51902

Site: New Bedford
Break: 10.7
Other:

Ref. #148 Part 2
Appendix A

GCA Corp., Technology Div., 9/82
Draft Report, "New Bedford Environmental Investigation-
Ambiaent Monitoring Program"
(1-619-079B)

U.S. v. AVX Original Litigation Document

SDMS DocID 51902

Ref 148

Part 2

NEW BEDFORD ENVIRONMENTAL
INVESTIGATION--AMBIENT
MONITORING PROGRAM

Final Report

GCA CORPORATION
Technology Division
213 Burlington Road
Bedford, Mass 01730

APPENDIX B

HI-VOLUME AIR SAMPLERS--
CALIBRATION DATA SHEETS

0

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 12302 Project No. _____

Rotameter S/N 14927 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 Est. date of next cal. _____

Temperature 70 Source Lab Thermometer

Barometric Pressure 29.84 Source Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	15	14	14	14.3	
25	1.38	22	22	22	22	
30	1.90	28	27	27	27.3	
40	3.55	47	48	46	47	
45	4.55	60	60	62	60.7	

Were corrections to the actual flow required? Yes ✓ No ___

If yes, by what percent? ___

Was timer check required? Yes ___ No ✓ Exp. time ___

Were any problems encountered during calibration? Yes ___ No ✓

Remarks: _____

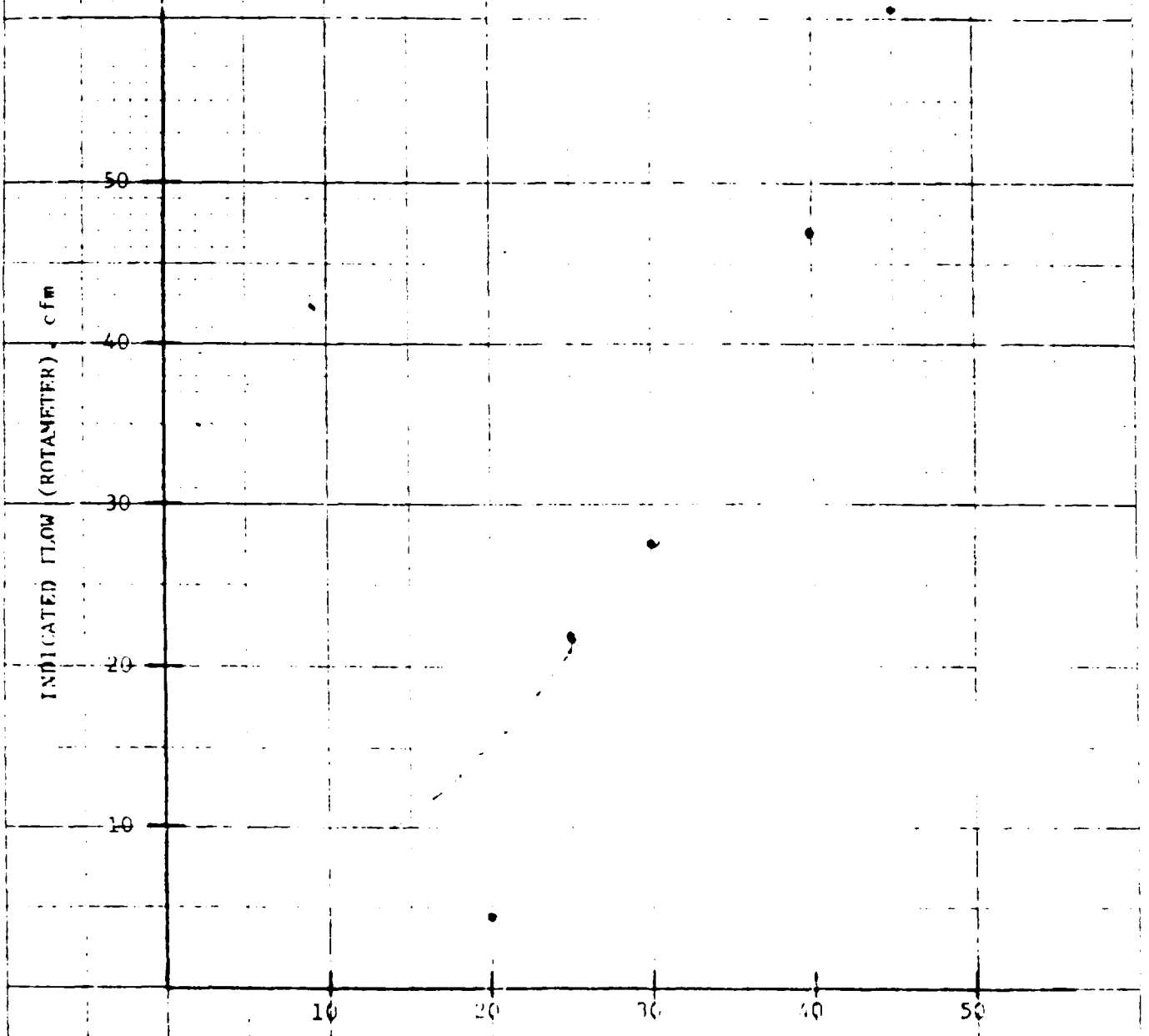
Date of completion: 8-3-82 Technician: Pendleton

Reviewed by: [illegible] Date: 8/4/82

HiVol S/N 12302

Rotameter S/N 14927

Date 8-3-82



Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 12529 Project No. _____

Rotameter S/N 14929 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 72 Source: Lab Thermometer

Barometric Pressure 29.73 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Mean Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	18	18	17	17.7	
25	1.38	25	25	25	25	
30	1.90	32	33	32	32.3	
40	3.55	60	59	59	59.3	
45	4.55	70+	70+	70+	70+	

Were corrections to the actual flow made? Yes ✓ No

If yes, by what percent? _____

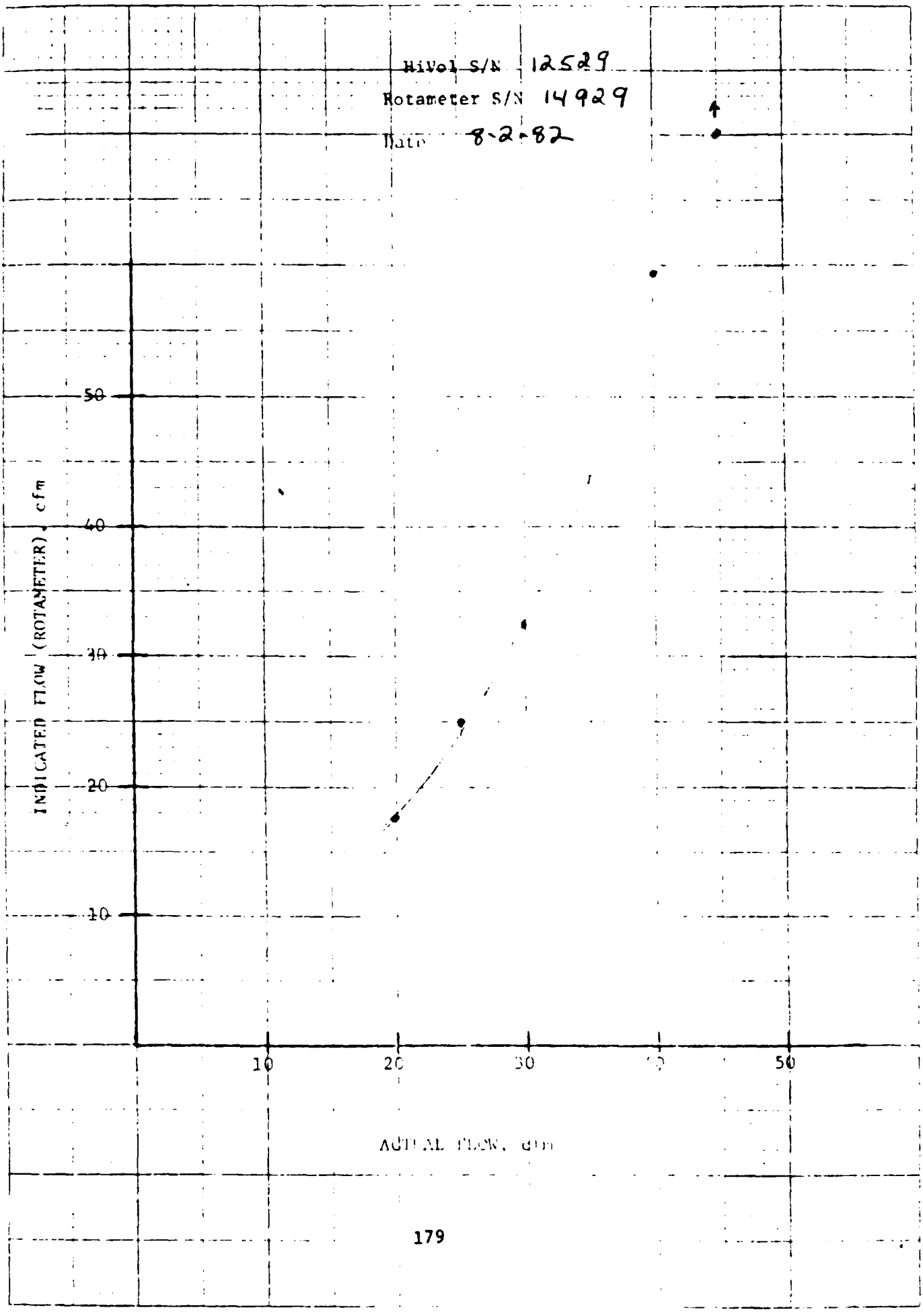
Was timer check required? Yes ____ No ✓ Elapsed time _____

Were any problems encountered during calibration? Yes ____ No ✓

Remarks: _____

Date of completion: 8-2-82 Calibrator: Bendickson

Reviewed by: [illegible] Date: 6/4/82


Hivol S/N 12529
Rotameter S/N 14929
Date 8-2-82
50
40
30
20
10
INDICATED FLOW (ROTAMETER), cfm
10
20
30
50
ACTUAL FLOW, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 14926 Project No. _____

Rotameter S/N 18798 Date _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 22 °F Source: _____

Barometric Pressure 29.07 in. Hg Place _____

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	15	14	15	14.7	
25	1.38	24	24	24	24	
30	1.90	30	30	30	30	
40	3.55	48	50	50	49.3	
45	4.55	50	59	59	58.3	

Were corrections to actual flow _____

If yes, by what percent _____

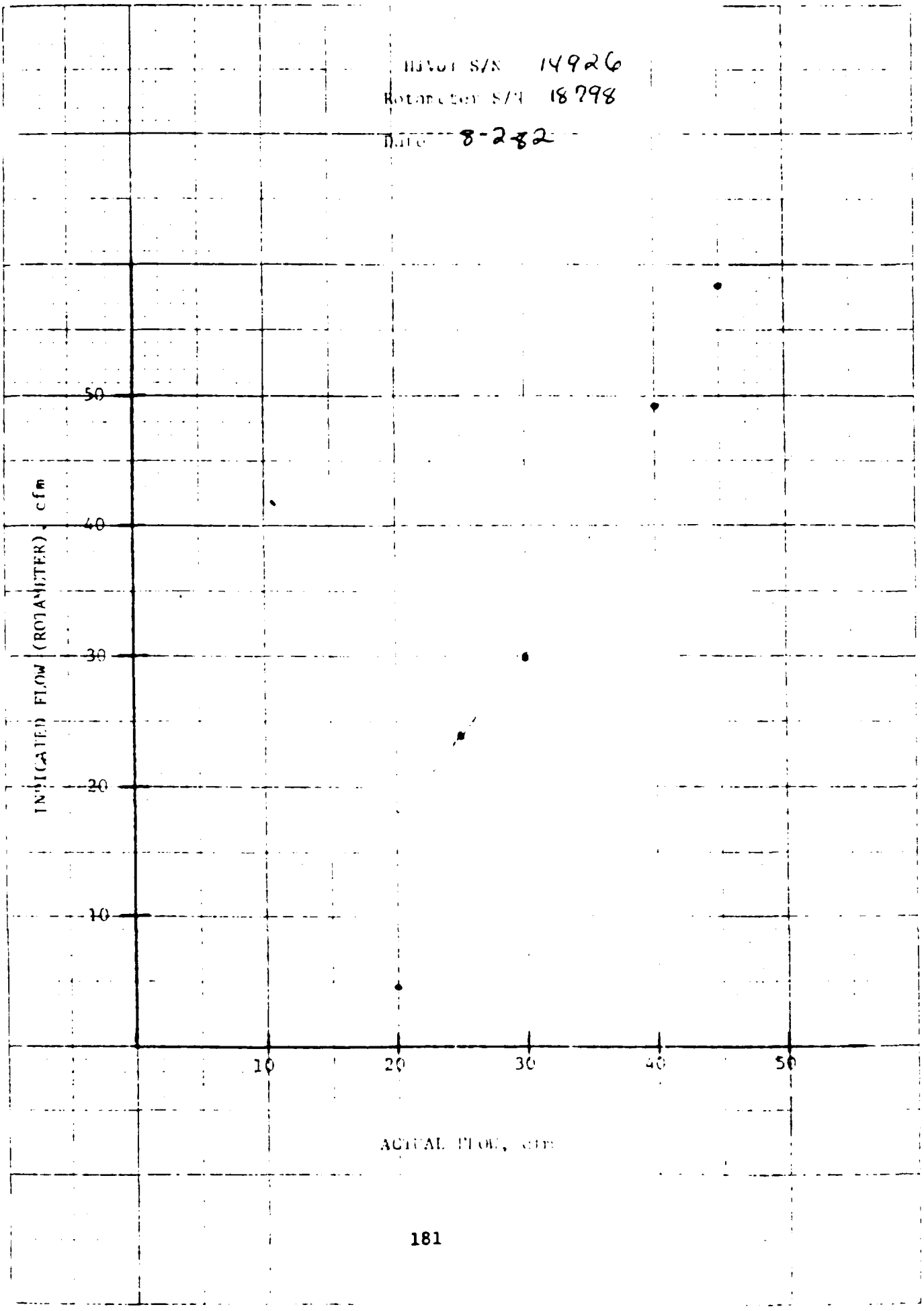
Was timer check required for _____

Were any problems encountered during calibration for _____

Remarks: _____

Date of completion: 8-2-82 Technician: [illegible]

Reviewed by: [illegible] Date: 8/9/82


Nozzle S/N 14926
Rotameter S/N 18798
Date 8-2-82
INDICATED FLOW (ROTAMETER), cfm
50
40
30
20
10
10
20
30
40
50
ACTUAL FLOW, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 14928 Project No. _____

Rotameter S/N 19000 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 72 Calibrated _____

Barometric Pressure 29.73 in. Hg Checked _____

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	18	19	19	17.3	
25	1.38	25	25	25	25	
30	1.90	31	32	32	31.7	
40	3.55	55	55	55	55	
45	4.55	70	70 +	70 +	70 +	

Were corrections to the actual flow made? Yes ✓ No ___

If yes, by what percent? ___

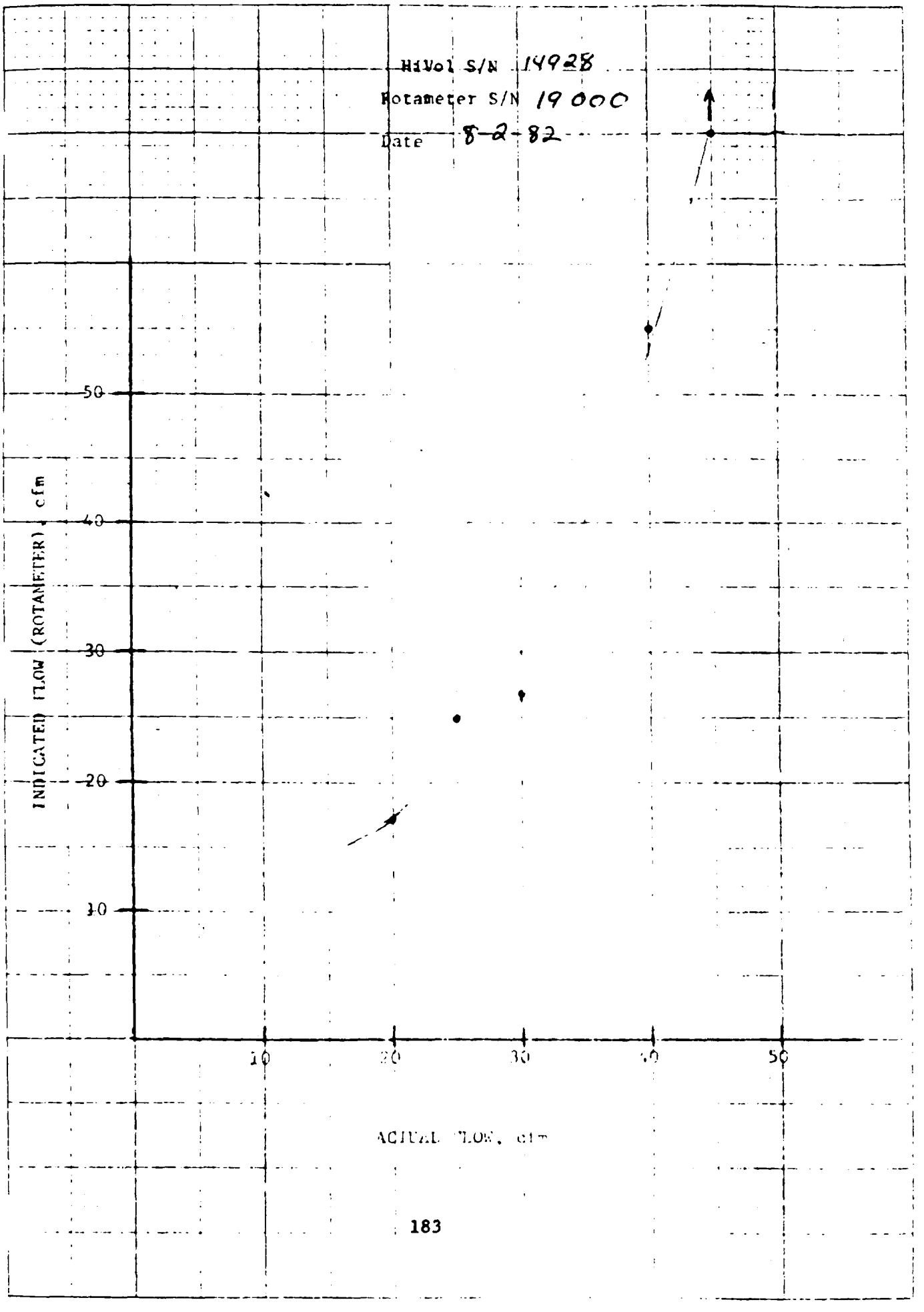
Was timer check required? Yes ___ No ✓ Stop watch time ___.

Were any problems encountered during calibration? Yes ___ No ✓.

Remarks: _____

Date of completion: 8-2-82 Calibrated by: Pendleton

Reviewed by: MWH Date: 8/3/82


HiVol S/N 14928
Rotameter S/N 19000
Date 8-2-82
INDICATED FLOW (ROTAMETER), cfm
50
40
30
20
10
10
20
30
40
50
ACTUAL FLOW, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 149361 Project No. _____

Rotameter S/N 16403 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-4-82 VRC date of next cal. _____

Temperature 69 °F Source: Lab Thermometer

Barometric Pressure 29.91 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	15	15	15	15	
25	1.38	24	24	24	24	
30	1.90	30	30	30	30	
40	3.55	50	50	52	50	
45	4.55	62	63	62	62.3	

Were corrections to the actual flow required? Yes ✓ No

If yes, by what percent? _____

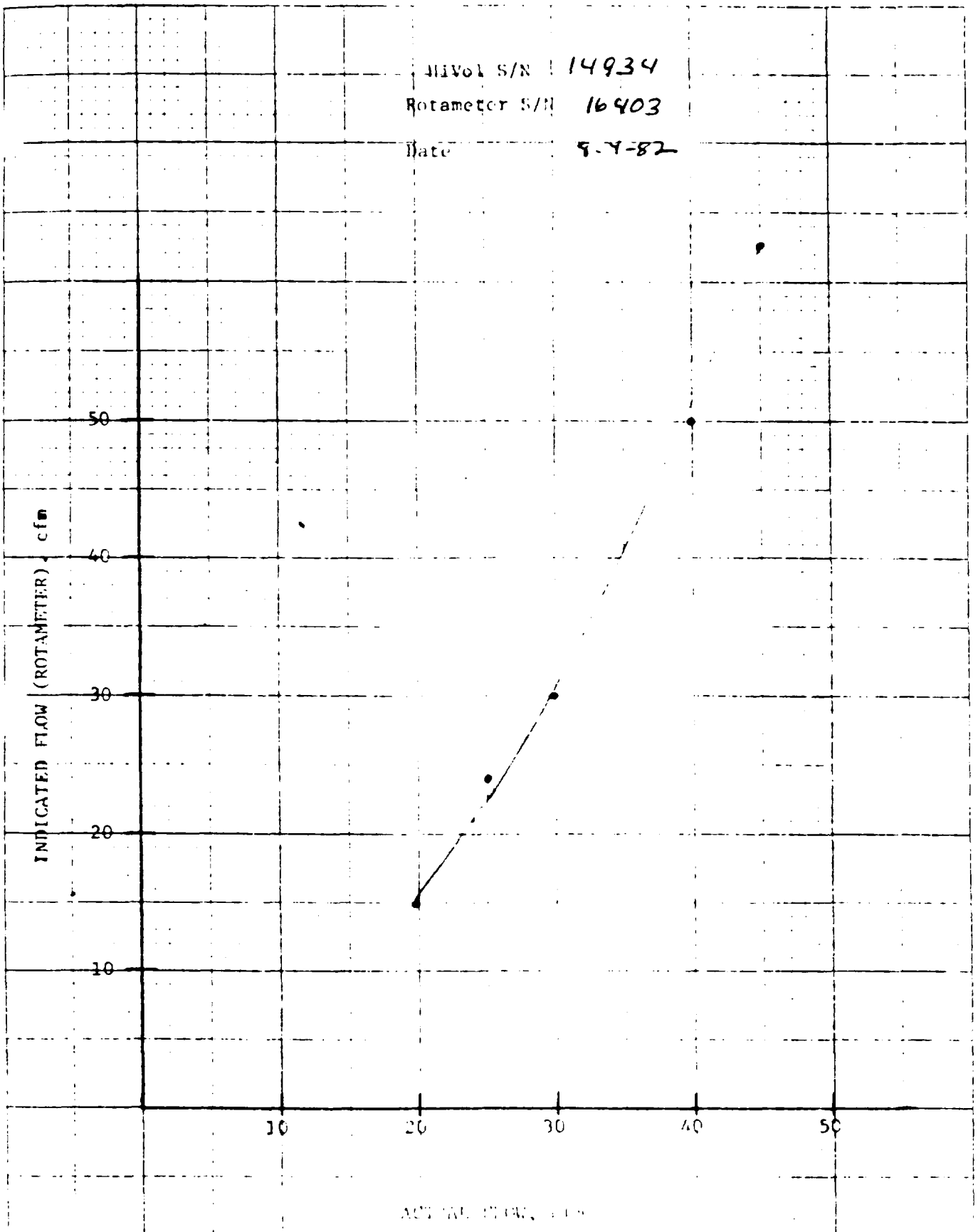
Was timer check required? Yes ✓ No ✓ Time of check

Were any problems encountered during calibration? _____

Remarks: _____

Date of completion: 8-4-82 Bradleton

Reviewed by: [illegible] 8/4/82


Hivol S/N 14934
Rotameter S/N 16403
Date 8-4-82
INDICATED FLOW (ROTAMETER), cfm
50
40
30
20
10
10
20
30
40
50

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 14935 Project [illegible]

Rotameter S/N 16402 Site [illegible]

VRC S/N 3569 Location [illegible]

VRC date of last cal. 3-9-82 Est. date of next cal. [illegible]

Temperature 70 Source: Lab Therm.

Barometric Pressure 29.84 in. Hg Source: Lab Barom.

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	14	14	13	13.7	
25	1.38	23	23	23	23	
30	1.90	30	31	30	30.3	
40	3.55	53	53	53	53	
55	4.55	60	60	60	60	

Were corrections to the actual flow [illegible]

If yes, by what percent?

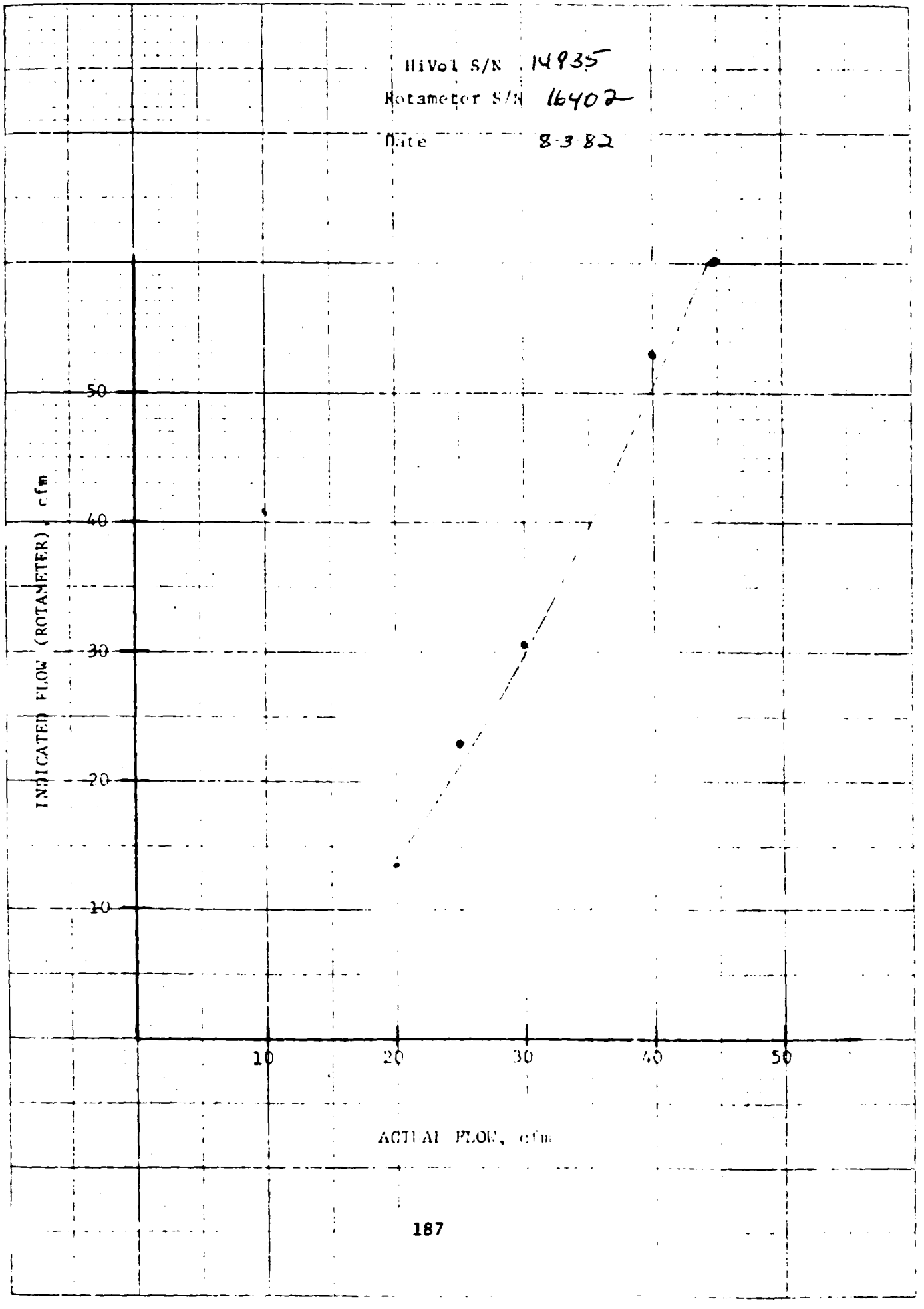
Was timer check required? Yes___ No [illegible]

Were any problems encountered during [illegible]

Remarks:

Date of completion: 8-3-82 Technician: Pendleton

Reviewed by: Nuhite Date: 8/4/82


HiVol S/N 14935
Rotameter S/N 16402
Date 8-3-82
50
40
30
20
10
INDICATED FLOW (ROTAMETER), cfm
10
20
30
40
50
ACTUAL FLOW, cfm

Form 1

0

BGI Hi-Volume Air Sampler Calibration Data Sheet

FH Crossthreaded (M.M.)

Hi-Vol S/N 15005 Hi-Vol No.

Rotameter S/N 17491

VRC S/N 3569 Location

VRC date of last cal. 3-9-82 VRC date of next cal.

Temperature 20

Barometric Pressure 29.84

Actual Flow cfm	Manometer Setting in. H_2O	Run 1	Run 2	Run 3	Average Reading	Actual Corrected Flow cfm
.20	0.86	15	16	16	15.7	
.25	1.38	24	24	25	24.3	
.30	1.96	29	29	30	29.3	
.40	3.55	46	46	46	46	
.45	4.55	54	58	58	54	

Are corrections to the actual flow [illegible]

[illegible], by what percent

[illegible] other [illegible]

Were any problems encountered [illegible]

Comments:

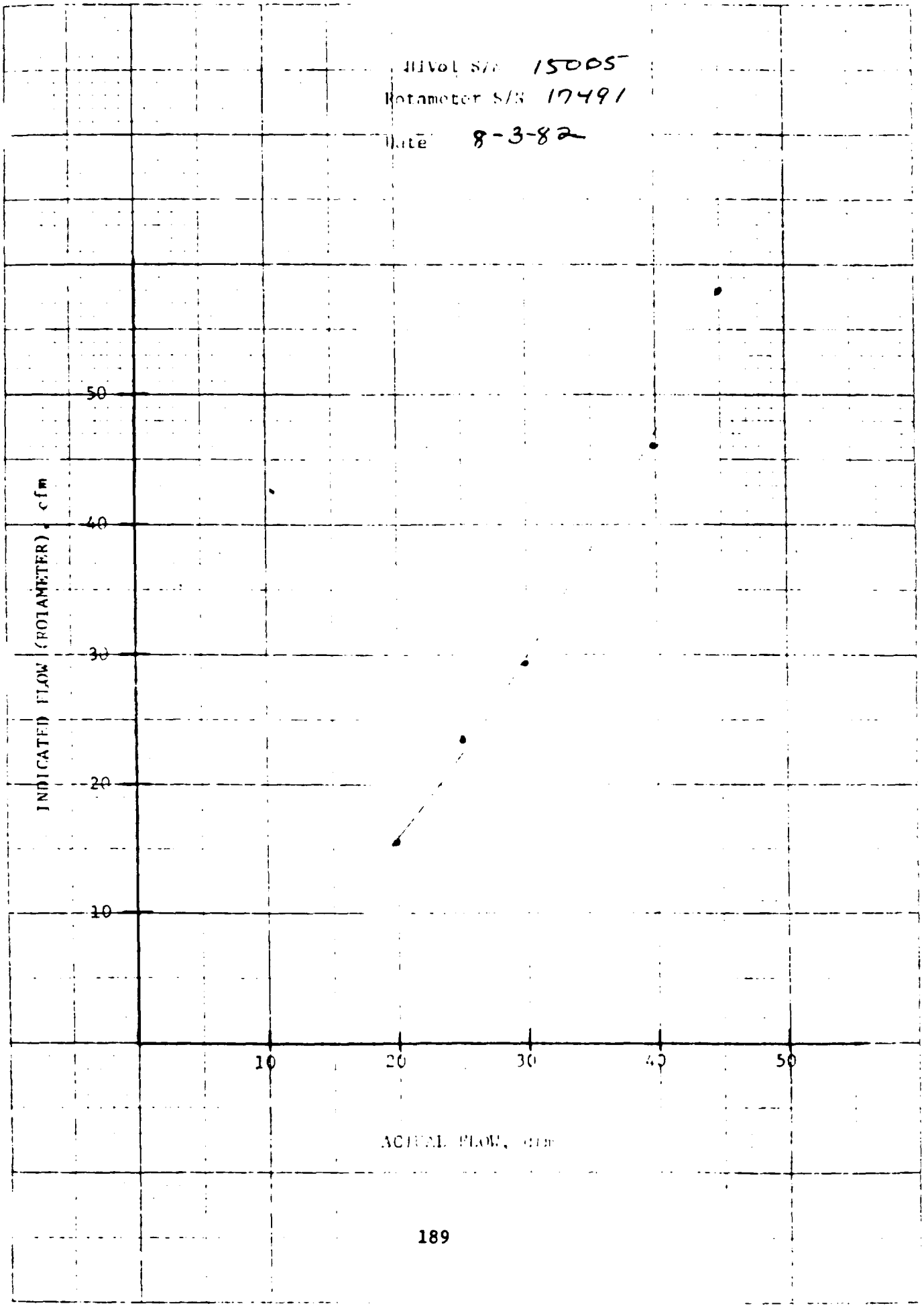
Date of completion: 8-3-82 Rendle Cook

Reviewed by: [illegible] White 8/4/82

HiVol S/N 15005

Rotameter S/N 17491

Date 8-3-82



D

BGI Hi-Volume Air

Hi-Vol S/N 15006

Rotameter S/N 17492

VRC S/N 3569

VRC date of last cal. 3-9-82

Temperature 72 °F Source: Lab Thermometer

Barometric Pressure 29.73 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	17	17	17	17	
25	1.38	25	24	24	24.3	
30	1.90	30	30	30	30	
40	3.55	48	49	48	48	
45	4.55	~~45~~ 60	60	60	60	

Were corrections to the actual flow made? ✓

If yes, by what percent?

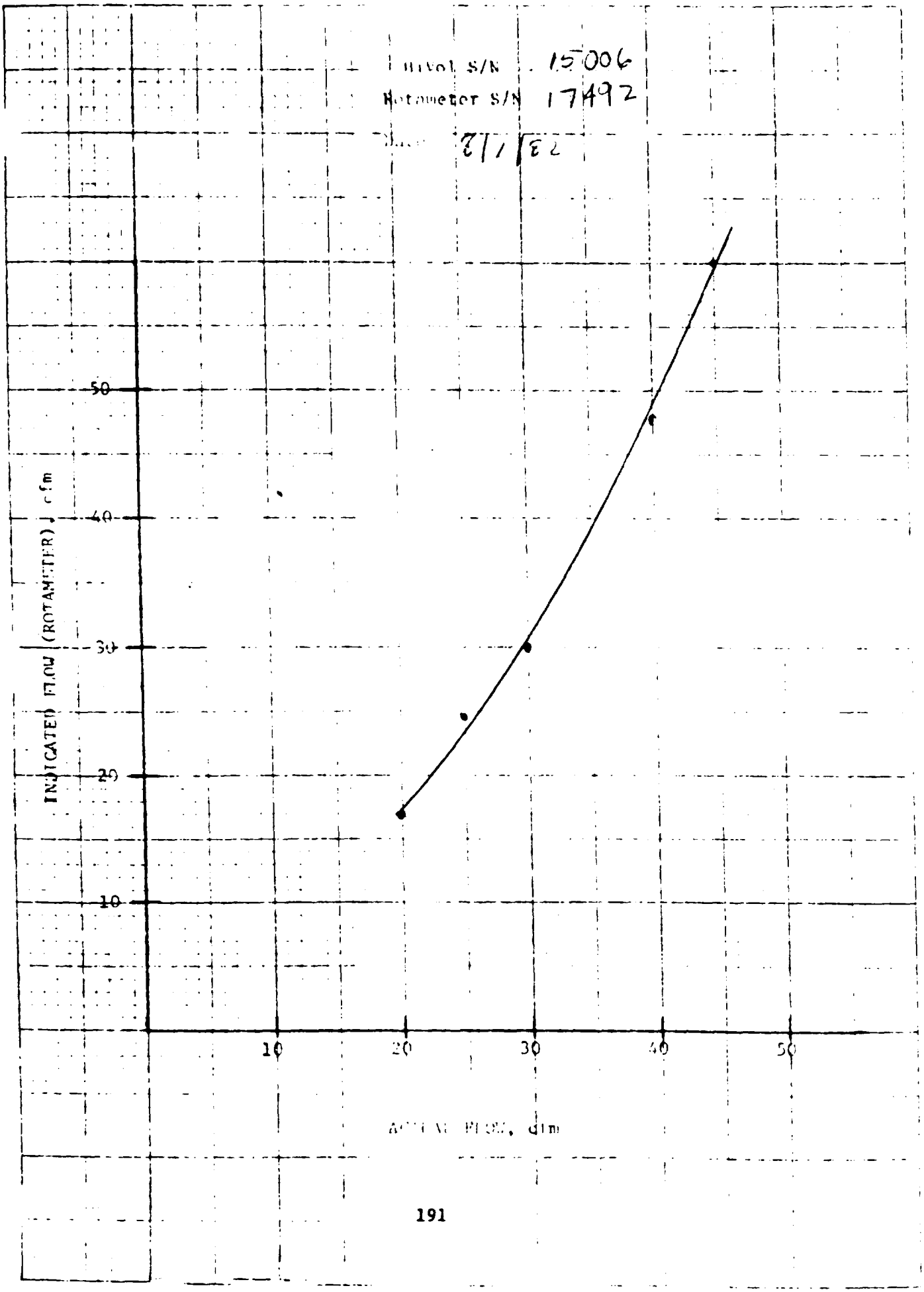
Was timer check required? Yes ✓ No

Were any problems encountered during calibration? Yes No ✓

Remarks:

Date of completion: 8-2-82 Technician: Pendleton

Reviewed by: [illegible] Date: 8/4/82


Hivol S/N 15006
Rotameter S/N 17492
23/1/82
INDICATED FLOW (ROTAMETER), cfm
50
40
30
20
10
10
20
30
40
50
ACTUAL FLOW, cfm

B

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 15007 Project No. _____

Rotameter S/N 6008 Site _____

VPC S/N 3569 Location _____

VRC date of last cal. 3-4-82 VRC date of next cal. _____

Temperature 72 Source: Lab Thermometer

Barometric Pressure 29.73 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	17	17	17	17	
25	1.38	25	25	25	25	
30	1.90	31	30	31	30.7	
40	3.55	54	54	54	54	
45	4.55	65	65	66	65.3	

Were corrections to the actual flow made? Yes ✓ No ___

If yes, by what percent? ___

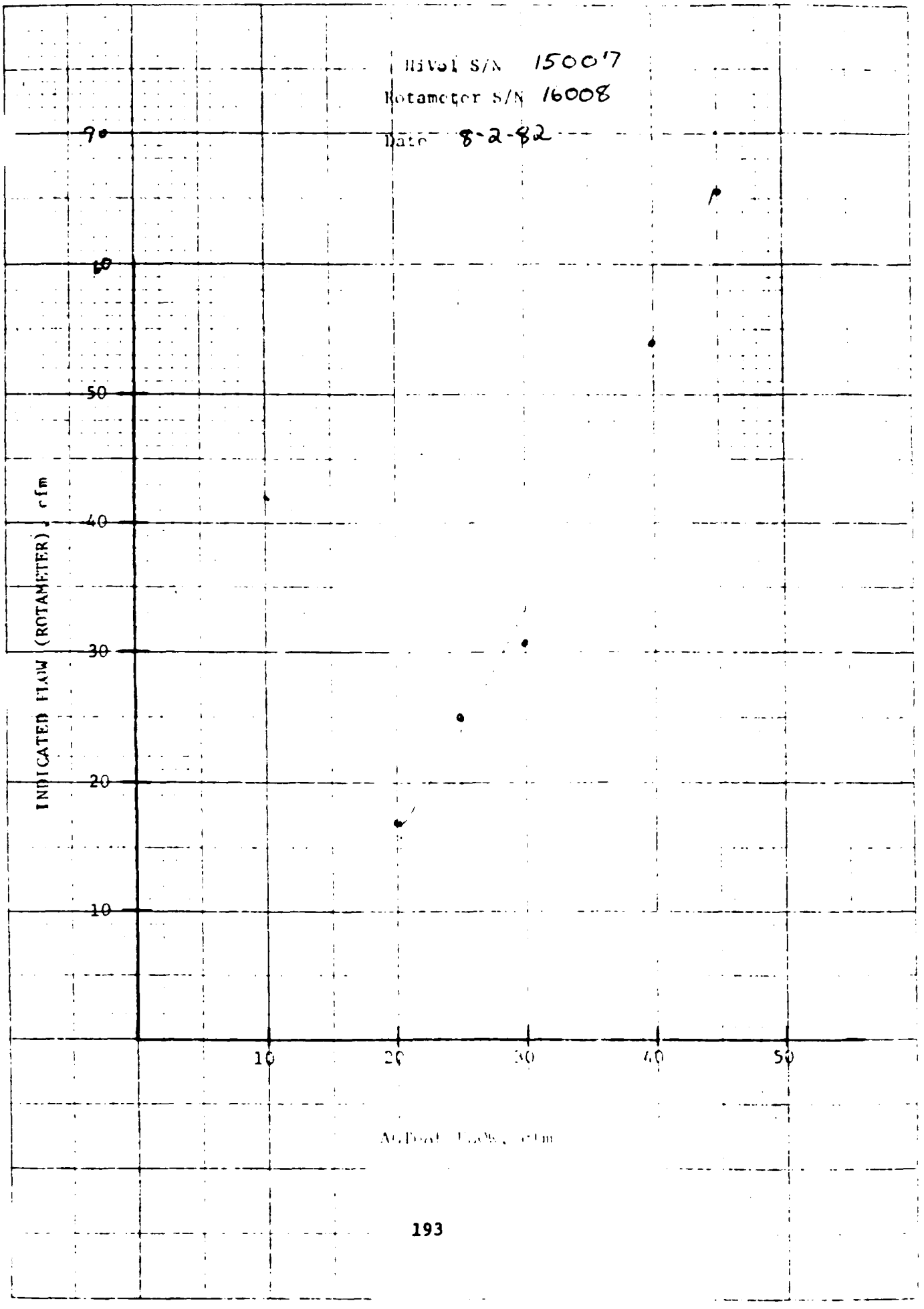
Was timer check required? Yes ___ No ✓ Error of timer ___

Were any problems encountered during calibration? Yes ___ No ✓

Remarks: _____

Date of completion: 8-2-82 Technician: Pendleton

Reviewed by: [illegible] Date: 8/4/82


HiVol S/N 15007
Rotameter S/N 16008
Date 8-2-82
INDICATED FLOW (ROTAMETER) cfm
90
60
50
40
30
20
10
10
20
30
40
50
Actual Flow, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 15009 Project No. _____

Rotameter S/N 17498 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 20 °C Source: Lab Thermometer

Barometric Pressure 29.24 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	15	16	16	15.7	
25	1.98	24	23	23	23.3	
30	1.90	30	30	30	30	
40	3.55	55	54	55	54.7	
45	4.55	67	65	66	66	

Were corrections to the actual flow required? Yes ✓ No ___

If yes, by what percent? _____

Was timer check required? Yes ___ No ✓ Elapsed time ___

Were any problems encountered during calibration? Yes ___ No ✓

Remarks: _____

Date of completion: 8-3-82 Technician: Pendleton

Reviewed by: [illegible] Date: 8/4/82

HiVol S/N 15009

Rotameter S/N 17488

Date 8-3-82

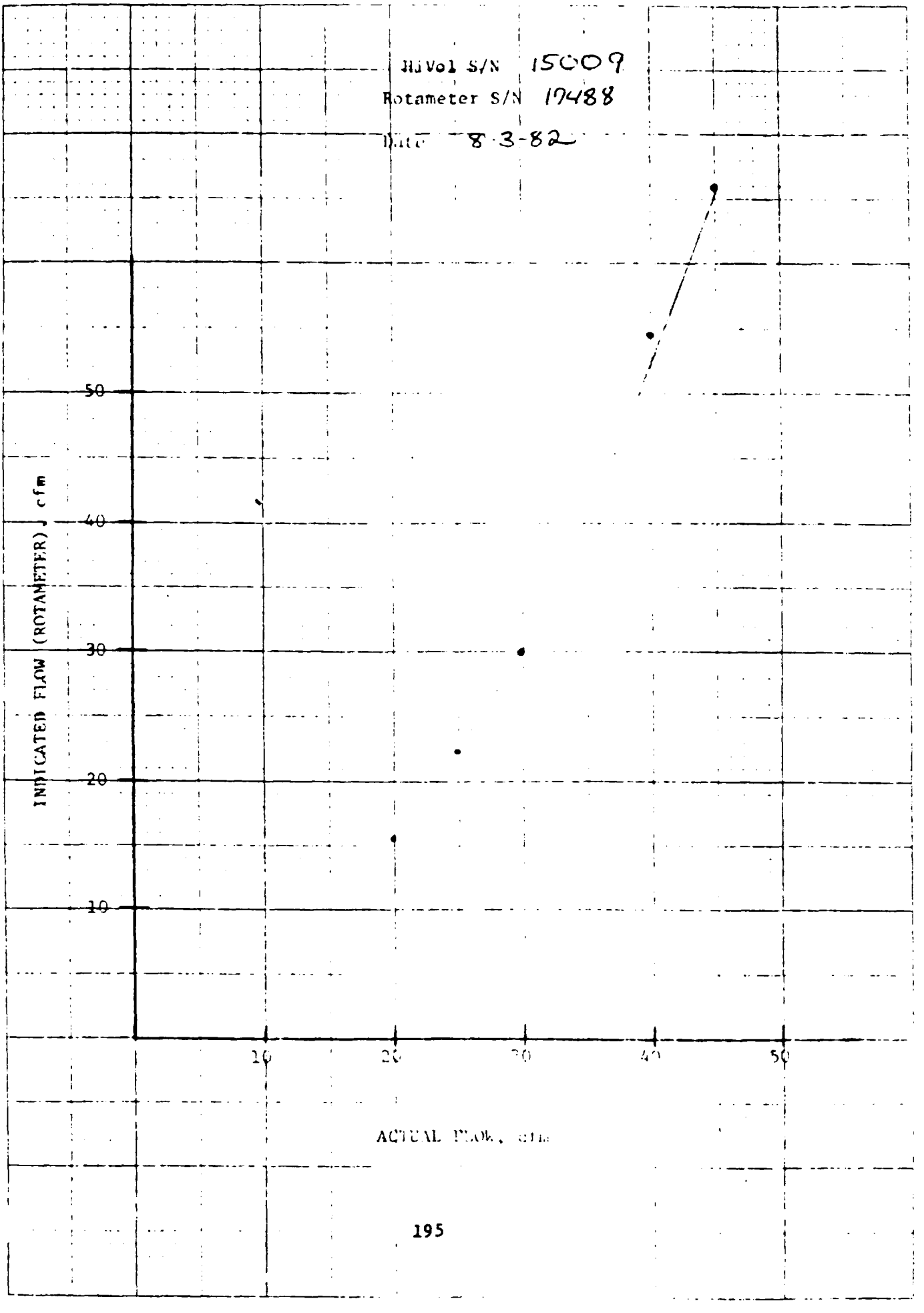


TABLE 4. HI-VOLUME AIR SAMPLER CALIBRATION DATA SHEET

Hi-Vol S/N 15010 Project No. _____

Rotometer S/N 1492 Site _____

VRC S/N 3571 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 69 °F Source Lab Thermometer

Barometric Pressure 29.91 in. Hg. Source Lab Barometer

Actual flow cfm	Manometer setting in. H_2O	Rotometer reading			Average rotometer reading	Actual corrected flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	15	15	15	15	
25	1.38	23	23	23	23	
30	1.90	30	30	30	30	
40	3.55	58	58	56	57.3	
45	4.55	70+	70+	70+	70+	

Were corrections to the actual flow required? _____

If yes, by what percent? _____

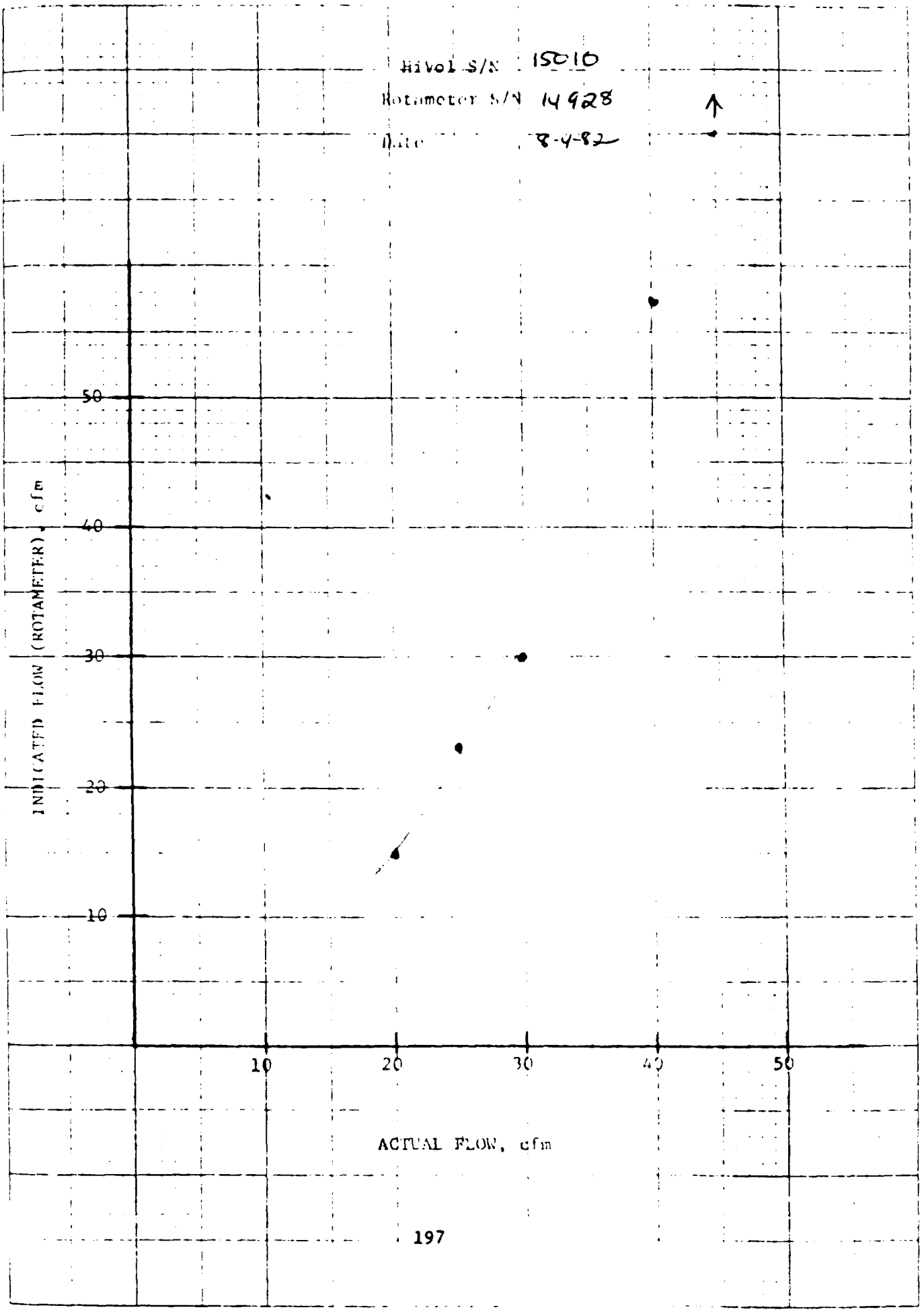
Was timer check required? Yes _____

Were any problems encountered during calibration? _____

Remarks: _____

Date of completion: 3-4-82 Signature Pendleton

Reviewed by: [illegible] 3/4/82


Hivol S/N 15010
Rotameter S/N 14928
Date 8-4-82
50
40
30
20
10
INDICATED FLOW (ROTAMETER), cfm
10
20
30
40
50
ACTUAL FLOW, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 15011 Project No. _____

Rotameter S/N 14934 By _____

VRC S/N 3569 Date _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 72 Source: Lab Thermometer

Barometric Pressure 29.22 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	17	17	15	17.3	
25	1.38	25	25	25	25	
30	1.90	31	31	30	30.7	
40	3.55	52	57	59	57.7	
45	4.55	63	63	62	62.7	

Were corrections to the actual flow required? Yes ✓ No

If yes, by what percent _____

Was timer check required? Yes ✓ No Time _____

Were any problems encountered during calibration? Yes No ✓

Remarks: _____

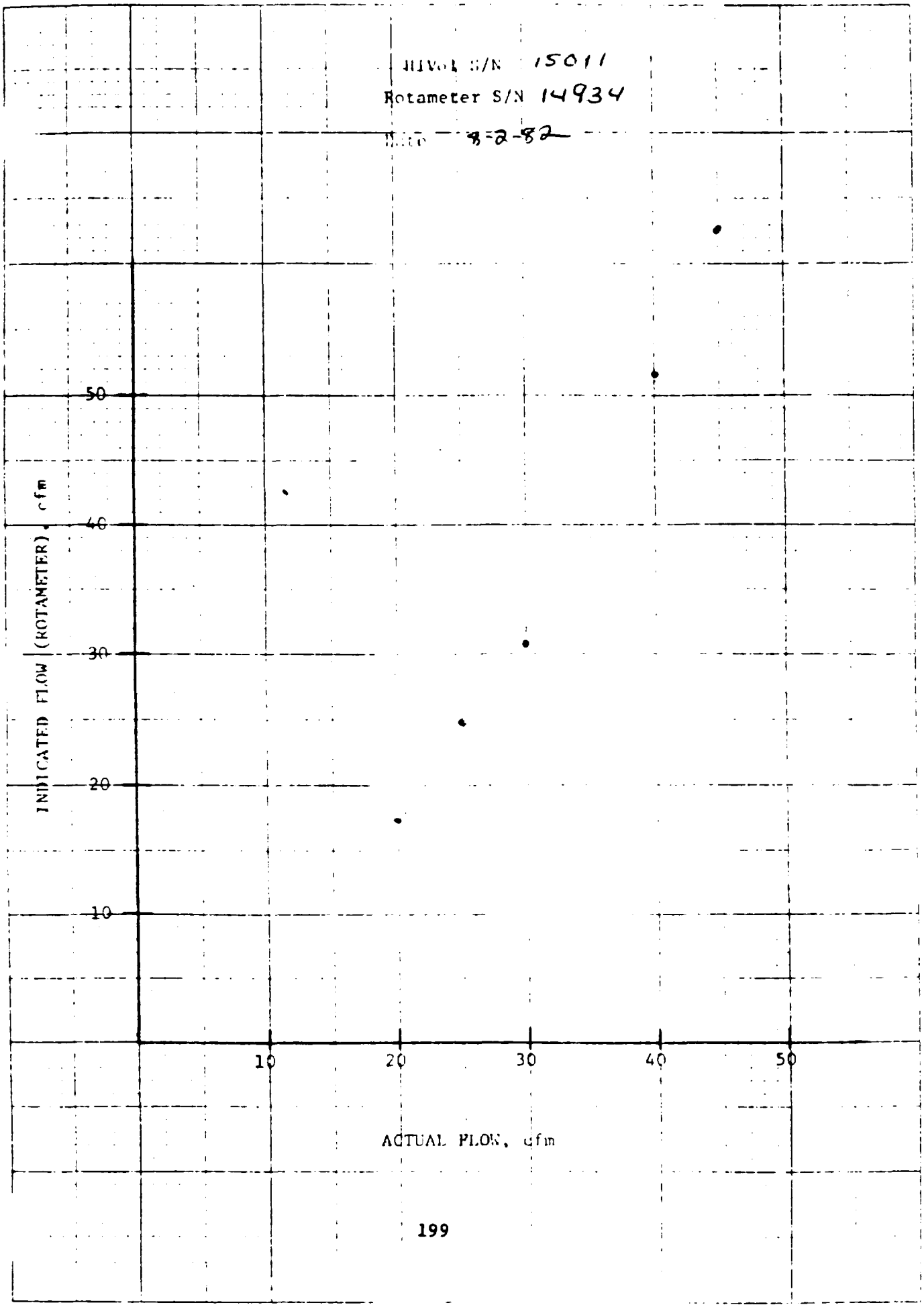
Date of completion: 8-2-82 Technician: Pendleton

Reviewed by: M. Wilt Date: 8/4/82

HIVol S/N 15011

Rotameter S/N 14934

Date 8-2-82



D

TABLE 4. HI-VOLUME AIR SAMPLER CALIBRATION DATA SHEET

Hi-Vol S/N 16400 Project No. _____

Rotometer S/N 5964 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 70 °F Source Lab Thermometer

Barometric Pressure 29.11 in. Hg. Source Lab Barometer

Actual flow cfm	Manometer setting in. H_2O	Rotometer reading			Average rotometer reading	Actual corrected flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	20	20	20	20	
25	1.38	27	25	25	25.7	
30	1.90	30	30	30	30	
40	3.55	41	42	42	42.7	
45	4.55	47	47	47	47	

Were corrections to the actual flow required? _____

If yes, by what percent? _____

Was timer check required? Yes _____

Were any problems encountered during calibration? _____

Remarks: _____

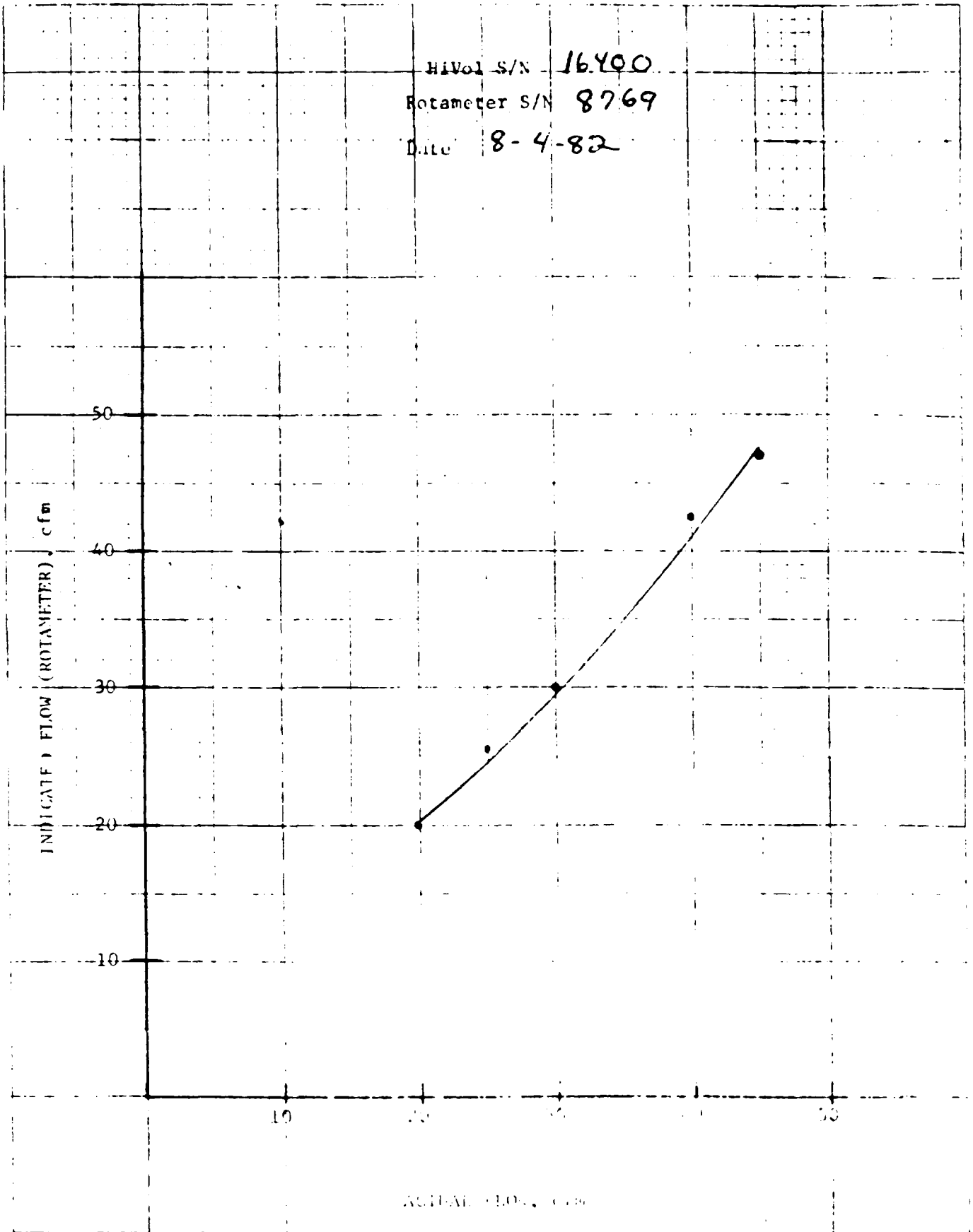
Date of completion: 3-9-82 Technician _____

Reviewed by: _____

HiVol S/N 16400

Rotameter S/N 8769

Date 8-4-82



Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 16401 Project No. _____

Rotameter S/N 19414 Site _____

VRC S/N 2569 Location _____

VRC date of last cal. 3-4-82 VRC date of next cal. _____

Temperature 20 °C [illegible]

Barometric Pressure 29.84 in. Hg [illegible] mate

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	15	16	16	15.7	
25	1.33	23	23	23	23	
[illegible]	1.9	28	28	28	28	
40	2.55	48	[illegible]	49	48	
45	4.55	63	63	64	63.5	

Were corrections to the actual flow [illegible] Yes No

If yes, by what percent? _____

Was timer check required? Yes No [illegible]

Were any problems encountered [illegible]

Remarks: _____

Date of completion: 8-3-82 [illegible]

Reviewed by: [illegible] 8/4/82

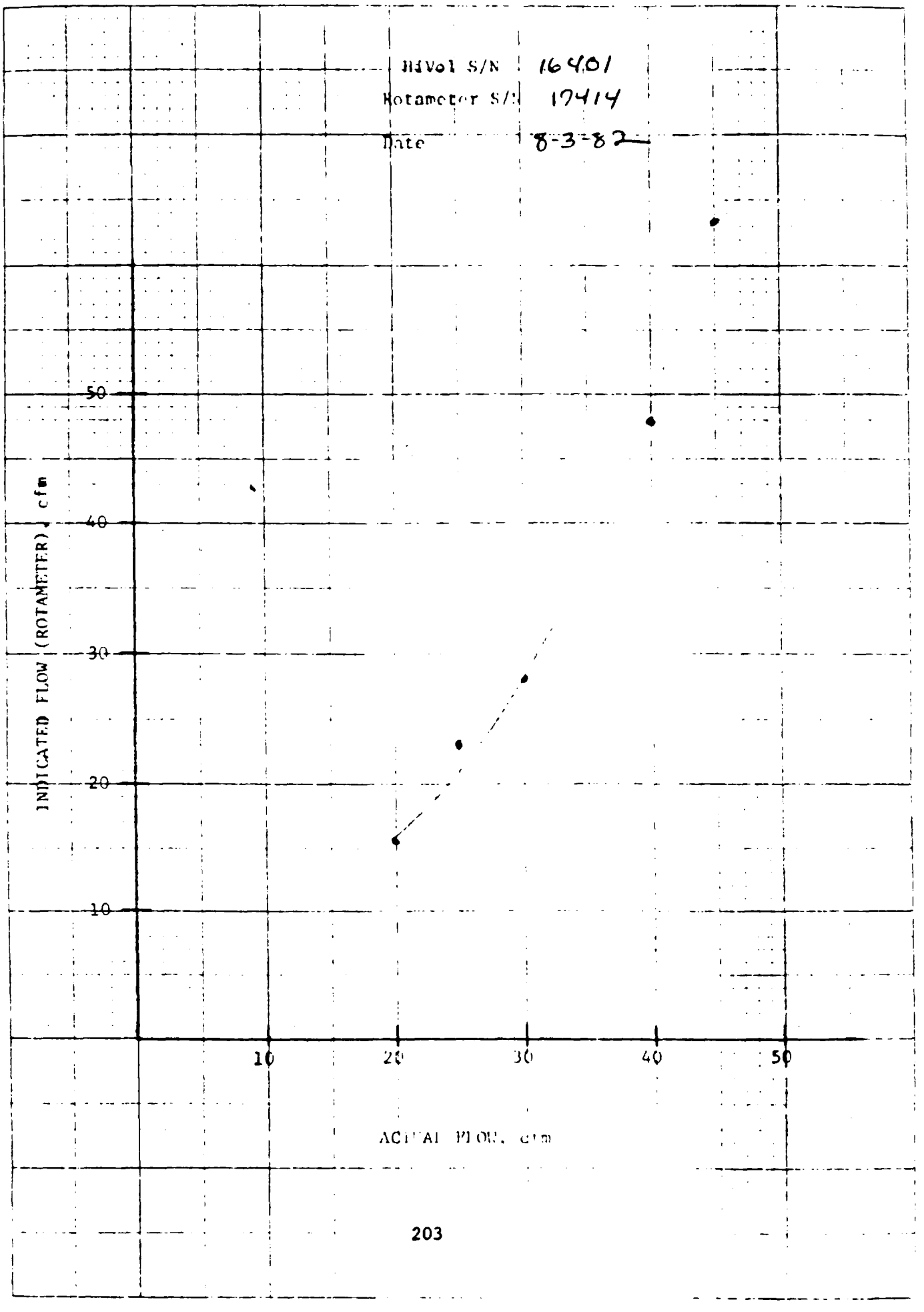

HiVol S/N 16401
Rotameter S/N 17414
Date 8-3-82
50
40
30
20
10
INDICATED FLOW (ROTAMETER), cfm
10
20
30
40
50
ACTUAL FLOW, cfm

TABLE 4. HI-VOLUME AIR SAMPLER CALIBRATION DATA SHEET

Hi-Vol S/N 16402 Project No. _____

Rotometer S/N — Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal _____

Temperature 70 °F Source: Lab Manometer

Barometric Pressure 29.91 in. Hg. Source: Lab Barometer

Actual flow cfm	Manometer setting in. H_2O	Rotometer reading			Average rotometer reading	Actual corrected flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	12	13	13	12.7	
25	1.38	23	23	24	23.3	
30	1.90	30	30	30	30	
40	3.55	50	51	50	50.3	
45	4.55	58	59	60	59	

Were corrections to the actual flow required? _____

If yes, by what percent? _____

Was timer check required? Yes _____ No _____ If yes, explain _____.

Were any problems encountered during calibration? Yes _____ No _____.

Remarks: _____

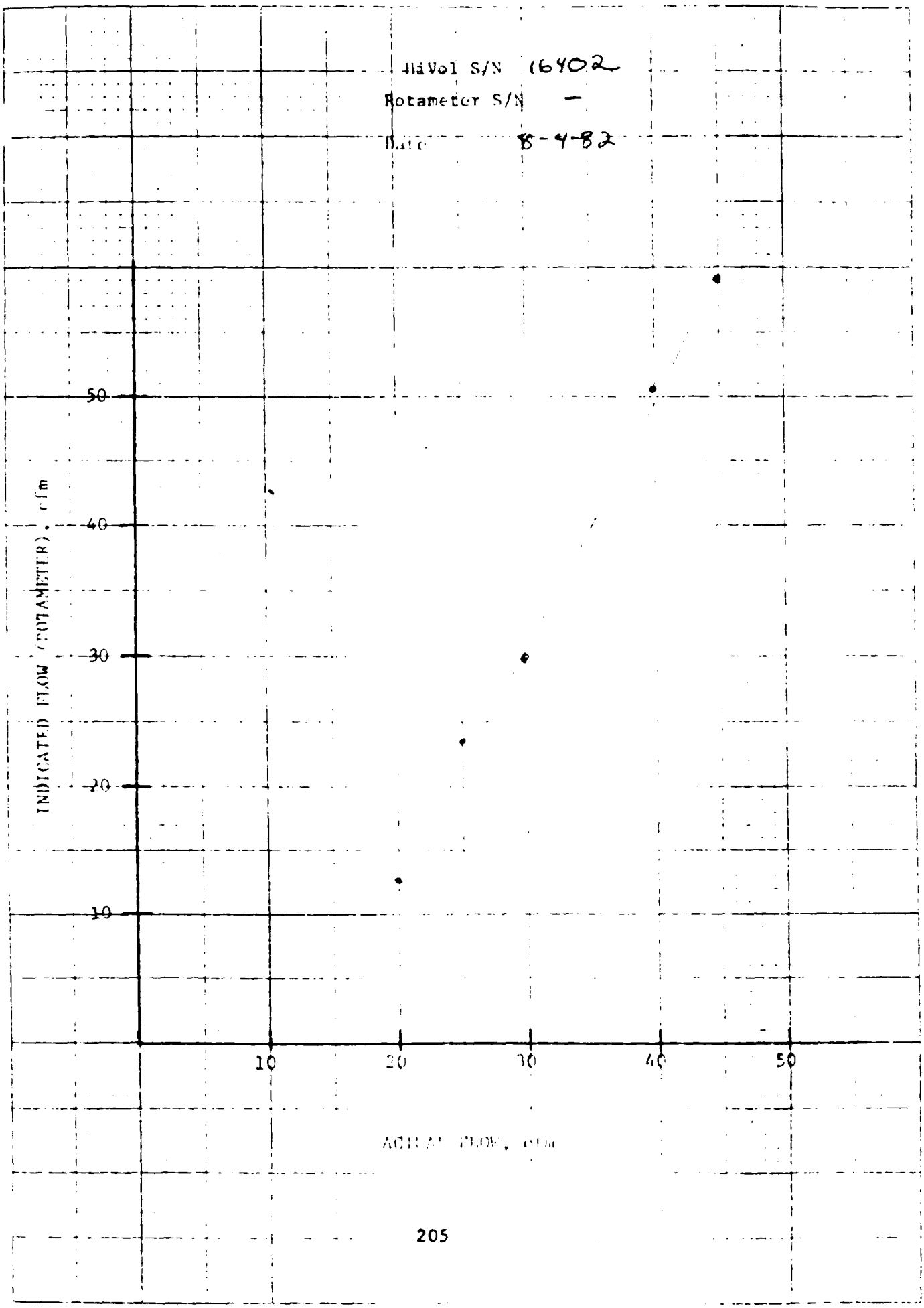
Date of completion: 3-4-82 Anderton

Reviewed by: _____ 3/4/82

HiVol S/N 16402

Rotameter S/N —

Date 8-4-82



D

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 16464 Project No. _____

Rotameter S/N 17489 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 70 °F Source: Lab Thermometer

Barometric Pressure 29.84 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	15	15	15	15	
25	1.38	24	24	24	24	
30	1.9	30	30	30	30	
40	3.55	53	54	53	53.3	
45	4.55	70	68	68	68.7	

Were corrections to the actual flow required? Yes ✓ No ____

If yes, by what percent? _____.

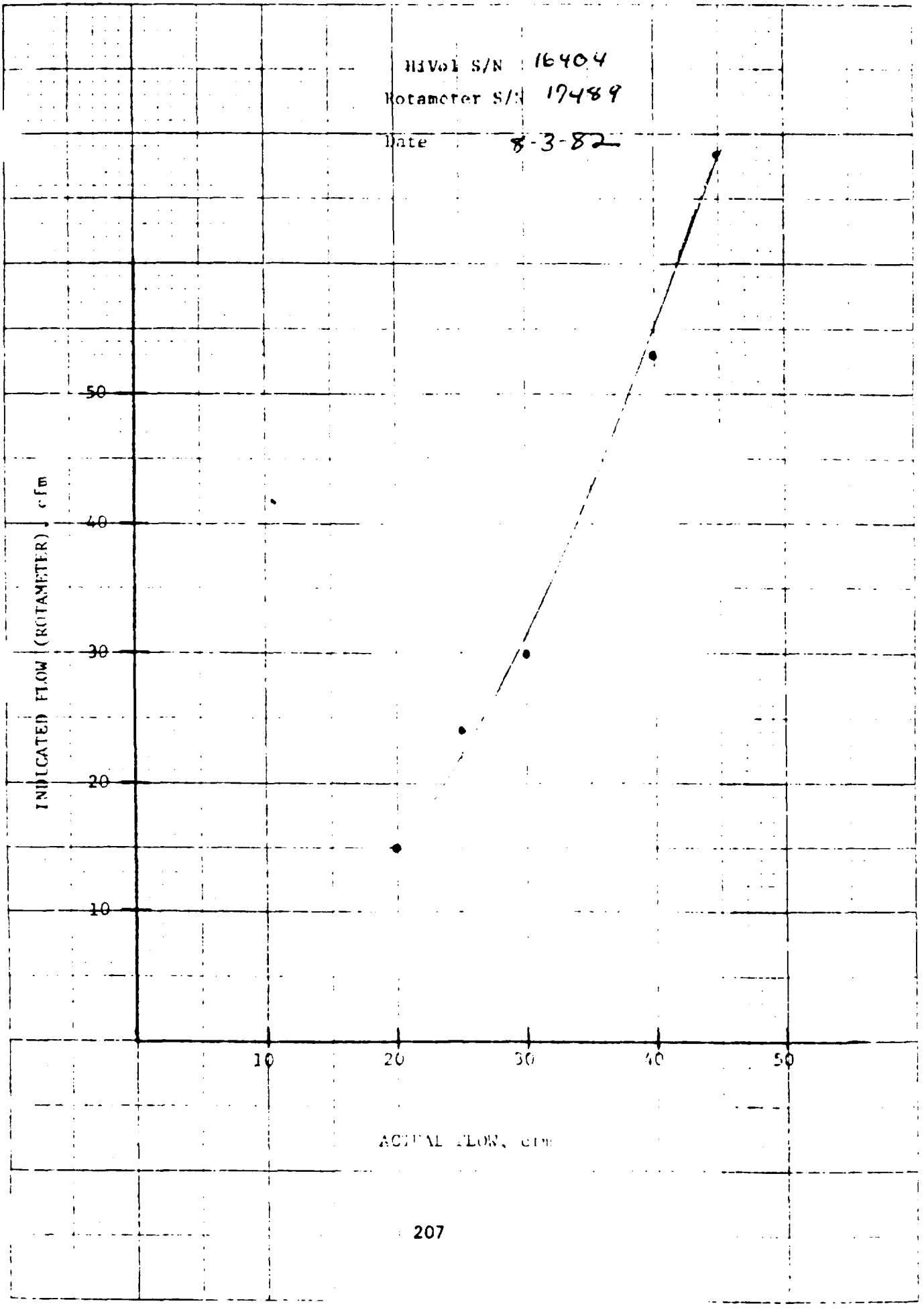
Was timer check required? Yes ____ No ✓ Elapsed time _____.

Were any problems encountered during calibration? Yes ____ No ✓.

Remarks: _____

Date of completion: 8-3-82 Technician: Pudleton

Reviewed by: [illegible] Date: 8/3/8


HiVol S/N 16404
Rotameter S/N 17489
Date 8-3-82
INDICATED FLOW (ROTAMETER), cfm
50
40
30
20
10
10
20
30
40
50
ACTUAL FLOW, cfm

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 19411 Project No. _____

Rotameter S/N 14935 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 20C Lab Thermometer

Barometric Pressure 29.84 Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	18	17	17	17.3	
25	1.38	25	25	24	24.7	
30	1.9	30	30	30	30	
40	3.55	45	45	45	45	
45	4.55	55	54	55	54.7	

Were corrections to the actual flow [illegible] No ____

If yes, by what percent? ____

Was timer check required? Yes ____ No [illegible] Stop Time ____.

Were any problems encountered during calibration? Yes ____ No ____.

Remarks: _____

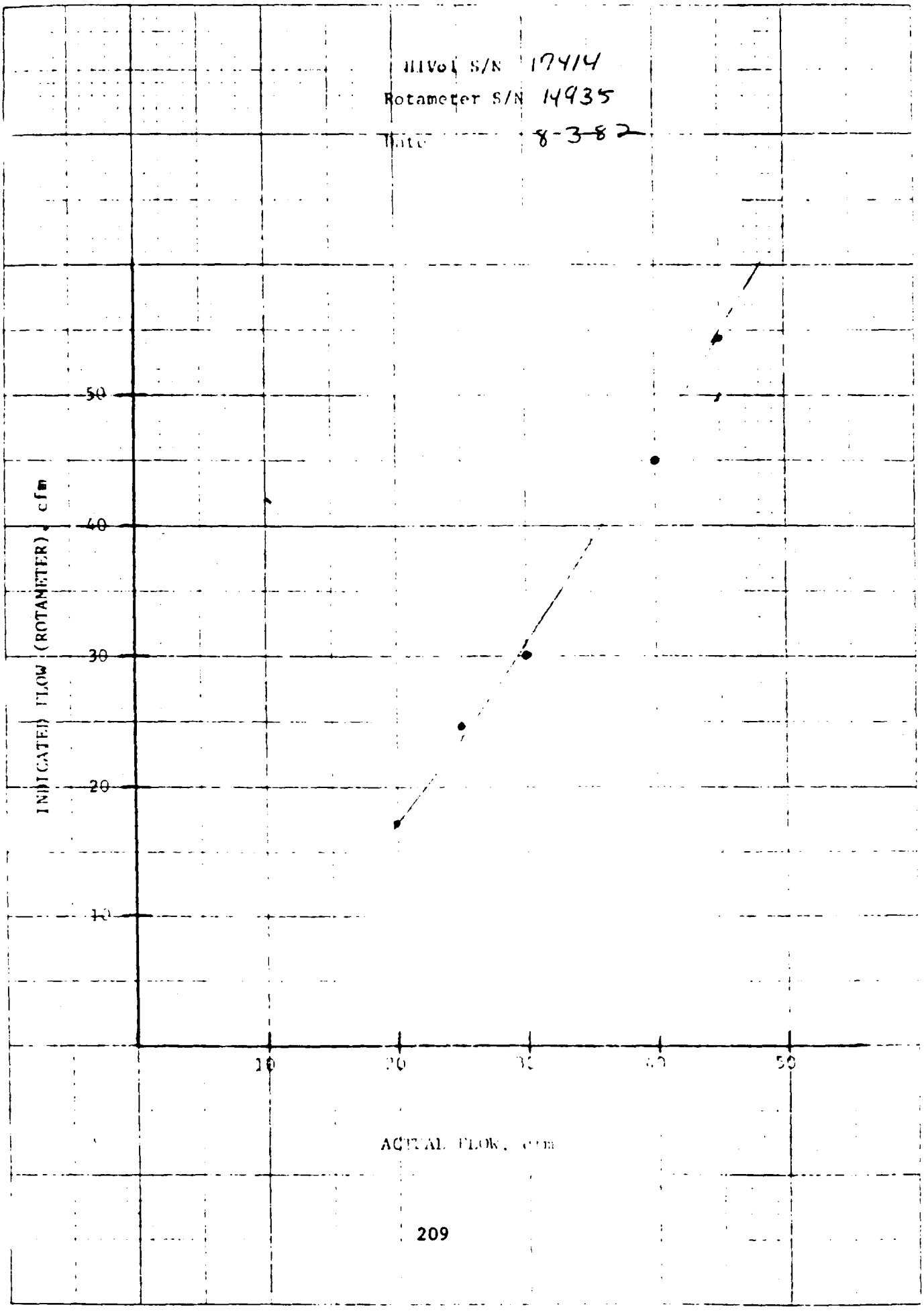
Date of completion: 8-3-82 Technician: [illegible]

Reviewed by: [illegible] Date: 8/4/82

HiVol S/N 17414

Rotameter S/N 14935

Date 8-3-82



Form 1

BGI Hi-Volume Air Sampler Calibration Sheet

Hi-Vol S/N 17488 Project No. _____

Rotameter S/N 15099 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 72 °F Source: Lab Thermometer

Barometric Pressure 29.93 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	15	13	13	13.7	
25	1.38	24	23	[illegible]	23.7	
30	1.90	30	[illegible]		30	
40	3.55	44	46	[illegible]	44.7	
45	4.5[illegible]	5[illegible]	55	55	55	

Were corrections to the actual flow [illegible] No ___

If yes, by what percent? ___

Was timer check required? Yes ___ No ___ [illegible] time ___.

Were any problems encountered during calibration? Yes ___ No ___.

Remarks: _____

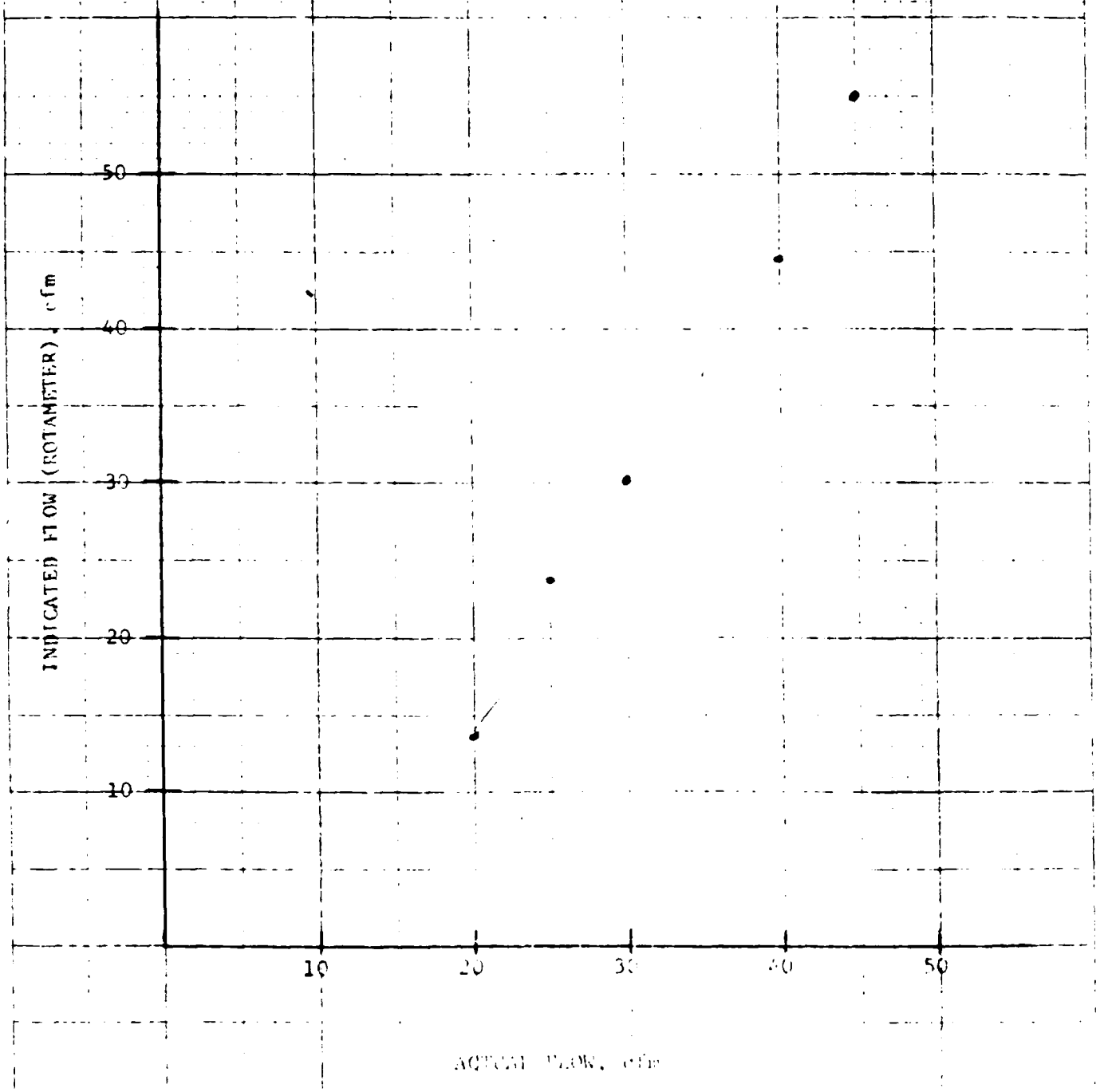
Date of completion: 8-2-82 Technician: [illegible]

Reviewed by: M White Date: 8/4/82

HiVol S/N 17488

Rotameter S/N 15009

Date 8-2-80



Form 1

BCI Hi-Volume Air [illegible]

Hi-Vol S/N ~~7430~~ 17490 (m.m.?)

Rotameter S/N 17490

VRC S/N 3569

VRC date of last cal. 5-4-82 VRC date of next cal.

Temperature 50 °F [illegible] Hg Thermometer

Barometric Pressure 29.81 in. Hg [illegible] Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
30	0.36	15	16	16	15.7	
25	1.24	25	25	25	25	
30	1.90	30	30	30	30	
40	3.55	50	50	52	50.7	
45	4.55	65	65	66	65.3	

Were corrections to [illegible]

If yes, by what percent

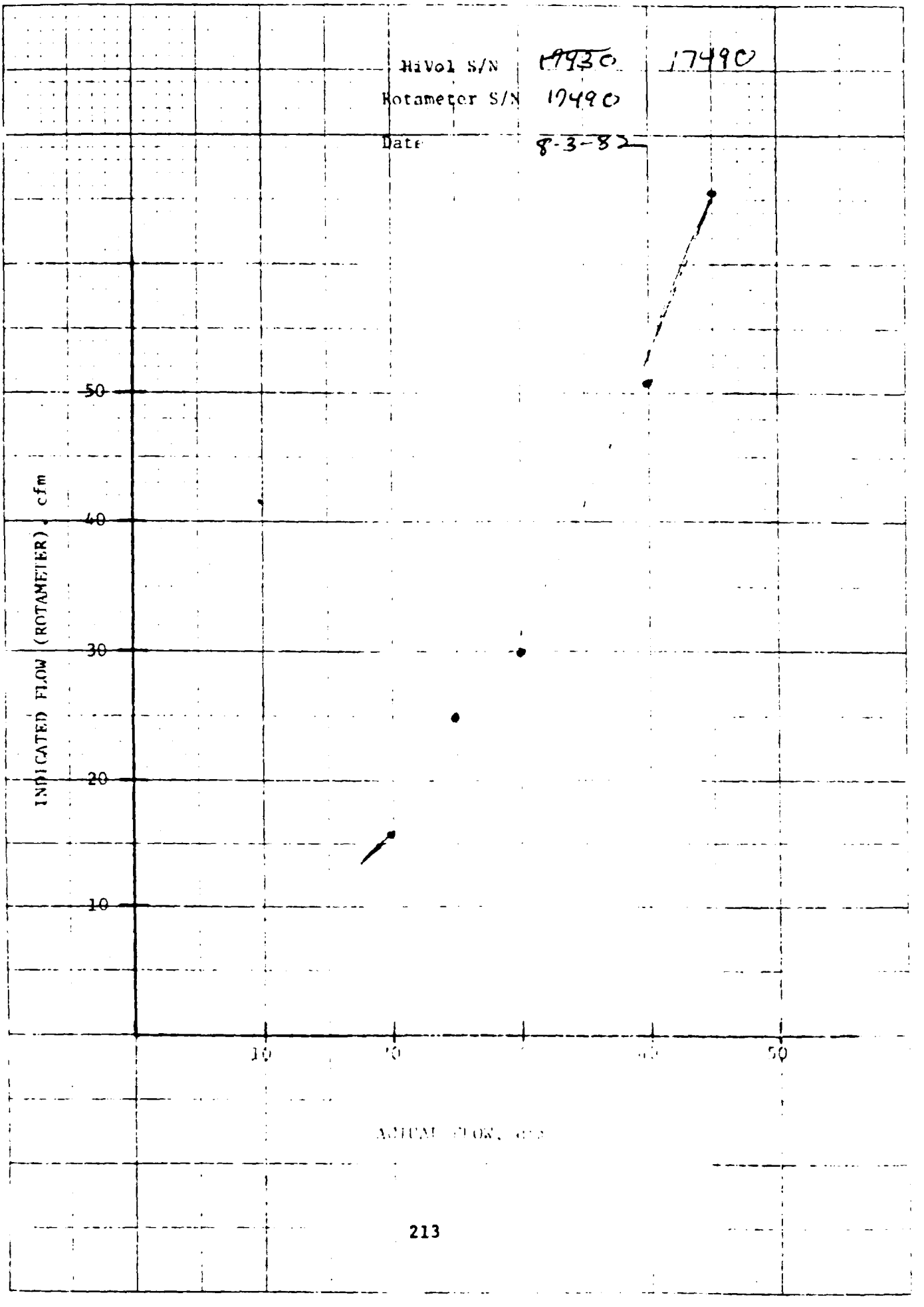
Was timer check required [illegible]

Were any problems encountered [illegible]

Remarks:

Date of completion: 8-3-82 [illegible] Rodkey

Reviewed by: [illegible] 8/4/82


HiVol S/N ~~1993~~ 1749C
Rotameter S/N 1749C
Date 8-3-82
50
40
30
20
10
INDICATED FLOW (ROTAMETER), cfm
10
50

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 17491 Project No. [illegible]

Rotameter S/N 17494 [illegible]

VRC S/N [illegible]769 [illegible]

VRC date of last cal. [illegible] VRC date of next cal. [illegible]

Temperature 70 °F Lab Thermometer

Barometric Pressure 29.[illegible] in. Hg Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Readings			Average Rotameter Reading	Actual Corrected Flow cfm (If applicable)
		Run 1	Run 2	Run 3		
20	0.8	17	17	16	16.[illegible]	
25	1.38	25	24	25	24.[illegible]	
30	1.90	30	30	30	30	
40	2.55	50	52	51	51	
45	4.55	63	63	63	63	

Were corrections to the [illegible]

If yes, by what percent

Was timer check required [illegible] ✓

Were any problems encountered [illegible] ✓

Comments: [illegible]

Date of completion 8-3-82 Performed by [illegible]

Reviewed by: [illegible] 4/1/83

HiVol S/N 17491

Rotameter S/N 17494

Date 8-3-82

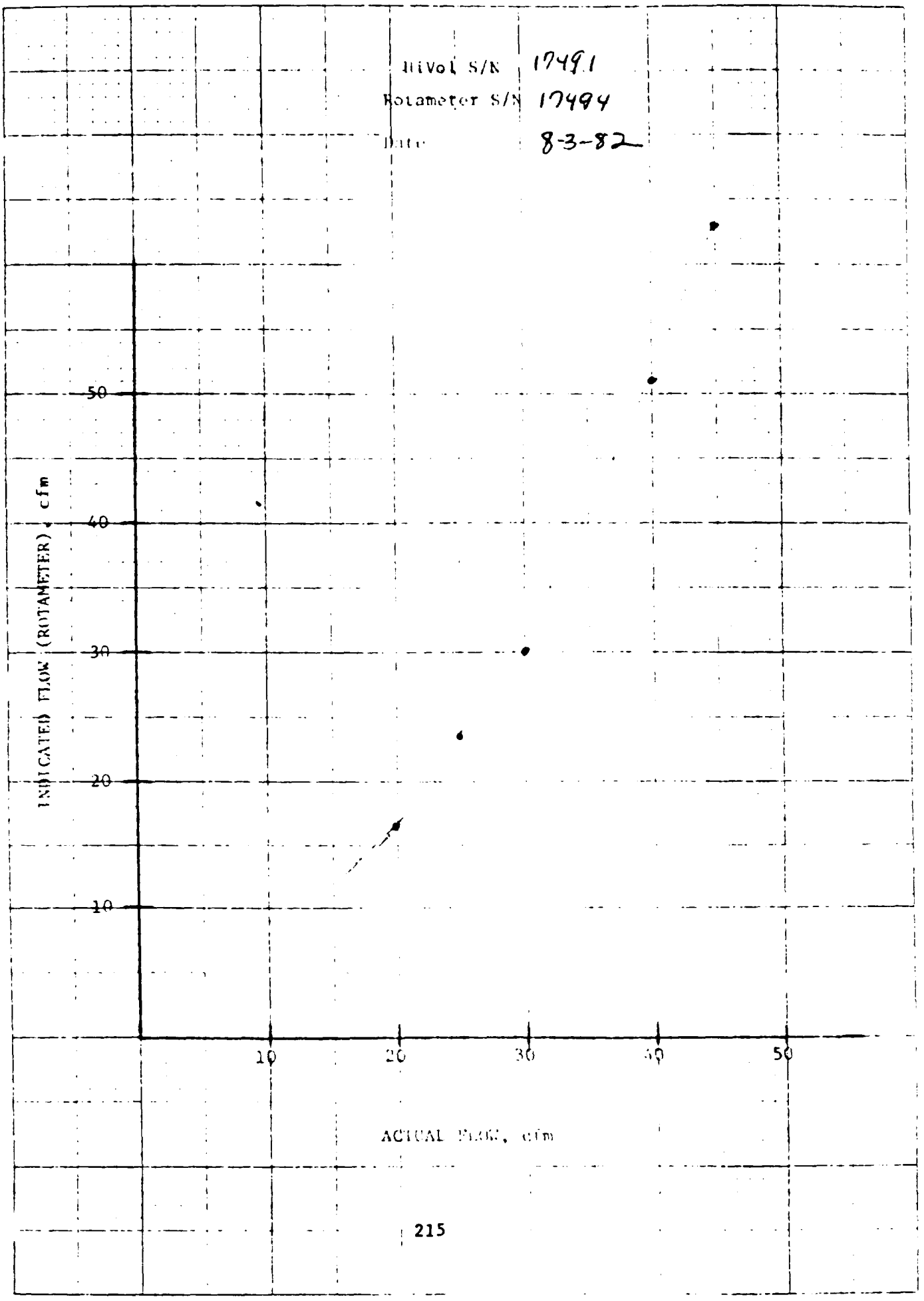


TABLE 4. HI-VOLUME AIR SAMPLER CALIBRATION DATA SHEET

Hi-Vol S/N 17493 Project No. _____

Rotometer S/N 14926 Site _____

VRC S/N 2569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 69 °F Source: Lab Thermometer

Barometric Pressure 24.91 in. Hg. Source: Lab Barometer

Actual flow cfm	Manometer setting in. H_2O	Rotometer reading Run 1	Run 2	[illegible]	Average of all readings	Actual corrected flow cfm (if applicable)
20	0.86	11	10	10	10.3	
25	1.38	22	22	22	22	
30	1.90	30	30	30	30	
40	3.55	54	55	55	54.7	
45	4.55	64	64	63	63.7	

Were corrections to the actual flow required? [illegible]

If yes, by what percent? [illegible]

Was timer check required? [illegible]

Were any problems encountered during [illegible]

Remarks: _____

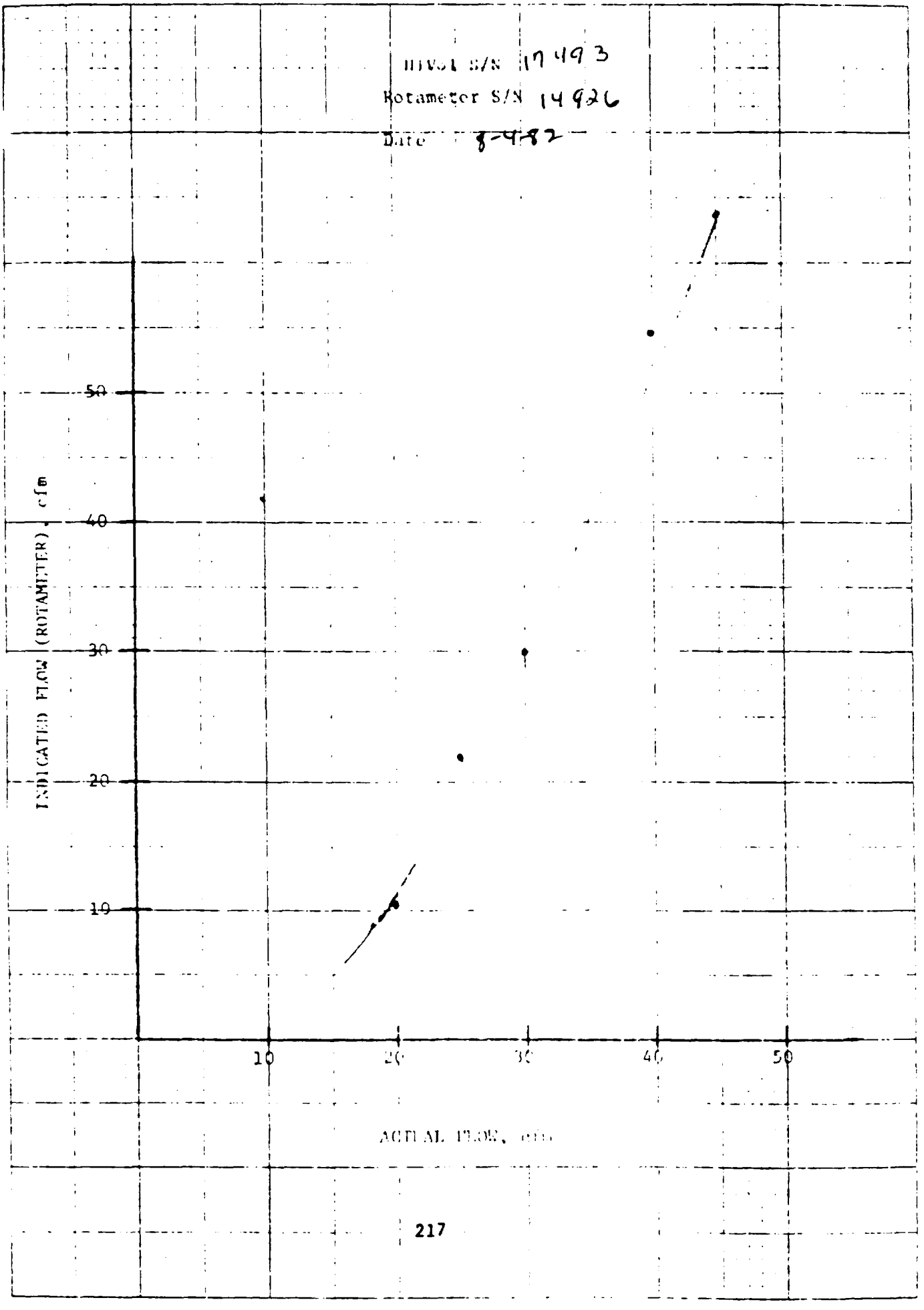
Date of completion: 8-4-82 Pendleton

Reviewed by: [illegible] 8/4/82

HIVOL S/N 17493

Rotameter S/N 14926

Date 8-4-82



D

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 17494
Rotameter S/N 17493
VRC S/N 3569
VRC date of last cal. 3-9-82

Project No. _____
Site _____
Location _____
VRC date of next cal. _____

Temperature 69 °F Source: Lab Thermometer
Barometric Pressure 29.91 in. Hg Source: Lab Barometer

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	0.86	17	17	17	17	
25	1.38	24	25	25	24.7	
30	1.90	30	30	30	30	
40	3.55	50	50	50	50	
45	4.55	65	65	65	65	

Were corrections to the actual flow required? Yes ___ No ___

If yes, by what percent? _____

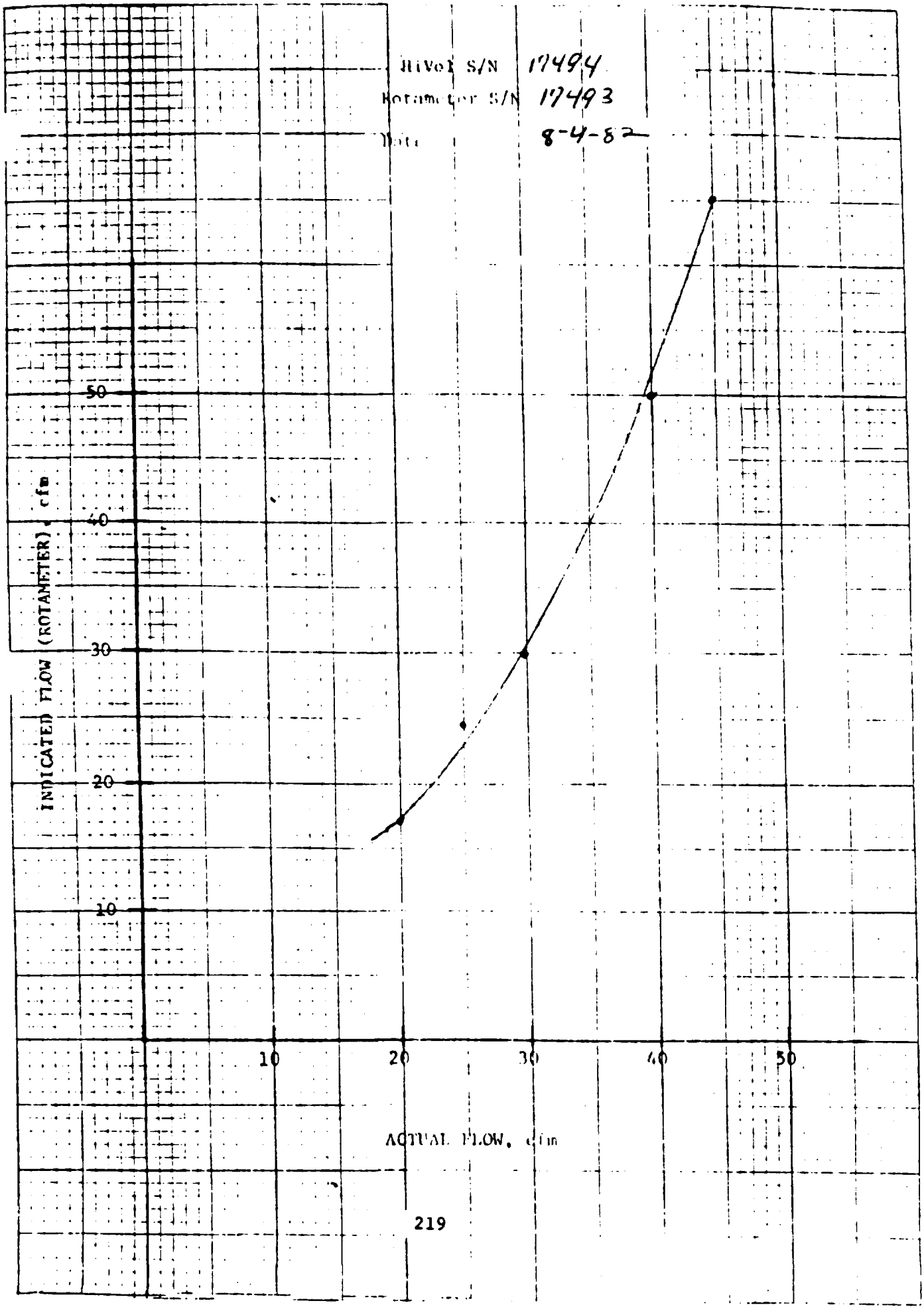
Was timer check required? Yes ___ No ___ Elapsed time ___

Were any problems encountered during calibration? Yes ___ No ___

Remarks: _____

Date of completion: 8-4-82 Technician: Radke

Reviewed by: _____ Date: _____


Rivet S/N 17494
Rotameter S/N 17493
Date 8-4-82
INDICATED FLOW (ROTAMETER), cfm
ACTUAL FLOW, cfm
10
20
30
40
50

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 18798 Project No. _____

Rotameter S/N 120 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3/9/83 VRC date of next cal. _____

Temperature 74 °F Source: _____

Barometric Pressure 29.94 in. Hg Source: _____

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading			Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
		Run 1	Run 2	Run 3		
20	.86	20	20	20	20	
25	1.38	25	25	25	25	
30	1.90	30	30	30	30	
40	3.55	42	42	42	42	
45	4.55	50	50	50	50	

Were corrections to the actual flow required? Yes ____ No ____

If yes, by what percent? _____.

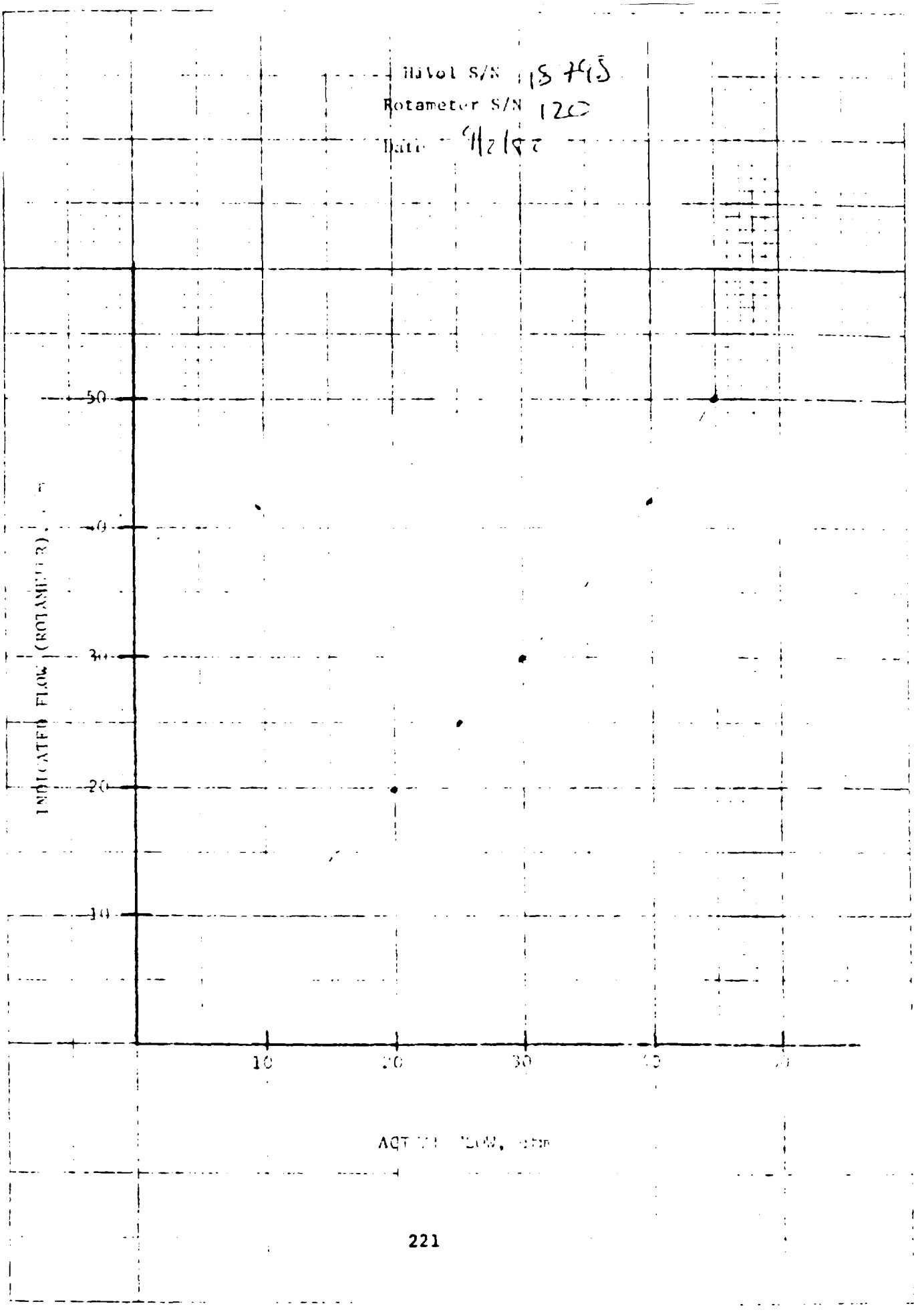
Was timer check required? Yes ____ No ____ Elapsed time _____.

Were any problems encountered during calibration? Yes ____ No ____.

Remarks: _____

Date of completion: 9/2/82 Technician: [illegible]

Reviewed by: [illegible] Date: 9/1/82


Rotameter S/N 120
50
40
30
20
10
10
20
30
40

0

Form 1

BGI Hi-Volume Air Sampler Calibration Data Sheet

Hi-Vol S/N 18799 Project No. _____

Rotameter S/N 15006 Site _____

VRC S/N 3569 Location _____

VRC date of last cal. 3-9-82 VRC date of next cal. _____

Temperature 72 Source Lab Therm

Barometric Pressure 29.73 Source Lab Baro

Actual Flow cfm	Manometer Setting in. H_2O	Rotameter Reading Run 1	Run 2	Run 3	Average Rotameter Reading	Actual Corrected Flow cfm (if applicable)
20	0.86	20	18	19	19	
25	1.38	26	24	26	25.3	
30	1.90	31	30	30	30.3	
40	3.55	46	45	45	45.3	
45	4.55	55	55	55	55	

Were corrections to the actual flow required? Yes ✓ No ___

If yes, by what percent? _____

Was timer check required? Yes ___ No ✓ ___, Time ___

Were any problems encountered during calibration? Yes ___ No ✓

Remarks: _____

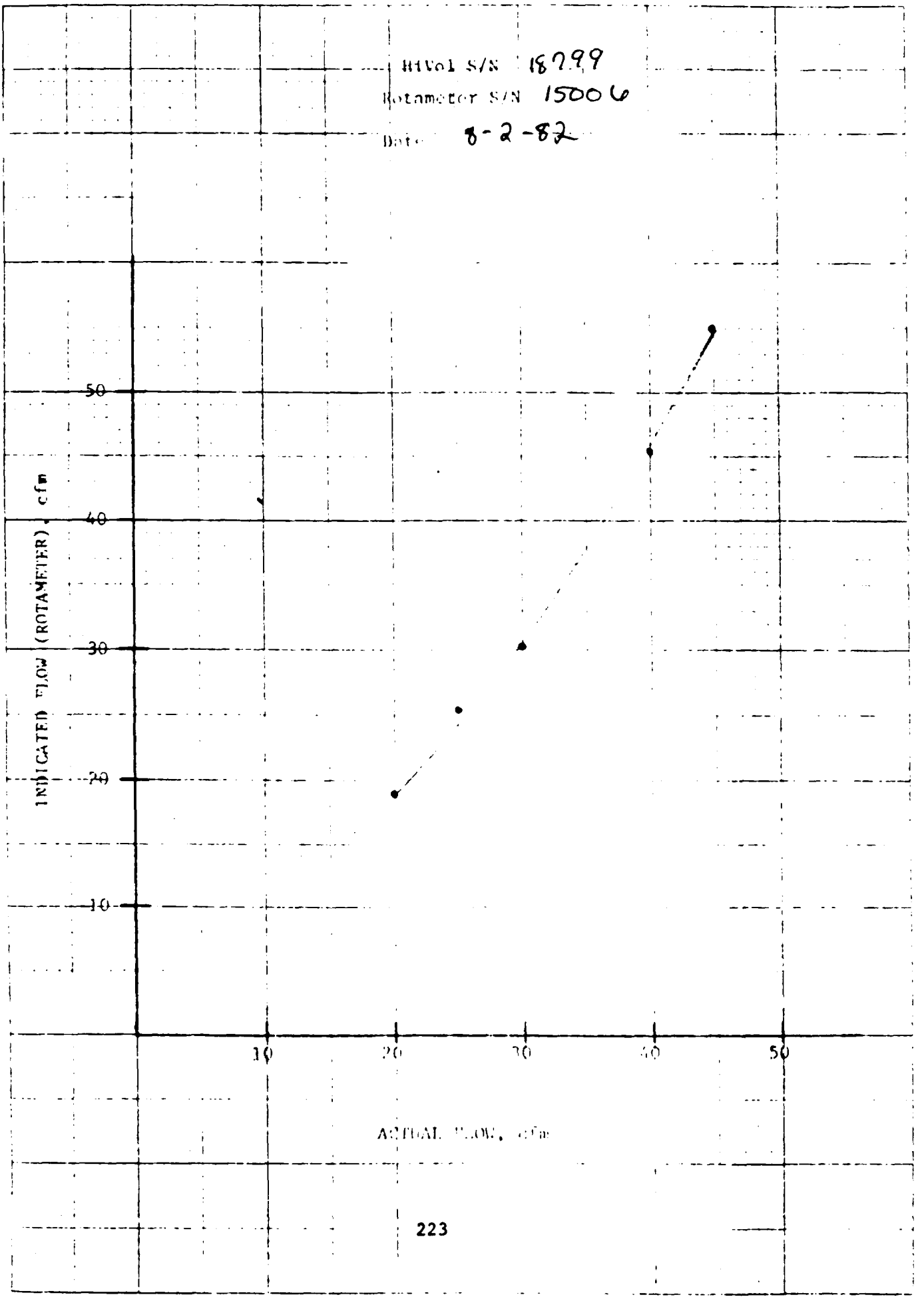
Date of completion: 8-2-82 Technician: Pendleton

Reviewed by: [illegible] Date: 8/4/82

HiVol S/N 18799

Rotameter S/N 15006

Date 8-2-82



APPENDIX C

TRACE METAL DATA SHEETS
COMPREHENSIVE STATIONS - DAY 2/3

Project 1-619-079 B GCA Control No. 25400

DATA REPORT SHEET

Metals

Sample I.D. 6-Cushman Park Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	< 0.002
Antimony	< 0.004
Arsenic	< 0.007
Barium	0.0026
Beryllium	< 0.0001
Boron	< 0.0009
Cadmium	< 0.0002
Calcium	< 0.002
Chromium	0.0016
Cobalt	0.0108
Copper	0.0203
Iron	0.376
Lead	0.161
Magnesium	0.056
Manganese	0.0054
Molybdenum	<0.0005
Nickel	<0.001
Selenium	<0.004
Silicon	<0.001
Silver	0.0008
Sodium	38.2
Strontium	<0.0005
Thallium	<0.009
Tin	<0.007
Titanium	0.0002
Vanadium	0.0074
Zinc	0.0353

Project 1-619-079 B GCA Control No. 25422

DATA REPORT SHEET

Metals

Sample I.D. 13-Fire Station #2 Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.007
Antimony	< 0.003
Arsenic	< 0.004
Barium	0.0016
Beryllium	< 0.0001
Boron	< 0.0006
Cadmium	< 0.0001
Calcium	0.016
Chromium	0.0007
Cobalt	0.0005
Copper	0.0121
Iron	0.159
Lead	0.148
Magnesium	0.025
Manganese	0.0027
Molybdenum	< 0.0003
Nickel	< 0.0007
Selenium	< 0.003
Silicon	< 0.0007
Silver	< 0.0001
Sodium	28.2
Strontium	0.0002
Thallium	< 0.0006
Tin	< 0.004
Titanium	< 0.0001
Vanadium	0.0053
Zinc	0.0185

Project 1-619-079 B GCA Control No. 25430

DATA REPORT SHEET

Metals

Sample I.D. 1-Dartmouth Town Hall Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.100
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0042
Beryllium	< 0.0001
Boron	< 0.001
Cadmium	< 0.0002
Calcium	0.291
Chromium	0.0042
Cobalt	0.0021
Copper	0.0347
Iron	0.174
Lead	0.110
Magnesium	0.210
Manganese	0.0042
Molybdenum	< 0.0005
Nickel	0.004
Selenium	< 0.005
Silicon	< 0.001
Silver	< 0.0002
Sodium	59.8
Strontium	0.0018
Thallium	< 0.01
Tin	< 0.007
Titanium	< 0.002
Vanadium	0.0074
Zinc	0.0425

GCA CORPORATION
Technology Division
GCA

Project 1-619-079 B GCA Control No. 25432

DATA REPORT SHEET

Metals

Sample I.D. 18-Incinerator #3 Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.112
Antimony	< 0.004
Arsenic	< 0.007
Barium	0.0060
Beryllium	0.0001
Boron	< 0.0009
Cadmium	0.0004
Calcium	< 0.002
Chromium	0.0071
Cobalt	0.0011
Copper	0.0270
Iron	0.358
Lead	0.116
Magnesium	0.105
Manganese	0.0038
Molybdenum	0.0006
Nickel	0.002
Selenium	< 0.004
Silicon	< 0.001
Silver	< 0.0002
Sodium	40.2
Strontium	0.0011
Thallium	< 0.009
Tin	< 0.007
Titanium	< 0.0002
Vanadium	0.0055
Zinc	0.0530

Project 1-619-079 B GCA Control No. 25436

DATA REPORT SHEET

Metals

Sample I.D. 3-Shawmut St. Station - A Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	< 0.002
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0044
Beryllium	< 0.0001
Boron	< 0.001
Cadmium	< 0.0002
Calcium	< 0.002
Chromium	0.0011
Cobalt	< 0.0007
Copper	0.0579
Iron	0.157
Lead	0.109
Magnesium	< 0.005
Manganese	0.0028
Molybdenum	< 0.0005
Nickel	0.027
Selenium	< 0.005
Silicon	< 0.001
Silver	< 0.0002
Sodium	44.1
Strontium	< 0.0002
Thallium	< 0.01
Tin	< 0.007
Titanium	< 0.0002
Vanadium	0.0046
Zinc	0.0314

GCA CORPORATION
Technology Division
GCA

Project 1-619-079 B GCA Control No. 25440

DATA REPORT SHEET

Metals

Sample I.D. 3-Shawmut St. Station - B Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.083
Antimony	< 0.005
Arsenic	< 0.08
Barium	0.0040
Beryllium	< 0.0001
Boron	0.0095
Cadmium	< 0.0003
Calcium	0.143
Chromium	0.0080
Cobalt	00.0018
Copper	0.0656
Iron	0.160
Lead	0.115
Magnesium	0.103
Manganese	0.0035
Molybdenum	< 0.0005
Nickel	0.029
Selenium	< 0.005
Silicon	< 0.001
Silver	< 0.0003
Sodium	53.8
Strontium	< 0.0009
Thallium	< 0.01
Tin	< 0.008
Titanium	< 0.0003
Vanadium	0.0050
Zinc	0.0681

Project 1-619-079 B GCA Control No. 25444

DATA REPORT SHEET

Metals

Sample I.D. C&W Welding - A Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.352
Antimony	< 0.005
Arsenic	< 0.008
Barium	0.0114
Beryllium	0.0001
Boron	< 0.001
Cadmium	0.0003
Calcium	0.864
Chromium	0.0033
Cobalt	0.0014
Copper	0.0773
Iron	0.5460
Lead	0.445
Magnesium	0.458
Manganese	0.0105
Molybdenum	< 0.0005
Nickel	0.015
Selenium	< 0.005
Silicon	0.150
Silver	< 0.003
Sodium	66.0
Strontium	0.0052
Thallium	< 0.01
Tin	< 0.008
Titanium	0.0110
Vanadium	0.0143
Zinc	0.445

Project 1-619-079 B GCA Control No. 25446

DATA REPORT SHEET

Metals

Sample I.D. C&W Welding - B Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.184
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0068
Beryllium	0.0002
Boron	< 0.001
Cadmium	0.0005
Calcium	0.614
Chromium	0.0025
Cobalt	0.0007
Copper	0.0489
Iron	0.3810
Lead	0.327
Magnesium	0.246
Manganese	0.0063
Molybdenum	< 0.0005
Nickel	0.055
Selenium	< 0.005
Silicon	< 0.001
Silver	0.0011
Sodium	54.1
Strontium	0.0034
Thallium	< 0.01
Tin	0.021
Titanium	< 0.0002
Vanadium	0.0082
Zinc	0.275

Project 1-619-079 B GCA Control No. 25553

DATA REPORT SHEET

Metals

Sample I.D. 6-Cushman Park Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.574
Antimony	< 0.006
Arsenic	< 0.009
Barium	0.0134
Beryllium	< 0.0002
Boron	0.007
Cadmium	< 0.0003
Calcium	0.652
Chromium	0.0024
Cobalt	0.0033
Copper	0.0294
Iron	0.498
Lead	0.048
Magnesium	0.311
Manganese	0.0081
Molybdenum	< 0.0006
Nickel	0.008
Selenium	< 0.006
Silicon	1.26
Silver	< 0.0003
Sodium	28.4
Strontium	0.0033
Thallium	< 0.01
Tin	< 0.009
Titanium	0.0053
Vanadium	0.007
Zinc	0.0386

Project 1-619-079 B GCA Control No. 25561

DATA REPORT SHEET

Metals

Sample I.D. 13-Fire Station No. 2 Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.263
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0046
Beryllium	0.0002
Boron	< 0.001
Cadmium	0.0002
Calcium	0.403
Chromium	< 0.0007
Cobalt	< 0.0007
Copper	0.0364
Iron	0.536
Lead	0.228
Magnesium	0.227
Manganese	0.0062
Molybdenum	< 0.0005
Nickel	< 0.001
Selenium	< 0.005
Silicon	< 0.001
Silver	< 0.0002
Sodium	10.9
Strontium	0.0020
Thallium	< 0.01
Tin	0.008
Titanium	< 0.0002
Vanadium	0.009
Zinc	0.0323

Project 1-619-079 B GCA Control No. 25573

DATA REPORT SHEET

Metals

Sample I.D. 1-Dartmouth Town Hall Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.399
Antimony	< 0.004
Arsenic	< 0.007
Barium	0.0041
Beryllium	< 0.0001
Boron	0.043
Cadmium	< 0.0002
Calcium	0.698
Chromium	0.0016
Cobalt	0.0007
Copper	0.0518
Iron	0.271
Lead	0.054
Magnesium	0.366
Manganese	0.0041
Molybdenum	< 0.0004
Nickel	< 0.001
Selenium	< 0.004
Silicon	0.353
Silver	< 0.0002
Sodium	25.8
Strontium	0.0039
Thallium	< 0.009
Tin	< 0.007
Titanium	< 0.0002
Vanadium	0.006
Zinc	0.0225

Project 1-619-079 B GCA Control No. 25579

DATA REPORT SHEET

Metals

Sample I.D. 3-Shawmut Pump Station - B Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	< 0.002
Antimony	< 0.005
Arsenic	< 0.007
Barium	< 0.0002
Beryllium	< 0.0001
Boron	< 0.001
Cadmium	< 0.0002
Calcium	< 0.002
Chromium	0.0008
Cobalt	< 0.0007
Copper	0.0431
Iron	0.239
Lead	0.037
Magnesium	0.005
Manganese	0.0022
Molybdenum	< 0.0005
Nickel	< 0.001
Selenium	< 0.005
Silicon	0.653
Silver	< 0.0002
Sodium	4.89
Strontium	< 0.0002
Thallium	< 0.01
Tin	< 0.007
Titanium	< 0.0002
Vanadium	0.005
Zinc	0.0264

Project 1-619-079 B GCA Control No. 25581

DATA REPORT SHEET

Metals

Sample I.D. 3-Shawmut Pump Station - A Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.099
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0076
Beryllium	< 0.001
Boron	0.008
Cadmium	< 0.0002
Calcium	0.159
Chromium	0.0036
Cobalt	0.0013
Copper	0.0135
Iron	0.219
Lead	0.044
Magnesium	0.145
Manganese	0.0031
Molybdenum	< 0.0005
Nickel	0.233
Selenium	< 0.005
Silicon	0.903
Silver	< 0.0002
Sodium	12.2
Strontium	0.0014
Thallium	< 0.009
Tin	0.015
Titanium	< 0.0002
Vanadium	0.006
Zinc	0.0210

Project 1-619-079 B GCA Control No. 25605

DATA REPORT SHEET

Metals

Sample I.D. 18-Incinerator No. 3 Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.884
Antimony	< 0.005
Arsenic	< 0.008
Barium	0.0934
Beryllium	0.0005
Boron	0.005
Cadmium	0.0054
Calcium	2.48
Chromium	0.0540
Cobalt	0.0029
Copper	0.183
Iron	1.94
Lead	0.067
Magnesium	0.818
Manganese	0.0169
Molybdenum	0.0028
Nickel	0.196
Selenium	< 0.005
Silicon	0.299
Silver	0.0096
Sodium	22.6
Strontium	0.0122
Thallium	< 0.01
Tin	0.011
Titanium	0.0392
Vanadium	0.011
Zinc	0.131

Project 1-619-079 B GCA Control No. 25607

DATA REPORT SHEET

Metals

Sample I.D. 9-C&W Welding - A Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.467
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0118
Beryllium	0.0002
Boron	0.030
Cadmium	0.0003
Calcium	0.765
Chromium	0.0042
Cobalt	0.0016
Copper	0.0278
Iron	0.605
Lead	0.158
Magnesium	0.450
Manganese	0.0095
Molybdenum	< 0.0005
Nickel	0.144
Selenium	< 0.005
Silicon	0.811
Silver	< 0.0002
Sodium	20.8
Strontium	0.0041
Thallium	< 0.01
Tin	< 0.007
Titanium	0.0031
Vanadium	0.017
Zinc	0.443

Project 1-619-079 B GCA Control No. 25611

DATA REPORT SHEET

Metals

Sample I.D. 9-C&W Welding - B Report Date 10/27/82

Sample Matrix Hi-Vol Filter

Element	Concentration ($\mu g/m^3$)
ICAP Analysis	
Aluminum	0.220
Antimony	< 0.005
Arsenic	< 0.007
Barium	0.0072
Beryllium	0.0002
Boron	< 0.001
Cadmium	0.0006
Calcium	0.373
Chromium	0.0039
Cobalt	0.0020
Copper	0.0319
Iron	0.489
Lead	0.207
Magnesium	0.283
Manganese	0.0078
Molybdenum	0.0005
Nickel	0.069
Selenium	< 0.005
Silicon	0.534
Silver	0.0006
Sodium	15.4
Strontium	0.0025
Thallium	< 0.009
Tin	0.015
Titanium	< 0.0002
Vanadium	0.017
Zinc	0.439

GCA CORPORATION
Technology Division
GCA

APPENDIX D

SELECTED MASS SPECTRAL DATA

REPRESENTATIVE TOTAL ION CHROMATOGRAMS AND COMPONENT SPECTRA

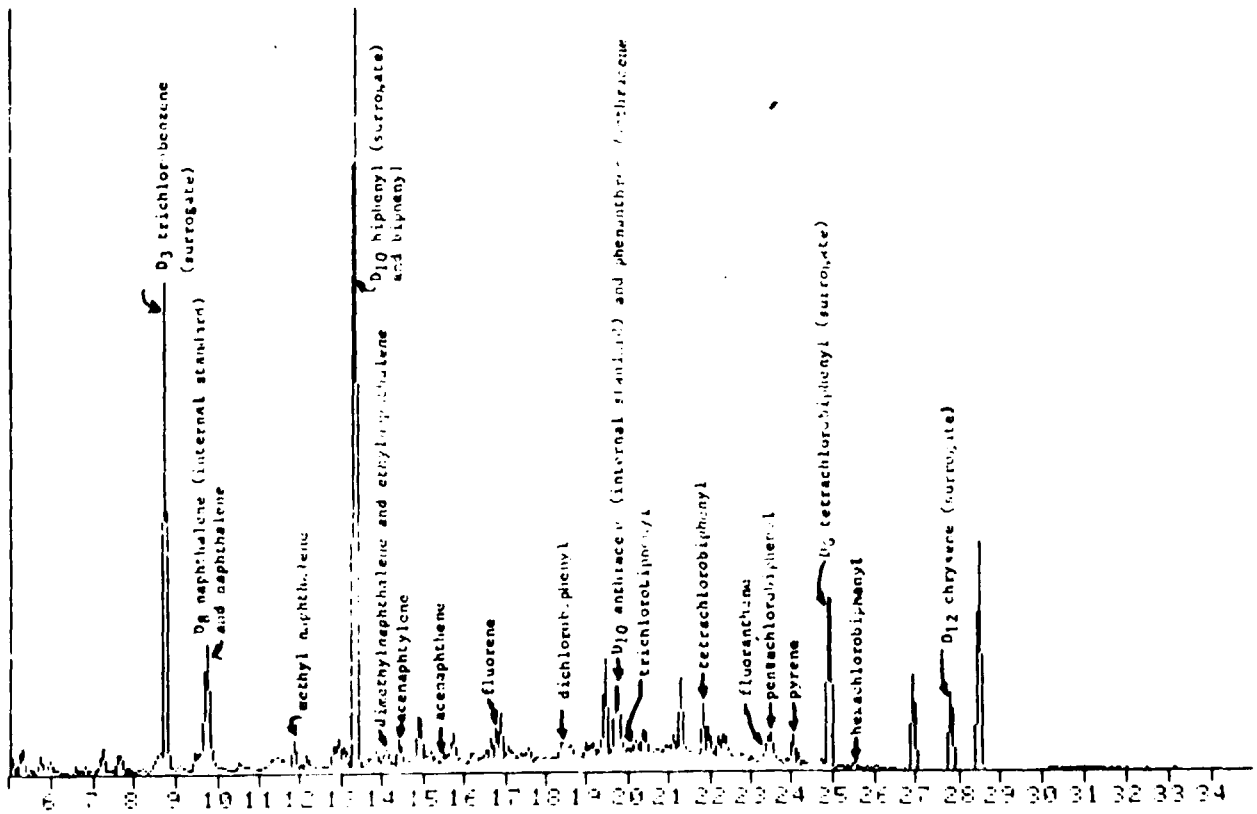
1. Sullivan's Ledge - Day 3 (GCA 25556)
2. Taber Street - Day 2 (GCA 25401)
3. Shawmut Street Station - Day 3 (GCA 25578)
4. Cushman Park - Day 2 (GCA 25399)

NAME 25556 HLY 730PM 111782 1619079B
MISC 60121-3001H108 1UL 5985

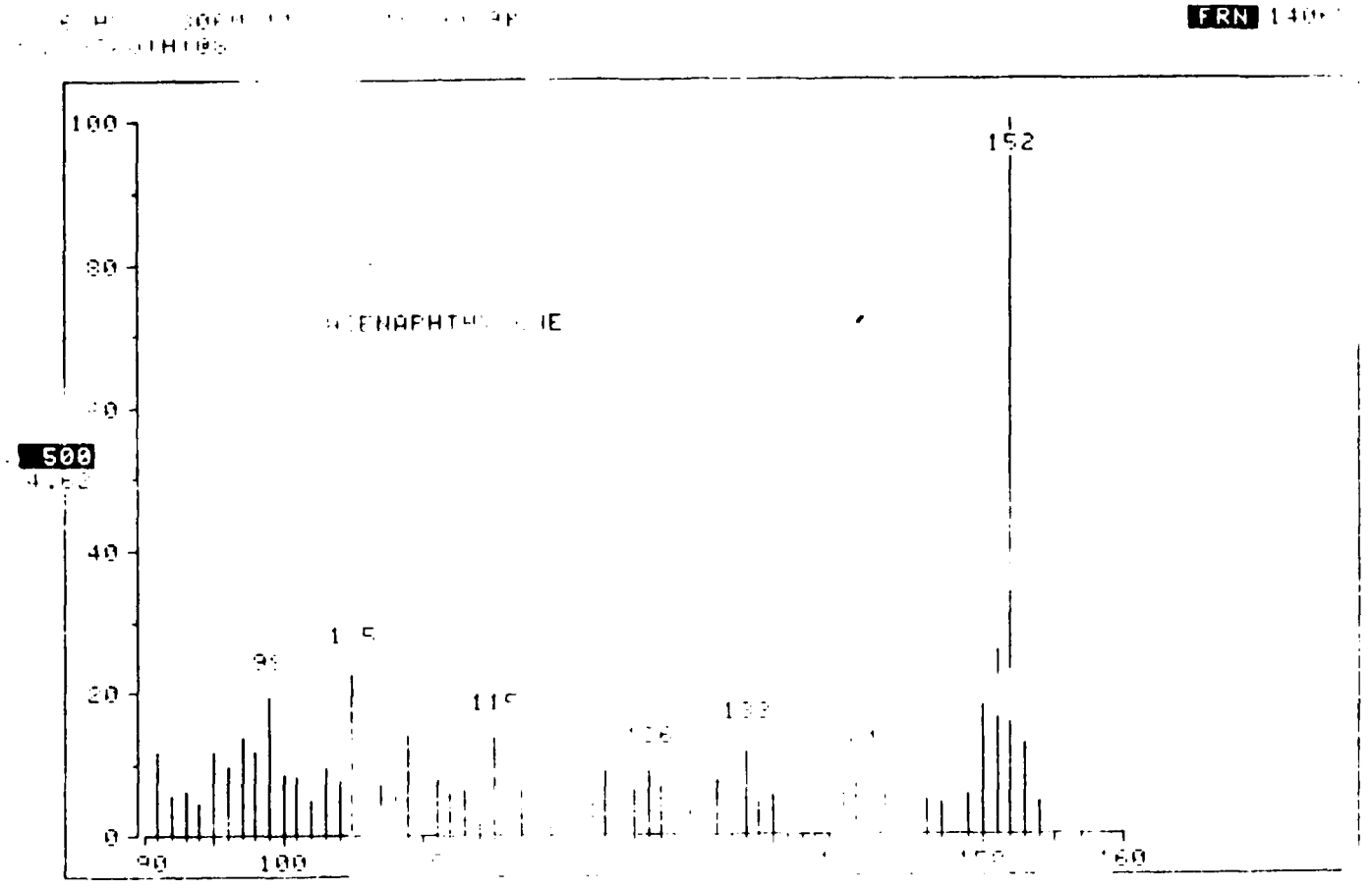
FRN 14065

121831

TI



Sullivan's Ledge--Day 3 (GCA 25556)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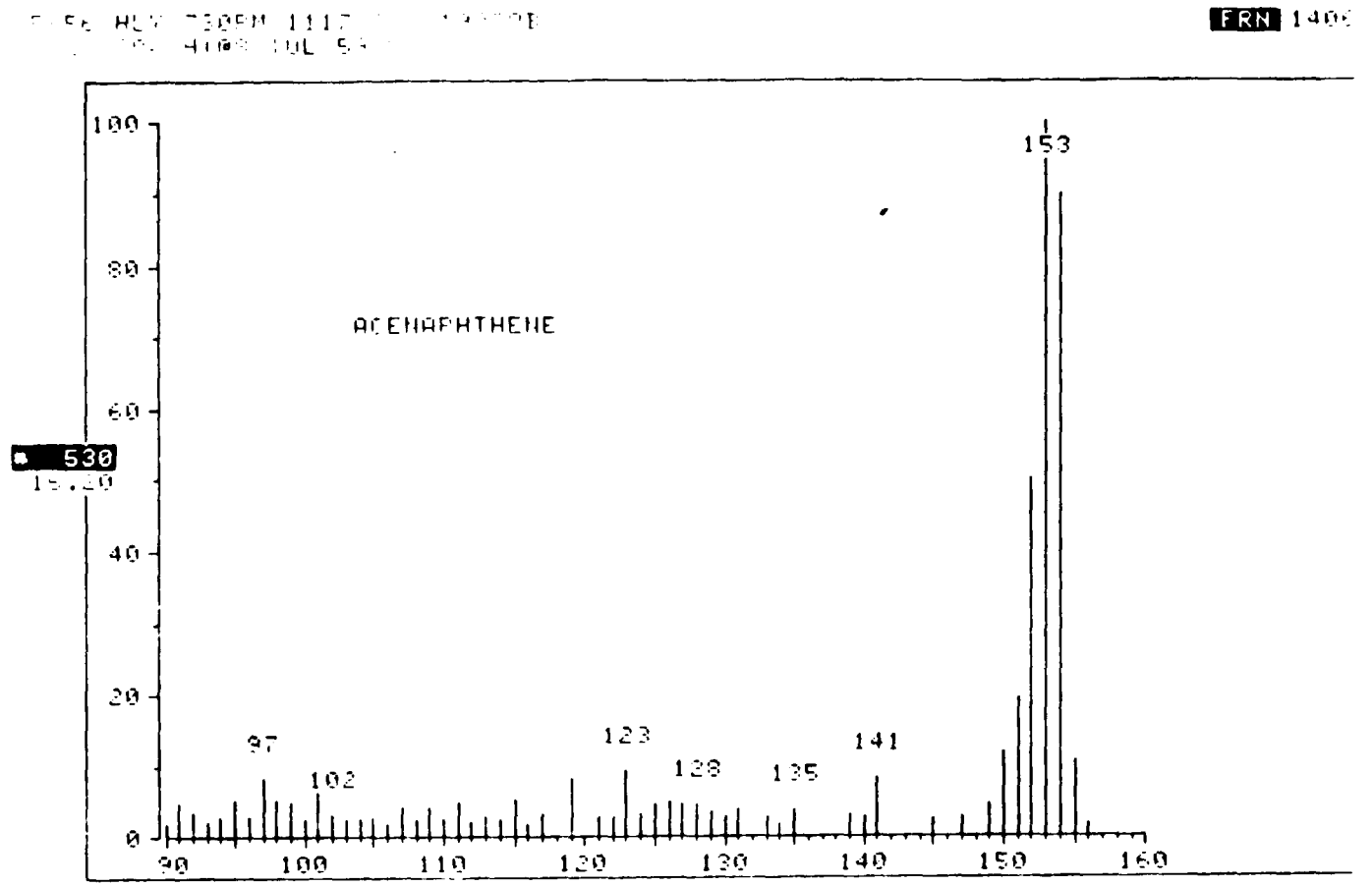
40
20
0
90
100
152
160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ACENAPHTHENE
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97
102
123
128
135
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530
15.20
100
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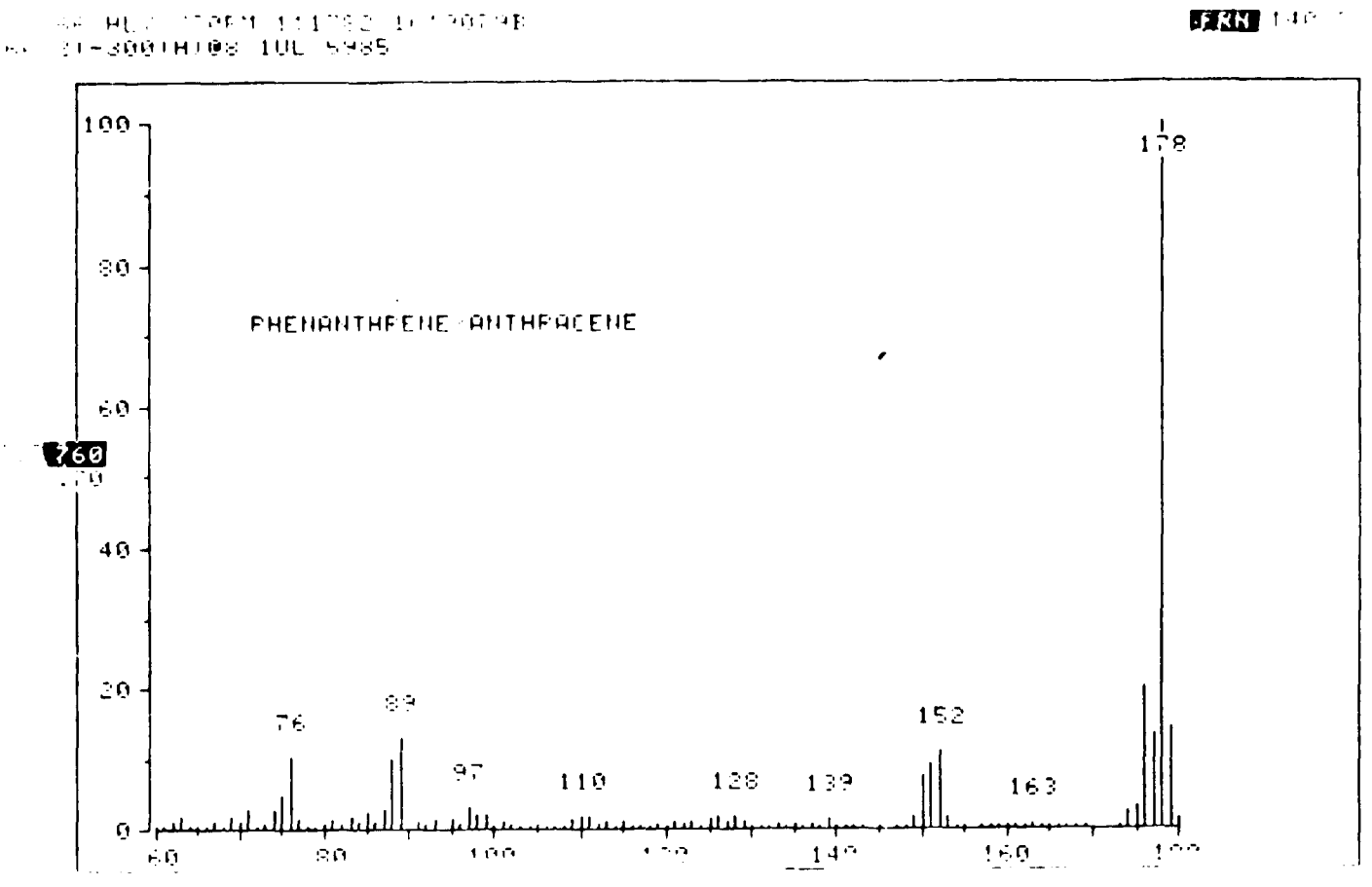
60
40
20
0
90
100
110
120
130
140
150
160


PHENANTHRENE ANTHRACENE
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20
0
76
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128
139
152
163
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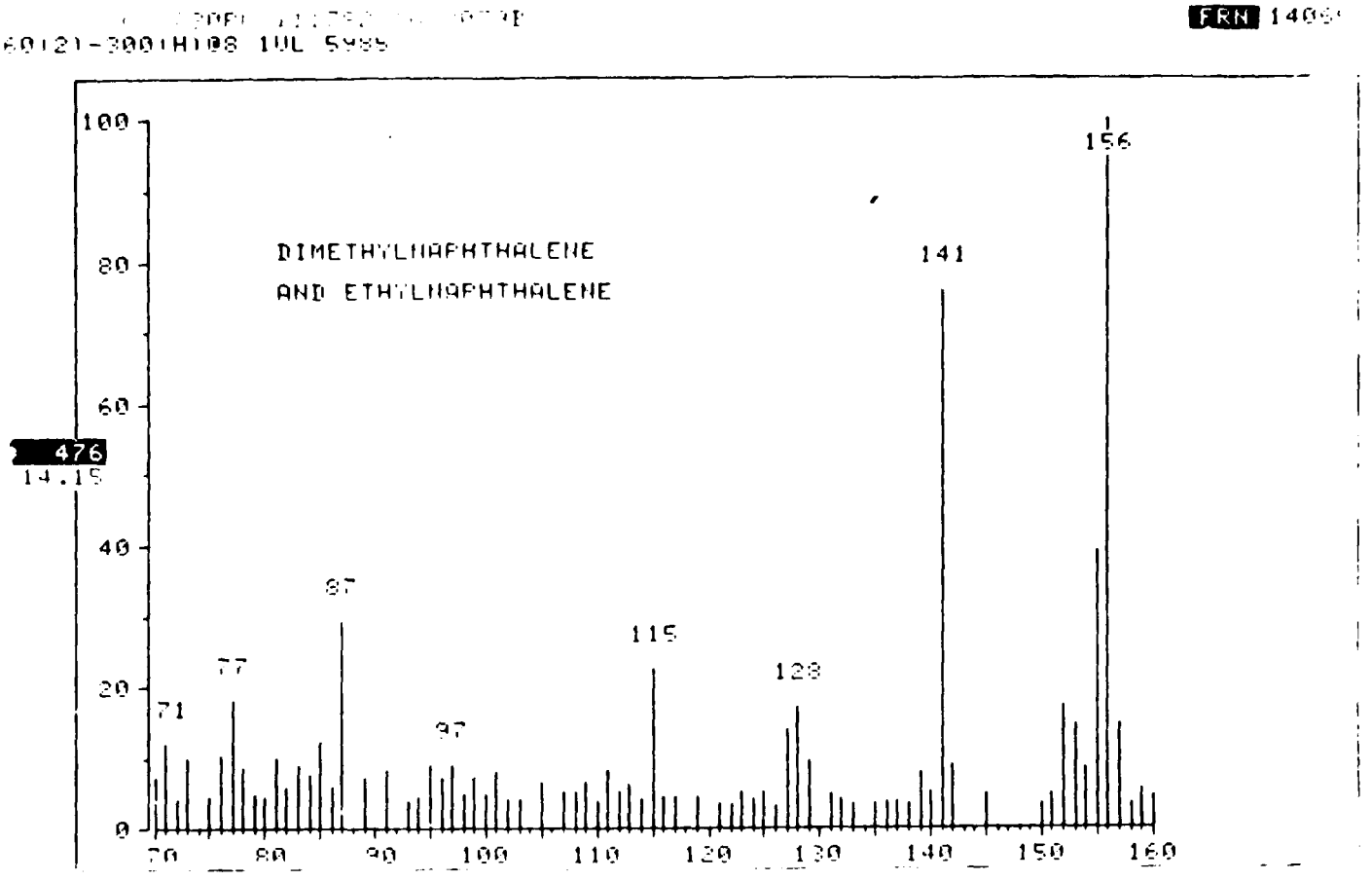
60
80
100
140
160


60121-3001H108 1UL 5985
FRN 1405
DIMETHYLNAPHTHALENE
AND ETHYLNAPHTHALENE
476
14.15
100
80
60
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20
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71
77
87
97
115
128
141
156
70
80
90
100
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120
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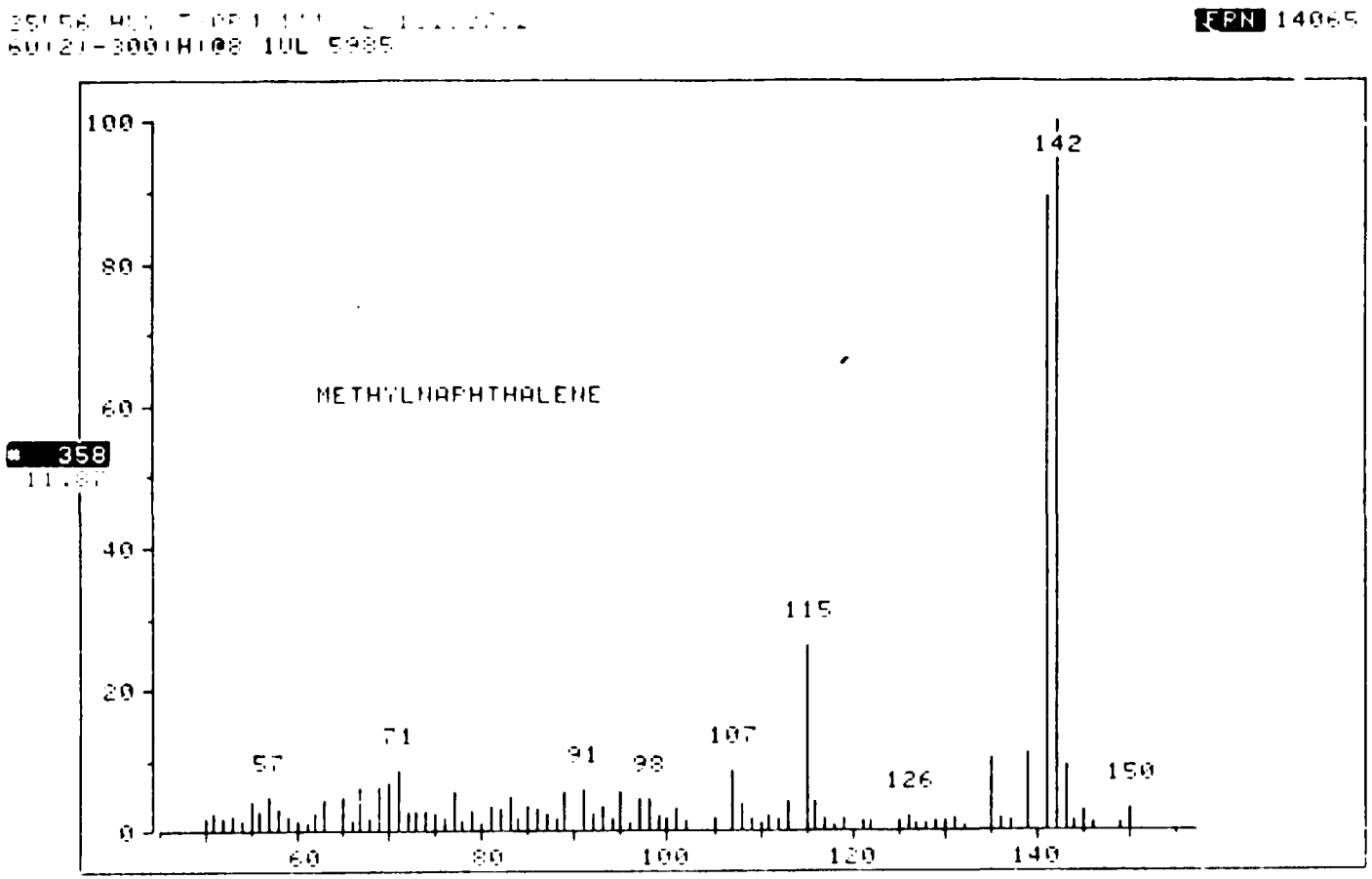
140
150
160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METHYLNAPHTHALENE
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100
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140
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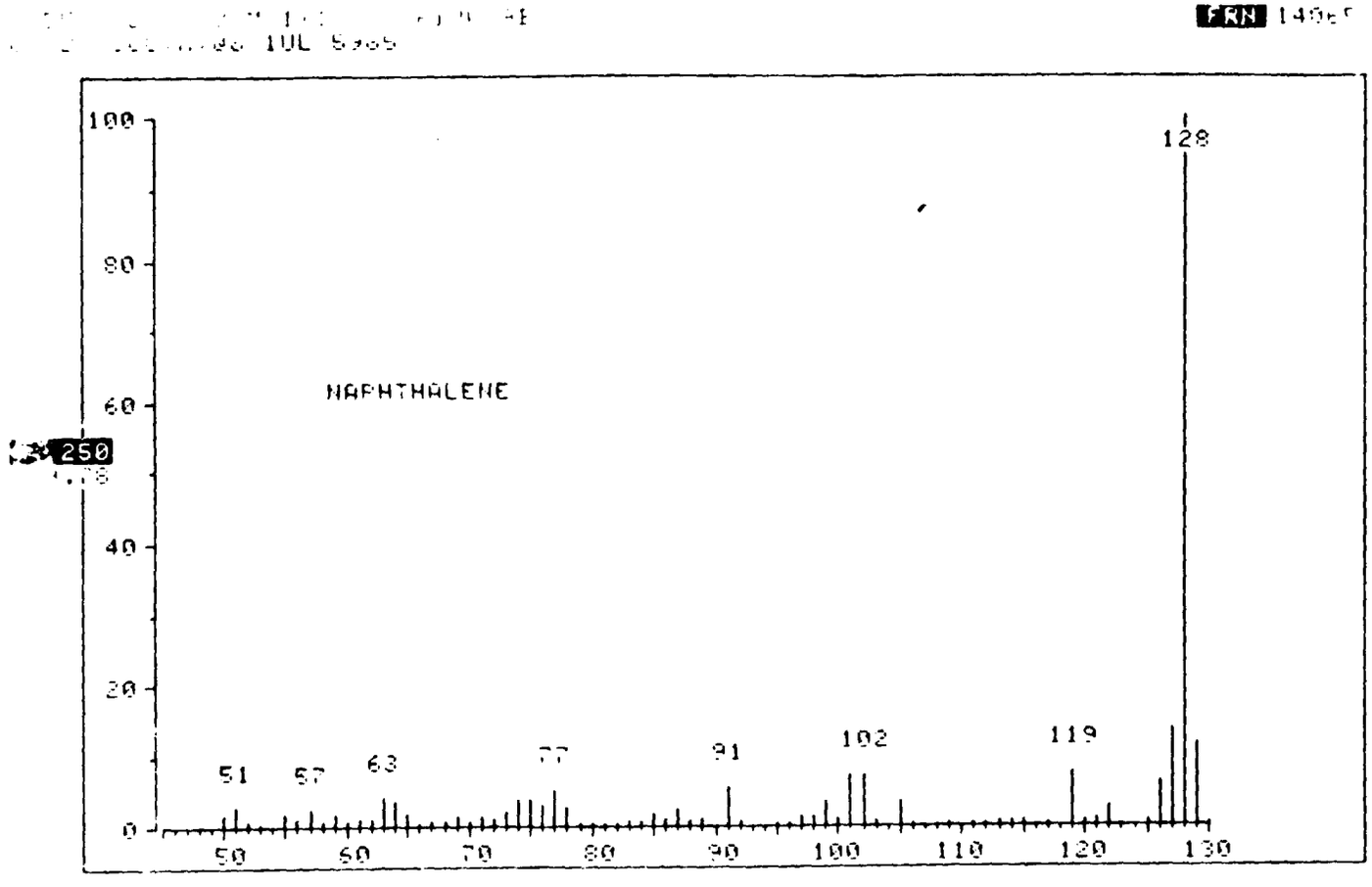
71
57
91
98
107
126
150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70
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77
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102
119
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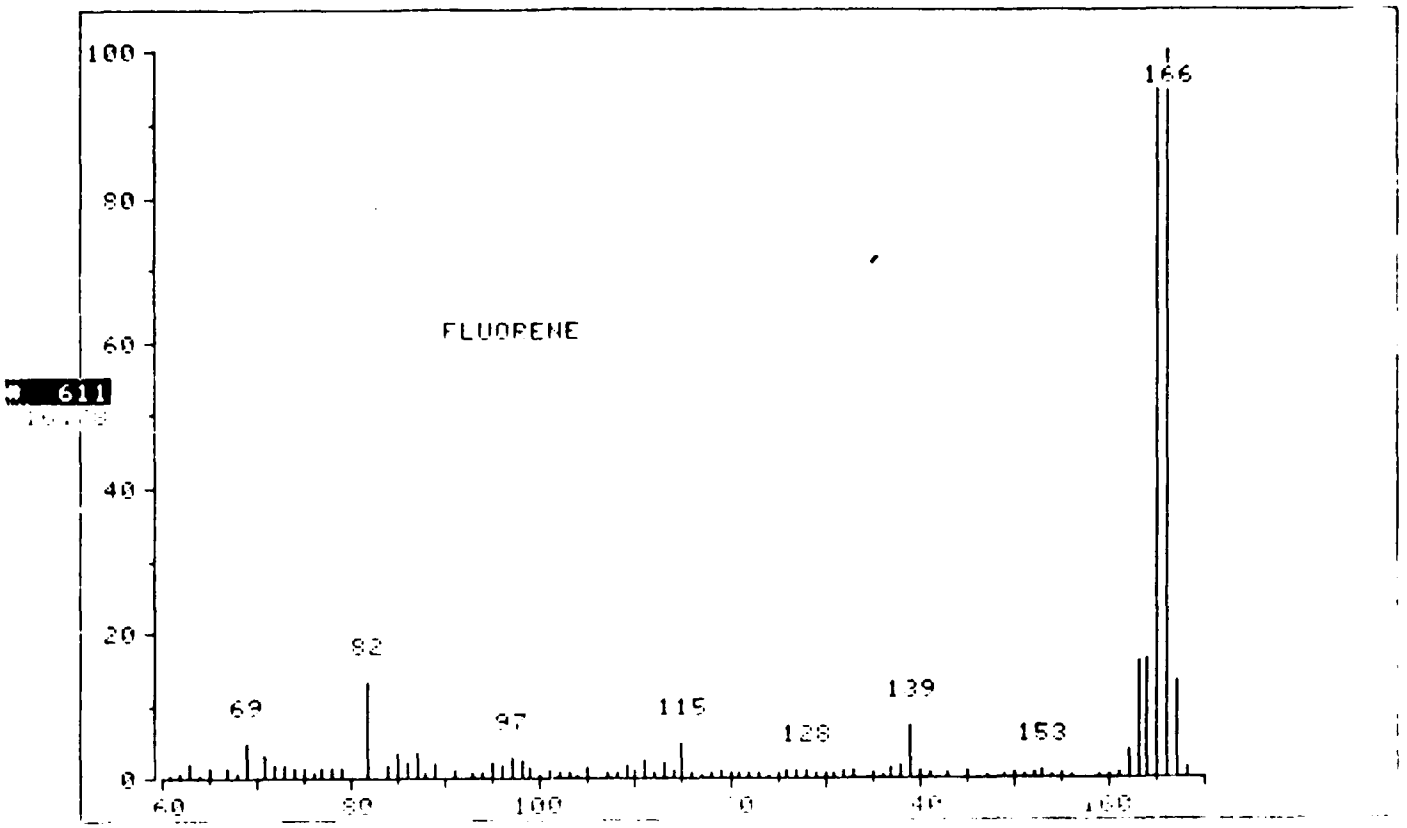
FLUORENE
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40
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166
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69
97
115
128
139
153
60
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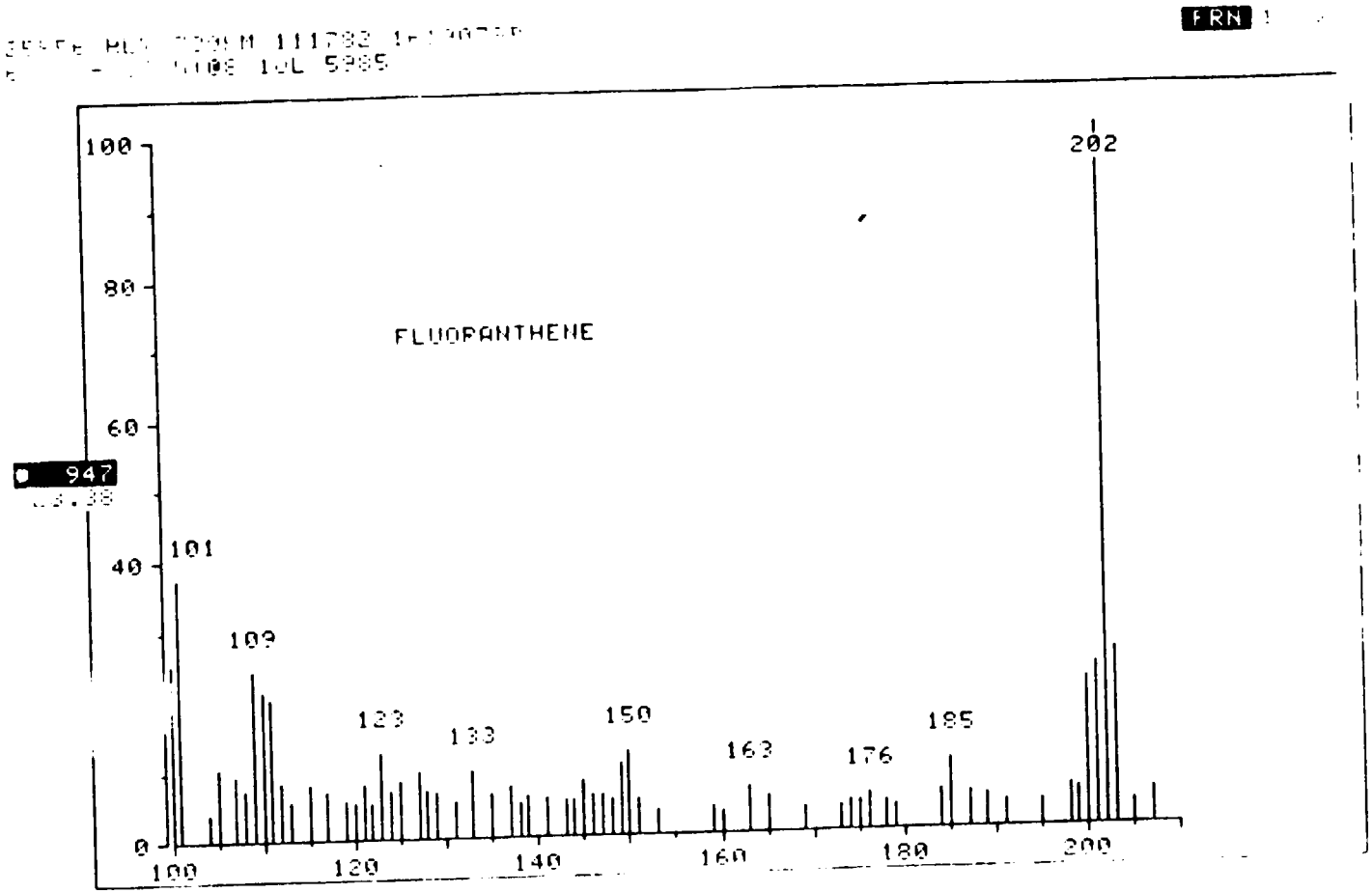
100
120
140
160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947
FLUORANTHENE
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101
109
123
133
150
163
176
185
202
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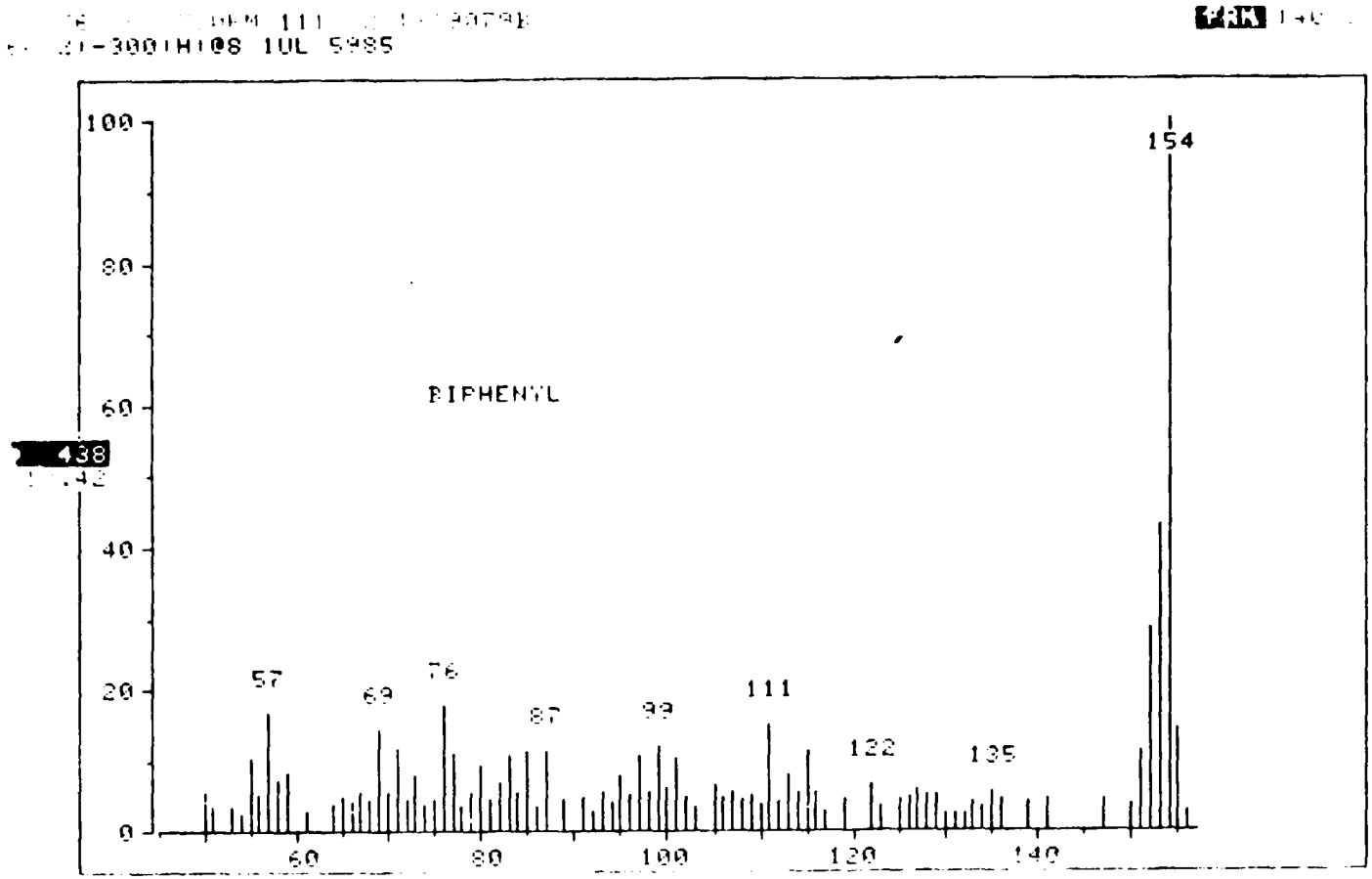
120
140
160
180
200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100
120
140
57
69
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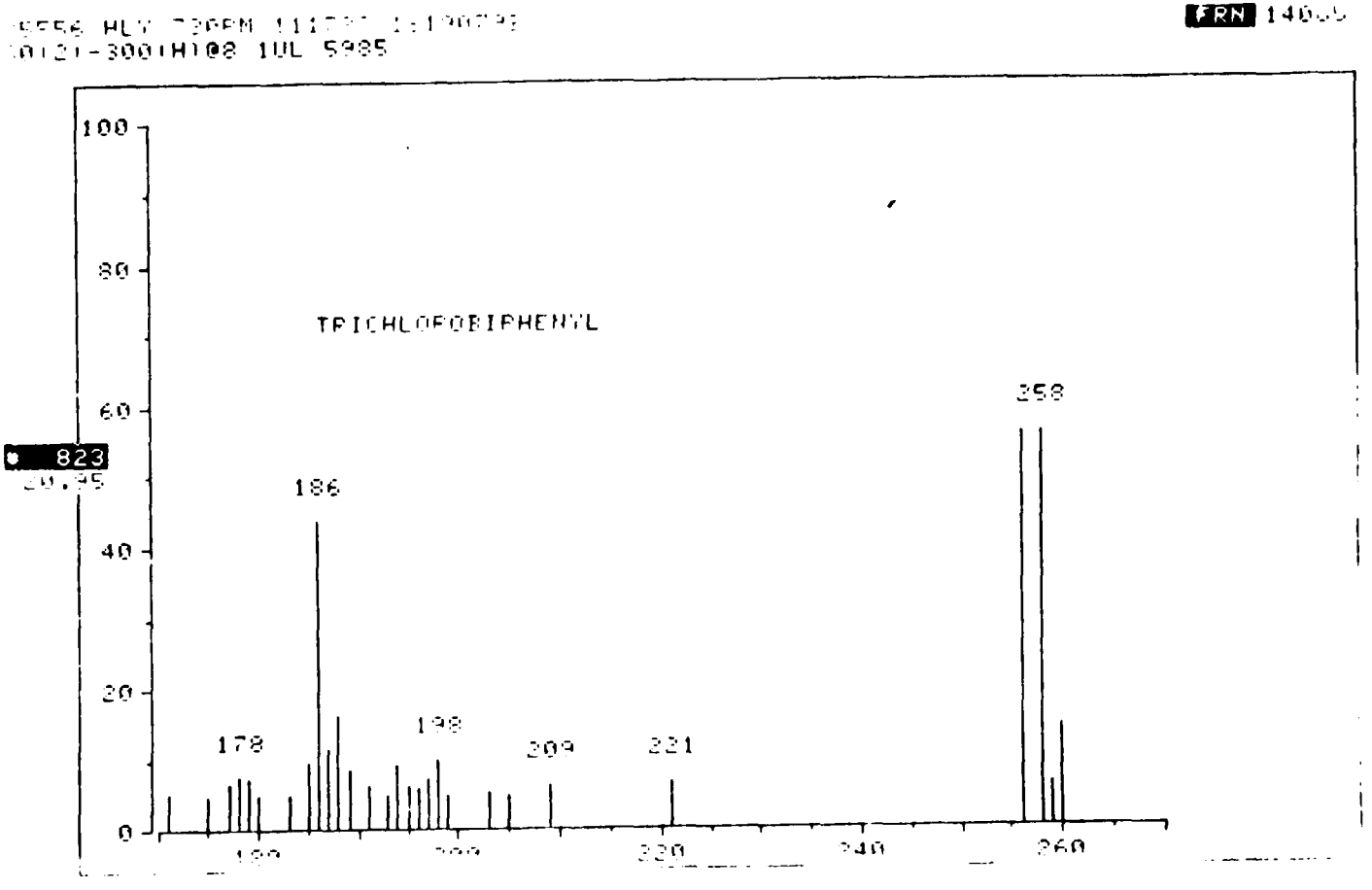
122
135
154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TRICHLOROBIPHENYL
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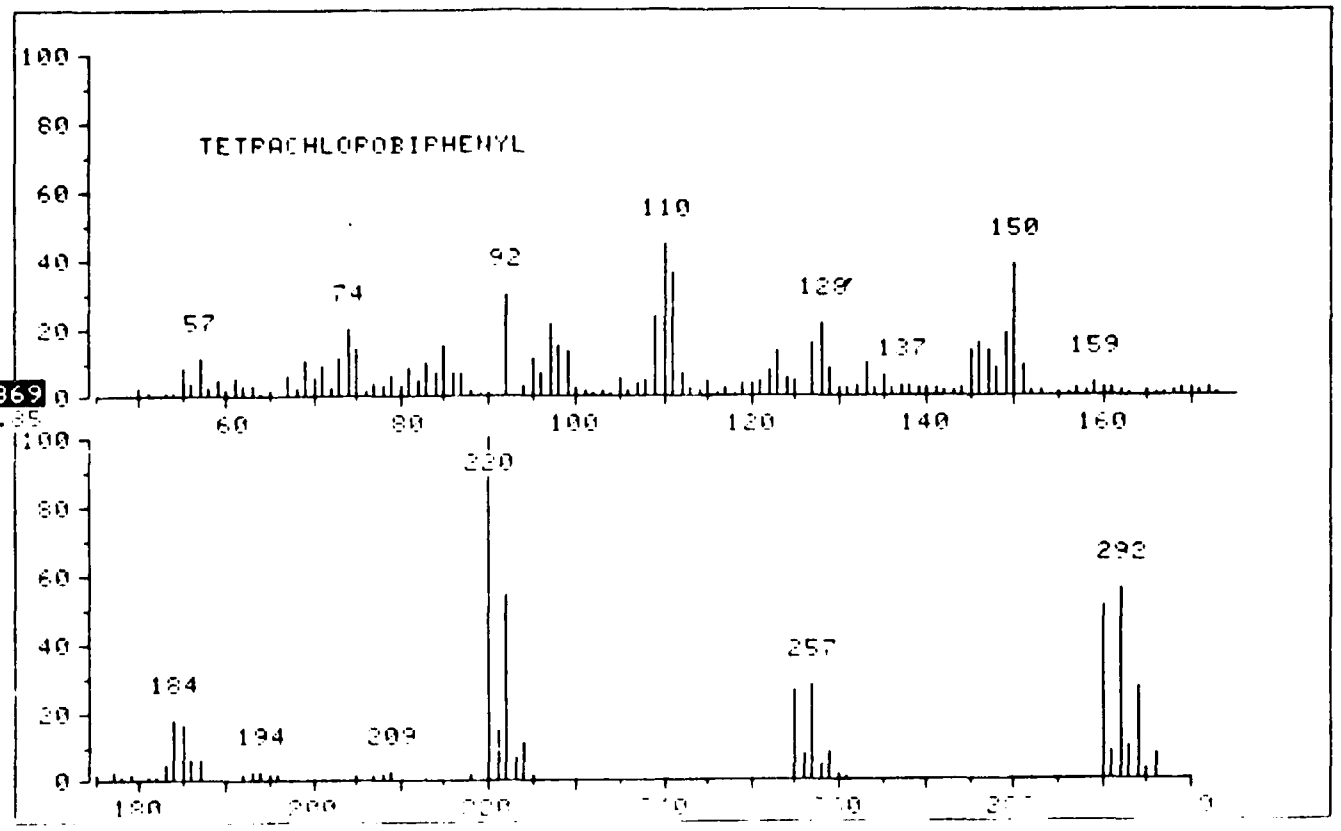
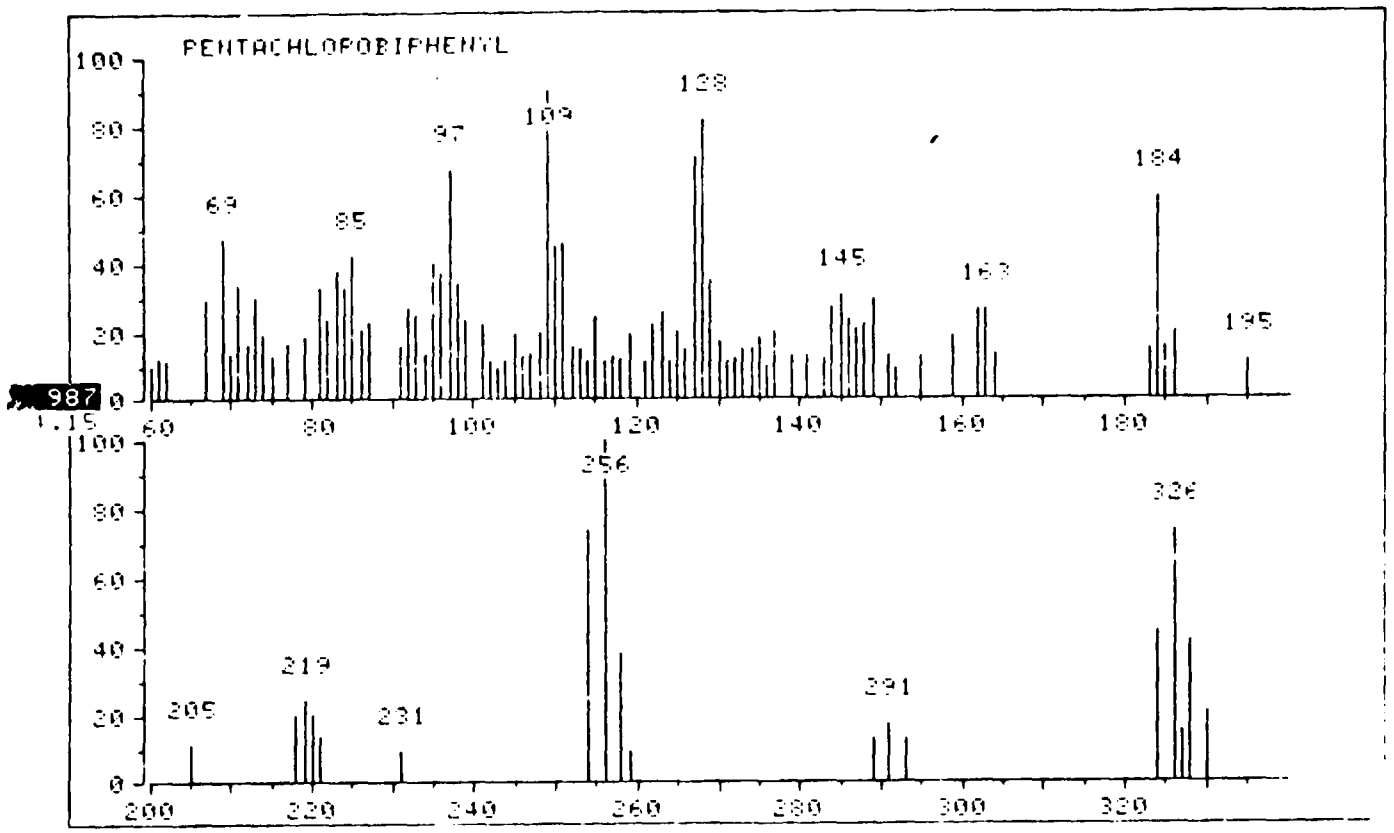
186
198
209
221
258
260

FPN 14065

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40
20
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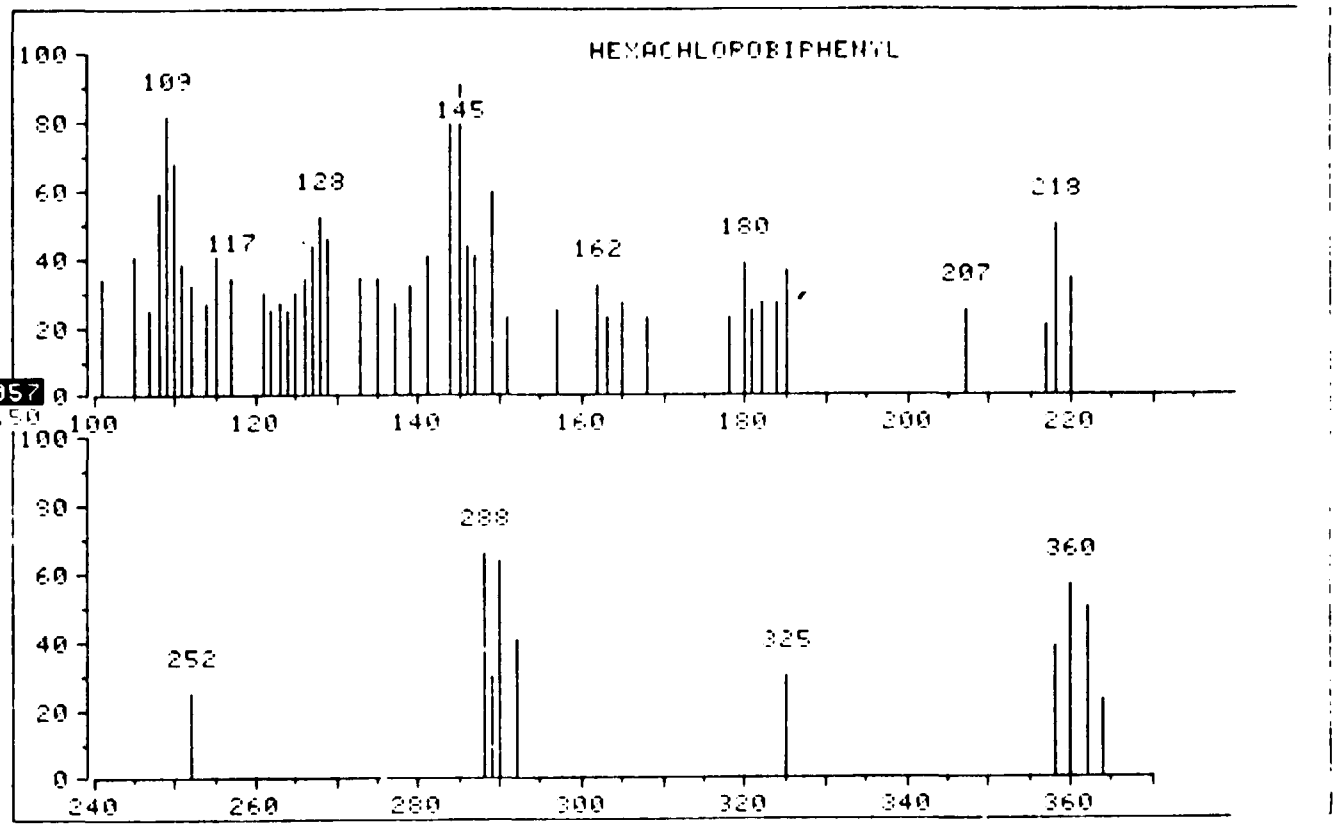
69
85
97
109
138
145
163
184
195
60
80
100
120
140
160
180
205
219
231
256
291
326
200
220
240
260
280
300
320

25556 HLV 730PM 111782 16130798
60121-3001H108 1UL 5985

FRN 1406



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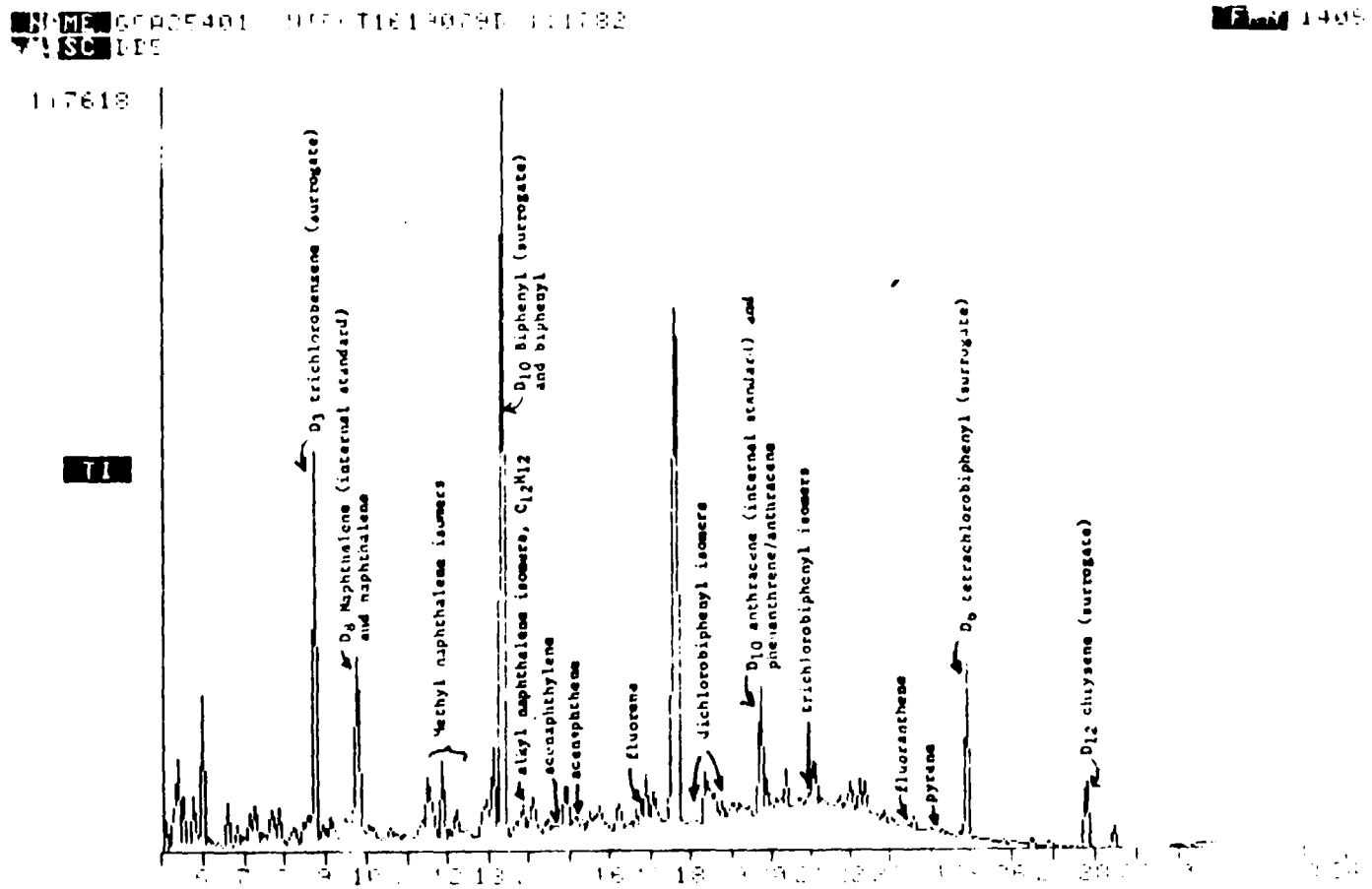
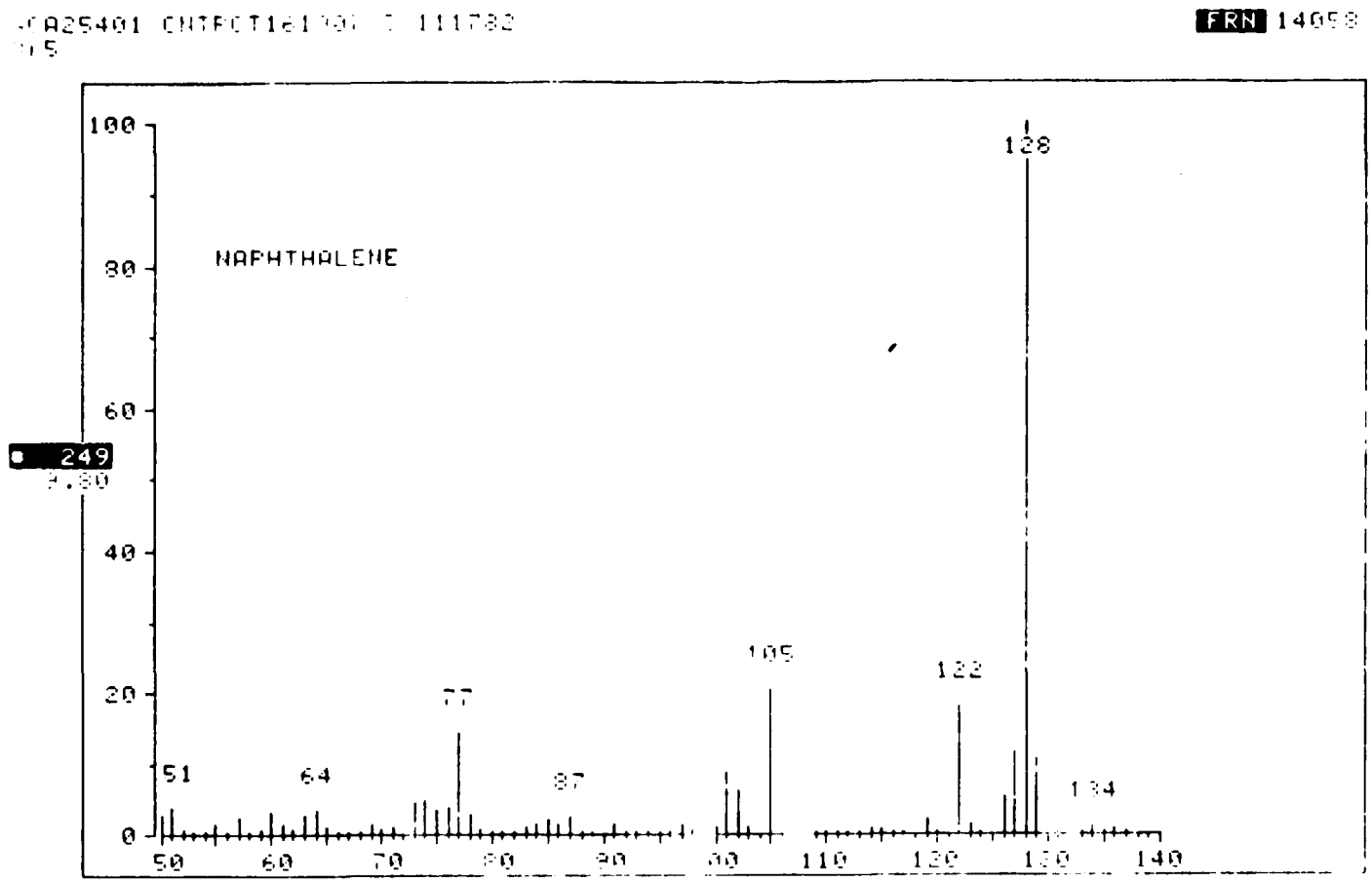
25.50



Taber St. Station (Marsh Island)--Day 2 (GCA 25401)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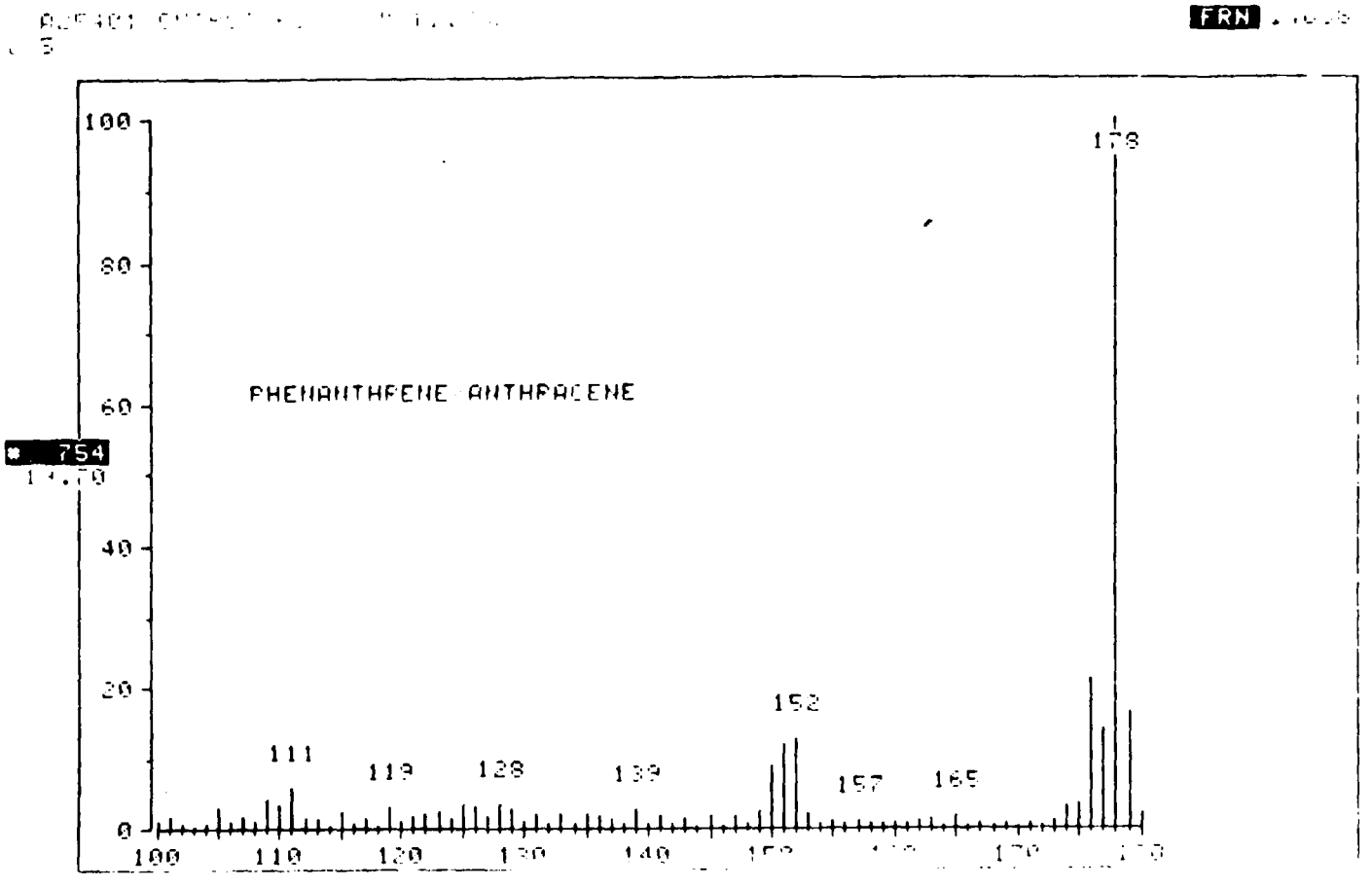
60
70
110
140


FRN
PHENANTHRENE ANTHRACENE
* 754
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20
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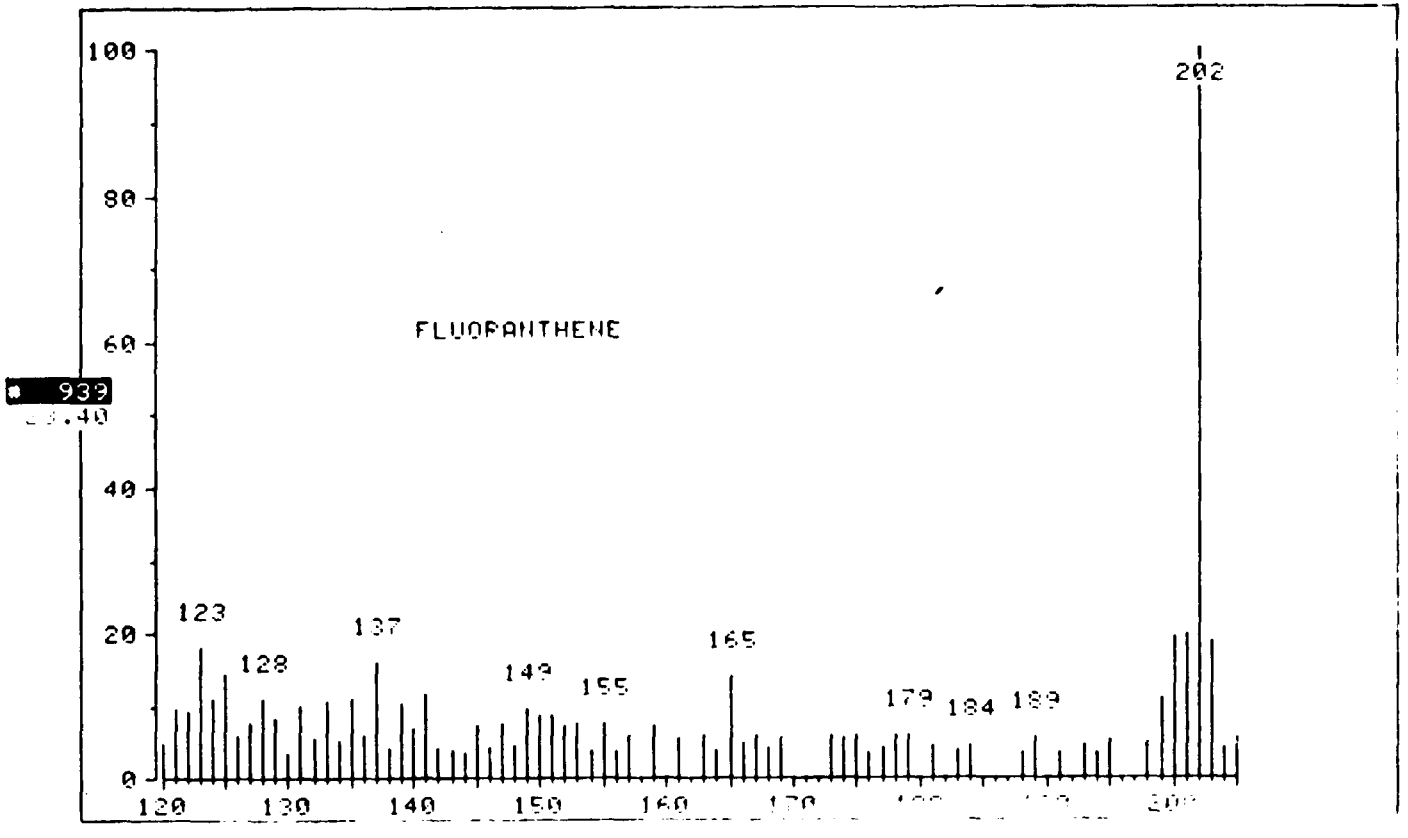
152
111
119
128
139
157
165
100
110
120
140


FLUORANTHENE
100
80
60
40
20
0
120
130
140
150
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202
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128
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149
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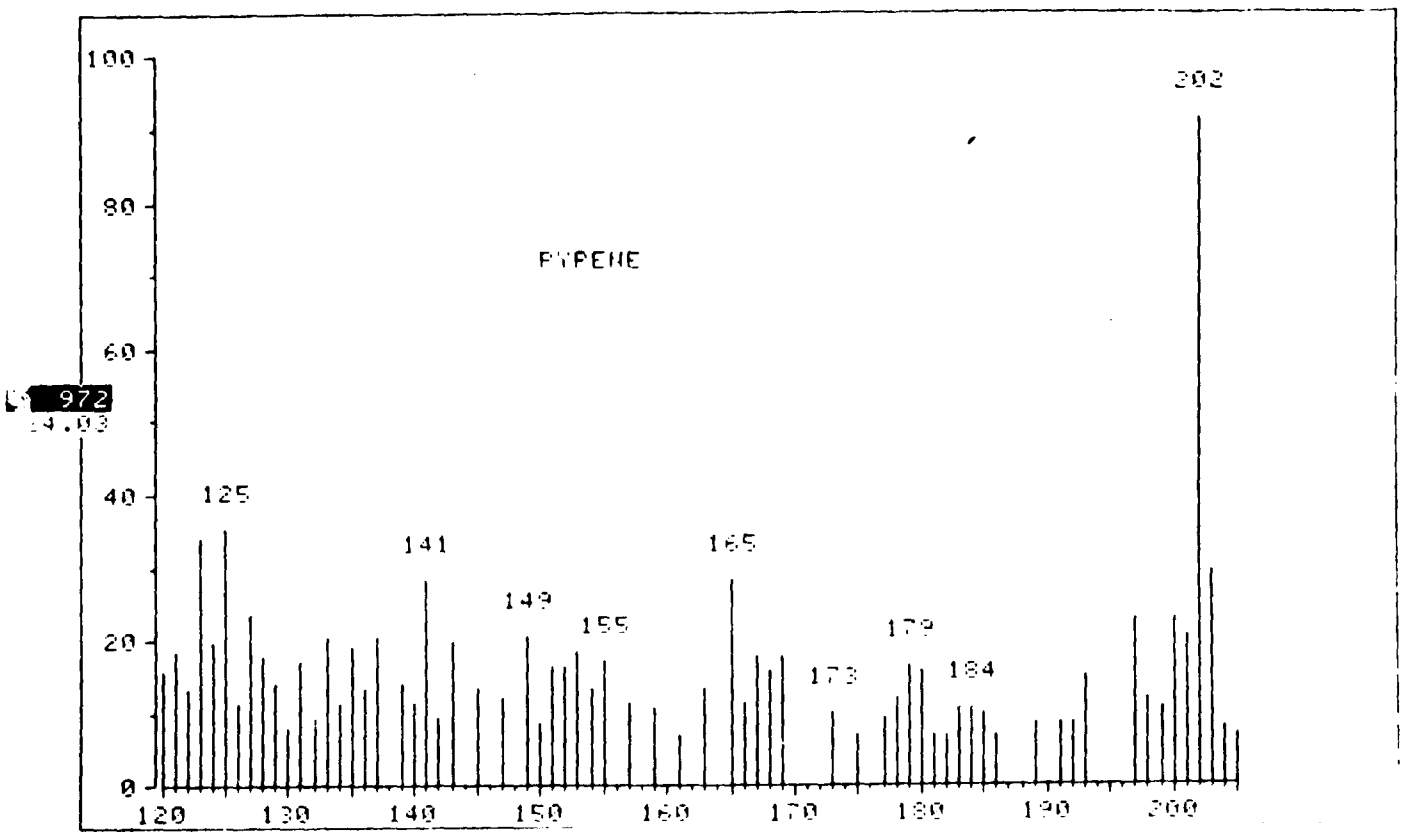
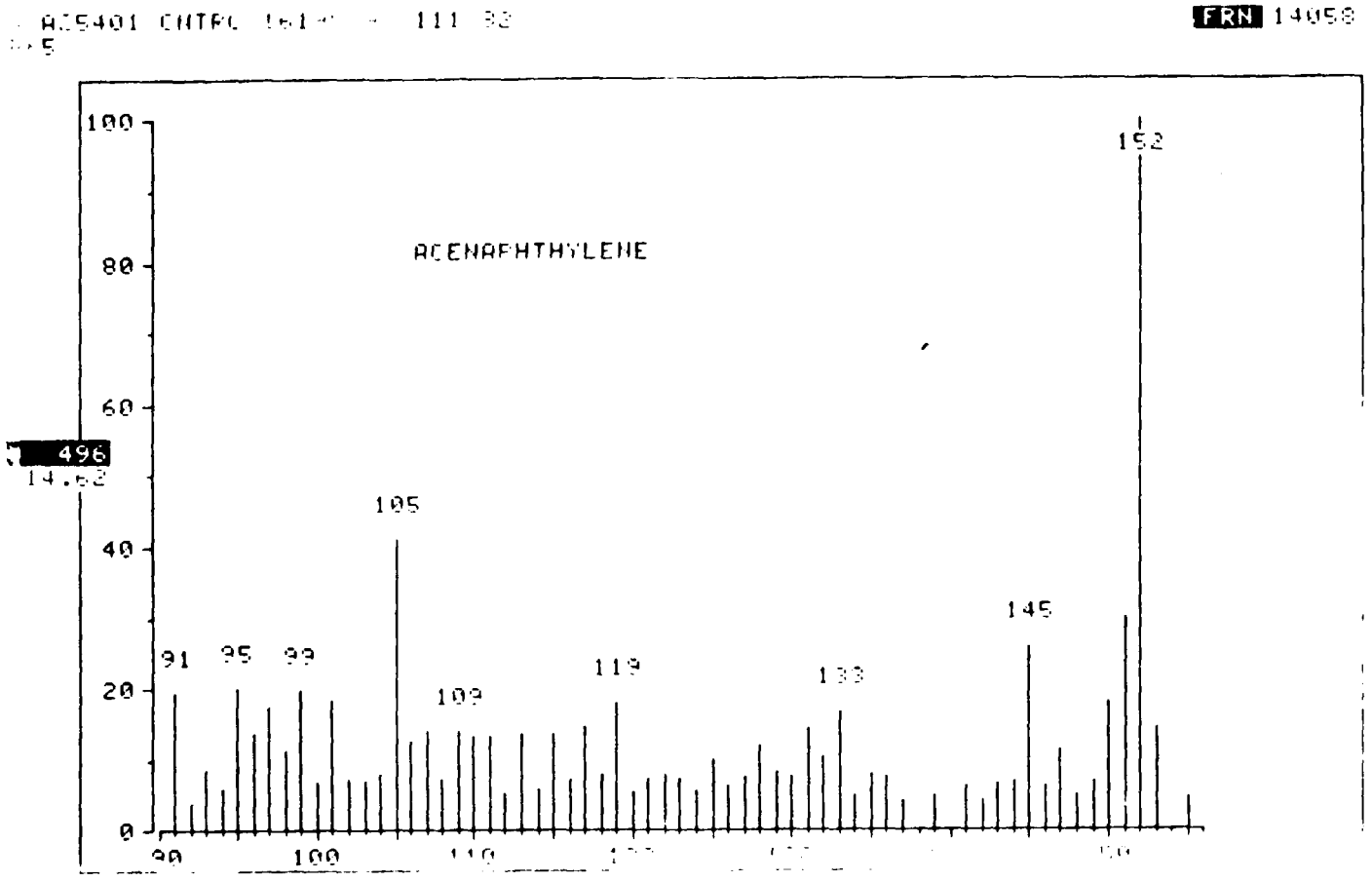
165
179
184
189

A25401 CNTPCT161907?B 111?? FRN

5

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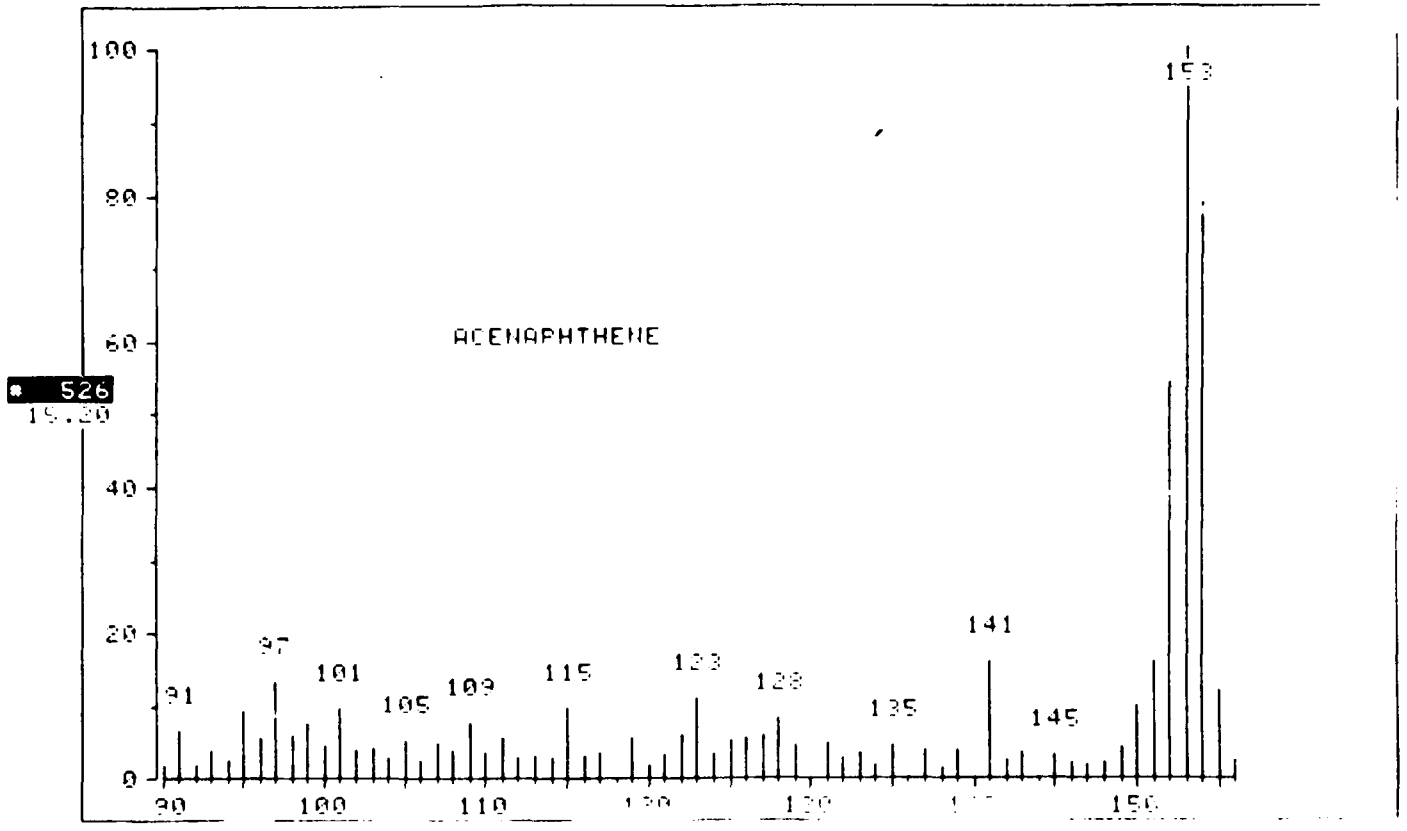
GCA25401 CNTRLT16190798 111782
DB5

FRN 1



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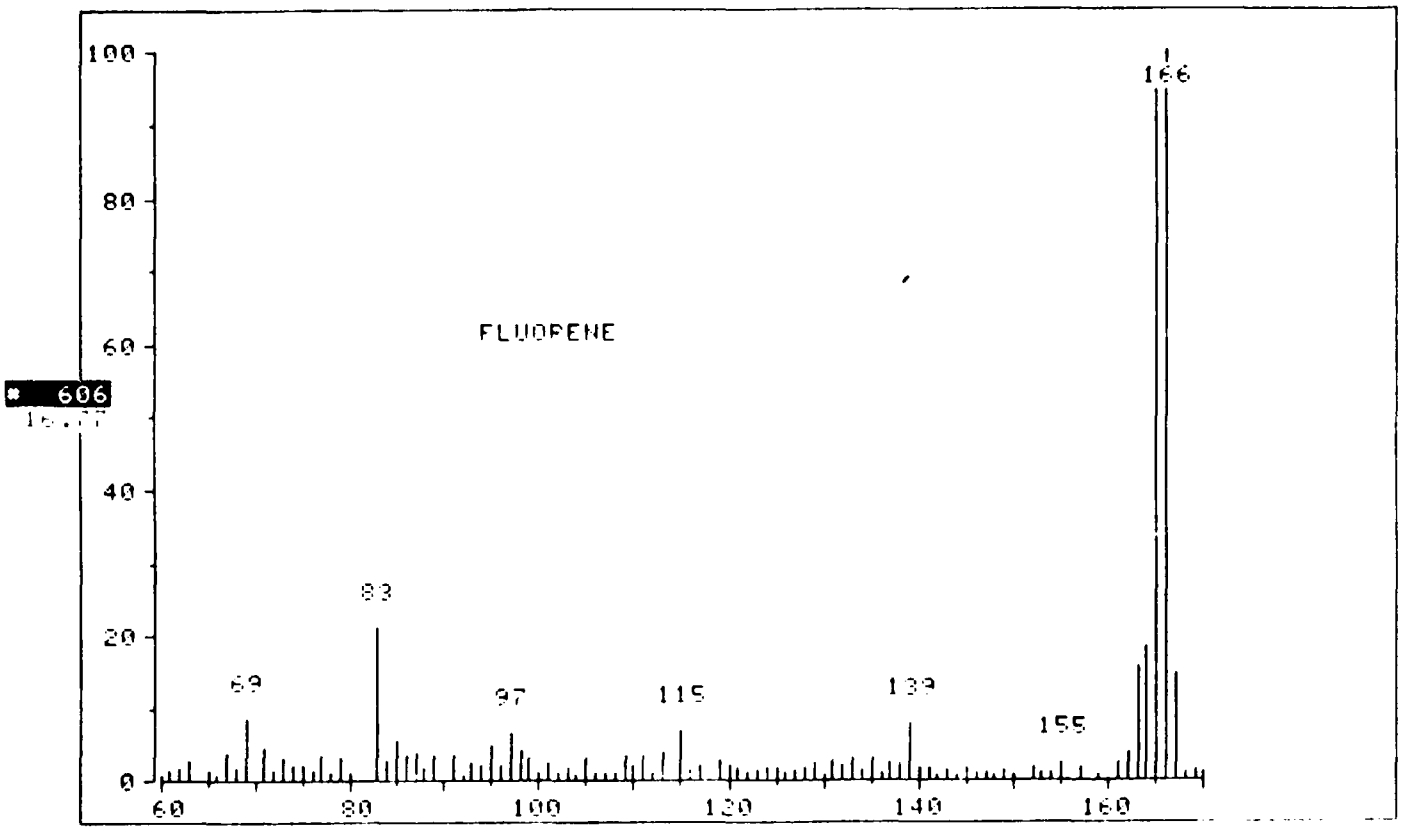
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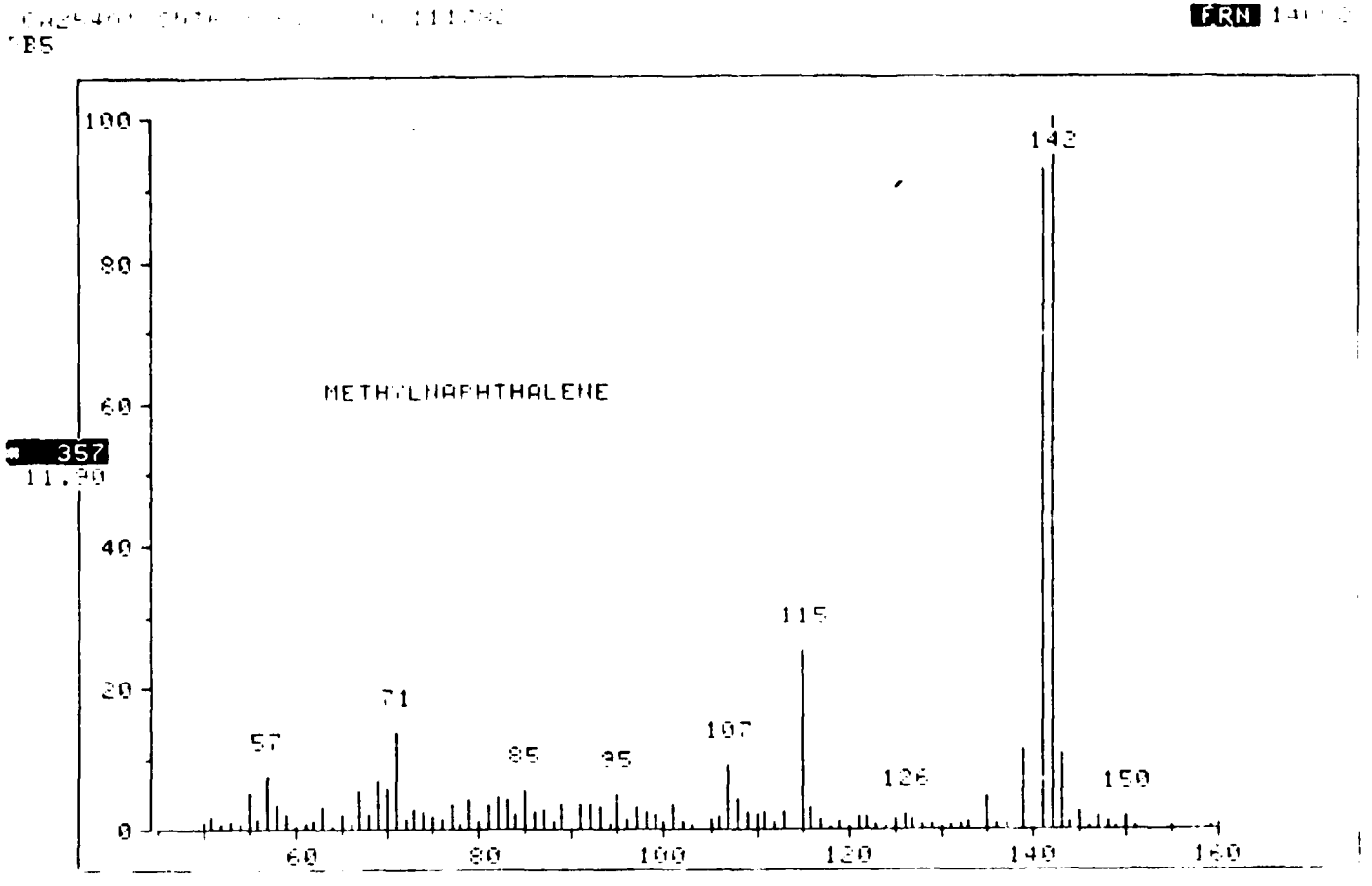
155
166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METHYLNAPHTHALENE
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71
85
95
107
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126
142
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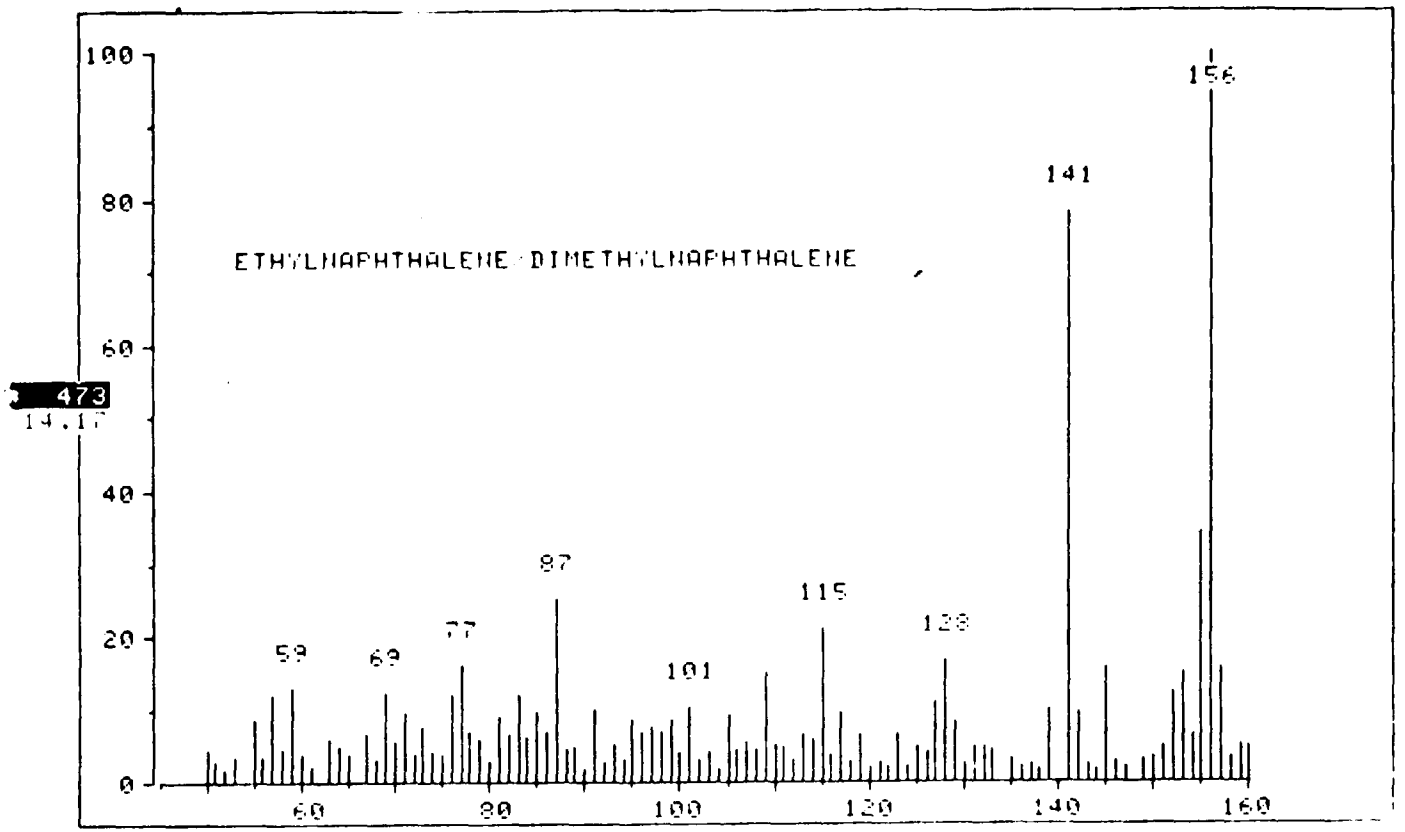
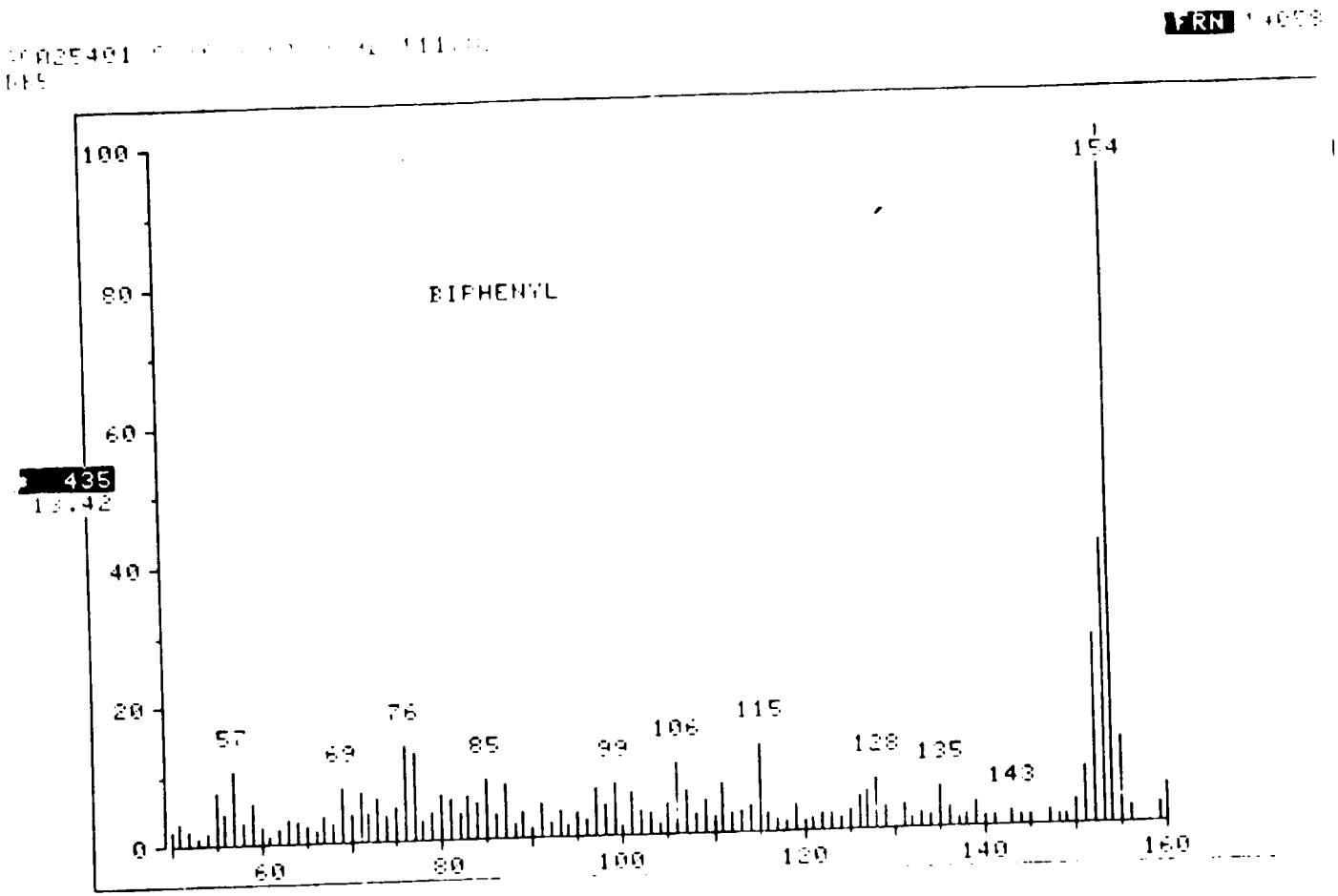
6.02E401 CNTRCT16190798 111792 RN 14056

DB5

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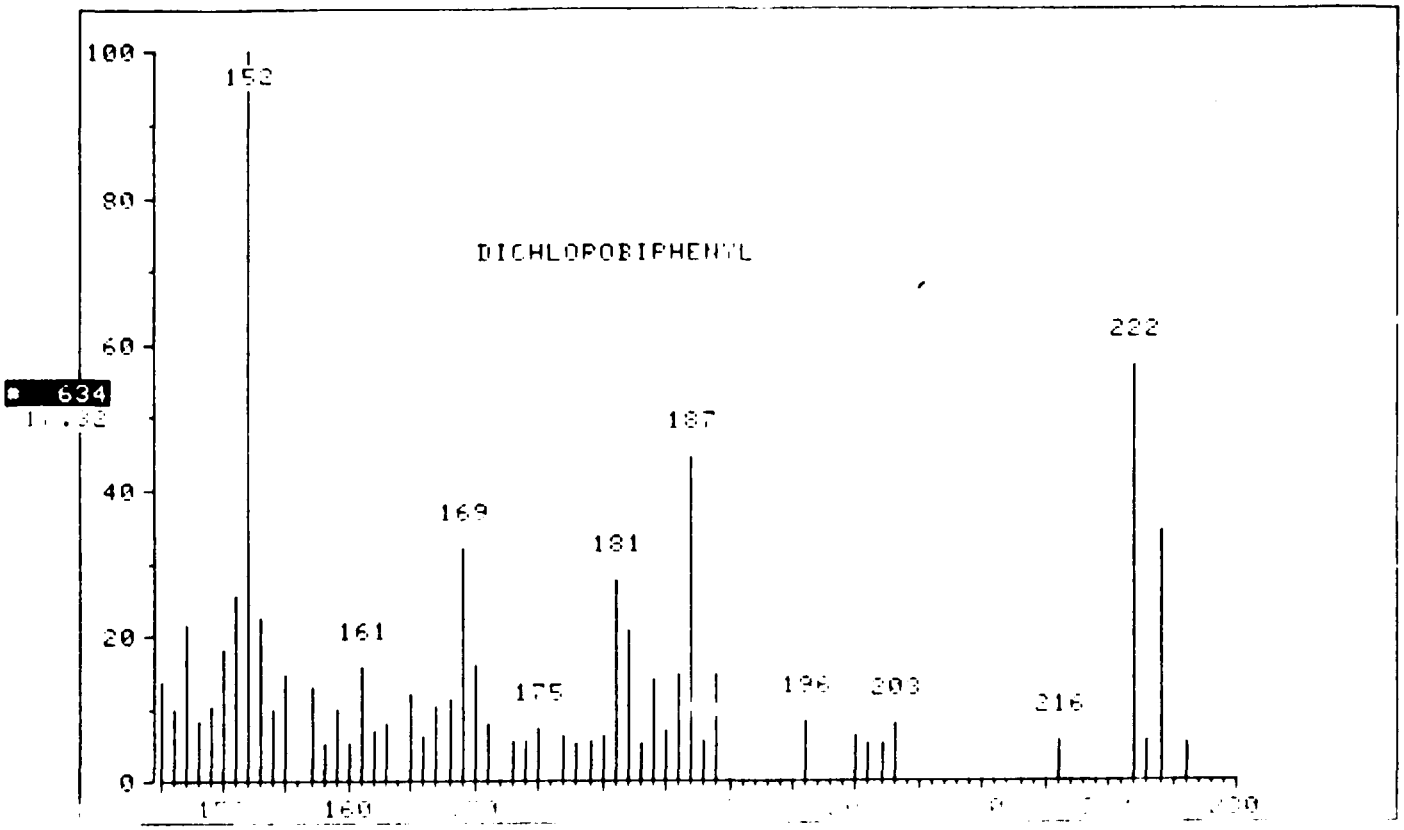
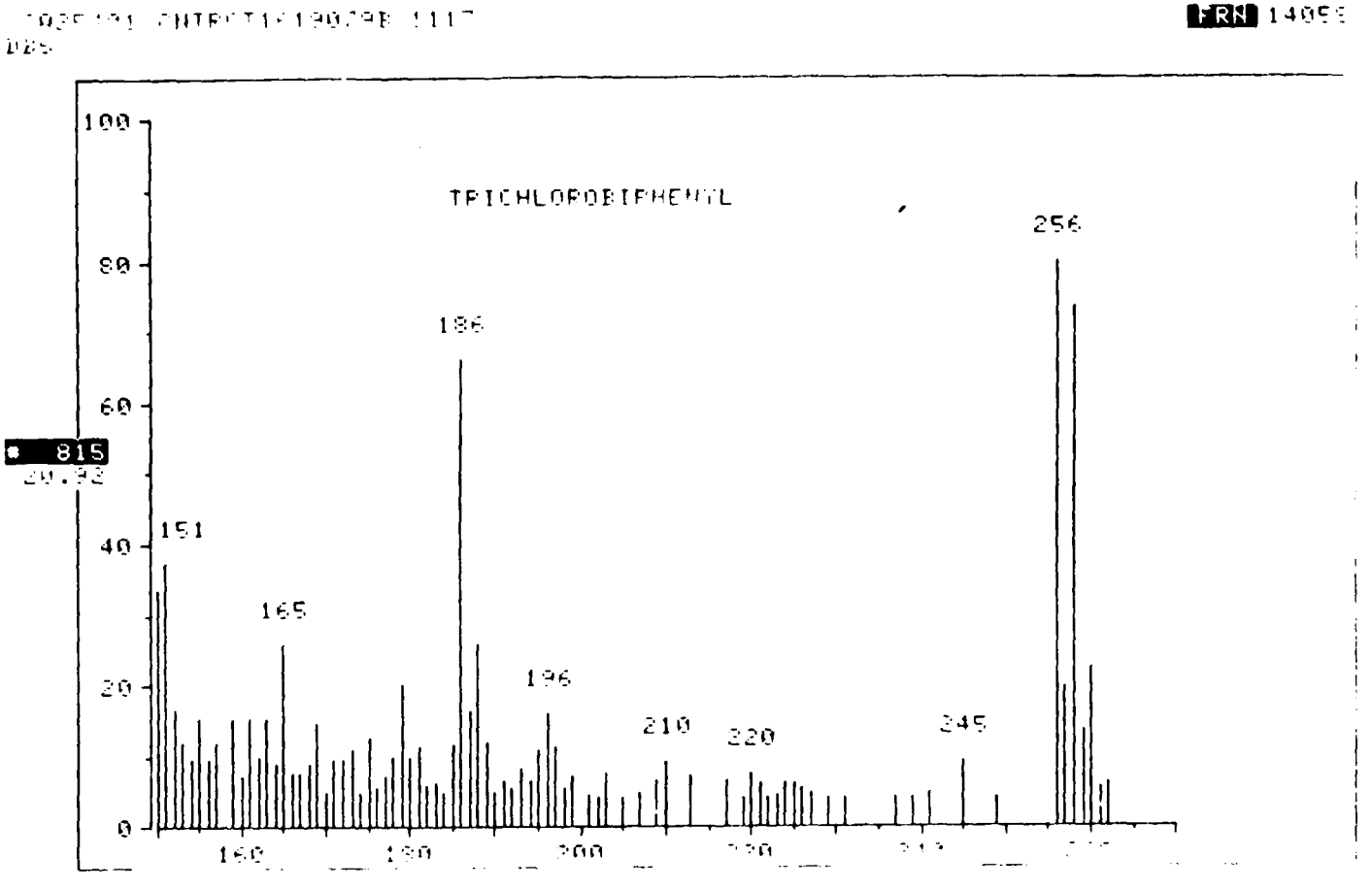
160

025401 CNTPCT16190798 111722
DB5

FRN 14058

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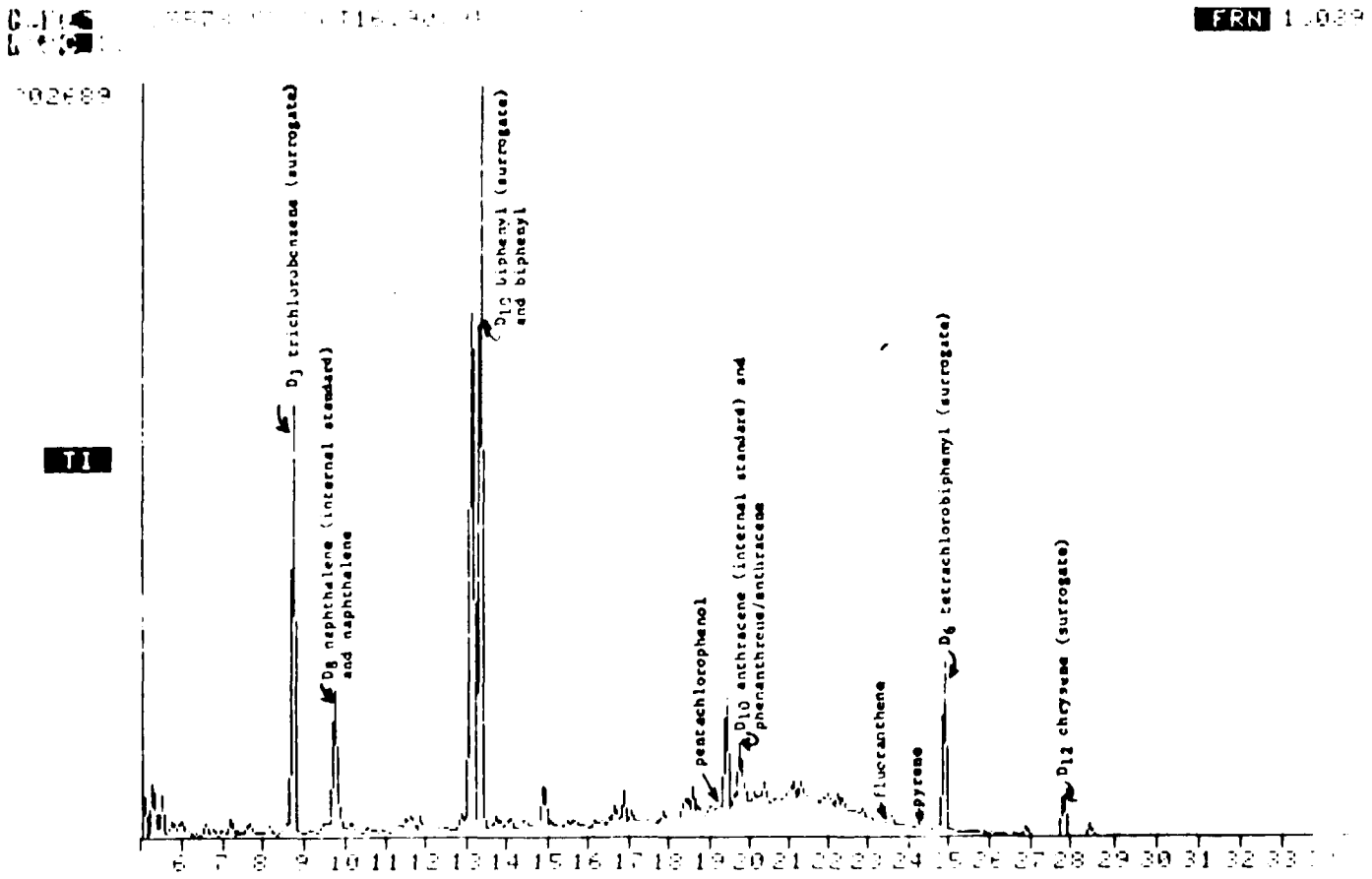
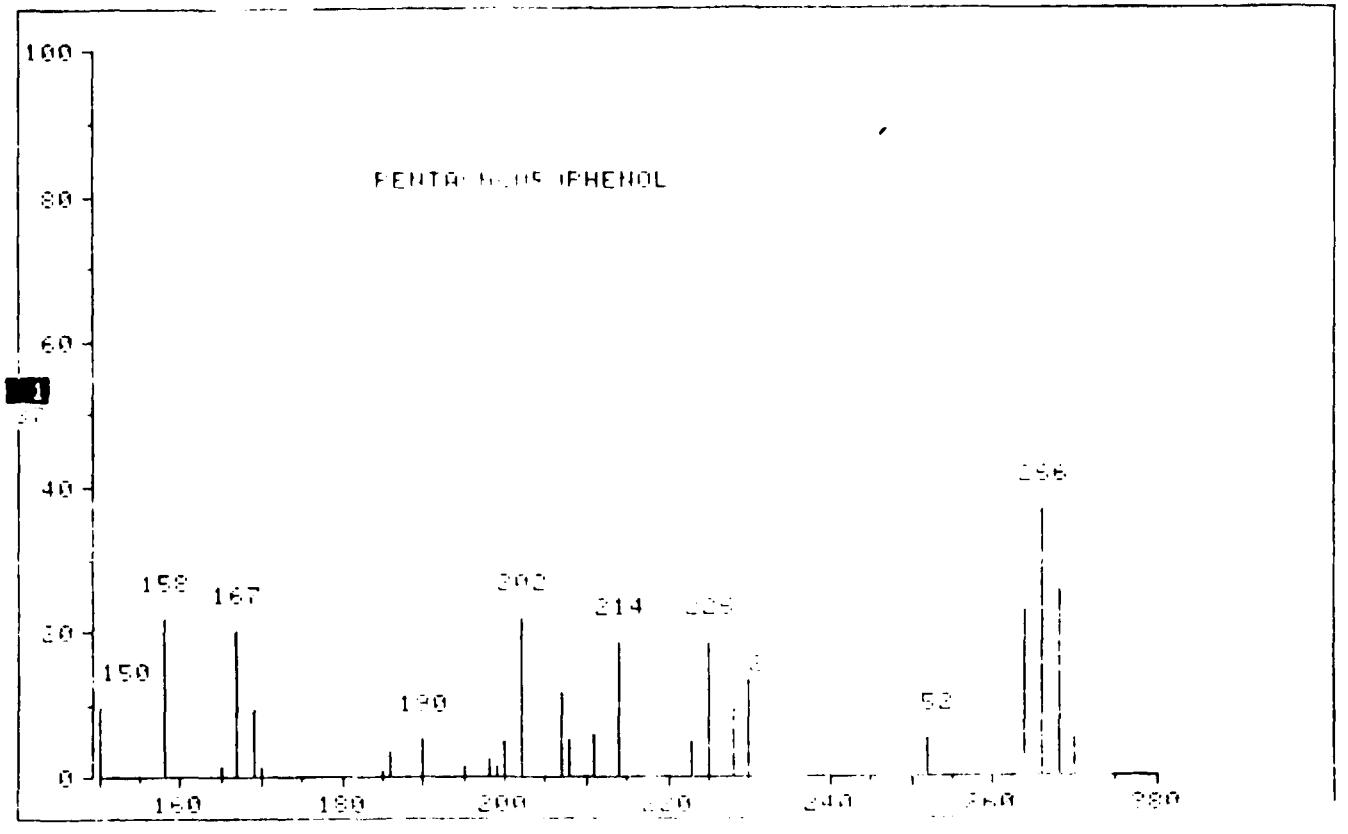
80
60
40
20
0
815
151
165
186
196
210
220
245
256



Shawmut St. Station--Day 3 (GCA 25578)

FRN 15799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PHENOL
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240
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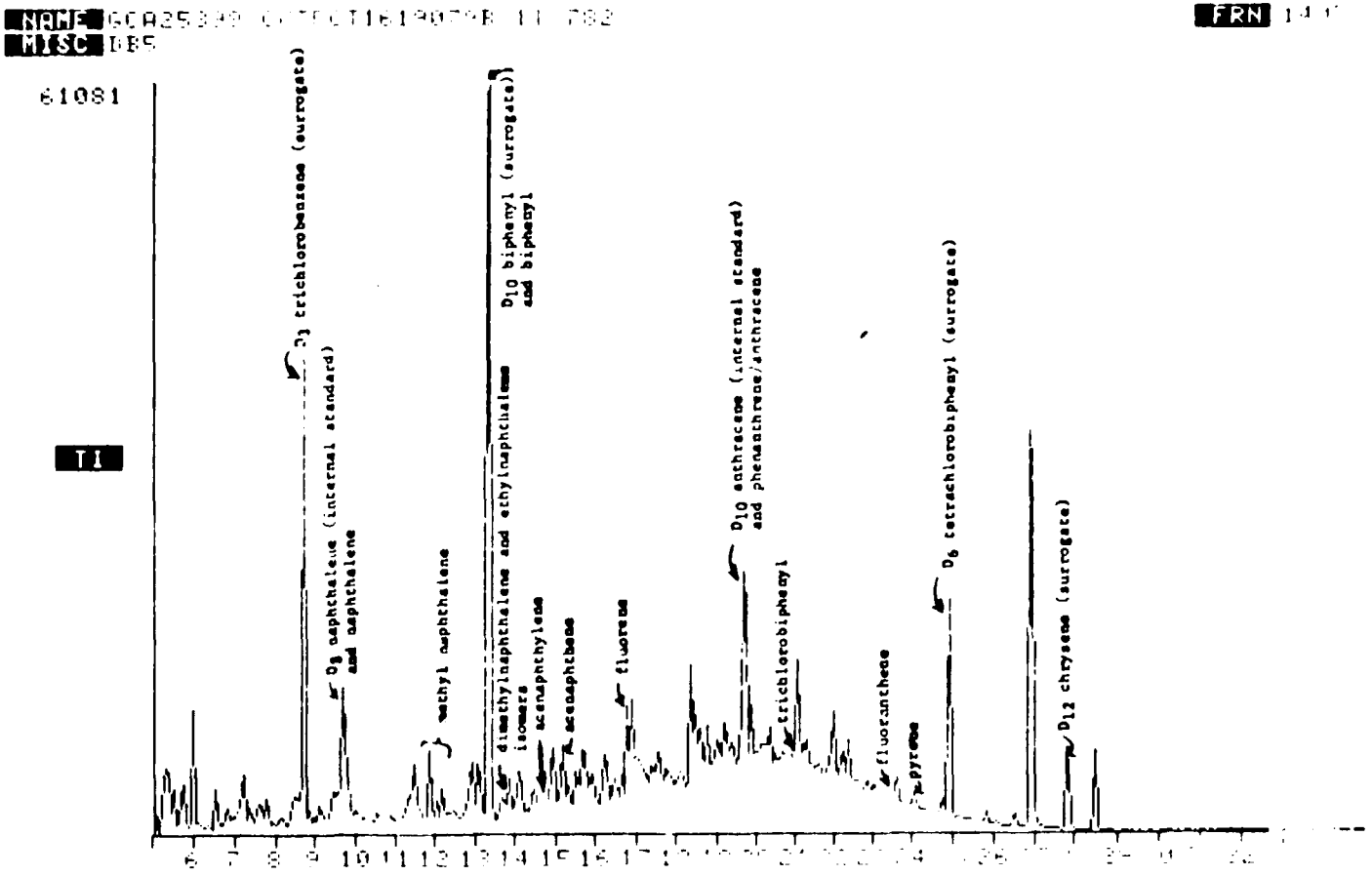
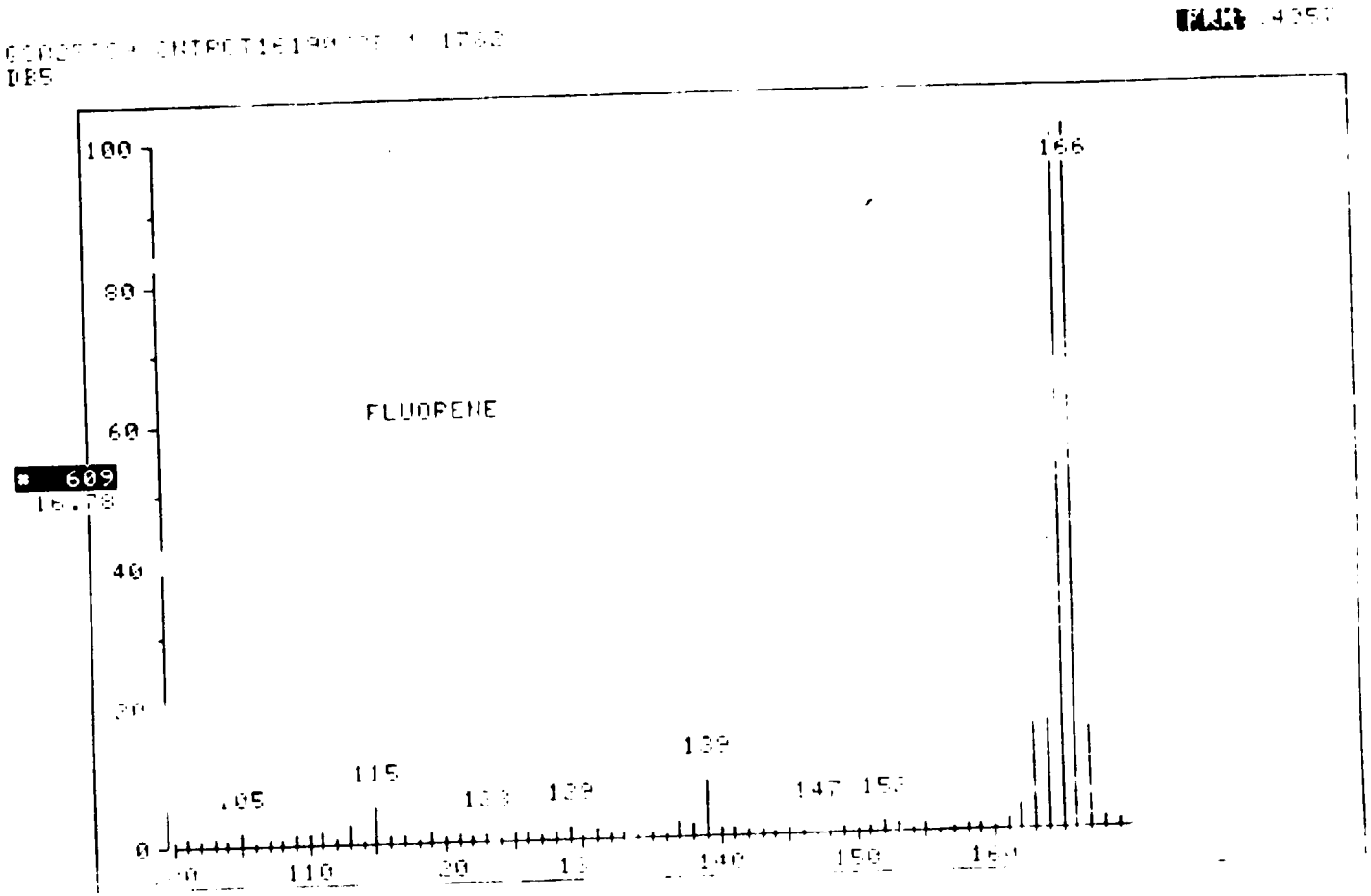


Cushman Park--Day 2 (GCA 25399)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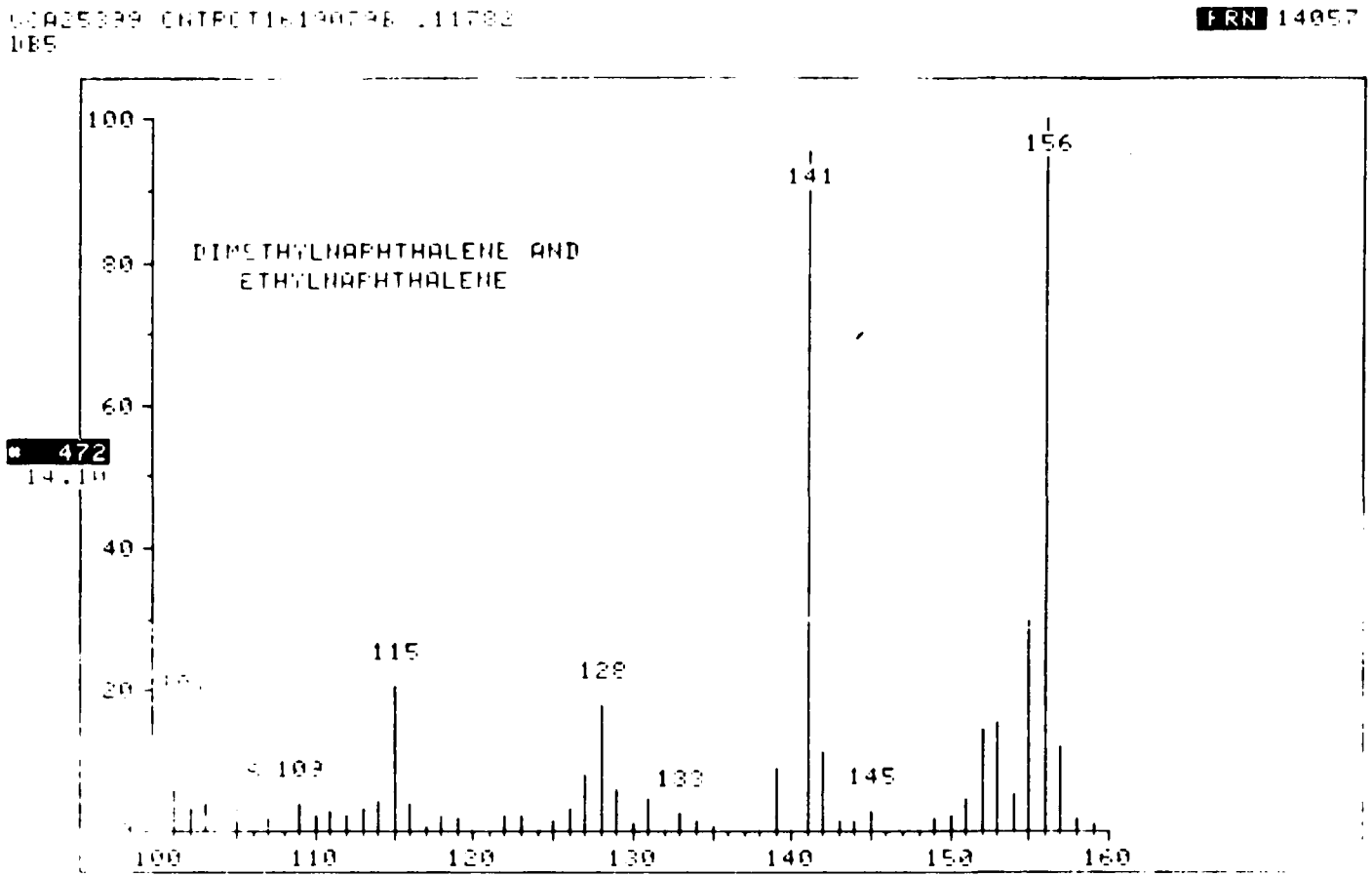
60
40
0
609
166
139
115
105
147
110


FRN 14057
DIMETHYLNAPHTHALENE AND
ETHYLNAPHTHALENE
100
80
60
40
20
472
115
128
141
156
133
145
100
110
120
130
140
150
160

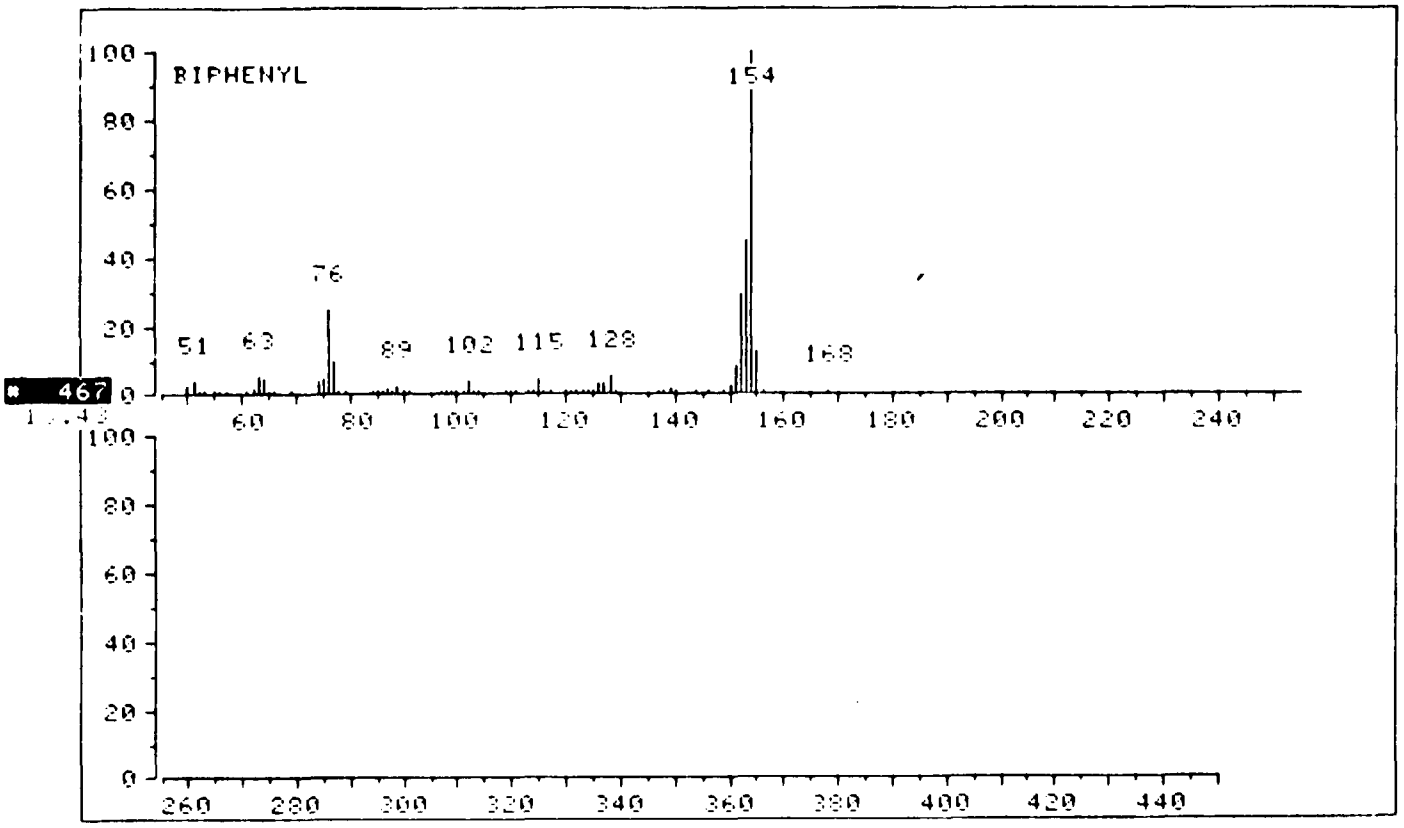
APPENDIX E

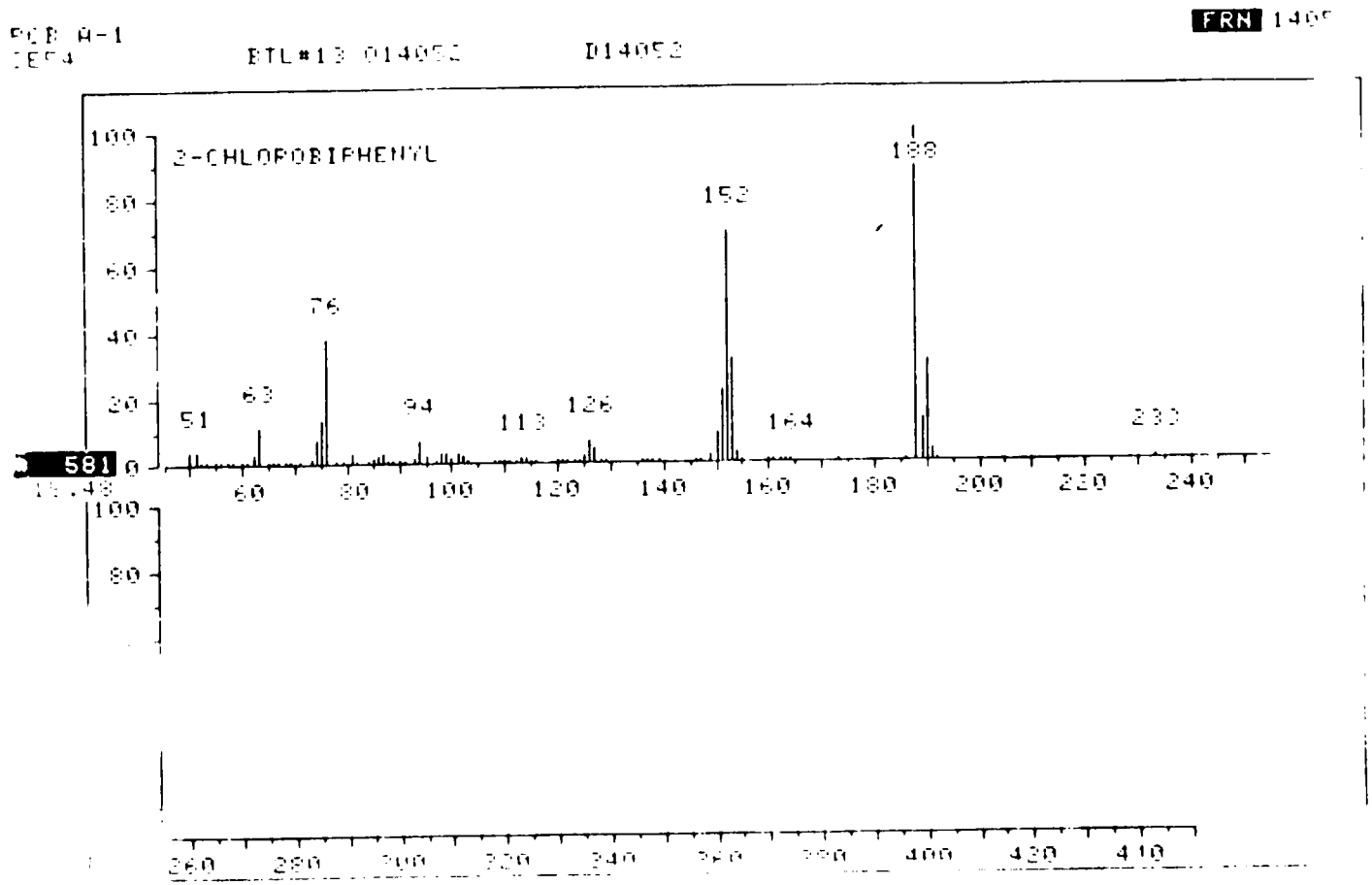
MASS SPECTRAL DATA
REPRESENTATIVE REFERENCE SPECTRA

SELECTED CHLOROBIPHENYLS (PCBs),
CHLORINATED BENZENES,
CHLORINATED PHENOLS,
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

PCB A-1
3E54 BTL#13 Q14052 D14052

FRN 14052




FRN
BTL#13 014052
D14052
2-CHLOROBIPHENYL
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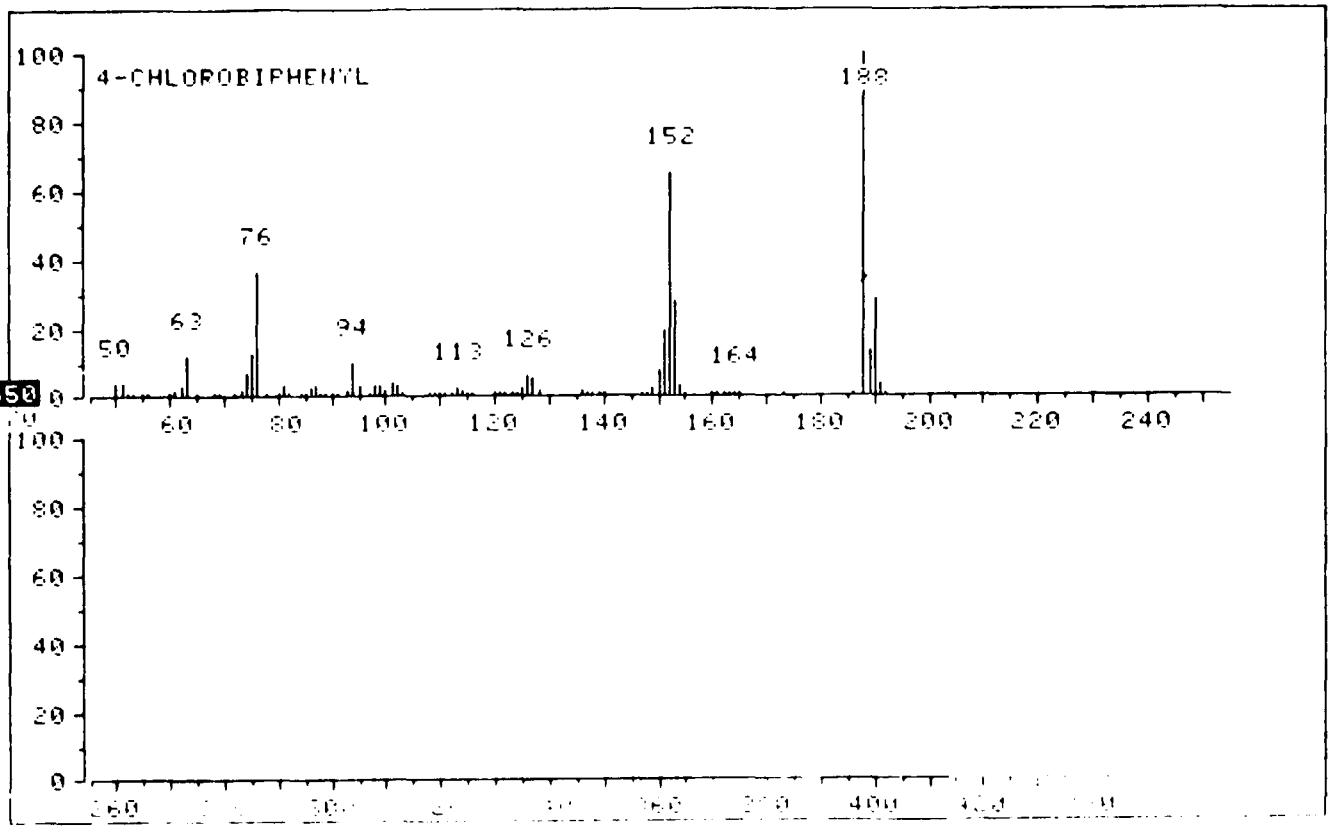
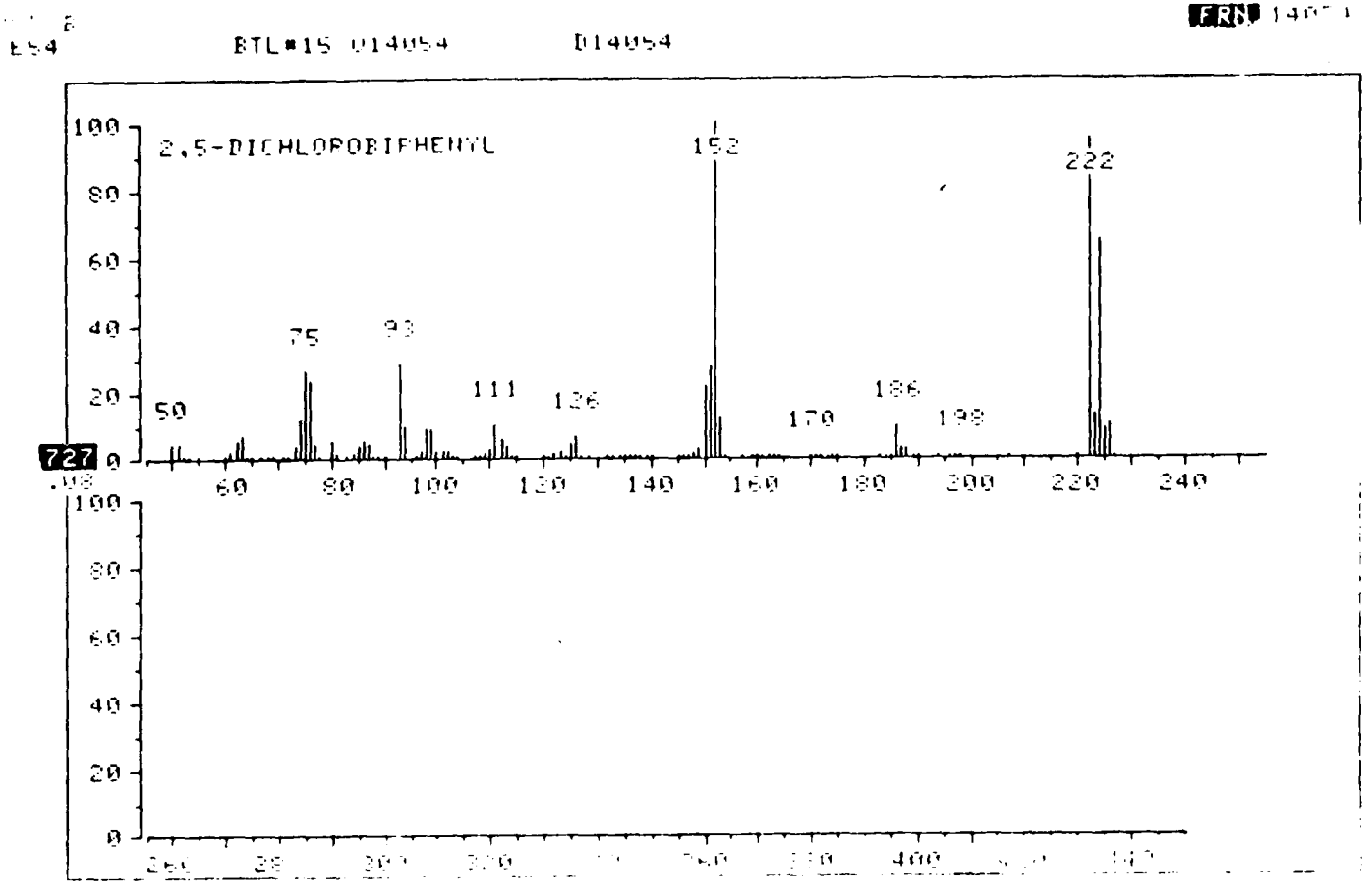
63
76
94
113
126
152
164
188
233

BTL#15 D14054 D14054

FRN 14054



650


BTL#15 014054
D14054
2,5-DICHLOROBIPHENYL
152
222
75
93
111
126
50
170
186
198
727
100
80
60
40
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60
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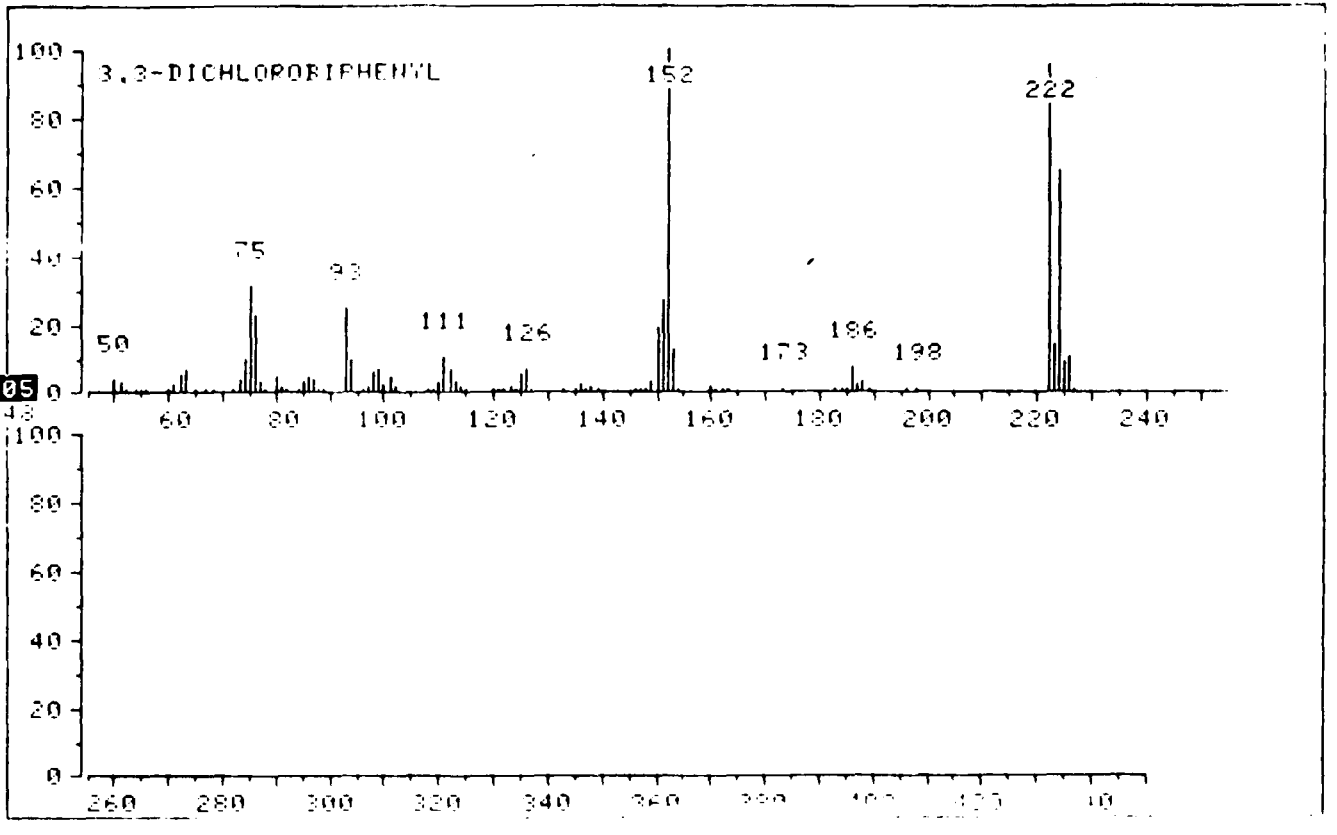
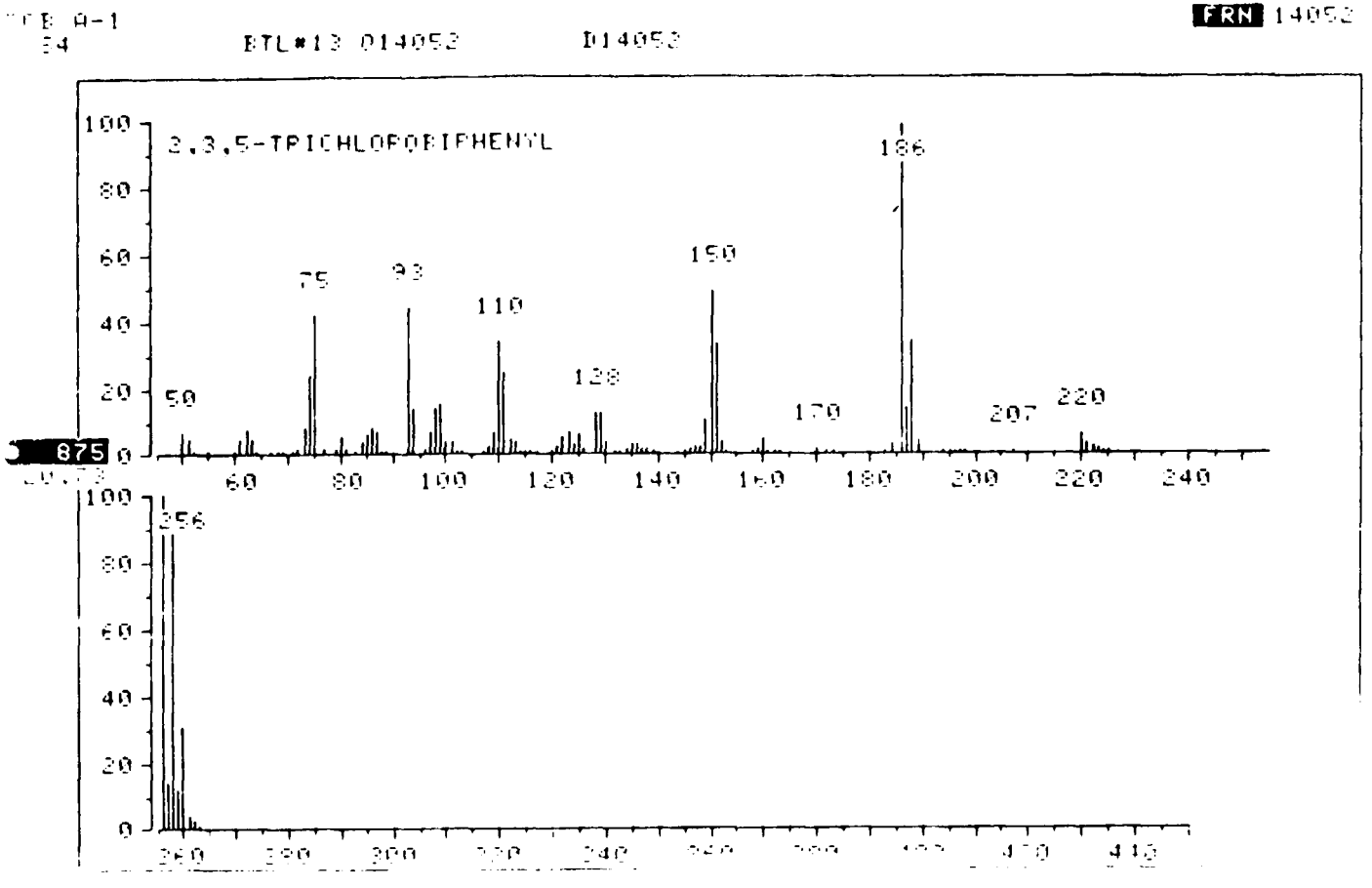
120
140
160
180
200
220
240

SE54 BTL#13 014052 D14052 FRN

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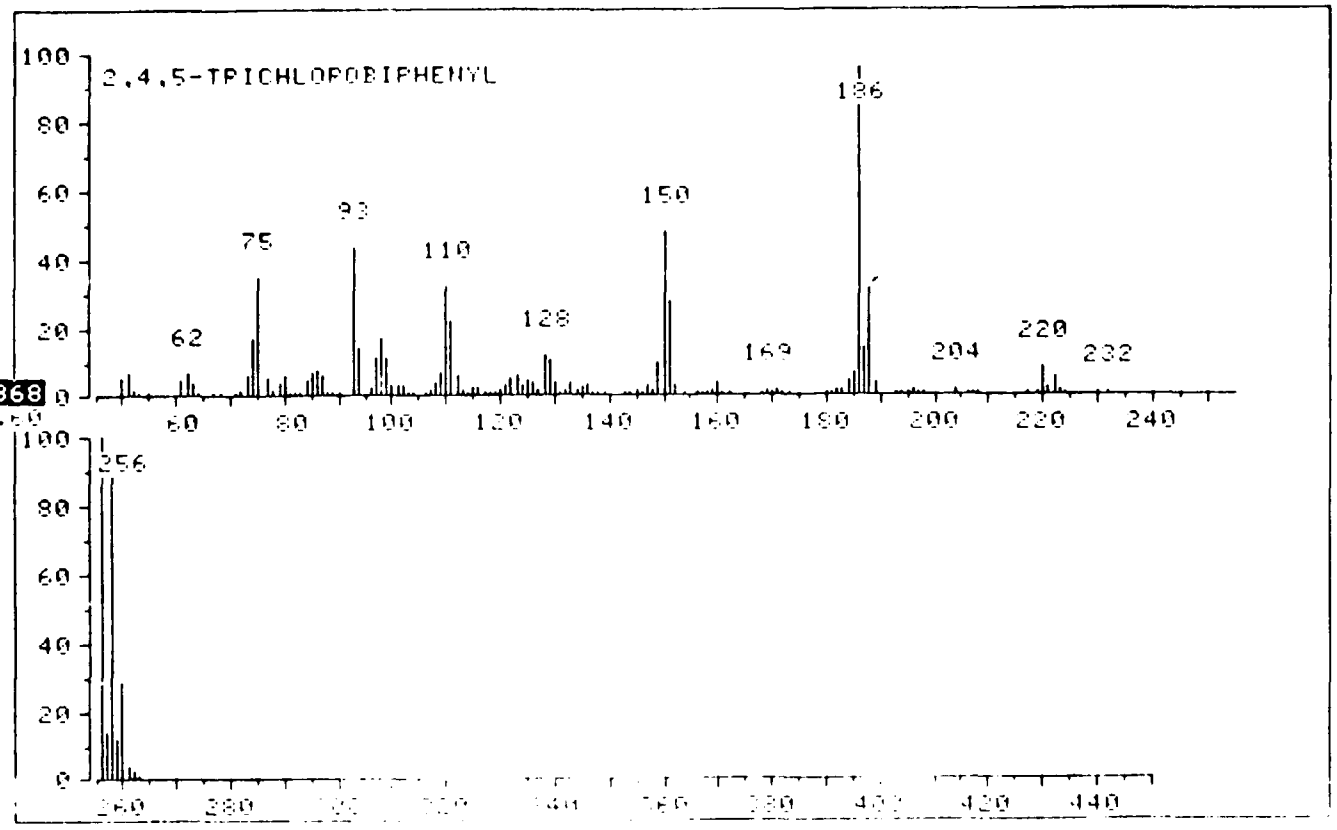
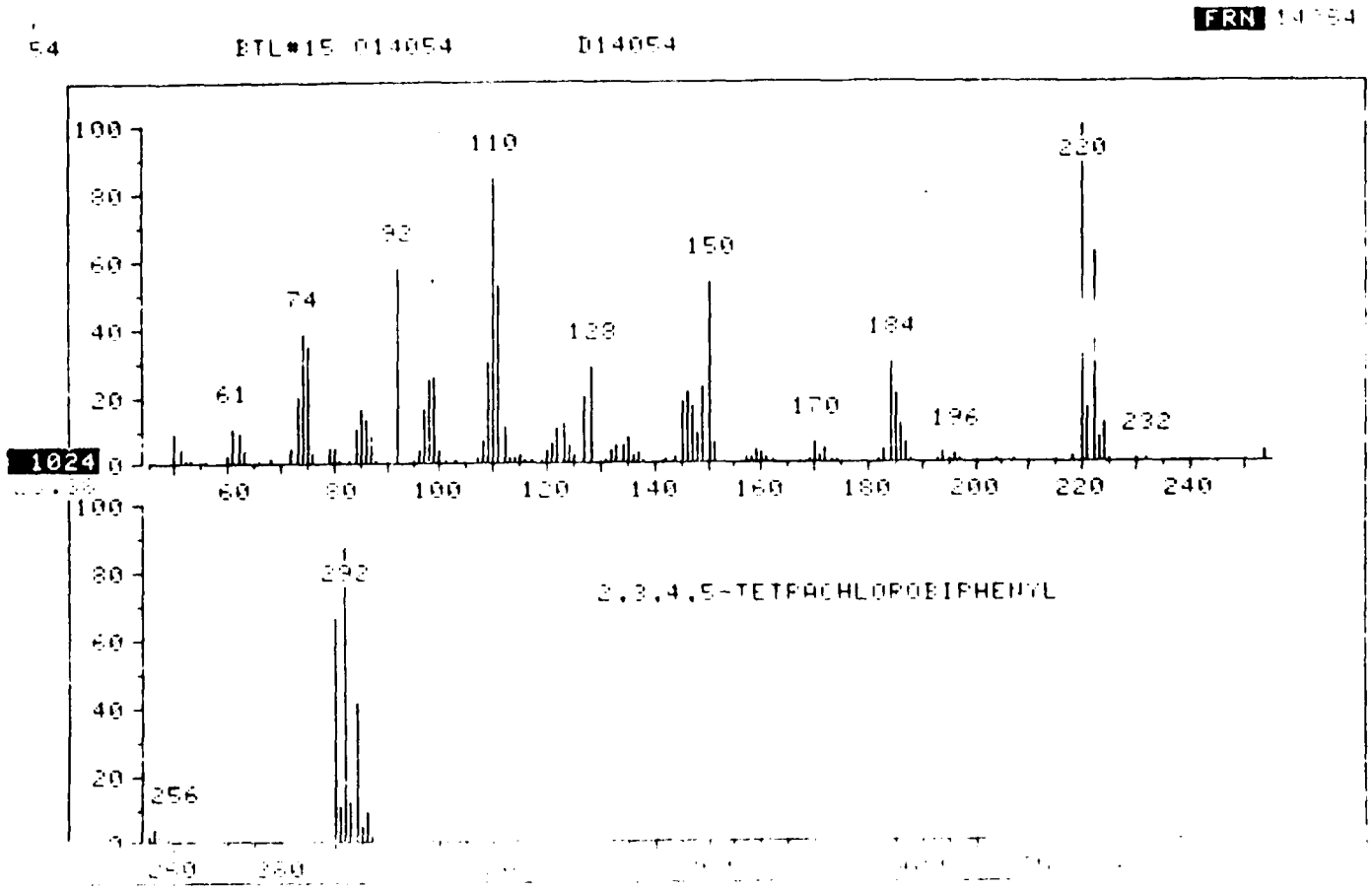
356

BTL#1 014054 D14054

FRN

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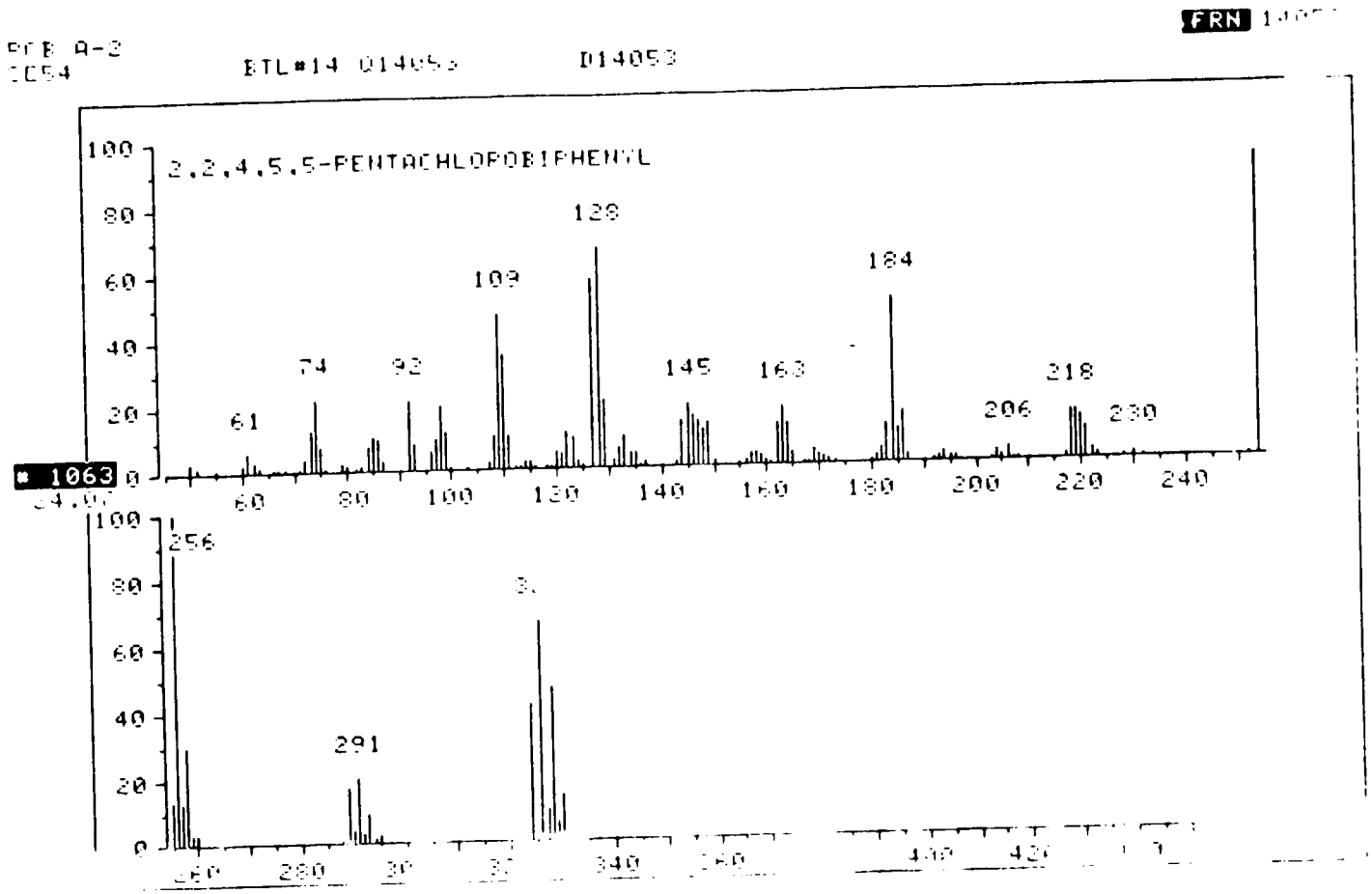
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61
74
92
109
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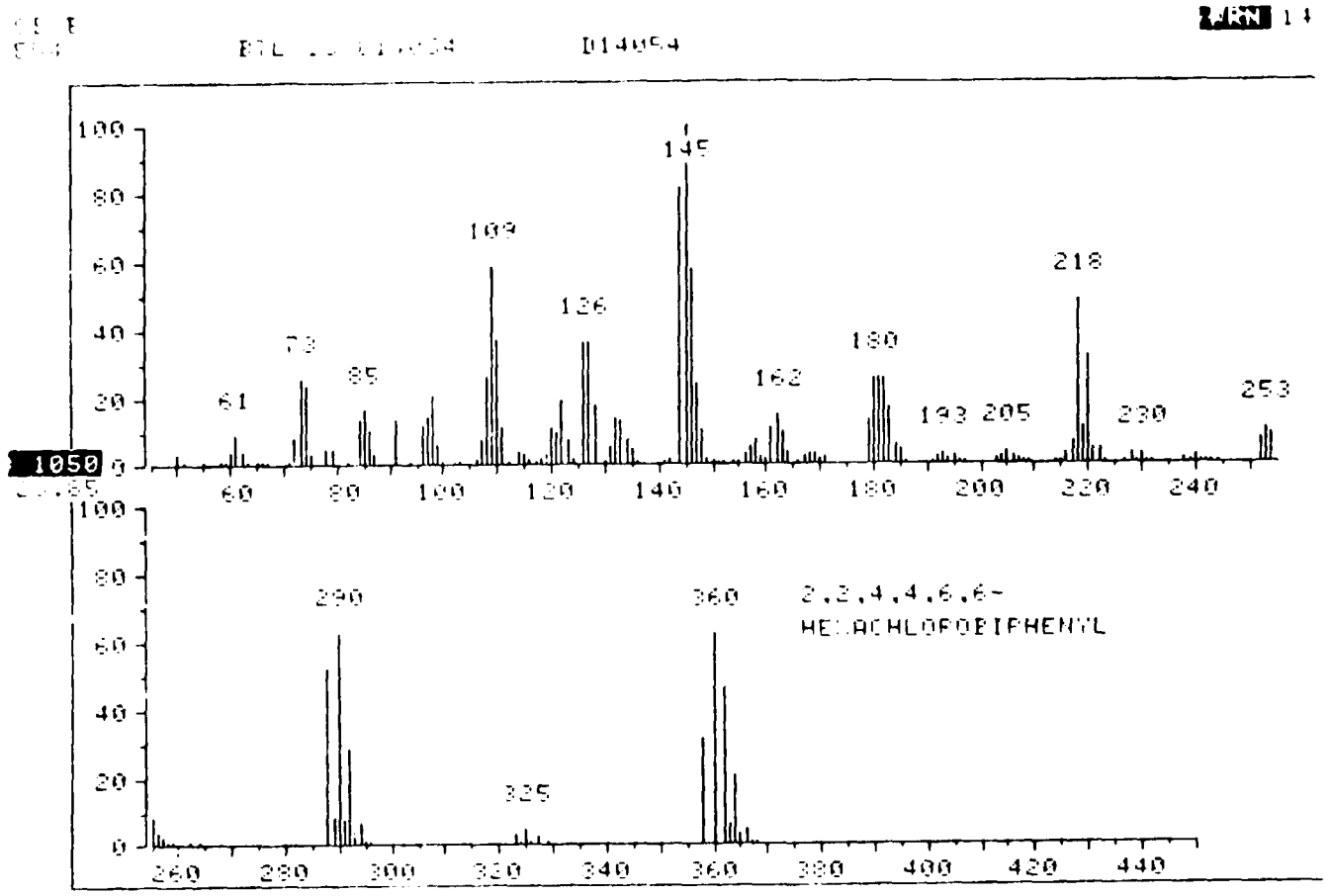
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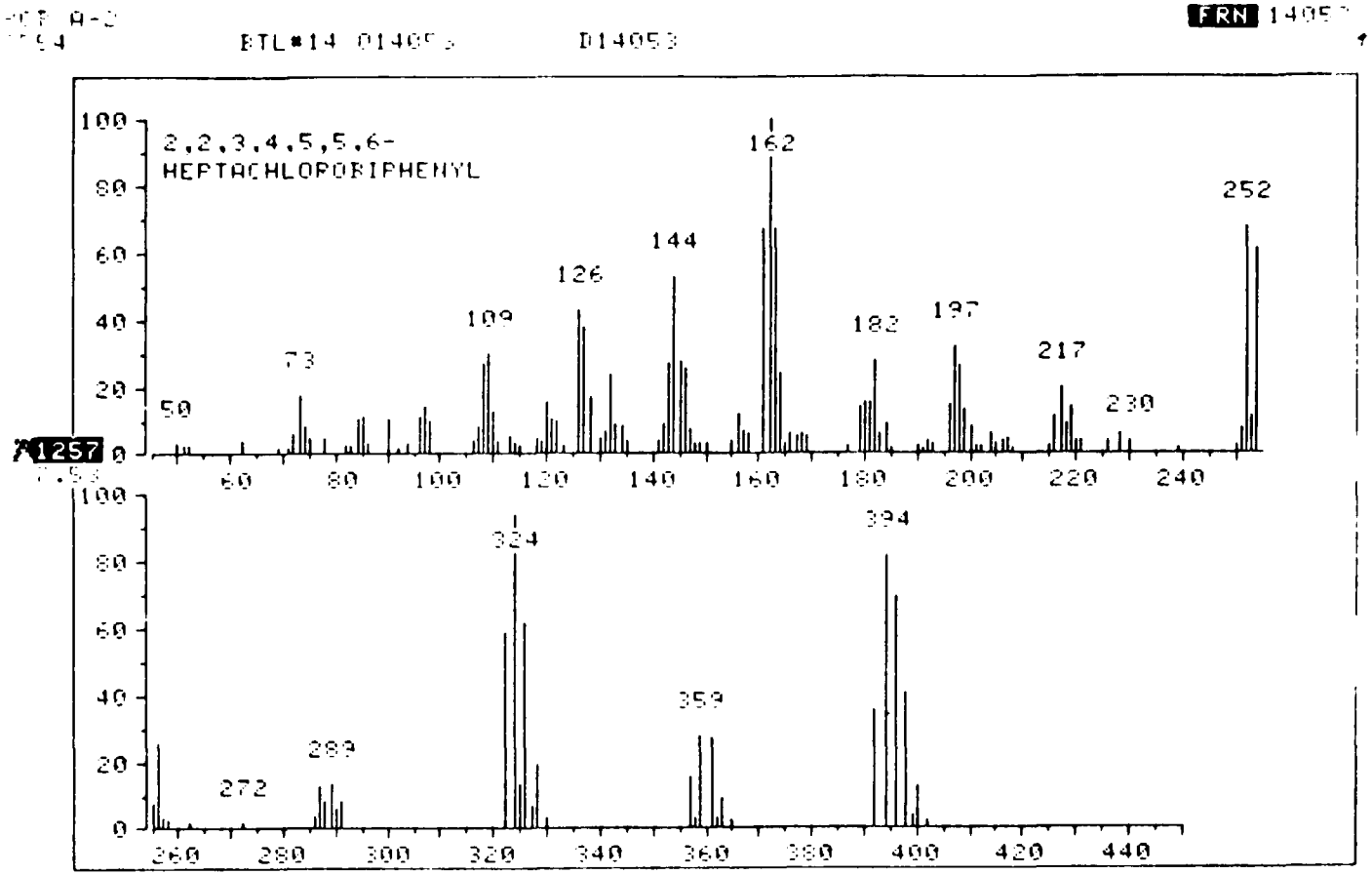
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73
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289
324
359
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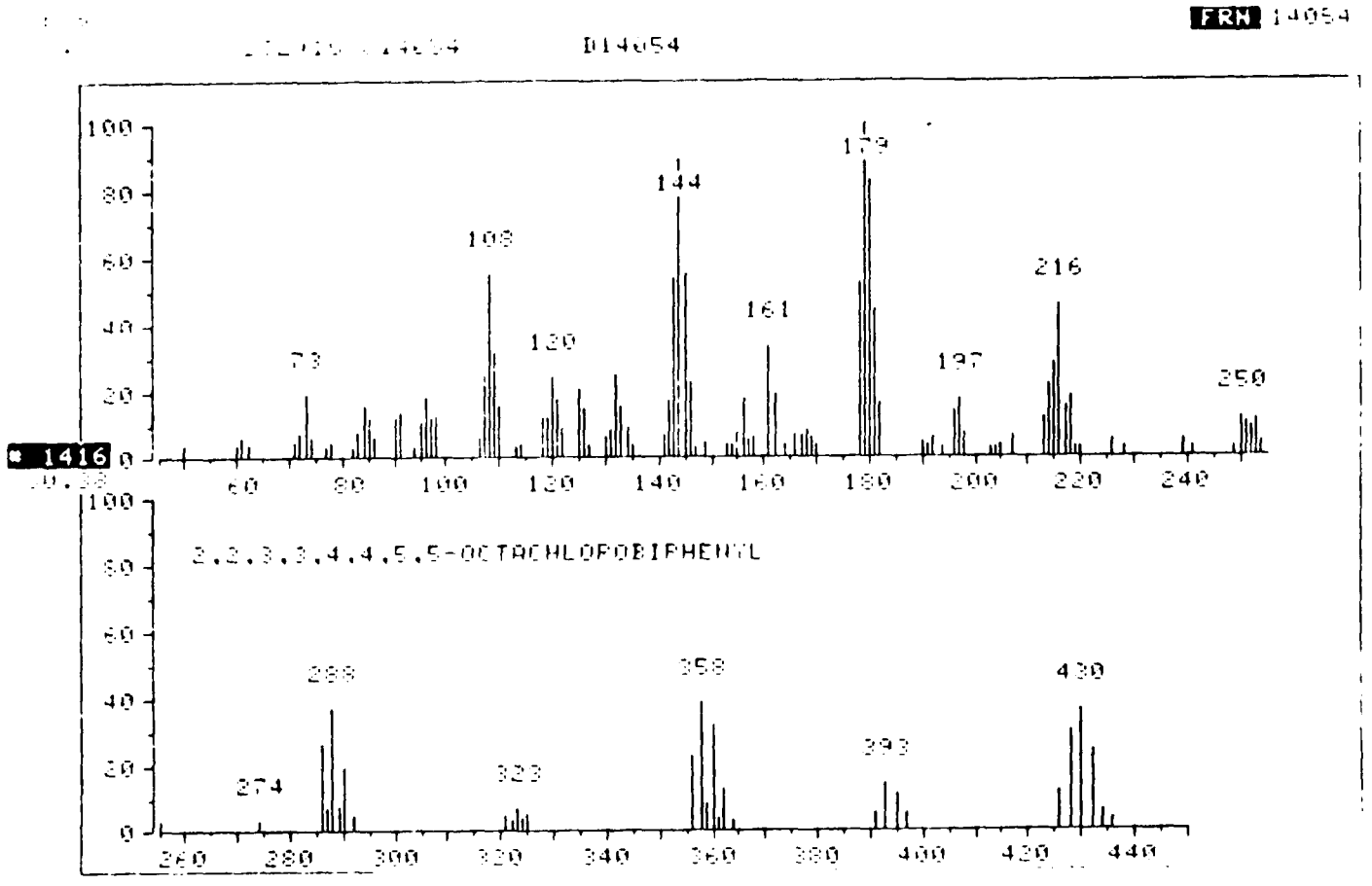
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288
323
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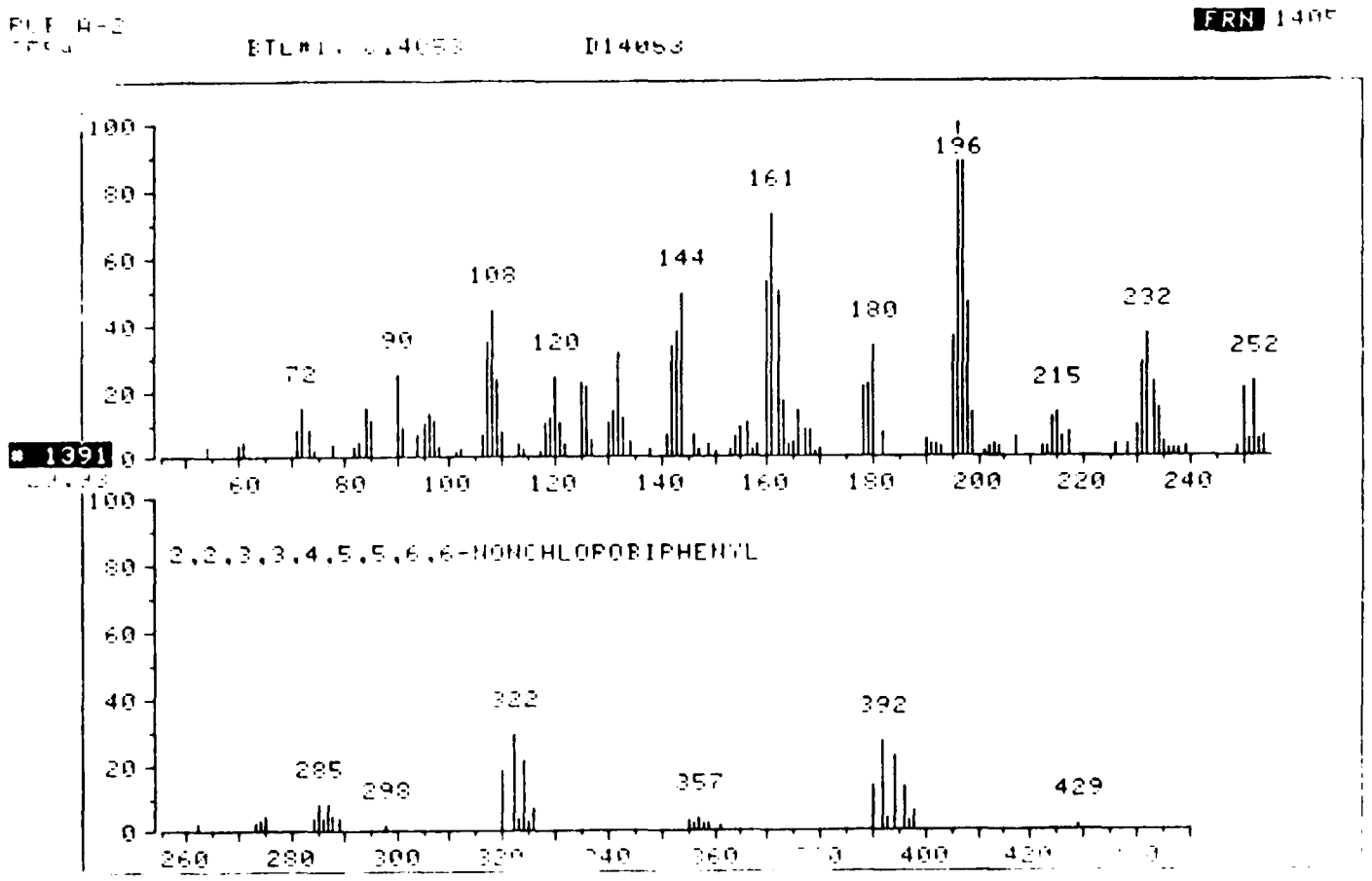
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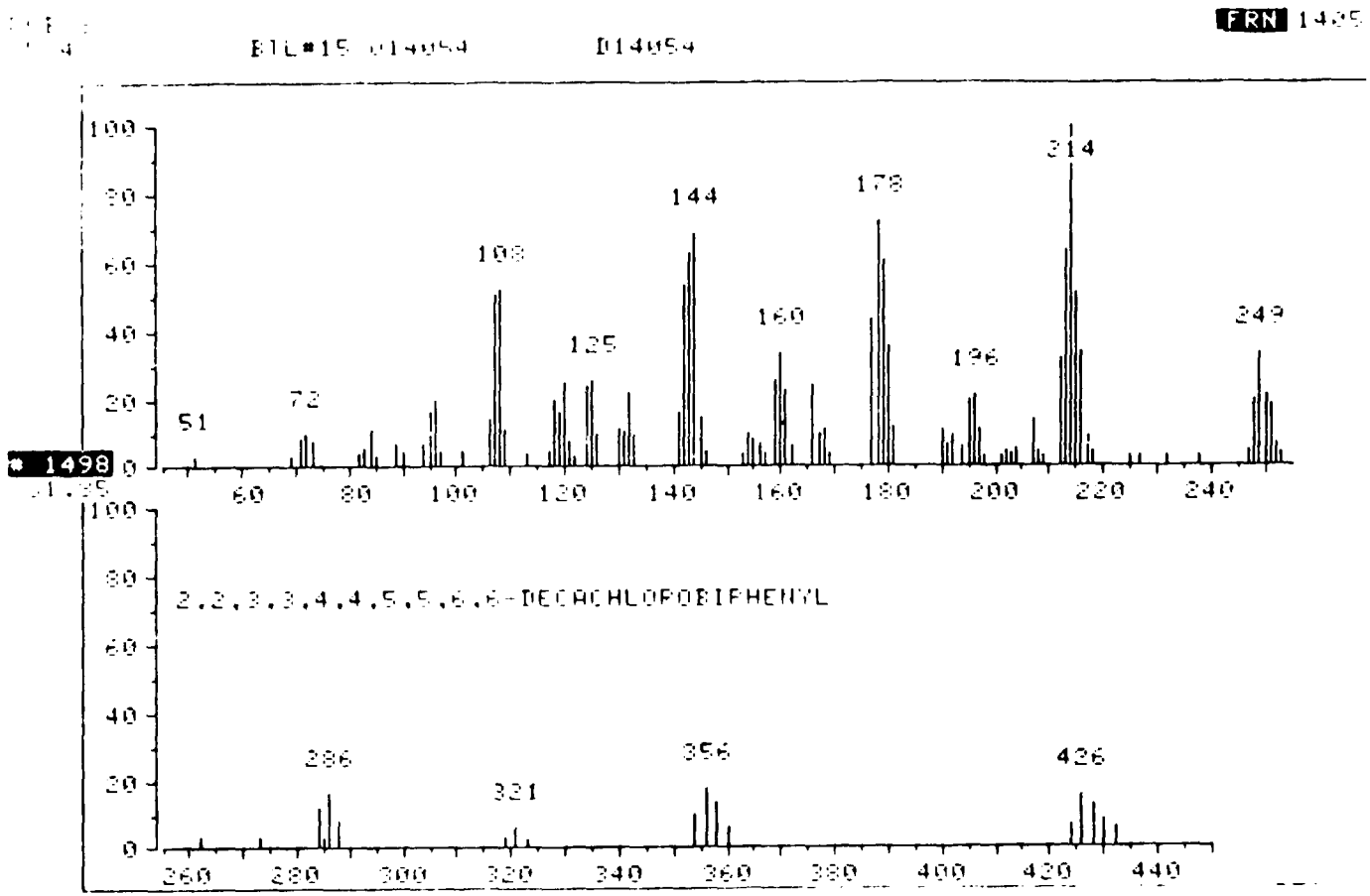
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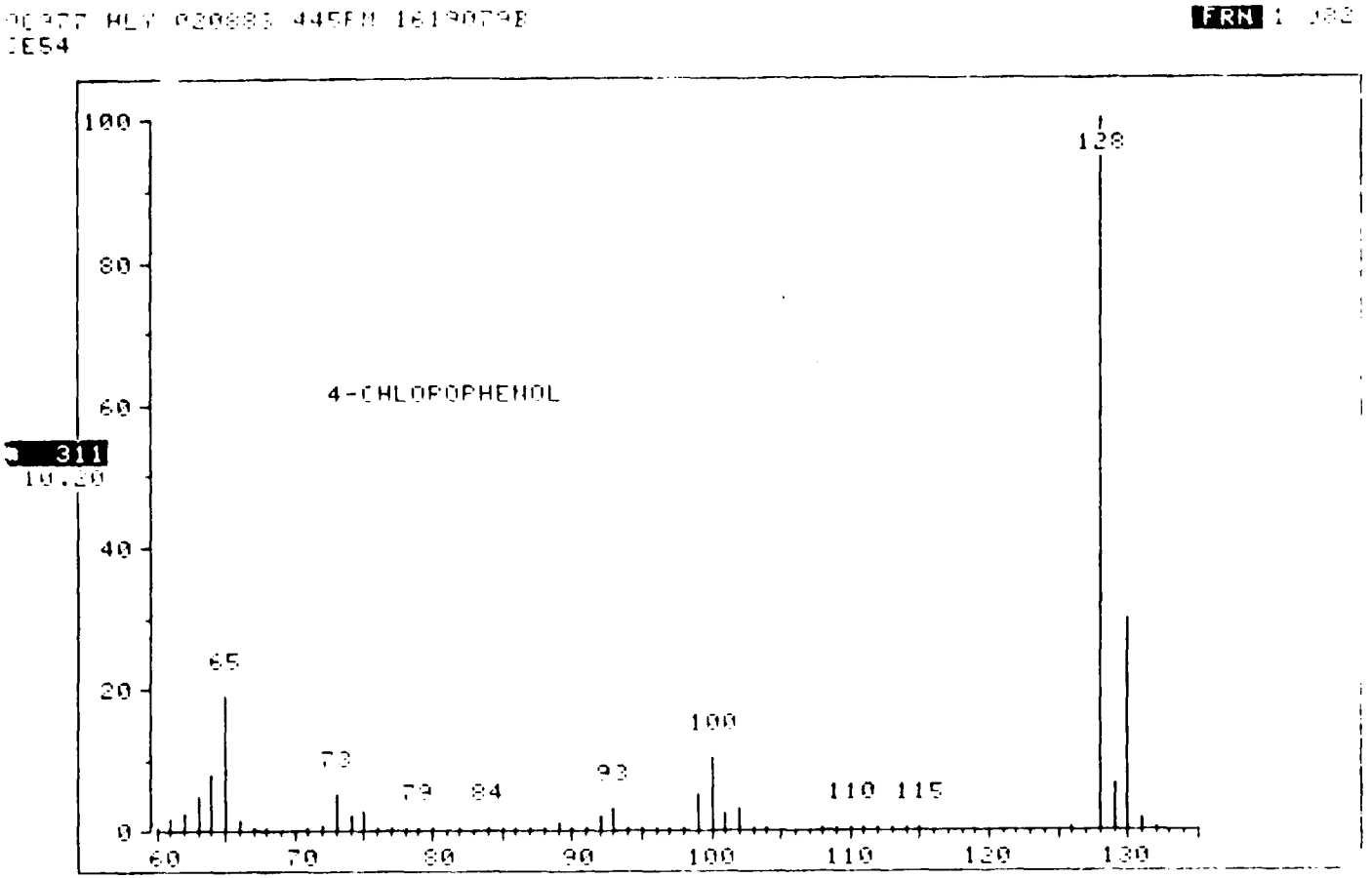
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80
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115
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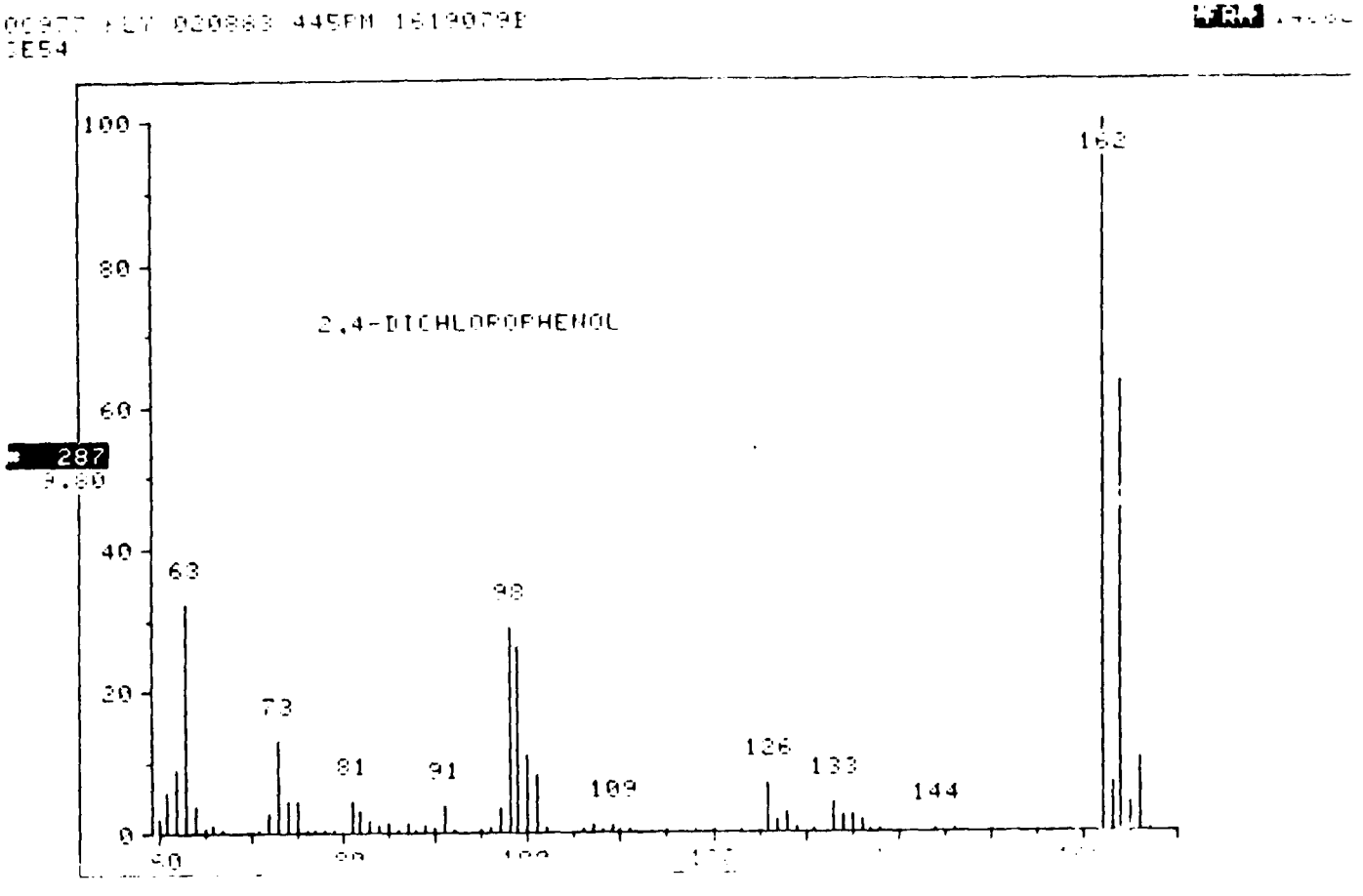
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133
144
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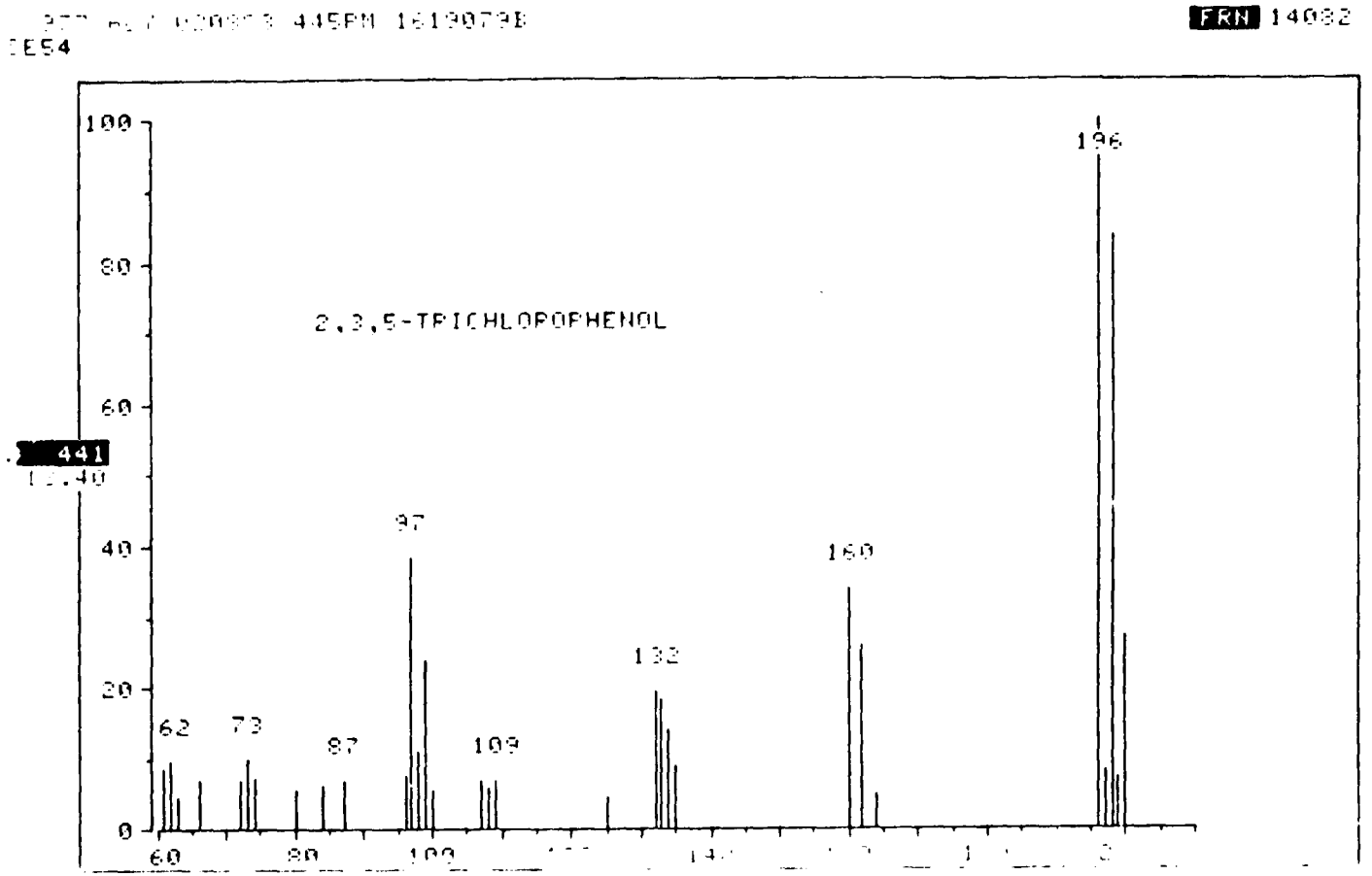
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2,3,5-TRICHLOROPHENOL
441
100
80
60
40
20
0
62
73
87
97
109
132
160
196
60
80
100

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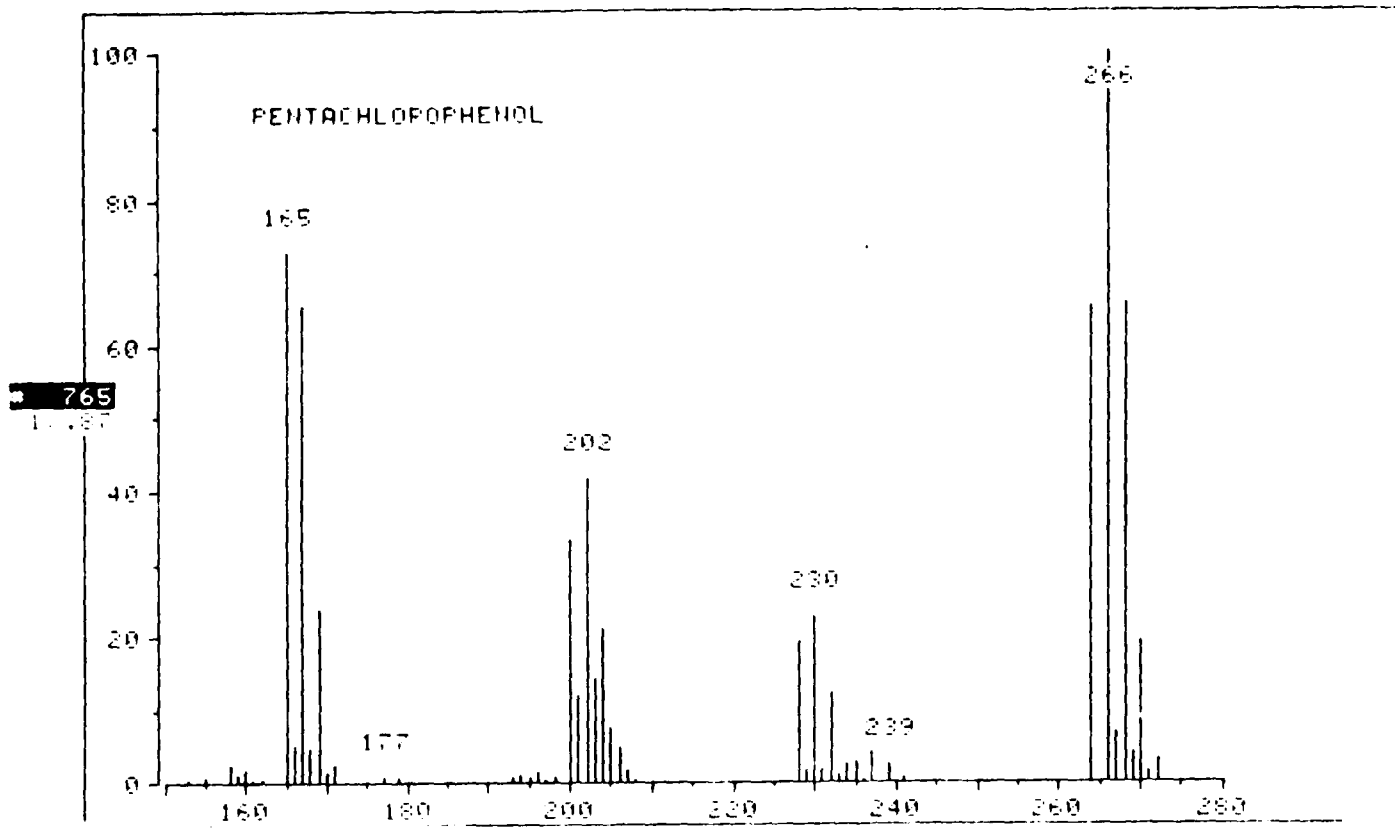
IE54



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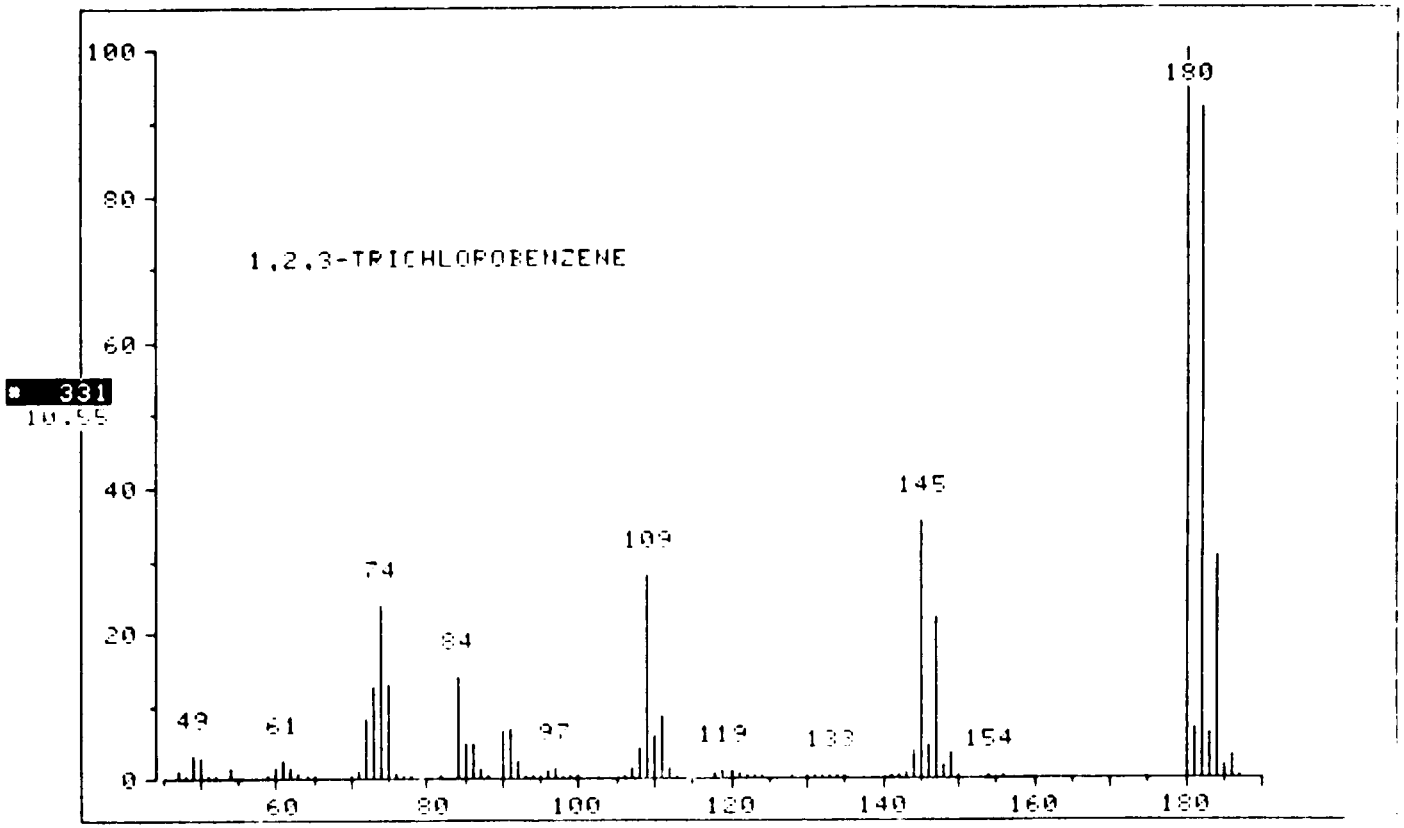

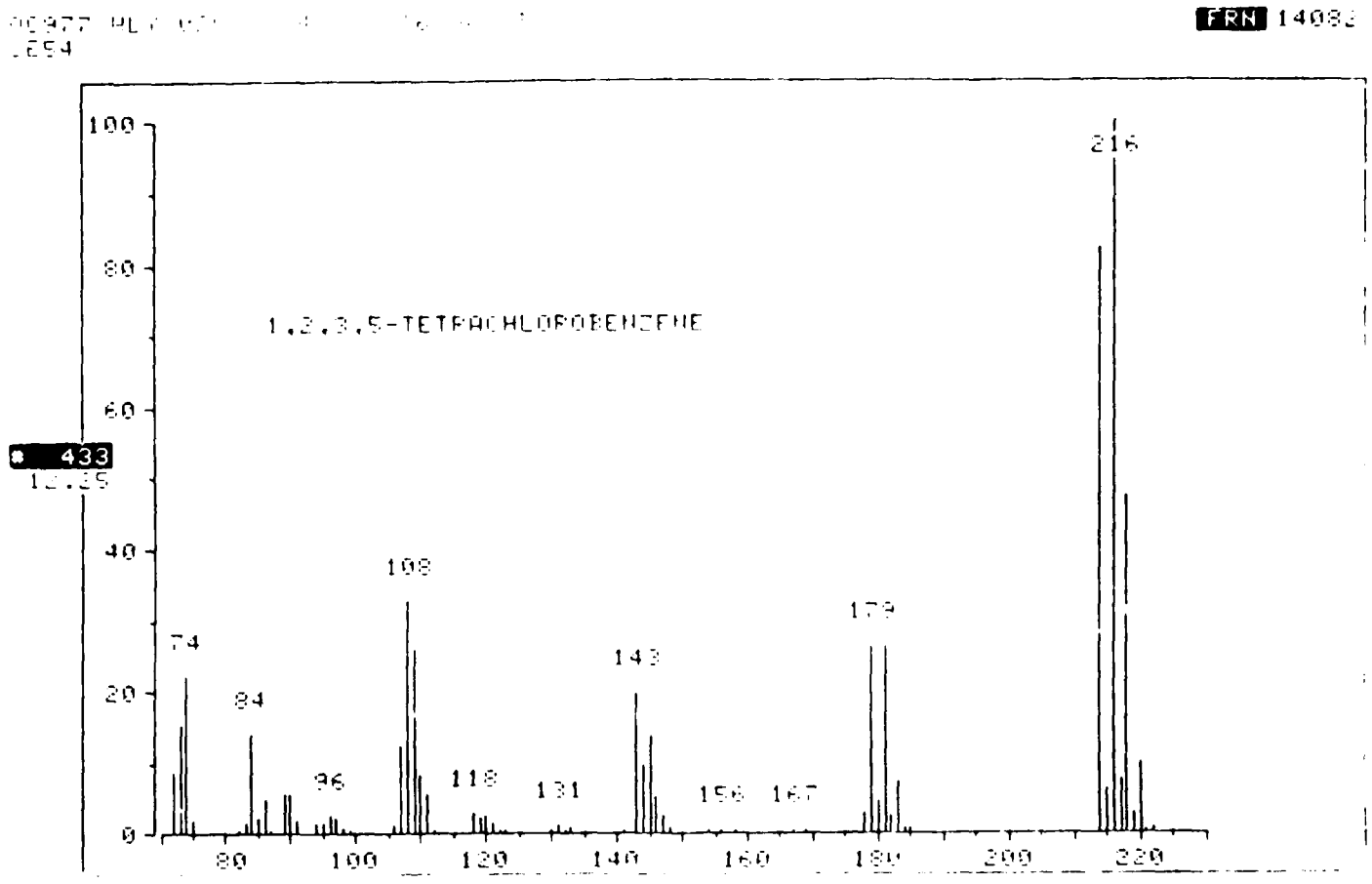
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1,2,3,5-TETRACHLOROBENZENE
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100
80
60
40
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0
74
84
96
108
118
131
143
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80
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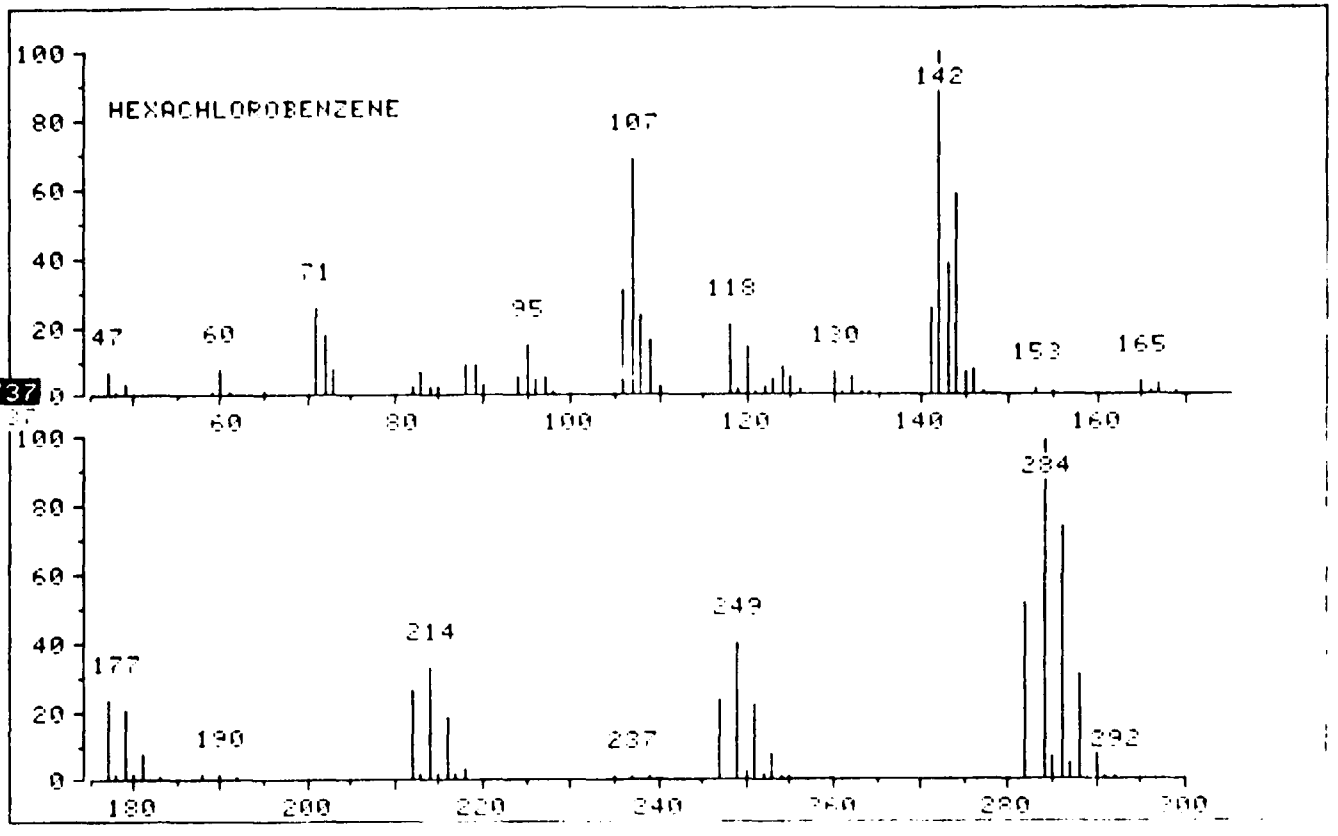
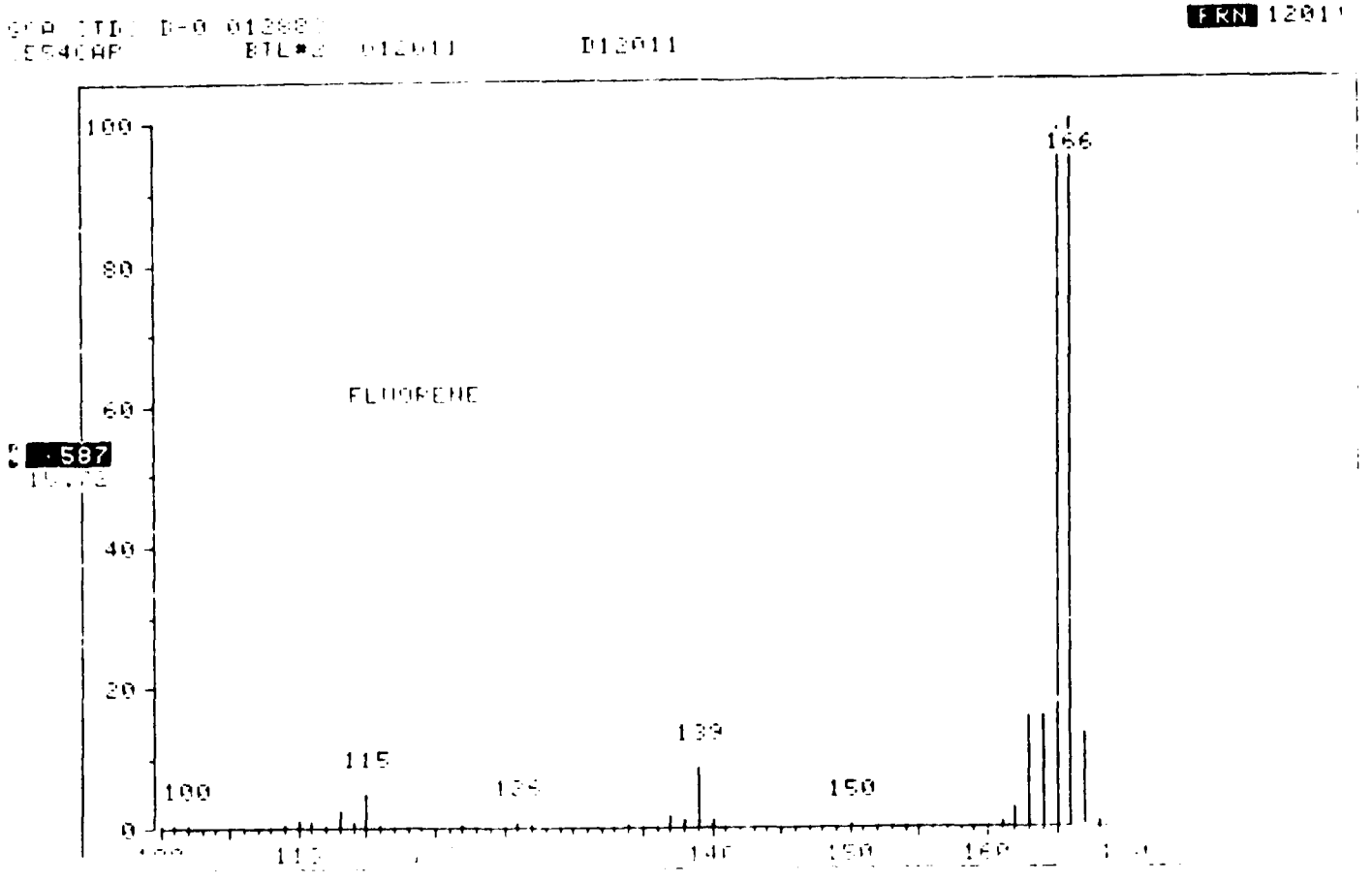
DC 978 HHLV 020883 600PM 16190798 FRN 14083
IE54

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D12011
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166
139
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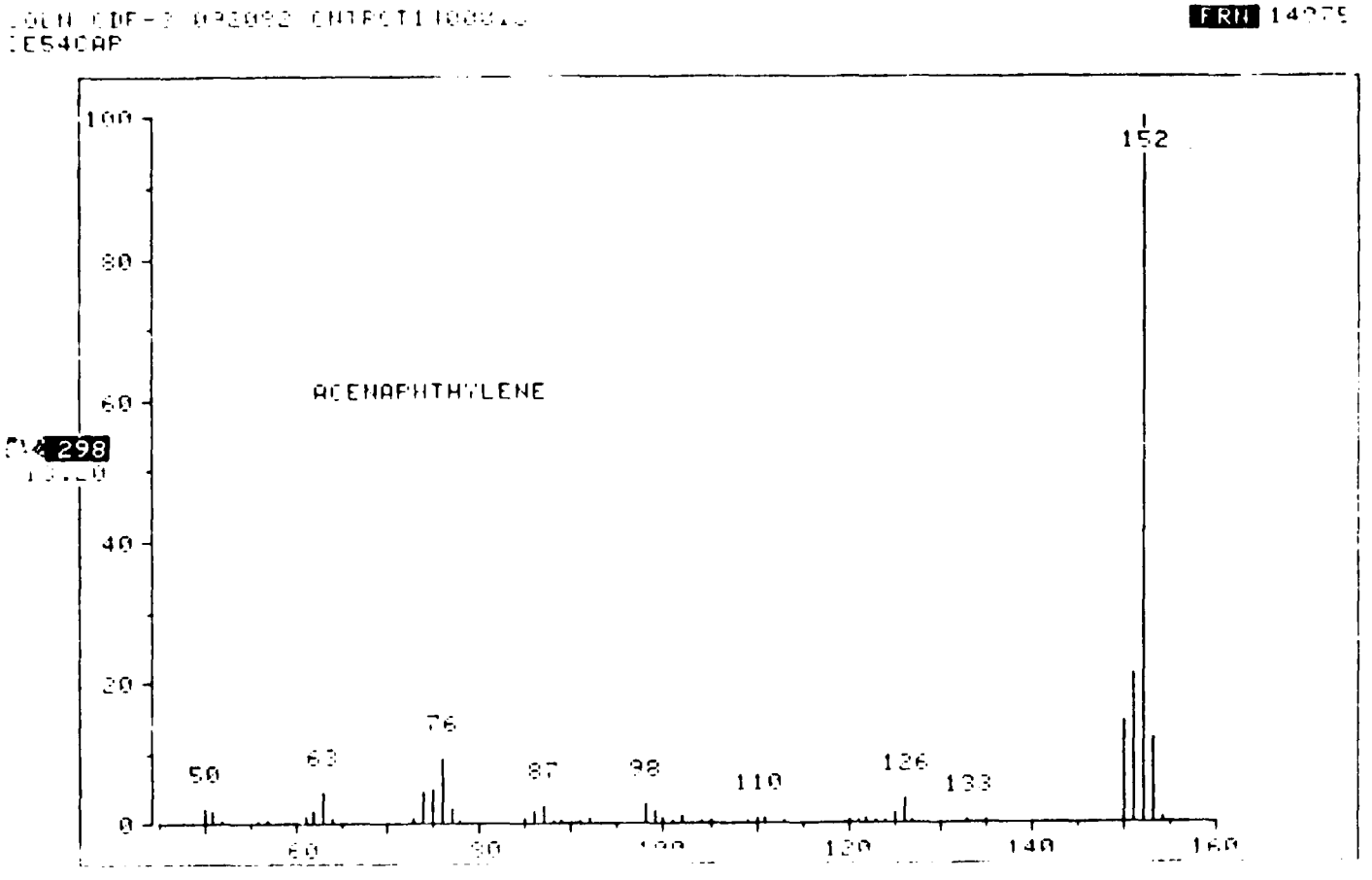
100
150


FRN
ACENAPHTHYLENE
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76
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98
110
126
133
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120
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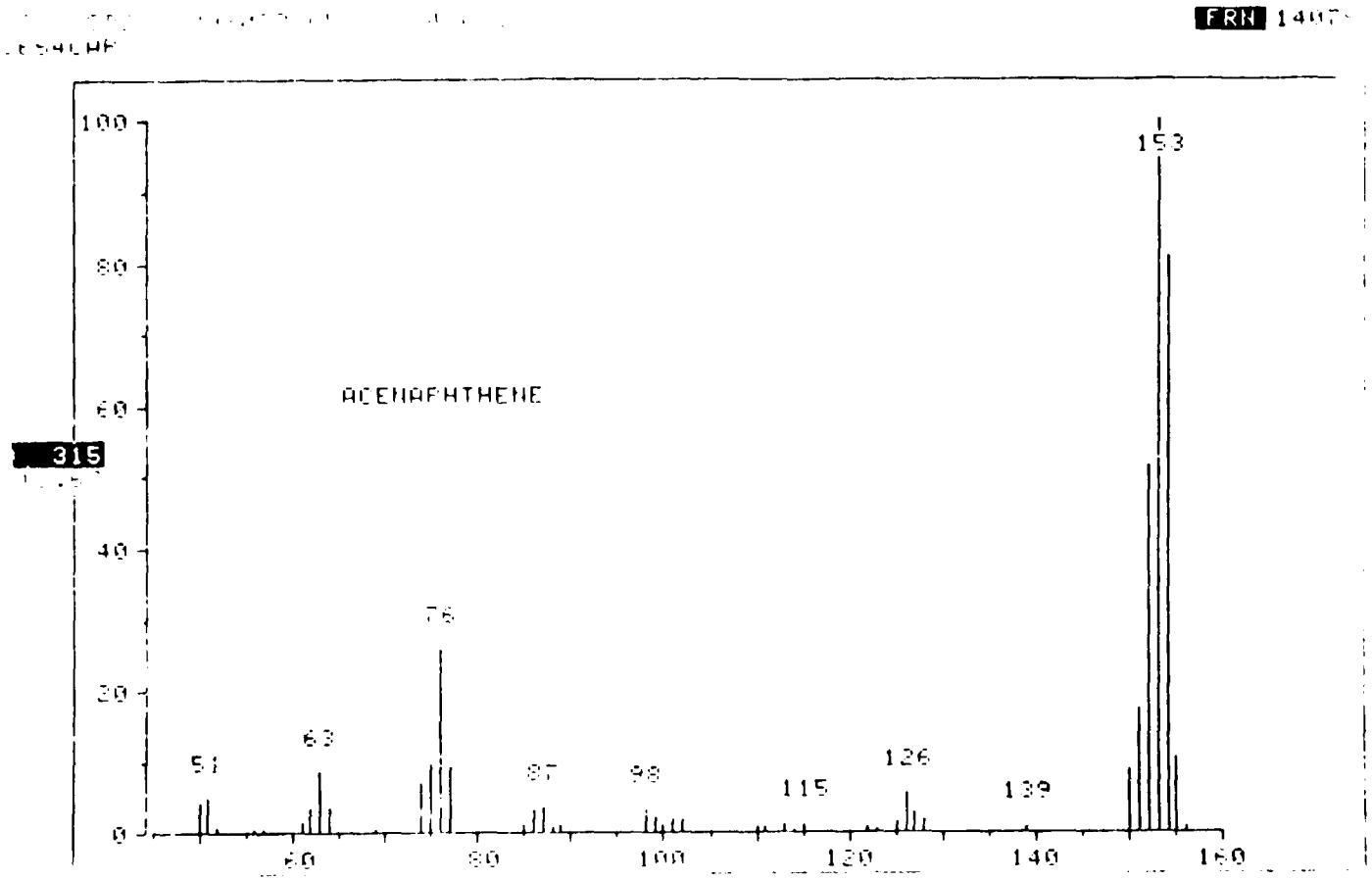
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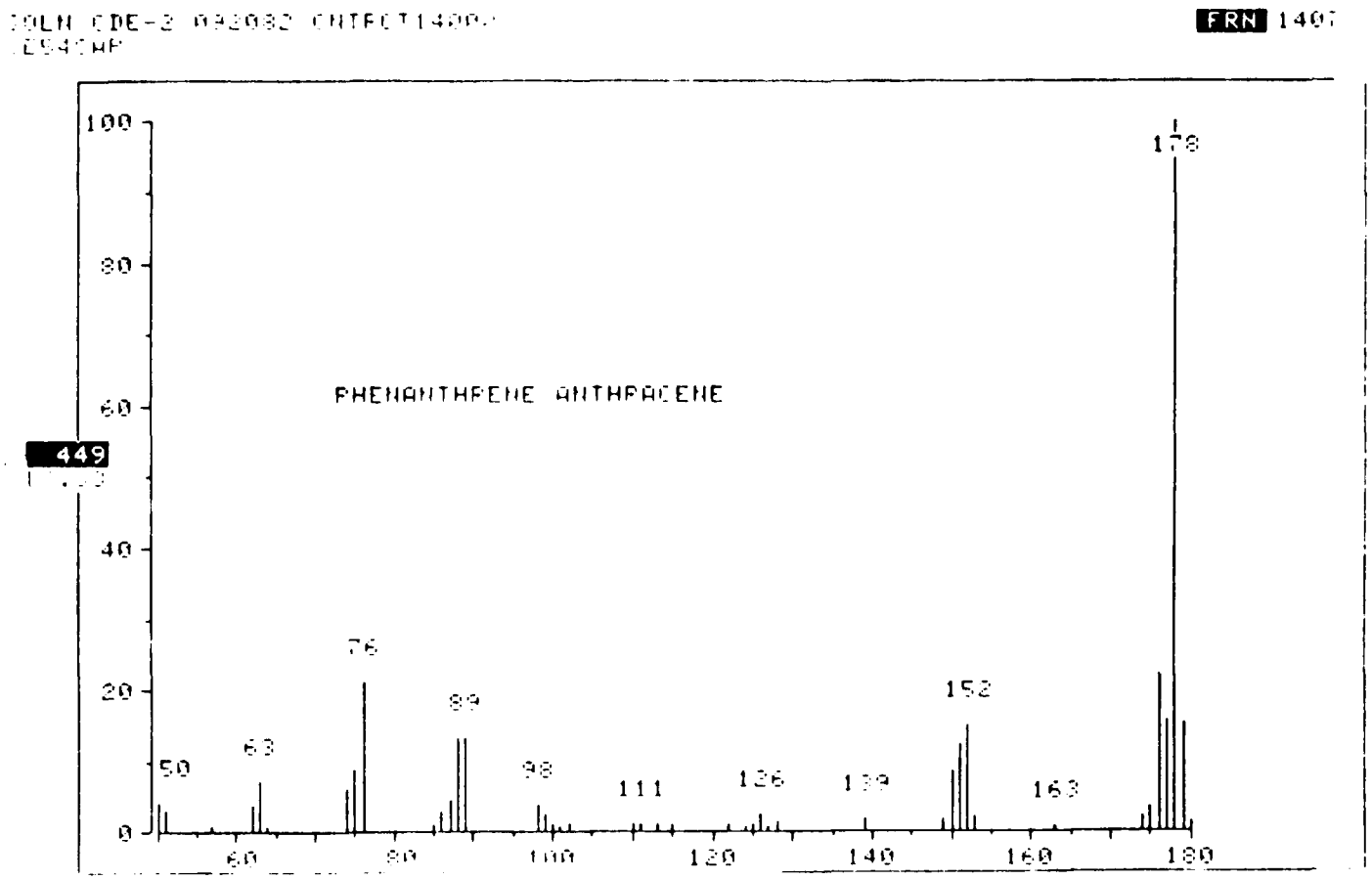
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80
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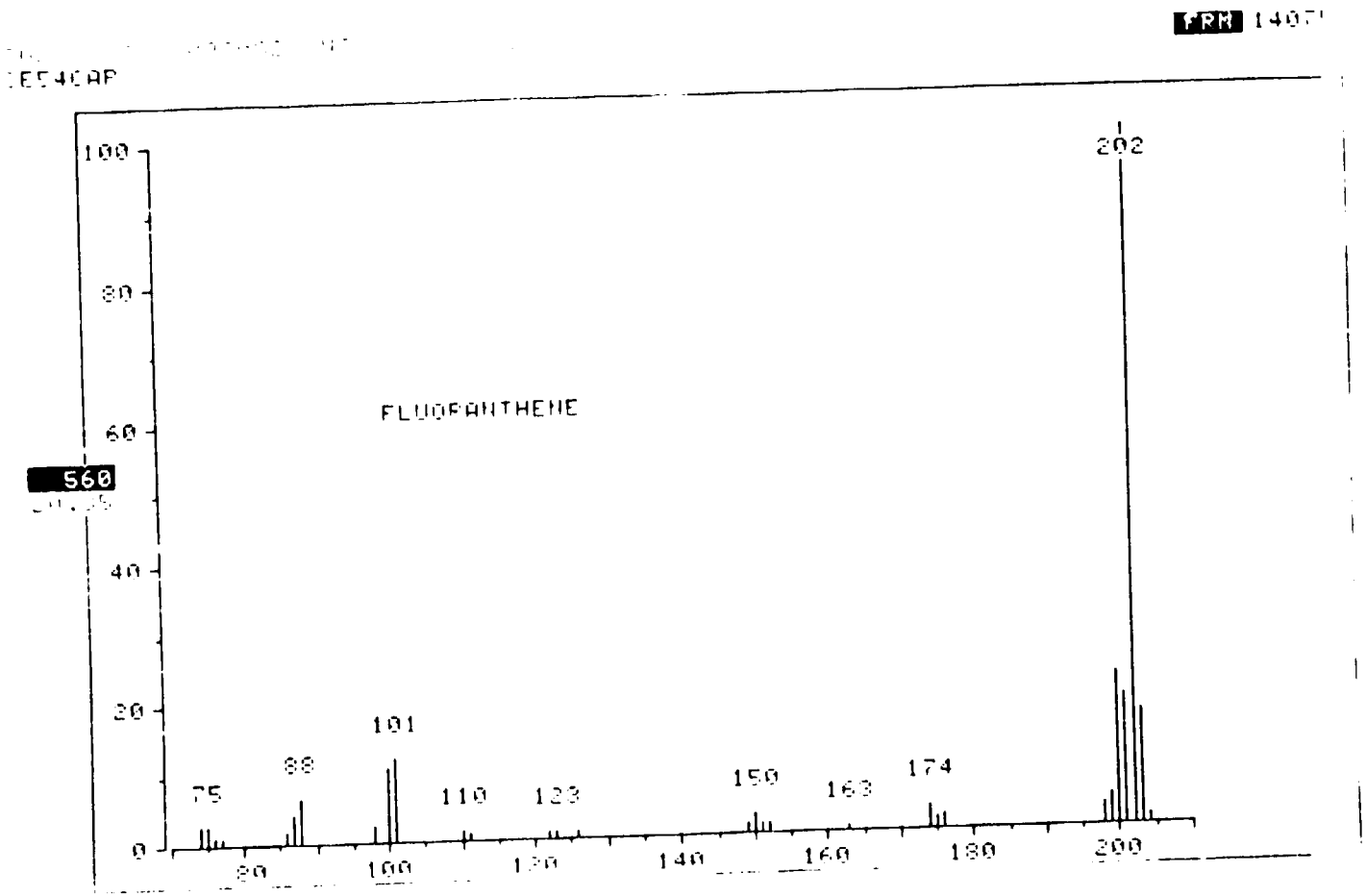
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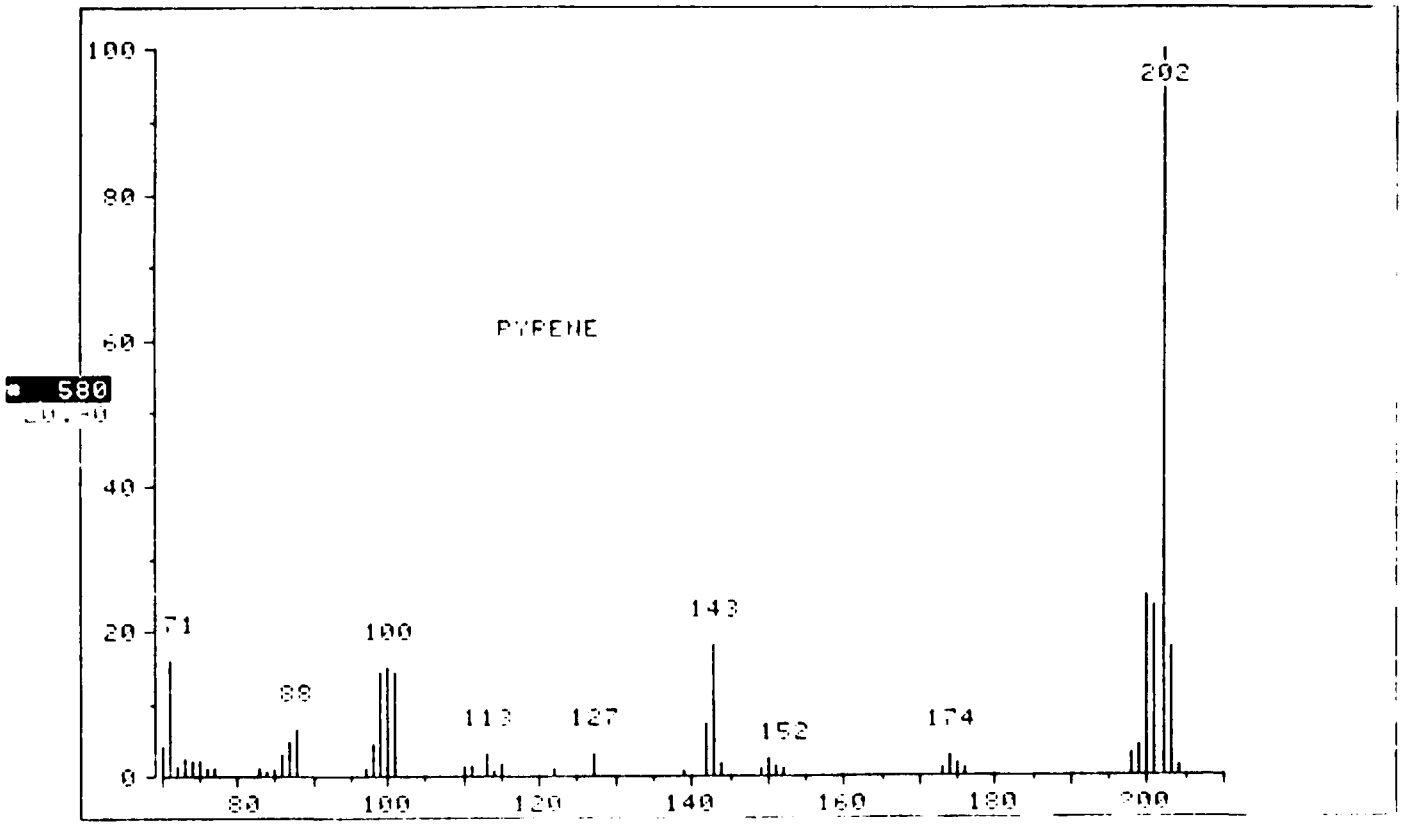
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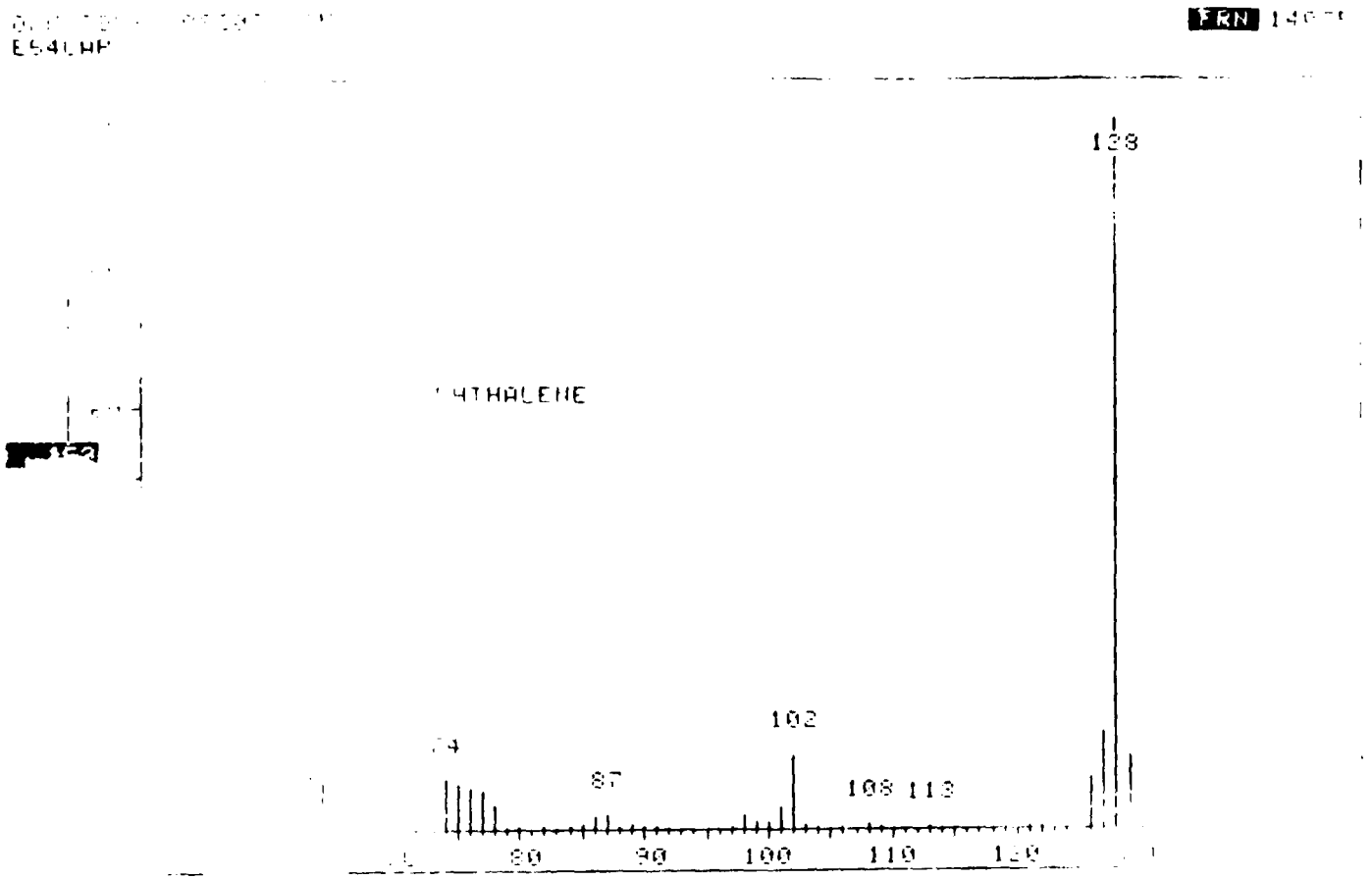
E54LHP
FRN
128
102
87
108 113
80
90
100
110

APPENDIX F

AMBIENT MONITORING OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) EMPLOYING HIGH VOLUME POLYURETHANE FOAM (PUF) SAMPLERS

MANUSCRIPT PRESENTED AT
EIGHTH INTERNATIONAL SYMPOSIUM ON
POLYNUCLEAR AROMATIC HYDROCARBONS
HELD AT BATTELLE COLUMBUS LABORATORIES,
COLUMBUS, OHIO, OCTOBER 26-28, 1983

AMBIENT MONITORING OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAHS) EMPLOYING HIGH VOLUME POLYURETHANE FOAM (PUF) SAMPLERS.

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GCA/Technology Division, 213 Burlington Road, Bedford,
Massachusetts 01730, USA

INTRODUCTION

The presence of polynuclear aromatic hydrocarbons (PAHs) in ambient air, particularly in urban locations, is well documented. Typically, these constituents are present in low ng/m^3 concentrations and are historically thought to be associated only with airborne particulate matter derived from a variety of sources including but not limited to stationary combustion sources (1-5) automotive exhaust emissions (1-3, 5) and a variety of industrial processes (5) such as roofing and paving operations (6).

For this reason, sampling protocols consisting of high volume samplers containing particulate filters have traditionally been employed for the collection of ambient polynuclear aromatics. Recent investigations, however, have shown that the collection of ambient particulates under high-volume conditions may result in significant losses of PAHs effected by either in situ chemical reactions (e.g., oxidation) while sorbed on the filter media (7-13) or direct volatilization from particulate matter under the conditions of high-volume air sampling. Keller and Bidleman have reported losses from the filter in excess of 80% for phenanthrene and pyrene and further that the majority of 3 and 4 ring PAHs are not retained by the filter under high-volume sampling conditions (16). Similar trends were noted for the 2 and 3 ring PAH homologues (phenanthrene, anthracene, pyrene, and fluoranthene) during an ambient monitoring program conducted in Belgium by Cautreels and Van Cauwenberghe (18). In fact, observations by Thrane and Mikalsen made during a 1979 Norwegian ambient air survey indicated that only 5-6% of the total PAH were retained by the filter under high-volume sampling conditions (15).

As a consequence of these observations, it is strongly recommended that conventional high-volume sampling apparatus be modified to contain back-up sorbent cartridges comprised of polymeric materials such as polyurethane foam, tenax, or XAD-2 for more efficient collection of both vapor phase and particulate associated PAHs (14-18, 21, 23).

The present investigation included the use of high-volume air samplers containing both glass fiber filters and polyurethane foam cartridges (PUF) to collect ambient levels (ng/m^3) of PAHs. Analytical protocols included the use of soxhlet extraction, solvent concentration in a Kuderna-Danish, and subsequent analysis by capillary column gas chromatography/mass spectrometry. Quality control protocols included the use of deuterated surrogates (i.e., d_{10}-biphenyl, d_{12}-chrysene), deuterated internal standards (i.e., d_8-naphthalene, d_{10}-anthracene) and laboratory control spikes.

Field investigations employing the above ambient monitoring protocols were conducted in August and September of 1982 as part of a comprehensive Superfund field investigation in the New Bedford, Massachusetts metropolitan area. The primary focus of this program was to monitor ambient levels of polychlorinated biphenyls (PCBs) and industrially related organochlorine compounds (e.g., chlorinated benzenes) historically associated with capacitor and transformer manufacturing facilities situated in the New Bedford region. Monitors were operated simultaneously at each of 21 stations situated throughout the effective study region.

Additionally, organic analyses were conducted at the majority of these stations including analyses for approximately 18 PAH isomers commonly found in ambient atmospheres.

Samples (400 m^3) were collected over an approximate 12-hour period on each of 2 days during the late summer of 1982. Results (ng/m^3) will be provided for 18 PAH isomers at each of 21 stations and will focus particularly on levels associated with the polyurethane foam (PUF) cartridges only. In instances when analysis of the particulate filter and PUF cartridges were conducted separately, data and comments on the distribution of PAH isomers between the particulate filters and sorbent cartridges will be provided.

The precision of the combined sampling and analysis scheme, as evidenced by four pairs of collocated monitors (one pair at each of two sites on each test day) will also be presented. In addition, the cumulative PAH data base assumed to represent the New Bedford region during summer months will be compared to summertime PAH levels in a number of U.S. and European urban and rural locations. Some recommendations for future study will also be presented.

Site History and Locations

New Bedford, Massachusetts is a coastal city located in the southeastern portion of the state approximately 55 miles south of Boston. Environmental PCB contamination, effected by the activities of the capacitor manufacturing industry since the end of War II, has prompted the Environmental Protection Agency to conduct a comprehensive evaluation of the occurrences, distribution, transport, and fate of polychlorinated biphenyls and related organic contaminants within the area.

An integral part of this program is a complete evaluation of the ambient air in and around the New Bedford Metropolitan area. In response to these requirements, GCA/Technology Division, in conjunction with the Environmental Protection Agency, designed a comprehensive monitoring program to assess ambient levels of PCBs, trace metals, and a variety of organic components within the New Bedford area. The resulting program consisted of sampling at each of 21 stations, encompassing a geographical area which included New Bedford, Fairhaven, Dartmouth, and Acushnet, Massachusetts. It was the intent of this program to provide quantitative "real time" measurements over the study region using high-volume air samplers operating simultaneously at each of the 21 stations. As a consequence, samples were collected for a 12-hour period on each of 2 days: September 3, 1983 and September 9, 1982.

The specific site locations in Figure 1, include a number of areas of particular interest to both the Environmental Protection Agency and the Massachusetts Department of Environmental Quality Engineering. Included in the "target" site summary were a number of potentially contaminated (i.e., PCBs) areas, as well as urban New Bedford and Fairhaven background stations.

The 21 station sampler network was distributed throughout the study region centered primarily around sites of known or "suspected" PCB contamination. Additionally, for quality control purposes samples were collocated at stations 3 (Shawmut Street), 7 (Job C Tripp School), and 9 (C&W Welding). The majority of these sites were located in urban and rural locations not directly impacted by identified point sources of PAH emissions. As a consequence of this random distribution the monitoring network displayed in Figure 1 can be expected to provide a representative picture of ambient summertime PAH levels in the New Bedford region.

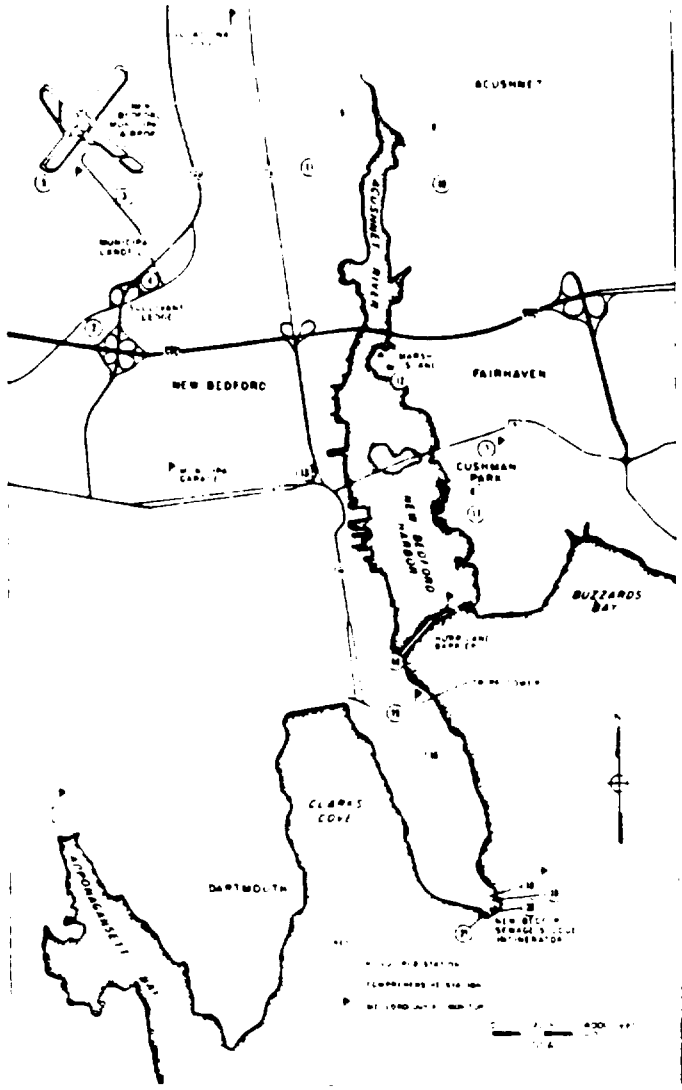

FIGURE 1. New Bedford ambient monitoring network - schematic of site locations.

MATERIALS AND METHODS

Meteorological Conditions

Six "existing" meteorological monitoring installations and two "temporary" stations were used to determine macro and

micrometeorological conditions in the study area during the specified sampling periods. Refer to Figure 1 for a schematic illustrating the locations of these stations.

The six "existing" stations are actually temporary installations currently being operated by the University of Massachusetts, for an ongoing study concerning the feasibility of wind-generated electricity in the New Bedford area. The two temporary stations were set up and monitored by GCA specifically for this project and were located in areas of concern that were not in the vicinity of the existing stations. All stations were equipped to continuously monitor wind speed and wind direction. In addition, barometric pressure and relative humidity data were also recorded on the day of sampling. Ambient temperatures were recorded continuously at the background station in Dartmouth. Regional surface weather observations from the national "Daily Weather Maps," prepared by the Environmental Data and Information Service of the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce, were reviewed, along with local hourly wind observations made in the study area. Hourly wind directions and wind speeds were available from the six permanent local sources of data and two temporary local installations as shown in Figure 1. The permanent sources of data are located at the Hurricane Barrier in New Bedford Harbor and operated by the Army Corps of Engineers, the Greater New Bedford Regional Technical Vocational High School, the Tripp Towers apartment building, the Municipal Sewage Treatment Plant, the Parker Street Municipal Garage, and the New Bedford Airport. The temporary installations were located at the Dartmouth Town Hall and the Tripp School in Fairhaven. The meteorological data collected during the sampling program were evaluated for each of the 2 sampling days. A summary of these pertinent meteorological data are provided below:

September 3, 1982

The national weather map for 0700 EST showed that a low pressure center was located to the NW of the region, bringing SSW to W winds to the study area. The local sources of meteorological data showed winds from the SSW to W with a tendency towards WSW to W direction prevailing. Speeds were moderate (10-12 mph) for most of the day. An average temperature of 24.7°C was recorded at the start of the sampling period compared to 24.0°C at the conclusion of the daily sampling period.

September 9, 1983

The national weather map for 0700 EST showed a high pressure center located to the south of the study area, causing generally SW to W winds. The local meteorological data showed the wind to be much more definitely from the west. However, data were missing from five of the eight sites from noon until the end of the day. Wind speeds were light to moderate (3-10 mph) throughout the day. An average temperature of 20.8°C was recorded at the start of the sampling period compared to a temperature of 23.0°C at the conclusion of the sampling period.

Sample Collection

Sampling was performed using high-volume samplers which comply with 40 CFR 50 Appendix B--Reference Method for the Determination of Suspended Particulates in Ambient Atmosphere (High-Volume Method) modified as described in "A Method for Sampling and Analyses of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA-600/4-78-048, August 1978. This modification involves an extension of the throat assembly at the filter holder outlet with a piece of cylindrical aluminum. Additional modifications include replacement of rubber gasket material with Teflon and the attachment of flexible duct work to direct electric motor exhaust downward of the sampler inlet. A detailed schematic is provided in Figure 2.

As shown, the polyurethane foam plugs were located in the aluminum throat extension located downstream of the filter assembly. Each throat assembly contained two cylindrical foam (polyether type) plugs, each 4 inches in diameter cut from 3 inch (depth) stock with a specified density of 0.21 gm/m^3. All foam plugs were pre-cleaned in the laboratory and subjected to rigorous quality control criteria prior to release for field sampling. Laboratory clean-up procedures were as follows:

- Soxhlet extract foam plugs for 24 hours in 5 percent diethyl ether in hexane.

- Remove excess solvent by pressing the extracted plugs against the inside of the extractor apparatus. Remove the remaining solvent by placing the plugs in a clear vacuum desiccator or oven, heating to 40°C and drawing prepurified nitrogen through them.

- Plugs extracted and dried as a group are assigned the same lot number. One plug from each lot is subjected to a quality control check; i.e., extraction and analysis for the organics of interest.

- After cleanup, wrap each plug in hexane-rinsed aluminum foil and store in a clean glass jar with a Teflon-lined cap.

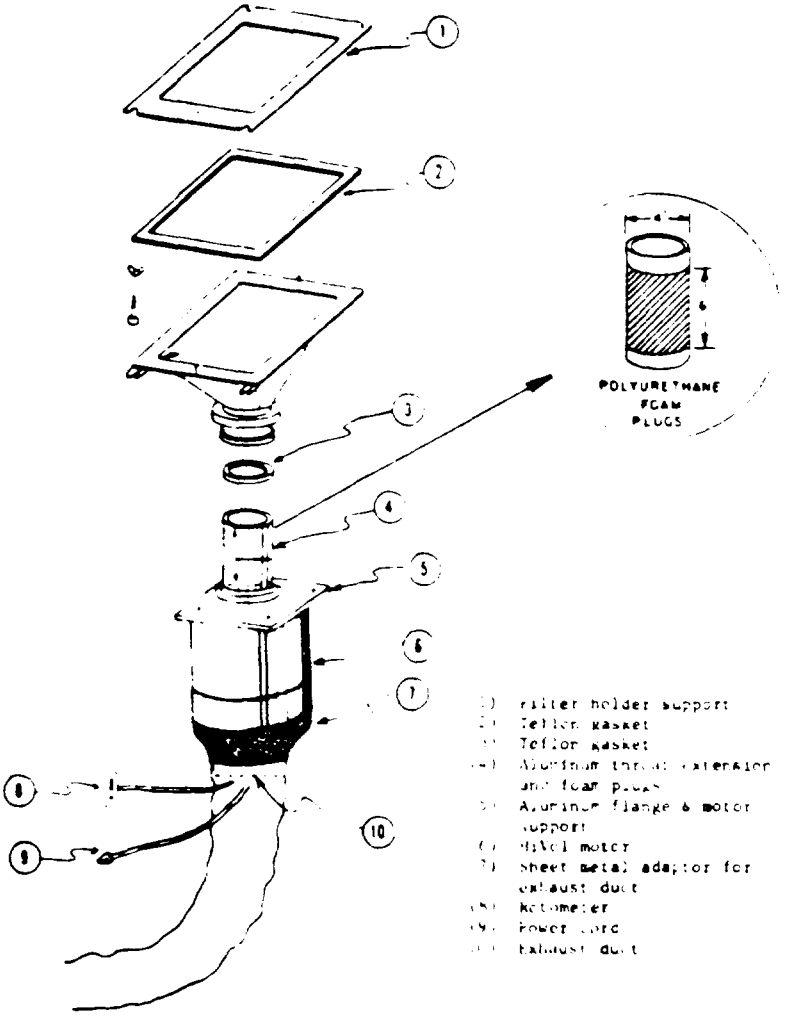

FIGURE 2. Schematic of high volume sampling system modified for addition of a polyurethane foam cartridge.

Pre-cleaned and dried PUF cartridges were placed in the actual throat assembly and the entire unit (items 1-5 in Figure 2) was covered with aluminum foil for transport to the field. A total of 24 samples (21 locations and 3 collocated sites) were operated for an approximate 12-hour period spanning from 8-10 AM until 8-10 PM on each of the 2 test days.

Flow rates were adjusted to approximately 0.566 m^3/min (20 ft^3/min) resulting in a total air volume of 350-450 m^3 for each 12-hour period. In addition, a field blank consisting of a fully configured high-volume sampler was situated at the Shawmut St. site (No. 3) on each test day. The mouth of the filter assembly was covered with pre-rinsed aluminum foil and no air was actually drawn over the filter/PUF throat assembly. At the conclusion of each test day the entire filter and throat assembly (items 1-5, Figure 2) was removed, the inlet and outlet apertures were covered with foil and transported intact (to minimize field handling and potential contamination) to the GCA laboratory in Bedford, Massachusetts for subsequent analyses.

Analytical Procedures

Polyurethane Foam Cartrides (PUF). High-volume air samplers were collected at 21 separate locations as noted in Figure 1 on each test day and returned to the GCA laboratory in Bedford, Massachusetts for analysis. Each set of polyurethane foam (PUF) cartridges including spikes and associated field and method blanks were extracted overnight (16 hours) in a soxhlet extraction apparatus containing an ethyl ether/hexane (5/95) solvent system. After cooling the resultant extract was reduced to 5.0 ml in a Kuderna-Danish evaporative concentrator. Each extract was restored to a final volume of 10.0 ml and apportioned for subsequent analysis as illustrated in Figure 3.

While all extracts underwent analyses for PCBs by GC/ECD only approximately 50% of these PUF extracts (24 sets) were designated for comprehensive organic analyses including the analyses of 18 PAH isomers commonly found in ambient urban atmospheres. In these instances, a 4.0 ml aliquot of each 10.0 ml PUF extract was fortified with a surrogate cocktail containing 20-50 μg quantities of the following deuterated compounds: d_3-trichlorobenzene, d_{10}-biphenyl, d_6-tetrachlorobiphenyl and d_{12}-chrysene. All extracts including blanks and spikes were then reduced under a gentle stream of prepurified nitrogen to 100 μl. Again, each

concentrate was fortified with 4 μg quantities of two internal standards, d_8-naphthalene and d_{10}-anthracene, prior to GC/MS analysis. All analyses were conducted using a Hewlett-Packard 5985 GC/MS/DS system fitted with a DB-5 fused silica capillary column. A summary of pertinent GC/MS operating parameters is provided in Table 1.

Standard PAH reference materials listed in Table 2 were used to establish pertinent chromatographic (RT) and mass spectral (RF) identification criteria. The complete spectral identification criteria including secondary and tertiary ions for the polynuclear aromatic hydrocarbons listed in Table 2 were consistent with those specified in EPA Method 625 (32). Typical PAH retention time (RT) data and corresponding mass spectral response factors relative to the closest eluting internal standard are also provided in Table 2. Three serial dilutions of each PAH stock calibration mixture ranging in concentration from 10 ng/μl to 400 ng/μl were used to establish the working curve prior to analysis. All results are provided in units of ng/m^3 for each of 18 PAH isomers shown in Table 2.

Particulate Filters. Particulate filters from 24 samples collected on each of 2 test days were returned to the GCA laboratory for subsequent analysis. Total (net) particulate weights for each of the two 2 test days were recorded, and a 50% aliquot of selected filters from Days 2 and 3 was removed for analysis of semivolatile organics.

It should be noted that the corresponding filters from only 16 of the 24 PUF cartridges noted earlier were prepared for semivolatile organic analyses including the analysis of the 18 PAH isomers listed in Table 2. Analyses were conducted independently from the PUF cartridges as noted below.

Each filter aliquot was surrogate-spiked with 40 to 50 μg quantities of a variety of deuterated analogues (d_3-trichlorobenzene, d_{10}biphenyl, d_6-tetrachlorobiphenyl, d_{12}-chrysene) and soxhlet-extracted in methylene chloride for a period of 24 hours. Extracts were then reduced using a Kuderna-Danish evaporative concentrator to a final volume of 10.0 ml. A 5.0 ml portion of the final extract was held in reserve while the remaining 5.0 ml was further concentrated, under a gentle stream of nitrogen, to 0.1 ml for GC/MS analysis.

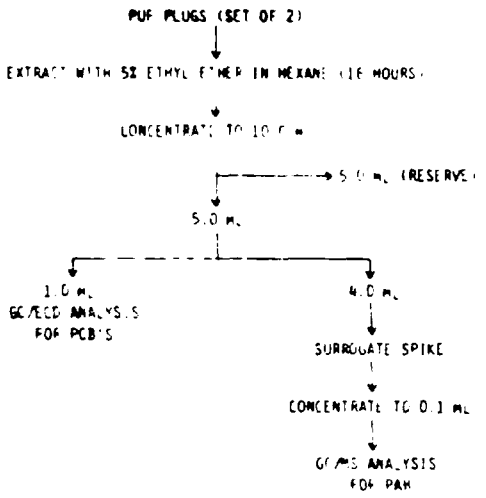

FIGURE 3. Polyurethane foam cartridge-analytical scheme.

TABLE 1

SUMMARY OF PERTINENT GC/MS OPERATING CONDITIONS

Instrument	Hewlett-Packard 5985, quadrupole mass spectrometer
GC Conditions	
Column	DB-5 30M fused silica capillary
Temperature	50°C held for 2 min then 10°/min to 300°C and held
Injector type	Grob w/0.5 min sweep time
Injector temperature	275°C
Injection volume	1 µl, splitless
Column flow	UHP helium, 0.5 ml/min
MS Conditions	
Emission	300 µA
Electron energy	70 eV
Scan time	1.0 s/scan
Mass interval	40 to 450 amu
Source temperature	200°C

TABLE 2

SUMMARY OF GC/MS CRITERIA FOR THE IDENTIFICATION AND QUANTITATION OF PAH REFERENCE MATERIALS

PAHS	Quantitative ion	Internal standard[a]	RT minutes	Average[b] RF
Naphthalene	128	d_8	9.8	1.38
Biphenyl	154	d_8	13.5	0.654
2-Chloronaphthalene	162	d_8	13.4	0.456
Acenaphthylene	152	d_{10}	14.6	1.05
Acenaphthene	154	d_{10}	15.2	0.592
Fluorene	166	d_{10}	16.8	1.95
Phenanthrene/Anthracene[c]	178	d_{10}	19.8	0.890
Fluoranthene	202	d_{10}	23.4	0.814
Pyrene	202	d_{10}	24.0	0.685
Chrysene	228	d_{10}	27.9	0.144
Benzo(a)anthracene	228	d_{10}	27.8	0.236
Benzo(b)fluoranthene	252	d_{10}	30.9	0.043
Benzo(k)fluoranthene	252	d_{10}	31.0	0.115
Benzo(a)pyrene	252	d_{10}	31.7	0.094
Dibenzo(a,h)anthracene	278	d_{10}	35.1	0.053
Benzo(g,h,i)perylene	276	d_{10}	35.0	0.047
Indeno(1,2,3-cd)pyrene	276	d_{10}	35.2	0.010
Surrogate Compounds				
d_3-Trichlorobenzene	185	d_8	8.8	0.250
d_{10}-Biphenyl	164	d_8	13.3	0.589
d_6-Tetrachlorobiphenyl	298	d_{10}	24.9	0.064
d_{12}-Chrysene	240	d_{10}	27.8	0.070

[a]Response factors calculated relative to most closely eluting internal standard, either d_8-naphthalene or d_{10}-anthracene.

[b]Response factor of component calculated versus the appropriate internal standard according to the following equation:

$$RF = \frac{A_x \, W_{IS}}{A_{IS} \, W_x}$$

where: RF = Response Factor
A_x = Area of the Quantitative Ion of Compound x
W_x = Quantity in Nanograms Eliciting This Area Response
A_{IS} = Area of the Quantitative Ion of the Internal Standard
A_{IS} = Quantity in Nanograms Eliciting the Area Response

The values shown here represent average component response factors.

[c]Phenanthrene and anthracene could not be differentiated under GC/MS conditions employed here.

GC/MS analyses were identical to those used for the PUF cartridge samples in accordance with the operating conditions provided in Table 1. Results are again provided in ng/m^3 for each of 16 particulate filter samples.

RESULTS AND DISCUSSION

Ambient Monitoring Data Summary

A complete summary of PAH results for each of the 21 locations on each of 2 test days is provided in Table 3. Concentrations are reported for 24 sets of PUF cartridges and 16 of 24 sets of particulate filter samples. The remaining 8 filter samples as noted earlier did not undergo GC/MS analyses. All results as shown are provided in units of ng/m^3 and reflect field and method blank corrected values.

It is interesting to note the predominance of PAH volatile 2-4 ring isomers on each of the PUF sorbent cartridges and not on the corresponding particulate filter samples. This particular trend is consistent with the behavior of PAHs under high-volume air sampling noted by a number of other investigators (15, 16, 18, 21, 23). The virtual absence of PAHs on the particulate filters, particularly the higher molecular weight species (MW 252 and greater), is due in part to limitations in sensitivity of the analytical instrumentation and the likely lower levels of these components present in the New Bedford atmosphere.

No apparent trends aside from the phenanthrene/anthracene values noted for Site 9 on each of the test days are apparent. At the present time no obvious source can be offered for the elevated levels of these compounds. Their appearance in both sets of collocated samplers confirms that it is environmental in origin and not an artifact of either the sampling or analysis scheme.

Further comparison of cumulative 21 station concentrations (averages) for selected PAHs on each of the 2 test days is illustrated in Figure 4. Aside from the phenanthrene/anthracene values no marked differences as evidenced by the overall range of values are apparent in comparing the two daily data sets.

TABLE 3

NEW BEDFORD PAH DATA SUMMARY--DAILY CONCENTRATIONS BY SITE[a] (ng/m^3)

Component	Site No. 1[b]		Site No. 2[c]		Site No. 6[b]		Site No. 8[c]		Site No. 12[c]	
	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
Naphthalene	7.5	3.0	9.1	4.1	9.6	8.2	8.1	6.7	5.5	4.3
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	1.1	1.1	2.6	1.1	2.2	1.8	5.3	2.1	1.7	1.0
Acenaphthene	4.5	1.6	16	4.0	22	17	8.6	6.7	4.1	3.8
Fluorene	2.8	1.6	10	6.1	15	13	15	9.7	4.1	3.5
Phenanthrene/Anthracene[d]	14	9.3	42	28	90	52	150	110	18	16
Fluoranthene	1.8	1.4	2.7	2.2	8.5	5.5	11	8.5	1.8	1.7
Pyrene	1.1	1.2	1.7	1.2	5.1	3.4	5.6	4.2	1.3	1.1
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Dibenzo(a,h)anthracene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Benzo(g,h,i)perylene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Biphenyl	4.4	2.0	2.9	1.4	4.3	2.9	2.6	2.4	1.4	1.4
Total methylnaphthalene isomers	12	4.0	12	7.8	14	13	12	8.7	8.7	6.7
Total ethylnaphthalene and dimethylnaphthalene isomers	14	5.6	11	7.6	34	29	18	11	9.5	10

(continued)

TABLE 3 (continued)

Component	Site No. 13[b]		Site No. 18[b]		Site No. 19[c]		Site No. 3[b,e]		Site No. 9[b,e]	
	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
Naphthalene	3.5	5.9	6.2	9.3	1.9	9.9	5.5	1.9	12	6.6
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	0.9	2.6	0.5	ND	ND	ND	1.8	ND	7.7	4.2
Acenaphthene	2.8	5.8	2.4	0.9	1.0	0.9	2.5	-	8.3	6.5
Fluorene	3.3	6.3	2.7	2.5	1.1	2.9	1.6	1.0	15	17
Phenanthrene/Anthracene[d]	52	68	14	9.0	5.4	9.8	5.8	5.1	320	210
Fluoranthene	4.7	6.2	2.0	1.1	0.7	1.0	-	0.7	19	11
Pyrene	2.9	4.1	1.2	0.6	ND	ND	-	-	10	5.5
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Dibenzo(a,h)anthracene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Benzo(g,h,i)perylene*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Biphenyl	4.7	9.6	1.8	2.8	1.1	2.0	1.1	1.3	2.9	2.5
Total methylnaphthalene isomers	5.1	9.8	8.0	7.4	3.2	9.2	8.9	3.1	20	8.3
Total ethylnaphthalene and dimethylnaphthalene isomers	9.8	15	12	16	7.6	16	8.9	3.7	22	9.9

[a]Site identifications correspond to numbered locations provided in Figure 1.
[b]All concentrations reflect values for polyurethane foam cartridges and filter samples combined. Since no PAHs were detected on the filters, the reported numerical values are those of the PUF cartridges only. PAH detection limits for particulate filters were <0.5 ng/m^3 with the exception of the components noted above (*) which were <2 ng/m^3.
[c]Values provided for PUF cartridges only; the corresponding particulate filters were not analyzed.
[d]Components coelute under the chromatographic conditions employed.
[e]Collocated sampler site; all daily values shown are an average of two independent measurements.
ND = <0.5 ng/m^3. ND* = <2 ng/m^3.

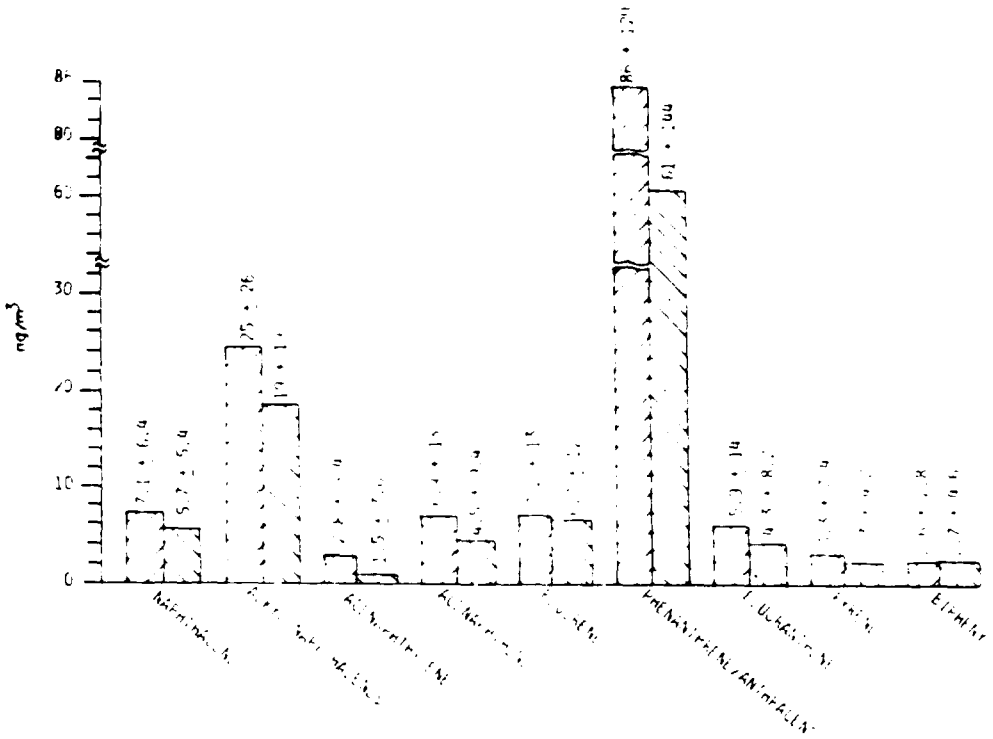

FIGURE 4. New Bedford ambient monitoring survey--comparison of day 2 and day 3 average (21 stations) PAH concentrations.

Again, for comparison purposes some representative summertime PAH data from selected U.S. and European rural and urban locations are provided in Table 4. As shown in Figure 4, the cumulative Day 2 and Day 3 data (for components common to both Figure 4 and Table 4) are comparable to concentrations noted during summer months for other urban locations.

Particulate/Sorbent (PUF) Distribution

The predominance of the more volatile 2-3 ring PAH on the back-up sorbent cartridges as evidenced in Table 3 lends further credibility to the use of polyurethane foam for the collection of airborne PAHs. These data further corroborate that glass fiber filters alone under actual high-volume air sampling conditions do not provide an accurate assessment of PAHs in ambient atmospheres.

TABLE 4

SELECTED PAH[a] DATA FROM OTHER URBAN AND RURAL LOCATIONS - SUMMER MONTHS

Location/Time	Anth	Phen	Fluor	Pyr	Chry	B(a)A	BF	B(e)P	B(a)P	Comments	Ref.
	ng/m^3										
Urban Antwerp, Belgium 1976-78	0.07	-	2.08	1.43	-	8.46	-	-	14.9	Hi-Vol filter/sorbent	25
Urban Goteborg, Sweden 1980 (April)	1.5	-	1.7	2.1	2.3	2.6	3.8	1.2	0.51	Hi-Vol filter only	11
Urban Columbia, S.C. 1981-82 (Annual Mean)	1.2	37	6.8	12	-	-	0.08	-	0.5	Hi-Vol filter PUF	26
Urban Pittsburgh, PA 1964	-	-	-	13.6	4.8	147	10.5	5.4	11.9	Two stage elutriator particulate only	27
Urban Los Angeles County (CA) July-Sept. 1974	-	-	0.24	0.25	0.44	0.10	0.60	0.62	0.26	Hi-Vol filters only	28
Urban/Rural England/France (Cumulative Data)	4.7	-	6.6	4.9	1.8	0.59	4.3	1.2	0.97	Hi-Vol filters only	29

(continued)

TABLE 4 (continued)

Location/Time	Anth	Phen	Fluor	Pyr	Chry	B(a)A	BF	B(e)P	B(a)P	Comments	Ref.
	ng/m^3										
Urban/Rural Northern England/Scotland (Cumulative Data)	1.2	-	4.0	3.3	3.3	0.74	4.0	2.6	0.97	Hi-Vol filters only	29
Urban Cleveland, Ohio (Annual Mean)	-	-	-	0.25	-	1.37	4.45	1.04	1.45	Hi-Vol filters only	30
Rural Lake Michigan (Transect from Saugatuck to Milwaukee)	-	-	1.7	4.2	-	0.8	-	-	-	Hi-Vol filters only	31
Rural Botrange, Belgium	0.75	-	0.82	0.44	-	1.41	2.06	-	1.78	Hi-Vol filter/sorbent	25
Rural Aiken, S.C. 1981-82 (Annual Mean)	0.11	10	1.2	2.0	-	-	-	-	ND (<0.2)	Hi-Vol filter PUF	26

*Abbreviations noted represent PAH isomers as follows: Anth = anthracene, Phen = phenanthrene, Fluor = fluoranthene, Pyr = pyrene, Chry = chrysene, B(a)A = benzo(a)anthracene, BF = total benzofluoranthenes (b,k,f), B(e)P = benzo(e)pyrene, and B(a)P = benzo(a)pyrene.

The apparent % distribution of selected PAH between the filter and sorbent media as derived from Table 3 are shown in Figure 5.

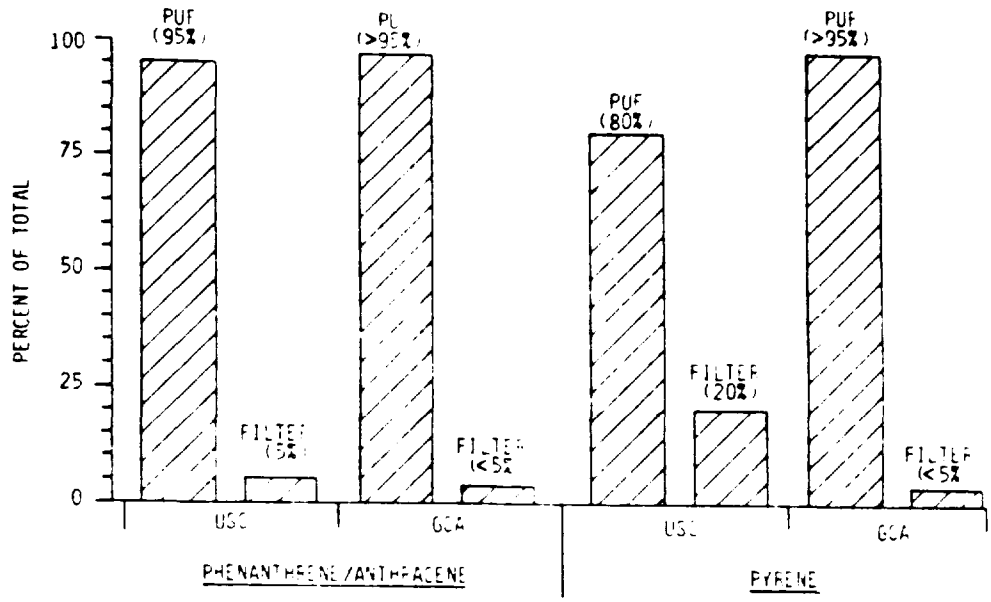

FIGURE 5. Filter retained percentages of selected PAH compounds - GCA and the University of South Carolina (USC).

(USC data from "Collection of Vapor-Phase Polycyclic Aromatic Hydrocarbons in Ambient Air," C. Keller and T. Bidleman, presented at September 1982 meeting of the Environmental Chemistry Division, American Chemical Society, Kansas City, Mo.).

Please note that owing to the absence of actual PAH on the particulate filters that numerical % distribution data cannot be provided. Actual data are unavailable owing to limitations in the sensitivity of the analytical instrumentation as applied to the particulate samples. As shown, the distribution data are in good agreement with data provided in the recent literature by Bidleman (16), Grosjean (20), Yamasaki (23), Galasyn (21), Cautreels and Cauwenberghe (18) and Thrane and Mikalsen (15).

The latter researchers have in fact reported that on the average only 5-6% of the total ambient PAHs is retained by the

filter. Our findings certainly support these earlier observations. It is our contention that the warmer summertime ambient temperatures in evidence during this sampling program strongly favored transfer of the lower molecular weight PAHs onto the PUF sorbent cartridge. The strong influence of ambient temperatures as suggested by Bidleman (16) can account for the predominance of the 2-4 ring PAHs on the sorbent cartridge. Collection temperature is in fact the most important consideration in ambient air sampling under high-volume conditions. PAH sampling conducted in the early fall of 1976 (7-29 October) in Belgium by Cautreels and Van Cauwenberghe (18) resulted in % filter retained values of 2.0% for phenanthrene/anthracene, 21% for fluoranthene and 33% for pyrene. The distribution values noted here again reflect the strong influence of an average ambient temperature of 10.2°C contrasted to an average 24°C recorded during the present sampling program. These particular trends in fact make it extremely difficult to ascertain the true state of airborne polynuclear aromatic hydrocarbons (either vapor phase or associated with airborne particulate matter). This particular phenomenon certainly complicates assessing the health impacts of ambient particulate containing PAHs.

Precision of Collocated Monitors

PAH results for each of four pairs of collocated monitors are provided in Table 5. The overall precision of the combined sampling and analysis scheme for each of nine measured parameters expressed as an average % difference is also provided. A graphic daily comparison of collocated sampler data (ng/m^3) for selected PAH is shown in Figure 6.

CONCLUSIONS

- Air samplers containing both polyurethane foam cartridges and glass fiber filters provide a more accurate representation of ambient PAH levels than particulate filters alone.

- Under actual high-volume (e.g., 400 m^3) air sampling conditions the more volatile PAHs are predominantly (>95%) distributed on the PUF cartridge and not on the particulate filter.

- The overall precision of four pairs of collocated monitors expressed as % difference ranged from

TABLE 5

PRECISION OF COLLOCATED SAMPLES EXPRESSED AS PERCENT DIFFERENCE[a]

Component	Concentration (ng/m^3)											
	Station 3						Station 9					
	Day 2			Day 3			Day 2			Day 3		
	A	B	% Diff.[a]	A	B	% Diff.[a]	A	B	% Diff.[a]	A	B	% Diff.[a]
Naphthalene	3.0	8.0	90	1.6	2.2	31	11	12	9.1	6.7	6.4	2.3
Acenaphthylene	1.1	2.4	74	ND	ND	-	8.9	6.5	31	4.3	4.1	4.8
Acenaphthene	1.4	3.5	87	ND	0.8	-	9.4	7.1	14	7.5	5.8	26
Fluorene	1.0	2.2	75	0.8	1.1	31	19	10	64	18	15	19
Phenanthrene/ Anthracene	3.5	8.1	79	4.1	6.1	39	250	380	41	230	190	19
Fluoranthene	ND	0.8	-	0.6	0.8	28	15	22	39	12	10	18
Pyrene	ND	0.7	-	ND	0.5	-	7.6	12	45	5.6	5.3	5.4
Biphenyl	0.6	1.6	91	1.2	1.4	15	2.6	3.1	18	2.6	2.4	8.0
Alkyl Naphthalenes	8.5	27	100	6.0	7.7	25	40	43	7.3	20	17	17
Average percent difference	-	-	85[b]	-	-	27	-	-	30	-	-	15

[a]Percent difference = $\frac{A-B}{(A+B)/2}$

[b]Value determined to be an outlier using Dixon's Criteria as stated in the Quality Assurance Handbook for Air Pollution Measurement Systems (EPA-600/9-76-007).

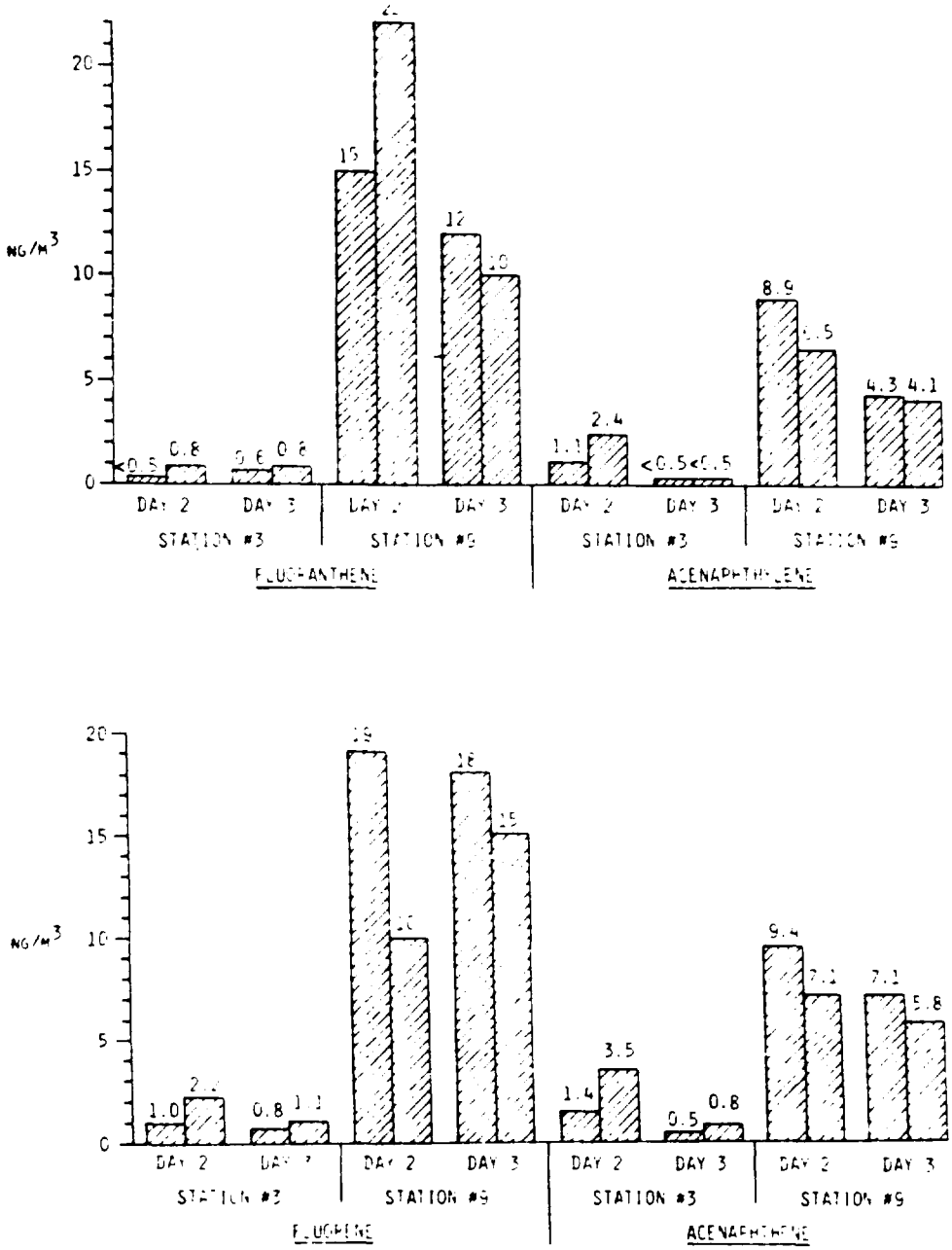

FIGURE 6. Precision of collocated samples - comparison of measured concentrations for selected PAH on each of 2 test days.

15-30% for nine PAH species commonly found in ambient atmospheres.

- Ambient PAH levels in the New Bedford area are comparable to other U.S. and European urban locations.

- The collaborative sampling and analysis scheme lends further credibility to the use of polyurethane foam for the collection of airborne PAHs and further corroborates that glass fiber filters alone under high-volume air sampling conditions do not provide a quantitative assessment of PAHs present in ambient atmospheres.

RECOMMENDATIONS FOR FURTHER STUDY

- Formal method validation activities including retention/collection efficiency and breakthrough studies for PAHs under actual high-volume air sampling conditions using polyurethane foam.

- Further definition of the precision and accuracy of high-volume air samplers for the collection of ambient PAH under both simulated laboratory and actual sampling conditions.

- Reevaluate the existing PAH ambient air data base comprised of high volume sampler measurements using particulate filters only.

- Development of sampler design to preserve the integrity of ambient particulate catches in high-volume air samplers. This will promote a more realistic correlation of particulate related PAH with potential inhalation health effects.

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AMBIENT MONITORING OF POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) EMPLOYING HIGH VOLUME POLYURETHANE FOAM (PUF) SAMPLERS

KEY WORD INDEX

Ambient Monitoring

High-Volume Sampling

- Collocated Monitors
- Polyurethane Foam (PUF) Cartridges

Gas Chromatography/Mass Spectrometry (GC/MS)
Meteorological Conditions

Particulate Matter

Standardized Procedures

- Soxhlet Extraction
- Kuderna-Danish Concentrator