(12.0)	(7.45)				(8.40)	
	Day	1218	2147					
	ppm	(11.7)	(7.80)					
	Day	2171						
	ppm	(11.9)						

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

2.0 ETHYLENE STABILITY STUDY

Cylinder No.		2A	2B	2C	2D	2E	2F	2G
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	2920	3000	4960	4970	19900	19900	4.95
RTI Concentration	Date	2/23/78	2/23/78	2/23/78	2/23/78	2/24/78	2/24/78	4/27/78
	ppm	(3070)	(3130)	(5210)	(5200)	(20400)	(20600)	(4.70)
	Day	49	49	48	48	48	48	29
	ppm	(3120)	(3180)	(5340)	(5280)	(20800)	(20800)	(4.70)
	Day	198	198	201	201	200	200	106
	ppm	(2880)	(2940)	(4660)	(4910)	(20200)	(20300)	(4.85)
	Day	809	809	809	809	808	808	741
	ppm	(3200)	(3270)	(5380)	(5340)	(18900)	(19000)	(4.62)
	Day	2291	2291	2291	2291	2290	2290	1180
	ppm	(3280)	(3350)	(5520)	(5480)	(20600)	(20700)	(5.12)
	Day							2224
	ppm							(4.50)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, Durapak n-octane on Porasil C column at 30 degrees Celsius.

CALIBRATION: NBS-SRM Propane is used for standard calibration.

2.0 ETHYLENE STABILITY STUDY (Continued)

Cylinder No.		2H	2I	2J	2K	2L	2M	2N
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	10.0	15.0	19.9	300	448	603	701
RTI Concentration	Date	4/27/78	4/28/78	4/28/78	4/28/78	4/28/78	4/28/78	4/28/78
	ppm	(9.70)	(14.4)	(19.2)	(306)	(468)	(629)	(740)
	Day	29	28	28	33	33	34	34
	ppm	(9.60)	(14.4)	(19.3)	(319)	(493)	(646)	(749)
	Day	106	104	104	105	104	104	104
	ppm	(9.90)	(14.9)	(20.3)	(312)	(473)	(636)	(737)
	Day	740	739	739	728	740	740	740
	ppm	(8.40)	(18.0)	(21.5)	(300)	(457)	(606)	(703)
	Day	1180	1179	1179	2225	2225	2225	2225
	ppm	(10.0)	(14.4)	(18.9)	(291)	(435)	(583)	(678)
	Day	2224	2223	2223				
	ppm	(9.50)	(14.2)	(18.9)				
	Day	2587						
		(9.54)						

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

3.0 PROPYLENE STABILITY STUDY

Cylinder No.		3A	3B	3C	3D	3E	3F	3G	3H
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	4.94	9.91	14.8	20.0	298	446	585	683
RTI Concentration	Date	4/27/78	4/27/78	4/27/78	4/27/78	4/27/78	4/27/78	4/27/78	4/27/78
	ppm	(4.86)	(9.83)	(14.6)	(19.8)	(296)	(442)	(577)	(672)
	Day	26	26	26	27	27	27	27	27
	ppm	(4.94)	(9.85)	(14.5)	(19.0)	(286)	(428)	(560)	(655)
	Day	27	104	104	104	104	105	104	105
	ppm	(4.78)	(10.3)	(14.8)	(20.0)	(317)	(474)	(629)	(729)
	Day	104	749	749	749	750	750	750	750
	ppm	(4.98)	(9.76)	(14.8)	(20.3)	(324)	(479)	(620)	(721)
	Day	749	1250	**	2229	820	2229	2229	820
	ppm	(4.93)	(9.63)		(19.7)	(328)	(444)	(579)	(725)
	Day	2229	2229			**			2229
	ppm	(4.80)	(9.80)						(676)
	Day	2601							
	ppm	(4.75)							

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame ionization detector, Durapak n-octane on Porasil C column at 30 degrees Celsius

CALIBRATION: NBS-SRM Propane is used for standard calibration.

4.0 METHANE/ETHANE STABILITY STUDY

Cylinder No.		4A		4B		4C		4D	
Cylinder Construction*		Al		Al		Al		Al	
Audit Material**		M	E	M	E	M	E	M	E
Manufacturer Concentration	ppm	6000	714	8130	597	1000	295	1670	202
	Date	7/21/78	7/21/78	7/21/78	7/21/78	7/21/77	7/21/77	7/21/77	7/21/77
	ppm	(6210)	(773)	(8130)	(654)	(1020)	(315)	(1710)	(220)
	Day	264	163	35	35	264	163	35	29
	ppm	(5980)	(715)	(7550)	(663)	(983)	(292)	(1560)	(218)
	Day	662	264	264	163	1027	264	264	157
RTI Concentration	ppm	(6580)	(684)	(7820)	(606)	(1290)	(283)	(1640)	(202)
	Day	2145	662	662	264	2510	1027	1027	258
	ppm	(6460)	(703)	(8590)	(577)	(1068)	(284)	(1950)	(195)
	Day		2145	2145	662		2510	2510	1027
	ppm		(730)	(8430)	(598)		(300)	(1770)	(206)
	Day				2145				2510
	ppm				(619)				(207)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**M = Methane; E = Ethane.

ANALYTICAL CONDITIONS: Flame ionization detector, Durapak n-octane on Porasil C column at 30 degrees celsius.

CALIBRATION: NBS-SRM methane is used for standard calibration.

5.0 PROPANE STABILITY STUDY

Cylinder No.		5A	5B	5C	5D	5E	5F	5G	5H
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	5.01	10.0	14.6	20.0	303	439	604	708
RTI Concentration	Date	4/25/78	4/25/78	4/25/78	4/25/78	4/26/78	4/26/78	4/26/78	4/27/78
	ppm	(4.90)	(9.70)	(14.3)	(19.5)	(304)	(441)	(615)	(730)
	Day	24	24	25	25	24	24	27	26
	ppm	(4.90)	(9.80)	(14.5)	(19.8)	(301)	(436)	(615)	(723)
	Day	108	108	108	108	107	107	107	106
	ppm	(5.10)	(10.1)	(14.9)	(20.3)	(305)	(440)	(607)	(710)
	Day	605	513	582	582	530	530	604	603
	ppm	(4.89)	(10.6)	(15.0)	(20.8)	(316)	(450)	(613)	(718)
	Day	729	752	736	736	581	581	735	734
	ppm	(5.20)	(10.0)	(14.7)	(20.1)	(316)	(453)	(628)	(734)
	Day	**	914	2220	1252	735	728	2218	2218
	ppm		(10.0)	(14.8)	(19.7)	(313)	(472)	(607)	(715)
	Day		2220	2589	2220	752	**		
	ppm		(10.9)	(14.8)	(20.0)	(314)			
	Day					913			
	ppm					(309)			
	Day					1251			
	ppm					(296)			
	Day					2219			
	ppm					(308)			

*Al = Aluminum; S = Steel, LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame ionization detector, Durapak n-octane on Porasil C column at 30 degrees Celsius.

CALIBRATION: NBS-SRM Propane is used for standard calibration.

UNCERTAINTY OF REPORTED CONCENTRATIONS: ± 3.5%

5.0 PROPANE STABILITY STUDY (Continued)

Cylinder No.		5I	5J	5K	5L
Cylinder Construction*		Al	Al	Al	Al
Manufacturer Concentration	ppm	1000	2000	10,000	20,000
	Date	3/3/83	3/3/83	3/3/83	3/3/83
	ppm	(1027)	(2100)	(11800)	(20700)
RTI Concentration	Day	452	452	452	452
	ppm	(1070)	(2180)	(13000)	(21000)
	Day	734	734	734	734
	ppm	(1006)	(2052)	(13021)	(21302)

*Al = Aluminum; S = Steel, LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, Durapak n-octane on Porasil C column at 30 degrees Celsius.

CALIBRATION: NBS-SRM Propane is used for standard calibration.

UNCERTAINTY OF REPORTED CONCENTRATIONS: ± 3.5%

6.0 TOLUENE STABILITY STUDY

Cylinder No.		6A	6B	6C	6D	6E	6F
Cylinder Construction*		LS	LS	S	S	S	S
Manufacturer Concentration	ppm	408	606	16.2	9.11	9.00	430
RTI Concentration	Date	12/6/78	12/6/78	10/3/78	10/3/78	3/29/83	7/1/80
	ppm	(405)	(585)	(17.3)	(9.62)	(8.51)	(430)
	Day	3	3	48	64	744****	861
	ppm	(405)	(579)	(14.9)	(8.50)	(8.04)	(347)
	Day	86	86	365	66		1115
	ppm	(394)	(577)	(15.0)	(8.60)		(338)
	Day	100	358	1373	160		1505
	ppm	(393)	(615)	(14.8)	(8.20)		(427)***
	Day	**	2079	**	**		1765****
	ppm		(663)***				(351)
	Day		2338****				
	ppm		(603)				

*Al = Aluminum, S = Steel, LS = Low Pressure Steel.

**Cylinder empty.

***Questionable value.

****Concentration uncertainty: ± 7%

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 60 degrees Celsius.

CALIBRATION: Reagent grade "Toluene" liquid is used as a standard. Pressure-dilution technique is utilized for generation of series of standards for calibration.

6.0 TOLUENE STABILITY STUDY (Continued)

Cylinder No.		6G	6H	6I	6J	6K	6L
Cylinder Construction*		Al	Al	Al	Al	LS	LS
Manufacturer Concentration	ppm	18.2	9.0	10.3	21.7	196	310
	Date	7/27/83	7/1/80	12/11/84	12/11/84	12/11/84	12/11/84
	ppm	(16.1)	(8.50)	(9.27)	(20.3)	(183)	(290)
RTI	Day	383	1505	192****	121****	141****	141****
Concentration	ppm	(19.1)***	(9.40)	(8.70)	(18.9)	(184)	(281)
		**	**				

*Al = Aluminun, S = Steel, LS = Low Pressure Steel.

**Cylinder empty.

***Questionable value.

****Concentration uncertainty: ± 7%

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 60 degrees Celsius.

CALIBRATION: Reagent grade "Toluene" liquid is used as a standard. Pressure-dilution technique is utilized for generation of series of standards for calibration.

7.0 HYDROGEN SULFIDE STABILITY STUDY

Cylinder No. Cylinder Construction*		7A Al	7B Al	7C Al	7D Al	7E Al	7F Al	7G Al
Manufacturer Concentration	ppm	399	9.15	16.7	649	6.95	6.45	671
	Date	10/1/78	7/7/78	10/1/78	10/1/78	10/1/78	10/1/78	3/2/83
	ppm	(371)	(9.73)	(16.1)	(641)	(7.05)	(4.94)	(628)
	Day	38	87	38	38	87	38	687
	ppm	(424)	(6.72)	(16.5)	(655)	(5.75)	(5.14)	(683)
	Day	111	124	111	111	124	111	833
	ppm	(414)	(7.11)	(15.7)	(690)	(5.62)	(4.81)	(654)
RTI	Day	1030	197	580	1030	197	580	
Concentration	ppm	(437)	(6.36)	(16.2)	(647)	(5.23)	(4.35)	
	Day	2270	696	1030		696	1030	
	ppm	(444)	(6.23)	(17.5)	**	(5.14)	(3.71)	
	Day	2446	1116	2270		1116	2325	
	ppm	(401)	(8.32)	(14.5)		(5.38)	(4.3)	
	Day		2399	2300		2325	2446	
	ppm		(8.0)	(15.3)		(4.6)	(4.1)	
	Day		2424	2446		2446		
	ppm		(6.6)	(15.6)		(4.4)		
	Day		2545					
	ppm		(6.0)					

*Al = Aluminum, S = Steel, LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame photometric detector, Chromosil 330 column at 60 degrees Celsius.

CALIBRATION: Reagent grade pure "Hydrogen sulfide" gas is used as a standard. Dilutions are made in a Tedlar bag for generation of series of standards for calibration. Permeation tube is used as a standard for calibration for the last two analyses of low concentration cylinders.

ANALYTICAL PROBLEMS: Only a Teflon® column and Teflon® lines should be used. The air-to-hydrogen ratio is critical to the sensitivity of the FPD.

Cylinder No.		7H	7I	7J	7K	7L	7M	7N	7O
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	20.77	29.27	39.14	97.31	206.3	323.2	417	503.2
RTI Concentration	Date	1/17/85	1/17/85	1/17/85	1/17/85	1/16/85	1/16/85	1/16/85	1/16/85
	ppm	(17.7)	(22.6)	(31.6)	(83.7)	(200)	(291)	(398)	(489)
	Day	25	25	25	146	147	147	147	147
	ppm	(20.6)	(30.4)	(42.4)	(92.1)	(210)	(320)	(415)	(514)
	Day	146	146	146					
	ppm	(21.0)	(30.5)	(40.5)					

*Al = Aluminum, S = Steel, LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame photometric detector, Chromosil 330 column at 60 degrees Celcius.

CALIBRATION: Reagent grade pure "Hydrogen sulfide" gas is used as a standard. Dilutions are made in a Tedlar bag for generation of series of standards for calibration. Permeation tube is used as a standard for calibration for the last two analyses of low concentration cylinders.

ANALYTICAL PROBLEMS: Only a Teflon® column and Teflon® lines should be used. The air-to-hydrogen ratio is critical to the sensitivity of the FPD.

8.0 M-XYLENE STABILITY STUDY

Cylinder No. / Cylinder Construction*		8A LS	8B LS	8C S	8D S	8E LS	8F LS	8G Al
Manufacturer Concentration	ppm	405	613	17.3	7.33			
RTI Concentration	Date	10/5/78	10/5/78	10/5/78	10/5/78	6/7/85***	6/7/85***	6/7/85***
	ppm	(480)	(720)	(16.6)	(6.20)	(596)	(362)	(11.5)
	Day	63	63	63	63			
	ppm	(445)	(676)	(17.2)	(6.81)			
	Day	158	158	166	166			
	ppm	(425)	(656)	(20.8)	(6.82)			
	Day	412	606	302	1036			
	ppm	(487)	(760)	(16.4)	(5.66)			
	Day	606	2140	1036				
	ppm	(507)	(598)	(19.0)				
		**	**	**	**			

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

***Concentration uncertainty: ± 7%

CALIBRATION: Reagent grade "M-Xylene" liquid is used. Pressure-dilution technique is used for generation of series of standards for calibration.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 60, 120 or 140 degrees Celsius.

9.0 METHYL ACETATE STABILITY STUDY

Cylinder No.		9A	9B	9C	9D
Cylinder Construction*		S	S	S	S
Manufacturer Concentration	ppm	326	455	6.84	17.2
	Date	10/13/78	10/13/78	10/13/78	10/13/78
	ppm	(271)	(428)	(5.29)	(12.9)
	Day	230	230	230	230
	ppm	(340)	(437)	(4.86)	(12.5)
RTI Concentration	Day	286	286	286	286
	ppm	(324)	(442)	(5.02)	(11.8)
	Day	629	629	630	630
	ppm	(348)	(479)	(5.88)	(12.5)
	Day	2442**	2442**	2442**	2442**
	ppm	(336)	(470)	(5.32)	(17.2)***

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%

***Questionable value.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-275 on Chromosorb WHP column at 50 degrees Celsius.

CALIBRATION: Reagent grade "Methyl acetate" liquid is used as a standard. Pressure-dilution technique is utilized for generation of series of standards for calibration.

10.0 CHLOROFORM STABILITY STUDY

Cylinder No.		10A	10B	10C	10D
Cylinder Construction*		S	S	S	S
Manufacturer Concentration	ppm	520	348	8.70	16.9
RTI Concentration	Date	10/17/78	10/17/78	10/17/78	10/17/78
	ppm	(529)	(345)	(8.08)	(17.6)
	Day	161	161	161	161
	ppm	(515)	(351)	(7.39)	(16.5)
	Day	256	256	256	256
	ppm	(514)	(340)	(7.50)	(16.2)
	Day	553	975	553	553
	ppm	(531)	(325)	(8.11)	(16.5)
	Day	**	2422***	2422***	2422***
	ppm		(333)	(4.26)	(14.9)

*Al = Aluminum; S = Steel; LS = Low Pressure.

**Cylinder empty.

***Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 50 or 100 degrees Celsius.

CALIBRATION: Reagent grade "Chloroform" liquid is used as a standard. Pressure-dilution technique is utilized for generation of series of standards for calibration.

11.0 CARBONYL SULFIDE STABILITY STUDY

Cylinder No.		11A	11B	11C	11D	11E	11F
Cylinder Construction*		S	S	S	S	AL	AL
Manufacturer Concentration	ppm	251	100	9.96	7.03	9.54	101
RTI Concentration	Date	11/3/78	11/3/78	11/3/78	11/3/78	9/18/81	9/18/81
	ppm	(276)	(109)	(9.10)	(6.81)	(12.9)	(111)
	Day	78	78	78	78	35	35
	ppm	(281)	(111)	(8.66)	(6.48)	(12.5)	(117)
	Day	185	185	185	185	222	
	ppm	(275)	(95.0)	(8.23)	(6.41)	(9.08)	
		**	**	**	**		**

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame photometric detector, Carbopak B column at 50 degrees Celsius or Chromosil 330 column at 60 degrees Celsius.

CALIBRATION: Reagent grade pure "Carbonyl Sulfide" gas is used as a standard. Dilutions are made in Teflon® bag for generation of series of standards for calibration.

ANALYTICAL PROBLEMS: Only a Teflon column and Teflon lines should be used. The air-to-hydrogen ratio is critical to the sensitivity of the FPD.

11.0 CARBONYL SULFIDE STABILITY STUDY (Continued)

Cylinder No.		11G	11H	11I
Cylinder Construction*		Al	Al	Al
Manufacturer Concentration	ppm	99.2	225	414
RTI Concentration	Date	1/11/85	1/11/85	1/11/85
	ppm	(101)	(228)	(423)
	Day	150	150	150
	ppm	(96.5)	(199)	(404)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame photometric detector, Carbopak B column at 50 degrees Celsius or Chromosil 330 column at 60 degrees Celsius.

CALIBRATION: Reagent grade pure "Carbonyl Sulfide" gas is used as a standard. Dilutions are made in Teflon® bag for generation of series of standards for calibration.

ANALYTICAL PROBLEMS: Only a Teflon column and Teflon lines should be used. The air-to-hydrogen ratio is critical to the sensitivity of the FPD.

12.0 METHYL MERCAPTAN STABILITY STUDY

Cylinder No.		12A	12B	12C	12D
Cylinder Construction*		Al	Al	Al	Al
Manufacturer Concentration	ppm	8.03	10.0	3.55	4.22
RTI Concentration	Date	1/24/79	1/24/79	1/24/79	1/24/79
	ppm	(5.66)	(7.94)	(3.65)	(4.23)
	Day	104	104	104	104
	ppm	(5.60)	(8.10)	(3.50)	(4.76)
	Day	139	139	139	139
	ppm	(5.65)	(7.90)	(3.56)	(4.54)
	Day	985	985	985	**
	ppm	(5.40)	(8.42)	(3.64)	
	Day	2194	2194	2194	
	ppm	(5.45)	(8.00)	(3.80)	
	Day	2331	2331	2331	
	ppm	(4.70)	(8.00)	(3.40)	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame photometric detector, Carbopak B column at 50 degrees Celsius or Chromosil 330 column at 60 degrees Celsius.

CALIBRATION: Reagent grade pure "Methyl mercaptan" gas is used a standard. Dilutions are made in a Teflon® bag for generation of series of standards for calibration. Permeation tube was used as a standard for calibration for the last two analyses.

ANALYTICAL PROBLEMS: Only a Teflon column and Teflon lines should be used. The air-to-hydrogen ratio is a critical variable.

13.0 HEXANE STABILITY STUDY

		13A	13B	13C	13D	13E
Cylinder No.		13A	13B	13C	13D	13E
Cylinder Construction*		LS	LS	Al	Al	Al
Manufacturer Concentration	ppm	1975	2973	30.6	79.2	80.0
RTI Concentration	Date	2/6/79	2/6/79	2/6/79	2/6/79	3/25/83
	ppm	(2170)	(3070)	(30.8)	(82.2)	(83.2)
	Day	6	6	296	296	376
	ppm	(1980)	(2860)	(30.1)	(81.0)	(88.2)
	Day	337	338	337	337	
	ppm	(2070)	(2950)	(30.6)	(81.3)	
	Day	469	469	469	469	
	ppm	(1990)	(3080)	(32.0)	(79.8)	
	Day	1886	1886	523	835	
	ppm	(1990)	(2980)	(30.0)	(80.2)	
	Day		**	835	1247	
	ppm			(30.2)	(82.7)	
	Day			1886	**	
	ppm			(32.8)		

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 60 or 100 degrees Celsius.

CALIBRATION: Reagent grade "Hexane" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

14.0 1,2 DICHLOROETHANE STABILITY STUDY

Cylinder No.		14A	14B	14C	14D	14E	14F	14G	14H
Cylinder Construction*		Al	Al	Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	14.4	9.64	100	526	6.92	12.5	97.9	439
	Date	1/19/79	1/19/79	1/19/79	1/19/79	4/5/79	4/5/79	4/5/79	4/5/79
	ppm	(14.1)	(9.20)	(96.2)	(498)	(10.0)	(15.2)	(102)	(463)
	Day	58	58	58	58	30	30	30	30
	ppm	(15.2)	(10.8)	(103)	(534)	(9.42)	(14.7)	(105)	(451)
	Day	155	155	155	155	69	69	69	69
	ppm	(14.9)	(10.0)	(98.2)	(524)	(9.30)	(14.3)	(99.0)	(462)
	Day	811	811	501	501	586	811	425	589
RTI Concentration	ppm	(14.2)	(9.56)	(87.3)	(592)**	(9.14)	(14.5)	(87.3)	(432)
	Day	835	835	920	920	811	835	844	697
	ppm	(13.5)	(9.19)	(102)	(502)	(9.70)	(13.8)	(101)	(451)
	Day	1964	1964	1964	1964	835	1888	1888	844
	ppm	(13.9)	(9.68)	(94.9)	(477)	(9.16)	(13.9)	(92.4)	(453)
	Day	2333***	2333***	2333***	2333***	2247***	2247***	2247***	1888
	ppm	(14.1)	(9.30)	(96.7)	(496)	(9.32)	(14.3)	(96.0)	(416)
	Day								2247***
	ppm								(427)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Questionable value.

***Concentration uncertainty: ± 7%

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius.

CALIBRATION: Reagent grade "1,2 Dichloroethane" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

15.0 CYCLOHEXANE STABILITY STUDY

Cylinder No.		15A
Cylinder Construction*		Al
Manufacturer Concentration	ppm	99.1
RTI Concentration	Date	3/19/79
	ppm	(106)
	Day	147
	ppm	(93.4)
	Day	394
	ppm	(99.0)
	Day	926
	ppm	(102)
	Day	1966
	ppm	(95.9)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius.

CALIBRATION: Reagent grade "Cyclohexane" liquid is used as a standard. Pressure-dilution technique is used for making series of standards for calibration.

16.0 METHYL ETHYL KETONE STABILITY STUDY

Cylinder No.		16A
Cylinder Construction*		S
Manufacturer Concentration	ppm	43.7
RTI Concentration	Date	5/23/79
	ppm	(42.3)
	Day	28
	ppm	(40.0)
	Day	58
	ppm	(39.9)
	Day	380
	ppm	(44.5)
	Day	653
	ppm	(38.7)
	Day	1847
	ppm	(40.4)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, Chromosorb 101 column at 180 degrees Celsius.

CALIBRATION: Reagent grade "Methyl ethyl ketone" liquid is used as a standard. Pressure-diultion technique is utilized for making series of standards for calibration.

17.0 METHANOL STABILITY STUDY

Cylinder No.		17A	17B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	50.0	97.2
RTI Concentration	Date	5/17/79	11/28/84
	ppm	(58.8)	(106)
	Day	21	202**
	ppm	(52.3)	(88.4)
	Day	51	
	ppm	(51.1)	
	Day	196	
	ppm	(55.2)	
	Day	2020	
	ppm	(48.8)	
	Day	2224**	
	ppm	(45.8)	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%

ANALYTICAL CONDITIONS: Flame ionization detector, Chromosorb 101 column at 50 degrees Celsius or 0.2% Carbowax 1500 plus 0.1% SP-2100 on Carbowax C at 60 degrees Celsius.

CALIBRATION: Reagent grade "Methanol" is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

18.0 1,2-DICHLOROPROPANE (PROPYLENE DICHLORIDE) STABILITY STUDY

Cylinder No.		18A	18B	18C	18D
Cylinder Construction*		Al	Al	Al	Al
Manufacturer Concentration	ppm	7.07	14.6	476	664
RTI Concentration	Date	7/10/79	7/10/79	7/10/79	7/10/79
	ppm	(6.06)	(15.6)	(496)	(685)
	Day	28	28	28	28
	ppm	(5.52)	(16.4)	(455)	(621)
	Day	48	48	48	48
	ppm	(5.94)	(15.0)	(480)	(675)
	Day	497	749	372	372
	ppm	(6.03)	(16.3)	(497)	(685)
	Day	749	1793	1793	1793
	ppm	(5.59)	(12.1)	(402)	(557)
	Day	1793	1845	1845	1845
	ppm	(3.12)	(13.2)	(424)	(574)
	Day	1845	2155**	2155**	2155**
	ppm	(3.86)	(13.3)	(441)	(594)
	Day	2155**			
	ppm	(3.49)			

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius.

CALIBRATION: Reagent grade "1,2-Dichloropropane" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

19.0 TRICHLOROETHYLENE STABILITY STUDY

Cylinder No.		19A	19B	19C	19D
Cylinder Construction*		Al	Al	Al	Al
Manufacturer Concentration	ppm	9.23	14.7	100	505
RTI Concentration	Date	5/24/79	5/24/79	5/24/79	5/24/79
	ppm	(9.58)	(14.3)	(102)	(506)
	Day	77	77	77	77
	ppm	(10.2)	(15.1)	(103)	(503)
	Day	92	92	92	92
	ppm	(9.78)	(14.9)	(100)	(499)
	Day	683	683	810	810
	ppm	(9.03)	(13.6)	(105)	(522)
	Day	820	820	820	820
	ppm	(8.91)	(13.5)	(94.6)	(490)
	Day	1853	1853	1853	1853
	ppm	(9.40)	(14.0)	(105)	(523)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius.

CALIBRATION: Reagent grade "Trichloroethylene" liquid is used as a standard. Pressure-dilution technique is used for making series of standards for calibration.

20.0 1,1-DICHLOROETHYLENE (VINYLIDENE CHLORIDE) STABILITY STUDY

		20A	20B	20C	20D
Cylinder No.		20A	20B	20C	20D
Cylinder Construction*		Al	Al	Al	Al
Manufacturer Concentration	ppm	9.58	14.8	96.8	490
	Date	6/1/79	6/1/79	6/1/79	6/1/79
	ppm	(10.3)	(15.6)	(101)	(524)
	Day	35	35	35	35
	ppm	(9.90)	(15.1)	(99.0)	(510)
	Day	62	62	62	62
	ppm	(10.1)	(15.5)	(102)	(505)
RTI	Day	404	404	817	404
Concentration	ppm	(11.5)**	(17.1)**	(94.0)	(498)
	Day	818	818	1831	1831
	ppm	(9.00)	(14.2)	(98.4)	(488)
	Day	1831	1831	2190***	2190***
	ppm	(9.00)	(13.2)	(94.7)	(479)
	Day	2190***	2190***		
	ppm	(8.78)	(14.1)		

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Questionable value.

***Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius or 10% SP-2100 on Supelcoport column at 100 degrees Celsius.

CALIBRATION: Reagent grade "1,1-Dichloroethylene" pure liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

21.0 1,2-DIBROMOETHYLENE STABILITY STUDY

Cylinder No. Cylinder Construction*		21A LS	21B LS	21C LS	21D LS
Manufacturer Concentration	ppm	10.0	14.9	99.9	301
RTI Concentration	Date	6/18/79	6/18/79	6/1/79	6/18/79
	ppm	(7.90)	(12.2)	(110)	(265)
	Day	61	61	61	61
	ppm	(7.80)	(12.0)	(107)	(266)
	Day	89	89	89	89
	ppm	(7.40)	(11.6)	(105)	(257)
	Day	722	772	787	643
	ppm	(7.72)	(8.02)	(99.2)	(309)
		**	**	**	**

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinders returned due to partial conversion to an unknown compound.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 100 degrees Celsius.

CALIBRATION: Reagent grade "1,2-Dibromoethylene" pure liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

ANALYTICAL PROBLEMS: The gas mixtures and the calibration standards contain substantial amounts of both the <u>cis</u> and the <u>trans</u> isomers of 1,2-Dibromoethylene. The first three sets of analyses are questionable because only one isomer was measured during the calibrations and cylinder analyses. During the GC analyses on Day 1864, it was found that dibromoethylene partially converted to an unknown compound. Hence, dibromoethylene is not practical as an audit material.

22.0 PERCHLOROETHYLENE STABILITY STUDY

Cylinder No.		22A	22B	22C	22D
Cylinder Construction*		S	S	LS	LS
Manufacturer Concentration	ppm	7.98	13.0	487	629
	Date	7/6/79	7/6/79	7/6/79	7/6/79
	ppm	(8.40)	(15.0)	(419)	(624)
	Day	35	35	35	35
	ppm	(7.97)	(14.9)	(453)	(642)
	Day	52	52	52	52
	ppm	(7.92)	(14.7)	(440)	(619)
RTI	Day	376	376	677	677
Concentration	ppm	(7.94)	(14.5)	(361)	(542)
	Day	1818	1818	713	713
	ppm	(6.88)	(13.7)	(387)	(571)
	Day	2162**	2162**	1818	1818
	ppm	(6.88)	(13.3)	(349)	(557)
	Day			2162**	2162**
	ppm			(353)	(564)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 50 or 100 degrees Celsius.

CALIBRATION: Reagent grade "Perchloroethylene" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

23.0 VINYL CHLORIDE STABILITY STUDY

Cylinder No.		23A	23B	23C	23D	23E	23F	23G	23H	23I
Cylinder Construction*		S	S	S	S	S	S	S	S	S
Manufacturer Concentration	ppm	5.94	8.00	8.03	8.52	20.0	20.1	30.0	30.3	7.98
RTI Concentration	Date	10/1/79	10/1/79	10/1/79	10/1/79	10/1/79	10/1/79	10/1/79	10/1/79	10/1/79
	ppm	(5.87)	(7.71)	(7.82)	(7.85)	(19.7)	(20.1)	(29.6)	(29.8)	(7.31)
	Day	18	18	18	18	18	18	18	18	18
	ppm	(5.74)	(7.50)	(7.45)	(7.61)	(19.1)	(19.3)	(28.3)	(28.7)	(7.12)
	Day	700	**	700	700	700	700	700	700	700
	ppm	(6.60)		(8.44)	(8.41)	(20.7)	(20.9)	(29.4)	(29.4)	(8.39)
	Day	1812		1812	1812	1812	1812	1812	1812	1812
	ppm	(6.10)		(8.10)	(8.15)	(20.3)	(20.6)	(30.3)	(30.6)	(7.75)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame ionization detector, 0.4% Carbowax 1500 on Carbopak C at 50 degrees Celsius.

CALIBRATION: Vinyl chloride permeation tube purchased from Metronics is used for calibration. Permeation tube is maintained at 30°C.

24.0 1,3 BUTADIENE STABILITY STUDY

Cylinder No.		24A
Cylinder Construction*		S
Manufacturer Concentration	ppm	22.6
	Date	3/21/80
	ppm	(20.9)
	Date	95
RTI Concentration	ppm	(23.1)
	Day	480
	ppm	(24.0)
	Day	1718
	ppm	(22.9)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, 0.1% SP-1000 on Carbopak C column at 90 degrees Celsius or 10% OV-101 on Chromosorb WHP column at 60 degrees Celsius.

CALIBRATION: Reagent grade "1,3 Butadiene" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

25.0 ACRYLONITRILE STABILITY STUDY

Cylinder No.		25A	25B	25C	25D	25E	25F
Cylinder Construction*		LS	LS	LS	LS	AL	AL
Manufacturer Concentration	ppm	20.1	348	11.7	638	400	10.0
	Date	7/24/79	7/24/79	7/24/79	7/24/79	11/8/82	11/18/82
	ppm	(14.6)	(411)	(6.38)	(678)	(413)	(10.8)
	Day	185	185	185	185	134	139
	ppm	(12.7)	(416)	(3.35)	(699)	(410)	(11.7)
RTI	Day	349	349	349	349	787	787
Concentration	ppm	(13.2)	(441)	(2.87)	(703)	(421)	(10.8)
	Day	841	841	841	841		
	ppm	(9.96)	(397)	(4.05)	(667)		
	Day	**	**	**	**		
	ppm						

*Al = Aluminum; S = Steel; LS= Low Pressure Steel

**Cylinder empty

ANALYTICAL CONDITIONS: Flame ionization detector, 4% Carbowax 20M on Carbopak B at 50 or 150 degrees Celsius.

CALIBRATION: Acrylonitrile permeation tube or pressure-dilution technique is used for GC-FID calibration. Permeation tube is maintained at 30° ± 0.1°C.

ANALYTICAL PROBLEMS: The large changes noted at the low concentration levels are, at least in part, a result of difficulty in making precise measurements at these levels.

26.0 ANILINE STABILITY STUDY

Cylinder No.		26A	26B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	11.3	18.4
RTI Analysis		See Analytical Problems	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 250 degrees Celsius.

CALIBRATION: Reagent grade "Aniline" pure liquid is used as a standard. "Glass bulb" dilution technique is utilized for making series of standards for calibration.

ANALYTICAL PROBLEMS: Because aniline has an extremely high boiling point (186°C), special handling would be required to measure this compound. A completely heated system for sampling in the vapor phase and for preparing standards would be required. Temperature-dependent condensation in the cylinder and the regulator causes the amount of aniline which is delivered by the cylinder to vary. As a result, aniline is not considered to be practical as an audit material.

27.0 METHYL ISOBUTYL KETONE STABILITY STUDY

Cylinder No.		27A	27C
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	9.51	72.9
RTI Concentration	Date	12/18/80	7/8/81
	ppm	(10.2)	(75.4)
	Day	27	See Analytical Problems
	ppm	(10.6)	
	Day	83	
	ppm	(9.53)	
	Day	202	
	ppm	(9.49)	
	Day	1275	
	ppm	(8.40)	
	Day	1643**	
	ppm	(10.3)	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

**Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 0.1% SP-1000 on
Carbopak C column at 180° degrees Celsius.

CALIBRATION: Reagent grade "Methyl isobutyl ketone" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

ANALYTICAL PROBLEMS: Methyl isobutyl ketone at high concentrations is not practical as an audit material because pressurization of the cylinder above approximately 200 psi results in condensation of the analyte.

28.0 CYCLOHEXANONE STABILITY STUDY

Cylinder No.		28A	28B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	10.1	19.0
RTI Analysis	Date	12/11/80	12/11/80
	ppm	(8.19)	(25.5)
	Day	85	85
	ppm	(3.26)	(17.1)
		See Analytical Problems.	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

ANALYTICAL CONDITIONS: Flame ionization detector, 10% SP-1000 on Supelcoport column at 200 degrees Celsius.

CALIBRATION: Reagent grade "Cyclohexanone" liquid is used as a standard. Pressure-dilution technique is used for making series of standards for calibration.

ANALYTICAL PROBLEMS: The analysis of cyclohexanone gas is dependent on the temperatures of the cylinder and the regulator and on the length of the sampling line between the regulator and the gas chromatograph. The concentration in the cylinder decreases with time. Therefore, cyclohexanone is not practical as an audit material.

29.0 PARADICHLOROBENZENE STABILITY STUDY

Cylinder No.		29A	29B
Cylinder Construction*		S	S
Manufacturer Concentration	ppm	15.6	38.1
RTI Analysis		See Analytical Problems	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

ANALYTICAL CONDITIONS: Flame ionization detector, 10% SP-1000 on Supelcoport column at 200 degrees Celsius.

CALIBRATION: Reagent grade "Paradichlorobenzene" is used as a standard. "Glass bulb" technique is used for making series of standards for calibration.

ANALYTICAL PROBLEMS: The stability study for this compound was terminated bacause of analytical difficulties and because the cylinder pressure was less than 200 psig. Paradichlorobenzene is a solid at room temperature with a melting point of 54°C. Condensation in the cylinder, regulator and sampling lines was extreme. Paradichlorobenzene is not practical as an audit material.

30.0 ETHYLAMINE STABILITY STUDY

		30A	30B
Cylinder No.		30A	30B
Cylinder Construction*		S	S
Manufacturer Concentration	ppm	10	20
RTI Analysis		See Analytical Problems	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

ANALYTICAL CONDITIONS: Flame ionization detector, 10% OV-101 on Chromosorb WHP column at 250 degrees Celsius.

CALIBRATION: Reagent grade "Ethylamine" liquid is used as a standard. "Glass bulb" technique is utilized for making series of standards for calibration.

ANALYTICAL PROBLEMS: Because of vapor pressure considerations, the cylinders could not be fully pressurized. The pressure in the cylinder is less than 200 psi. A completely heated system for sampling in the vapor phase and for preparing standards would be required. Temperature-dependent condensation in the cylinder and the regulator causes the amount of ethylamine which is delivered by the cylinder to vary. As a result of these problems, ethylamine is not considered to be practical as an audit material.

31.0 FORMALDEHYDE STABILITY STUDY

RTI Requested Concentration	ppm	10	20

The speciality gas supplier indicated that they could not make gas mixtures containing formaldehyde.

32.0 METHYLENE CHLORIDE STABILITY STUDY

		32A	32B	32C
Cylinder No.		32A	32B	32C
Cylinder Construction*		Al	Al	Al
Manufacturer Concentration	ppm	10.2	1.0**	5.0**
RTI Concentration	Date	3/5/82		
	ppm	(10.8)		
	Day	31		
	ppm	(10.8)		
	Day	70		
	ppm	(10.6)		
	Day	96		
	ppm	(11.2)		
	Day	124		
	ppm	(11.4)		
	Day	160		
	ppm	(10.9)		
	Day	278		
	ppm	(10.2)		
	Day	381		
	ppm	(9.70)		
	Day	843		
	ppm	(9.20)***		
	Day	1198****		
	ppm	(11.5)		

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Nominal concentrations ordered from the manufacturer.

***Questionable value.

****Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10% SP-1000 on 80/100 Supelcoport. 30 cm^3/minute He carrier gas. Column temp. = 100°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "Methylene chloride" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

33.0 CARBON TETRACHLORIDE STABILITY STUDY

Cylinder No.		33A
Cylinder Construction*		AL
Manufacturer Concentration	ppm	11.3
RTI Concentration	Date	3/4/82
	ppm	(12.7)
	Day	74
	ppm	(11.7)
	Day	74
	ppm	(10.2)
	Day	98
	ppm	(11.1)
	Day	124
	ppm	(10.6)
	Day	161
	ppm	(10.2)
	Day	382
	ppm	(10.5)
	Day	832
	ppm	(9.60)**
	Day	1199***
	ppm	(12.2)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Questionable value.

***Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10% SP-1000 on 80/100 Supelcoport. 30 cm^3/minute He carrier gas. Column temp. = 100°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "Carbon tetrachloride" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

34.0 FREON 113 STABILITY STUDY

Cylinder No.		34A
Cylinder Construction*		Al
Manufacturer Concentration	ppm	10.4
RTI Concentration	Date	3/3/82
	ppm	(10.8)
	Day	34
	ppm	(10.1)
	Day	70
	ppm	(10.0)
	Day	70
	ppm	(9.60)
	Day	98
	ppm	(10.0)
	Day	125
	ppm	(10.0)
	Day	162
	ppm	(10.3)
	Day	384
	ppm	(9.80)
	Day	857
	ppm	(11.0)
	Day	1200**
	ppm	(8.79)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10% SP-1000 on 80/100 Supelcoport. 30 cm^3/minute He carrier gas. Column temp. = 100°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "Freon 113" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

35.0 METHYL CHLOROFORM STABILITY STUDY

Cylinder No.		35A
Cylinder Construction*		Al
Manufacturer Concentration	ppm	10.2
RTI Concentration	Date	3/2/82
	ppm	(10.3)
	Day	70
	ppm	(11.8)
	Day	99
	ppm	(10.7)
	Day	136
	ppm	(10.6)
	Day	161
	ppm	(10.0)
	Day	381
	ppm	(10.4)
	Day	858
	ppm	(10.0)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10% SP-1000 on 80/100 Supelcoport. 30 cm^3/minute He carrier gas. Column temp. = 100°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "Methyl chloroform" is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

36.0 ETHYLENE OXIDE STABILITY STUDY

Cylinder No.		36A	36B	36C	36D	36E
Cylinder Construction*		Al	Al	Al	Al	Al
Manufacturer Concentration	ppm	10.0	1.0**	5.0**	15.0**	20.0**
RTI Concentration	Date	3/12/82				
	ppm	(11.2)				
	Day	73				
	ppm	(9.60)				
	Day	88				
	ppm	(9.80)				
	Day	122				
	ppm	(9.60)				
	Day	157				
	ppm	(9.80)				
	Day	1012				
	ppm	(9.70)				

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Nominal concentrations ordered from manufacturer.

ANALYTICAL CONDITIONS: Flame ionization detector, 6 ft. x 1/8" SS column packed with 80/100 mesh Porapak QS. 30 cm^3/minute Helium carrier gas. Column temp. = 150°C. Detector temp. = 175°C.

CALIBRATION: Ethylene oxide permeation tube purchased from Metronics is used for GC-FID calibration. Permeation tube is maintained at 30°C.

ANALYTICAL PROBLEMS: There appeared to be some loss of ethylene oxide when a brass regulator was used on the cylinder.

37.0 PROPYLENE OXIDE STABILITY STUDY

Cylinder No.		37A	37B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	9.48	96.0
RTI Concentration	Day	8/4/82	8/4/82
	ppm	(12.3)	(89.5)
	Day	55	55
	ppm	(11.8)	(86.9)
	Day	76	76
	ppm	(10.6)	(83.6)
	Day	743	121
	ppm	(8.10)**	(90.8)
	Day	844	743
	ppm	(9.24)	(75.7)**
	Day	1057	844
	ppm	(9.65)	(82.8)
	Day		1057
	ppm		(91.7)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Questionable value.

ANALYTICAL CONDITIONS: Flame ionization detector, 6 ft. x 1/8" SS column packed with 80/100 mesh Porapak QS. 30 cm^3/min Helium carrier gas. Column temp. = 150°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "propylene oxide" is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

38.0 ALLYL CHLORIDE STABILITY STUDY

Cylinder No.		38A	38B	38C	38D
Cylinder Construction*		S	S	S	S
Manufacturer Concentration	ppm	10.2	99.5	8.7	92.4
RTI Concentration	Date	8/13/82**	8/13/82**	4/24/85****	4/30/85****
	ppm	(11.6)	(124)	(8.99)	(95.7)
	Day	75	74		
	ppm	(5.25)	(87.2)		
	Day	110	110		
	ppm	(5.08)	(87.7)		
	Day	167	167		
	ppm	(5.36)	(83.4)		
	Day	727	727		
	ppm	(4.53)	(53.6)		
		***	***		

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Initial analysis was questionable

***Returned due to impurities.

****Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10 % SP-1000 on Supelcoport. 30 cm^3/minute Helium carrier gas. Column temp. = 100°C. Detector temp. = 175°C,

CALIBRATION: Reagent grade "Allyl chloride" is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

39.0 ACROLEIN STABILITY STUDY

		39A	39B
Cylinder No.		39A	39B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	10.2	107
RTI Concentration	Date	8/18/82	8/18/82
	ppm	(10.6)	(90.4)
	Day	28	28
	ppm	(11.0)	(103)
	Day	69	69
	ppm	(9.74)	(106)
	Day	728	728
	ppm	(6.90)**	(80.8)**
	Day	833	833
	ppm	(8.97)	(97.3)
	Day	1031***	1031***
	ppm	(9.11)	(98.4)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Questionable value.

***Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector, 20 ft. x 1/8" SS column packed with 10 % SP-1000 on 80/100 Supelcoport. 30 cm^3/min Helium carrier gas. Column temp = 100°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade "acrolein" is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

40.0 CHLOROBENZENE STABILITY STUDY

Cylinder No.		40A	40B	40C
Cylinder Construction*		S	Al	Al
Manufacturer Concentration	ppm	9.66	14.84	4.89
	Date	8/6/82	10/11/83	10/11/83
	ppm	(9.03)	(14.7)	(4.19)
	Day	39	612**	612**
	ppm	(9.15)	(13.4)	(4.74)
RTI Concentration	Day	75		
	ppm	(9.20)		
	Day	380		
	ppm	(9.62)		
	Day	1043**		
	ppm	(8.11)		

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detection, 20' X 1/8" stainless steel column packed with 10% SP-1000 on 80/100 mesh Supelcoport. 30 cc/min Helium carrier gas. Column temp. = 150°C. Detector temp = 175°C.

CALIBRATION: Reagent grade chlorobenzene was used as a standard. Pressure-dilution technique is utilized for making a series of standards.

41.0 CARBON DISULFIDE STABILITY STUDY

Cylinder No.		41A	41B
Cylinder Construction*		Al	Al
Manufacturer Concentration	ppm	108	108
	Date	7/14/82	2/21/85
	ppm	(100)	(101)
	Day	34	110
RTI Concentration	ppm	(114)	(98.0)
	Day	72	
	ppm	(116)	
		**	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel.

**Cylinder empty.

ANALYTICAL CONDITIONS: Flame photometric detector, 4.6' X 1/4" Teflon® column packed with Carbopak BHT 100. 90 cc/min Helium carrier gas. Column temp. = 75°C. Detector temp. = 175°C.

CALIBRATION: Reagent grade carbon disulfide is injected into a Teflon® bag being filled with N_2 at 5 L/min. through a mass flow controller. The injection fitting is heated slightly to ensure volatilization.

ANALYTICAL PROBLEMS: There is significant peak "tailing" unless a very high flow rate is used. "Tailing" is also caused by "bleed" from the sample loop. Sample valve should be in the inject position for exactly 5 seconds and then switched back to the sampling position to attenuate tailing. All sample lines and regulators must be conditioned extensively.

42.0 EPA METHOD 25 GAS MIXTURE STABILITY STUDY*

Cylinder No.		42A	42B	42C	42D	42E	42F
Cylinder Construction***		Al	Al	Al	Al	Al	Al
Manufacturer Concentration	ppmC	100	100	200	750	1000	2000
RTI Concentration	Date	3/16/83	3/16/83	3/16/83	3/16/83	3/16/83	3/16/83
	ppmC	(102)	(107)	(205)	(775)	(1040)	(1940)
	Day	483	483	**	483	483	483
	ppmC	(97.9)	(104)		(779)	(1060)	(1930)
	Day	**	**		726****	726****	726****
	ppmC				(765)	(1020)	(1930)

*Gas Mixture contains an aliphatic hydrocarbon, an aromatic hydrocarbon, and carbon dioxide in nitrogen.

**Cylinder empty.

***Al = Aluminum; S = Steel; LS = Low Pressure Steel

****Concentration uncertainty: ± 7%.

ANALYTICAL CONDITIONS: Flame ionization detector Durapak n-octane on Poracil C column at 30°C for separation of aliphatic hydrocarbon and 10% OV-101 on chromosorb WHP column at 60°C for separation of aromatic hydrocarbon.

CALIBRATION: NBS-SRM was used as a standard for aliphatic hydrocarbon and Reagent grade liquid is used as a standard for aromatic hydrocarbon. Pressure-dilution technique is utilized for generation of series of standards for calibration.

42.0 EPA METHOD 25 GAS MIXTURE STABILITY STUDY* (Continued)

Cylinder No. Cylinder Construction**		42G Al	42H Al	42I Al	42J Al	42K Al	42L Al
Manufacturer Concentration	ppmC	96.7	98.6	147.6	151	198	197.5
RTI Concentration	Date	12/11/84	12/11/84	12/11/84	12/11/84	12/11/84	12/11/84
	ppmC	(96.4)	(98.9)	(149)	(153)	(195)	(195)
	Day	90***	90***	90***	90***	192	90***
	ppmC	(95.8)	(93.3)	(144)	(145)	(183)****	(187)

*Gas Mixture contains an aliphatic hydrocarbon, an aromatic hydrocarbon, and carbon dioxide in nitrogen.

**Al = Aluminum; S = Steel; LS = Low Pressure Steel

***Concentration uncertainty: ± 7%.

****Questionable value.

ANALYTICAL CONDITIONS: Flame ionization detector Durapak n-octane on Poracil C column at 30°C for separation of aliphatic hydrocarbon and 10% OV-101 on chromosorb WHP column at 60°C for separation of aromatic hydrocarbon.

CALIBRATION: NBS-SRM was used as a standard for aliphatic hydrocarbon and Reagent grade liquid is used as a standard for aromatic hydrocarbon. Pressure-dilution technique is utilized for generation of series of standards for calibration.

43.0 ETHYLENE DIBROMIDE STABILITY STUDY

Cylinder No.		43A	43B	43C	43D
Cylinder Construction*		S	S	S	S
Manufacturer Concentration	ppm	10	20	100	300
RTI Concentration	Date	10/24/84	10/24/84	10/24/85	10/24/84
	ppm	(9.3)	(17.5)	(96.1)	(266)
	Day	54	54	55	55
	ppm	(9.3)	(17.5)	(107)	(344)**
	Day	243	243	243	
	ppm	(8.66)	(15.4)	(84.0)	

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

**Questionable value.

ANALYTICAL CONDITIONS: Flame ionization detector, 5% OV-101 on Chromosorb WHP at 60°C.

CALIBRATION: Reagent grade "ethylene dibromide" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.

44.0 1,1,2,2-TETRACHLOROETHANE STABILITY STUDY

Cylinder No.		44A
Cylinder Construction*		Al
Manufacturer Concentration	ppm	12.2
RTI	Date	10/9/84
Concentration	ppm	(11.6)

*Al = Aluminum; S = Steel; LS = Low Pressure Steel

ANALYTICAL CONDITIONS: Flame ionization detector, 5% OV-101 on Chromosorb WHP at 100°C.

CALIBRATION: Reagent grade "1,1,2,2-Tetrachloroethane" liquid is used as a standard. Pressure-dilution technique is utilized for making series of standards for calibration.