GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. A-60-615 R6054-0A0 GTRC/~~GIT~~ DATE 11 / 21 / 85

Project Director: R.A. Karam School/~~Lab~~ NRC

Sponsor: E.I. DuPont DeNemours and Company Savannah River Plant
Aikens, SC 29808-0001

Type Agreement: P.O. No. AX0714704 Under D.O.E. Prime DE-AC09-76SR00001

Award Period: From 10/3/85 To ~~7/15/87~~ 6/30/88 (Performance) ~~7/15/86~~ 6/30/88 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$	$
Funded:	$ 117,311.00	$ 117,311.00

Cost Sharing Amount: $ ______ Cost Sharing No: ______

Title: Irradiation Studies of Activated Carbon

ADMINISTRATIVE DATA

OCA Contact John B. Schonk ~~R. Dennis Farmer~~ X4820

1) Sponsor Technical Contact:

M.L. Hyder
E.I. DuPont DeNemours & Company, Inc.
Savannah River Plant
Aiken, SC 29808-0001
(803) 725-3122

2) Sponsor Admin/Contractual Matters:

Earl L. Cagle, Jr. ~~G. R. Parks, Jr.~~
E ~~.I. DuPont DeNemours & Company, Inc.~~
Savannah River Plant
Building 742-A, Room 154
Aiken, SC 29808-0001
(803) 725-6211

Defense Priority Rating: ______ Military Security Classification: ______
(or) Company/Industrial Proprietary: ______

RESTRICTIONS

See Attached ______ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with NONE PROPOSED

COMMENTS:

NOV 1985 RECEIVED

COPIES TO:

SPONSOR'S I. D. NO. 03.240.004.85.001

Project Director	Procurement/GTRI Supply Services	GTRC
Research Administrative Network	Research Security Services	Library
Research Property Management	Reports Coordinator (OCA)	Project File
Accounting	Research Communications (2)	Other Jones

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Date 3/7/89

Project No. A-60-615 Center No. R6054-0A0

Project Director R. A. Karam School/Lab ME

Sponsor Savannah River Laboratory

Contract/Grant No. AX07-14704 GTRC XX GIT ___

Prime Contract No. DE-AC09-765R00001

Title Irradiation Studies of Activated Carbon

Effective Completion Date 6/30/88 (Performance) 6/30/88 (Reports)

Closeout Actions Required:

___ None
X Final Invoice or Copy of Last Invoice
X Final Report of Inventions and/or Subcontracts- Patent Questionnaire sent to P/I.
X Government Property Inventory & Related Certificate
___ Classified Material Certificate
X Release and Assignment
___ Other ___

Includes Subproject No(s). ___

Subproject Under Main Project No. ___

Continues Project No. ___ Continued by Project No. ___

Distribution:

X Project Director
X Administrative Network
X Accounting
X Procurement/GTRI Supply Services
X Research Property Management
___ Research Security Services
X Reports Coordinator (OCA)
X GTRC
X Project File
X Contract Support Division (OCA)(2)
___ Other ___

Georgia Institute of Technology
Neely Nuclear Research Center
Atlanta, Georgia 30332
(404) 894-3600

GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

August 15, 1986

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company, Inc.
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report through August 1986 on the project entitled, "Irradiation Studies of Activated Carbon," A-60-615.

I. Co^{60} Sources

The Neely Nuclear Research Center received a total of 150 slugs of Co-60 sources encased in aluminum tubes. These sources arrived in two shipments: one on July 14, 1986 and one on July 16, 1986. The total number of curies received according to SRL shipment papers, is 649,914 Ci.

The process of encapsulating these Co^{60} sources has already begun. To date, 26 slugs have been encapsulated. We expect to finish the encapsulation in one or two months.

II. Experimental Setup

The experimental setup for the project is being assembled and should be ready for use by the third or fourth week of September, 1986.

We enjoyed your visit (August 15, 1986) to the Center and look forward to further visits.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

Georgia Institute of Technology
Neely Nuclear Research Center
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GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

October 6, 1986

Dr. M.L. Hyder
Analytical Chemistry
E.I. Dupont de Nemours and Company, Inc.
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the month of September 1986 on the project entitled, "Irradiation Studies of Activated Carbon," A-60-615.

I. Experimental Setup

All parts have been ordered and most of them have been received (details listed in Table 1). Assembling the apparatus has begun. We expect testing and calibrations of the experimental setup to be performed during October.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

TABLE 1
Components Order for SRL Project

Ordered	Quantities Ordered	Quantities Received
Thermocouples	3	3
Thermocouple Wire	100 ft.	100 ft.
Terminal Plugs	12	12
Rotary Switch	1	1
Psychrometer Probe	1	1
Thermocouple Calibrator	1	1
Thermocouple Meter	1	1
Pencil Lamp	1	1
Pencil Lamp Power Supply	1	1
Photomultiplier Tube	1	1
Tube Base	1	1
Filters	1	2 received one pending
Flow Meter	1	1
Ball Valves	6	6
Fittings	35	35
Teflon Tools	3	3
Teflon Tubing	75 ft.	75 ft.
Plywood	1 sheet	1 sheet
2 X 4	3	3
Screws	1 bag	1 bag
Variac	1	1
Heating Tape	1	1
Electrometer	1	1
Pressure Gauges	4	4 Pending

Approximately $2,600

A-60-615

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GEORGIA TECH 1885-1985
DESIGNING TOMORROW TODAY

December 9, 1986

Dr. M.L. Hyder
Analytical Chemistry
E.I. Dupont de Nemours and Company, Inc.
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the months of October and November 1986 on the project entitled, "Irradiation Studies of Activated Carbon," A-60-615.

I. Experimental Setup

The experimental setup has been assembled and it is being tested. The as-built apparatus is shown in Figure 1.

Several tests have been conducted. One test comprised the following: (1) preheated air (200°C) is sucked through the apparatus for several hours. The purpose of this preheating is to raise the temperature of all the pipes and chambers so that steam condensation is minimized. (2) After the apparatus is preheated, the steam line is opened and steam is allowed to flow through the apparatus until equilibrium temperature and humidity are achieved. Again, this step lasted several hours. The equilibrium temperatures achieved were as follows (refer to Figure 1): The temperature in the mixing chamber was 95°C. The temperature at the inlet to the test chamber was 84°C. The temperature in the test chamber was 81°C. The temperature at the photomultiplier was 34°C. The humidity at the outlet of the test chamber was 100%.

The conditions achieved by this procedure appears to be appropriate for the actual experiments. We plan to repeat this experiment with and without I_2 in the system. The current through the photomultiplier will be monitored after equilibrium conditions have been achieved. The iodine content in the gas mixture will be determined from knowledge of the partial pressure of iodine at the appropriate temperature. For example, in the test chamber the vapor pressure of I_2 will be determined from knowledge of the temperature of the gas mixture. We are assuming here that excess iodine will condense out as the temperature is lowered.

Other tests which were carried out included photomultiplier current measurements with and without iodine. In these tests it was found that the temperature of the photomultiplier was not constant and that the current depended on the temperature. Effort has been successfully made to thermally isolate the photomultiplier from the rest of the system.

If you have any questions or would like to make any suggestions please let me know. We welcome your input.

With best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

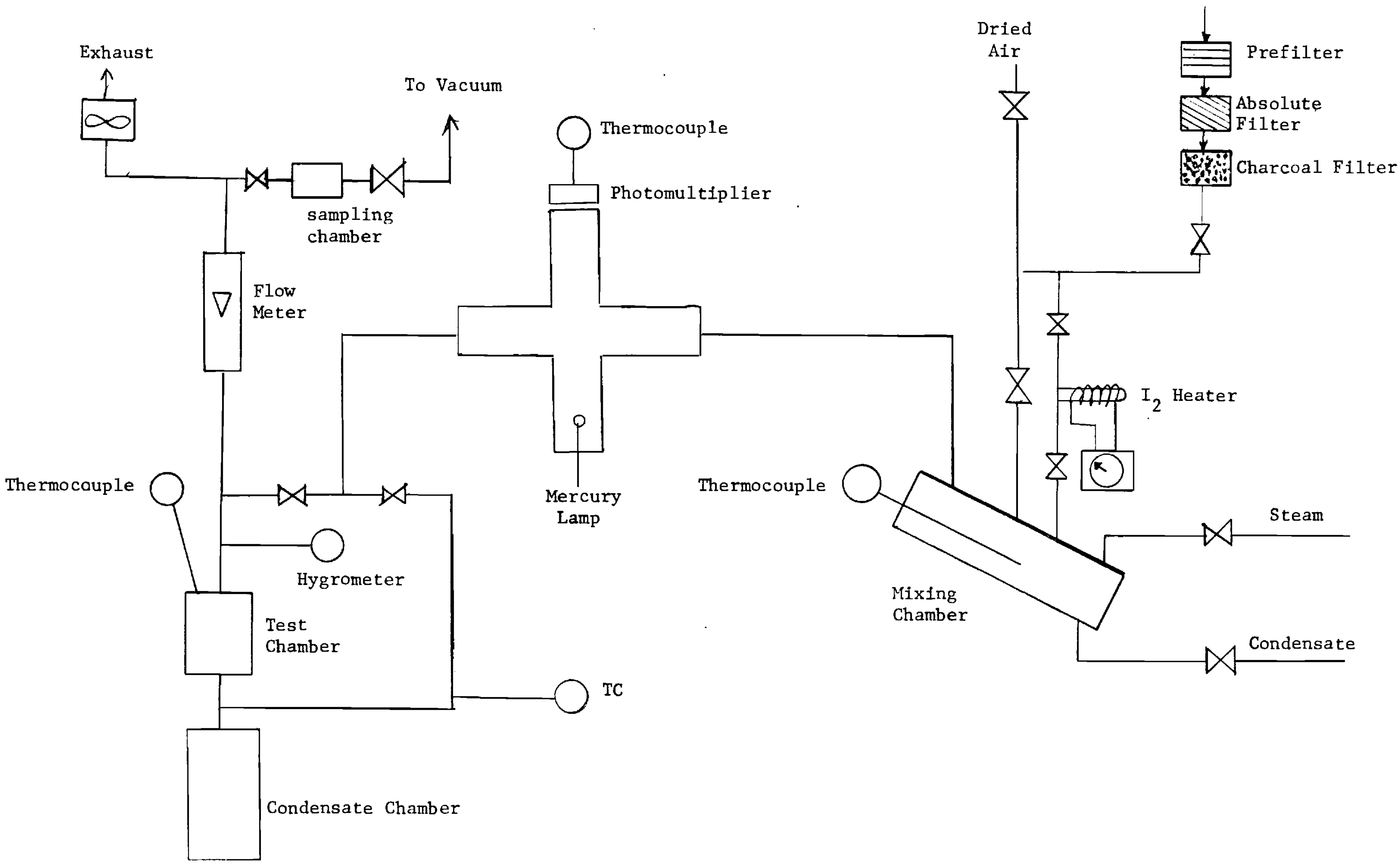

FIGURE 1. The As-built Apparatus for Irradiation Studies of Activated Carbon

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GEORGIA TECH 1885-1985

DESIGNING TOMORROW TODAY

March 18, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. Dupont de Nemours and Company, Inc.
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the months of December, January and February on the project entitled, "Irradiation Studies of Activated Carbon," A-60-615.

Background Determination

At the suggestion of Dr. Marilyn Black and Dr. Robert Pierotti and with your concurrence, an effort was made to determine the organic compounds background found in the high bay area around the water pool where the Co-60 sources are stored. The apparatus shown in Figure 1 was used. Ordinary room air was passed through a column of molecular sieve type 5A to remove humidity. This air was not filtered through the prefilter, absolute filter, and charcoal filter; it was simply sucked through the molecular sieve and through the system (percent humidity 15%). No iodine was added to the stream of air and no radiation was involved in this experiment. A portion of the dry air going through the apparatus was siphoned and passed through a sampling column, provided by Dr. Black, and containing Tenax and charcoal. Sample number 18588 was collected over a period of four hours and sample number 18589 was collected over a period of five hours and 12 minutes. The results from the GS/MS analysis are given in Tables 1 and 2. The vacuum system failed during the early portion of sample number 18589 and some data were lost.

It is obvious that the organic material background is significant. A better purification system is recommended. In order to filter out the organic material the molecular sieve type 5A and the triple filter system will be installed in a series instead of the parallel structure that exists now. Additionally, any grease which was used in fitting joints will be removed and replaced with a teflon tape. Dr. Black is investigating the possibility of using industrial air purifiers.

If you have any questions or would like to make any suggestions please let me know. We welcome your input. I look forward to having you with us on Friday, March 27, 1987. We have an appointment with Dr. Black at 1:00 p.m. on the 27th.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

pc: Dr. Black
Dr. Pierotti

TABLE 1

March 17, 1987

GEORGIA TECH RESEARCH INSTITUTE
GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC
DETERMINATION OF ORGANIC COMPOUNDS FOR
NEELY NUCLEAR RESEARCH CENTER

Lab No: 18588
Sample Description: Background
Chemist: LG
Sampling Media: Tenax/Charcoal Tube
CLIENT COLLECTED AND ONLY ESTIMATED COLLECTION VOLUME

Method: TD/GC/MS
Date Received:
Date Completed: 3/16/87

Compound	Concentration (ppbv)
methoxyethene	1.0
1,1,2-trichloro-2,2,1-trifluoroethane (freon)	0.30
methylene chloride	0.81
hexane	0.15
1,1,1-trichloroethane	0.17
benzene	0.86
heptane	1.0
trichloroethylene	0.04
toluene	0.05
tetrachloroethylene	0.01
ethylbenzene	0.05
1,2-dimethylbenzene	0.14
1,4-dimethylbenzene	0.04
2-butoxyethanol	0.07
1-methylethylbenzene	0.02
hydrocarbons	22

Identification of compounds (unless otherwise indicated) is based upon comparison to NBS library spectra only. Concentrations are only an estimate. Quantitation is based only on the internal standard response factor. The assumption is made that the identified compound will have a similar instrumental response.

APPROVED: ________ DATE: 3/17/87

TABLE 2

March 17, 1987

GEORGIA TECH RESEARCH INSTITUTE
GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC
DETERMINATION OF ORGANIC COMPOUNDS FOR
NEELY NUCLEAR RESEARCH CENTER

Lab No: 18589 | Method: TD/GC/MS
Sample Description: Background | Date Received:
Chemist: LG | Date Completed: 3/16/87
Sampling Media: Tenax/Ambersorb/Charcoal Tube
SAMPLE COLLECTION 5 HRS.12 MIN. SUPPLIED BY CLIENT.
VACUUM FAILED SO EARLY PORTION OF RUN WAS LOST

Compound	Concentration (ppbv)
1,1,2-trichloro-2,2,1-trifluoroethane (freon)	0.68
toluene	0.65
ethylbenzene	0.08
1,2-dimethylbenzene	0.17
hydrocarbons	66

Identification of compounds (unless otherwise indicated) is based upon comparison to NBS library spectra only. Concentrations are only an estimate. Quantitation is based only on the internal standard response factor. The assumption is made that the identified compound will have a similar instrumental response.

APPROVED: ____________ DATE: 3/17/87

PLEASE NOTE:

RE SAMPLES 18588 & 18589

High background in these samples may be due to:

1. Outgassing of oils used in pumps and used to lubricate fittings.
2. Outgassing of polybutylene piping.
3. Inadequate air purification systems.

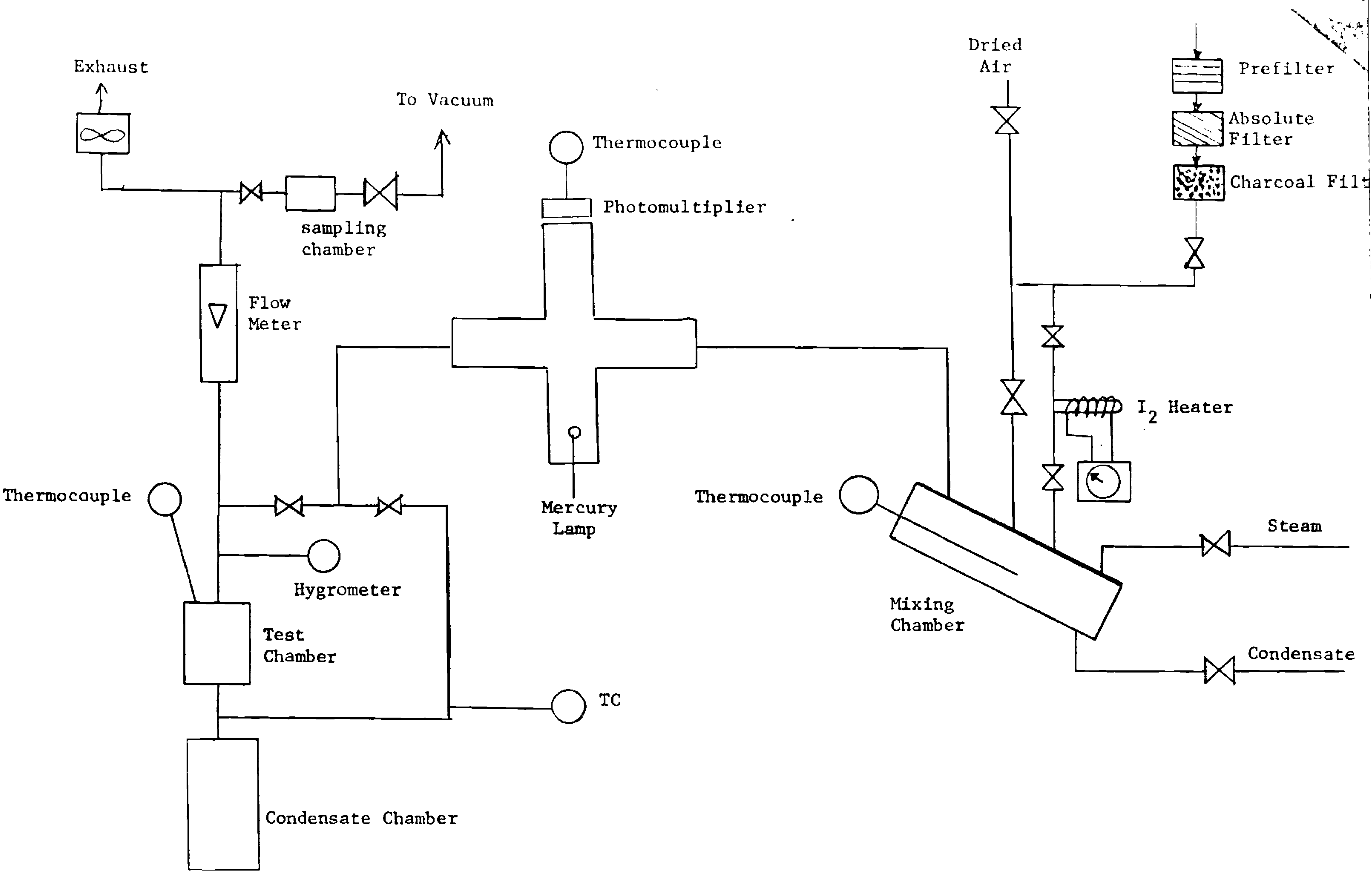

FIGURE 1. The As-built Apparatus for
Irradiation Studies of Activated Carbon

Georgia Institute of Technology

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May 13, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. Du Pont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report that covers work for the months of March and April, 1987 on the project entitled, "Irradiation Studies of Activated Carbon."

Background Determination

Dr. Marilyn Black has been attempting to determine the background levels of various organic compounds and the effectiveness of some of the adsorbents which she uses to collect these compounds. Her results, which were discussed with you during your May 5, 1987 visit, are shown in Tables I and II.

Based on the results collected thus far, Dr. Black has concluded that the collection rate through the adsorbent should be lowered to 200 c.c. per minute and that the total time for collection should not exceed 30 minutes.

The experiments which were discussed with you and are being performed during the week of May 11-15, 1987 are as follows:

1. Determine background level of organic compounds with no charcoal (new) present in the system. Collect material for 30 minutes at a flow rate of 200 c.c./min. on adsorbents prepared by Dr. Black.

2. Repeat step (1) but with "new" charcoal in system.

3. Repeat step (3) but this time have apparatus in radiation field.

4. Add iodine to step 3 for one hour. Obtain a sample through the adsorbent mixture 30 minutes after the iodine is added.

5. Obtain another sample through the adsorbent mixture 3 hours later.

I will keep you informed of the results. Should you have any questions, please let me know.

With best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

Enclosures

TABLE I

Collection of Background Levels of Organic Compounds in Tenax, Tenax and Charcoal, and in Tenax, Ambersorb and Charcoal

(All Units are in PPBV)

Organic Compound \ Adsorbent	Tenax/Charcoal Lot # 18588	Tenax/Amb./ Charcoal Lot # 18589	Tenax Lot # 18751	Tenax/Amb. Charcoal Lot # 18752
Vol. Collected, L	108	125.2	57.3	75.6
Methoxyethene	1.0			
1,1,2-Trichloro-2,2,1-Trifluoroethane	0.30	0.68	0.1	1.9
Methylene Chloride	0.81			0.14
Hexane	0.15		0.70	5.6
1,1-Trichloroethane	0.17		0.80	6.5
Benzene	0.86		0.40	0.30
Heptane	1.0		0.20	
Trichloroethylene	0.04			
Toluene	0.05	0.65	1.5	0.80
Tetrachloroethylene	0.01			
Ethyl benzene	0.05	0.08	0.1	0.70
O-Xylene	0.14	0.17	0.4	1.0
P-Xylene	0.04			0.10
2-Butoxyethanol	0.07			
1-Methylethylbenzene	0.02			
2-Propanone			4.0	8.1
Trichlorotrifluoromethane				
1,1-Dichloroethene				
2,2-Dimethylhexane				
1,5-Hexadiene				
2,2,4-Trimethylpentane				
2,2'-Dimethylethylene Oxide				0.60
(1-Methylethyl) Cyclopropane				0.50
2-Pentanone				8.1
Oxygenated HC				2.9
Hydrocarbons	22	66		9.7

TABLE II

Collection of Background Levels of Organic Compounds in Tenax, Tenax and Charcoal, and in Tenax, Ambersorb and Charcoal (All Units are in PPBV)

Organic Compound / Adsorbent / Vol. Collected, L	Tenax Lot # 18834 48 L	Tenax/Amb./ Charcoal Lot # 18835 48 L	Tenax Lot # 18972 15 L	Tenax/Amb./ Charcoal Lot # 18973 15 L
Methoxyethene				
1,1,2-Trichloro-2,2,1-Trifluoroethane			0.27	
Methylene Chloride	33	3.9	14	9.6
Hexane	0.88	0.46	1.1	0.91
1,1,1-Trichloroethane	13	2.7	6.6	7.0
Benzene	17	27	36	34
Heptane				
Trichloroethylene				
Toluene		14		1.8
Tetrachloroethylene				
Ethyl benzene				
O-Xylene				
P-Xylene				
2-Butoxyethanol				
1-Methylethylbenzene				
2-Propanone				5.2
Trichlorotrifluoromethane	1.7	0.19	1.3	0.48
1,1-Dichloroethene	1.4		0.63	
2,2-Dimethylhexane	3.0			
1,5-Hexadiene	0.24			
2,2,4-Trimethylpentane		0.80	1.5	1.1
2,2'-Dimethylethylene Oxide				
(1-Methylethyl) Cyclopropane				
2-Pentanone				
Oxygenated HC				
Hydrocarbons				

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
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(404) 894-3600

June 1, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report that covers the month of May 1987 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains a description of experiments and results obtained.

I. DESCRIPTION OF EXPERIMENTS

The experiments which were performed during this month were as follows:

1. The first experiment was run to determine background level of organic compounds with no charcoal present in the sample holder. An air flow velocity of 54 feet/minute was maintained in this and subsequent experiments. Sampling of the air flowing through the system was obtained by using a small pump and a flow rate meter forcing system air into a molecular sieve column prepared by Dr. M. Black and containing charcoal, ambersorb and tenax. The flow rate through Dr. Black's collection column was 200 c.c. per minute. Collection time was 30 minutes for a total volume of air flowing through the column of 6 liters.

2. Experiment (2) was a repeat of Experiment (1) but with activated charcoal GX 176, batch 8, lot 3327 (this charcoal is new), inserted in the sample holder. The amount of this charcoal used was 17.95 grams.

3. Experiment (3) was a repeat of Experiment (2) except in this experiment the apparatus was placed in the irradiation pipe. The field of radiation was 3.62 E6 rads per hour.

4. Experiment (4) was a repeat of Experiment (3) with one exception: iodine was added for two hours and five minutes. The sampling of gas through Dr. Black's column was begun at 1 hour and 29 minutes from the point of iodine introduction into the system. The temperature in the iodine vaporizer was 142°C.

5. Experiment (5) is a repeat of Experiment (4) except that the sampling time was begun one hour and five minutes after iodine flow was valved off.

Figure 1 shows the latest schematic diagram of the apparatus.

II. RESULTS

The results which Dr. Black obtained are summarized in Table 1. The thermocouple readings for Experiments (4) and (5) were as follows.

	Experiment 4	Experiment 5
TC1 (Return from charcoal bed) °C	39	39
TC2 (Mixing Chamber); °C	38	38
TC3 (Room Temperature); °C	38	38
TC4 (Charcoal Bed); °C	48	47
TC5 (Iodine Vaporizer); °C	142	44

III. PLANS FOR FUTURE EXPERIMENTS

Dr. Black recommends that the 5 experiments which were performed this month be repeated but with a collection column containing only ambersorb and tenax; i.e., without the charcoal. If this meets with your approval we will go with it.

Also you requested that the 5 experiments be repeated but with carbon 1502-1 instead of GX 176. This will also be done during the month of June.

If you have any questions or would like to make any suggestions please let me know.

Best personal wishes.

Sincerely yours,

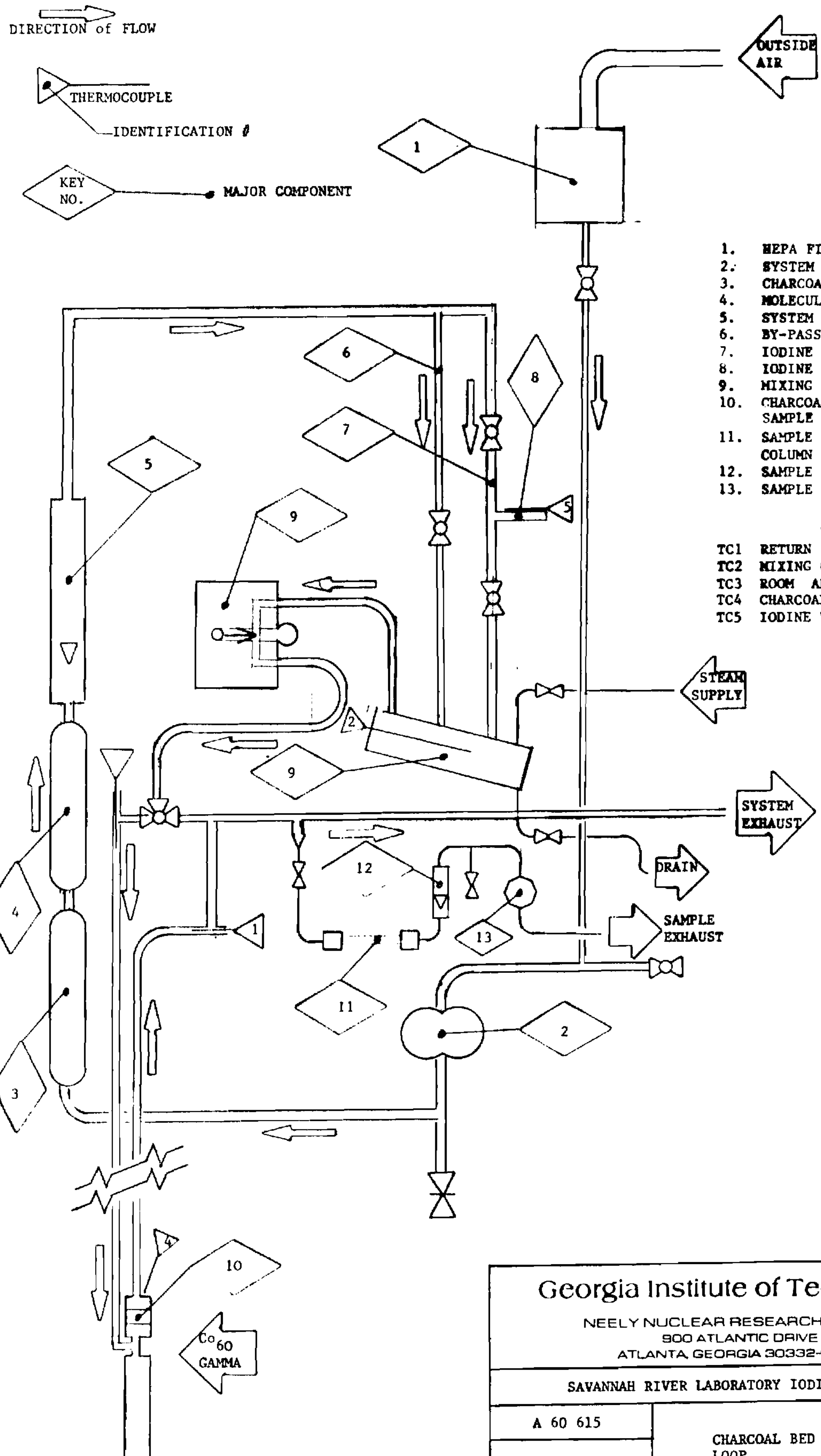
R.A. Karam
Director

RAK:jlr

TABLE I

Analysis of Chemicals Collected on Charcoal, Ambersorb and Tenax
(All Units are in PPBV)

Organic Compound	Experiment 1 (Background)	Experiment 2 (Same as Expt. 1 But Sample Holder Contains Carbon GX 176)	Experiment 3 (Same as Expt. 2 But in Radiation Field 3.62 E6 Rads per Hour)	Experiment 4 (Same as Expt. 3 but Iodine Flowing into System)	Experiment 5 (Same as Expt. 4 but no Iodine Flow)
1,1,2-Trichloro-2,2,1-Trifluoroethane				0.16	
Methylene Chloride				1.50	2.0
1,1,1-Trichloroethane	3.00	3.20	4.10	5.40	
Benzene	1.70	2.00	2.60	3.40	
Toluene				.89	3.0
2-Propanone	2.80				
Trichlorotrifluoromethane	0.08	0.64	0.71	1.60	3.2
1,1-Dichloroethene					



LEGEND

1. HEPA FILTER
2. SYSTEM PUMP
3. CHARCOAL FILTER
4. MOLECULAR SIEVE A2
5. SYSTEM FLOW METER
6. BY-PASS LINE
7. IODINE LOOP
8. IODINE VAPORIZER
9. MIXING CHAMBER
10. CHARCOAL BED AND SAMPLE HOLDER
11. SAMPLE COLLECTION COLUMN
12. SAMPLE FLOW METER
13. SAMPLE PUMP

THERMOCOUPLES

TC1 RETURN FROM CHARCOAL BED
TC2 MIXING CHAMBER
TC3 ROOM AMBIENT
TC4 CHARCOAL BED
TC5 IODINE VAPORIZING TUBE

REVISIONS			
MARK	DATE	BY	

Georgia Institute of Technology

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SAVANNAH RIVER LABORATORY IODINE PROJECT

A 60 615

CHARCOAL BED AND ANALYSIS LOOP

Georgia Institute of Technology

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July 13, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the month of June, 1987 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains a description of experiments and results obtained.

I. Description of Experiments

The experiments which were performed during this month comprised a repeat of the experiments reported for the month of May, 1987 using charcoal GX 176, Batch 8, lot 3327. This charcoal is new. Another set of identical experiments using charcoal 15021 (a bottle also marked M.L. Hyder 94646) was also performed. Each set comprised five runs. The runs are described below again for convenience.

1. The first run was performed to determine background level of organic compounds with no charcoal present in the sample holder. Air flow velocity of 54 feet/minute was maintained in this and subsequent experiments. Sampling of the air flowing through the system was obtained by using a small pump forcing air into a molecular sieve column prepared by Dr. M. Black and containing charcoal, ambersorb and tenax. The flow rate through Dr. Black's collection column was 200 c.c. per minute. Collection time was 30 minutes for a total volume of air flowing through the column of 6 liters.

2. The second run was a repeat of run (1) but with activated charcoal GX 176, batch 8, lot 3327 (this charcoal is new), inserted in the sample holder. The amount of this charcoal used was 17.95 grams.

3. The third run was a repeat of run (2) except in this run the apparatus was placed in the irradiation pipe. The field of radiation was 3.62 E6 rads per hour.

4. The fourth run (4) was a repeat of run (3) with one exception: iodine was added for two hours and five minutes. The sampling of gas through Dr. Black's column was begun at 1 hour and 29 minutes from the point of iodine introduction into the system.

5. The fifth (5) run is a repeat of run (4) except that the sampling time was begun one hour and five minutes after iodine flow was valved off.

Figure 1 shows the latest schematic diagram of the apparatus.

The conditions set for the second set of experiments using charcoal 15021 were identical to the one using GX 176. The only difference was that the quantity of 15021 charcoal was 17.77 g instead of 17.95 g for GX 176.

II. Results

The results are summarized in Tables I and II. The thermocouple readings for runs 4 and 4' and 5 and 5' (runs 4 and 5 refer to GX 176 charcoal and runs 4' and 5' refer to charcoal 1502) follow:

	Runs 4/4'	Runs 5/5'
TC_1 (Return from charcoal bed); °C	39/37	39/ * x
TC_2 (Mixing chamber); °C	38/40	38/38
TC_3 (Room temperature); °C	38/35	38/38
TC_4 (Charcoal bed); °C	48/66	47/63
TC_5 (Iodine vaporizer); °C	142/ *	44/ *

* Thermocouple failed

III. Plan for Future Experiments

Dr. Black is recommending that we try to collect the effluents in toluene and isooctane. I will discuss this with you over the phone later.

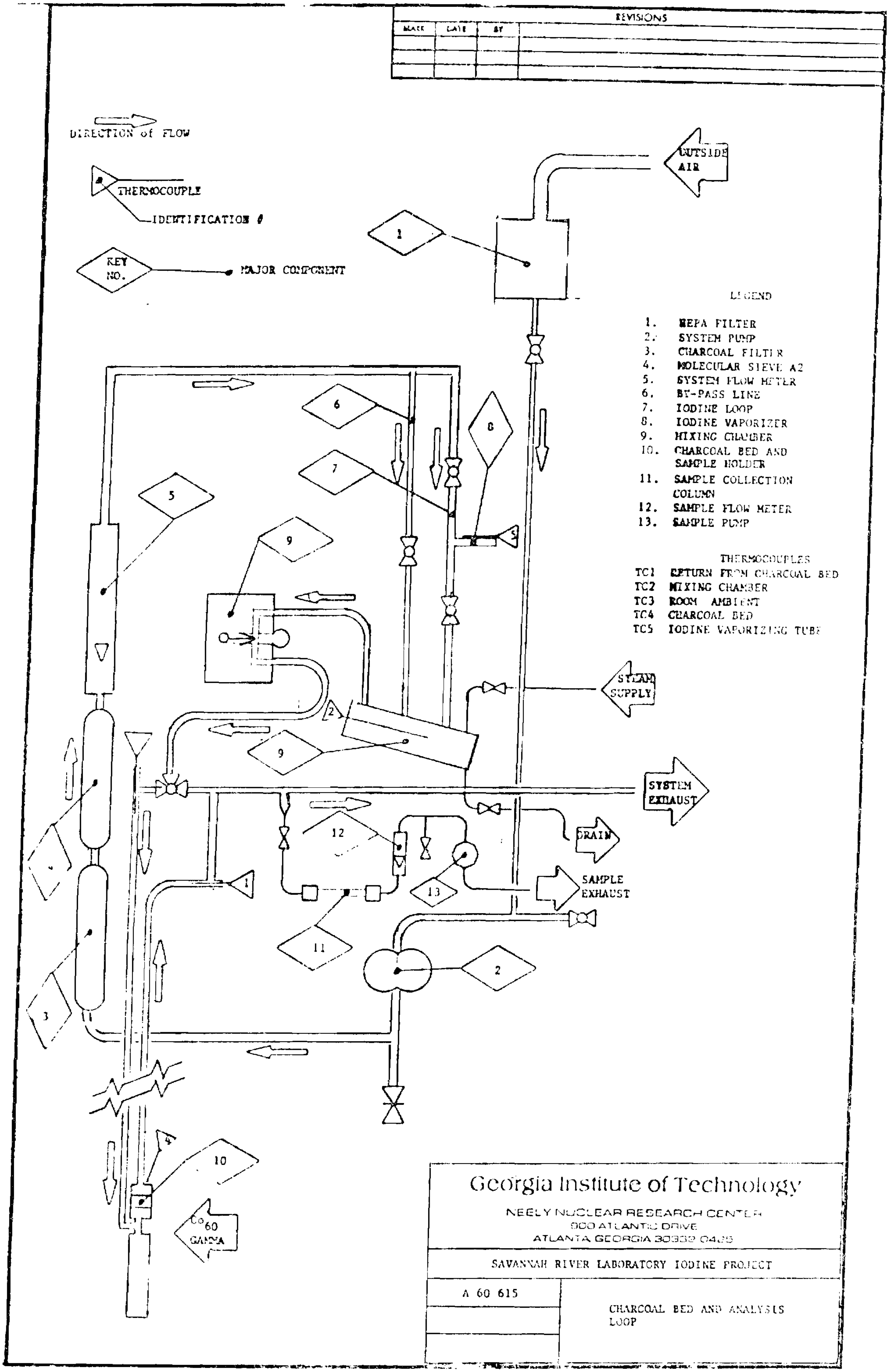
If you have any questions or would like to make any suggestions please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr


REVISIONS
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BY
DIRECTION of FLOW
THERMOCOUPLE
IDENTIFICATION #
KEY NO.
MAJOR COMPONENT
OUTSIDE AIR
LEGEND
1. HEPA FILTER
2. SYSTEM PUMP
3. CHARCOAL FILTER
4. MOLECULAR SIEVE A2
5. SYSTEM FLOW METER
6. BY-PASS LINE
7. IODINE LOOP
8. IODINE VAPORIZER
9. MIXING CHAMBER
10. CHARCOAL BED AND SAMPLE HOLDER
11. SAMPLE COLLECTION COLUMN
12. SAMPLE FLOW METER
13. SAMPLE PUMP
THERMOCOUPLES
TC1 RETURN FROM CHARCOAL BED
TC2 MIXING CHAMBER
TC3 ROOM AMBIENT
TC4 CHARCOAL BED
TC5 IODINE VAPORIZING TUBE
STEAM SUPPLY
SYSTEM EXHAUST
DRAIN
SAMPLE EXHAUST
Co 60 GAMMA
Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA GEORGIA 30332 0425
SAVANNAH RIVER LABORATORY IODINE PROJECT
A 60 615
CHARCOAL BED AND ANALYSIS LOOP

TABLE I
Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Carbon GX 176, Batch 8, Lot 3327)	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
[illegible]fluoromethane	5.9	3.5	23.00	7.3	6.3	9.0
[illegible]ethanol	0.77					0.26
Trichl[illegible]romethane	0.96	5.7	3.8	1.8	0.71	
[illegible]	0.88		12.00	9.9	0.69	
1,1,2-Trichloro-2,2,1-trifluoroethane	0.18	0.64	0.89	8.7	0.86	3.0
Methylene Chloride	8.7	17.00	73.00	7.9	7.3	13.00
[illegible]	0.89		1.1	1.2	3.6	
Ethyl Acetate	0.86	46.00	1.4	2.5	4.6	
1,1,1-Trichloroethane	9.4	26.00	31.00	8.9	15.00	12.00
Benzene	0.41	23.00	1.4	0.77	0.77	0.82
[illegible]2,4-Trimethyl pentane	0.39			0.44	0.61	1.2
[illegible]	9.1	1.6		13.00	13.00	9.5
[illegible]		0.85	3.5			
1,1[illegible]		1.5				
2-Eth[illegible]hydroxymethyl-1,3-propanediol		22.00				
Trichloro[illegible]ene		0.38				
[illegible]		0.25			0.08	
[illegible]			1.1			
[illegible]			1.6			
[illegible]			3.4			
[illegible]ethyl Heptane			0.92			
[illegible] Heptane		6.6				
[illegible]			2.3			
[illegible]			13 ug/cu m			
[illegible]4-[illegible]methyl Pentane			2.0			
[illegible]				2.7		
[illegible]				7.1		
[illegible]				0.39		
[illegible]				0.86		
[illegible]				0.12		
Ace[illegible] Anhydride					0.65	
[illegible]					0.31	
[illegible]						0.24

Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
1,2-Dichloroethene						0.35
(1-methylethyl) cyclopropane	0.83	5.8				6.7
2,2,[illegible]-trimethyl octane					0.59	0.42
2,2,3,4,5,6-hexamethyl heptane					0.53	0.23
5-Methyl-5-propylnonane						0.22
Trichloroethane	0.82					
[illegible]-(ethenyloxy)-2-methylpropane	0.35					
[illegible]		23.00	6.3	6.5	3.3	
2-Methyl butane		28.00	20.00			
[illegible] Methyl [illegible] butane		16.00				
[illegible] acid		22.00				
[illegible] 4-methyl-1-pentanol		0.64			1.2	
[illegible]		0.88				
[illegible]		0.43	1.2			
[illegible] acetate			16.00	6.3		
[illegible] ethanol			24.00			
[illegible]			32.00			
[illegible]			22.00			
[illegible] pentane						
[illegible] octane			8.5			
[illegible] heptane			0.47			
[illegible] nonane			7.2		25.00	
[illegible] nonane			0.54		26.00	
[illegible]			0.77		3.0	
[illegible]			0.45			
[illegible] methylcyclohexane			0.32			
[illegible]			0.52			
[illegible]			0.37			
[illegible]				7.8	1.7	
[illegible]				0.53		
[illegible]				11.00	6.5	
[illegible]				5.6		
[illegible]				5.3		

TABLE II
Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
[illegible]						
[illegible]methanol	0.73		3.5	2.0		
Trichlorofluoromethane	0.44	2.9	2.6		0.36	5.0
2-Propanone	2.0	23.00	58.00	51.00	9.5	7.3
1,1,2-Trichloro-2,2,1-trifluoroethane	5.3	15.00	27.00			0.91
Methylene Chloride	2.1		15.00		2.3	45.00
[illegible]	2.1	16.00			1.5	58.00
Ethyl Acetate						
1,1,1-Trichloroethane	1.0	40.00	93.00	1.2	0.93	9.2
Benzene	0.53	6.8	30.00			6.3
2,4-[illegible]methyl pentane			2.9		6.6	0.88
[illegible]	1.3	2.9	21.00	16.00	24.00	26.00
[illegible]						
[illegible]chloroethene		5.2	11.00			
[illegible]-2(hydroxymethyl)-1,3-propanediol						
[illegible]		1.6	6.7			
[illegible]			0.40		0.25	0.28
[illegible]methyl [illegible]						
Ethenyl Acetate						
[illegible]		1.1			14.00	
[illegible] Heptane			3.4	40.00		
[illegible] Heptane				15.00		
[illegible]		1.2	4.3			
[illegible]						
[illegible] Pentane						
[illegible]						
[illegible]		23.00	29.00			6.2
[illegible]						
[illegible]						
[illegible]				13.00	11.00	
[illegible] Acid Anhydride						
[illegible] Pentane		13.00				1.1
[illegible] Hexanone						

TABLE II continued
Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
1,3-Dichloropropanol				2.5		
Iodoethane				3.5	0.54	
3-Chloro-2-Methyl-1-Propene				1.9		
2-Ethyl butanal				2.1		
2-Methyl hexane				13.00		
[illegible] 2-Ethyl-4-methyl-1-pentanol				3.3		
[illegible]-Tetramethyl hexane				13.00	2.3	
?-Methyl-1,3-di[illegible] propane				1.4		
[illegible]4-Trimethyl decane				4.9		
[illegible] hexane				81.00		
[illegible] hydrocarbon						
[illegible]				76.00		
[illegible]				9.1		
[illegible] furanone				12.00		
[illegible]				0.97		
[illegible]				3.4		
[illegible]				2.3		
[illegible]				9.9	8.1	
[illegible]				3.6		
[illegible]				0.83		
[illegible]				1.5		
[illegible]					0.69	
[illegible]					1.1	
[illegible]					0.87	
[illegible]					0.77	
[illegible]					1.6	
[illegible]					2.7	
[illegible] cyclopentane					0.75	
[illegible] hydrocarbon						
[illegible]-1-Butene					1.4	
[illegible]					0.64	
[illegible]-methyl cyclohexane					11.00	
[illegible]					49.00	

TABLE II (continued)

Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax

(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field: 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
([illegible] Methylbutyl) cyclopentane					0.54	
[illegible] octane					1.0	
1-Propenyl cyclohexane					5.4	
1,[illegible],3-Trimethyl cyclohexane					1.1	
[illegible] benzene					2.7	
2,3,6-Trimethyl octane					1.9	
2,[illegible]-Trimethyl decane					0.59	

Georgia Institute of Technology

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August 10, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report that covers the month of July 1987 on the project entitled, "Irradiation Studies of Activated Carbon."

There is not really much hard data to report this month. As you know Dr. Marilyn Black tried to collect iodine compounds on Toluene and isooctane. The reason for the change in the collection method is increased sensitivity (approximately 1000 times) over the previous method and shorter time for analysis. Unfortunately the settings of the gas chromatograph needed to produce good results is difficult. Consequently we were not able to obtain any results this month. However Dr. Black informs me that she expects these problems to be resolved in about one week.

If you have any questions please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

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September 8, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the month of August, 1987 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains descriptions of experiments and results obtained. (Although the results have already been given to you during your recent visit on September 1, 1987, this letter formally transmits the progress to date.

1. Descriptions of Experiments

The basic five runs we have run in the past were repeated using charcoal 15021 (the bottle also marked M.L. Hyder 94646). The specifics of the runs were as follows:

1. The first run was to determine background level of iodide compounds. This was achieved by having fresh outside air flow through the apparatus at 54 ft/min. with no charcoal in it. The air was sampled at a rate of 200 c.c. per minute for 30 minutes through a toluene impinger. The sample was later analyzed for methyl and ethyl iodides by electron capture chromatography. I understand from Dr. Black that this is an extremely sensitive method.

2. The second run was a basic repeat of run (1) but with charcoal 15021 in sample holder. The amount of charcoal was 17.99 grams. The apparatus was not in irradiation pipe.

3. The third run was a repeat of run (2) except that the apparatus was placed in irradiation pipe. The field of radiation was 3.80×10^6 rads per hour.

4. The fourth run was a repeat of run (3) except in this run iodine was added for one hour and 10 minutes before sampling commenced. Sampling lasted for 30 minutes.

5. The fifth run was a repeat of run 4 except sampling in this case began 25 minutes after the addition of iodine was turned off. Again, sampling lasted for 30 minutes.

The results are summarized in Table I.

The thermocouples readings at the various stations were as follows:

	Run				
	1	2	3	4	5
TC_1 (Return from Charcoal Bed);* ^oC	40	39	37	49	42
TC_2 (Mixing Chamber); ^oC	39	39	36	41	40
TC_3 (Room Tempberature); ^oC	39	39	37	38	40
TC_4 (Charcoal Bed); ^oC	38	38	50	70	70
TC_5 (Iodine Vaporizer): ^oC	42	40	36	102	43

The iodine vaporizer temperature for run 5 is low because the heat to the iodine container was turned off and the flow from that section was completely valved off.

If you have any questions with regard to the results, please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

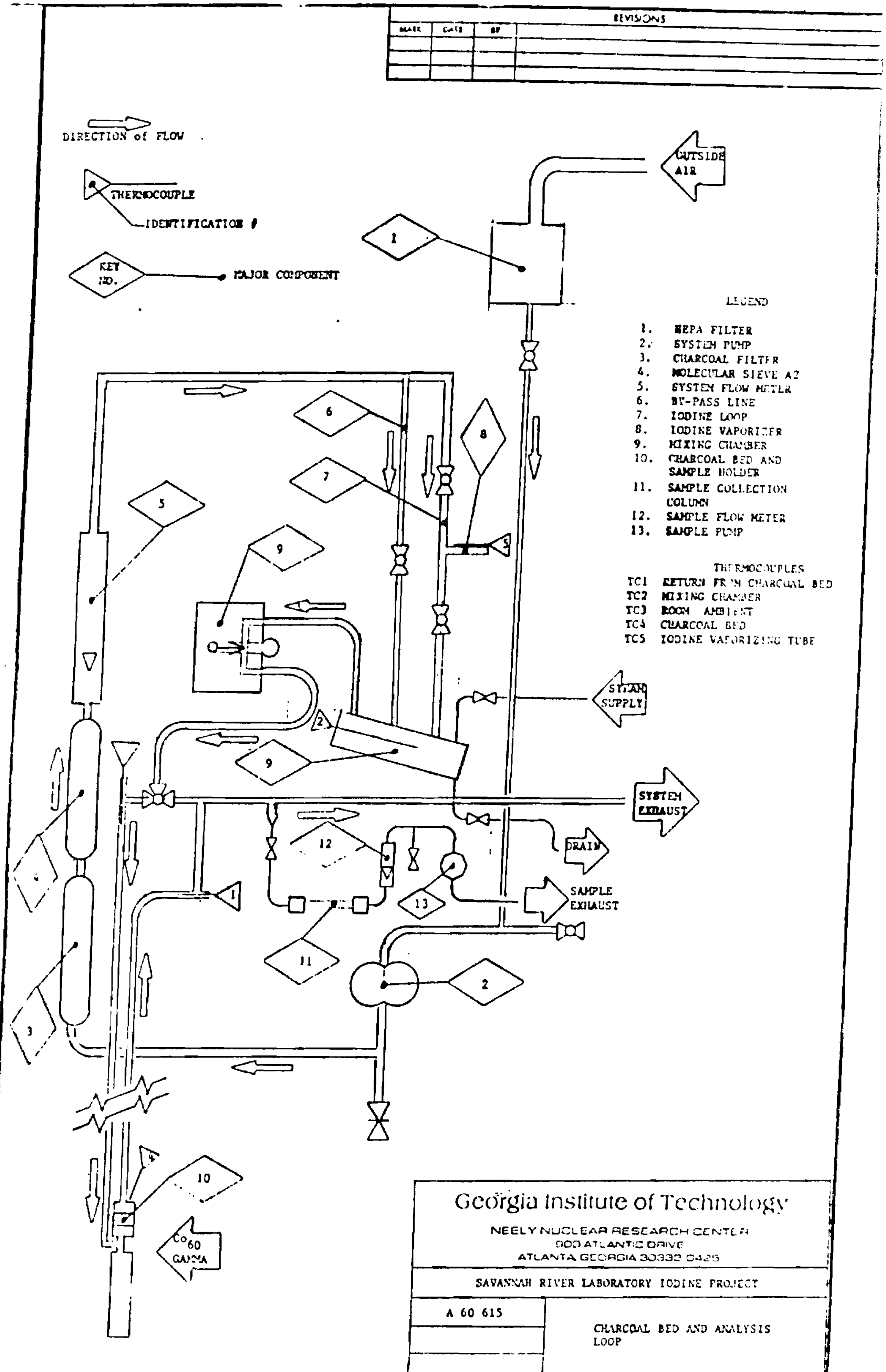
RAK:jlr

*Please refer to Figure 1 for exact locations of thermocouples.

TABLE I

METHYL AND ETHYL IODIDE ANALYSIS BY ELECTRON CAPTURE CHROMATOGRAPHY

Lab No.	Sample Description	Air Volume (Liters)	Methyl Iodide Units ppbv	Ethyl Iodide Units ppbv
Blank Toluene	Tolune used in impingers	-----	Non-detected	Non-detected
20805	Background; Run #1	6 L	<0.5	<0.5
20806	Charcoal (15021); Run #2	6 L	6.7	<0.5
20807	Charcoal (15021 in Gamma Field); Run #3	6 L	17.0	<0.5
20808	Run #4; Same as Run #3 but with Iodine Added	6 L	197.0	299.0
20809	Run #5; Same as Run #4 but Iodine Turned Off	6 L	4.7	<0.5


REVISIONS
DIRECTION of FLOW
THERMOCOUPLE
IDENTIFICATION #
KEY NO.
MAJOR COMPONENT
OUTSIDE AIR
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1. HEPA FILTER
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12. SAMPLE FLOW METER
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THERMOCOUPLES
TC1 RETURN FROM CHARCOAL BED
TC2 MIXING CHAMBER
TC3 ROOM AMBIENT
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CHARCOAL BED AND ANALYSIS LOOP

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November 6, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the months of September and October, 1987 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains results obtained during this period.

I. Description of Experiments

The basic five runs we have conducted in the past were repeated using the following charcoals:

1. Charcoal Batch # NRL 5340
2. Charcoal Batch # NRL 5338
3. Charcoal Batch # P.3 (29 month)
4. Charcoal Batch # K.2 (24 month 1984)
5. Charcoal Batch # 15732 C.6
6. Charcoal Batch # 2V8.2 INEL
7. Charcoal Batch # 15021 (marked radioactive 12/22/86)

For convenience we report the conditions for each run below.

1. A control sample, comprised of toluene in an impinger, was prepared exactly as other impingers used in this experiment but had no air flow through it. The toluene was analyzed for iodine compounds. This control sample served as a reference for the other 5 samples.

2. The first run was to determine background level of iodide compounds. This was achieved by having fresh outside air flow through the apparatus at 54 ft/min. with no charcoal in it. The air was sampled at a rate of 200 c.c. per minute for 30 minutes through a toluene impinger. The sample was later analyzed for methyl and other iodides by electron capture chromatography. The other iodides which were analyzed for but not found were: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane.

3. The second run was a basic repeat of run (1) but with charcoal in sample holder. The amount of charcoal in each sample is listed in Table I. The apparatus was not in the irradiation pipe.

4. The third run was a repeat of run (2) except that the apparatus was placed in the irradiation pipe. The field of radiation was 3.80×10^{6} rads per hour.

5. The fourth run was a repeat of run (3) except in this run iodine was added for about one hour before sampling commenced. Sampling lasted for 30 minutes.

6. The fifth run was a repeat of run (4) except sampling in this case began about one hour after the supply of iodine was exhausted. Again, sampling lasted for 30 minutes.

II. Results

The results are summarized in Table 1.

Dr. Black stated that the measurement uncertainty is plus or minus 0.5 ppbv. This uncertainty does not include systematic error such as loss of iodide from the toluene.

The iodine in all cases was completely gone (evaporated) before run #5 was begun. Adequate iodine supply was in the container however all through Run #4.

The humidity varied between 0.6% and 12%. The variation is attributed to the condition of the drying agent, molecular sieve type 5A.

The current through the iodine analyzer does not return to the pre-iodine introduction level. This indicates that a certain vapor pressure of iodine remains in the system after the supply of iodine has been consumed.

The variation in the temperature at each measuring location varied significantly from experiment to experiment and within an experiment from run to run. This indicates that in order to maintain a basis for temperature comparison, the measurement must be made at definite time intervals from the start. The reason for this is that there are three sources of heat in the system: (1) heating tape around the mixing chamber, (2) heating the iodine container, and (3) heating in the irradiation pipe due to gamma heating. It is difficult to reach equilibrium in every case. However, we can and will have better control of temperature variation in the future.

III. Future Experiment

It is planned to repeat the seven experiments described above with steam being added to the mixing chamber. The experiments will be performed during the month of November.

If you have any questions please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

TABLE I

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 1. CHARCOAL BATCH 5340 (18.128 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	08:47	09:17	66	30	31	31	87	8.00E-10	12.6%	0.19
2 (Charcoal)	09:31	10:01	90	32	30	31	108	8.40E-10	9.6%	0.45
3 (Charcoal in Gamma)	10:29	10:59	98	32	33	35	109	9.21E-10	8.9%	4.80
4 (Iodine Introduced)	11:32									
(9.502 G in container)	12:25	12:55	51	32	32	71	68	2.44E-10	10.8%	13.00
5 (Residual Iodine)	14:00	14:30	94	31	32	70	106	5.26E-10	9.6%	3.20

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

[redacted]

TABLE I CONTINUED

*Methyl Iodide Analysis by Electron Capture Chromatography**

EXPERIMENT 2. CHARCOAL BATCH 5338 (15.671 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:00	11:30	79	29	29	30	98	5.90E-10	.6%	ND
2 (Charcoal)	11:53	12:23	91	33	32	24	107	6.18E-10	.9%	ND
3 (Charcoal in Gamma)	12:35	13:05	99	31	30	38	115	6.63E-10	1.2%	0.16
4 (Iodine Introduced)	13:10									
(9.075 G in container)	14:12	14:42	51	29	30	50	73	2.21E-10		0.86
5 (Residual Iodine)	15:42	16:13	102	40	33	52	117	5.02E-10	10.8%	0.94

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

* *The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE I CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 3. CHARCOAL BATCH P.3 (22.7266 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:10	11:40	106	39	33	31	116	8.13E-10	1.3%	0.70
2 (Charcoal)	11:47	12:18	105	36	31	27	116	8.32E-10	1.2%	0.65
3 (Charcoal in Gamma)	12:35	13:05	108	38	31	38	118	8.32E-10	NO	0.74
4 (Iodine Introduced)	13:25									
(9.625 G in container)	14:32	15:02	71	65	32	37	52	3.40E-10	12.4%	0.95
5 (Residual Iodine)	16:21	16:51	53	38	33	63	83	8.17E-10	11.1%	0.99

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected NO = not observed

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE I CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 4. CHARCOAL BATCH K.2 (23.59746 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	10:03	10:33	74	32	30	29	91	6.88E-10	0.6%	0.23
2 (Charcoal)	10:43	11:13	96	41	34	23	106	7.35E-10	0.7%	0.29
3 (Charcoal in Gamma)	11:22	11:52	94	35	32	34	109	7.35E-10	1.2%	0.31
4 (Iodine Introduced)	11:54									
(11.03 G in container)	13:01	13:31	55	41	37	75	74	2.96E-10	1.3%	0.66
5 (Residual Iodine)	14:35	15:05	96	37	31	73	111	7.52E-10	9.8%	0.75

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE I CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (22.85725 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:44	12:14	93	31	29	27	108	6.71E-10	11.4%	1.80
2 (Charcoal)	12:29	12:59	99	37	31	27	109	6.75E-10	11.8%	1.80
3 (Charcoal in Gamma)	13:23	13:53	100	32	30	41	113	7.20E-10	10.4%	1.50
4 (Iodine Introduced)	15:01									
(10.03 G in container)	16:00	16:30	57	41	35	45	75	2.30E-10	8.7%	0.92
5 (Residual Iodine)	17:36	18:06	54	37	32	42	77	7.70E-10	8.7%	0.70

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE I CONTINUED

*Methyl Iodide Analysis by Electron Capture Chromatography**

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (17.95295 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	10:43	11:13	28	29	28	28	28	6.70E-10	.1%	3.30
2 (Charcoal)	11:18	11:48	33	29	28	28	44	6.70E-10	.1%	2.40
3 (Charcoal in Gamma)	12:00	12:30	57	31	30	38	72	6.93E-10	.1%	1.80
4 (Iodine Introduced)	12:32									
(10.04 G in container)	13:35	14:05	70	68	30	36	53	3.37E-10	.4%	2.50
5 (Residual Iodine)	15:05	15:35	56	39	31	69	80	6.62E-10	1.8%	1.80

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

* *The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE I CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 7. CHARCOAL BATCH 15021 (20.8699 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:24	11:54	90	35	29	28	100	7.47E-10	.4%	8.00
2 (Charcoal)	12:05	12:35	56	34	30	24	52	7.47E-10	.4%	2.50
3 (Charcoal in Gamma)	13:01	13:31	36	31	30	32	38	7.20E-10	1.0%	1.80
4 (Iodine Introduced)	13:35									
(9.238 G in container)	14:30	15:00	42	34	31	71	44	2.57E-10	1.0%	1.60
5 (Residual Iodine)	16:04	16:34	37	31	30	77	49	6.12E-10	12%	4.60

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
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December 15, 1987

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report for the months of November and December, 1987 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains results obtained during this period.

I. Description of Experiments

The basic five runs we have conducted in the past were repeated using the following charcoals:

1. Charcoal Batch # NRL 5340
2. Charcoal Batch # NRL 5338
3. Charcoal Batch # P.3 (29 month)
4. Charcoal Batch # K.2 (24 month 1984)
5. Charcoal Batch # 15732 C.6
6. Charcoal Batch # 2U8.2 INEL
7. Charcoal Batch # 15021 (marked radioactive 12/22/86)

One major difference from previous experiments was the fact that this time the humidity was high, approximately 90-100%. This high humidity created a minor problem in the toluene impinger--condensation of water vapor. This necessitated inserting in the line a moisture trap prior to the impinger. The material collected in this trap was also analyzed for methyl iodide. The results for this analysis are labeled run #6 (condensate collected) in Table 1. For convenience we report the conditions for each run below.

1. A control sample, comprised of toluene in an impinger, was prepared exactly as other impingers used in this experiment but had no air flow through it. The toluene was analyzed for iodine compounds. This control sample served as a reference for the other 6 samples.

2. The first run was to determine background level of iodide compounds. This was achieved by having fresh outside air flow thorugh the apparatus at 54 ft/min. with no charcoal in it. The air was sampled at a rate of 200 c.c. per minute for 30 minutes through a toluene impinger. The sample was later analyzed for methyl and other iodides by electron capture chromatography.

3. The second run was a basic repeat of run (1) but with charcoal in sample holder. The amount of charcoal in each sample is listed in Table I. The apparatus was not in the irradiation pipe.

4. The third run was a repeat of run (2) except that the apparatus was placed in the irradiation pipe. The field of radiation was 3.80×10^6 rads per hour.

5. The fourth run was a repeat of run (3) except in this run iodine was added for about one hour before sampling commenced. Sampling lasted for 30 minutes.

6. The fifth run was a repeat of run (4) except sampling in this case began about one hour after the supply of iodine was exhausted. Again, sampling lasted for 30 minutes.

II. RESULTS

The results are summarized in Table 1.

Dr. Black stated that the measurement uncertainty is plus or minus 0.5 ppbv. This uncertainty does not include systematic error such as loss of iodide from the toluene.

The iodine in all cases was completely gone (evaporated) before run #5 was begun. Adequate iodine supply was in the container however all through Run #4.

The humidity varied between 90 and 100%.

III. FUTURE EXPERIMENT

We await your instructions for the next set of experiments.

If you have any questions please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

TABLE I

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 1. CHARCOAL BATCH 5340 (17.4622 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:43	30 MIN	55	28	29	25	45	1.53E-08	100	0.2408
2 (Charcoal)	11:39		61	31	30	32	49	1.49E-08	91	5.934
3 (Charcoal in Gamma)	12:21		74	33	30	45	53	1.46E-08	91	12.642
4 (Iodine Introduced)	13:16									
1.0015 G in container	14:16		73	39	30	78	53	1.24E-08	92	52.7524
5 (Residual Iodine)	15:38		71	40	31	83	53	1.23E-08	93	155.0236
6 (condensate collected)	10:43	(cumulative)								7.224

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

[redacted]

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 2. CHARCOAL BATCH 5338 (16.2249 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:18	30 MIN	73	34	29	31	78	1.33E-08	100	1.8232
2 (Charcoal)	11:07		72	31	29	37	84	1.23E-08	100	0.4472
3 (Charcoal in Gamma)	11:46		71	37	29	52	83	1.24E-08	98	0.4472
4 (Iodine Introduced)	12:16									
1.001 G in container	13:16		70	39	30	66	78	1.29E-08	96	3.1476
5 (Residual Iodine)	14:48		71	39	30	67	79	1.29E-08	96	4.2656
6 (condensate collected)	10:18	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 3. CHARCOAL BATCH P.3 (23.8185 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:33	30 MIN	72	33	30	32	84	1.31E-08	93	0.1032
2 (Charcoal)	11:14		70	34	30	40	84	1.35E-08	92	nd
3 (Charcoal in Gamma)	12:06		71	33	31	35	89	1.36E-08	95	1.2212
4 (IodinIodine introduced	12:41									
1.0000 G in container	13:42		72	33	31	58	80	1.29E-08	96	2.5112
5 (Residual Iodine)	15:12		72	34	33	61	81	1.35E-08	93	2.494
6 (condensate collected)	10:33	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 4. CHARCOAL BATCH K.2 (22.5374 GRAMS USED)

RUN #		START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
	(Control)										nd
1	(Background)	09:38	30 MIN	73	31	31	37	86	1.28E-08	96	nd
2	(Charcoal)	10:28		73	31	30	33	86	1.39E-08	93	nd
3	(Charcoal in Gamma)	11:23		71	31	30	43	87	1.38E-08	91	1.0148
4	(Iodine Introduced)	12:24									
	1.001 G in container	13:24		74	32	31	68	86	1.32E-08	92	2.6144
5	(Residual Iodine)	14:54		73	32	31	63	89	1.20E-08	94	2.7692
6	(condensate collected)	09:38	(cumulative)								3.8184

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (24.8596 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:59	30 MIN	72	31	31	44	84	1.12E-08	97	nd
2 (Charcoal)	10:57		72	31	32	37	85	1.23E-08	97	nd
3 (Charcoal in Gamma)	11:39		71	31	31	44	85	1.22E-08	98	1.2212
4 (Iodine Introduced)	12:10									
1.0012 G in container	13:12		74	31	31	61	85	1.22E-08	98	3.0272
5 (Residual Iodine)	14:42		72	32	32	68	86	1.30E-08	100	1.4964
6 (condensate collected)	09:59	(cumulative)								26.144

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (20.1721 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:12	30 MIN	71	32	32	44	88	1.16E-08	98	nd
2 (Charcoal)	10:01		72	32	32	49	86	1.25E-08	97	nd
3 (Charcoal in Gamma)	10:38		71	32	32	45	86	1.34E-08	97	0.4988
4 (Iodine Introduced)	11:52									
1.001 G in container	12:52		72	33	33	59	80	1.26E-08	97	0.4816
5 (Residual Iodine)	14:26		72	34	33	62	88	1.32E-08	98	0.5504
6 (condensate collected)	09:12	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 7. CHARCOAL BATCH 15021 (22.5068 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:06	30 MIN	74	41	34	42	86	1.39E-08	98	nd
2 (Charcoal)	10:47		75	37	33	48	86	1.35E-08	98	nd
3 (Charcoal in Gamma)	11:19		73	34	35	48	86	1.30E-08	96	0.7568
4 (Iodine Introduced)	12:16									
1.0003 G in container	13:16		76	35	36	65	86	1.29E-08	96	2.9584
5 (Residual Iodine)	14:46		75	35	36	67	86	1.33E-08	96	4.8504
6 (condensate collected)	10:06	(cumulative)								1.7372

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

J. A. 615

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
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May 5, 1988

Dr. M.L. Hyder
Analytical Chemistry
E.I. DuPont de Nemours and Company
Atomic Energy Division
Savannah River Laboratory
Aiken, South Carolina 29808

Dear Lee:

This is a progress report through the month of April, 1988 on the project entitled, "Irradiation Studies of Activated Carbon." The report contains results obtained during this period.

I. Description of Experiments

A. Charcoal Absorptive Capacity in Radiation Field

The five basic runs we have conducted in the past were repeated using the following charcoals:

1. Charcoal Batch # NRL 5340
2. Charcoal Batch # NRL 5338
3. Charcoal Batch # P.3 (29 month)
4. Charcoal Batch # K.2 (24 month 1984)
5. Charcoal Batch # 15732 C.6
6. Charcoal Batch # 2V8.2 INEL
7. Charcoal Batch # 15021 (marked radioactive 12/22/86)

For convenience we report the conditions for each run below.

1. A control sample, comprised of toluene in an impinger, was prepared exactly as other impingers used in this experiment but had no air flow through it. The toluene was analyzed for iodine compounds. This control sample served as a reference for the other 5 samples.

2. The first run was to determine background level of iodide compounds. This was achieved by having fresh outside air flow through the apparatus at 54 ft/min. with no charcoal in it. The air was sampled at a rate of 200 c.c. per minute for 30 minutes through a toluene impinger. The sample was later analyzed for methyl and other iodides by electron capture chromatography. The other iodides which

were analyzed for but not found were: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane.

3. The second run was a basic repeat of run (1) but with charcoal in sample holder. The amount of charcoal in each sample is listed in Table I. The apparatus was not in the irradiation pipe.

4. The third run was a repeat of run (2) except that the apparatus was placed in the irradiation pipe. The field of radiation was 3.80 E6 rads per hour.

5. The fourth run was a repeat of run (3) except in this run iodine was added for about one hour before sampling commenced. Sampling lasted for 30 minutes.

6. The fifth run was a repeat of run (4) except sampling in this case began about one hour after the supply of iodine was exhausted. Again, sampling lasted for 30 minutes.

B. Surface Area and Pore Size Analysis

The surface area and pore size characterization was performed at the recommendation of Dr. Robert A. Pierotti by Micromeritics Instrument Corporation. Three types of carbons were used: (1) carbon 5340; (2) carbon 15021; and (3) carbon P.3. Three samples of each type of carbon were used: (1) a reference sample from the bottle; (2) a sample which was used under dry conditions; and (3) a sample which was used under wet conditions.

All samples were degassed at 350°C for 16 hours under vacuum.

II. Results

A. The charcoal adsorptive capacity results are summarized in Table 1.

Dr. Black stated that the measurement uncertainty is plus or minus 0.5 ppbv. This uncertainty does not include systematic error such as loss of iodide from the toluene.

B. The surface area and pore size analysis results are summarized in a brief memo from Dr. Pierotti to me. The memo is attached. The original computer output giving analysis results from Micromeritcs were sent to you previously.

III. Future Experiments

The details of future experiments will be worked out in accordance with your desires.

If you have any questions please let me know.

Best personal wishes.

Sincerely yours,

R.A. Karam
Director

RAK:jlr

Attachments

GEORGIA INSTITUTE OF TECHNOLOGY
School of Chemistry
Atlanta, Georgia 30332
(404)-894-4003

26-Apr-88

MEMORANDUM

TO: Dr. Ratib Karam, Director
Nuclear Reactor Center

FROM: Robert A. Pierotti, Director
School of Chemistry

SUBJECT: Summary of Surface Area and Pore Size Analysis

Data of Micromeritics February and March 1988

Carbon sample and history	new	dry	wet	average	
carbon 5340					
BET area(sq m/g)	731	926	783	813	[illegible]
Pore volume (cc/g)	0.403	0.513	0.429	0.448	0.4[illegible]
Pore Diameter (A)	14.5	14.3	14.4	14.4	
carbon 15021					
BET area(sq m/g)	542	266	507	4[illegible]	[illegible]
Pore volume (cc/g)	0.298	0.15	0.278	0.2[illegible]	[illegible]
Pore Diameter (A)	14.8	15.1	14.9	14[illegible]	
carbon P 3					
BET area(sq m/g)	429	384	322	[illegible]	
Pore volume (cc/g)	0.235	0.214	0.18[illegible]	0.21[illegible]	
Pore Diameter (A)	14.8	15	15.[illegible]	15.[illegible]	

All samples were degassed at 350 C for 16 hours under vacuum

It appears that the two samples designated dry 5340 and dry 15021 may have been misweighed, although Micromeritics did not think so. The BET surface area and the Pore volume are per gram. If the area and pore volume of these samples are normalized, it appears they would be yield essentially the same area and volume as their "new" and "wet" counterparts respectively (see the last column above). The pore size and the pore size distribution are not on a per gram basis and they seem to be unaffected by treatment.

It appears that the history of the sample including irradiation does not effect either the surface area, the pore volume, the average pore radius, or the pore size distribution and hence the ability of the the carbon to physically adsorb vapors should be unaffected by the extent of irradiation that these samples have undergone.

TABLE I

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 1. CHARCOAL BATCH 5340 (15.8585 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:45	30 MIN	41	29	28	28	55	9.02E-09	0.7	nd
2 (Charcoal)	11:53		49	31	31	27	60	8.97E-09	0.7	0.40
3 (Charcoal in Gamma)	12:30		48	29	29	39	59	8.52E-09	0.6	3.14
4 (Iodine Introduced)	13:06									
0.5000 G in container	14:06		43	32	29	68	49	8.46E-09	9.7	5.06
5 (Residual Iodine)	15:36		48	33	31	70	58	8.83E-09	17.6	2.44

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 2. CHARCOAL BATCH 5338 (17.2389 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:22	30 MIN	54	29	29	28	69	9.85E-09	0.2	nd
2 (Charcoal)	11:01		49	29	29	28	57	9.85E-09	0.2	nd
3 (Charcoal in Gamma)	11:46		48	30	27	41	57	9.72E-09	0.3	0.17
4 (Iodine Introduced)	12:17									
0.5025 G in container	13:18		43	33	29	68	48	8.36E-09	0.3	nd
5 (Residual Iodine)	12:58		49	34	30	68	60	8.34E-09	1.1	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 3. CHARCOAL BATCH P.3 (23.3151 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:55	30 MIN	47	32	32	30	60	8.75E-09	0.5	nd
2 (Charcoal)	11:03		47	32	30	25	60	8.99E-09	0.5	0.14
3 (Charcoal in Gamma)	11.39		48	33	33	60	60	9.01E-09	0.7	0.07
4 (IodinIodine introduced	12:13									
0.5041 G in container	13:13		44	34	31	64	50	8.28E-09	1.2	0.03
5 (Residual Iodine)	14:43		51	36	34	65	61	9.54E-09	12.0	0.07

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 4. CHARCOAL BATCH K.2 (21.6936 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:32	30 MIN	44	28	27	27	56	9.85E-09	0.1	nd
2 (Charcoal)	10:50		44	29	26	22	55	9.86E-09	0.1	nd
3 (Charcoal in Gamma)	11:34		45	29	27	61	57	9.98E-09	0.1	0.40
4 (Iodine Introduced)	12:23									
0.5032 G in container	13:23		40	31	28	65	46	8.64E-09	1.2	2.10
5 (Residual Iodine)	14:58		46	31	28	65	58	8.61E-09	1.2	2.10

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (24.1689 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:23	30 MIN	41	25	28	28	52	8.87E-09	0.6	nd
2 (Charcoal)	10:59		43	27	28	25	54	8.87E-09	0.3	nd
3 (Charcoal in Gamma)	12:09		47	31	29	56	58	9.06E-09	0.3	0.31
4 (Iodine Introduced)	12:44									
0.5074 G in container	13:50		45	32	28	63	54	8.12E-09	0.3	0.80
5 (Residual Iodine)	15:25		46	32	28	64	59	8.76E-09	0.3	0.58

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (19.4761 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:38	30 MIN	46	29	28	28	56	8.62E-09	0.4	nd
2 (Charcoal)	11:40		47	29	28	28	58	8.62E-09	0.4	nd
3 (Charcoal in Gamma)	12:12		48	32	29	53	56	8.54E-09	0.4	nd
4 (Iodine Introduced)	12:44									
0.5146 G in container	13:50		45	32	29	62	48	7.80E-09	0.5	nd
5 (Residual Iodine)	15:22		49	33	30	62	62	8.02E-09	0.6	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE I CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 7. CHARCOAL BATCH 15021 (20.8784 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:31	30 MIN	49	33	33	28	60	1.02E-08	0.1	nd
2 (Charcoal)	10:06		50	34	35	22	60	1.02E-08	0.1	nd
3 (Charcoal in Gamma)	10:46		52	36	36	58	61	1.00E-08	0.1	0.45
4 (Iodine Introduced)	11:27									
0.5005 G in container	12:27		43	35	34	60	50	8.44E-09	0.1	0.40
5 (Residual Iodine)	14:01		53	38	35	61	63	8.28E-09	0.1	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

IRRADIATION STUDIES OF ACTIVATED CARBON

A FINAL REPORT

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GEORGIA INSTITUTE OF TECHNOLOGY

FEBRUARY 18, 1989

INTRODUCTION

Activated Carbon is used in the operation of the Savannah River Plant to trap and retain radioactive iodine in the reactor building effluent air.

Airflow is directed through the carbon bed. Its ability to retain organic iodine degrades over time. Small traces of organic impurities in the air can have important cumulative effects over the service life of carbon.

Tests of the effects of organics on the release of radio iodine from carbon in high radiation field were conducted at the Neely Nuclear Research for Georgia Institute of Technology the Savannah River Laboratory over a period of 18 months. This report documents all results obtained during this period.

1. Experimental Apparatus

The Neely Nuclear Research Center designed and built the apparatus shown in Figure 1. Design features included the ability to do the following.

1. Determine background levels of organic compounds with no charcoal in the System. This simply meant fresh air circulation through the apparatus and collecting organic iodine compounds on different adsorbent columns.

2. Determine background levels of organic compounds in fresh air that has been circulated through activated carbon. This step is essentially a repeat of step 1 but with charcoal (old or new) in system. (Old charcoal refers to charcoal that has been used at SRP in ventilation beds and therefore was exposed to organics in the atmosphere. New charcoal is charcoal that has not been exposed to organic contamination).

3. Determine effects of intense radiation fields on background levels. This meant that the sample holder (shown in Figure 1) containing activated carbon was placed in the irradiation pipe of the Neely Nuclear Research Center. The dose rate in the pipe was approximately 5×10^6 rads/hour.

4. Determine organic iodide levels after about 1 gram of iodine vapor has been added to the system. Collection of iodide compounds on adsorbants starts 30 minutes after the process of iodine addition has stopped.

5. Determine organic iodide levels 3 hours after the process of iodine addition has ceased but sample of activated carbon remained in the intense radiation field.

Measurements with several types of activated carbon were made under dry and also under high humidity conditions.

II Results

Initial background level determinations of organic compounds collected in Tenax, Tenax and charcoal and in Tenax ambersorb and charcoal are listed in Table I. These results indicated that collection rate through the adsorbent should be lowered to 200 c.c. per minute and collection time should not exceed 30 minutes.

Conditions for the next set of measurements were as follows:

1. The first experiment was run to determine background level of organic compounds with no charcoal present in the sample holder. An air flow velocity of 54 feet/minute was maintained in this and subsequent experiments. Samples of the air flowing through the system were obtained by using a small pump to force system air into adsorbent columns containing charcoal, ambersorb and tenax. The flow rate was 200 c.c. per minute. Collection time was 30 minutes for a total volume of air flowing through the column of 6 liters.

2. Experiment (2) was a repeat of Experiment (1) but with activated charcoal GX 176, batch 8, lot 3327 (this charcoal is new), inserted in the sample holder. The amount of this charcoal used was 17.95 grams.

3. Experiment (3) was a repeat of Experiment (2) except in this experiment the apparatus was placed in the irradiation pipe. The field of radiation was 3.62 E6 rads per hour.

4. Experiment (4) was a repeat of Experiment (3) with one exception: iodine was added for two hours and five minutes. The sampling of gas was begun at 1 hour and 29 minutes from the point of iodine introduction into the system. The temperature in the iodine vaporizer was 142°C.

5. Experiment (5) is a repeat of Experiment (4) except that the sampling time was begun one hour and five minutes after iodine flow was valved off.

The results obtained from these experiments are shown in Table II.

The next set of experiments were performed using charcoal Gx176 and charcoal 1502. The run by run descriptions are similar to those described above. The results are given in Tables III and IV.

From here on the Columns used to collect organic iodine compounds were changed from charcoal, Tenax and ambersorb to toluene. The reason for the change was that collection in toluene is about 1000 times more sensitive than of the other mixtures.

The five basic runs to determine background and effects of radiation which were described above were repeated using the following charcoals:

1. Charcoal Batch # NRL 5340
2. Charcoal Batch # NRL 5338
3. Charcoal Batch # P.3 (29 month)
4. Charcoal Batch # K.2 (24 month 1984)
5. Charcoal Batch # 15732 C.6
6. Charcoal Batch # 2V8.2 INEL
7. Charcoal Batch # 15021 (marked radioactive 12/22/86)

The results are summarized in Table V. Note that only methyl iodide was determined in the analysis.

The experiments with the 7 types of charcoal were repeated at a humidity range of 90-100%. This high humidity created a minor problem in the toluene impinger: condensation of water vapor. This necessitated inserting in the line moisture trap prior to the impinger. The material collected in this trap was also analyzed for methyl iodide. The results for this analysis are labeled run #6 (condensate collected) in Table VI.

Finally the same 7 types of charcoal were used to remeasure charcoal adsorptive capacity in the high radiation field in dry atmosphere. For convenience we repeat the conditions for each run.

1. A control sample, comprised of toluene in an impinger, was prepared exactly as other impingers used in this experiment but had no air flow through it. The toluene was analyzed for iodine compounds. This control sample served as a reference for the other 5 samples.

2. The first run was to determine background level of iodide compounds. This was achieved by having fresh outside air flow through the apparatus at 54 ft/min. with no charcoal in it. The air was sampled at a rate of 200 c.c. per minute

for 30 minutes through a toluene impinger. The sample was later analyzed for methyl and other iodides by electron

capture chromatography. The other iodides which were analyzed for but not found were: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Idotoluene, Iododecane.

3. The second run was a basic repeat of run (1) but with charcoal in sample holder. The amount of charcoal in each sample is listed in Table VII. The apparatus was not in the irradiation pipe.

4. The third run was a repeat of run (2) except that the apparatus was placed in the irradiation pipe. The field of radiation was 3.80 E6 rads per hour.

5. The fourth run was a repeat of run (3) except in this run iodine was added for about one hour before sampling commenced. Sampling lasted for 30 minutes.

6. The fifth run was as repeat of run (4) except sampling in this case began about one hour after the supply of iodine was exhausted. Again, sampling lasted for 30 minutes.

The results of these measurements are summarized in Table VII.

The surface area and pore size characterizations was performed by Micromeritics Instrument Corporation. Three types of carbon were used: (1) carbon 5340; (2) carbon 15021; and (3) carbon P.3. Three samples of each type of carbon were used under dry and wet conditions. All samples were degassed at 350 C for 16 hours under vacuum.

The surface area and pore size analysis results are summarized Table VIII. The original computer output giving analysis results from Micromeritcs were sent to Dr. Hyder previously.

Table VIII

Summary of surface area and pore size analysis

Carbon sample and history	new	dry	wet	average	
carbon 5340					
BET area(sq m/g)	731	926	783	813	757
Pore volume (cc/g)	0.403	0.513	0.429	0.448	0.419
Pore Diameter (A)	14.3	14.3	14.4	14.4	

carbon 15021						
	BET area(sq m/g)	542	266	507	438	424.5
	Pore volume (cc/g)	0.298	0.15	0.278	0.242.	0.296
	Pore Diameter (A)	14.8	15.1	14.8	14.9	
carbon P 3						
	BET area (sq m/g)	429	384	322	378	
	Pore volume (cc/g)	0.235	0.214	0.181	0.210	
	Pore Diameter (A)	14.8	15	15.1	15.0	

It appears that the two samples designated dry 5340 and dry 15021 may have been misweighed, although Micromeritetics does not think so. The BET surface area and the Pore volume are per gram. If the area and pore volume of these samples are normalized, it appears they would yield essentially the same area and volume as their "new" and "wet" counterparts respectively (see the last column above). The pore size and the pore size distribution are not on a per gram basis and they seem to be unaffected by treatment.

It appears that the history of the sample including irradiation does not effect either the surface area, the pore volume, the average pore radius, or the pore size distribution and hence the ability of the carbon to physically adsorb vapors should be unaffected by the extent of irradiation that these samples have undergone.

Acknowledgement

The Neely Nuclear Research Center, Georgia Institute of Technology expresses its deep appreciation to the Savannah River Laboratory for the opportunity to be of Service to its Safety Programs.

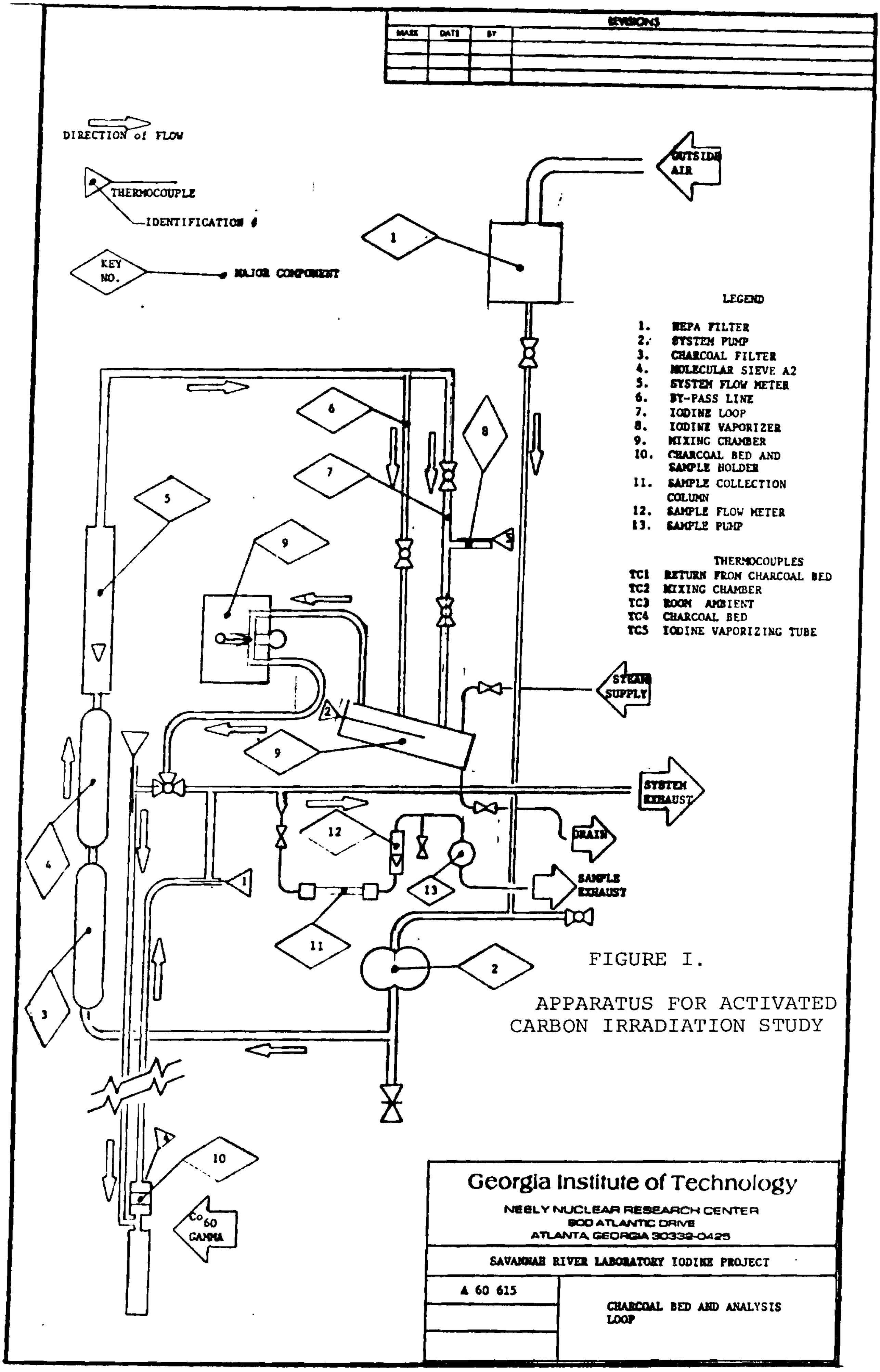

FIGURE I.

APPARATUS FOR ACTIVATED CARBON IRRADIATION STUDY

TABLE I

Collection of Background Levels of Organic Compounds in Tenax, Tenax and Charcoal, and in Tenax, Ambersorb and Charcoal

(All Units are in PPBV)

Organic Compound / Adsorbent	Tenax/Charcoal Lot # 18588	Tenax/Amb./Charcoal Lot # 18589	Tenax Lot # 18751	Tenax/Amb. Charcoal Lot # 18752
Vol. Collected, L	108	125.2	57.3	75.6
Methoxyethene				
1,1,2-Trichloro-2,2,1-Trifluoroethane	1.0			
Methylene Chloride	0.30	0.68	0.1	1.9
Hexane	0.81			0.14
1,1-Trichloroethane	0.15		0.70	5.6
Benzene	0.17		0.80	6.5
Heptane	0.86		0.40	0.30
Trichloroethylene	1.0		0.20	
Toluene	0.04			
Tetrachloroethylene	0.05	0.65	1.5	0.80
Ethyl benzene	0.01			
O-Xylene	0.05	0.08	0.1	0.70
P-Xylene	0.14	0.17	0.4	1.0
2-Butoxyethanol	0.04			0.10
1-Methylethylbenzene	0.07			
2-Propanone	0.02			
Trichlorotrifluoromethane			4.0	8.1
1,1-Dichloroethene				
2,2-Dimethylhexane				
1,5-Hexadiene				
2,2,4-Trimethylpentane				
2,2'-Dimethylethylene Oxide				
(1-Methylethyl) Cyclopropane				0.60
2-Pentanone				0.50
Oxygenated HC				8.1
Hydrocarbons				2.9

TABLE II

Analysis of Chemicals Collected on Charcoal, Ambersorb and Tenax
(All Units are in PPBV)

Organic Compound	Experiment 1 (Background)	Experiment 2 (Same as Expt. 1 But Sample Holder Contains Carbon GX 176)	Experiment 3 (Same as Expt. 2 But in Radiation Field 3.62 E6 Rads per Hour)	Experiment 4 (Same as Expt. 3 but Iodine Flowing into System)	Experiment 5 (Same as Expt. 4 but no Iodine Flow)
1,1,2-Trichloro-2,2,1-Trifluoroethane				0.16	
Methylene Chloride				1.50	2.0
1,1,1-Trichloroethane	3.00	3.20	4.10	5.40	
Benzene	1.70	2.00	2.60	3.40	
Toluene				.89	3.0
2-Propanone	2.80				
Trichlorotrifluoromethane	0.08	0.64	0.71	1.60	3.2
1,1-Dichloroethene					

TABLE II CONTINUED

Collection of Background Levels of Organic Compounds in Tenax, Tenax and Charcoal, and in Tenax, Ambersorb and Charcoal (All Units are in PPBV)

Organic Compound / Adsorbent / Vol. Collected, L	Tenax Lot # 18834 48 L	Tenax/Amb./ Charcoal Lot # 18835 48 L	Tenax Lot # 18972 15 L	Tenax/Amb./ Charcoal Lot # 18973 15 L
Methoxyethene				
1,1,2-Trichloro-2,2,1-Trifluoroethane			0.27	
Methylene Chloride	33	3.9	14	9.6
Hexane	0.88	0.46	1.1	0.91
1,1,1-Trichloroethane	13	2.7	6.6	7.0
Benzene	17	27	36	34
Heptane				
Trichloroethylene				
Toluene		14		1.8
Tetrachloroethylene				
Ethyl benzene				
O-Xylene				
P-Xylene				
2-Butoxyethanol				
1-Methylethylbenzene				
2-Propanone				5.2
Trichlorotrifluoromethane	1.7	0.19	1.3	0.48
1,1-Dichloroethene	1.4		0.63	
2,2-Dimethylhexane	3.0			
1,5-Hexadiene	0.24			
2,2,4-Trimethylpentane		0.80	1.5	1.1
2,2'-Dimethylethylene Oxide				
(1-Methylethyl) Cyclopropane				
2-Pentanone				
Oxygenated HC				
Hydrocarbons				

TABLE III
Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Carbon GX 176, Batch 8, Lot 3327)	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
Chlorodifluoromethane	5.9	3.5	23.00	7.3	6.3	9.0
Oxiranemethanol	0.77					0.26
Trichlorofluoromethane	0.96	5.7	3.8	1.8	0.71	
2-Propanone	0.88		12.00	9.9	0.69	
1,1,2-Trichloro-2,2,1-trifluoroethane	0.18	0.64	0.89	8.7	0.86	3.0
Methylene Chloride	8.7	17.00	73.00	7.9	7.3	13.00
Hexane	0.89		1.1	1.2	3.6	
Ethyl Acetate	0.86	46.00	1.4	2.5	4.6	
1,1,1-Trichloroethane	9.4	26.00	31.00	8.9	15.00	12.00
Benzene	0.41	23.00	1.4	0.77	0.77	0.82
2,2,4-Trimethyl pentane	0.39			0.44	0.61	1.2
Toluene	8.1	1.6		13.00	13.00	9.5
Propane		0.85	3.5			
1,1-Dichloroethene		1.5				
2-Ethyl-2(hydroxymethyl)-1,3-propanediol		22.00				
Trichloroethene		0.38				
Tetrachloroethene		0.25			0.08	
2,2-Dimethyl Oxetane			1.1			
Ethenyl Acetate			1.6			
3-Methyl Hexane			3.4			
3,4-Dimethyl Heptane			0.92			
3,5-Dimethyl Heptane		6.6				
Methyl Cyclohexane			2.3			
Hydrocarbon			13 ug/cu m			
2,2,3,4-Tetramethyl Pentane			2.0			
2-Methyl Propane				2.7		
Ethanol				7.1		
2-Methyl-2,4-Pentanediol				0.39		
2-Butanone				0.86		
2,3,4-Trimethyl Hexane				0.12		
Acetic Acid Anhydride					0.65	
3 Methyl Pentane					0.31	
3,4-Epoxy-2-Hexanone						0.24

TABLE IV
Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
Chlorodifluoromethane						
Oxiranemethanol	0.73		3.5	2.0		
Trichlorofluoromethane	0.44	2.9	2.6		0.36	5.0
2-Propanone	2.0	23.00	58.00	51.00	9.5	7.3
1,1,2-Trichloro-2,2,1-trifluoroethane	5.3	15.00	27.00			0.91
Methylene Chloride	2.1		15.00		2.3	45.00
Hexane	2.1	16.00			1.5	58.00
Ethyl Acetate						
1,1,1-Trichloroethane	1.0	48.00	93.00	1.2	0.93	9.2
Benzene	0.53	6.8	30.00			6.3
2,2,4-Trimethyl pentane			2.8		6.6	0.88
Toluene	1.3	2.9	21.00	16.00	24.00	26.00
Propane						
1,1-Dichloroethene		5.2	11.00			
2-Ethyl-2(hydroxymethyl)-1,3-propanediol						
Trichloroethene		1.6	6.7			
Tetrachloroethene			0.48		0.25	0.28
2,2-Dimethyl Oxetane						
Ethenyl Acetate						
3-Methyl Hexane		1.1			14.00	
3,4-Dimethyl Heptane			3.4	40.00		
3,5-Dimethyl Heptane				15.00		
Methyl Cyclohexane		1.2	4.3			
Hydrocarbon						
2,2,3,4-Tetramethyl Pentane						
2-Methyl Propane						
Ethanol		23.00	29.00			6.2
2-Methyl-2,4-Pentanediol						
2-Butanone						
2,3,4-Trimethyl Hexane				13.00	11.00	
Acetic Acid Anhydride						
3 Methyl Pentane		13.00				1.1
3,4-Epoxy-2-Hexanone						

TABLE IV CONTINUED

Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax
(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
1,2-Dichloroethene						0.35
(1-Methylethyl) cyclopropane	0.83	5.8				6.7
2,2,6-Trimethyl octane					0.59	0.42
2,2,3,4,6,6-Hexamethyl heptane					0.53	0.23
5-Methyl-5-propylnonane						0.22
Chloromethane	0.82					
1-(Ethenyloxy)-2-methylpropane	0.35					
2-Butene		23.00	6.3	6.5	3.3	
2-Methyl butane		28.00	20.00			
2-Methyl butane		16.00				
Diethylmethyleser borinicacid		22.00				
2-Ethyl-4-methyl-1-pentanol		0.64			1.2	
Heptane		0.88				
1,4 Dioxane		0.43	1.2			
2-Methyl-2-propene-1-01 acetate			18.00	6.3		
1,2-Propanediol			24.00			
3,3-Dimethyl pentane			32.00			
3-Methyl pentane			22.00			
Mixture 2,3 Butadione/2-Methyl pentane						
7-Methyl-1-octane			8.5			
5-Methyl-1-heptene			0.47			
4-Methyl nonane			7.2		85.00	
5-Methyl nonane			0.54		26.00	
1,3-Dimethyl cyclohexane			0.77		3.0	
1,2-Dimethyl cyclohexane			0.45			
1-Ethyl-1-methylcyclohexane			0.32			
Butyl cyclohexane			0.52			
2,3-Dimethyl hexane			0.37			
Difluoromethylsilane				7.8	1.7	
Dodecafluoropentane				0.53		
Iodomethane				11.00	6.5	
2-Propanol				5.6		
2-Methyl-2-propanol				5.3		

TABLE IV CONTINUED

Analysis of Chemicals Collected on Charcoal, Ambersorb, and Tenax

(All Units are in PPBV)

Organic Compound	RUN # 1 Background	RUN # 2 (Same as Run 1 But Sample Holder Contains Used Carbon 15021	RUN # 3 (Same as Run 2 But in Radiation Field 3.62 E6 Rads Per Hour	RUN # 4 (Same as Run 3 But Iodine Flowing Into System	RUN # 5 (Same as Run 4 But No Iodine Flow	RUN # 6 Control (Molecular Sieve Column Never Opened)
3-(Methylbutyl) cyclopentane					0.54	
4-Methyl octane					1.0	
2-Propenyl cyclohexane					5.4	
1,3,5-Trimethyl cyclohexane					1.1	
Ethyl benzene					2.7	
2,5,6-Trimethyl octane					1.9	
2,2,8-Trimethyl decane					0.59	

TABLE V

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 1. CHARCOAL BATCH 5340 (18.128 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	08:47	09:17	66	30	31	31	87	8.00E-10	12.6%	0.19
2 (Charcoal)	09:31	10:01	90	32	30	31	108	8.40E-10	9.6%	0.45
3 (Charcoal in Gamma)	10:29	10:59	98	32	33	35	109	9.21E-10	8.9%	4.80
4 (Iodine Introduced)	11:32									
(9.502 G in container)	12:25	12:55	51	32	32	71	68	2.44E-10	10.8%	13.00
5 (Residual Iodine)	14:00	14:30	94	31	32	70	106	5.26E-10	9.6%	3.20

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis by Electron Capture Chromatography**

EXPERIMENT 2. CHARCOAL BATCH 5338 (15.671 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:00	11:30	79	29	29	30	98	5.90E-10	.6%	ND
2 (Charcoal)	11:53	12:23	91	33	32	24	107	6.18E-10	.9%	ND
3 (Charcoal in Gamma)	12:35	13:05	99	31	30	38	115	6.63E-10	1.2%	0.16
4 (Iodine Introduced)	13:10									
(9.075 G in container)	14:12	14:42	51	29	30	50	73	2.21E-10		0.86
5 (Residual Iodine)	15:42	16:13	102	40	33	52	117	5.02E-10	10.8%	0.94

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

* *The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 3. CHARCOAL BATCH P.3 (22.7266 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:10	11:40	106	39	33	31	116	8.13E-10	1.3%	0.70
2 (Charcoal)	11:47	12:18	105	36	31	27	116	8.32E-10	1.2%	0.65
3 (Charcoal in Gamma)	12:35	13:05	108	38	31	38	118	8.32E-10	NO	0.74
4 (Iodine Introduced)	13:25									
(9.625 G in container)	14:32	15:02	71	65	32	37	52	3.40E-10	12.4%	0.95
5 (Residual Iodine)	16:21	16:51	53	38	33	63	83	8.17E-10	11.1%	0.99

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected NO = not observed

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 4. CHARCOAL BATCH K.2 (23.59745 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	10:03	10:33	74	32	30	29	91	6.88E-10	0.6%	0.23
2 (Charcoal)	10:43	11:13	96	41	34	23	106	7.35E-10	0.7%	0.29
3 (Charcoal in Gamma)	11:22	11:52	94	35	32	34	109	7.35E-10	1.2%	0.31
4 (Iodine Introduced)	11:54									
(11.03 G in container)	13:01	13:31	55	41	37	75	74	2.96E-10	1.3%	0.66
5 (Residual Iodine)	14:35	15:05	96	37	31	73	111	7.52E-10	9.8%	0.75

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iodododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (22.85725 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:44	12:14	93	31	29	27	108	6.71E-10	11.4%	1.80
2 (Charcoal)	12:29	12:59	99	37	31	27	109	6.75E-10	11.8%	1.80
3 (Charcoal in Gamma)	13:23	13:53	100	32	30	41	113	7.20E-10	10.4%	1.50
4 (Iodine Introduced)	15:01									
(10.03 G in container)	16:00	16:30	57	41	35	45	75	2.30E-10	8.7%	0.92
5 (Residual Iodine)	17:36	18:06	54	37	32	42	77	7.70E-10	8.7%	0.70

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis by Electron Capture Chromatography**

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (17.95295 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	10:43	11:13	28	29	28	28	28	6.70E-10	.1%	3.30
2 (Charcoal)	11:18	11:48	33	29	28	28	44	6.70E-10	.1%	2.40
3 (Charcoal in Gamma)	12:00	12:30	57	31	30	38	72	6.93E-10	.1%	1.80
4 (Iodine Introduced)	12:32									
(10.04 G in container)	13:35	14:05	70	68	30	36	53	3.37E-10	.4%	2.50
5 (Residual Iodine)	15:05	15:35	56	39	31	69	80	6.62E-10	1.8%	1.80

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE V CONTINUED

*Methyl Iodide Analysis By Electron Capture Chromatography**

EXPERIMENT 7. CHARCOAL BATCH 15021 (20.8699 GRAMS USED)

Run #	Time On	Time Off	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity	Methyl Iodide ppbv
Control										ND
1 (Background)	11:24	11:54	90	35	29	28	100	7.47E-10	.4%	8.00
2 (Charcoal)	12:05	12:35	56	34	30	24	52	7.47E-10	.4%	2.50
3 (Charcoal in Gamma)	13:01	13:31	36	31	30	32	38	7.20E-10	1.0%	1.80
4 (Iodine Introduced)	13:35									
(9.238 G in container)	14:30	15:00	42	34	31	71	44	2.57E-10	1.0%	1.60
5 (Residual Iodine)	16:04	16:34	37	31	30	77	49	6.12E-10	12%	4.60

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the Mixing Chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

ND = not detected

**The following substances were analyzed for but were not detected: Ethyl Iodide, Iodopropane, Iodopropene, Iodobutane, Iodopentane, Iodohexane, Iodobenzene, Iodotoluene, Iododecane*

TABLE VI

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 1. CHARCOAL BATCH 5340 (17.4622 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:43	30 MIN	55	28	29	25	45	1.53E-08	100	0.2408
2 (Charcoal)	11:39		61	31	30	32	49	1.49E-08	91	5.934
3 (Charcoal in Gamma)	12:21		74	33	30	45	53	1.46E-08	91	12.642
4 (Iodine Introduced)	13:16									
1.0015 G in container	14:16		73	39	30	78	53	1.24E-08	92	52.7524
5 (Residual Iodine)	15:38		71	40	31	83	53	1.23E-08	93	155.0236
6 (condensate collected)	10:43	(cumulative)								7.224

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 2. CHARCOAL BATCH 5338 (16.2249 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:18	30 MIN	73	34	29	31	78	1.33E-08	100	1.8232
2 (Charcoal)	11:07		72	31	29	37	84	1.23E-08	100	0.4472
3 (Charcoal in Gamma)	11:46		71	37	29	52	83	1.24E-08	98	0.4472
4 (Iodine Introduced)	12:16									
1.001 G in container	13:16		70	39	30	66	78	1.29E-08	96	3.1476
5 (Residual Iodine)	14:48		71	39	30	67	79	1.29E-08	96	4.2656
6 (condensate collected)	10:18	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 3. CHARCOAL BATCH P.3 (23.8185 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:33	30 MIN	72	33	30	32	84	1.31E-08	93	0.1032
2 (Charcoal)	11:14		70	34	30	40	84	1.35E-08	92	nd
3 (Charcoal in Gamma)	12:06		71	33	31	35	89	1.36E-08	95	1.2212
4 (IodinIodine introduced	12:41									
1.0000 G in container	13:42		72	33	31	58	80	1.29E-08	96	2.5112
5 (Residual Iodine)	15:12		72	34	33	61	81	1.35E-08	93	2.494
6 (condensate collected)	10:33	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 4. CHARCOAL BATCH K.2 (22.5374 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:38	30 MIN	73	31	31	37	86	1.28E-08	96	nd
2 (Charcoal)	10:28		73	31	30	33	86	1.39E-08	93	nd
3 (Charcoal in Gamma)	11:23		71	31	30	43	87	1.38E-08	91	1.0148
4 (Iodine Introduced)	12:24									
1.001 G in container	13:24		74	32	31	68	86	1.32E-08	92	2.6144
5 (Residual Iodine)	14:54		73	32	31	63	89	1.20E-08	94	2.7692
6 (condensate collected)	09:38	(cumulative)								3.8184

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (24.8596 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:59	30 MIN	72	31	31	44	84	1.12E-08	97	nd
2 (Charcoal)	10:57		72	31	32	37	85	1.23E-08	97	nd
3 (Charcoal in Gamma)	11:39		71	31	31	44	85	1.22E-08	98	1.2212
4 (Iodine Introduced)	12:10									
1.0012 G in container	13:12		74	31	31	61	85	1.22E-08	98	3.0272
5 (Residual Iodine)	14:42		72	32	32	68	86	1.30E-08	100	1.4964
6 (condensate collected)	09:59	(cumulative)								26.144

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (20.1721 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:12	30 MIN	71	32	32	44	88	1.16E-08	98	nd
2 (Charcoal)	10:01		72	32	32	49	86	1.25E-08	97	nd
3 (Charcoal in Gamma)	10:38		71	32	32	45	86	1.34E-08	97	0.4988
4 (Iodine Introduced)	11:52									
1.001 G in container	12:52		72	33	33	59	80	1.26E-08	97	0.4816
5 (Residual Iodine)	14:26		72	34	33	62	88	1.32E-08	98	0.5504
6 (condensate collected)	09:12	(cumulative)								nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VI CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(High Humidity Conditions)

EXPERIMENT 7, CHARCOAL BATCH 15021 (22.5068 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:06	30 MIN	74	41	34	42	86	1.39E-08	98	nd
2 (Charcoal)	10:47		75	37	33	48	86	1.35E-08	98	nd
3 (Charcoal in Gamma)	11:19		73	34	35	48	86	1.30E-08	96	0.7568
4 (Iodine Introduced)	12:16									
1.0003 G in container	13:16		76	35	36	65	86	1.29E-08	96	2.9584
5 (Residual Iodine)	14:46		75	35	36	67	86	1.33E-08	96	4.8504
6 (condensate collected)	10:06	(cumulative)								1.7372

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII
Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 1. CHARCOAL BATCH 5340 (15.8585 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:45	30 MIN	41	29	28	28	55	9.02E-09	0.7	nd
2 (Charcoal)	11:53		49	31	31	27	60	8.97E-09	0.7	0.40
3 (Charcoal in Gamma)	12:30		48	29	29	39	59	8.52E-09	0.6	3.14
4 (Iodine Introduced)	13:06									
0.5000 G in container	14:06		43	32	29	68	49	8.46E-09	9.7	5.06
5 (Residual Iodine)	15:36		48	33	31	70	58	8.83E-09	17.6	2.44

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 2. CHARCOAL BATCH 5338 (17.2389 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:22	30 MIN	54	29	29	28	69	9.85E-09	0.2	nd
2 (Charcoal)	11:01		49	29	29	28	57	9.85E-09	0.2	nd
3 (Charcoal in Gamma)	11:46		48	30	27	41	57	9.72E-09	0.3	0.17
4 (Iodine Introduced)	12:17									
0.5025 G in container	13:18		43	33	29	68	48	8.36E-09	0.3	nd
5 (Residual Iodine)	12:58		49	34	30	68	60	8.34E-09	1.1	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D
Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 3. CHARCOAL BATCH P.3 (23.3151 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:55	30 MIN	47	32	32	30	60	8.75E-09	0.5	nd
2 (Charcoal)	11:03		47	32	30	25	60	8.99E-09	0.5	0.14
3 (Charcoal in Gamma)	11.39		48	33	33	60	60	9.01E-09	0.7	0.07
4 (IodinIodine introduced	12:13									
0.5041 G in container	13:13		44	34	31	64	50	8.28E-09	1.2	0.03
5 (Residual Iodine)	14:43		51	36	34	65	61	9.54E-09	12.0	0.07

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D

Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 4. CHARCOAL BATCH K.2 (21.6936 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:32	30 MIN	44	28	27	27	56	9.85E-09	0.1	nd
2 (Charcoal)	10:50		44	29	26	22	55	9.86E-09	0.1	nd
3 (Charcoal in Gamma)	11:34		45	29	27	61	57	9.98E-09	0.1	0.40
4 (Iodine Introduced)	12:23									
0.5032 G in container	13:23		40	31	28	65	46	8.64E-09	1.2	2.10
5 (Residual Iodine)	14:58		46	31	28	65	58	8.61E-09	1.2	2.10

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D
Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 5. CHARCOAL BATCH 15732 C.6 (24.1689 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	10:23	30 MIN	41	25	28	28	52	8.87E-09	0.6	nd
2 (Charcoal)	10:59		43	27	28	25	54	8.87E-09	0.3	nd
3 (Charcoal in Gamma)	12:09		47	31	29	56	58	9.06E-09	0.3	0.31
4 (Iodine Introduced)	12:44									
0.5074 G in container	13:50		45	32	28	63	54	8.12E-09	0.3	0.80
5 (Residual Iodine)	15:25		46	32	26	64	59	8.76E-09	0.3	0.58

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D
Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 6. CHARCOAL BATCH 2U8.2 (19.4761 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:38	30 MIN	46	29	28	28	56	8.62E-09	0.4	nd
2 (Charcoal)	11:40		47	29	28	28	58	8.62E-09	0.4	nd
3 (Charcoal in Gamma)	12:12		48	32	29	53	56	8.54E-09	0.4	nd
4 (Iodine Introduced)	12:44									
0.5146 G in container	13:50		45	32	29	62	48	7.80E-09	0.5	nd
5 (Residual Iodine)	15:22		49	33	30	62	62	8.02E-09	0.6	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected

TABLE VII CONT'D
Methyl Iodide Analysis By Electron
Capture Chromatography
(Low Humidity Conditions)

EXPERIMENT 7. CHARCOAL BATCH 15021 (20.8784 GRAMS USED)

RUN #	START	SAMPLE TIME	TC1	TC 2	TC 3	TC 4	TC 5	Current Amps	Humidity Percent	Methyl Iodide ppbv
(Control)										nd
1 (Background)	09:31	30 MIN	49	33	33	28	60	1.02E-08	0.1	nd
2 (Charcoal)	10:06		50	34	35	22	60	1.02E-08	0.1	nd
3 (Charcoal in Gamma)	10:46		52	36	36	58	61	1.00E-08	0.1	0.45
4 (Iodine Introduced)	11:27									
0.5005 G in container	12:27		43	35	34	60	50	8.44E-09	0.1	0.40
5 (Residual Iodine)	14:01		53	38	35	61	63	8.28E-09	0.1	nd

All temperatures in degrees Celsius

TC 1 (Type K thermocouple located in the internal volume of the mixing chamber)

TC 2 (Type K thermocouple located in the return from the charcoal bed)

TC 3 (Type K thermocouple measuring room temperature)

TC 4 (Type T thermocouple located in the charcoal bed)

TC 5 (Type T thermocouple measuring surface temperature of the mixing chamber)

nd = not detected