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Re: United States v. Reilly Tar & Chemical Corp.
No. 4-80-469 (D. Minn.)

Dear Gentlemen:

Enclosed please find the expert witness statements of Joanna Hall, Denis Foerst, and Brenda Kimble (Part I). Dr. Carnow and Mr. Huidrobro's statements will be provided subsequently in accordance with my letter of December 28. Two additional experts, Viorica Lopez-Avila and Ted Willhite of the Acurex Corporation will testify about new data whch is presently being collected and analyzed by Acurex. Their statements will be presented at the time designated in the Case Management Order for statements dealing with new data.

Sincerely yours,

Assistant Attorney General
Land and Natural Resources Division

David Hird

By: David Hird, Attorney
Environmental Enforcement Section

Enclosure

Expert Witness Statement of Denis Foerst

I have reviewed analytical data at CH_2M Hill at Montgomery, Alabama, concerning the analyses performed on wells around St. Louis Park, Minnesota.

The laboratory followed the provisions of their Quality Assurance Project Plan (Attachment A dated September 8, 1982). The conclusions in my memo to Mike Harris (attachment B dated June 23, 1983) are valid concerning the performance of the laboratory regarding PAH analyses.

While in Montgomery, I reviewed raw data, standards and laboratory worksheets. Special attention was given to:

3421G	Blank	9-21-82	Attachment C	14 pages
3421A	SLP-4	9-21-82	Attachment D	13 pages
3421P	SLP-15	9-24-82	Attachment E	26 pages
STDS			Attachment F	7 pages

The results reported by the lab represent the concentration of PAH compounds in the samples. Because of the constraints of using an MDL (Method Detection Limit) the laboratory occasionally reported BMDL (below Method Detection Limit) for some PAH compounds which indeed may have been present. This error of the second kind is to be expected when analyzing samples at low levels and is acceptable.

Based upon this review, I am prepared to testify that the laboratories results are valid and represent the concentrations of PNA compounds in the samples.

Quality Assurance Project Plan for the Measurement of PAH Compounds at ng/L Levels by Gas Chromatography/Mass Spectrometry

Prepared for CH_2M Hill

Denis L. Foerst, Research Chemist
Organic Analyses Section
Physical and Chemical Methods Branch

Robert L. Booth, Acting QA Officer
Environmental Monitoring and Support
Laboratory - Cincinnati

ATTACHMENT A

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3. PROJECT DESCRIPTION

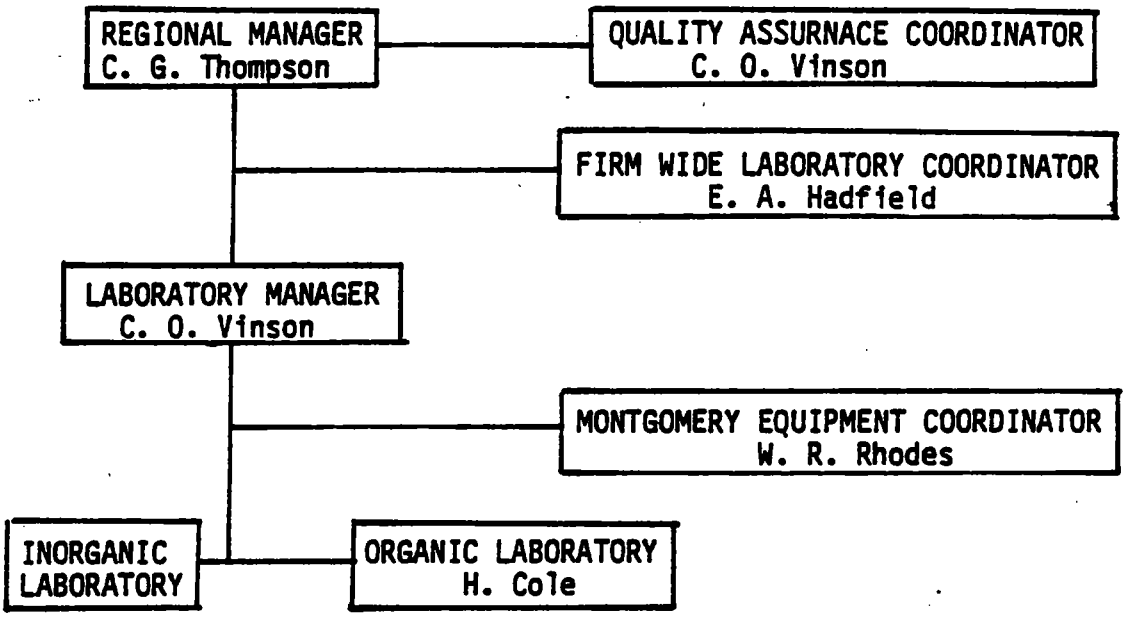
CH_2M Hill is to conduct a project to measure the PAH concentration at ng/L levels in:

- the ground water in the vicinity of Saint Louis Park, Minnesota,
- the influent, the effluent, and various stages of the existing treatment facility,
- various stages during a series of bench scale treatments,
- the influent and effluent of a pilot plant during a 30 day study.

The analytical procedure involves the serial extraction of the aqueous sample with methylene chloride at pH >11 and then pH <2, concentration, and analysis via capillary column gas chromatography/mass spectrometry (GC/MS).

The anticipated sampling schedule is given in Table 1. The target compounds are listed in Table 2. The PAH measurement data will be used to judge the treatability of the selected treatment process.

4. PROJECT ORGANIZATION AND RESPONSIBILITY



4.1 The Regional Manager will review all QA data with the Laboratory Manager on a quarterly basis.

4.2 The Laboratory Manager is responsible for the continuity and control of the QA program.

4.3 The Quality Assurance Coordinator is responsible for:

4.3.1 Logging samples and introducing control samples.
4.3.2 Monitoring QA activities.
4.3.3 Informing the staff and management of non conformance to the QA program.
4.3.4 Reviews purchased materials to ensure that quality materials are purchased.
4.3.5 Receives data prior to reporting and maintains QA documents.

5. QA OBJECTIVES FOR PAH MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS AND METHOD DETECTION LIMITS

5.1 The QA objective for precision is an average relative range for duplicate analyses of less than 30% at a 95% confidence level. The preliminary validation study indicates that the relative standard deviation of laboratory control standards exhibits a slight concentration dependence (Figure 1).

5.2 The QA objective for accuracy is an average bias for the spiked samples of less than 25%. The preliminary validation study exhibited an average bias of -8% and -18% for 15 PAH compounds for true values of 10 ng/L and 25 ng/L, respectively and an average bias of -3% for 27 compounds at a nominal value of 4 ng/L.

5.3 The QA objective for completeness is 90%. No more than 10% of the data is to be ruled invalid due to QA/QC checks on the overall system performance.

5.4 The QA objective for method detection limit (MDL) is an average MDL of less than 5 ng/L. The validation study gave an average MDL of 1.2 ng/L for the 27 compounds listed in Table 3.

6. SAMPLING PROCEDURE

6.1 Method 624, purgeables, requires a duplicate sample to be collected and preserved with acid if analysis is to be performed between 7 and 14 days after collection due to the potential biological degradation of benzene, toluene, and ethylbenzene. If not acid preserved, the purgeable samples must be analyzed within 7 days.

6.2 The PNA compounds are susceptible to photodegradation, therefore, amber containers or foil wrapped containers must be used. Extraction must be completed within 7 days of collection. Extracts must be analyzed within 40 days of extraction.

6.3 Sample containers must be scrupulously cleaned. All sample containers are to be washed with detergent, rinsed with tap water, reagent water, and set aside to dry. PNA sample containers, after drying, are rinsed with a polar and a non-polar organic solvent and again set aside to dry before use.

6.4 Triplicates, duplicates and field blanks are included in each set of samples as scheduled on Table 1. The field blank is sent from the lab to the field and back to the laboratory with the other samples.

6.5 The composition of the duplicates and triplicates must be homogenous. Collect these samples in as short a period of time as possible. Fill each bottle of a duplicate or a triplicate set by sequential thirds to ensure homogeneity.

6.6 When sampling inactive wells, record the number of well volumes that have been pumped prior to filling an individual sample. A minimum of 10 casing volumes should be pumped before collecting a sample.

6.7 When sampling an active well, record the number of gallons pumped in the previous 24 hours.

6.8 The specific sample tag is illustrated in Figure 2.

6.9 Field records must be completed at the time the samples are collected. The records must be signed or initialed including the date and time by each member of the sampling team. A Field Tracking Report Form is given in Figure 4.

7. SAMPLE CUSTODY

7.1 Chain of custody procedures will apply to all samples. A chain of Custody Record form is given in Figure 5. All entries are to be completed in indelible ink. Dean Malotky is the field sampling team leader.

7.2 The original chain of custody record is sealed in a watertight plastic sandwich bag and shipped inside the sealed transportation case. A copy of the record is retained by the sampling team.

7.3 The samples are shipped to Harold Cole, the designated custodian at CH_2M Hill. A permanent log book will be kept describing the samples as received. Log book entries are to include; the person delivering the sample, date and time received, source of sample, sample ID or log number, mode of transport, and the condition of the sample as received.

7.4 Samples are to be stored in the custody room, a securely locked area. Only the custodian is to deliver samples to the laboratory personnel. The laboratory is to be maintained as a secured area, restricted to authorized personnel only. Laboratory personnel are responsible for the care and custody of the sample after being received from the custodian. The sample must always be in the possession or view of the laboratory personnel or secured in the laboratory at all times until analysis is completed.

7.5 The unused portion of the sample, if any, and all identifying labels must be returned to the custodian. The custodian will retain unused portions of the sample until the State's Authorized Agent, Michael J. Hansel, authorizes that the unused samples are to be destroyed.

8. CALIBRATION PROCEDURES AND FREQUENCY

8.1 The procedures for internal standard or external standard calibration are described in methods 624 and 625. The laboratory is responsible for demonstrating the linear range and the linearity of the calibration curve. If the concentration level of a target compound exceeds the linear range, the extract is diluted and reanalyzed for that compound.

8.2 The calibration of the GC/MS system is to be verified each day by 1) achieving the DFTPP or BFB key ion abundance criteria as appropriate, 2) achieving the benzidine or pentachlorophenol tailing factor criteria as appropriate, and 3) chromatographing an aliquot of the standard solution that contains the appropriate target compounds and updating the response factors if necessary.

8.3 Sources of the individual target compounds are given in Table 2. The source, purity, lot number, and certificate of true values for standard solutions will be recorded.

9. ANALYTICAL PROCEDURES

9.1 Method 624 is to be used without change for the analysis of the purgeable samples.

9.2 The PNA compounds are analyzed using a procedure developed at CH_2M Hill. This procedure is very similar to method 625 with the following exceptions:

9.2.1 Two surrogate standards are used instead of three.

9.2.2. The volume of the final extract is 0.02 mL instead of 1.00 mL.

9.2.3 The internal standards are added just prior to the final concentration, subsequent analysis is performed immediately after this concentration. Method 625 calls for adding the internal standards just prior to analysis.

9.2.4 The retention time agreement is to be ± 10 sec. instead of ± 30 sec.

9.2.5 The MDL for the priority pollutant PNAs average less than 5 ng/L. Method 625 gives an average MDL of 3200 ng/L for the priority pollutant PNAs.

Bis/ether [800 fold] Volume is 2-L.

State disc. regs. — clean/dirty matrices.

10. DATA ANALYSIS, VALIDATION AND REPORTING

10.1 The area of each PNA internal standard (IS) is used to judge the validity of the assay step. The area of d-8 naphthalene and d-10 anthracene must be greater than 20,000 counts and for d-12 chrysene, greater than 10,000 counts. If the area is less than that required, the GC/MS system must be retuned or the sample must be reanalyzed after additional concentration.

10.2 The recovery of the surrogate compounds is used to judge the validity of the sample processing steps. The surrogate standard recovery statistics are to be updated weekly to establish the control limits of R ± 3s. The sample processing steps are valid if the recovery for the surrogate compounds falls within the control limits.

10.3 The equations in Section 7 and 15 of Method 625 are to be used to calculate the concentration of the target compounds. Report "not detected" if the calculated concentration is less than the MDL. Report the MDL concentration if the calculated concentration is between the MDL and two times the MDL. Report the concentration in µg/L for purgeables or in ng/L for the PNAs if the calculated concentration is greater than two times the MDL.

11. INTERNAL QUALITY CONTROL CHECKS

11.1 Field Blanks -- One field blank is included with each sample set. Once received back in the laboratory, the field blank is treated and an authentic sample and is used to monitor for contamination during transport and sampling.

11.2 Laboratory Blanks -- A laboratory blank is analyzed whenever a field blank indicates the possibility of contamination or whenever a new lot of solvents is first used.

11.3 Surrogate Standards -- All samples, including blanks, are spiked with the surrogate standards prior to extraction and are used to monitor the sample processing steps. The surrogate standards are 1-fluoronaphthalene and 2,4,6-tribromophenol..

11.4 Internal Standards -- All extracts are spiked with the internal standards just prior to the final concentration. The internal standards are d-8 naphthalene, d-10 anthracene, d-12 chrysene, 2-fluorobiphenyl, and d-5 phenol.

11.5 Duplicates and Spiked Samples -- The duplicate pairs are used to give overall precision of the data in both a relatively clean and a contaminated matrix. The third sample of the triplicate is used to give spiked recovery or accuracy data. The background concentration is the mean value from the two unspiked samples of the triplicate. Since the spiked samples should always be relatively clean samples, a constant amount (100 ng) of each target compound should be used in all spiked samples.

11.6 Refereed Samples -- Samples sent out to the referee laboratories should include a field blank and a triplicate so that interlaboratory precision and accuracy can be compared. Capsule Labs will analyze samples using GC/MS, (modified Method 625), the Minnesota Department of Health will analyze samples using HPLC (modified Method 610), and EMSL-Cincinnati will analyze samples using HPLC method 610 and GC/MS method 625.

11.7 Quality Control Check Samples -- The analytical laboratories must compare calibration standards with the EPA QC check samples at least once during this study.

12. PERFORMANCE AND SYSTEM AUDITS

12.1 Not applicable. No formal certification program or relevant interlaboratory performance evaluation study is available or planned for these compounds at the concentrations of interest. The data from the preliminary validation study will indirectly serve as the performance and system audits.

13. PREVENTIVE MAINTENANCE

Not applicable -- The system performance checks will show whether the participants' analytical systems are operable or not; the length of time necessary to do the required research does not warrant mandatory preventive maintenance programs. However, if any maintenance is performed - during the time frame of the project - then, that maintenance must be documented.

14. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND OUTLIERS

14.1 Precision -- The percent relative range (%RR) is used to assess the precision of the PAH measurements and is calculated using Equation 1.

Equation 1
$$\% RR = \frac{2 * |X_1 - X_2|}{(X_1 + X_2)} * 100$$

Where: $|X_1 - X_2|$ is the absolute value of the difference between the duplicate results

The overall precision of the data set at the 95% confidence level is calculated from the average of all the %RR values using Equation 2.

Equation 2
$$\bar{P}_{95} = 2.51 * \frac{\sum_{i=1}^{n} \%RR_i}{n}$$

Where: $\%RR_i$ is each individual percent relative range
n = the number of duplicates

$\bar{P}_{95}$ = 95% confidence level of the average precision

14.2 Accuracy -- The accuracy of the data set is determined from the analysis of the spiked samples. The accuracy for each PAH compound is calculated using Equation 3.

Equation 3
$$A = 100 \frac{(Z - \bar{X})}{T}$$

Where: Z - is the analytical result in ng/L for the spiked sample

$\bar{X}$ - is the mean background concentration from the duplicate results

T - is the true value of the added spike

A - is the recovery for the added spike

The overall accuracy for each compound is the arithmetic mean over all the spiked samples, Equation 4.

Equation 4 $\bar{A}j = \dfrac{\sum_{i=1}^{n} Aij}{n}$

Where: Aij - is each recovery value for compound j

n - is the number of spiked samples

$\bar{A}j$ - is the average recovery for compound j

The 95% confidence level for each mean recovery is computed using equation 5.

Equation 5 $CL_{95} = \bar{A}_j \pm t(n-1, \alpha = 0.05) \cdot S$

Where: $t(n-1, \alpha = 0.05)$ is the appropriate two tailed students' t at $\alpha = 0.05$

S - is the standard deviation associated with $\bar{A}_j$

CL_{95} - is the upper and lower 95% confidence limits of A_j

14.3 Outliers -- An outlier is an extreme value, high or low, which has questionable validity as a member of the measurement set with which it is associated. Outliers may be rejected from the data set for the following reasons.

14.3.1 A known experimental aberration occurred, such as instrument failure or there was an inconsistency in the procedure or technique.

14.3.2 The t value for the datum is larger than the tabulated two tailed students' t for $\alpha = 0.05$ at n-1 degrees of freedom. The t value is calculated using Equation 6.

Equation 6 $t = \dfrac{(Xi - \bar{X})}{S}$

Where: X_i - is the extreme value being tested

$\bar{X}$ - is the mean of the measurement set for n observations

S - is the standard deviation associated with $\bar{X}$

If a value is rejected, the mean ($\bar{X}$) and standard deviation are recalculated using the remaining data. This procedure can be reiterated using the next extreme value until no outliers remain.

15. CORRECTIVE ACTION

15.1 Corrective action is initiated whenever the system is out of control. The following criteria are used to indicate out of control situations.

15.1.1 The area of either d-8 naphthalene or d-10 anthracene internal standard is < 20,000 counts or the area of d-12 chrysene internal standard is <10,000 counts.

15.1.2 The recovery of a surrogate standard falls outside the range of R ± 3s when R is the mean recovery and s is its associated standard deviation. This range is from 70% to 118% for 1-fluoronaphthalene at the beginning of this study and should be updated on a weekly basis.

15.1.3 The percent relative range for a given analyte of a duplicate pair exceeds 40% and the range is larger than the MDL for that analyte. This control limit is calculated using Equation 2 but substituting 3.27 for the constant 2.51 and should be updated after every fifth duplicate pair is analyzed.

15.1.4 The recovery for a spiked sample falls outside the range of $A_j \pm t(n-1, \alpha = .01)*S$ where $t(n-1, \alpha = 0.01)$ is the 99% two tailed t value for n-1 degrees of freedom. This range is from 48% to 118% at for all compounds the beginning of the study and should be updated for each compound after every fifth spike sample is analyzed.

15.2 If the out of control situation is due to an instrumental problem, the sample is reanalyzed after corrective action is completed. Results from the out of control analysis are discarded if the new analysis gives values that are in control.

15.3 If the out of control situation is due to other than instrumental problems, all samples analyzed between the last in control and present out of control sample are declared suspect and should be reanalyzed to ensure the validity of the data. This is just the out of control sample for the criteria in sections 15.1.1 and 15.1.2, and all samples run since the last in control duplicate for the criterion section 15.1.3, and all samples run since the last in control spike sample for the criterion in 15.1.4.

15.4 A log will be kept describing the out of control situations and the corrective action taken to remedy the situation.

16. QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 The analyst will identify and report any significant QA problems and recommend remedial steps to correct the problems.

16.2 At the end of the study, a report will be made that identifies the frequency of out of control situations and the necessary corrective action, the overall precision and accuracy of the data set, and the individual outliers.

TABLE 1

ANTICIPATED SAMPLING SCHEDULE

Sample Set	Source	No. of Samples	Field Blanks	Duplicate	Triplicate/Spike[a]
1	Wells (12) and existing treatment (6)	18	1	1	1
2	Wells (12) and bench test (6)	18	1	1	1
3	Bench test	18	1	1	1
4	Bench test	18	1	1	1
5	Bench test	16	1	1	1
6	Bench test	16	1	1	1
7	Bench test	16	1	1	1
8	Wells (3) and pilot test (4)	7	1	1	1
9	Pilot test	4	1	-	-
10	Pilot test	4	1	1	1
11	Pilot test	4	1	-	-
12	Pilot test	4	1	1	1
13	Pilot test	4	1	-	-
14	Pilot test	4	1	1	1
15	Pilot test	4	1	-	-
16	Pilot test	4	1	1	1
17	Pilot test	4	1	-	-
	TOTAL	163	17	12	12
	GRAND TOTAL	204 analyses			

[a] One of the triplicates is spiked at the lab to give the spiked sample.

TABLE 2

TARGET COMPOUNDS FOR GC/MS ANALYSES

Compound	CAS	IONS Primary	IONS Secondary	Source*
PNAs				
Acenaphthene	83-32-9	154	153,152	E,N,R
Acenaphthylene	208-96-8	152	151,153	E,N,R
Anthracene	120-12-7	178	179,176	E,N,R
Benzo(a)anthracene	56-55-3	228	229,226	E,N,R
Benzo(b)fluoranthene	205-99-2	252	253,125	E,N,R
Benzo(k)fluoranthene	207-08-9	252	253,125	E,N,R
Benzo(g,h,i)perylene	191-24-2	276	138,277	E,N
Benzo(a)pyrene	50-32-8	252	250,125	E,N,R
Benzo(e)pyrene	192-97-2	252	250,125	A,S
Chrysene	218-01-9	228	226,229	E,N,R
Dibenzo(a,h)anthracene	53-70-3	278	139,279	E,N
Fluoranthene	206-44-0	202	101,100	E,N,R
Fluorene	86-73-7	166	165,167	N,R
Indeno(1,2,3-cd)pyrene	193-39-5	276	138,277	N
1-Methylnaphthalene	90-12-0	142	141,115	A
2-Methylnaphthalene	91-57-6	142	141,115	A
Naphthalene	91-20-3	128	129,127	E,N,R
Perylene	198-55-0	252	250,126	A,S
Phenanthrene	85-01-8	178	179,176	E,N,R
Pyrene	129-00-0	202	101,100	E,N,R
NITROGEN HETEROCYCLES				
Acridine	260-94-6	179	178,89	A,S
Carbazole	86-74-8	167	166,139	A,S
Indole	120-72-9	117	90,89	A,S
Phenanthridine	229-87-8	179	178,151	A
Quinoline	91-22-5	129	102,128	A

Table 2. Continued

Compound	CAS	IONS Primary	IONS Secondary	Source*
SULFUR HETEROCYCLES				
Benzo(b)thiophene	95-15-8	134	135,89	A
MISCELLANEOUS				
Biphenyl	92-52-4	154	153,76	A
2,3-Dihydroindene	496-11-7	117	118,91	A
Indene	95-13-6	116	115,89	A
AROMATIC AMINES**				

* E - EPA QC Check Samples
N - NBS SRM-1647
R - EPA Repository Radian
A - Aldrich Chemical, Milwaukee, WI.
S - Sigma Chemical, St. Louis, Mo.

** Up to 3; to be chosen after first round of testing.

TABLE 3

MDL DATA FROM VALIDATION STUDY

Compound	Spike ng/L[a]	Mean	Percent Recovery	Std. Dev.	MDL[b]	Critical F-Ratio[c] 8.94	Critical F-Ratio[c] 4.76	MDL (ng/L)
PNAs								
Acenaphthene	25	20.4	82	1.54	4.8			
	10	8.3	83	0.39	1.8	15.6		
	4	4.5	113	0.53	1.7		1.84	1.3[d]
Acenaphthylene	25	19.9	80	1.22	3.8			
	10	7.4	74	0.39	1.8	9.78		
	4	4.3	107	0.36	1.1		1.17	1.0[d]
Anthracene	25	18.1	72	3.99	12.6			
	10	8.0	80	0.70	3.1	32.5		
	4	3.3	83	0.10	0.3		49.0	0.3
Benzo(a)anthracene	25	21.6	86	3.10	9.7			
	10	10.9	109	1.00	4.5	9.61		
	4	4.2	104	0.23	0.7		18.9	0.7
Benzo(b)fluor-anthene	25	22.0	88	2.81	8.8			
	10	10.9	109	0.20	0.9	197.		0.9
	4	e	e	e	e		e	
Benzo(ghi)perylene	25	19.9	80	2.66	8.4			
	10	8.9	89	0.95	4.3	7.84		
	4	2.4	59	0.32	1.0		8.81	1.0
Benzo(a)pyrene	25	17.8	71	5.48	17.2			
	10	8.3	83	0.96	4.4	32.6		
	4	3.4	86	0.32	1.0		9.0	1.0
Chrysene	25	19.6	67	3.71	11.7			
	10	9.5	95	0.50	2.3	55.		
	4	3.8	95	0.31	1.0		2.60	1.0[d]
Dibenzo(a,h)-anthracene	25	19.7	79	2.78	8.7			
	10	9.2	92	1.20	5.4	5.37		
	4	2.5	63	0.44	1.4		7.43	1.4

TABLE 3, Continued

MDL DATA FROM VALIDATION STUDY

Compound	Spike ng/L[a]	Mean	Percent Recovery	Std. Dev.	MDL[b]	Critical F-Ratio[c] 8.94	Critical F-Ratio[c] 4.76	MDL (ng/L)
Fluoranthene	25	23.1	93	2.33	7.3			
	10	9.4	94	1.20	5.4	3.77		
	4	4.1	102	0.26	0.8		21.3	0.8
Fluorene	25	22.5	90	1.21	4.2			
	10	7.6	76	1.00	4.5	1.46		
	4	4.4	109	0.44	1.4		5.16	1.4
Indeno(1,2,3-cd)-pyrene	25	20.3	81	2.39	7.5			
	10	8.8	88	0.90	4.1	7.05		
	4	2.6	64	0.44	1.4		4.18	1.7[d]
1-Methyl-naphthalene	4.5	4.5	100	0.65	2.0	-	-	2.0
2-Methyl-naphthalene	7.2	6.2	86	0.39	1.2	-	-	1.2
Naphthalene	25	20.1	80	3.71	11.7			
	10	9.3	93	1.40	6.4	7.02		
	4	4.4	110	0.59	1.9		5.63	1.9
Perylene	4	3.1	78	0.31	1.0	-	-	1.0
Phenanthrene	25	20.4	81	3.35	10.5			
	10	9.8	98	3.00	13.6	1.24		
	4	4.0	101	0.13	0.4		56.3	0.4
Pyrene	25	24.0	96	2.31	7.3			
	10	11.4	114	1.00	4.5	5.34		
	4	4.4	110	0.29	0.9		11.9	0.9

TABLE 3, Continued

MDL DATA FROM VALIDATION STUDY

Compound	Spike ng/L[a]	Mean	Percent Recovery	Std. Dev.	MDL[b]	Critical F-Ratio[c] 8.94	4.76	MDL (ng/L)
NITROGEN HETEROCYCLES								
Acridine	4	3.6	90	0.59	1.8	-	-	1.8
Carbazole	4	3.7	93	0.34	1.1	-	-	1.1
Indole	4	5.7	143	0.93	2.9	-	-	2.9
Phenanthridine	4	4.0	99	0.46	1.4	-	-	1.4
Quinoline	5.5	6.4	116	0.22	0.7	-	-	0.7
SULFUR HETEROCYCLES								
Benzo(b)thiophene	4	3.8	95	0.21	0.7	-	-	0.7
MISCELLANEOUS								
Biphenyl	4	4.0	100	0.22	0.7	-	-	0.7
2,3-Dihydroiadene	4.3	3.5	81	0.43	1.4	-	-	1.4
Indene	4.4	3.6	82	0.21	0.7	-	-	0.7
							Average	1.2

a) Seven replicates at 25 ng/L and 4 ng/L, four replicates at 10 ng/L.
b) MDL = STD DEV* 3.143 at 25 ng/L and 4 ng/L; MDL = Std. Dev.* 4.541 at 10 ng/L
c) Pool the two most recent MDLs if F-ratio < critical value.
d) Pooled result = pooled std dev* 2.718
e) Coeluting contaminant present in this iteration.

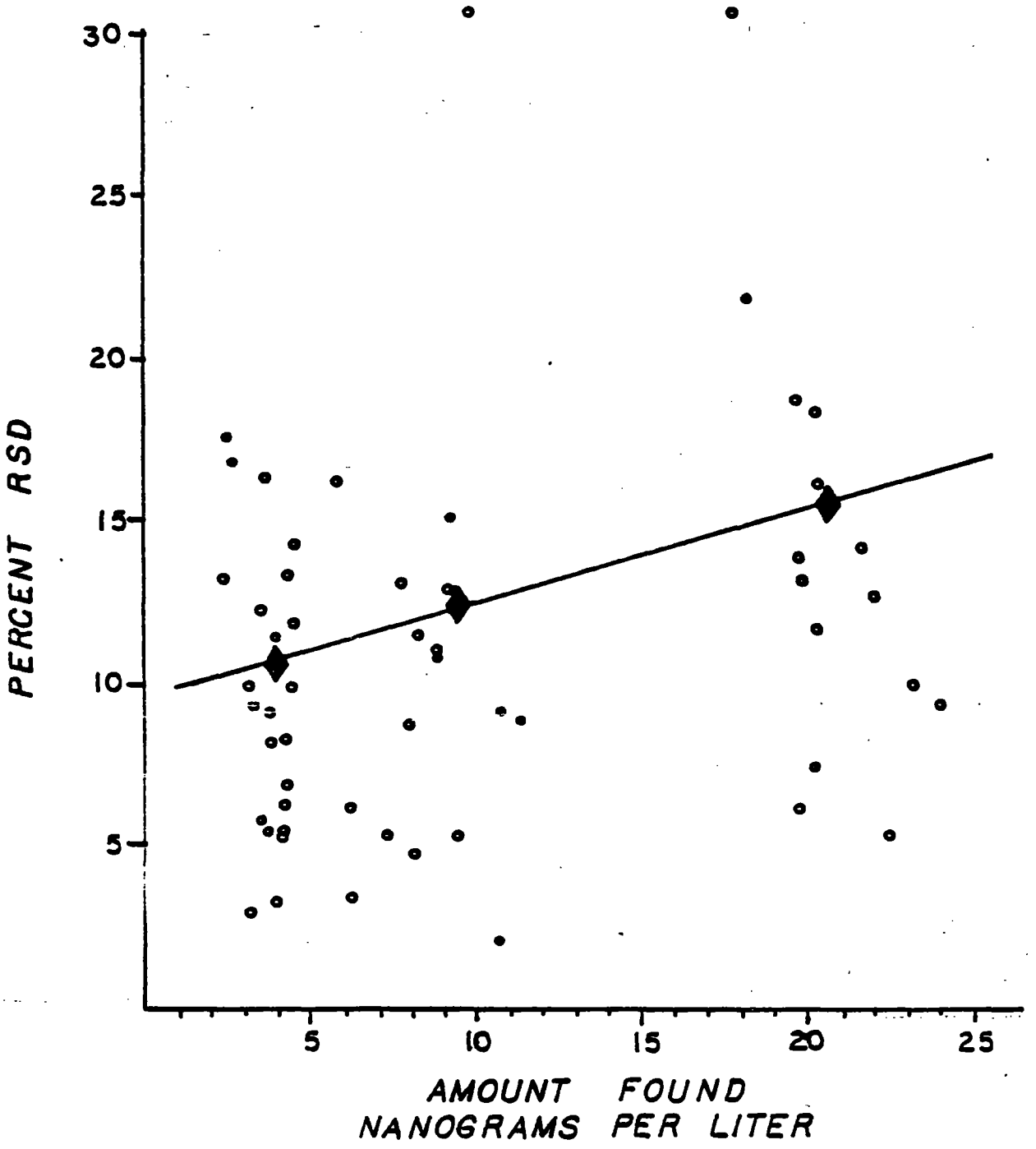


Figure 1. Relative Precision versus Concentration in the Validation Study.

CH2M HILL

PH. 205/834/2870
Montgomery, Office
807 South McDonough Street
Montgomery, Alabama 36104

CLIENT _____

SAMPLE NO. _____

LOCATION _____

_____

ANALYSIS _____

_____

PRESERVATIVE _____

DATE _____ BY _____

Figure 2. Sample Tag for Purgeables Sample.

W/O No. _____ Page____

FIELD TRACKING REPORT: _____-_____
(LOC-SN)

FIELD SAMPLE CODE (FSC)	BRIEF DESCRIPTION	DATE	TIME(s)	SAMPLER

Figure 3. Field Tracking Report Form.

CHAIN OF CUSTODY RECORD

				SAMPLERS (Signature)					
STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE Water Comp.	Water Grab.	Air	SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED

Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Received by: (Signature)	Received by Mobile Laboratory for field analysis: (Signature)	Date/Time
Dispatched by: (Signature) Date/Time	Received for Laboratory by:	Date/Time
Method of Shipment:		

Distribution: Orig.—Accompany Shipment
1 Copy—Survey Coordinator Field Files

Figure 4. Chain of Custody Report Form.

June 23, 1993

Mike Harris
CH2M Hill
P.O. Box 2090
Milwaukee, Wisconsin 53201

Dear Mike:

I have received the QA/QC data that you have sent. This summary is derived from the duplicate sample and spiked sample data contained in those reports. The source and lab numbers for the samples are given in Table 1.

The Quality Assurance Plan describes using the relative range from the duplicate samples to obtain a measure of the precision of the data. There were 135 useful pairs of duplicate measurements, four additional pairs were reported with one of the results given as not detected. These four pairs were not used in this summary. The analyst's report notes that a new technician was used to process samples 3507 K and J and that the data obtained were not consistent with previous duplicate results. As such, the precision data were treated with and without this sample. The results are summarized in Table 2. The validation work indicated that precision exhibited a dependence upon the concentration of the analyte; therefore, the data has been grouped into concentration ranges. No duplicate data was reported for the 5 and 6 ring PAH analytes.

The overall precision (95% Confidence Level) for the 2, 3, and 4 ring PAHs, benzo(b)thiophene, and dibenzofuran is 25% (123 duplicates). Similarly, the overall precision for the nitrogen PAHs is 38% based on 12 duplicates. The precision improves to 17% for 113 duplicate observations for the PAHs and 36% for 11 duplicate observations of the nitrogen PAHs when the 12 pairs from sample 3507 K and J are removed from the data. Clearly the new technician had an effect on the data.

In any event, including or excluding sample 3507 K and J, the overall data achieves the QA objectives for precision which is a RPD of less than 30%. The results for the nitrogen PAHs are less precise than the results for the PAHs.

Accuracy is measured by the recovery from spiked samples. Inspection of the individual recovery statistics indicates that only the 5 ring and 6 ring PAH analytes demonstrate recoveries dependent upon the spiking level. The generally low recoveries for these high molecular weight PAHs can be due to adsorption on the solids formed under the basic conditions of the extraction step.

ATTACHMENT B

The recovery data for the 5 ring PAHs, aniline, and 1-aminionaphthalene are quite erratic when compared to the rest of the data. See Table 3 and Figure 3. The presence of residual chlorine in sample 3547 had a pronounced effect on the recoveries of the primary and secondary amines. These five analytes gave an average recovery of 9% in the Plymouth effluent sample. The tertiary amines gave an average recovery of 95% in this chlorinated effluent.

Overall, the accuracy data indicates that, taken as a whole, the QA objective for accuracy is being achieved. The average accuracy is 77.5% (bias of -22.5%) for all 286 recovery values. The accuracy for the 5 ring PAHs, 6 ring PAHs and the primary amines does not achieve the objective for accuracy. The method is biased low for these compounds especially when the true value in the actual samples is less than 50 ppt.

Table 4 lists the individual recovery statistics for the analytes that give low recoveries when spiked into the real samples. All other analytes exhibit good accuracy and gave recoveries in line with the recovery of the surrogate compound 1-fluoronaththalene.

Sincerely yours,

Denis L. Foerst, Research Chemist
Organic Analyses Section
Physical and Chemical Methods Branch

Enclosures: (5)
As Stated

cc: Mike Kosakowski w/enclosures
Paul Bitter w/enclosures
Harold Cole w/enclosures
CH_2M Hill, 807 South McDonough Street, Montgomery, Alabama 36104

EMSL:CI:DFoerst:plh:STC:rm.572:x7311:6/22/83:4314c

Table 1. IDENTIFICATION OF QA/QC SAMPLES

Source	Duplicate Samples	Spiked Samples	Dosing Level ppt
SLP-4	3421 A and B	3421 D	50
SLP-4	3507 K and J	3507 L	50[a]
Plymouth Eff.	3547 E and D	3547 F	50[b]
Muchar	M-167	M-167	50
SLP-8	3676 H and I	3676 J	50
SLP-15	3587 K and L	3587 M	500
INFL	3758 J and K	3758 L	500
INFL	3774 F and G	3774 H	500
INFL	3803 F and G	3803 H	500
INFL	3819 H and I	3819 J	500

[a]New technician involved with extractions
[b]Chlorinated effluent

Table 2. PERCENT RELATIVE RANGE (95% CONFIDENCE LEVEL) VERSUS CONCENTRATION

Range (ppt)	Number of Duplicates	$\bar{P}_{95}$	Number of Duplicates[a]	$\bar{P}_{95}$[a]
PAHs[b]				
1 to 10	22	23	22	19
10.1 to 25	22	41	17	25
25.1 to 50	6	24	5	6
50.1 to 100	3	46	2	33
100.1 to 250	18	23	15	12
250.1 to 500	13	13	13	13
500.1 to 1000	13	12	13	12
> 1000	25	20	25	20
Nitrogen PAHs				
1 to 10	2	41	2	41
10.1 to 25	2	38	2	38
25.1 to 50	1	(12)	1	(12)
50.1 to 100	1	(58)	--	--
Overall	135	26	~~129~~ 127	19

a) Delete 12 pairs from Sample 3507 K and J
b) Includes benzo(b)thiophene and dibenzofuran

Table 3. RECOVERY OF SPIKED SAMPLES

Compound	n	outliers	A (%)	SD	RSD (%)	UCL_{95} (%)	LCL_{95} (%)
2,3,4 ring PAH[a,b]	160	9	90.2	12.2	14	114	66
5 ring PAH[a]	20	0	24.0	14.0	58	53	-5
5 ring PAH[b]	20	0	53.6	8.4	13	81	46
6 ring PAH[a]	10	0	11.8	3.9	33	21	3
6 ring PAH[b]	10	0	56.6	6.7	12	72	41
Aniline[a,b,c]	7	1	37.4	19.1	51	84	-9
1-Aminonaphthalene[a,b,c]	7	1	73.0	35.6	49	160	-14
2-Aminobiphenyl[a,b,c]	7	1	67.7	12.7	19	99	36
Secondary amines[a,b,c,]	17	3	86.4	11.8	14	111	61
Tertiary amines[a,b]	28	2	92.5	8.1	9	109	75
1-Fluoranaphthalene[a]	10	0	91.8	7.0	8	108	76
Overall[d]	286	15	77.5				

[a] 50 ppt spike
[b] 500 ppt spike
[c] Does not include Plymouth effluent
[d] Overall average does not include 1-fluoronaphthalene

Table 4. ANALYTES SHOWING LOW RECOVERIES

Compound	50 ppt X	50 ppt SD	50 ppt RSD	500 ppt X	500 ppt SD	500 ppt RSD
B(b&k) fluoranthene[a]	27.0	10.2	38	69.6	6.4	9
Benzo(a&e) pyrene[a]	22.8	12.8	56	64.2	6.6	10
Perylene	24.4	13.4	55	67.0	4.8	7
Dibenzo(a,h)anthracene[a]	21.0	21.6	99	53.5	6.7	12
Indeno(1,2,3-cd)pyrene[a]	12.8	4.1	32	57.2	7.9	14
Benzo(ghi)perylene[a]	10.8	4.0	37	56.0	6.2	11
Aniline[b]	36.7	31.9	87	39.0	6.7	18
1-Aminonaphthalene[b]	67.0	37.3	56	77.5	39.2	51
1-Aminobiphenyl[b]	61.0	11.8	19	72.3	12.4	17

[a]Five samples each at 50 ppt and 500 ppt
[b]Three samples at 50 ppt and 4 samples at 500 ppt.

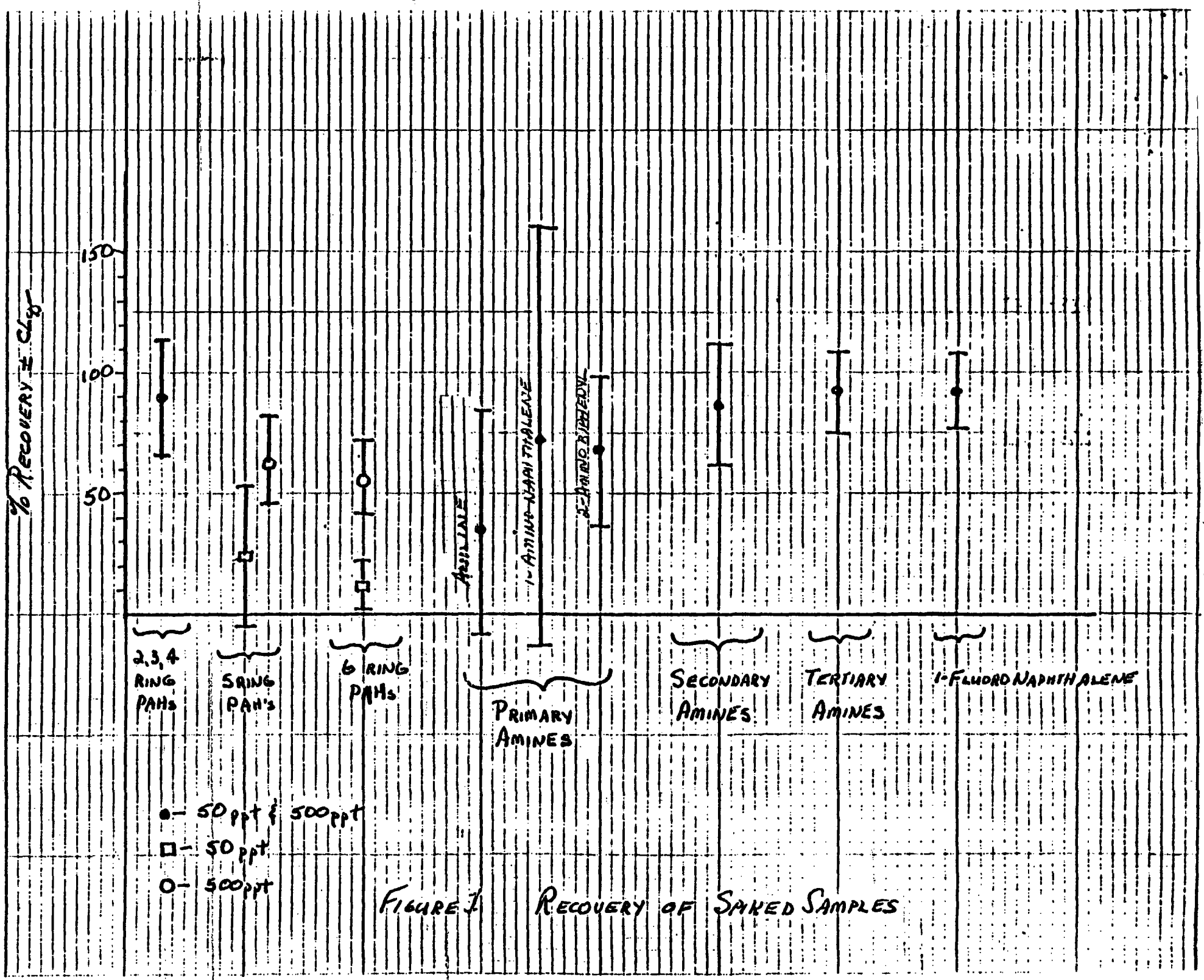
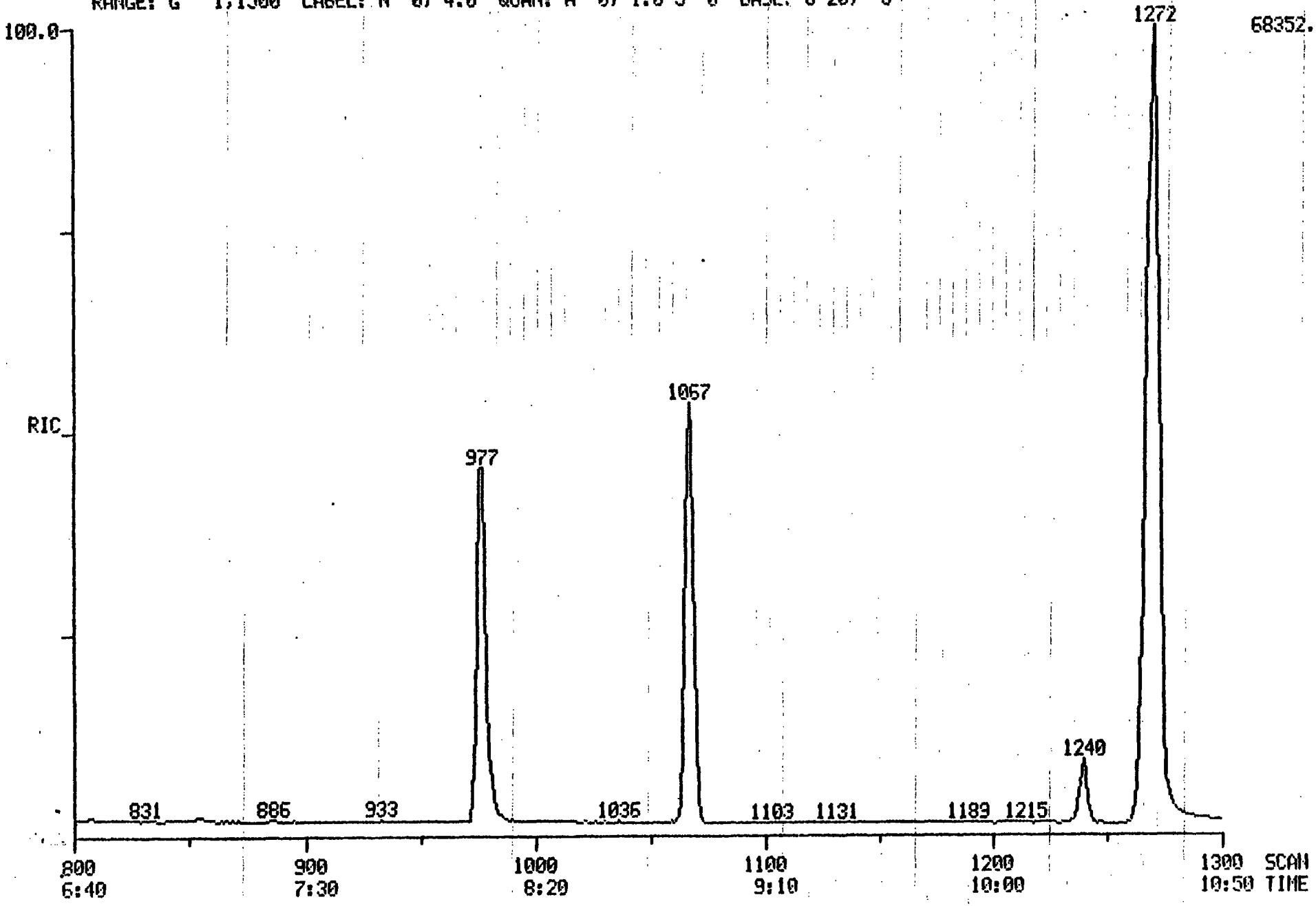


Figure 1 Recovery of Spiked Samples

RIC
09/21/82 9:27:00
SAMPLE:
CONDS.:
RANGE: G 1,1500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

DATA: EPAQCTEST #1
CALI: TUE092182A #1

SCANS 800 TO 1300



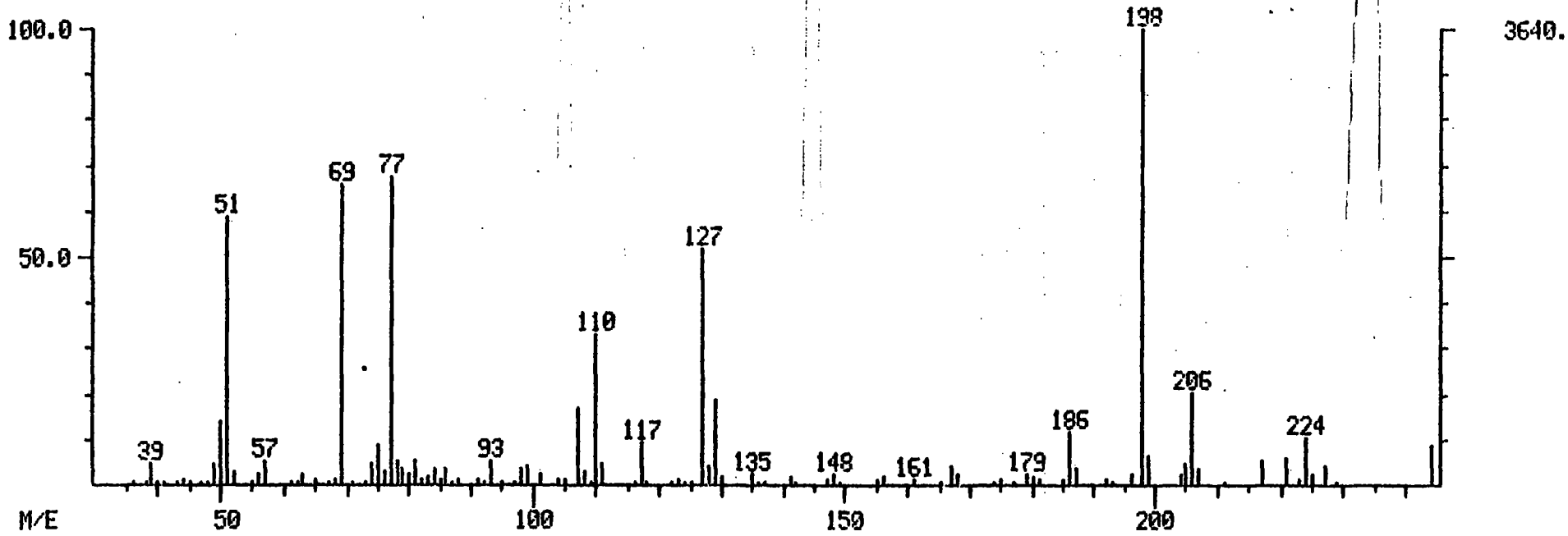
ATTACHMENT C

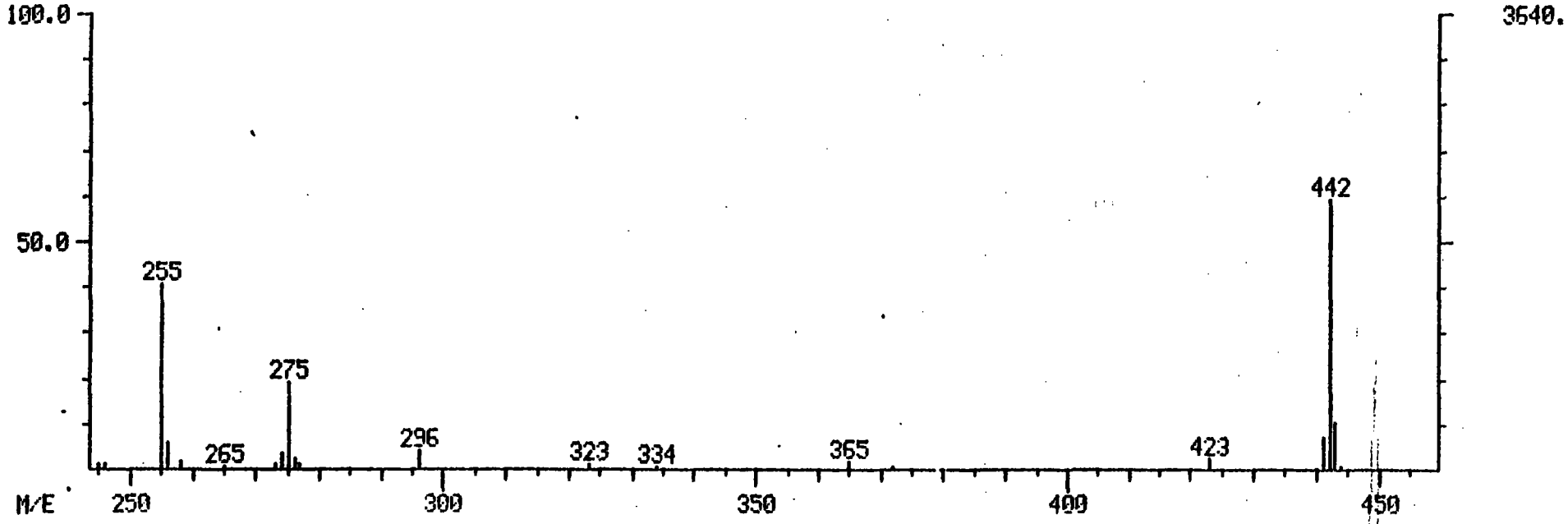
3721G-1

MASS SPECTRUM
09/21/82 9:27:00 + 8:53
SAMPLE:
CONDS.:
#1066 - #1058 - #1058

DATA: EPAQCTEST #1066
CALI: TUE092182A #1

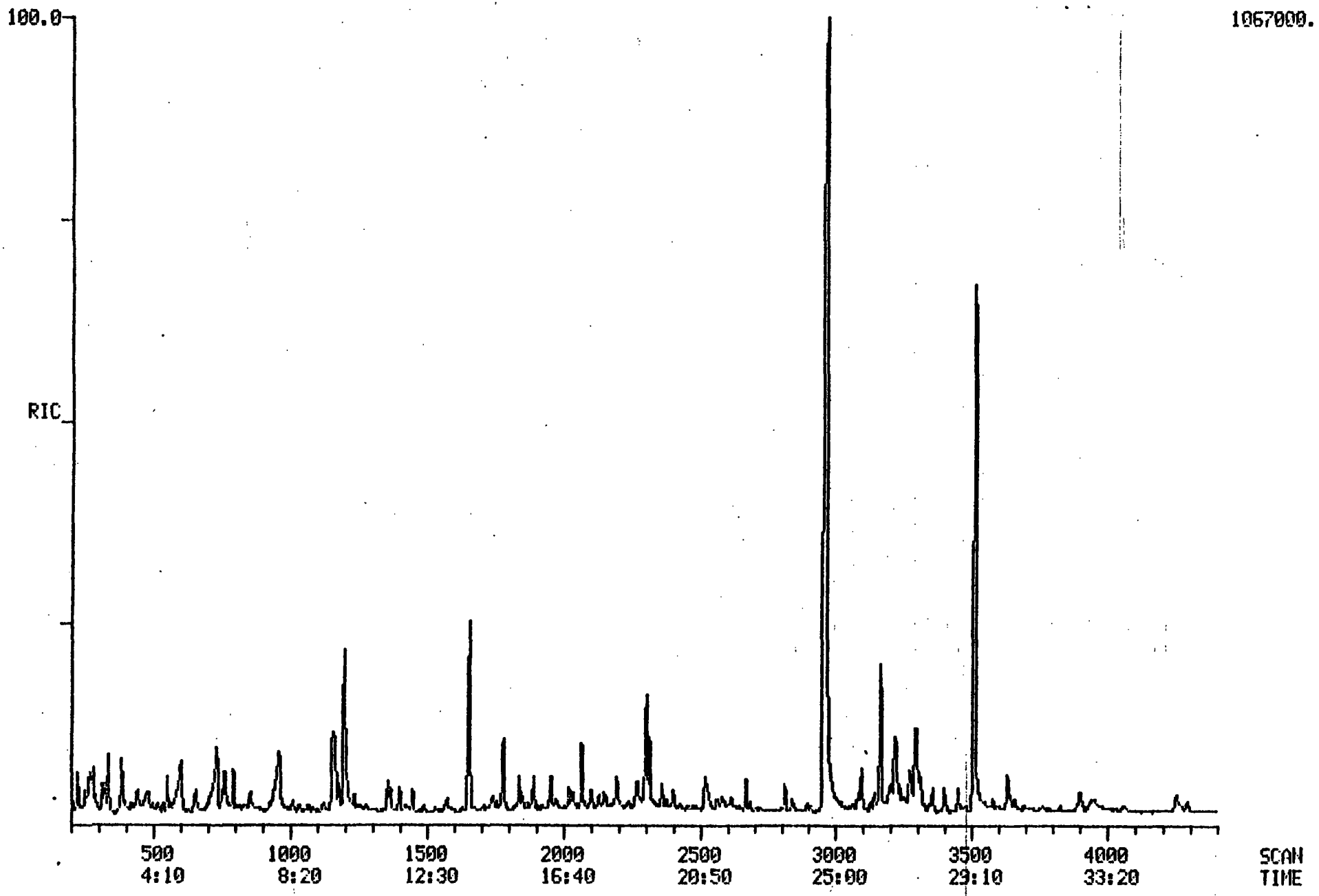
BASE M/E: 198
RIC: 31168.





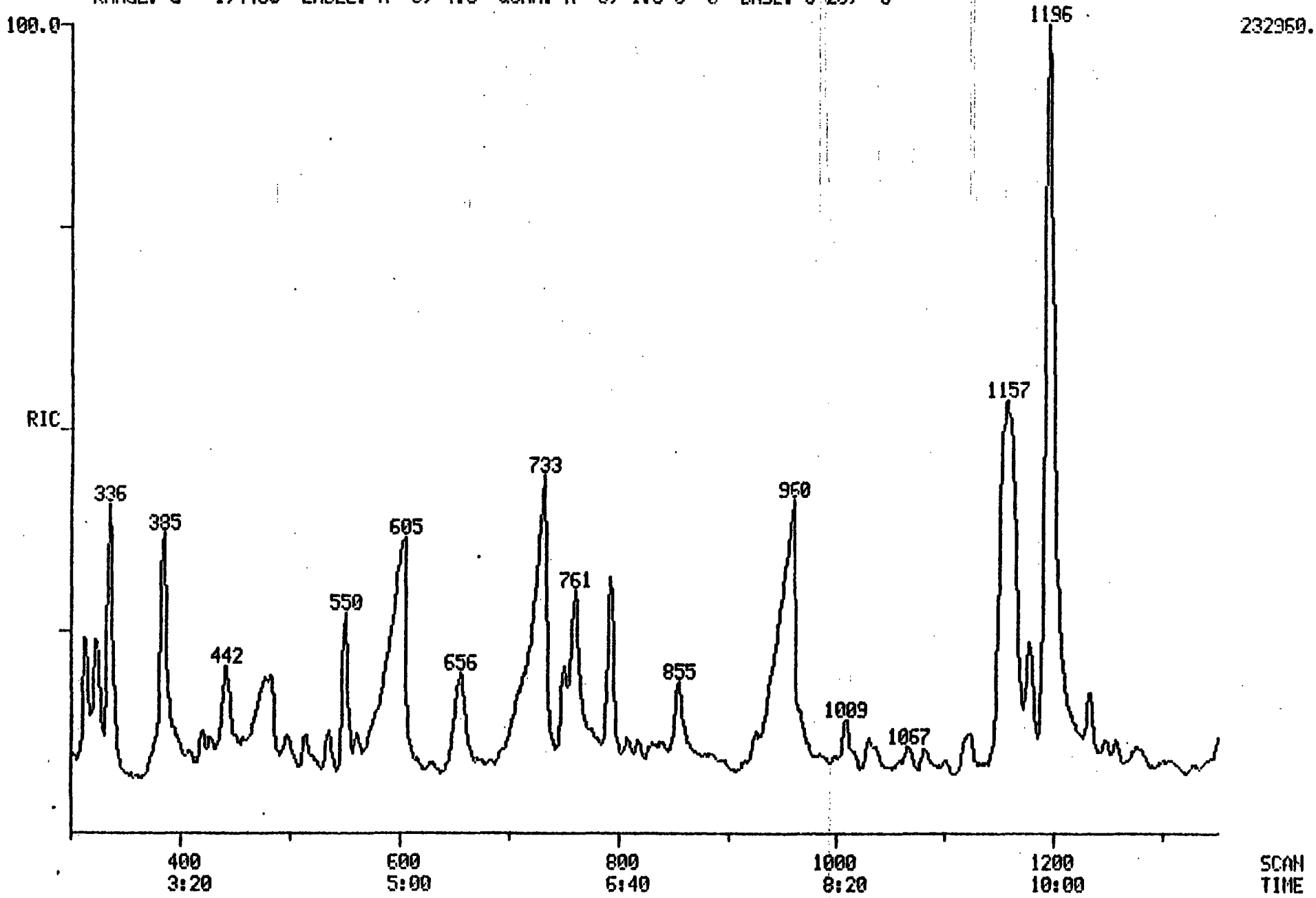
3421-6

RIC DATA: 3421GBN #1 SCANS 200 TO 4400
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



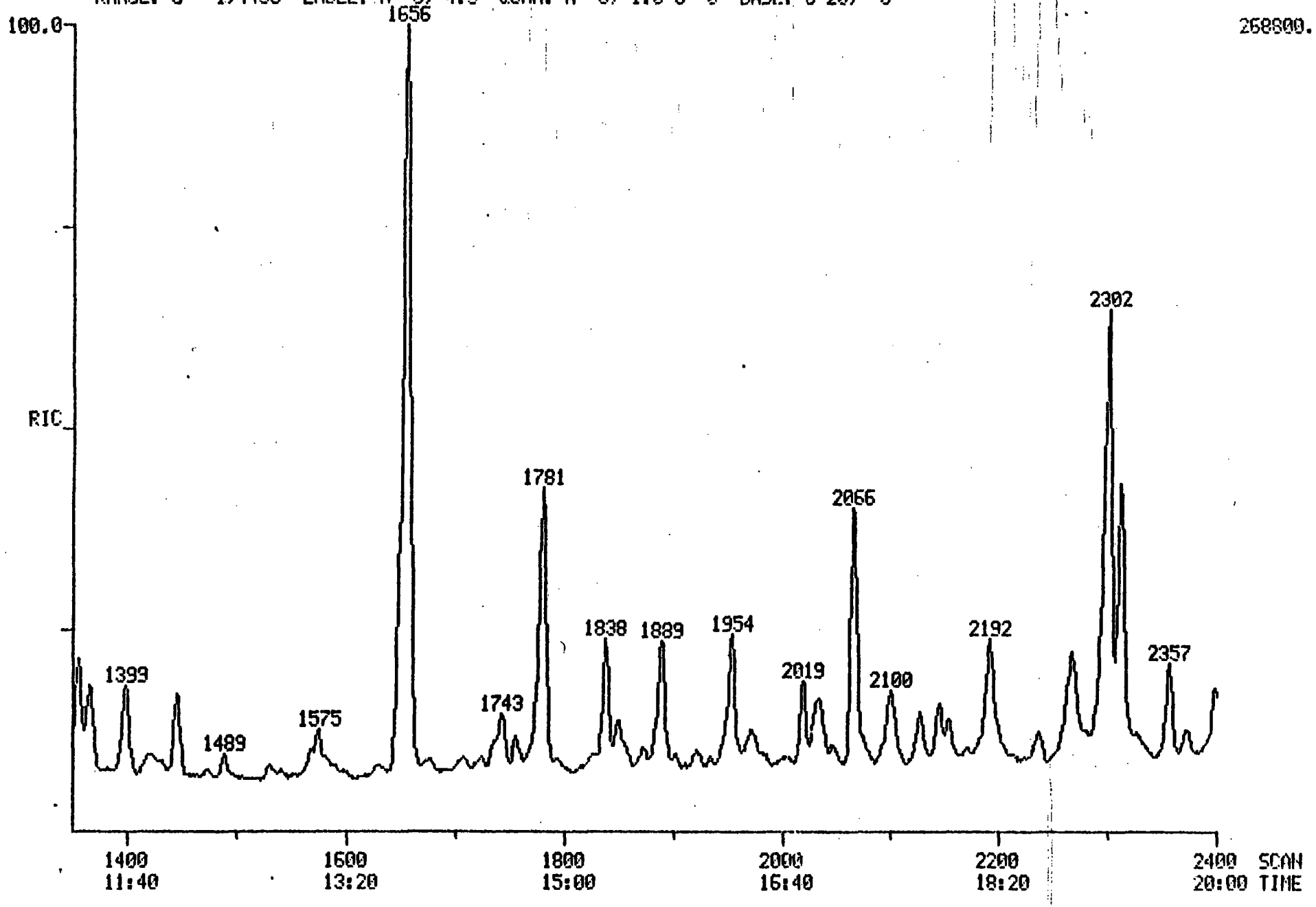
3421-G-3

RIC DATA: 3421GBN #1 SCANS 300 TO 1350
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



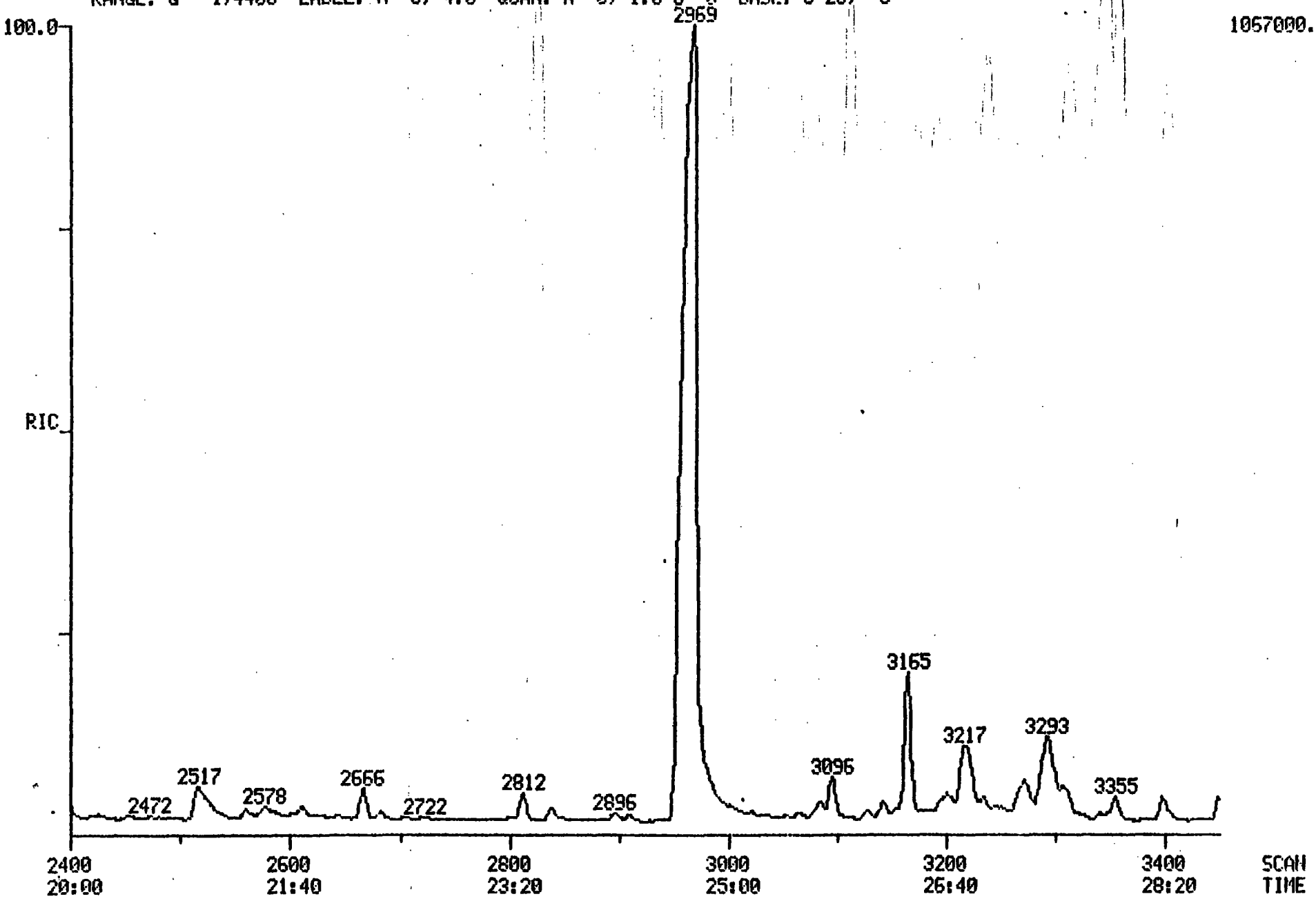
3421-6-7

RIC DATA: 3421GBN #1 SCANS 1350 TO 2400
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



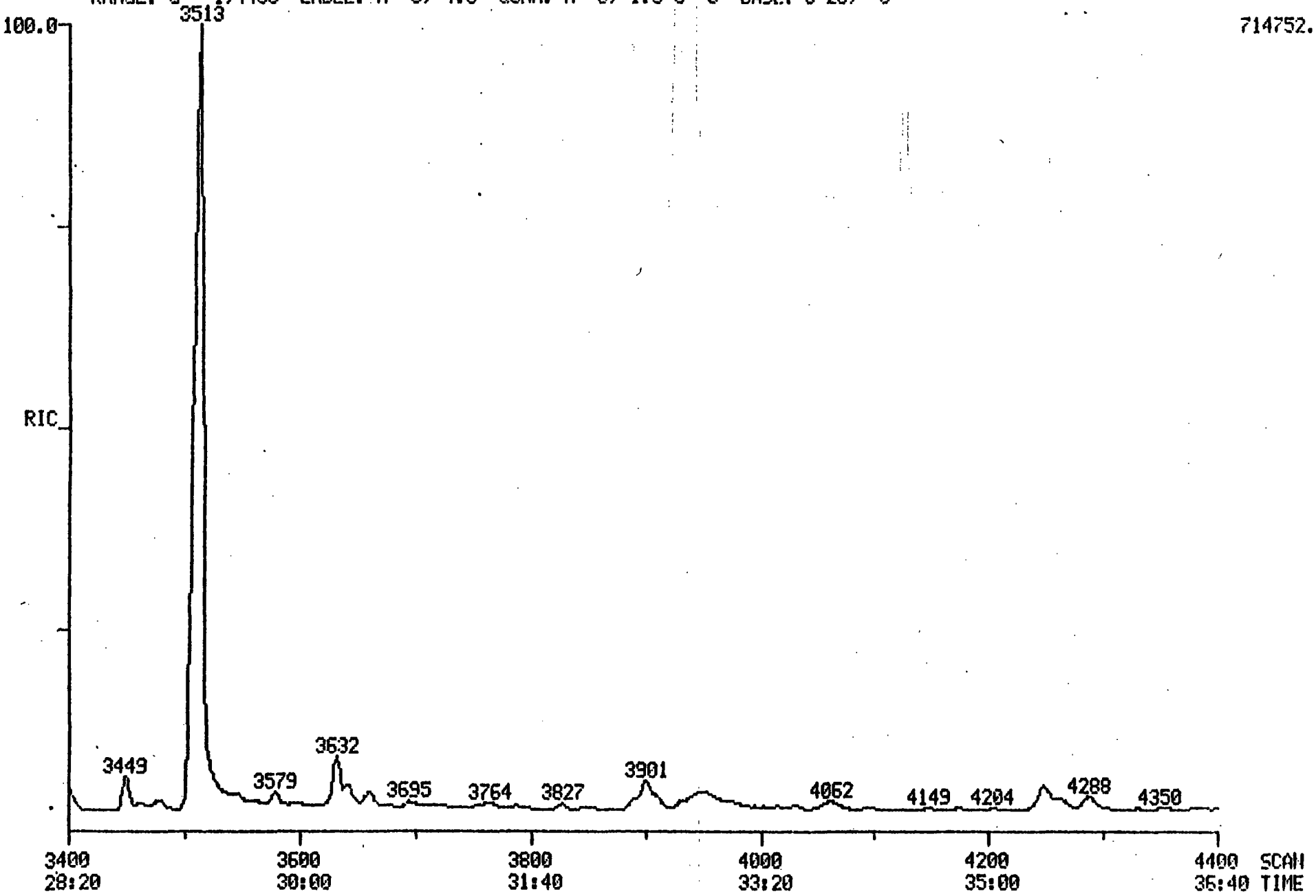
3421-6-5

RIC DATA: 3421GBN #2954 SCANS 2400 TO 3450
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



3721-6-6

RIC DATA: 3421GBN #2954 SCANS 3400 TO 4400
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

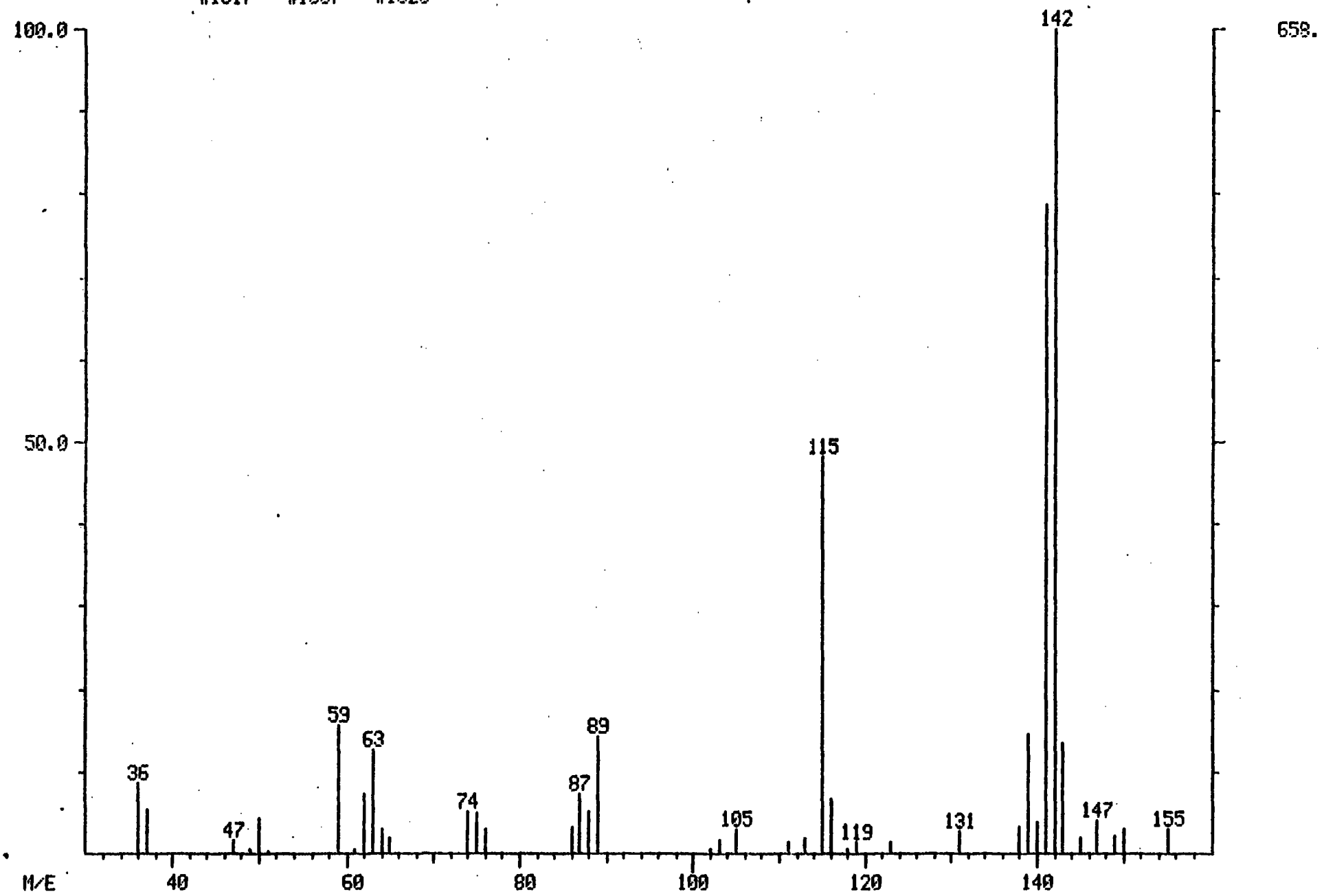


3421-G-2

MASS SPECTRUM
09/21/82 12:07:00 + 8:28
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 100 MLS OF CH2CL2
CONDS.:
#1017 - #1007 - #1028

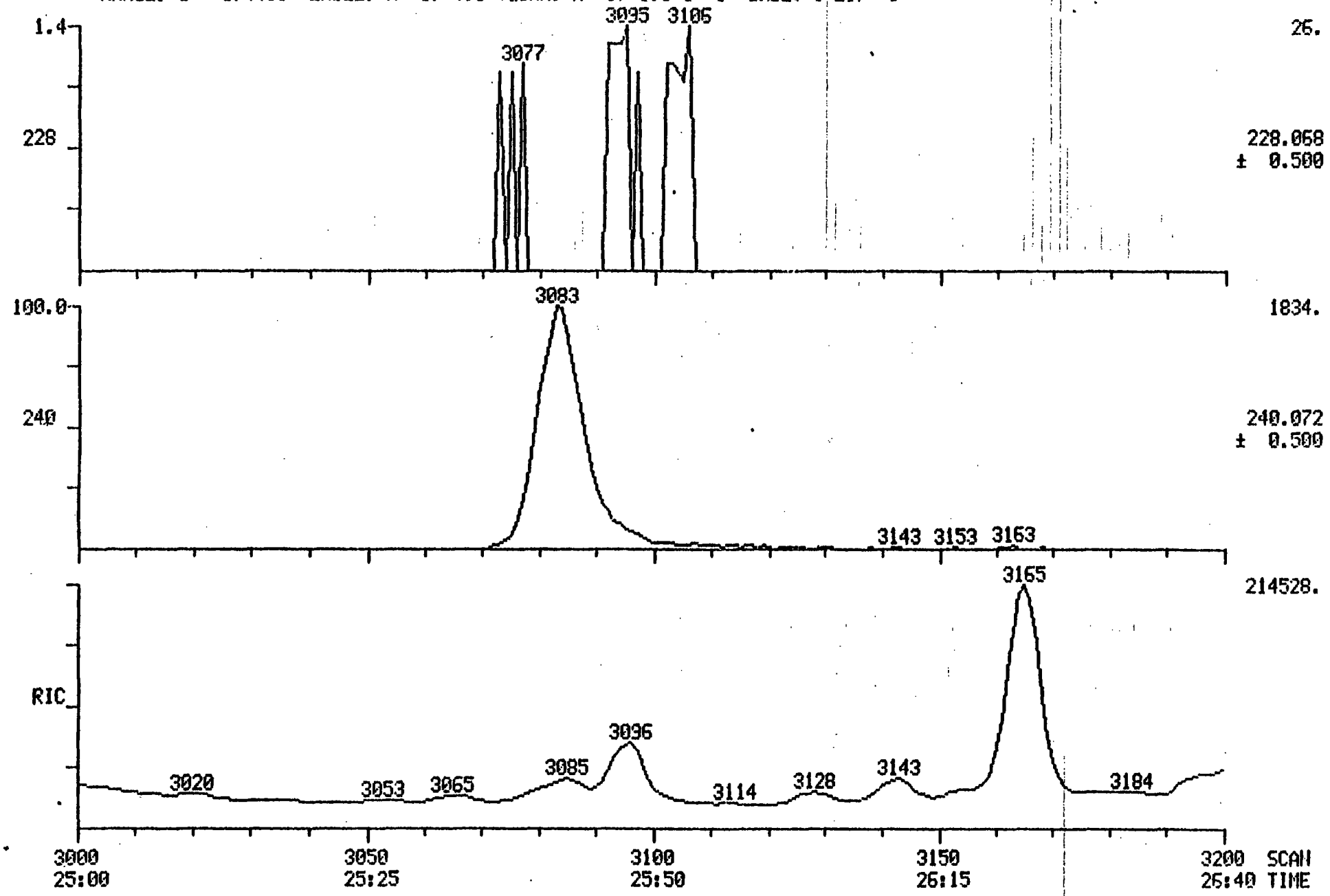
DATA: 3421GBN #1017
CALI: TUE092182A #1

BASE M/E: 142
RIC: 2644.



3421-6-5

RIC + MASS CHROMATOGRAMS DATA: 3421GBN #1017 SCANS 3000 TO 3200
09/21/82 12:07:00 CALI: TUE092182A #1
SAMPLE: FIELD BLANK #2 FINAL VOL=20 UL IS SPIKE=20 NG 180 MLS OF CH2CL2
CONDS.:
RANGE: G 1,4400 LABEL: H 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



3421-6-9

CH2M HILL

ANALYTICAL REPORT

PAH, N and S Heterocyclic Compounds

Sample Identification: Field Blank 2 Lab #: 3421G

Date Received: 9/16/82 Date Extracted: 9/17/82

Date Analyzed: 9/21/82

Compounds	MDL[1] ng/l	Conc[2] ng/l	Compounds	MDL[1] ng/l	Conc[2] ng/l
2,3-Dihydro-1-Indene	1.4	~~BMDL~~ 0.2	Acridine	1.8	BMDL
1H-Indene	1.0	BMDL	Phenanthridine	1.4	BMDL
Naphthalene	1.9	1.9 3.5	Carbazole	1.1	BMDL
Benzo(b)thiophene	1.0	BMDL	Fluoranthene	1.0	BMDL
Quinoline	1.0	BMDL	Pyrene	1.0	BMDL
Indole	2.9	BMDL	Benzo(a)anthracene	1.0	BMDL
2-Methylnaphthalene	2.0	~~BMDL~~ 1.8	Chrysene	1.0	BMDL
1-Methylnaphthalene	1.2	BMDL 0.85	Benzo(b & k)Floranthene	1.0	BMDL
Biphenyl	1.0	BMDL	Benzo(a & e)pyrene	1.0	BMDL
Acenaphthylene	1.0	BMDL	Perylene	1.0	BMDL
Acenaphthene	1.3	BMDL	Indeno(1,2,3-cd)pyrene	1.7	BMDL
Fluorene	1.4	BMDL	Dibenzo(a,h)anthracene	1.4	BMDL
Phenanthrene	1.0	~~BMDL~~ 0.4	Benzo(g,h,i)perylene	1.0	BMDL
Anthracene	1.0	BMDL			

Percent Recovery of 1-Fluoronaphthalene = NA

[1]MDL = Method Detection Limit

[2]BMDL = Below Method Detection Limit

Blue - designating MDL Concentration.

3421-G-10

CH2M HILL

LABORATORY WORKSHEET

St. Louis Park Project

I. SAMPLE INFORMATION: Date Received 9/16/82 by HEC Lab # 3421 G

Condition of Sample: cold - ice present

Labeled: Field Blank 2 9/15/82 Sealed yes

II. SAMPLE EXTRACTION: Date Extracted 9/17/82 Extracted by WLH

Volume Extracted — Final Vol. of Extract 20 µl

Surrogate Spike Concentration —

Extraction Difficulties —

III. SAMPLE GC/MS ANALYSIS: Analyst HEC Analysis Date 9/21/82

Internal Standard Spike Concentration 20 ng

1100 Volts

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117		2509	0.06
1H-Indene X	116		—	
D_8-Naphthalene (IS)	136	750	43391	
Naphthalene	128	757	19658	0.45
1-Fluoronaphthalene (S)	146		—	
Benzo(b)Thiophene	134		—	
Quinoline	129		—	
Indole	117		—	
2-Methylnaphthalene	142	1016	5139	0.17
1-Methylnaphthalene	142	1057	2654	0.09 ≤ 0.09
2-Fluorobiphenyl (IS)	172	1177	29886	
Biphenyl X	154	1208	1052	0.03
Acenaphthylene	152		—	
Acenaphthene	154		—	
Fluorene	166		—	
Phenanthrene	178	2020	1528	0.04
D_{10}-Anthracene (IS)	188	2031	35058	
Anthracene	178		—	
Acridine	179		—	
Penanthridine	179		—	

3421-6-11

Compounds	QM	Scan	Area	
Carbazole	167		—	
Fluoranthene	202		—	
Pyrene	202		—	
Benzo(a)anthracene	228		—	
D_{12}-Chrysene (IS)	240	3083	18369	
Chrysene	228		—	
Benzo(b)Fluoranthene	252		—	
Benzo(a)pyrene	252		—	
Perylene	252		—	
Indeno(1,2,3-Cd)Pyrene	276		—	
Dibenzo(a,h)anthracene	278		—	
Benzo(g,h,i)Perylene	276		—	

HEK 11/15/84

3521-G-12

CALCULATION WORKSHEET

LAB # 3421G
Field Blank 2

D_5-Phenol (IS)

2,3-Dihydro-1H-Indene -- $\frac{0.06 \times 20}{0.84 \times 2.0}$ = 0.7 ppt → 0.7 ppt.

1H-Indene - - - - - - - - - - _____

D_8-Naphthalene (IS)

Naphthalene - - - - - - - - - $\frac{0.45 \times 20}{1.45 \times 2.0}$ = 3.1

1-Fluoronaphthalene (S) _____

Benzo(b)Thiophene - - - - - _____

Quinoline - - - - - - - - - - _____

Indole - - - - - - - - - - - - _____

2-Methylnaphthalene - - - $\frac{0.17 \times 20}{0.94 \times 2.0}$ = 1.8

1-Methylnaphthalene - - - - $\frac{0.09 \times 20}{1.08 \times 2.0}$ 0.83

2-Fluorobiphenyl (IS)

Biphenyl - - - - - - - - - - _____

Acenaphthylene - - - - - - - _____

Acenaphthene - - - - - - - - _____

Fluorene - - - - - - - - - - - - _____

Phenanthrene - - - - - - - - - $\frac{0.04 \times 20}{1.10 \times 2.0}$ = 0.4

D_{10}-Anthracene (IS)

Anthracene

Acridine

Penanthridine

Carbazole

Fluoranthene

Pyrene

Benzo(a)anthracene

D_{12}-Chrysene (IS)

Chrysene

Benzo(b)Fluoranthene

Benzo(a)pyrene

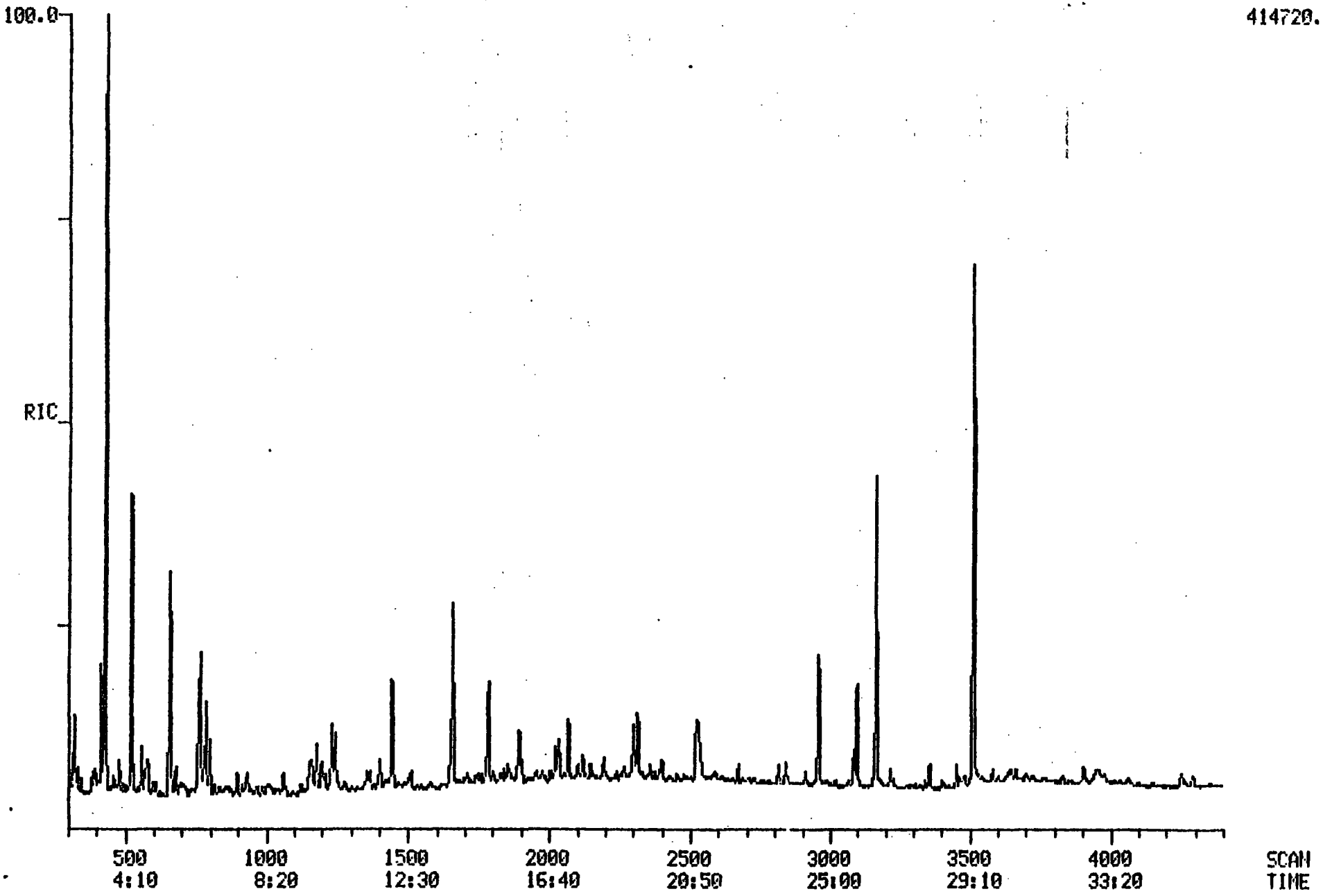
Perylene

Indeno(1,2,3-Cd)Pyrene

Dibenzo(a,h)anthracene

Benzo(g,h,i)Perylene

RIC DATA: 3421ABN #1 SCANS 300 TO 4400
09/21/82 14:01:00 CALI: TUE092182A #1
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



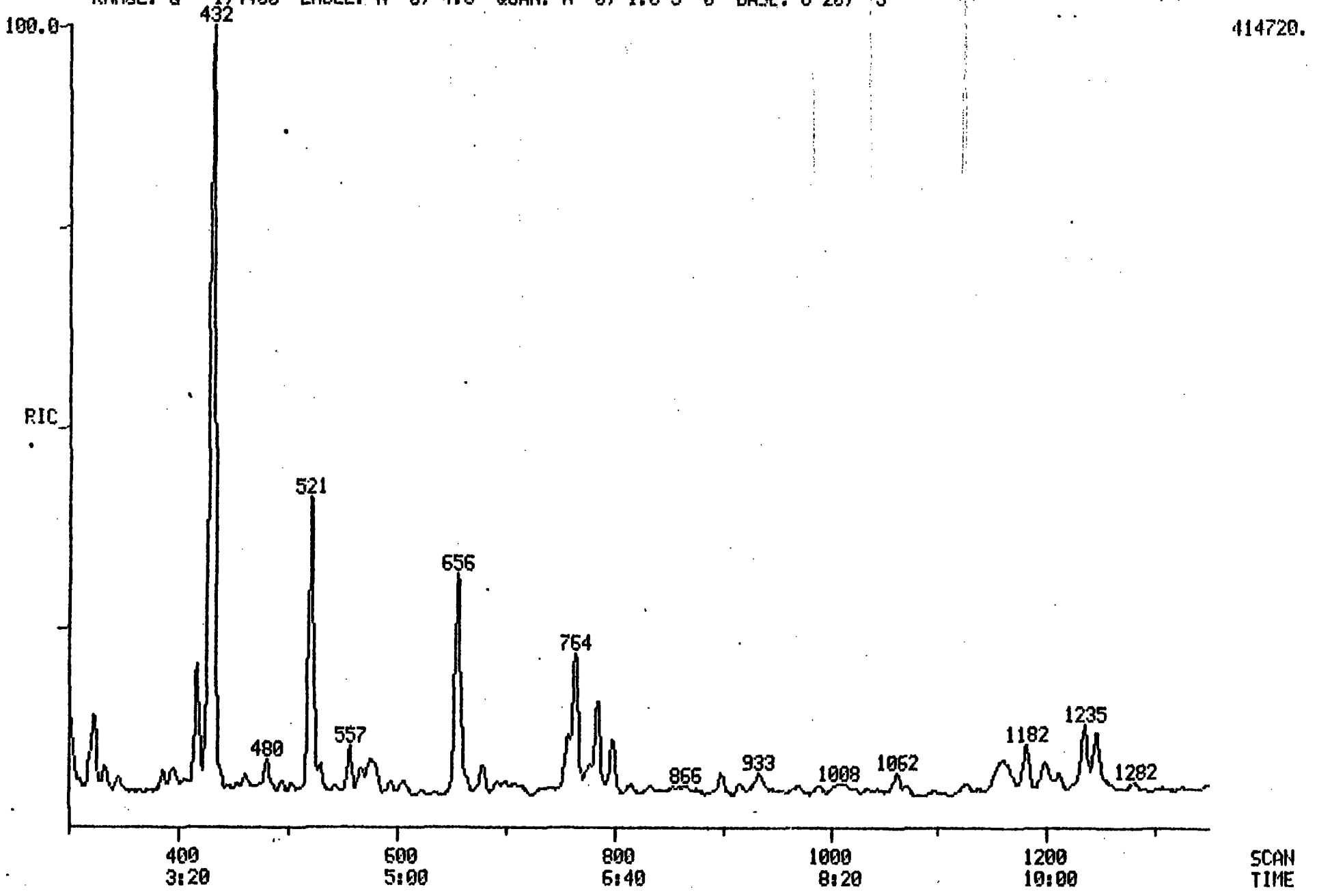
3421-A -1

ATTACHMENT D

RIC
09/21/82 14:01:00
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

DATA: 3421ABN #1
CALI: TUE092182A #1

SCANS 300 TO 1350

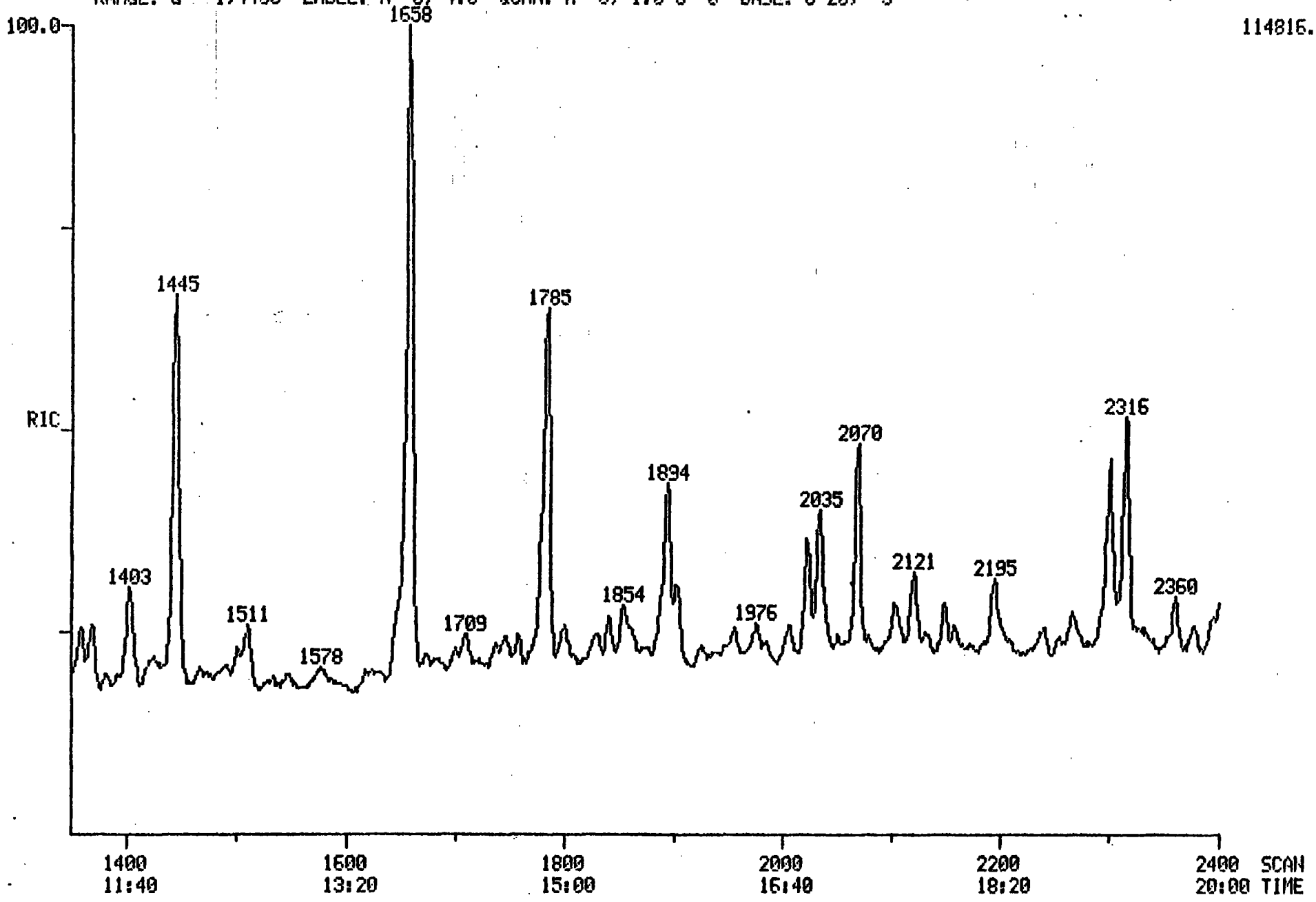


3421-4-2

RIC
09/21/82 14:01:00
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

DATA: 3421ABN #1
CALI: TUE092182A #1

SCANS 1350 TO 2400

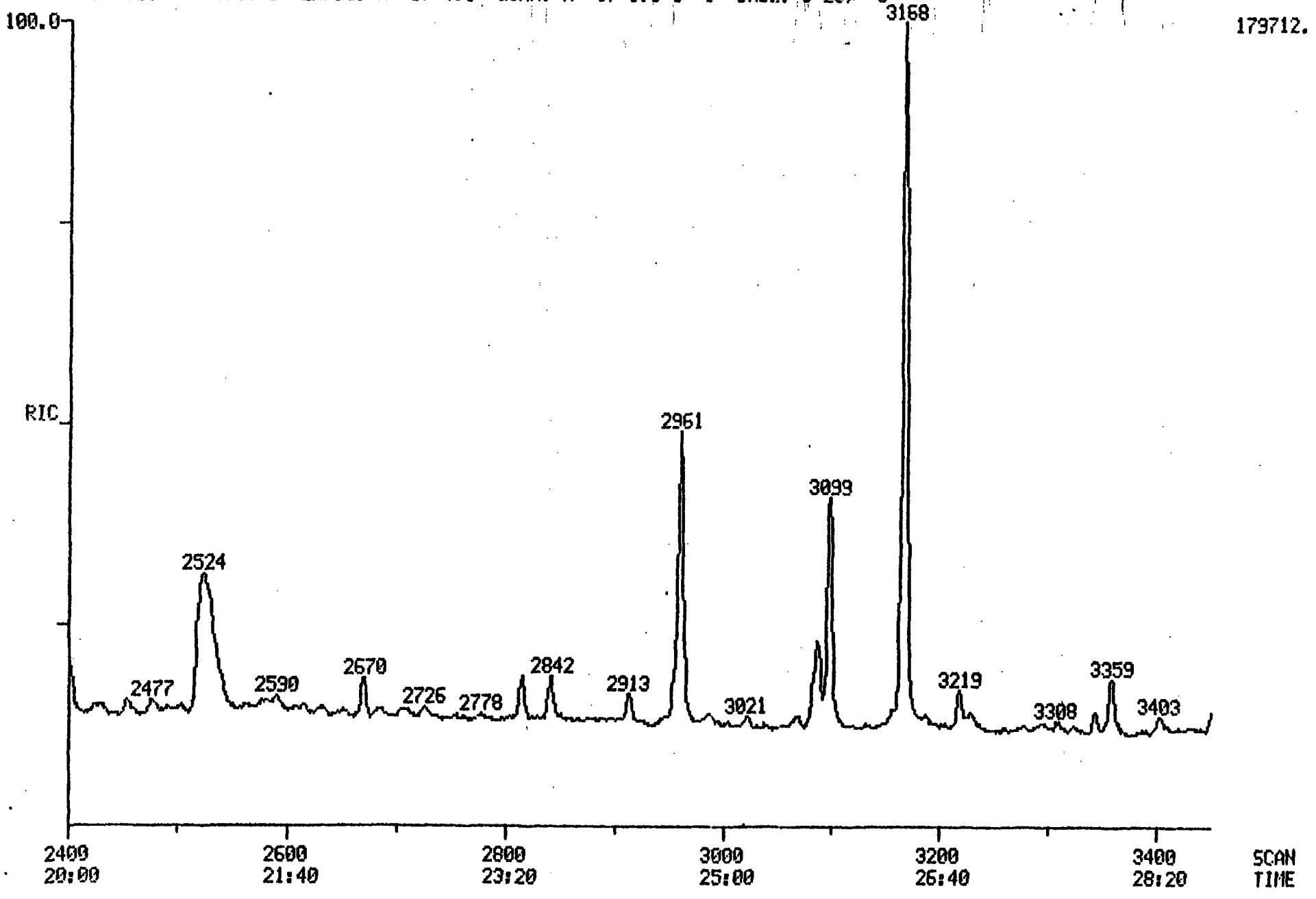


3421-A-3

RIC
09/21/82 14:01:00
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

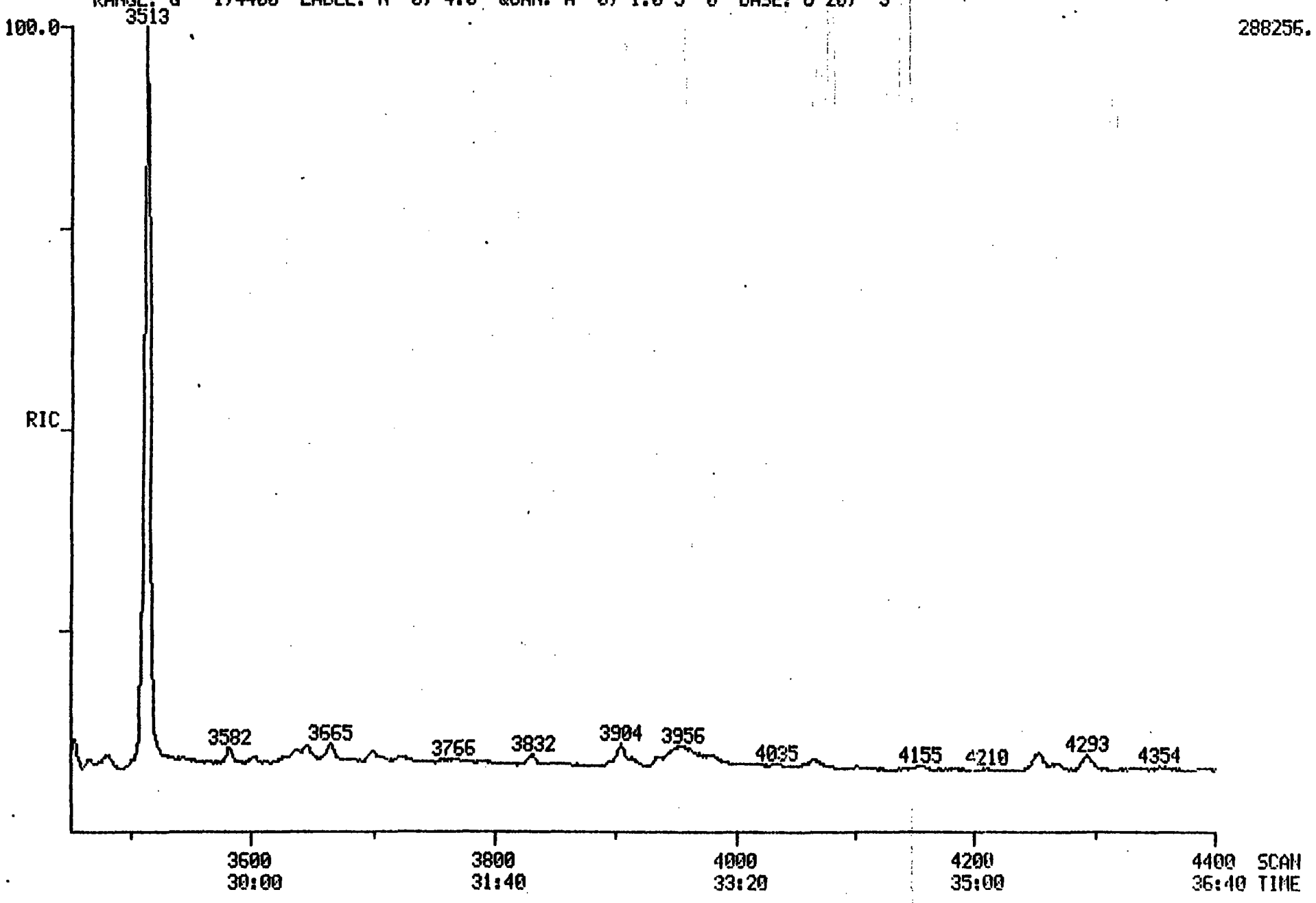
DATA: 3421ABN #1
CALI: TUE092182A #1

SCANS 2400 TO 3450



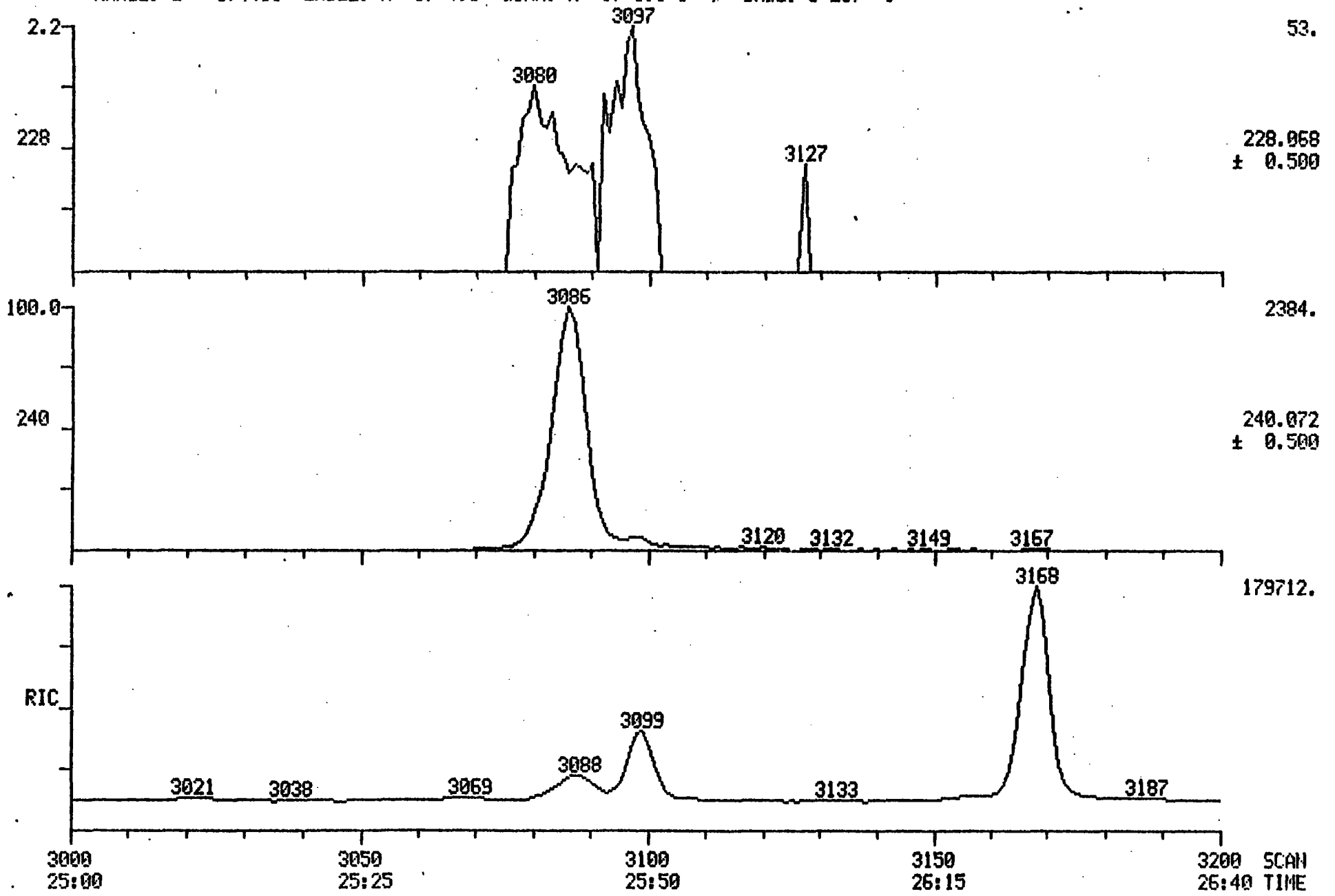
3421-A-4

RIC DATA: 3421ABN #1 SCANS 3450 TO 4400
09/21/82 14:01:00 CALI: TUE092182A #1
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



3421-A-5

RIC + MASS CHROMATOGRAMS DATA: 3421ABN #1 SCANS 3000 TO 3200
09/21/82 14:01:00 CALI: TUE092182A #1
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
RANGE: G 1,4400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

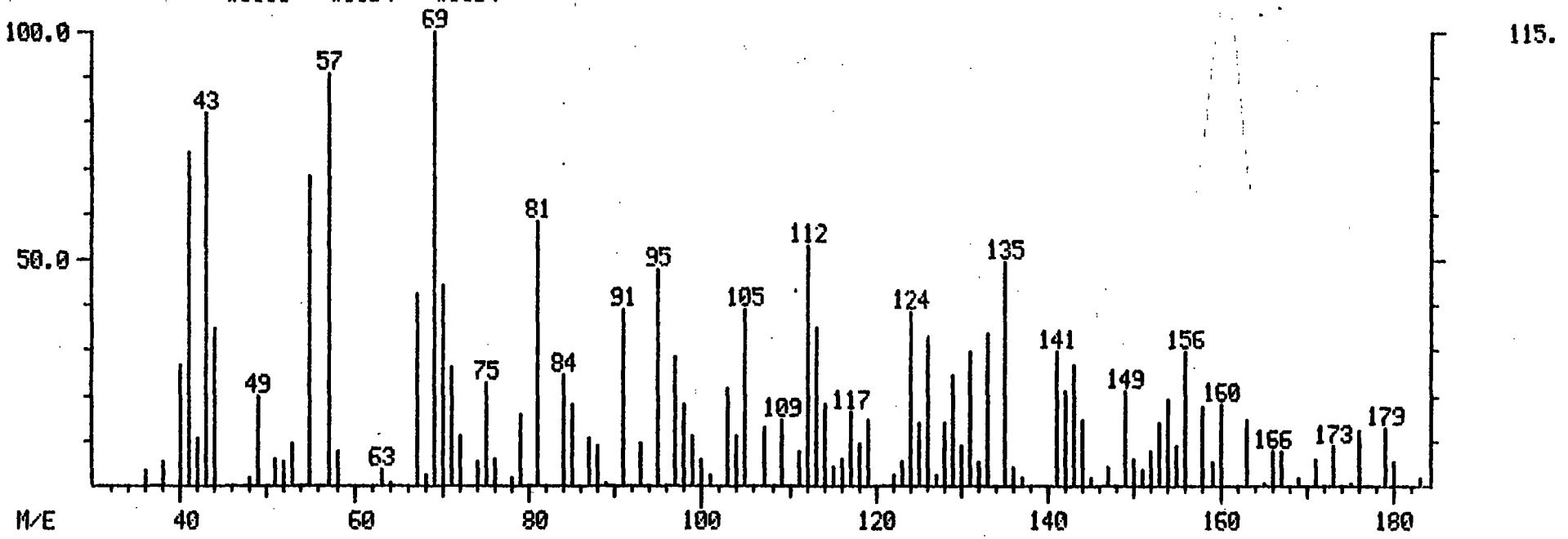


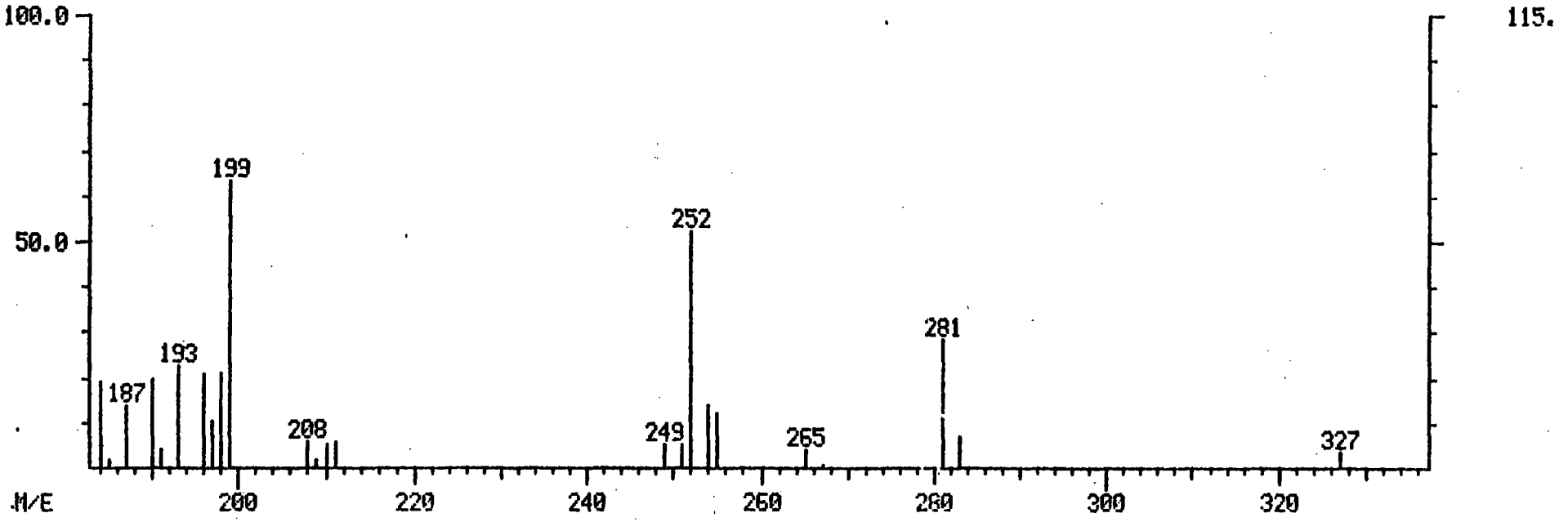
3421-A-6

MASS SPECTRUM
09/21/82 14:01:00 + 30:00
SAMPLE: FINAL VOLUME=100 UL IS SPIKE=120 NG
CONDS.:
#3601 - #3594 - #3594

DATA: 3421ABN #3601
CALI: TUE092182A #1

BASE M/E: 69
RIC: 2608.





3421-A-7

CH2M HILL

ANALYTICAL REPORT

PAH, N and S Heterocyclic Compounds

Sample Identification SLP-4 Lab # 3421A

Date Received 9/16/82 Date Extracted 9/17/82

Date Analyzed 9/21/82

Compounds	MDL[1] ng/l	Conc[2] ng/l	Compounds	MDL[1] ng/l	Conc[2] ng/l
2,3-Dihydro-1-Indene	7.0	110	Acridine	9.0	BMDL
1H-Indene*	5.0	7.9	Phenanthridine	7.0	BMDL
Naphthalene	9.5	12	Carbazole	5.5	41
Benzo(b)thiophene	5.0	120	Fluoranthene	5.0	BMDL
Quinoline	5.0	BMDL	Pyrene	5.0	BMDL
Indole	15	BMDL	Benzo(a)anthracene	5.0	BMDL
2-Methylnaphthalene	10	BMDL	Chrysene	5.0	BMDL
1-Methylnaphthalene	6.0	20	Benzo(b & k)Floranthene	5.0	BMDL
Biphenyl	5.0	18	Benzo(a & e)pyrene	5.0	BMDL
Acenaphthylene	5.0	5.6	Perylene	5.0	BMDL
Acenaphthene	6.5	140	Indeno(1,2,3-cd)pyrene	8.5	BMDL
Fluorene	7.0	18	Dibenzo(a,h)anthracene	7.0	BMDL
Phenanthrene	5.0	33	Benzo(g,h,i)perylene	5.0	BMDL
Anthracene	5.0	BMDL			

Percent Recovery of 1-Fluoronaphthalene = 92%

[1]MDL = Method Detection Limit

[2]BMDL = Below Method Detection Limit

*Interferring ion present

Blue - calc. no MDL criteria
Black - B.lank values

3421-A-8

Note: Extract concentrated to 100 ml showed pink color and ~~Fluoresed Green~~ Green fluoresence

CH2M HILL

LABORATORY WORKSHEET

St. Louis Park Project

I. SAMPLE INFORMATION: Date Received 9/16/82 by HEC Lab # 3421 A

Condition of Sample: cold - ice present

Labeled: SLP-4 9/15/82 Sealed yes

II. SAMPLE EXTRACTION: Date Extracted 9/17/82 Extracted by MTP/WLH

Volume Extracted 1955 mls Final Vol. of Extract 100

Surrogate Spike Concentration 50ng 1-2 Naphthalene 100ng 2,4,6-Tribromophenol

Extraction Difficulties B/N emulsion

III. SAMPLE GC/MS ANALYSIS: Analyst HEC Analysis Date 9/21/82

Internal Standard Spike Concentration 20 + 100 = 120

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	417	71878	1.56
1H-Indene *	116	437	4748	0.10
D_8-Naphthalene (IS)	136	756	45988	
Naphthalene	128	763	12811	0.29
1-Fluoronaphthalene (S)	146	763	17944	0.39
Benzo(b)Thiophene	134	784	78667	1.71
Quinoline	129		—	
Indole	117		—	
2-Methylnaphthalene	142	1022	2882	0.10
1-Methylnaphthalene	142	1062	10961	0.36
2-Fluorobiphenyl (IS)	172	1182	30232	
Biphenyl	154	1212	11401	0.38
Acenaphthylene	152	1370	3646	0.12
Acenaphthene	154	1445	74188	2.45
Fluorene	166	1646	8812	0.25
Phenanthrene	178	2024	20976	0.59
D_{10}-Anthracene (IS)	188	2034	35525	—
Anthracene	178	2043	1707	0.05
Acridine	179		—	
Penanthridine	179		—	

* Interference

Note: Started Scanning at 3.4 min (Std = 3.5)

3421-A-9

Compounds		QM	Scan	Area	
Carbazole	✓	167	2120	26144	0.74
Fluoranthene	✓	202	2503	2017	0.06
Pyrene	✓	202	2510	1705	0.05
Benzo(a)anthracene		228	>95	—	>0.0024
D_{12}-Chrysene (IS)		240	3086	18555	
Chrysene		228	>53	—	>0.00240
Benzo(b)Fluoranthene	X	252		t	
Benzo(a)pyrene	X	252	3602	t 419	0.0226
Perylene	X	252		t	
Indeno(1,2,3-Cd)Pyrene	X	276		437	.0236
Dibenzo(a,h)anthracene	X	278		408	0219
Benzo(g,h,i)Perylene	X	276		574	.0309

3421-4 -10

CALCULATION WORKSHEET

LAB # 3421 A / SLP-4

D_5-Phenol (IS)

2,3-Dihydro-1H-Indene -- $\frac{1.56 \times 120}{0.84 \times 1.955}$ = 114 ppt

1H-Indene - - - - - - - - - $\frac{0.10 \times 120}{0.78 \times 1.955}$ = 7.9 ppt.

D_8-Naphthalene (IS)

Naphthalene - - - - - - - - $\frac{0.29 \times 120}{1.45 \times 1.955}$ = 12 ppt

1-Fluoronaphthalene (S) $\frac{0.39 \times 120 \times 100}{1.02 \times 50}$ = 92% Rec

Benzo(b)Thiophene - - - - - $\frac{1.71 \times 120}{0.91 \times 1.955}$ = 115 ppt

Quinoline - - - - - - - - - ——— —

Indole - - - - - - - - - - - ——— —

2-Methylnaphthalene - - - $\frac{0.10 \times 120}{0.94 \times 1.955}$ = 6.5 ppt

1-Methylnaphthalene - - - - $\frac{0.36 \times 120}{1.08 \times 1.955}$ = 20 ppt

2-Fluorobiphenyl (IS)

Biphenyl - - - - - - - - - - $\frac{0.38 \times 120}{1.31 \times 1.955}$ = 18 ppt

Acenaphthylene - - - - - - $\frac{0.12 \times 120}{1.58 \times 1.955}$ = 5.6 ppt

Acenaphthene - - - - - - - - $\frac{2.45 \times 120}{1.11 \times 1.955}$ = 135 ppt

Fluorene - - - - - - - - - - - $\frac{0.25 \times 120}{0.85 \times 1.955}$ = 18 ppt

Phenanthrene - - - - - - - - - $\frac{0.59 \times 120}{1.10 \times 1.955}$ = 33 ppt

D_{10}-Anthracene (IS)

3421-A-11

Anthracene - - - - - - - $\frac{0.05 \times 120}{1.26 \times 1.955}$ = 2.4

Acridine - - - - - - - - - ——— —

Penanthridine - - - - - - - ——— -

Carbazole - - - - - - - - $\frac{0.74 \times 120}{1.11 \quad 1.955}$ = 41 ppt

Fluoranthene - - - - - - - $\frac{0.06 \times 120}{1.05 \times 1.955}$ = 3.5

Pyrene - - - - - - - - - - $\frac{0.05 \times 120}{1.10 \times 1.955}$ = 2.8

Benzo(a)anthracene - - - $\frac{.00243 \quad 120}{1.27 \quad 1.955}$ = 0.12

D_{12}-Chrysene (IS)

Chrysene - - - - - - - - - $\frac{.00285 \quad 120}{1.54 \quad 1.955}$ ~ 0.11

Benzo(b)Fluoranthene - ———

Benzo(a)pyrene - - - - - $\frac{0.0226 \times 120}{0.9045 \quad 1.955}$ = 1.53 ppt. ✓

Perylene - - - - - - - - ———

Indeno(1,2,3-Cd)Pyrene $\frac{.0236 \times 120}{0.78 \quad 1.955}$ 1.857

Dibenzo(a,h)anthracene $\frac{.0219 \quad 120}{0.74 \quad 1.955}$ 1.817

Benzo(g,h,i)Perylene $\frac{.0309 \quad 120}{0.69 \quad 1.955}$ 2.75

3421-A-12

Audi.

C I- SC d

d 9-21-82

EPAQC- out OK.

Analyte. Ubiquitest

d8-Naph (136) 756-45 88 45942 (-0.1

1-F Naph 146) 763-179 84 17973 (+0.16)

MS out d12 Chrys = 3421-A (3086) std - 3085

3601 - BaP. ~~3598~~ Std. (3602) vs 3598 std. OK => 1.5 ppt.

area 252 = 419.

ANALYTE	3421-A	std.
d-12 Chrys.	3086	3085
BbF		3487
BaP		3598
Perylene		3628
BaA	3080 (+4)	3076
Chrys.	3097 (+3)	3094.

dot. but not quant. - 0.1

more abund = 53 Chrys -0.1 ppt

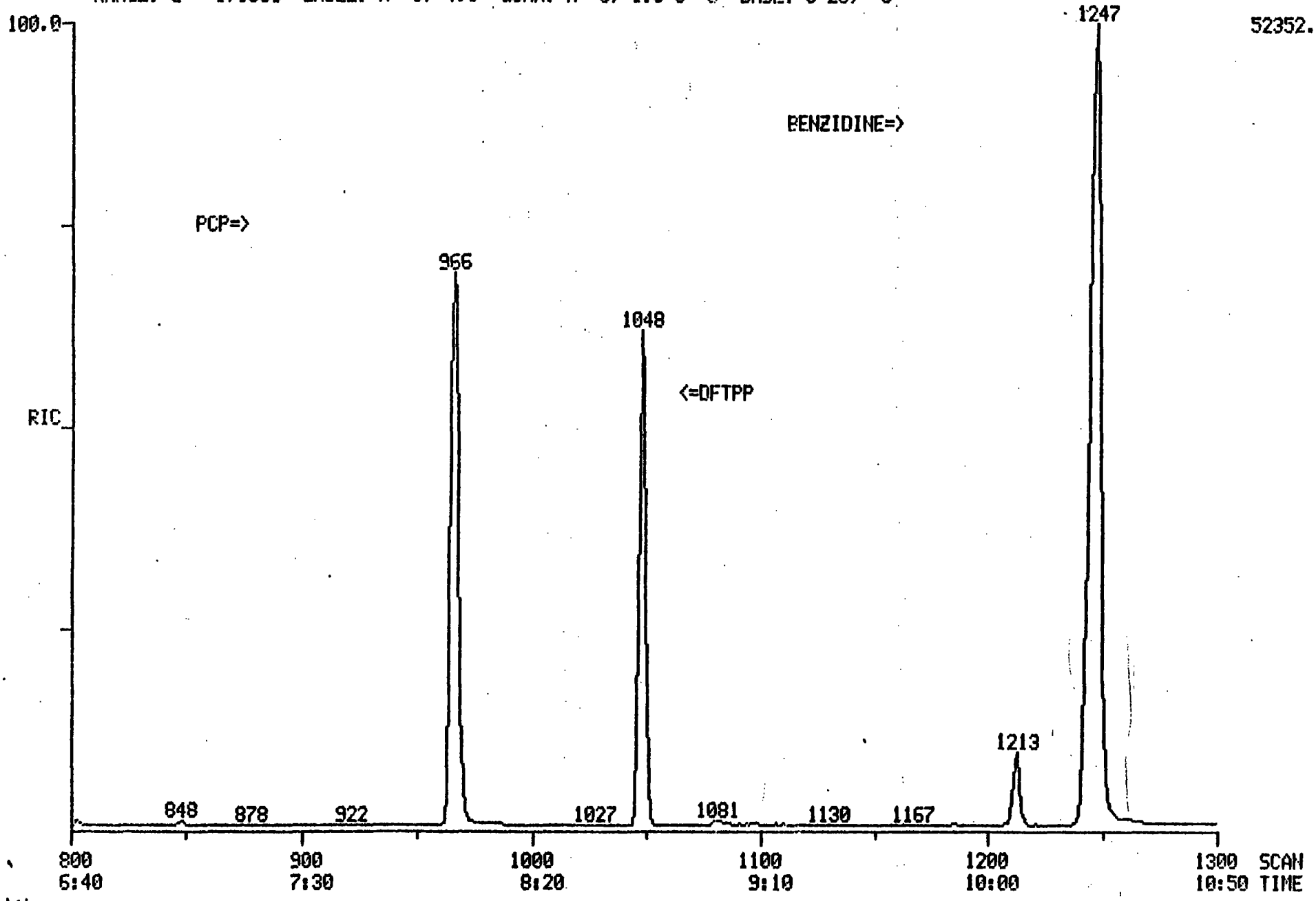
more abund = +45 BaA -0.1 ppt.

3421-A-13

RIC
09/24/82 8:57:00
SAMPLE:
CONDS.:
RANGE: G 1,1500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

DATA: EPAQCTEST #1
CALI: FRI092482A #2

SCANS 800 TO 1300



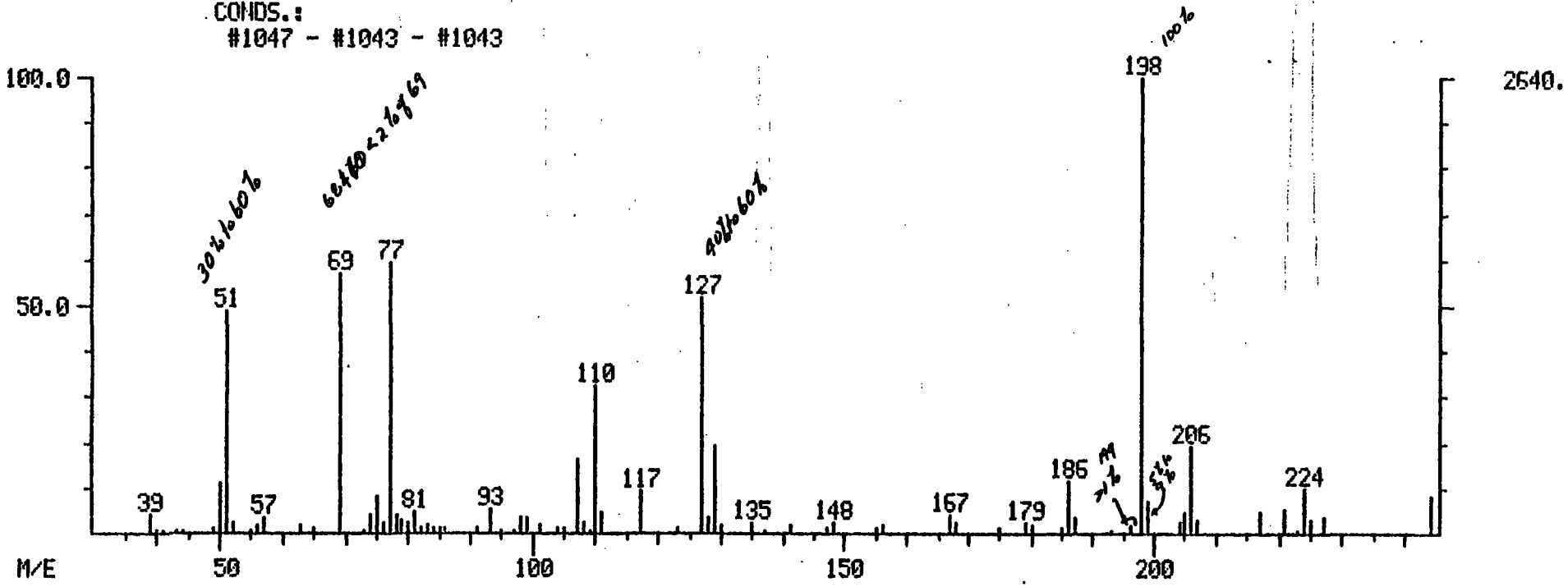
3421-P-1

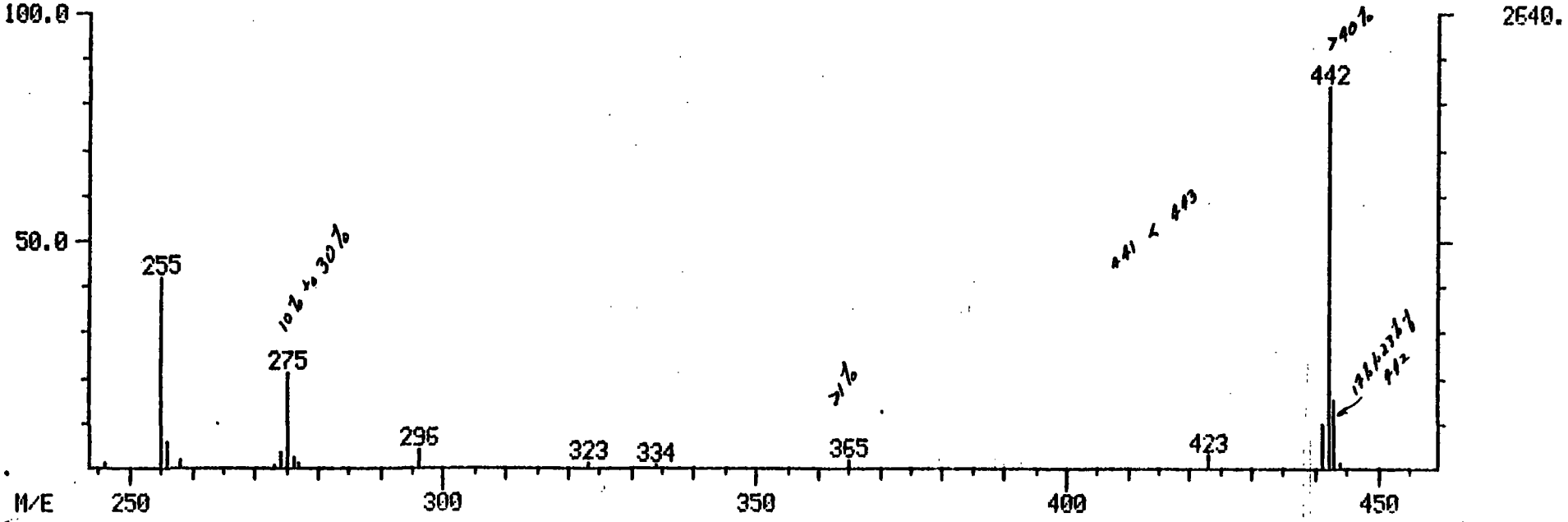
ATTACHMENT E

MASS SPECTRUM
09/24/82 8:57:00 + 8:43
SAMPLE:
CONDS.:
#1047 - #1043 - #1043

DATA: EPAQCTEST #1047
CALI: FRI092482A #2

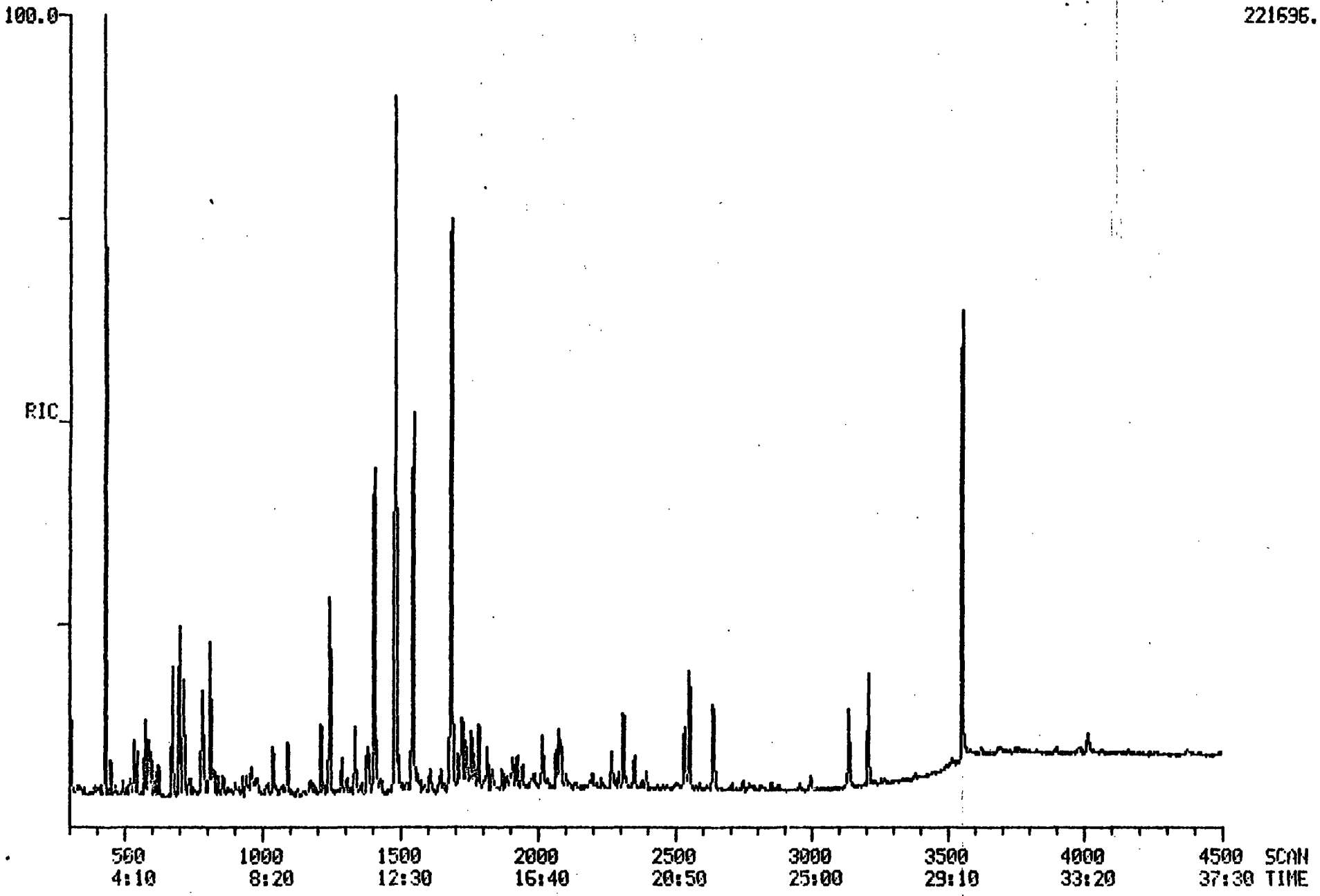
BASE M/E: 198
RIC: 21280.





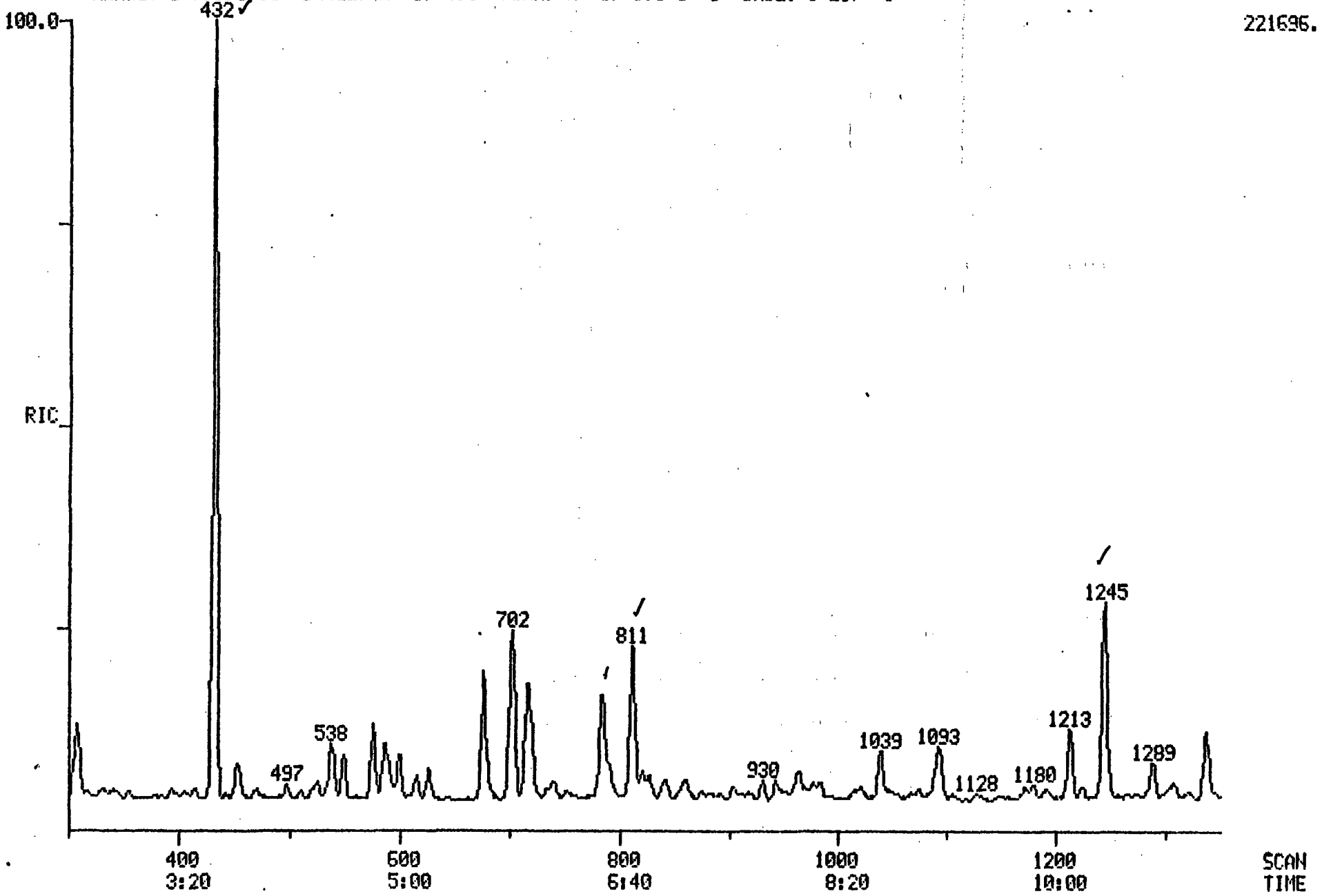
3421-P-2

RIC DATA: 3421FBN #1 SCANS 300 TO 4500
09/24/82 11:08:00 CALI: FRI092482A #2
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
RANGE: G 1,4500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



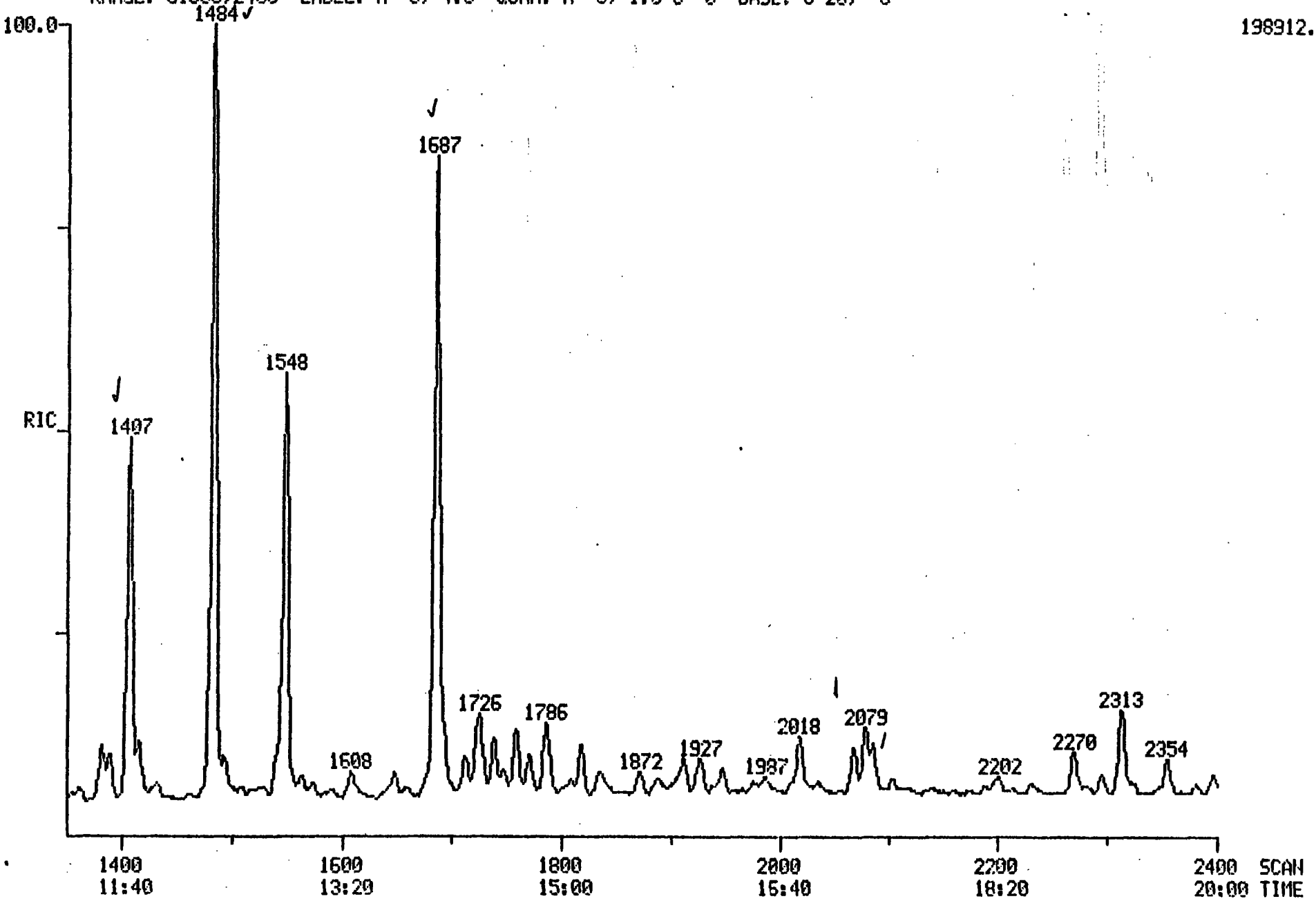
3421-P-3

RIC DATA: 3421PBH #1 SCANS 300 TO 1350
09/24/82 11:08:00 CALI: FRI092482A #2
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
RANGE: G 300,1350 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



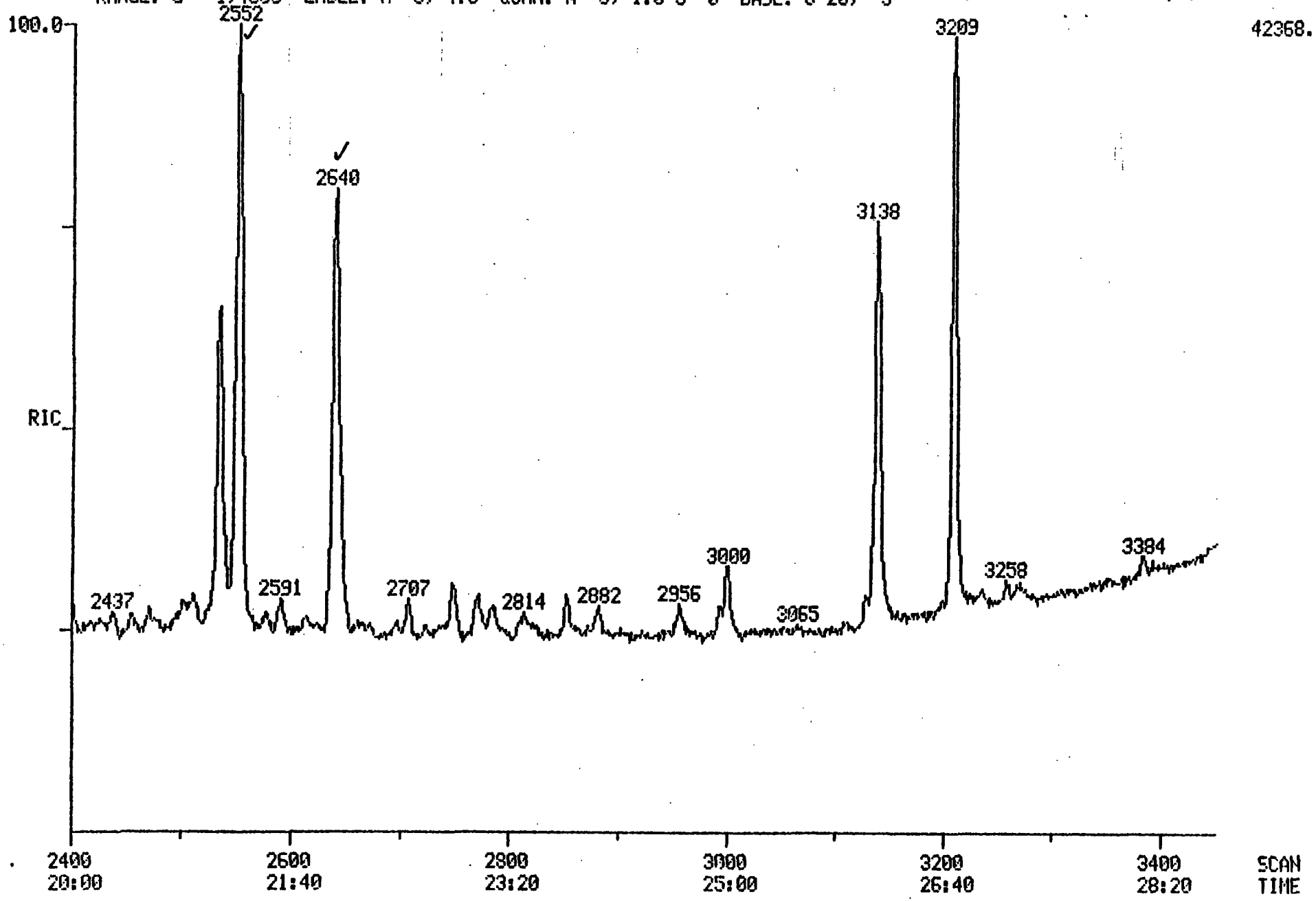
3421-P-4

RIC
09/24/82 11:08:00
DATA: 3421PBN #1
CALI: FRI092482A #2
SCANS 1350 TO 2400
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
RANGE: G1350,2400 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



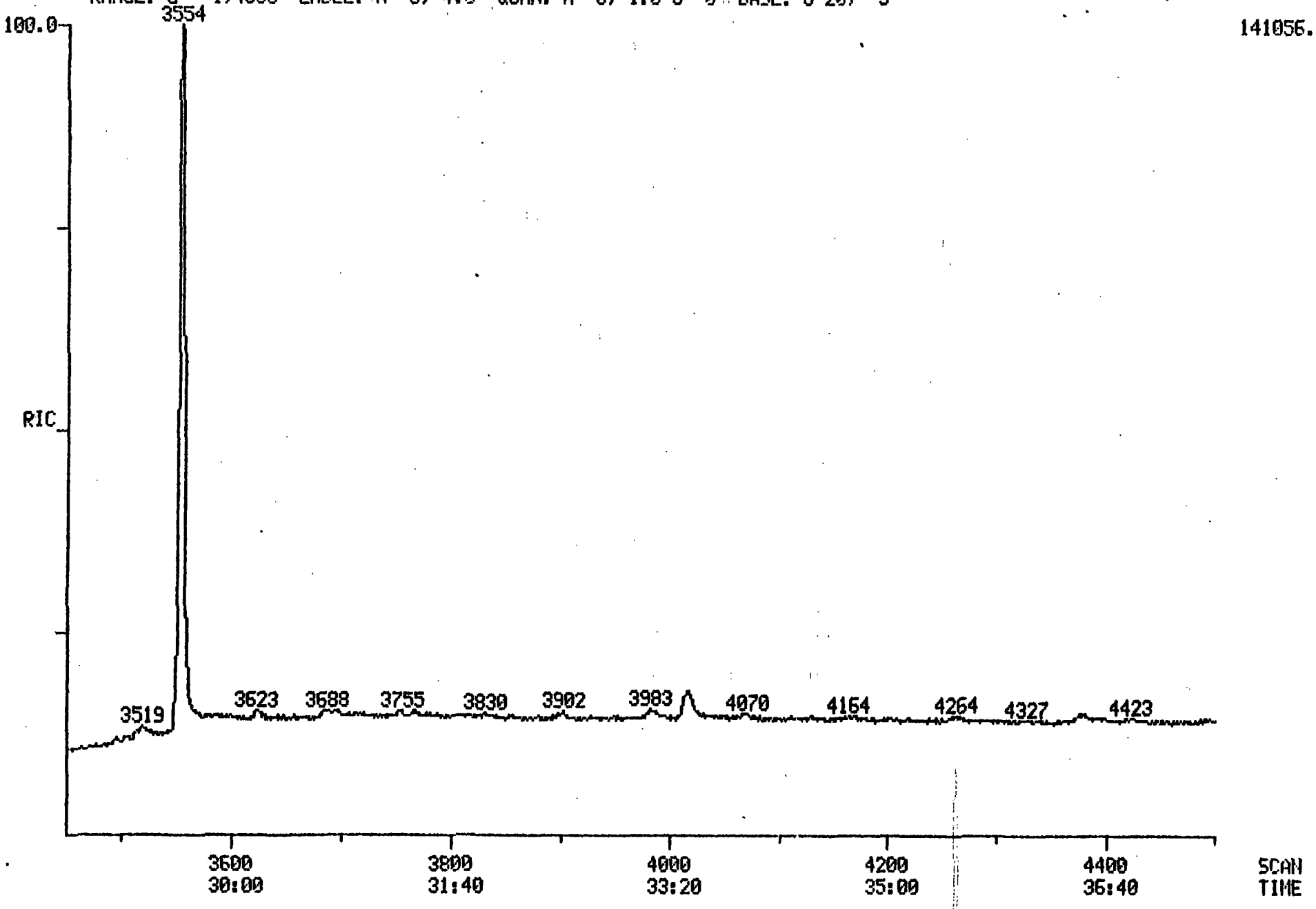
3421-P-5

RIC
09/24/82 11:08:00
DATA: 3421PBN #1
CALI: FRI092482A #2
SCANS 2400 TO 3450
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
RANGE: G 1,4500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



3421-P-6

RIC DATA: 3421PBN #1 SCANS 3450 TO 4500
09/24/82 11:08:00 CALI: FRI092482A #2
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
RANGE: G 1,4500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

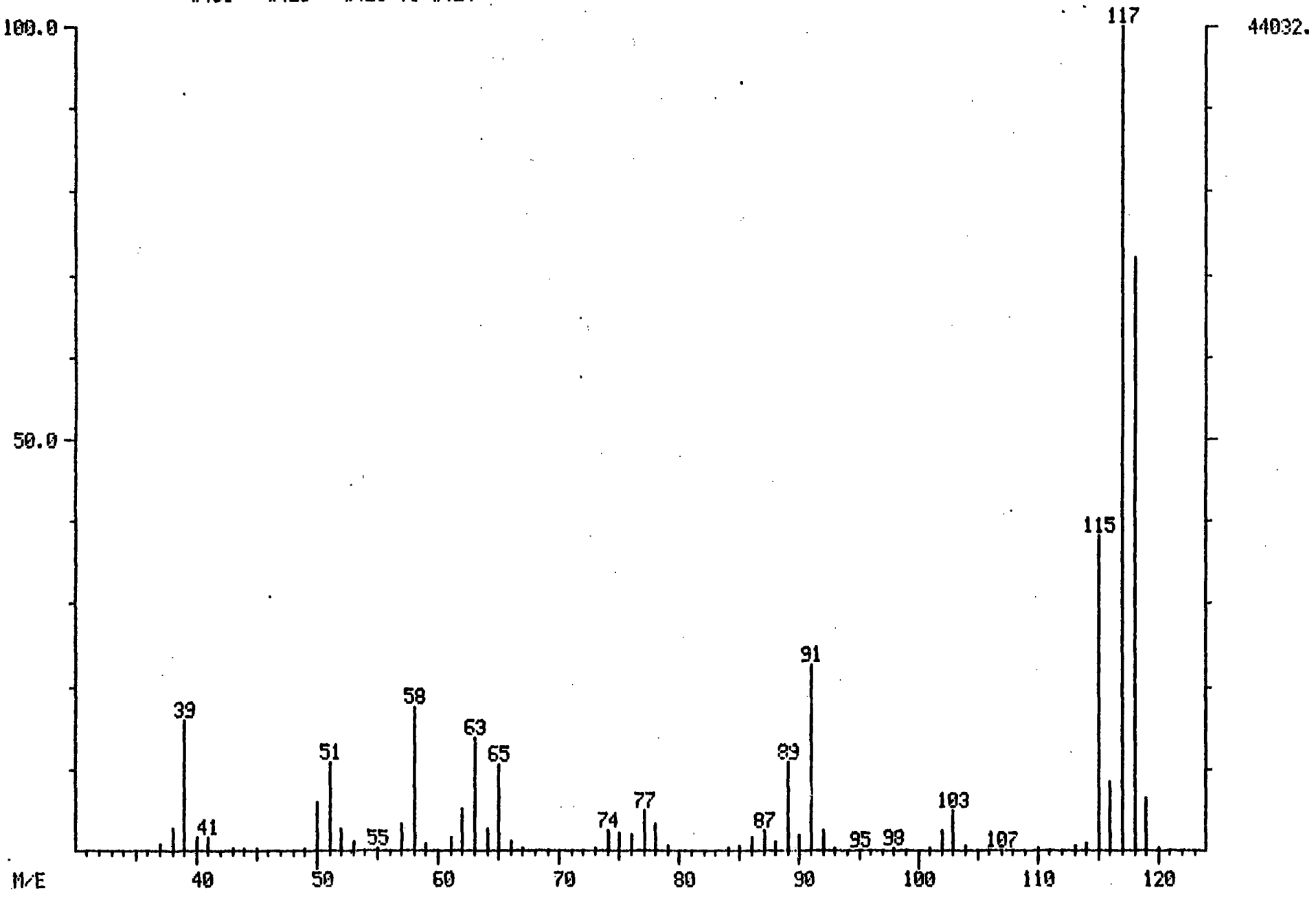


3421-P-7

MASS SPECTRUM
09/24/82 11:08:00 + 3:35
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#431 - #423 - #423 TO #424

DATA: 3421PBN #431
CALI: FRI092482A #2

BASE M/E: 117
RIC: 174592.

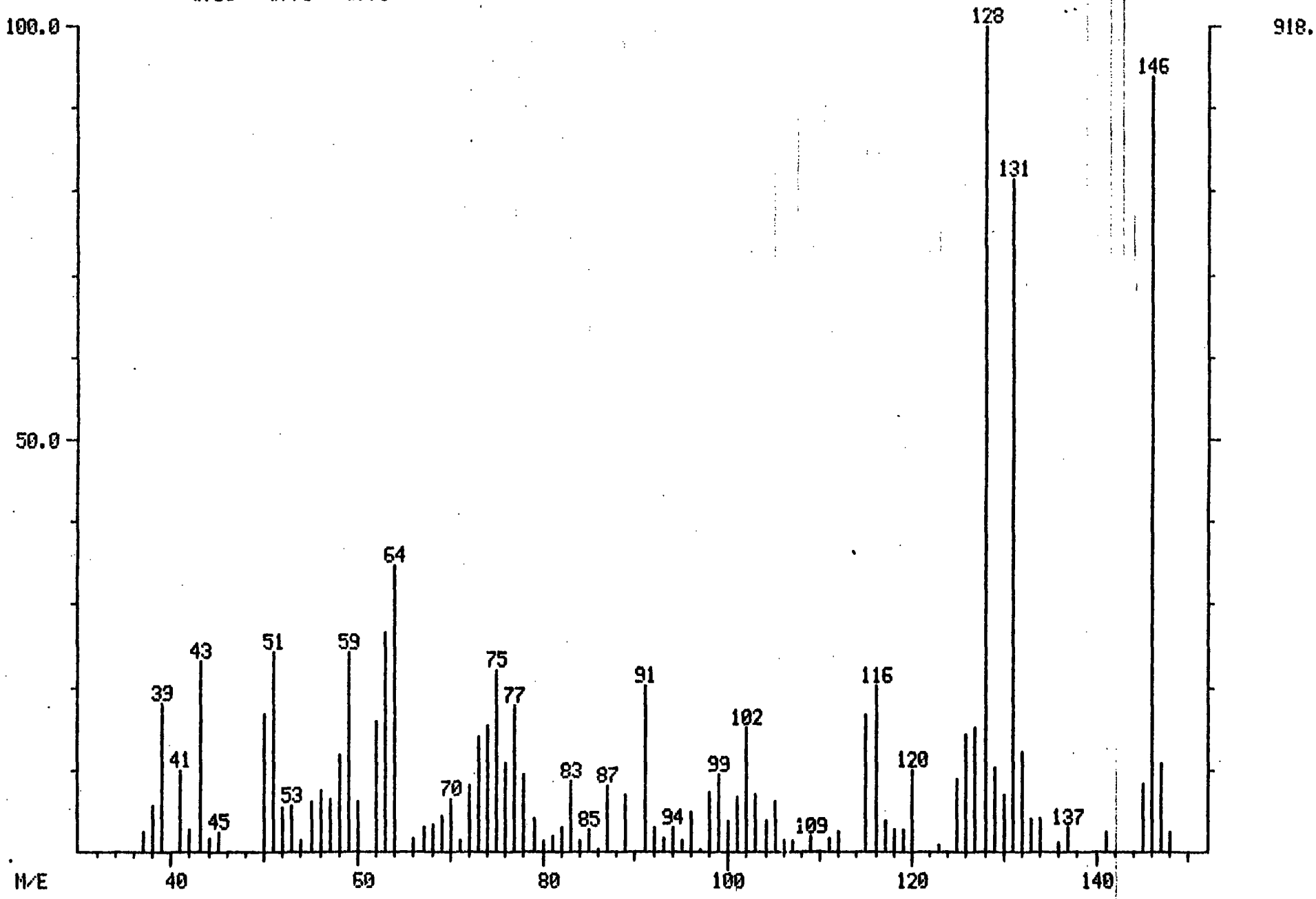


3421-P-7

MASS SPECTRUM
09/24/82 11:08:00 + 6:35
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#790 - #776 - #776

DATA: 3421PBN #790
CALI: FRI092482A #2

BASE M/E: 128
RIC: 8752.

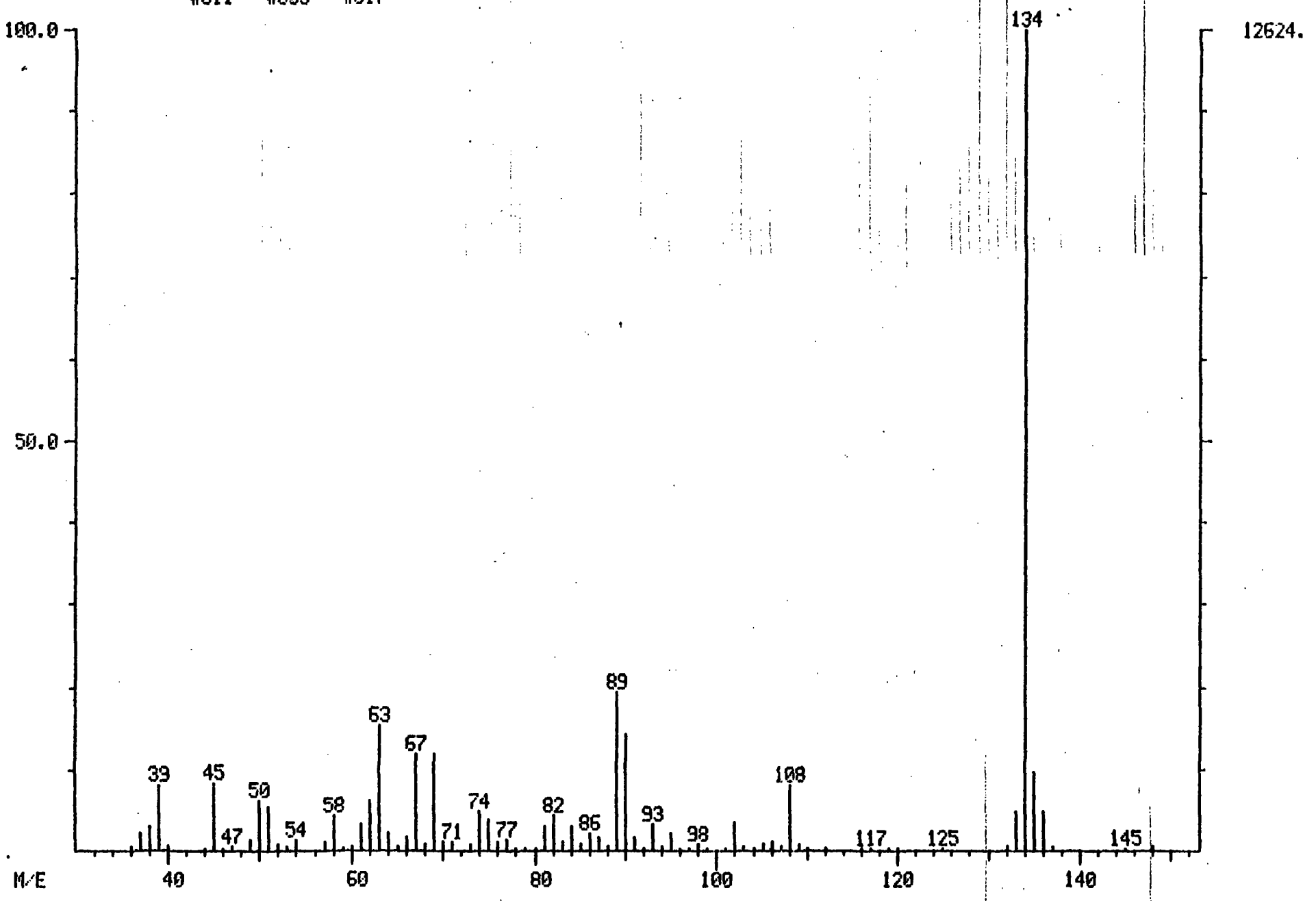


3421-P-10

MASS SPECTRUM
09/24/82 11:08:00 + 6:45
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#811 - #803 - #817

DATA: 3421PBN #811
CALI: FRI092482A #2

BASE M/E: 134
RIC: 39360.

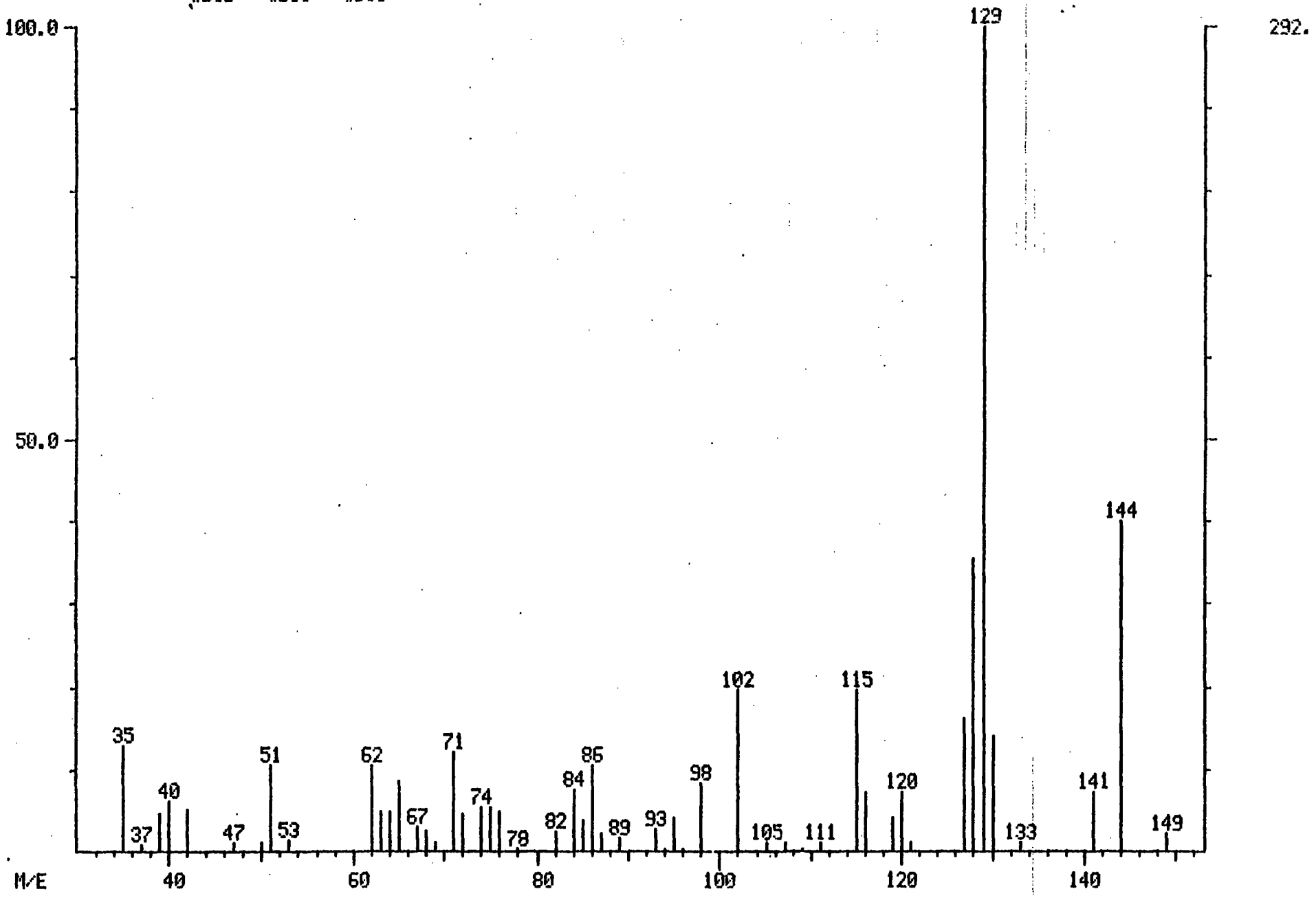


3421-P-11

MASS SPECTRUM
09/24/82 11:08:00 + 7:39
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#919 - #913 - #913

DATA: 3421PBN #919
CALI: FRI092482A #2

BASE M/E: 129
RIC: 1270.

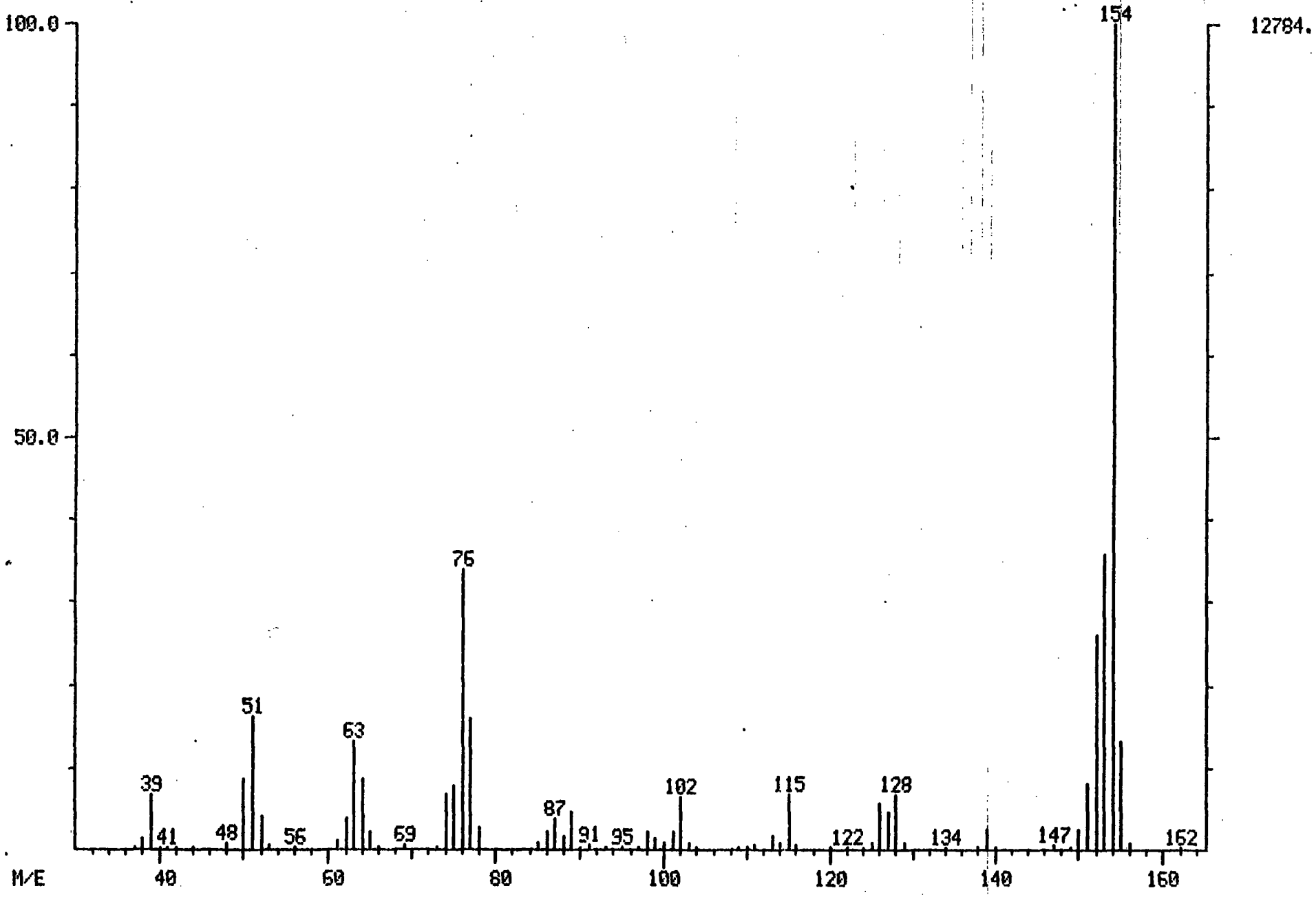


3421-P-12

MASS SPECTRUM
09/24/82 11:08:00 + 10:22
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#1244 - #1236 - #1236

DATA: 3421PBN #1244
CALI: FRI092482A #2

BASE M/E: 154
RIC: 49536.

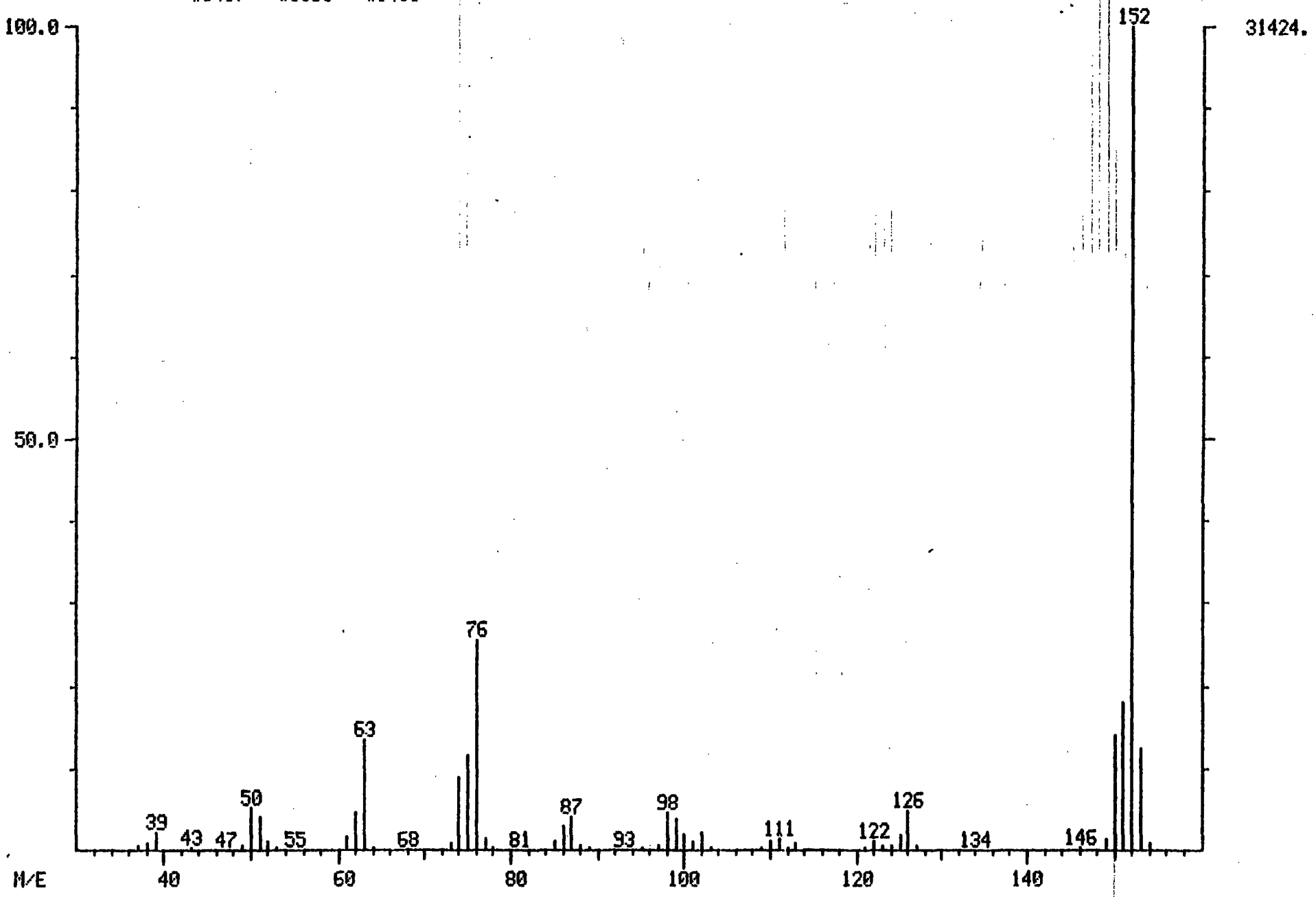


3421-P-13

MASS SPECTRUM
09/24/82 11:08:00 + 11:43
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#1407 - #1396 - #1413

DATA: 3421FBN #1407
CALI: FRI092482A #2

BASE M/E: 152
RIC: 84096.

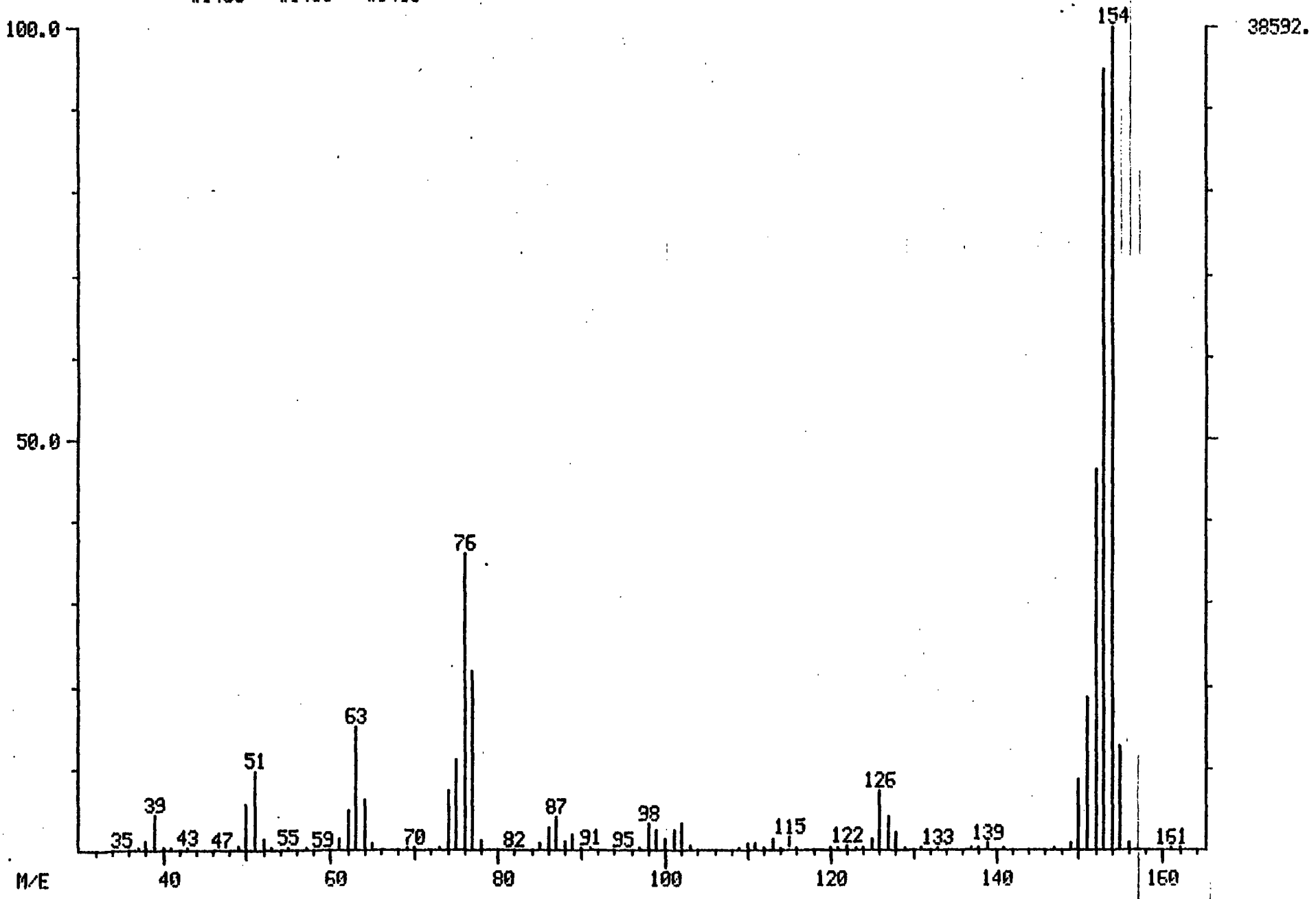


3421-P-14

MASS SPECTRUM
09/24/82 11:08:00 + 12:21
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#1483 - #1468 - #1468

DATA: 3421PBN #1483
CALI: FRI092482A #2

BASE M/E: 154
RIC: 178944.

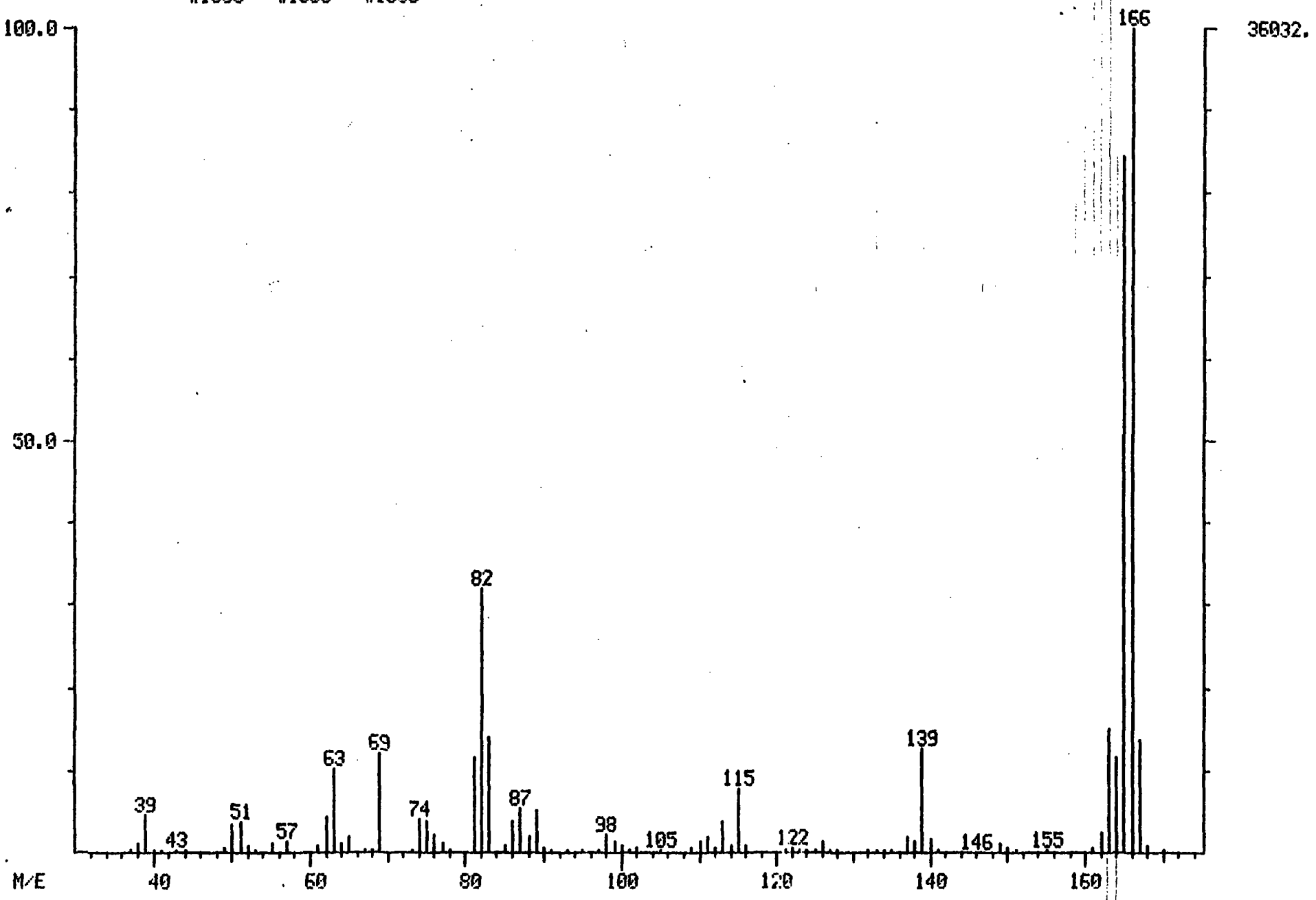


3421-P-15

MASS SPECTRUM
09/24/82 11:08:00 + 14:03
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#1686 - #1665 - #1665

DATA: 3421PBN #1686
CALI: FRI092482A #2

BASE M/E: 166
RIC: 148480.

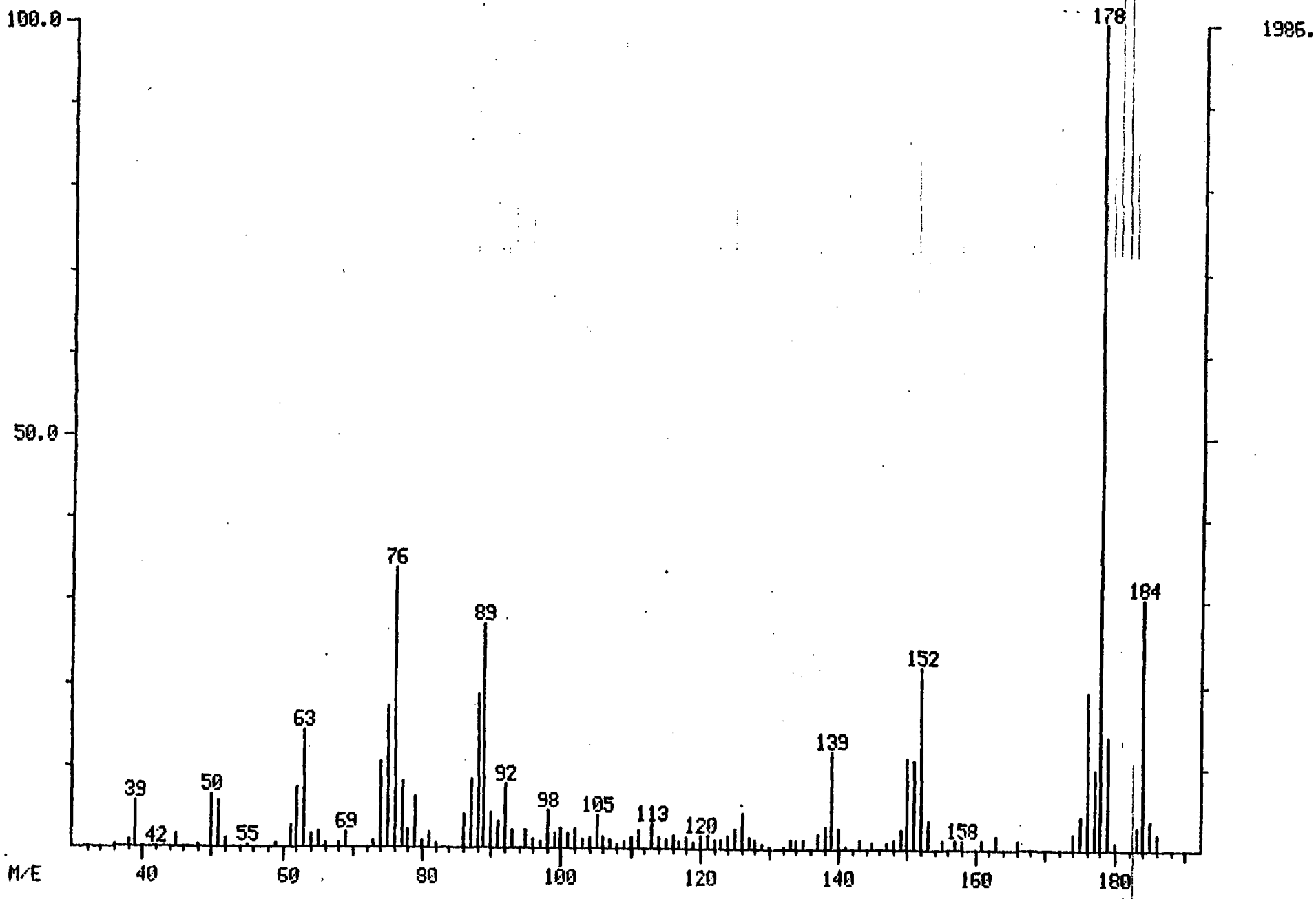


3421-P-16

MASS SPECTRUM
09/24/82 11:08:00 + 17:13
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#2067 - #2057 - #2057

DATA: 3421PBN #2067
CALI: FRI092482A #2

BASE M/E: 178
RIC: 10768.

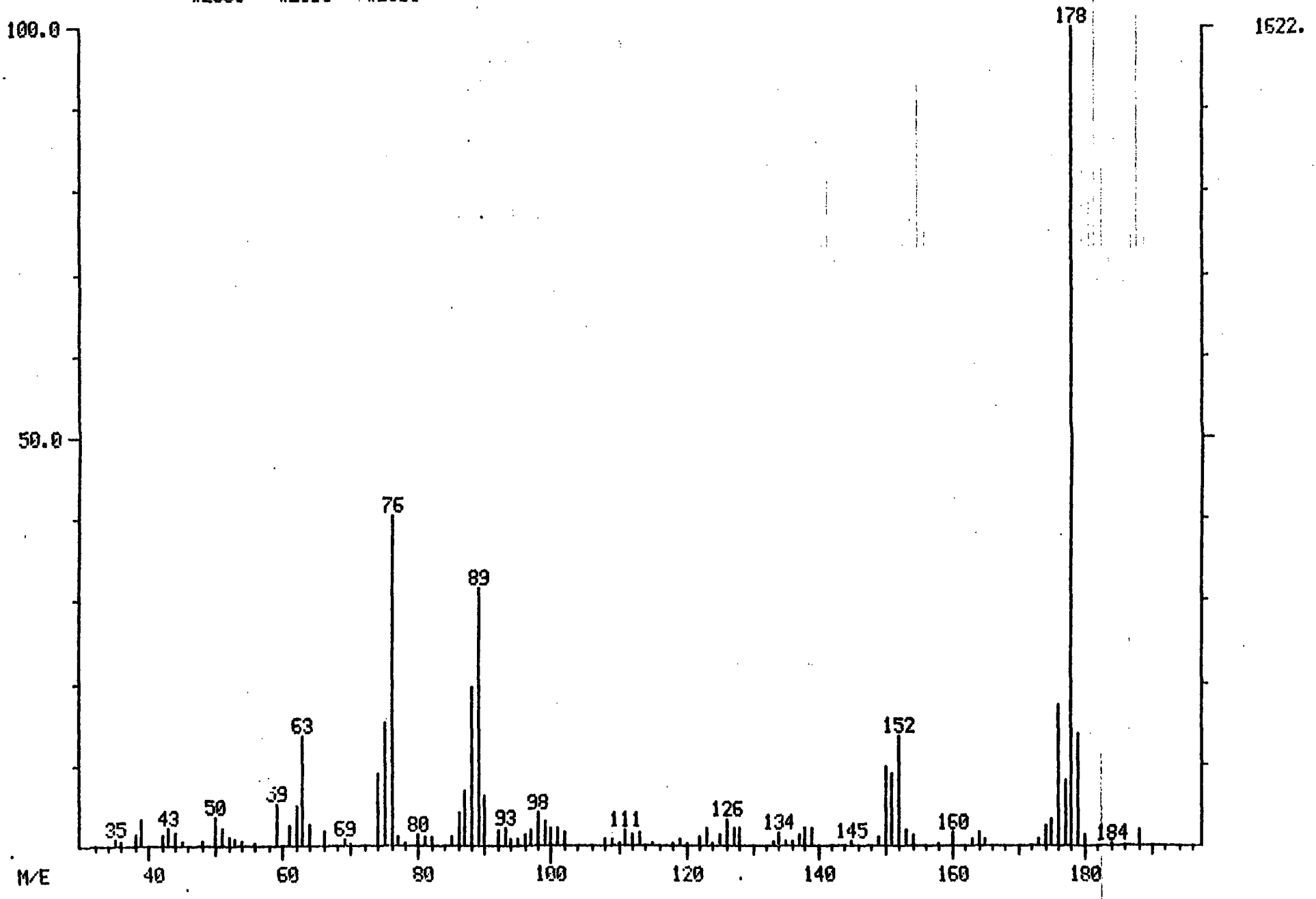


3421-P-17

MASS SPECTRUM
09/24/82 11:08:00 + 17:24
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#2088 - #2093 - #2093

DATA: 3421FBN #2088
CALI: FRI092482A #2

BASE M/E: 178
RIC: 7056.

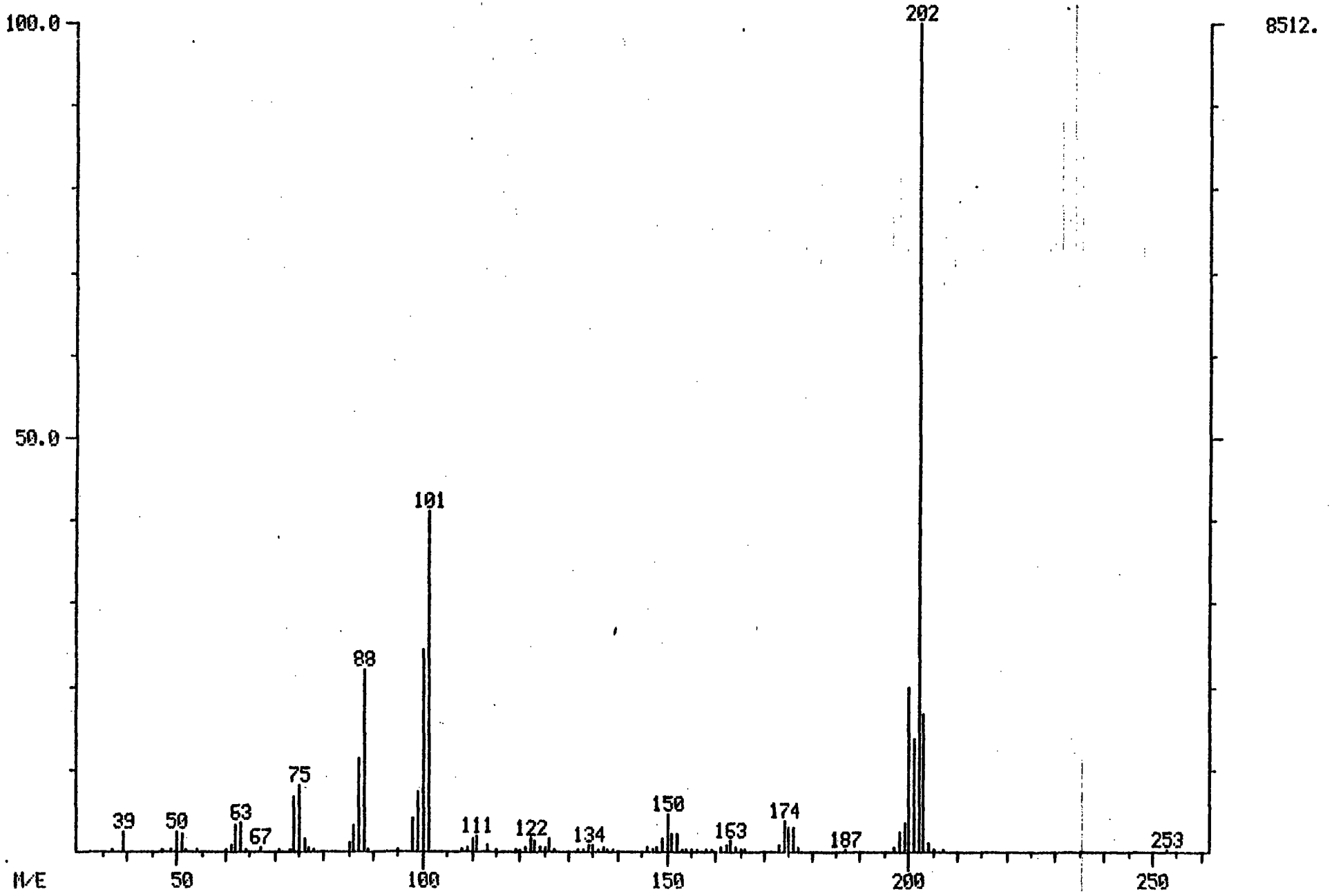


3421-P-15

MASS SPECTRUM
09/24/82 11:08:00 + 21:16
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#2552 - #2542 - #2543

DATA: 3421PBN #2552
CALI: FRI092482A #2

BASE M/E: 202
RIC: 30176.

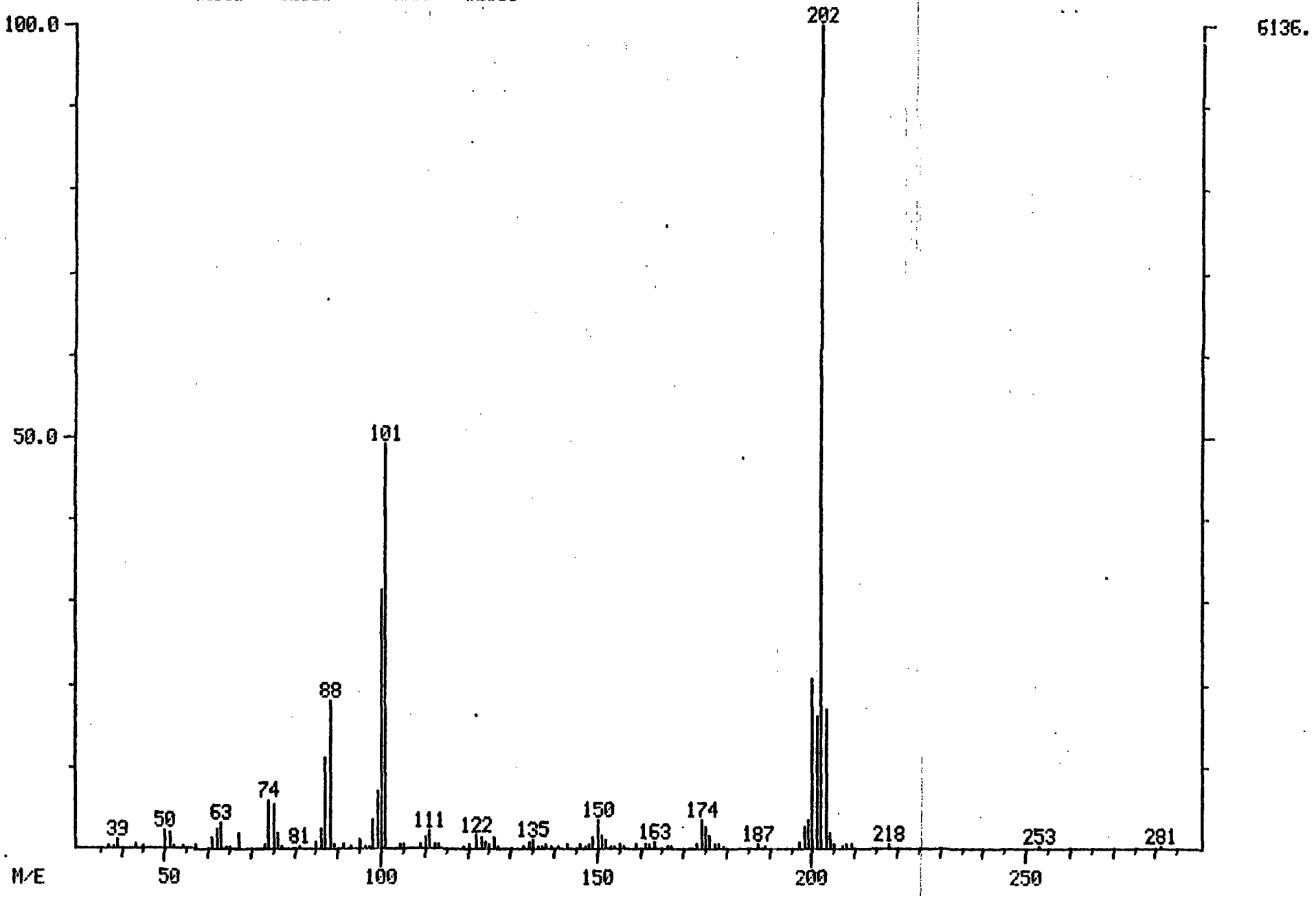


3421-P-19

MASS SPECTRUM
09/24/82 11:08:00 + 21:59
SAMPLE: SLP-15 WELL HEAD VOL EXT'D=1940MLS FINAL VOL=400 UL IS SPIKE=400
CONDS.:
#2639 - #2629 TO #2630 - #2630

DATA: 3421PBN #2639
CALI: FRI092482A #2

BASE M/E: 202
RIC: 22496.



3421-P-20

CH2M HILL

ANALYTICAL REPORT

PAH, N and S Heterocyclic Compounds

Sample Identification SLP-15 Well Head Lab # 3421P

Date Received 9/16/82 Date Extracted 9/20/82

Date Analyzed 9/24/82

Compounds	MDL[1] ng/l	Conc[2] ng/l	Compounds	MDL[1] ng/l	Conc[2] ng/l
2,3-Dihydro-1-Indene	35	~~1700~~ 1662	Acridine	40	BMDL
1H-Indene	25	72	Phenanthridine	35	BMDL
Naphthalene	47	17	Carbazole	28	BMDL
Benzo(b)thiophene	25	~~390~~ 385	Fluoranthene	25	430 434
Quinoline	25	BMDL	Pyrene	25	340 342
Indole	72	BMDL	Benzo(a)anthracene	25	BMDL
2-Methylnaphthalene	50	BMDL	Chrysene	25	BMDL
1-Methylnaphthalene	30	93	Benzo(b & k)Floranthene	25	BMDL
Biphenyl	25	540 544	Benzo(a & e)pyrene	25	BMDL
Acenaphthylene	25	1200 1166	Perylene	25	BMDL
Acenaphthene	33	2200 2190	Indeno(1,2,3-cd)pyrene	43	BMDL
Fluorene	35	2100 2134	Dibenzo(a,h)anthracene	35	BMDL
Phenanthrene	25	100	Benzo(g,h,i)perylene	25	BMDL
Anthracene	25	130 126			

Percent Recovery of 1-Fluoronaphthalene = 100%

[1]MDL = Method Detection Limit

[2]BMDL = Below Method Detection Limit

Blue - divergent MDL Constituents
Black - BLANK

3221-P-21

CH2M HILL

LABORATORY WORKSHEET

St. Louis Park Project

I. SAMPLE INFORMATION: Date Received 9/16/82 by HEC Lab # 3421 P

Condition of Sample: cold - ice present

Labeled: SLP-15 Well Head Sealed yes

II. SAMPLE EXTRACTION: Date Extracted 9/20/82 Extracted by MTP

Volume Extracted 1940 mls Final Vol. of Extract 400 µl.

Surrogate Spike Concentration 50ng 1-Fl Naphthalene 100ng 2,4,6-Tribromophe

Extraction Difficulties B/N emulsion

III. SAMPLE GC/MS ANALYSIS: Analyst HEC Analysis Date 9/24/82

Internal Standard Spike Concentration 400 ng

1125 volts.

Note: The Interfering Compound for Indene Not Present in this Ext.

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	432	230851	6.29
1H-Indene	116	452	9561	0.26
D_8-Naphthalene (IS)	136	783	36686	
Naphthalene	128	790	4458	0.12
1-Fluoronaphthalene (S)	146	790	4675	0.13
Benzo(b)Thiophene	134	811	67693	1.85
Quinoline	129	(919)	E? (1458)	0.0397
Indole	117		–	
2-Methylnaphthalene	142		E	
1-Methylnaphthalene	142	1094	10788	0.50
2-Fluorobiphenyl (IS)	172	1213	21607	
Biphenyl	154	1245	74163	3.43
Acenaphthylene	152	1407	186416	8.63
Acenaphthene	154	1484	229690	10.63
Fluorene	166	1687	219562	9.44
Phenanthrene	178	2068	13131	0.56
D_{10}-Anthracene (IS)	188	2078	23258	—
Anthracene	178	2086	18057	0.78
Acridine	179		– E?	
Penanthridine	179		– E?	

3421-P-22

Compounds		QM	Scan	Area	
Carbazole	X	167		± ?	
Fluoranthene	✓	202	2552	55862	2.40
Pyrene	✓	202	2640	45171	1.94
Benzo(a)anthracene	X	228		±	
D_{12}-Chrysene (IS)		240		9669	
Chrysene	X	228		± (43)	
Benzo(b)Fluoranthene		252		—	
Benzo(a)pyrene		252		—	
Perylene		252		—	
Indeno(1,2,3-Cd)Pyrene		276		—	
Dibenzo(a,h)anthracene		278		—	
Benzo(g,h,i)Perylene		276		—	

CALCULATION WORKSHEET

LAB # 3421 P

SLP-15 @ well head

D_5-Phenol (IS)

2,3-Dihydro-1H-Indene -- $\frac{6.29 \times 400}{0.77 \times 1.94} = 1684$

1H-Indene - - - - - - - - - $\frac{0.26 \times 400}{0.74 \times 1.94} = 72$ ppt.

D_8-Naphthalene (IS)

Naphthalene - - - - - - - - $\frac{0.12 \times 400}{1.46 \times 1.94} = 17$ ppt.

1-Fluoronaphthalene (S) $\frac{0.13 \times 400 \times 100}{1.04 \times 50} = 100\%$

Benzo(b)Thiophene - - - - - $\frac{1.85 \times 400}{0.99 \times 1.94} = 385$

Quinoline - - - - - - - - - $\frac{0.0942 \times 400}{0.82 \times 1.94} = 9.99 = 10$

Indole - - - - - - - - - - - —

2-Methylnaphthalene - - - — t

1-Methylnaphthalene - - - - $\frac{0.50 \times 400}{1.11 \times 1.94} = 93$

2-Fluorobiphenyl (IS)

Biphenyl - - - - - - - - - - $\frac{3.43 \times 400}{1.30 \times 1.94} = 544$

Acenaphthylene - - - - - - - $\frac{8.63 \times 400}{1.50 \times 1.94} = 1186$

Acenaphthene - - - - - - - - $\frac{10.63 \times 400}{1.01 \times 1.94} = 2170$

Fluorene - - - - - - - - - - - $\frac{9.44 \times 400}{0.91 \times 1.94} = 2139$

Phenanthrene - - - - - - - - - $\frac{0.56 \times 400}{1.16 \times 1.94} = 100$ ppt.

D_{10}-Anthracene (IS)

Anthracene	$\frac{0.78}{1.27} \times \frac{400}{1.94}$	= 126	
Acridine	—		
Penanthridine	—		
Carbazole	—		
Fluoranthene	$\frac{2.40}{4.14} \times \frac{400}{1.94}$	434	
Pyrene	$\frac{1.94}{1.17} \times \frac{400}{1.94}$	342	
Benzo(a)anthracene			
D_{12}-Chrysene (IS)			
Chrysene	$\frac{0.00858}{1.42} \times \frac{400}{1.94}$	1.24	~ 1.2 ppt.
Benzo(b)Fluoranthene			
Benzo(a)pyrene			
Perylene			
Indeno(1,2,3-Cd)Pyrene			
Dibenzo(a,h)anthracene			
Benzo(g,h,i)Perylene			

3411 P.

Daily EPAQC Test — $C_{60}H_{122}Cl_5$ DFTPP BNZD OK.

Plot cont. 300 - 1350
1350 - 2400
2400 - 3450
3450 - 4500 scans.

AREA INTEGRATION

		WORKsheet. scan - area	Manual Int. scan - area	STD.	RF
25-out.)	2,3 H_2 Indene	432 - 230851	431 -	428-64871	0.7681
	d_8-Naph. (IS)	783 - 36686	36686	783-78202	1
	Naph.	790 - 4658	4624 (3.7%)	791-114267	1.4612
	1-F Naph	790 - 4675	4631 (-0.9%)	790-51292	1.039
	2-F Biphenyl.	1213 - 21607	21607 (0.00%)		
	Acenyl	1407 - 186416	186545	+0.07%	0.6275
	d-10 Anth.	2065 - ~~[illegible]~~ 23251	23050	-0.9%	
	d-12 Chrysene	9669	9669	0.00%	

Scan. 811 - Benzo(b) Thiophene Forward Search. Purity 783 Fwd. 996

Spectra looks good!

Quinoline — 919 - 1458. — (10 ppt.)

Chrys: small peak, Skewed max abund (228) = 83 = min f. (1.2 ppt.)

contaminant @ 3555 — 2,6,10,14,18,22 tetracosane hexamethyl. $C_{30}H_{50}$ Pr = 410
2,6,10,14,19,23 hexamethyl.
from cosmetics etc.

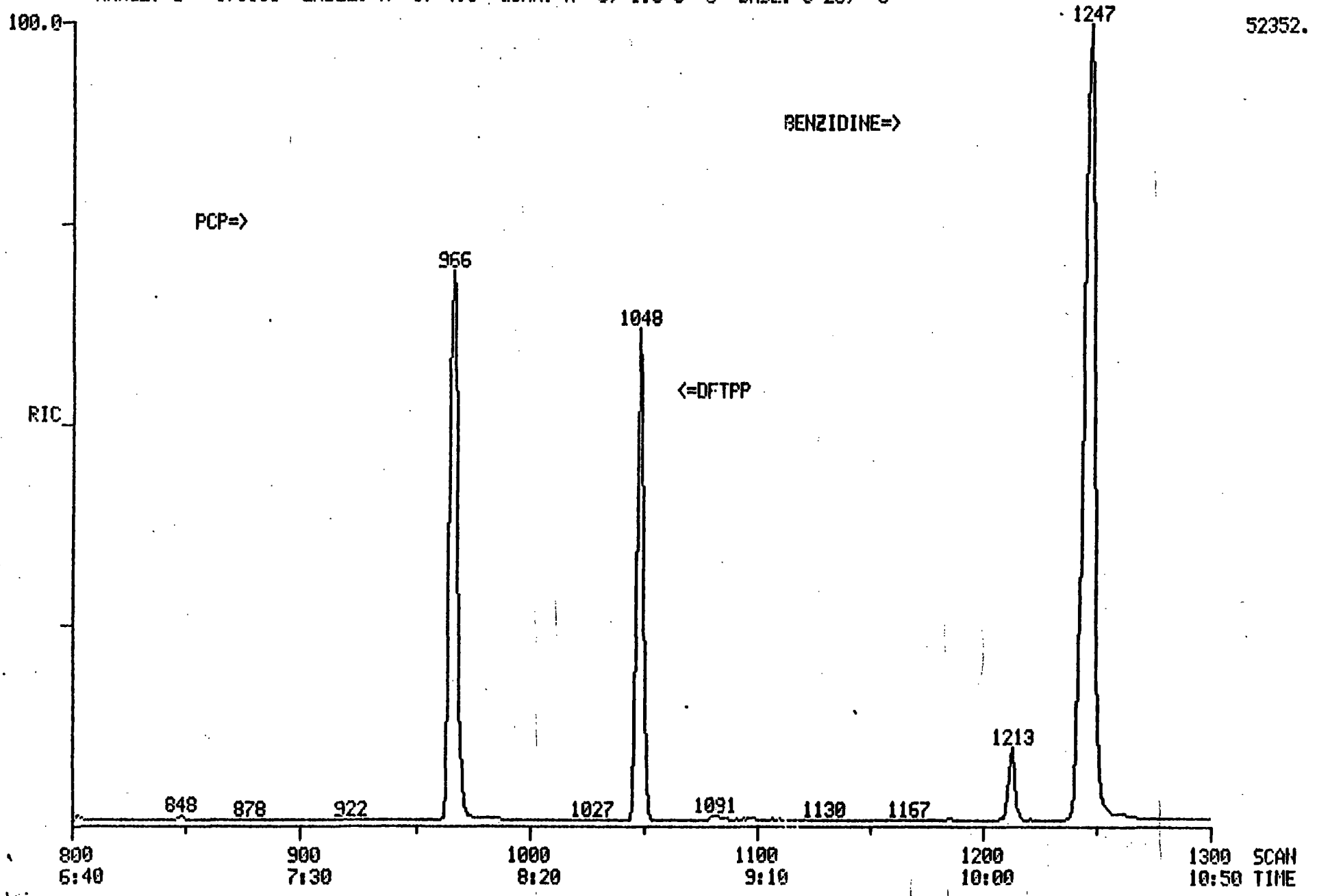
Mass Spectra Out:

Scan.	Analyte.	Scan Std.	Scan	Analyte		Std.
431	2,3 H_2 Indene	428	1483	Acen		1486
452	Indene.	449	1685	Fluor		1689
790	1-F Naph + Naph.	790	2067	Phen	some contam.	2072
811	B(b) Thiophene	812	2085	Anth		2092
919	Quinoline	918	2552	Fluora		2557
1244	Biphenyl	1247	2639	Pyrene		2644
1407	Acenaphthene	1410				

RIC
09/24/82 8:57:00
SAMPLE:
CONDS.:
RANGE: G 1,1500 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

DATA: EPAQCTEST #1
CALI: FRI092482A #2

SCANS 800 TO 1300



3421-P-1

ATTACHMENT E

PAHSNSfd.1

900 Volts

9/17/82

RESPONSE FACTORS

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	402	95060	0.84 X20/21.6=0.78
1H-Indene	116	422	88973	0.78 X20/21.8=0.72
D_8-Naphthalene (IS)	136	752	113378	
Naphthalene	128	760	154499	1.36
1-Fluoronaphthalene (S)	146	760	107190	0.95
Benzo(b)Thiophene	134	780	107955	0.95
Quinoline	129	886	172118	1.08 X20/27.4=0.79
Indole	117	1014	100347	1.19
2-Methylnaphthalene	142	1023	133292	1.58 X20/35.8=0.88
1-Methylnaphthalene	142	1064	118099	1.40 X20/27=1.03
2-Fluorobiphenyl (IS)	172	1183	84397	
Biphenyl	154	1213	105034	1.24
Acenaphthylene	152	1374	123560	1.46
Acenaphthene	154	1450	83014	0.98
Fluorene 86185	166	1652	86485	1.0
Phenanthrene	178	2035	102242	1.19
D_{10}-Anthracene (IS)	188	2047	86242	
Anthracene	178	2054	107430	1.24
Acridine	179	2073	79488	0.92
Penanthridine	179	2115	83641	0.97
Carbazole	167	2131	103516	1.20
Fluoranthene	202	2520	97452	1.13
Pyrene	202	2607	101175	1.17
Benzo(a)anthracene	228	3100	64623	1.35
D_{12}-Chrysene (IS)	240	3109	46734	
Chrysene	228	3119	69745	1.49
Benzo(b)Fluoranthene	252	3575	44855	0.91
Benzo(a)pyrene	252	3629	41463	0.89
Perylene	252	3661	54753	1.17
Indeno(1,2,3-Cd)Pyrene	* 276	4168	34538	0.74
Dibenzo(a,h)anthracene	278	4123	33261	0.71
Benzo(g,h,i)Perylene	276	4239	32250	0.69

* Corrected

20 µg/ml exce
for Compounds Cont

ATTACHMENT F

STDS-i

PAH STD 2

DATE 9/18/82

RESPONSE FACTORS

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	389	60939	0.83 X20/21.6 = 77
1H-Indene	116	409	56586	0.77 X20/21.8 = 71
D_8-Naphthalene (IS)	136	735	73360	
Naphthalene	128	743	114874	1.57
1-Fluoronaphthalene (S)	146	743	86631	1.18
Benzo(b)Thiophene	134	763	74908	1.02
Quinoline	129	869	83988	1.14 X20/27.4 = 0.84
Indole	117	997	74207	1.43
2-Methylnaphthalene	142	1005	94826	1.82 X20/35.8 = 1.02
1-Methylnaphthalene	142	1045	78807	1.51 X20/27 = 1.13
2-Fluorobiphenyl (IS)	172	1165	51837	
Biphenyl	154	1195	66627	1.29
Acenaphthylene	152	1354	85878	1.66
Acenaphthene	154	1430	54786	1.06
Fluorene	166	1632	53299	0.98
Phenanthrene	178	2011	70173	1.16
D_{10}-Anthracene (IS)	188	2022	60736	
Anthracene	178	2030	77265	1.27
Acridine	179	2049	53893	0.89
Penanthridine	179	2090	55596	0.91
Carbazole	167	2107	70712	1.16
Fluoranthene	202	2491	61371	1.01
Pyrene	202	2577	64343	1.06
Benzo(a)anthracene	228	3068	56580	1.13
D_{12}-Chrysene (IS)	240	3076	49851	
Chrysene	228	3086	64448	1.29
Benzo(b)Fluoranthene	252	3480	47046	0.94
Benzo(a)pyrene	252	3591	45502	0.91
Perylene	252	3620	55311	1.11
Indeno(1,2,3-Cd)Pyrene	276	4032	37661	0.76
Dibenzo(a,h)anthracene	278	4046	38097	0.76
Benzo(g,h,i)Perylene	276	4150	33828	0.68

STD5-2

PAHsN std3

DATE 9/20/82

RESPONSE FACTORS

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	389	76767	0.88 X20/21.6 = 0.82
1H-Indene	116	409	70755	0.81 X20/21.8 = 0.75
D_8-Naphthalene (IS)	136	737	87053	
Naphthalene	128	745	133049	1.53
1-Fluoronaphthalene (S)	146	744	95738	1.10
Benzo(b)Thiophene	134	765	81374	0.93
Quinoline	129	870	919461	1.04 X20/27.4 = 0.76
Indole	117	999	15620	1.16
2-Methylnaphthalene	142	1007	107196	1.69 X20/35.8 = 0.94
1-Methylnaphthalene	142	1047	92597	1.46 X20/27 = 1.08
2-Fluorobiphenyl (IS)	172	1166	63468	
Biphenyl	154	1198	79979	1.26
Acenaphthylene	152	1356	90063	1.42
Acenaphthene	154	1432	1.2054	0.99
Fluorene	166	1634	64213	0.89
Phenanthrene	178	2013	80434	1.12
D_{10}-Anthracene (IS)	188	2025	71924	
Anthracene	178	2032	90845	1.26
Acridine	179	2052	61435	0.85
Penanthridine	179	2092	65261	0.91
Carbazole	167	2108	78139	1.09
Fluoranthene	202	2493	81418	1.13
Pyrene	202	2579	84978	1.18
Benzo(a)anthracene	228	3070	65983	1.22
D_{12}-Chrysene (IS)	240	3078	54226	
Chrysene	228	3088	71287	1.31
Benzo(b)Fluoranthene	252	3482	53474	0.99
Benzo(a)pyrene	252	3593	50197	0.93
Perylene	252	3622	63573	1.17
Indeno(1,2,3-Cd)Pyrene	276	4034	41410	0.76
Dibenzo(a,h)anthracene	278	4048	42498	0.78
Benzo(g,h,i)Perylene	276	4153	37344	0.69

PAHSNStd 4

DATE 9/21/82

RESPONSE FACTORS

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	386	52742	0.91 X20/21.6 = 0.8
1H-Indene	116	406	49432	0.85 X20/21.8 = 0.78
D_8-Naphthalene (IS)	136	737	58220	
Naphthalene	128	744	84249	1.45
1-Fluoronaphthalene (S)	146	744	59452	1.02
Benzo(b)Thiophene	134	765	52730	0.91
Quinoline	129	872	51394	0.88 X20/27.4 = 0.64
Indole	117	1000	45127	1.23
2-Methylnaphthalene	142	1008	61959	1.68 X20/35.8 = 0.94
1-Methylnaphthalene	142	1049	53783	1.46 X20/27 = 1.08
2-Fluorobiphenyl (IS)	172	1169	36804	
Biphenyl	154	1201	48310	1.31
Acenaphthylene	152	1360	57976	1.58
Acenaphthene	154	1436	40761	1.11
Fluorene	166	1638	42567	0.85
Phenanthrene	178	2018	65319	1.10
D_{10}-Anthracene (IS)	188	2030	50077	
Anthracene	178	2038	63160	1.26
Acridine	179	2057	42340	0.85
Penanthridine	179	2097	44199	0.88
Carbazole	167	2115	55445	1.11
Fluoranthene	202	2499	52718	1.05
Pyrene	202	2585	54872	1.10
Benzo(a)anthracene	228	3076	40467	1.27
D_{12}-Chrysene (IS)	240	3085	31926	
Chrysene	228	3094	49334	1.54
Benzo(b)Fluoranthene	252	3487	30037	0.94
Benzo(a)pyrene	252	3598	28878	0.90
Perylene	252	3628	39822	1.25
Indeno(1,2,3-Cd)Pyrene	276	4054	24933	0.78
Dibenzo(a,h)anthracene	278		23748	0.74
Benzo(g,h,i)Perylene	276	4159	21978	0.69

5 rted Scanning
3.5 min. into
rogram

PAHSN std 5 DATE 9/23/82

RESPONSE FACTORS
PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	368	80702	0.87 X20/21.6 = 0.80
1H-Indene	116	388	74943	0.80 X20/21.8 = 0.74
D_8-Naphthalene (IS)	136	714	93134	
Naphthalene	128	722	131511	1.41
1-Fluoronaphthalene (S)	146	722	95058	1.02
Benzo(b)Thiophene	134	742	91082	0.98
Quinoline	129	848	100329	1.08 X20/27.4 = 0.79
Indole	117	977	86125	1.24
2-Methylnaphthalene	142	984	113994	1.63 X20/35.8 = 0.91
1-Methylnaphthalene	142	1024	99031	1.47 X20/27 = 1.05
2-Fluorobiphenyl (IS)	172	1144	69817	
Biphenyl	154	1176	87412	1.25
Acenaphthylene	152	1333	101520	1.45
Acenaphthene	154	1409	67826	0.97
Fluorene	166	1612	67555	0.91
Phenanthrene	178	1996	87547	1.18
D_{10}-Anthracene (IS)	188	2007	74475	
Anthracene	178	2015	93574	1.26
Acridine	179	2034	64996	0.87
Penanthridine	179	2075	68401	0.92
Carbazole	167	2093	83915	1.13
Fluoranthene	202	2479	80784	1.08
Pyrene 80373	202	2565	80733	1.08
Benzo(a)anthracene	228	3061	53653	1.22
D_{12}-Chrysene (IS)	240	3069	44018	
Chrysene	228	3078	60398	1.37
Benzo(b)Fluoranthene	252	3473	41145	0.93
Benzo(a)pyrene	252	3585	37916	0.86
Perylene	252	3614	49332	1.12
Indeno(1,2,3-Cd)Pyrene	276	4624	32792	0.74
Dibenzo(a,h)anthracene	278	4037	32004	0.73
Benzo(g,h,i)Perylene	276	4139	28830	0.65

STDS - 5

PAHSNStd 6

Started Scanning @ 3.8 min.

DATE 9/24/82

RESPONSE FACTORS

PAH, N and S Heterocyclic Compounds

Compounds	QM	Scan	Area	
D_5-Phenol (IS)	99			
2,3-Dihydro-1H-Indene	117	428	64871	0.83 X20/21.6 = 0.77
1H-Indene	116	449	62900	0.80 X20/21.8 = 0.74
D_8-Naphthalene (IS)	136	783	78202	
Naphthalene	128	791	114267	1.46
1-Fluoronaphthalene (S)	146	790	81292	1.04
Benzo(b)Thiophene	134	812	77135	0.99
Quinoline	129	918	87923	1.18 X20/27.4 = 0.82
Indole	117	1045	75108	1.41
2-Methylnaphthalene	142	1056	92107	1.73 X20/35.8 = 0.97
1-Methylnaphthalene	142	1096	79986	1.50 X20/27 = 1.11
2-Fluorobiphenyl (IS)	172	1216	53155	
Biphenyl	154	1247	68847	1.30
Acenaphthylene	152	1410	79868	1.50
Acenaphthene	154	1486	53532	1.01
Fluorene	166	1684	53404	0.91
Phenanthrene	178	2072	67938	1.16
D_{10}-Anthracene (IS)	188	2084	58745	
Anthracene	178	2092	74729	1.27
Acridine	179	2110	52089	0.89
Penanthridine	179	2151	53915	0.92
Carbazole	167	2166	68547	1.17
Fluoranthene	202	2557	66995	1.14
Pyrene	202	2644	68694	1.17
Benzo(a)anthracene	228	3138	50262	1.15
D_{12}-Chrysene (IS)	240	3145	43847	
Chrysene	228	3155	62337	1.42
Benzo(b)Fluoranthene	252	3551	44469	1.01
Benzo(a)pyrene	252	3669	39579	0.90
Perylene	252	3702	48997	1.12
Indeno(1,2,3-Cd)Pyrene 29596	276	4168	28842	0.67
Dibenzo(a,h)anthracene	278	4181	28812	0.66
Benzo(g,h,i)Perylene	276	4303	27308	0.62

STDS-6

Factors Selected Ov ter.

	Quinoline	Indole. Nap	Acridine	Phenanthr	
9-17	~~0.64~~ 0.79	1.19	0.92	0.97	1.20
9-18	0.84	1.43	0.89	0.91	1.16
9-20	0.76	1.16	0.85	0.91	1.09
9-21	0.64	1.23	0.85	0.88	1.11
9-23	0.79	1.24	0.87	0.92	1.13
9-24	0.82	1.41	0.89	0.92	1.17
$\bar{x}$	0.77	1.28	0.88	0.92	1.14
SD	.071	.115	0.027	0.029	0.041
RSD	9.2%	9.0%	3.1%	3.2%	3.6%

	Naph.	Acany.	Acen	FLUORA	Pyr.	BaA	Chry.	BaP	BghiP
	1.36	~~1.66~~ 1.46	0.98	~~1.01~~ 1.13	~~1.06~~ 1.17	~~1.13~~ 1.35	~~1.29~~ 1.49	0.89	0.69
	1.57	1.60	1.06	1.01	1.06	1.13	1.29	0.91	0.68
	1.53	1.42	0.99	1.13	1.18	1.22	1.31	0.93	0.69
	1.45	1.58	1.11	1.05	1.10	1.27	1.54	0.90	0.69
	1.41	1.45	0.97	1.08	1.08	1.22	1.37	0.86	0.65
	1.46	1.50	1.01	1.14	1.17	1.15	1.42	0.90	0.62
$\bar{x}$	1.46	1.51	1.02	1.09	1.13	1.23	1.40	0.90	0.67
SD	.077	0.091	0.054	0.053	0.053	0.090	0.099	0.023	0.029
RSD	5.3%	6.0%	5.3%	4.8%	4.7%	7.3%	7.1%	2.6%	4.3%