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EVALUATION OF THE WALKTHROUGH SURVEY METHOD FOR DETECTION OF VOLATILE ORGANIC COMPOUND LEAKS

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During 1978 and 1979, the Emission Standards and Engineering Division of EPA's Office of Air Quality Planning and Standards conducted a fugitive volatile organic compound (VOC) emission sampling program in organic chemical manufacturing plants and petroleum refineries. As a part of their sampling program, several "walkthrough surveys," also called "unit area surveys," were conducted. The assistance of EPA's Industrial Environmental Research Laboratory-Cincinnati was requested in the analysis of the walkthrough survey data.

Fourteen walkthrough surveys were analyzed, from four plants. The analysis reported here focuses on the variability and reproducibility of the survey method. One indicator of variability which was studied was the coefficient of variation (CV). The CV's ranged from 55% to 408%, for each pair of walkthrough surveys. Further, the linear correlation coefficients for each set of surveys ranged from 0.046 to 0.98. No attempt was made to evaluate the sources of the variability.

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FOREWORD

When energy and material resources are extracted, processed, converted and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This report, "Evaluation of the Walkthrough Survey Method for Detection of Volatile Organic Compound Leaks," presents an evaluation of data collected by EPA's Emission Standards and Engineering Division, Office of Air Quality Planning and Standards, on a field survey technique for the detection of leaks of volatile organic compounds (VOC) from process equipment. The analysis reported here focuses on the variability and reproducibility of the survey method.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

During 1978 and 1979, the Emission Standards and Engineering Division of EPA's Office of Air Quality Planning and Standards conducted a fugitive volatile organic compound (VOC) emission sampling program in organic chemical manufacturing plants and petroleum refineries. As a part of their sampling program, several "walkthrough surveys," also called "unit area surveys," were conducted. The assistance of EPA's Industrial Environmental Research Laboratory-Cincinnati was requested in the analysis of the walkthrough survey data.

Fourteen walkthrough surveys were analyzed, from four plants. The analysis reported here focuses on the variability and reproducibility of the survey method. One indicator of variability which was studied was the coefficient of variation (CV). The CV's ranged from 55% to 408%, for each pair of walkthrough surveys. Further, the linear correlation coefficients for each set of surveys ranged from 0.046 to 0.98. No attempt was made to evaluate the sources of the variability.

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SECTION 1

INTRODUCTION

During 1978 and 1979, the Emission Standards and Engineering Division of EPA's Office of Air Quality Planning and Standards conducted a fugitive volatile organic compound (VOC) emission sampling program in organic chemical manufacturing plants and petroleum refineries. The data were used in the development of background information documents for regulations to control VOC emissions resulting from leaks in process equipment. As a part of this sampling program, several "walkthrough surveys," also called "unit area surveys," were conducted. A unit area survey involves measuring the ambient VOC concentration within approximately 1 meter of all ground level equipment within a processing area. These measurements are performed with a portable VOC detection instrument utilizing a strip chart recorder. An elevated reading on the strip chart is assumed to be indicative of a leak. Each individual piece of equipment located in the area where the elevated VOC concentration was found is then checked to determine the sources of the VOC emissions.

The purpose of the walkthrough surveys conducted by EPA was to determine if this approach represents a viable technique for the detection of leaks within a regulatory context. The assistance of EPA's Industrial Environmental Research Laboratory in Cincinnati was requested in the analysis of the walkthrough survey data. The purpose of this report is to document the techniques of data analysis and to present the results. Fourteen walkthrough surveys from four plants were analyzed. The analysis reported here focuses on the variability and reproducibility of repeated surveys and does not attempt to correlate increased ambient VOC concentrations with specifically located VOC sources.

SECTION 2

WALKTHROUGH SURVEY METHOD

The walkthrough surveys were conducted at four plants: two chloromethane units, one ethylene unit, and a benzene-toluene-xylene (BTX) unit in one petroleum refinery. The instrument used in all cases was the Century Systems Corporation Organic Vapor Analyzer (OVA), Model 108, which was equipped with a strip chart recorder. The instrument measures organic vapor concentrations in ppmv. For each unit or section of a unit, a walkthrough path was developed. This path was intended to pass within a meter of major pieces of equipment at ground level, e.g., pump rows, compressors.

Copies of the strip charts from the OVA recorder are in the Appendix (Figures 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25 and 27). The letters (A, B, C, etc.) on the charts designate specified locations within the process unit. Two surveys were conducted sequentially, usually within a few minutes of each other. In the Appendix, the strip charts for the two surveys are placed side by side to facilitate comparison. The beginning and ending times were also recorded.

SECTION 3

DATA ANALYSIS METHODS AND RESULTS

As stated before, the data analysis focused on the variability and reproducibility of the measurement technique. That is, the data were analyzed to determine if an increased VOC concentration was found at the same location on two surveys. Therefore, both the coefficient of variation (CV) and the linear correlation coefficients (R) were evaluated, for each pair of walk-through surveys (i.e., the sequential surveys for each path). First, however, a technique was developed to facilitate direct comparison of the two chart recordings.

The first step was to trace a continuous curve through the discontinuous marks made on the strip chart by the OVA recorder. The "smooth" curve on the strip chart was then divided into cells which contained the location designations A, B, C, etc. This was done by finding the midpoints of the interval between two locations, e.g., B to C, and C to D. These two midpoints, then, form the cell boundary for the cell which contains "C." These are shown in the charts as long, darker horizontal lines. Once the cells were identified, the maximum value for each cell was read directly from the chart. Although the actual units are unimportant for the analysis reported here, the instrument read-out is in ppmv. It should be noted that the charts have a logarithmic scale.

In the Appendix, the chart on the left has been designated as Survey A and the chart on the right as Survey B. The tables in the Appendix (Tables 2 through 15) include the survey location codes, the maximum values in each cell for Survey A and Survey B, and the absolute value of the difference between the corresponding maximum values for each cell, designated as $|(A-B)|$. The absolute value of the difference was used since only the magnitude of the difference is important, and not the fact that values from Survey A are higher (or lower) than Survey B.

The following statistics were calculated for each pair of walkthrough surveys:

$$\bar{x} = \text{mean difference} = \frac{\sum^{n} |(A-B)|}{n}$$

s = standard deviation of the mean difference

$$CV = \text{coefficient of variation} = \frac{s}{\bar{x}} \times 100$$

R = linear correlation coefficient (between the Survey A and Survey B values)

The results are summarized in Table 1.

The coefficient of variation provides one way to evaluate the variability of data sets which have widely varying means. Because the means observed were widely different, a simple analysis of the standard deviations for each walkthrough survey would not yield meaningful results. To reduce the effect of the differing means, the coefficient of variation was selected.

The CV's ranged from 85% to 408%. Further, there does not appear to be any trend relative to plant or type of production facility.

The sample linear correlation coefficients ranged from 0.046 to 0.98. A value near 1 indicates a strong linear relationship in which the value from Survey B increases when the value from Survey A increases. A value of R close to zero results from data that display a strictly random effect, which implies little or no relationship. However, since R is a measure of the linear relationship, a value of R near zero really implies a lack of linearity and not necessarily a lack of association. Therefore, the data were plotted to observe the suitability of the linearity assumption. These are Figures 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26 and 28 in the Appendix.

Based on the results reported here, it appears that the walkthrough survey technique is highly variable and is not reproducible in many cases, even when repeated within minutes. In several instances, there is essentially no correlation between the pair of surveys, as indicated both by the linear correlation coefficients (R) and by the plots of the data. Thus, there is no indication that the walkthrough survey method can be used as the basis of a leak detection program for regulatory purposes. To be used for such purposes a maximum local ambient VOC concentration which triggers remedial action would have to be established. This analysis shows that on repeated surveys a local concentration is usually not repeated on two passes by the same location, nor are the concentrations linearly proportional.

TABLE 1
WALKTHROUGH SURVEY SUMMARY

	Plant	n	$\bar{x}$	s	CV	R
1)	Dow Chemical, Plaquemine, La. (grid #1)	9	0.89	0.78	88%	0.77
2)	Dow Chemical, Plaquemine, La. (grid #2)	25	4.04	8.82	218%	0.51
3)	Dow Chemical, Plaquemine, La. (grid #2, rpt)	25	0.96	1.43	149%	0.98
4)	Dow Chemical, Plaquemine, La. (grid #3)	26	0.87	0.87	100%	0.37
5)	Dow Chemical, Plaquemine, La. (grid #4)	38	9.57	39.01	408%	0.65
6)	Dow Chemical, Plaquemine, La. (grid #5)	26	14.77	31.11	211%	0.046
7)	Dow Chemical, Plaquemine, La. (grid #6)	11	1.91	1.04	55%	0.11
8)	Stauffer, Louisville, Ky. (Walkthrough Survey)	32	160.66	373.80	233%	0.89
9)	Union Carbide, Torrance, Ca. (Storage Area #2)	9	81.22	79.63	98%	0.14
10)	Union Carbide, Torrance, Ca. (Furnace Unit #4)	27	12.85	18.12	141%	0.58
11)	Union Carbide, Torrance, Ca. (Separation Area)	32	114.50	290.75	254%	0.84
12)	Union Carbide, Torrance, Ca. (Olefins Separation Plant)	32	186.75	179.63	95%	0.70
13)	Union Carbide, Torrance, Ca. (Compressor Bldg, Area #3)	27	247.11	431.65	175%	0.80
14)	Sun Oil, Toledo, Oh. (Unit Walkthrough, BTX)	51	2.27	7.38	325%	0.25

n = number of data points
$\bar{x}$ = mean difference
s = standard deviation
CV = coefficient of variation
R = linear correlation coefficient

APPENDIX

FIGURE 1

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 1)

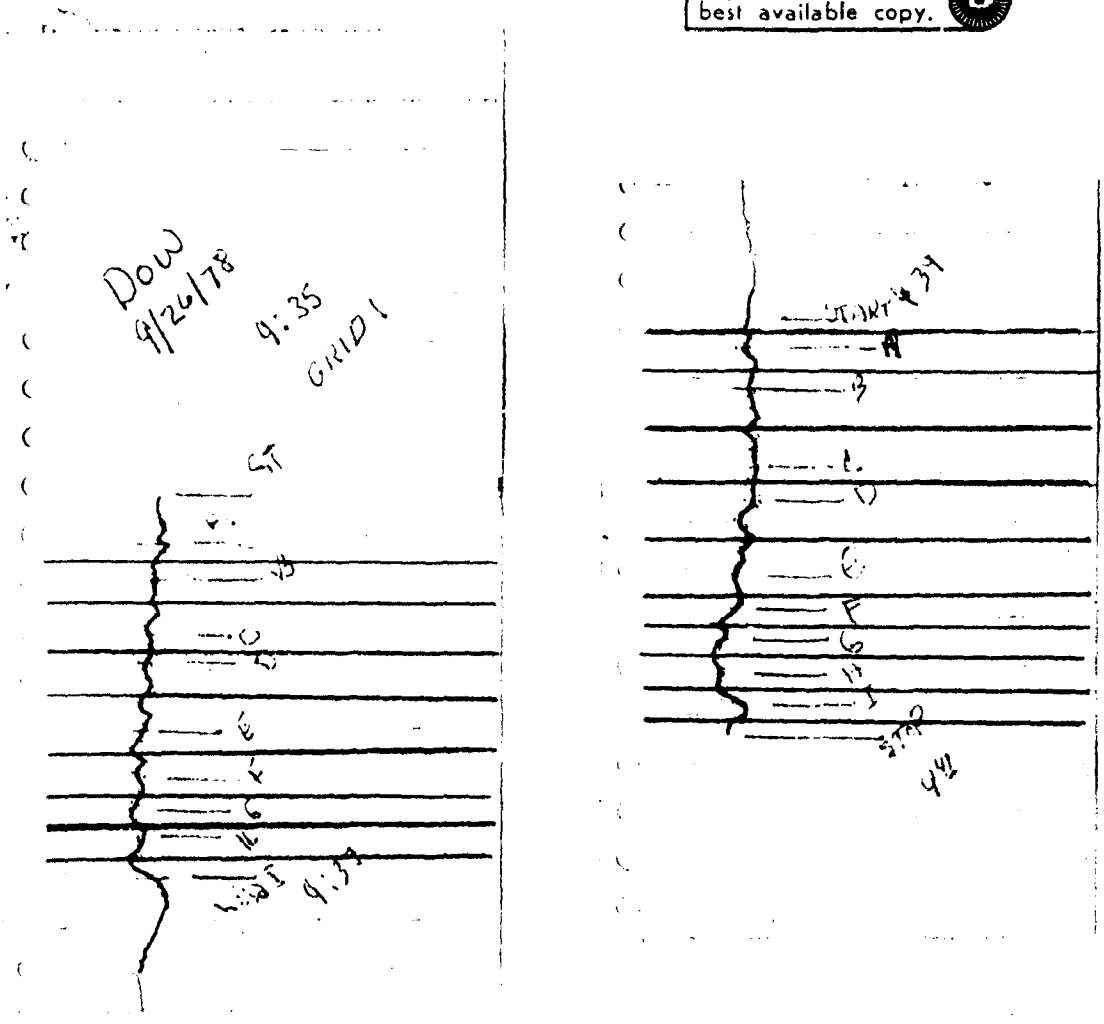


TABLE 2

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #1

	maximum value (ppm)		absolute value of the difference
Grid Location	Survey A	Survey B	|(A-B)|
A	10	9	1
B	9	10	1
C	9	9	0
D	8	9	1
E	8	8	0
F	7	7	0
G	6	5	1
H	7	5	2
I	10	8	2

FIGURE 7

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 1)

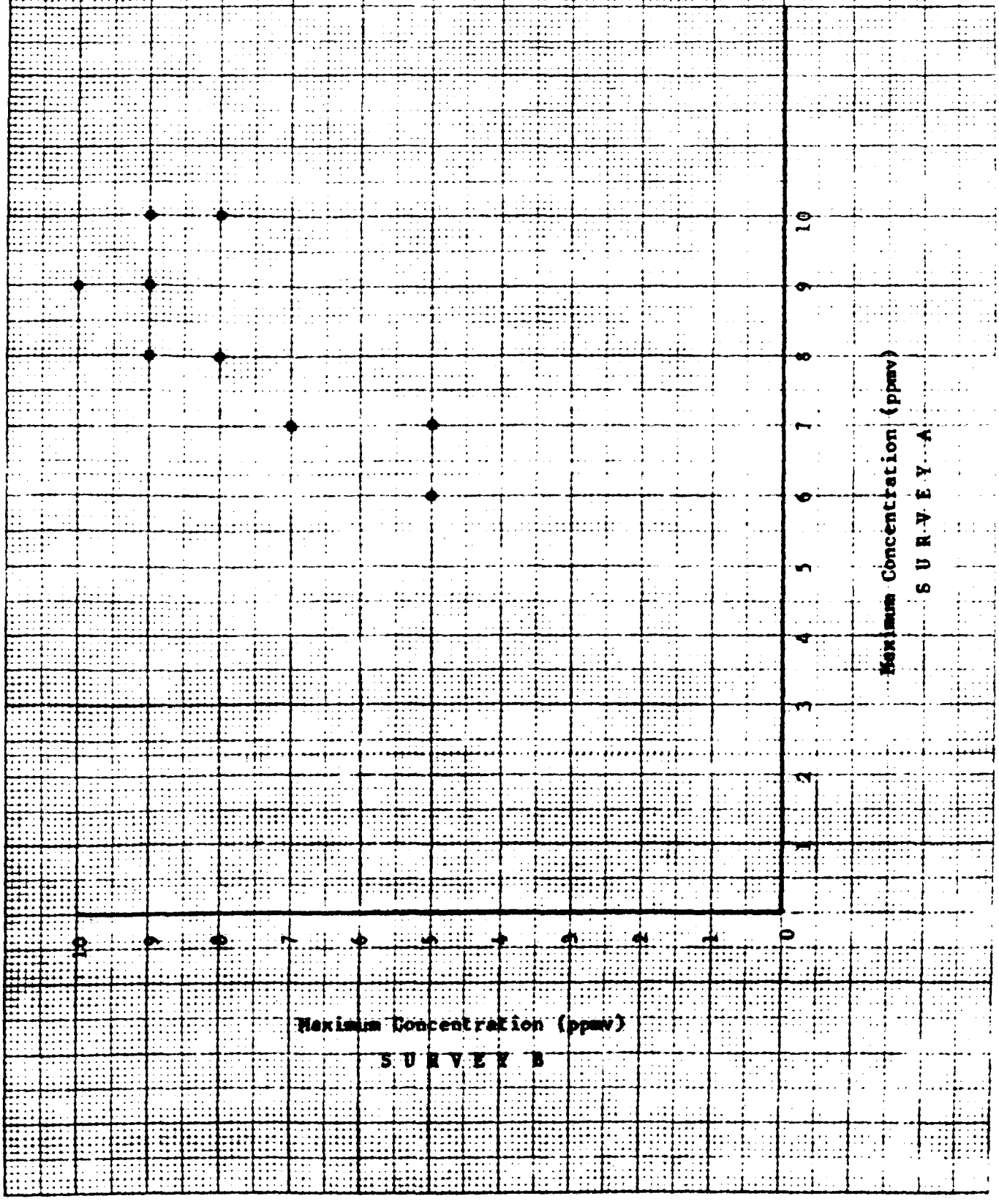


FIGURE 3

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 2)

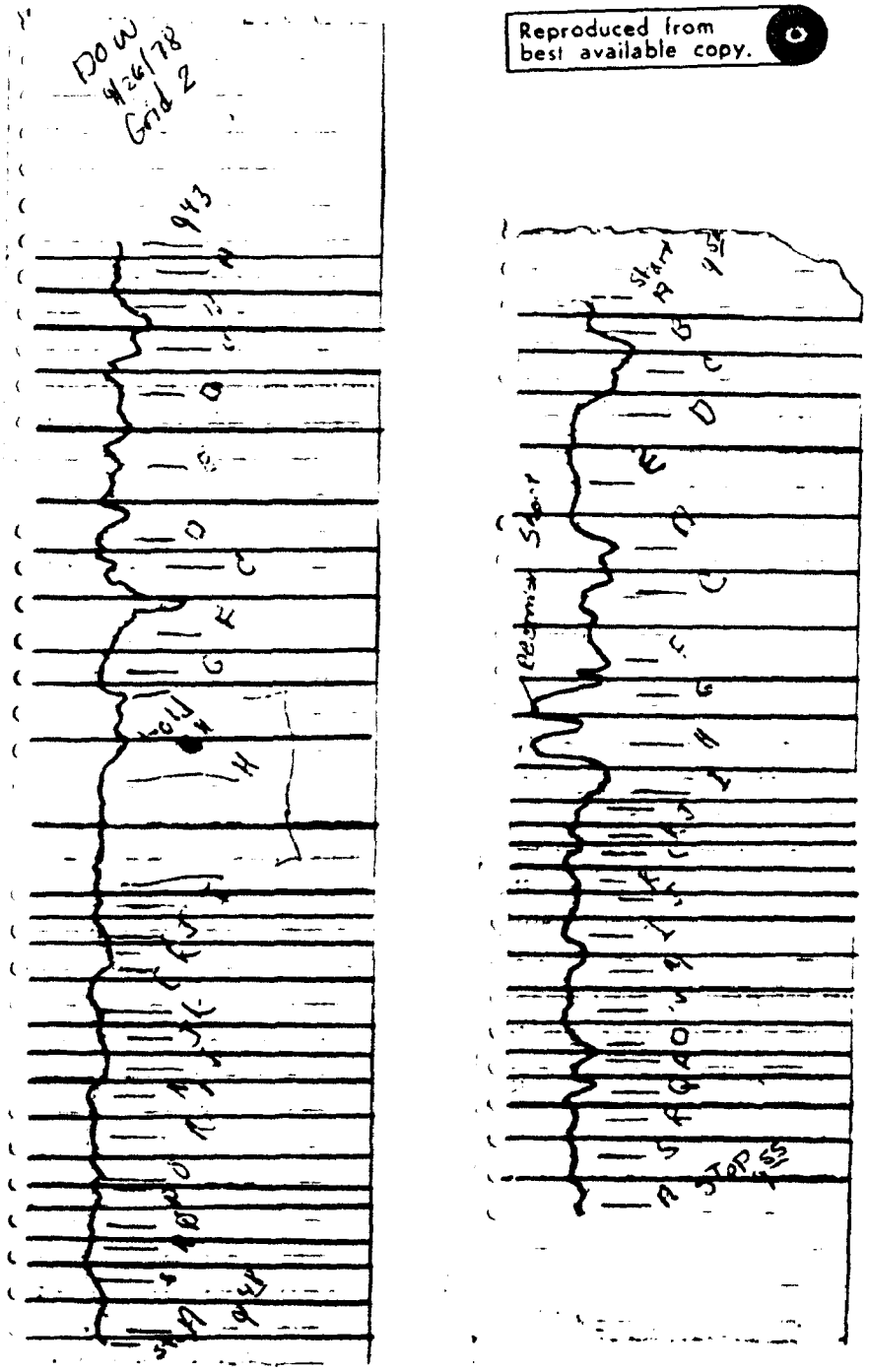


TABLE 3

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #2

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	8	7	1
B	20	20	0
C	20	20	0
D	12	10	2
E	12	5	7
D	10	15	5
C	20	15	5
F	60	15	45
G	7	10	3
H	12	10	2
I	6	15	9
J	7	6	1
K	8	6	2
L	8	8	0
K	6	8	2
J	7	5	2
I	8	7	1
M	7	7	0
N	6	5	1
O	7	10	3
P	7	10	3
Q	6	10	4
R	5	6	1
S	8	6	2
A	8	8	0

FIGURE 4

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 2)

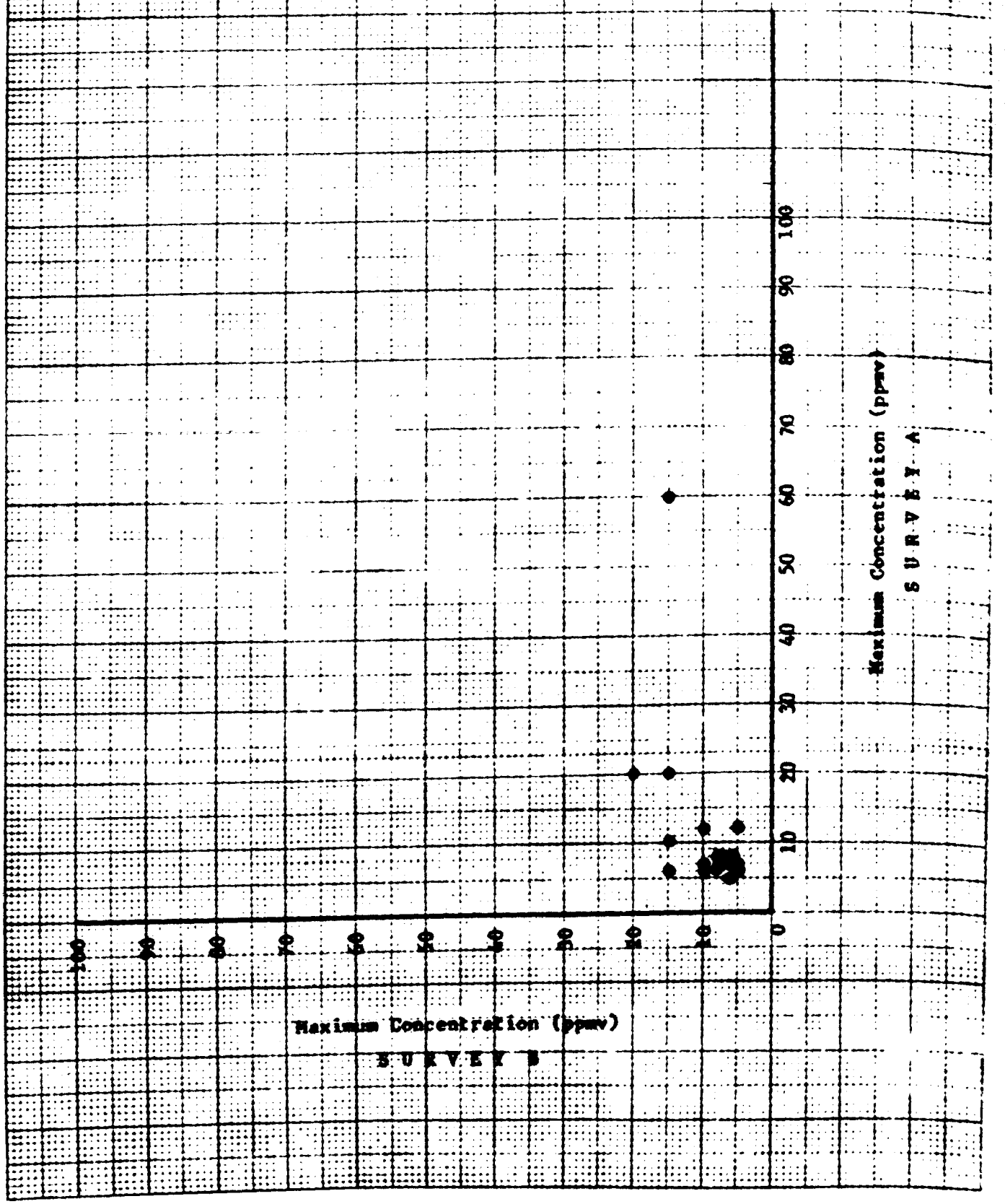


FIGURE 5

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 2 - repeat)

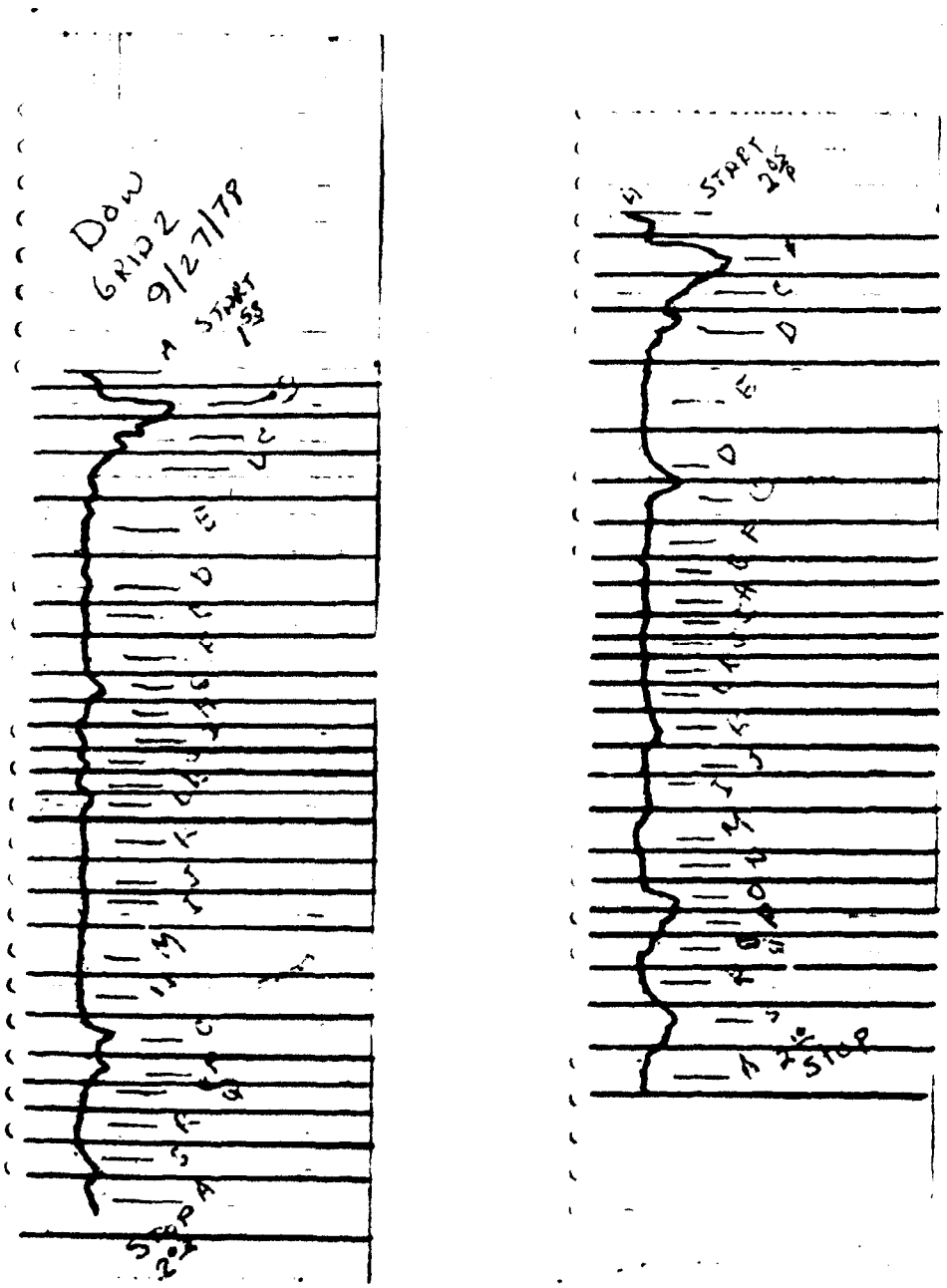


TABLE 4

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough #2 (Repeat)

	maximum value (ppm)		absolute value of the difference
Grid Location	Survey A	Survey B	|(A-B)|
A	5	5	0
B	40	40	0
C	20	20	0
D	7	10	3
E	4	4	0
D	4	8	4
C	4	9	5
F	4	5	1
G	6	4	2
H	4	4	0
I	4	4	0
J	4	4	0
K	4	4	0
L	5	5	0
K	4	5	1
J	4	4	0
I	4	5	1
M	4	5	1
N	4	4	0
O	10	10	0
P	8	9	1
Q	5	5	0
R	4	6	2
S	6	9	3
A	6	6	0

FIGURE 6

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 2 - repeat)

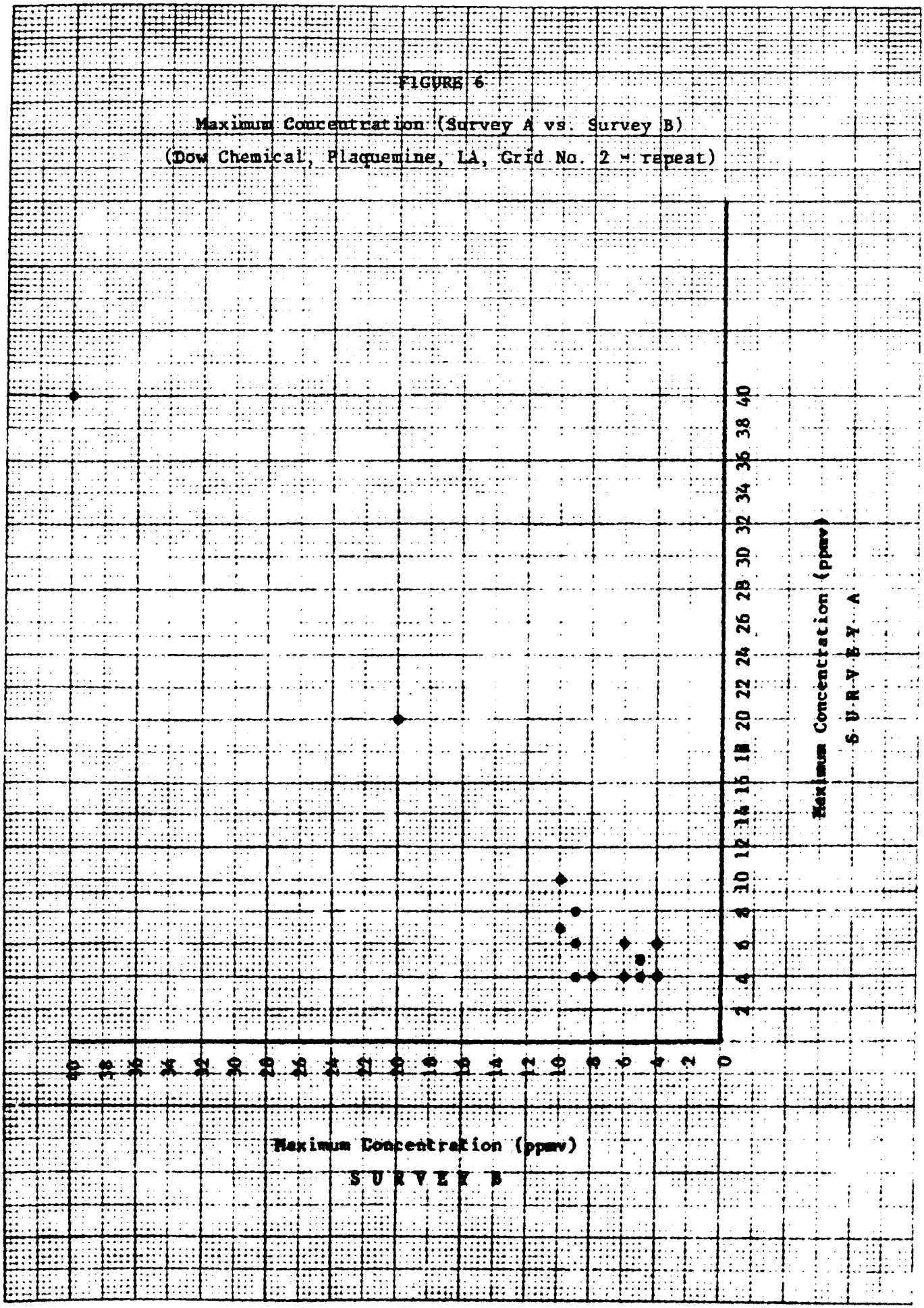


FIGURE 7

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 3)

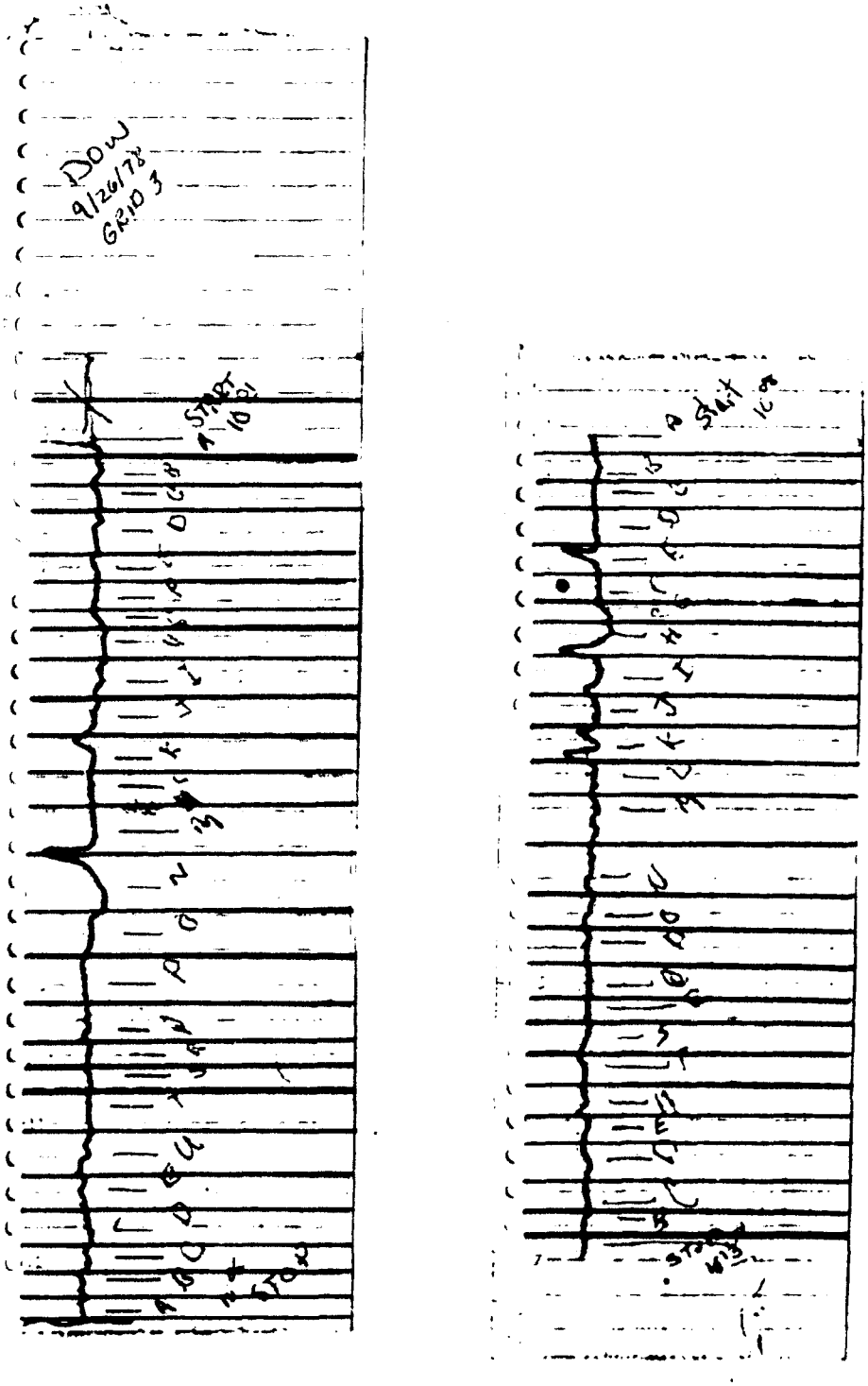


TABLE 5

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #3

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	6	5	1
B	7	6	1
C	6	5	1
D	7	5	2
E	6	5.5	0.5
F	6	6	0
G	7	8	1
H	8	9	1
I	8	6	2
J	6	6	0
K	6	6	0
L	6	5.5	0.5
M	6	6	0
N	9	5	4
O	7	5.5	1.5
P	5	5	0
Q	6	5	1
R	6	5	1
S	6	5	1
T	6	5	1
U	6	5	1
E	5	6	1
D	6	6	0
C	6	5.5	0.5
B	6	5.5	0.5
A	5	5	0

FIGURE 8

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 3)

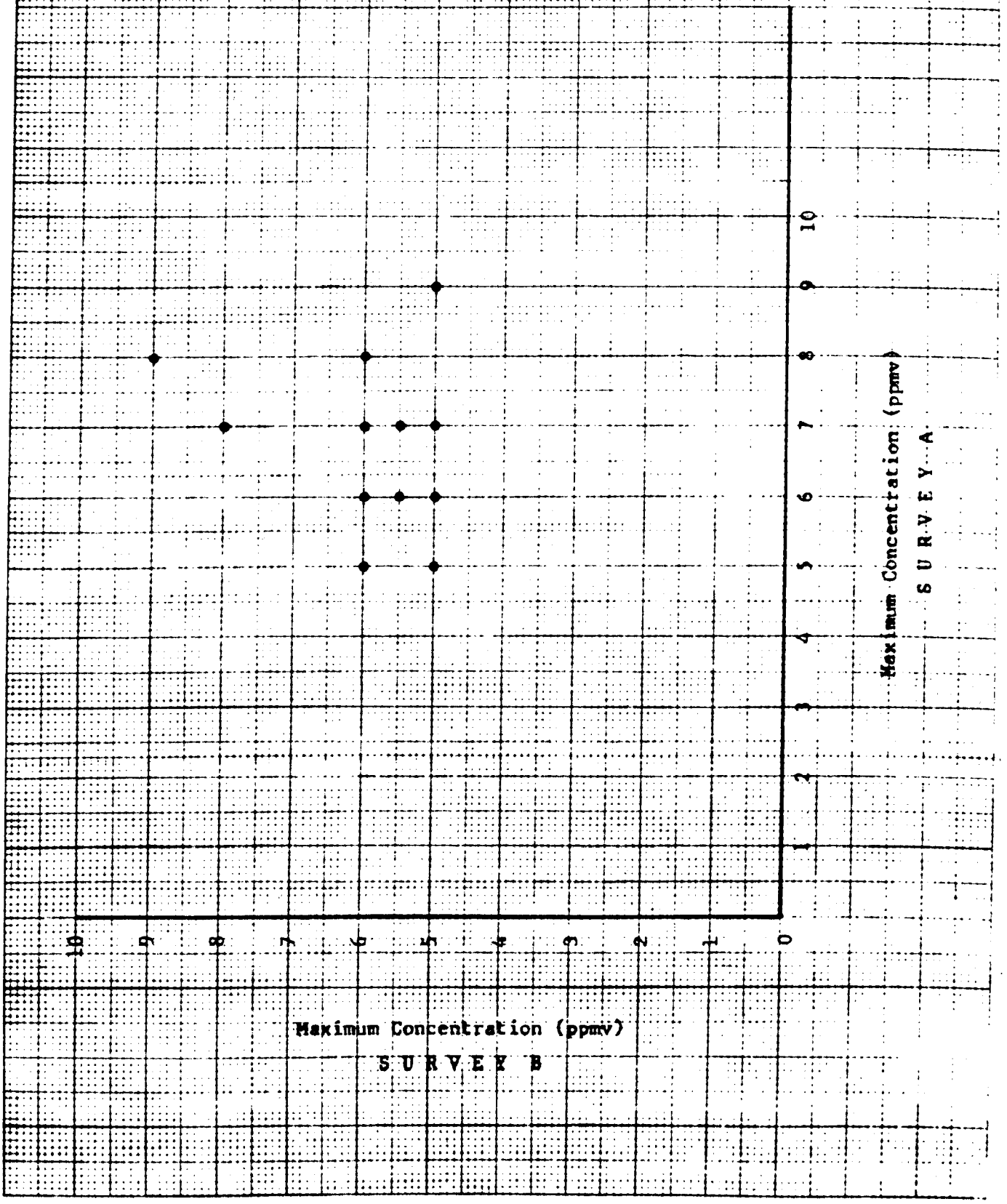
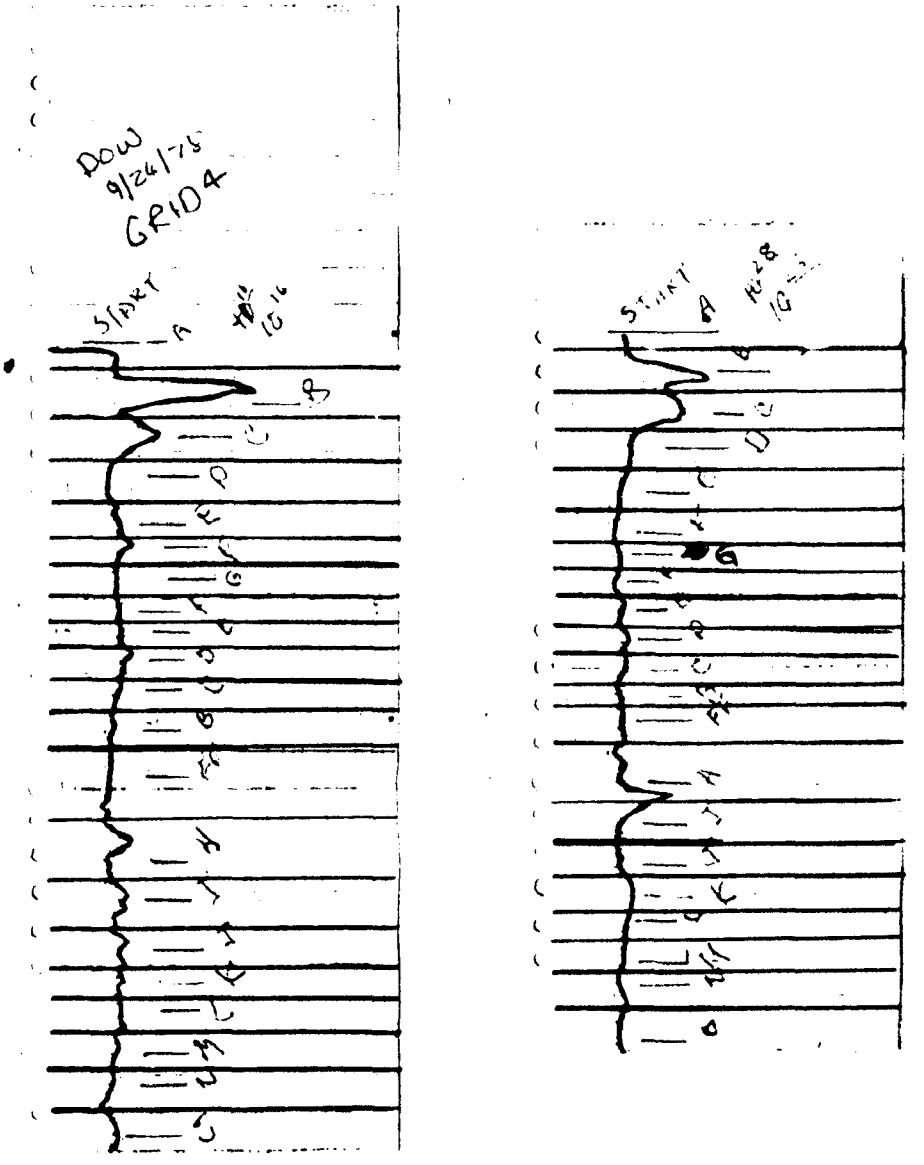


FIGURE 9

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No 4)



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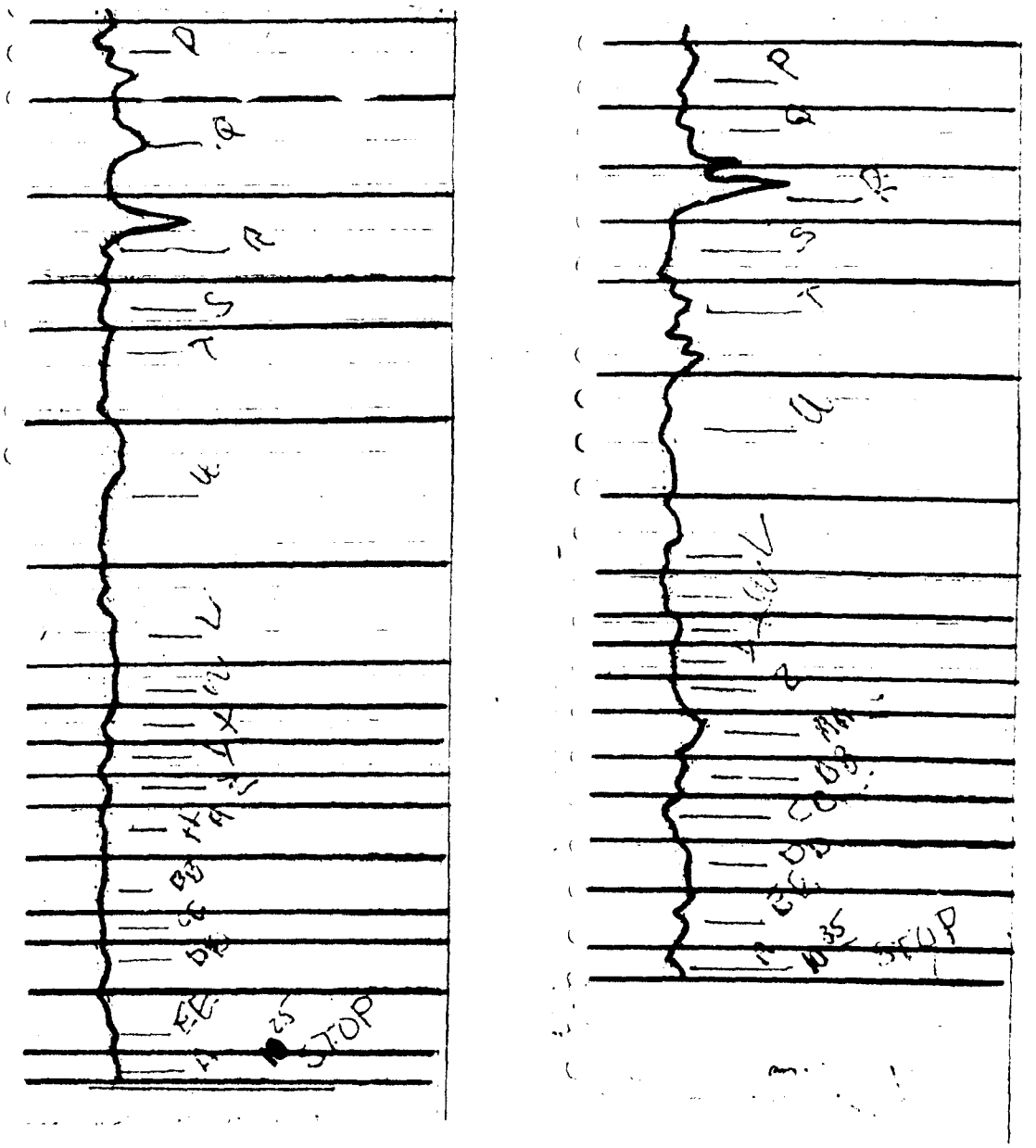

TABLE 6

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #4

Grid Location	maximum value (ppm) Survey A	Survey B	absolute value of the difference |(A-B)|
A	5	6	1
B	300	60	240
C	17	30	13
D	5	9	4
E	6	6	0
F	8	5	3
G	5	5	0
F	6	5	1
E	6	6	0
D	8	7	1
C	6	7	1
B	5	6	1
FF	5	5	0
H	9	25	16
I	7.5	10	2.5
J	7	6	1
K	6	8	2
L	7	6	1
M	5	6	1
N	5	7	2
O	5	6	1
P	9	8	1
Q	13	20	7
R	30	70	40
S	5	5	0
T	5	9	4
U	7	5	2

TABLE 6 (Continued)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
V	7	6	1
W	7	6	1
X	6	6	0
Y	6	5	1
Z	6	7	1
AA	5	10	5
BB	5	9	4
CC	5	6	1
DD	6	8	2
EE	8	9	1
A	7	8	1

FIGURE 10

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 4)

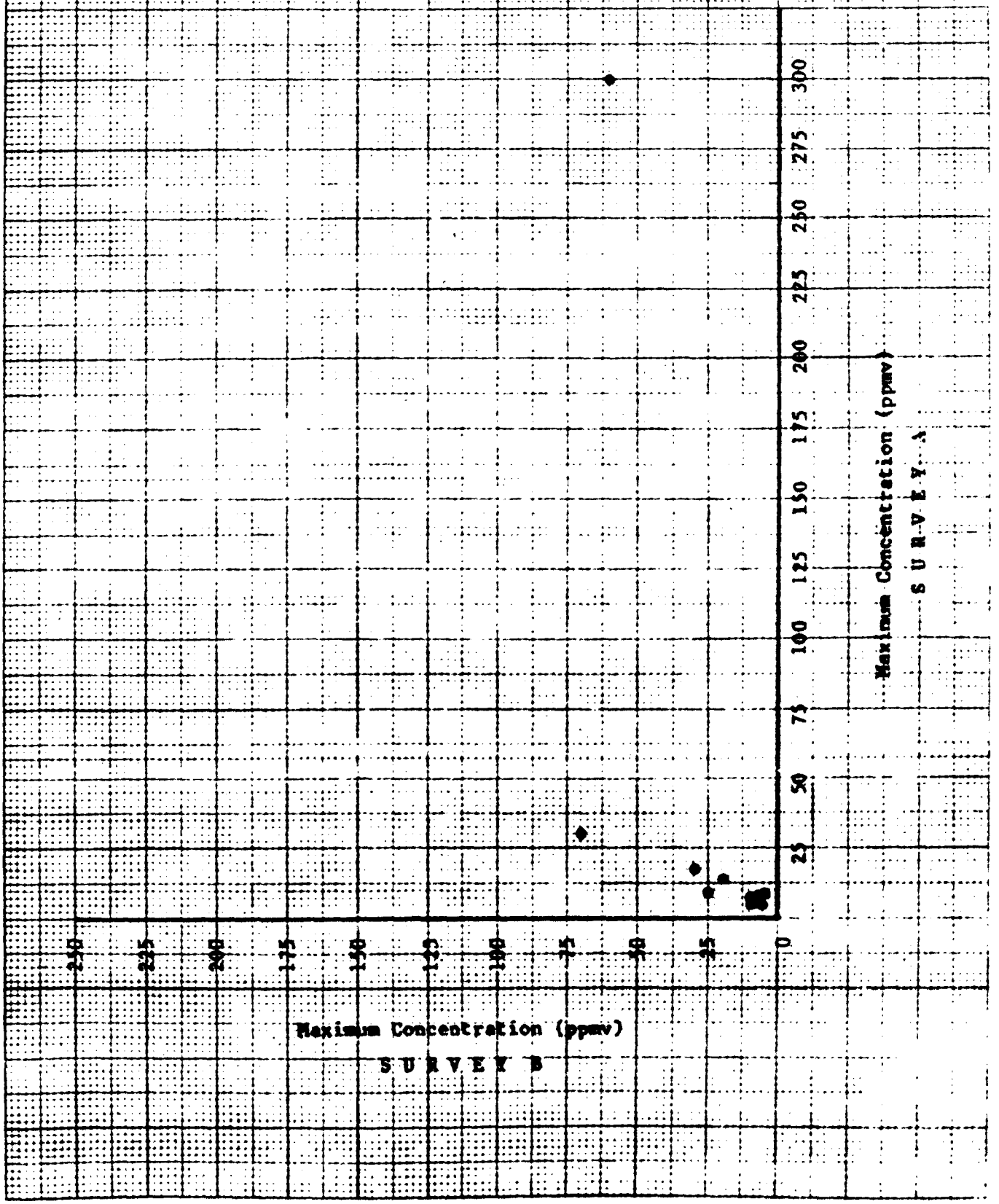

FIGURE 11

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 5)

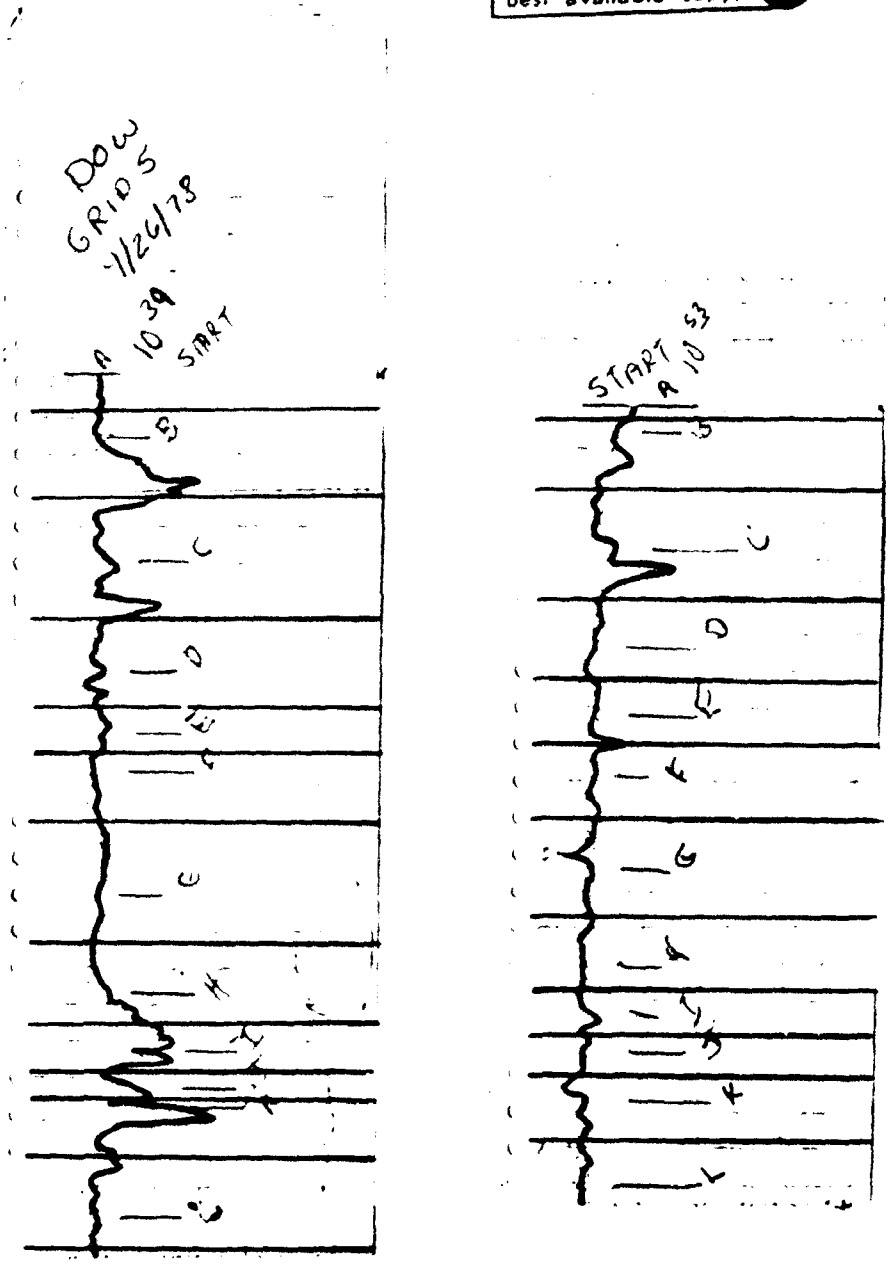

FIGURE 11 (Continued)

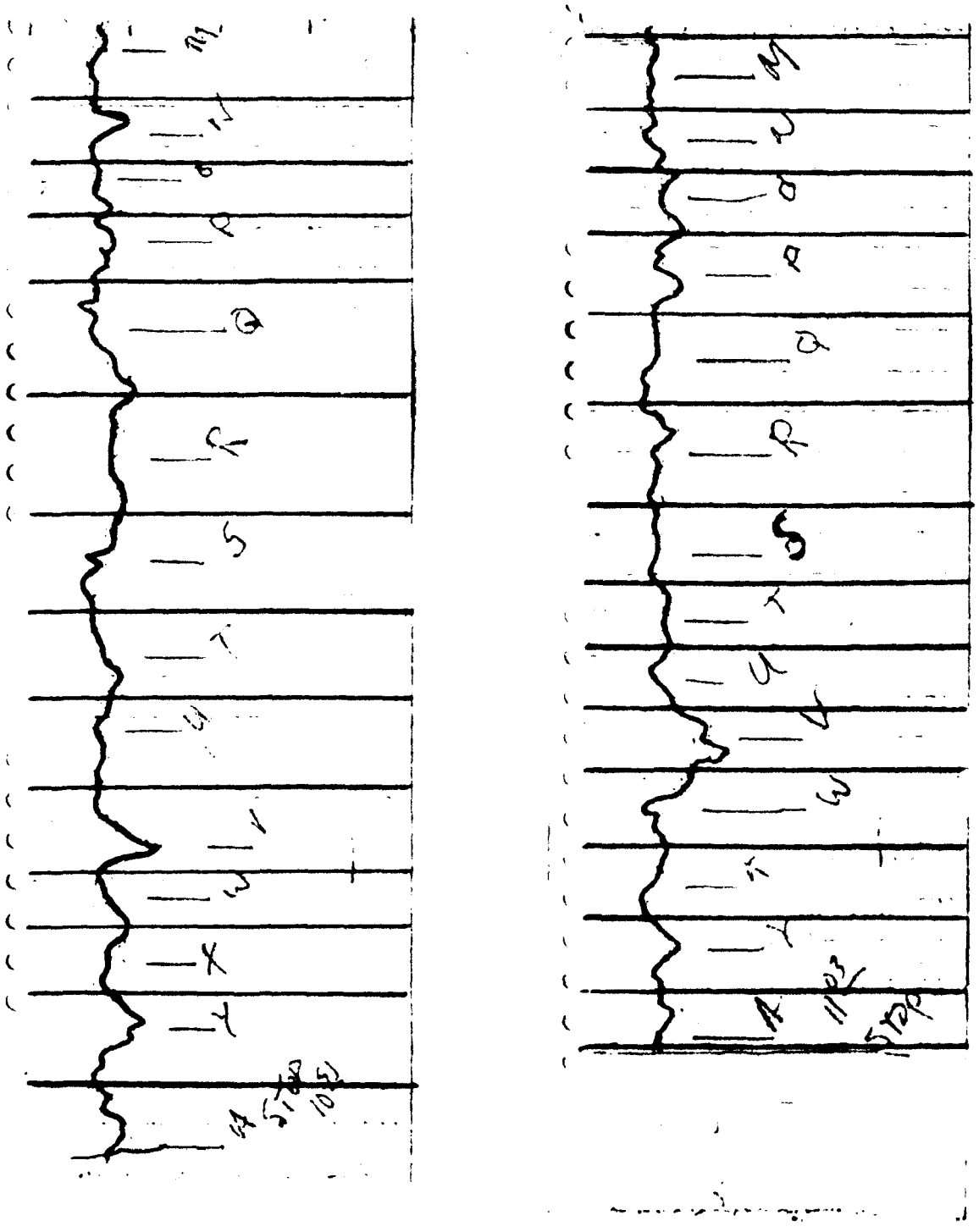

TABLE 7

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #5

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	6	15	9
B	90	15	75
C	30	40	10
D	7	5	2
E	7	10	3
F	5	10	5
G	7	5	2
H	20	5	15
I	50	6	44
J	30	5	25
K	150	5	145
L	10	5	5
M	6	6	0
N	10	6	4
O	7	10	3
P	7	10	3
Q	12	5	7
R	10	8	2
S	8	6	2
T	9	7	2
U	7	8	1
V	25	30	5
W	10	15	5
X	10	7	3
Y	15	10	5
A	10	8	2

FIGURE 12

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 5)

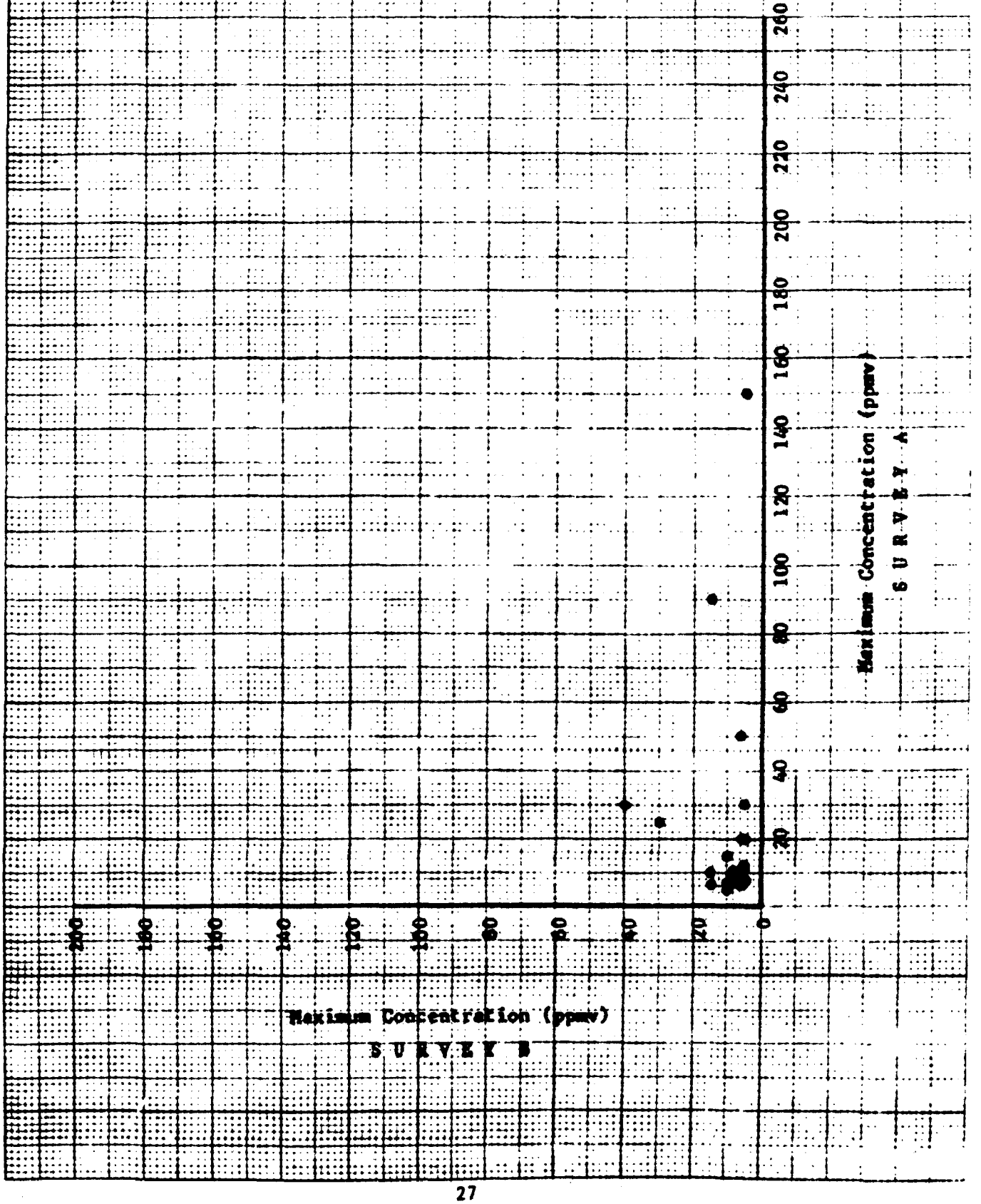

FIGURE 13

Strip Chart Recording
(DOW Chemical, Plaquemine, LA, Grid No. 6)

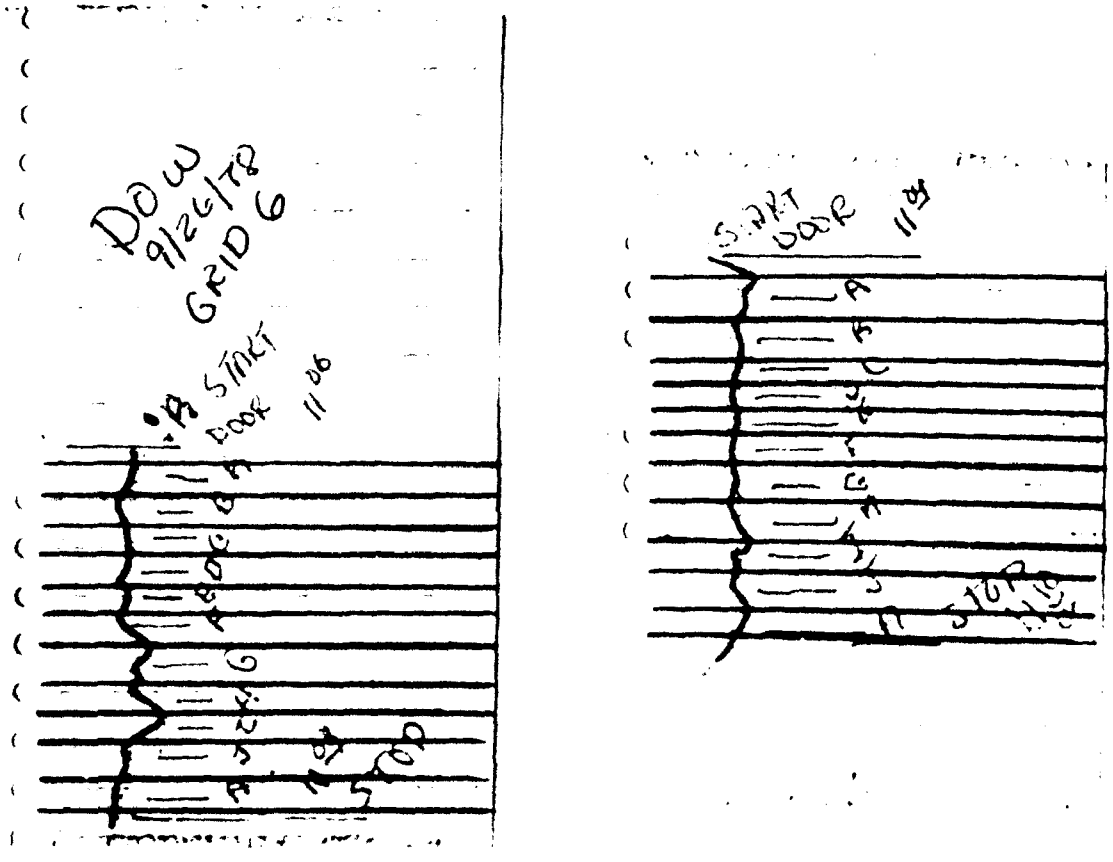

TABLE 8

Dow Chemical Company
Plaquemine, Louisiana
Walkthrough Grid #6

	maximum value (ppm)		absolute value of the difference
Grid Location	Survey A	Survey B	|(A-B)|
A	6	8	2
B	5	6	1
C	5	6	1
D	5	5	0
E	5	6	1
F	8	5	3
G	9	6	3
H	10	7	3
I	10	7	3
J	6	8	2
A	5	7	2

FIGURE 14

Maximum Concentration (Survey A vs. Survey B)

(Dow Chemical, Plaquemine, LA, Grid No. 6)

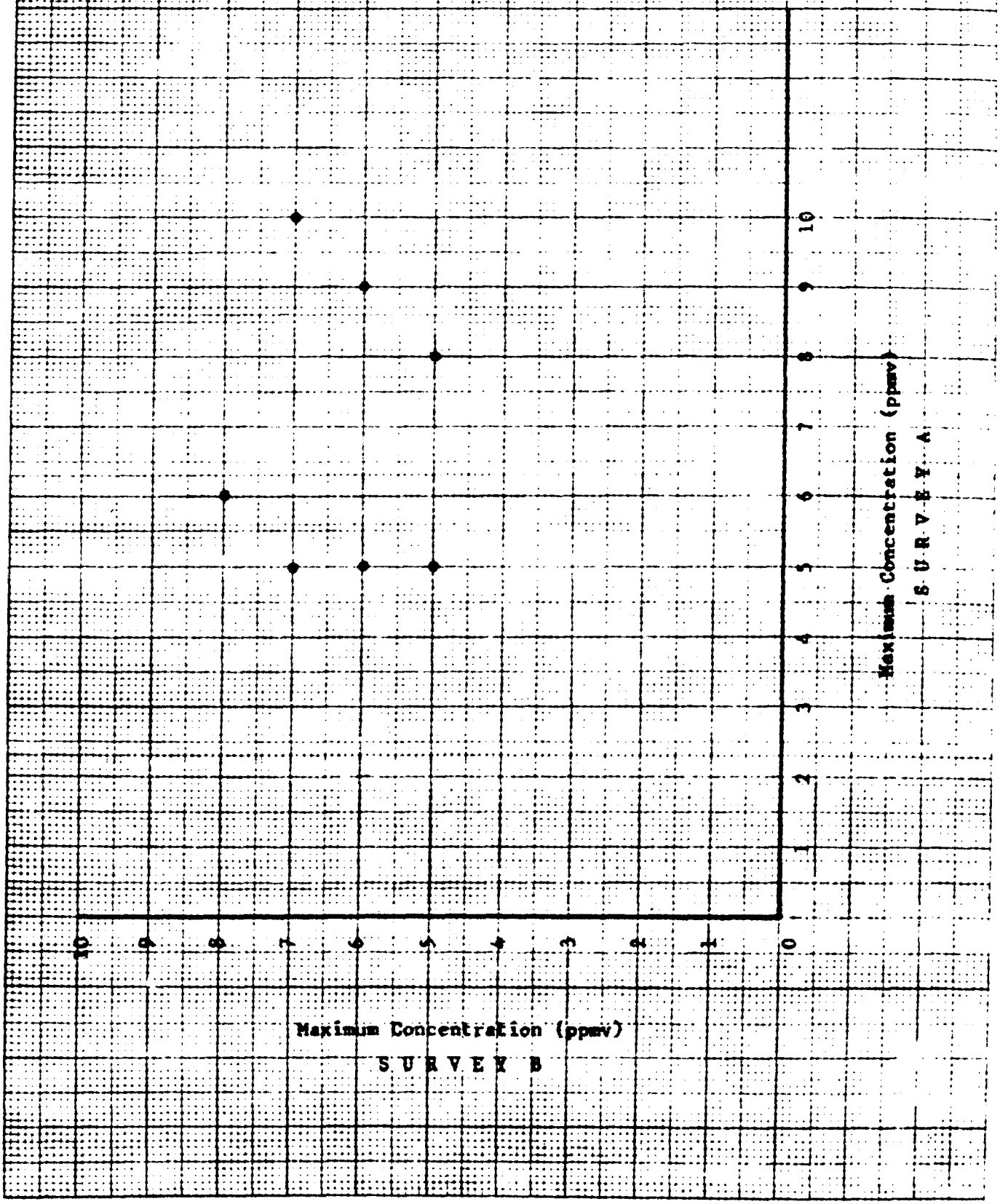

FIGURE 15

Strip Chart Recording
(Stauffer Chemical, Louisville, KY)

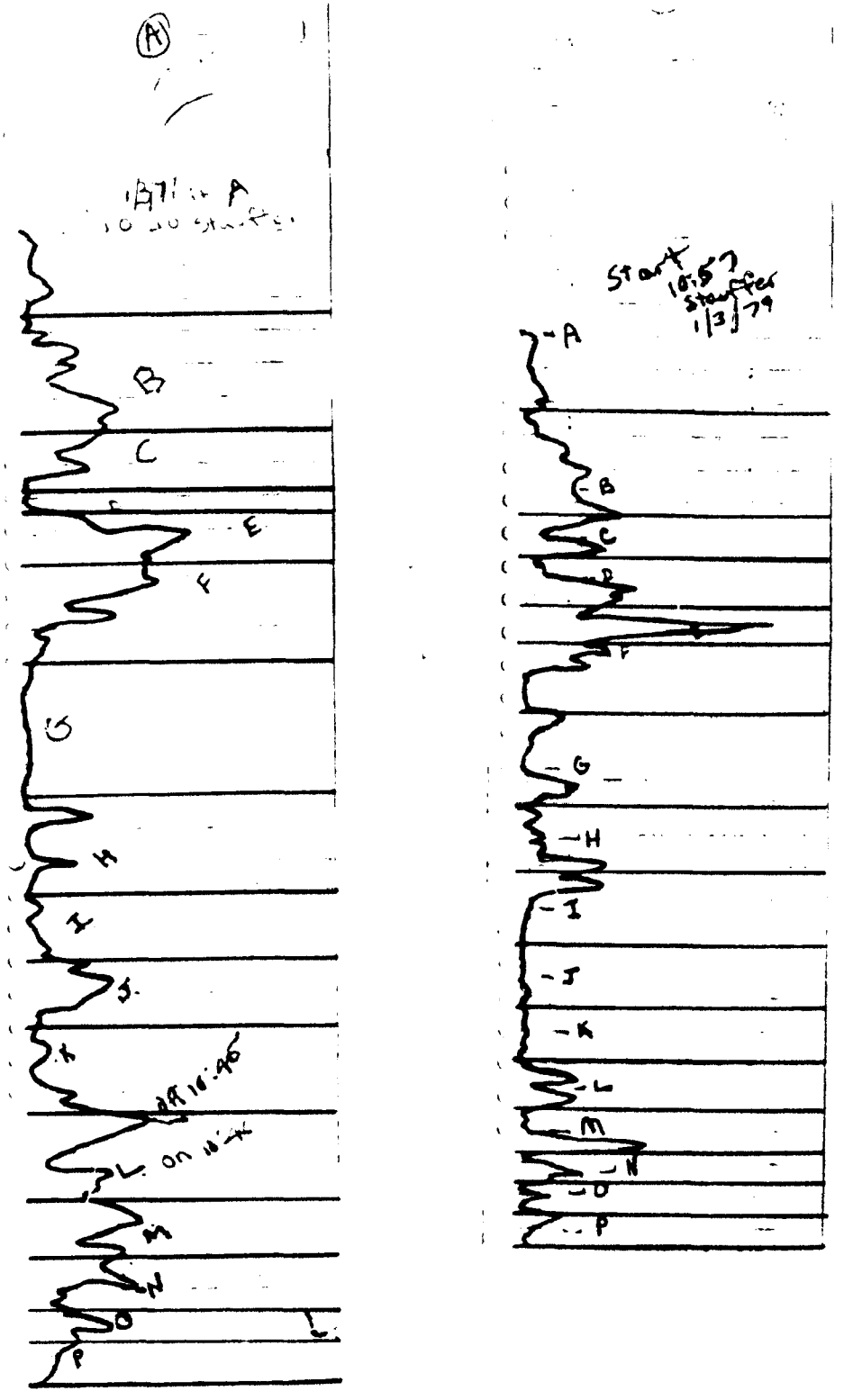

FIGURE 15 (Continued)

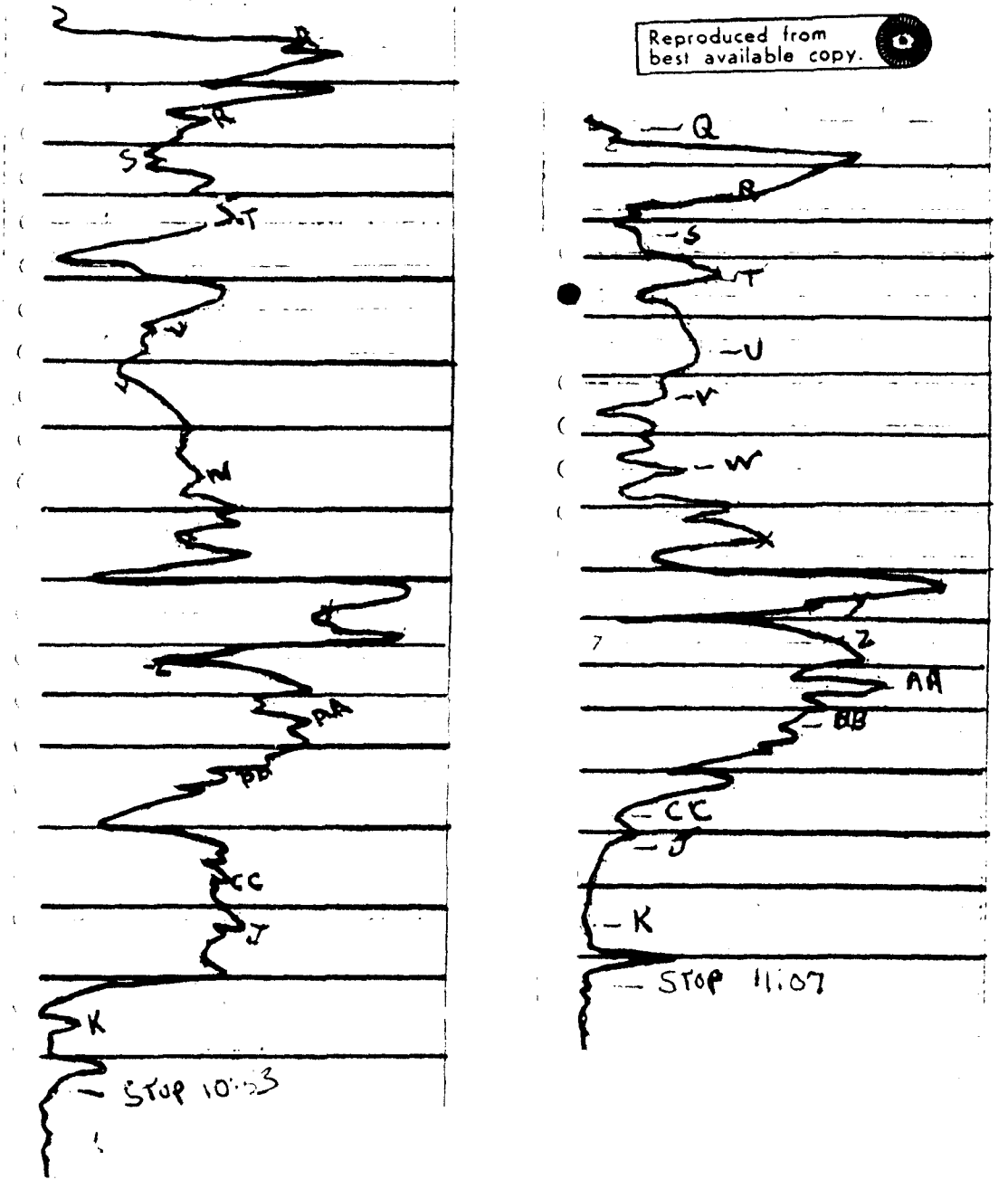

TABLE 9

Stauffer Chemical Company
Louisville, Kentucky
Walkthrough Survey

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	2.5	2	.50
B	18	18	0
C	10	12	2
D	3	40	37
E	150	2000	1850
F	60	15	45
G	1.5	6	4.5
H	8	15	7
I	3	12	9
J	12	1.5	10.5
K	20	1.5	18.5
L	30	6	24
M	30	50	20
N	25	7	18
O	10	3	7
P	4	4	0
Q	1000	600	400
R	800	300	500
S	50	10	40
T	90	20	70
U	60	15	45
V	25	6	19
W	80	30	50
X	120	60	60
Y	5000	4000	1000
Z	600	800	200

TABLE 9 (Continued)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
AA	500	1000	500
BB	300	300	0
CC	80	30	50
J	100	4	96
K	60	6	54
Stop	4	8	4

FIGURE 16

Maximum Concentration (Survey A vs. Survey B)

(Stauffer Chemical, Louisville, KY)

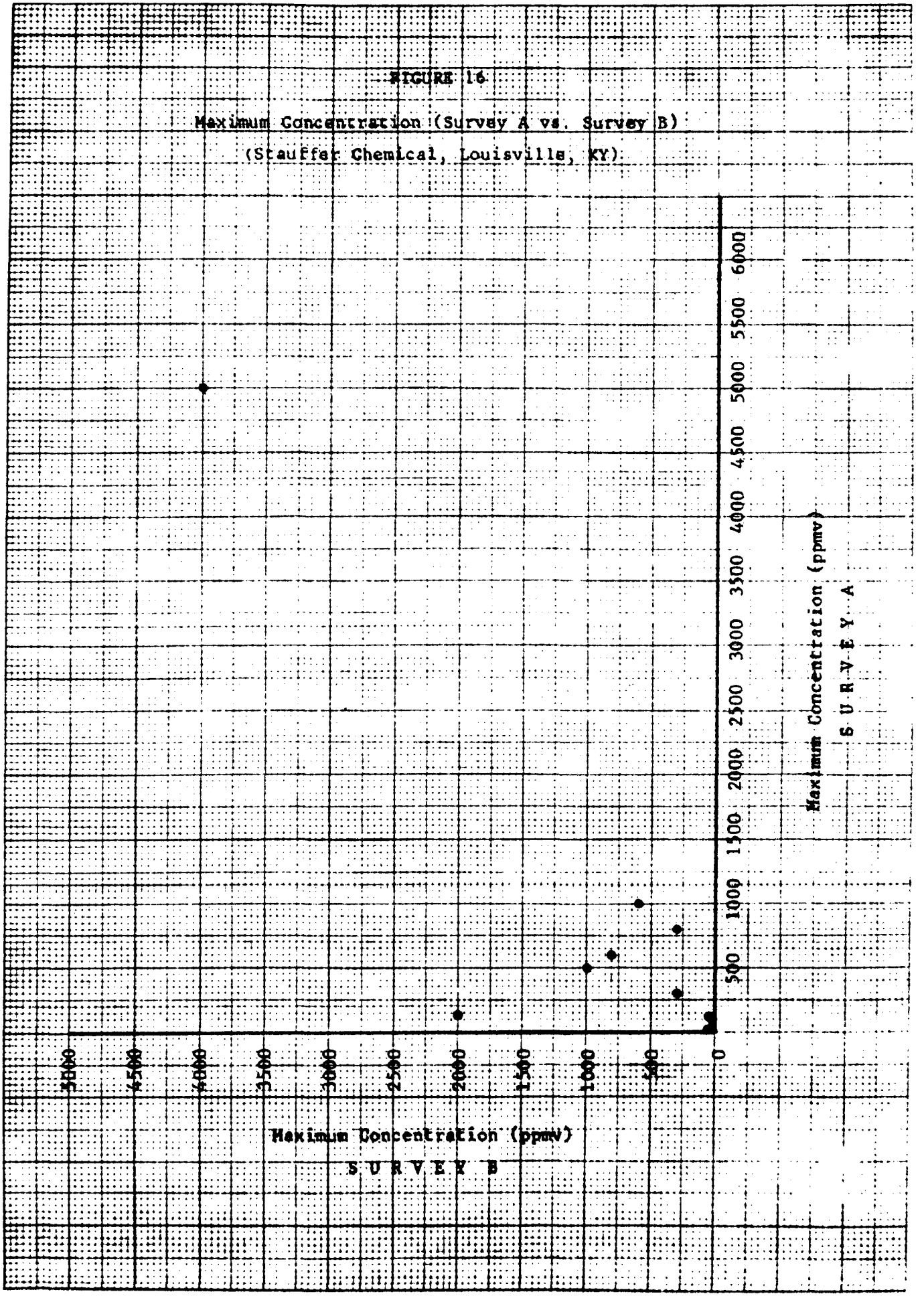

FIGURE 17

Strip Chart Recording
(Union Carbide, Torrance, CA, Storage)

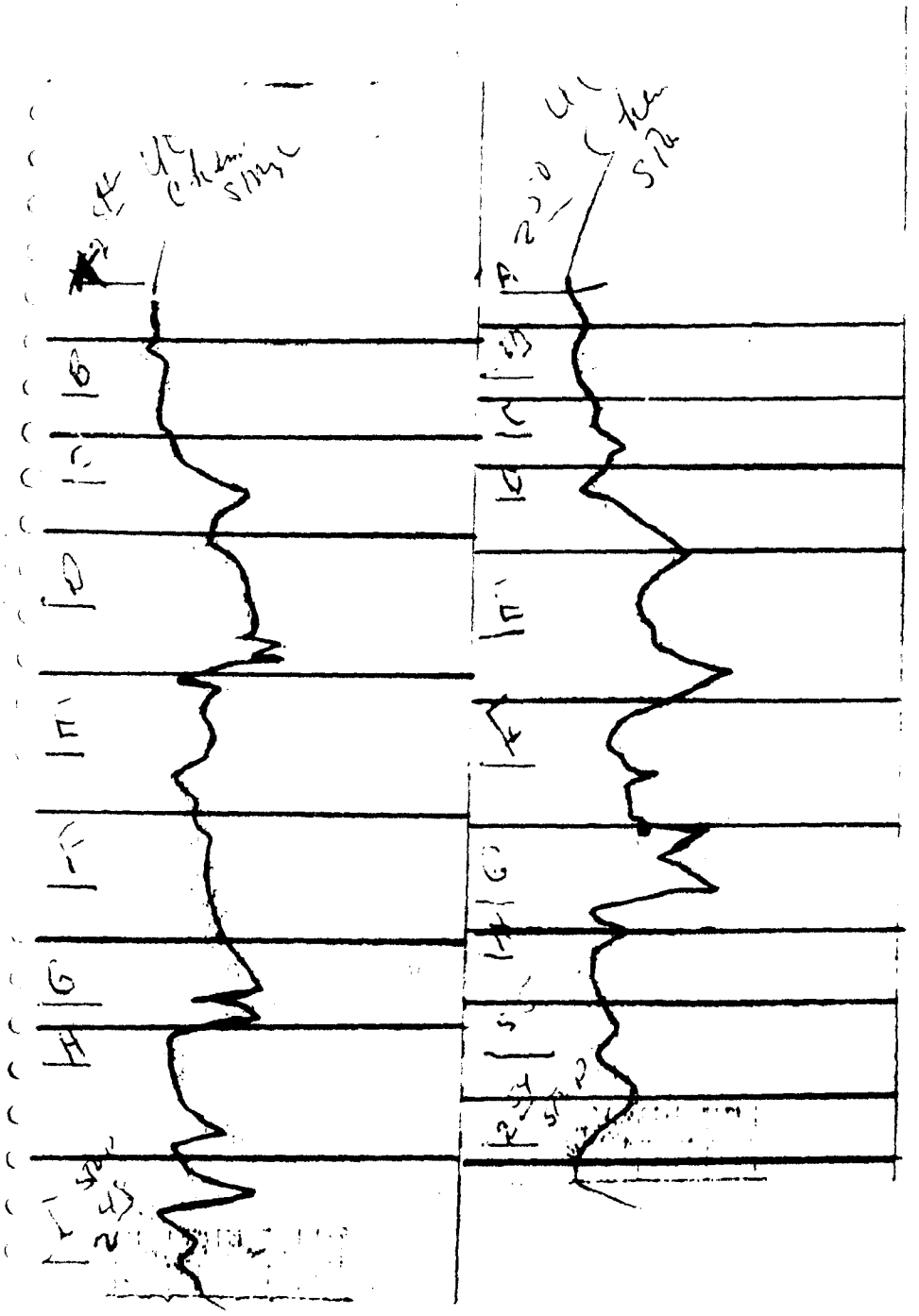

TABLE 10

Union Carbide
Torrance, California
Storage Area Walkthrough (Area #2)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	9	10	1
B	15	15	0
C	80	30	50
D	200	100	100
E	50	300	250
F	60	200	140
G	150	200	50
H	60	30	30
I	150	40	110

FIGURE 18

Maximum Concentration (Survey A vs. Survey B)

(Union Carbide, Torrance, CA, Storage)

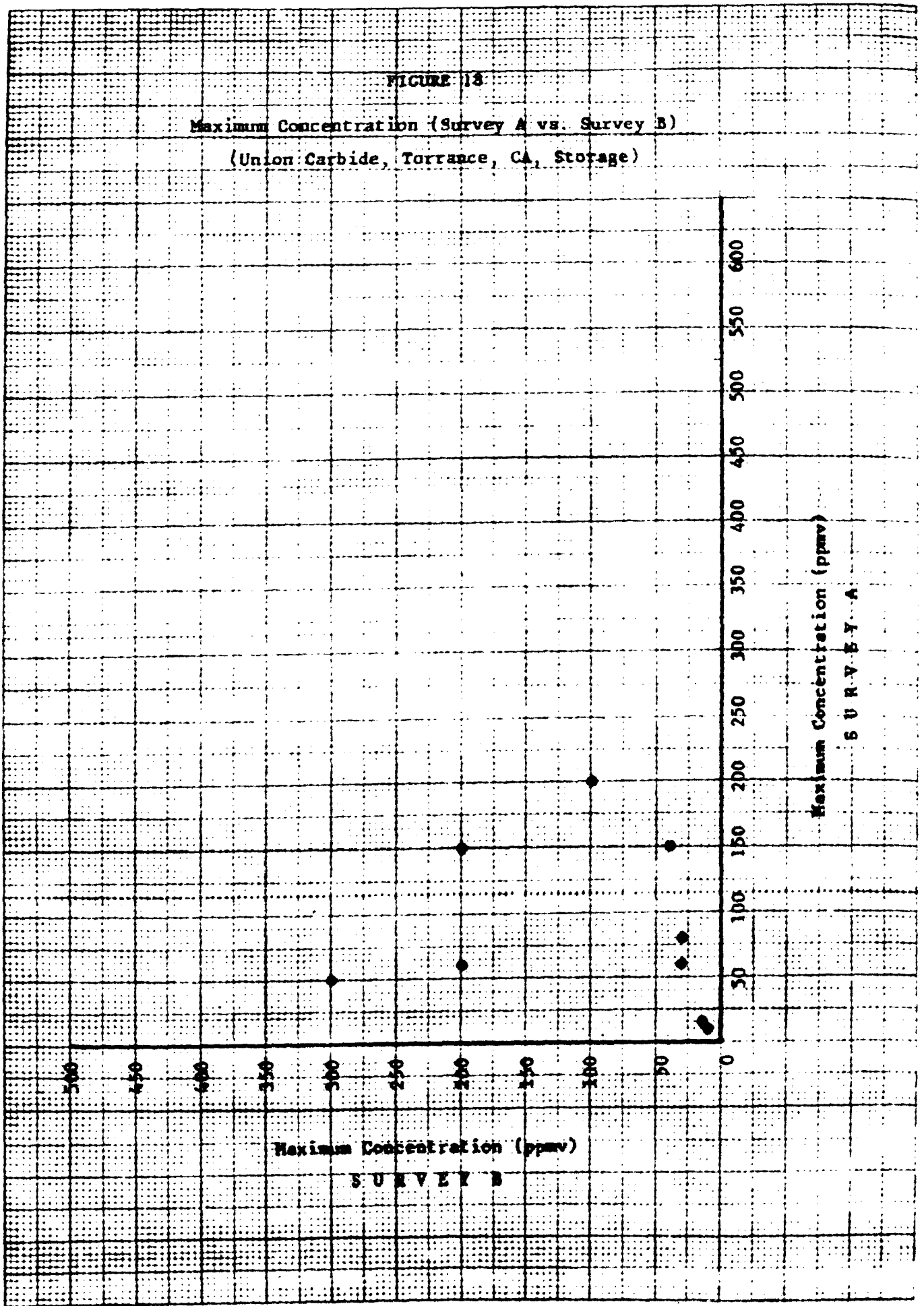

FIGURE 19

Strip Chart Recording
(Union Carbide, Torrance, CA, Furnace Unit)

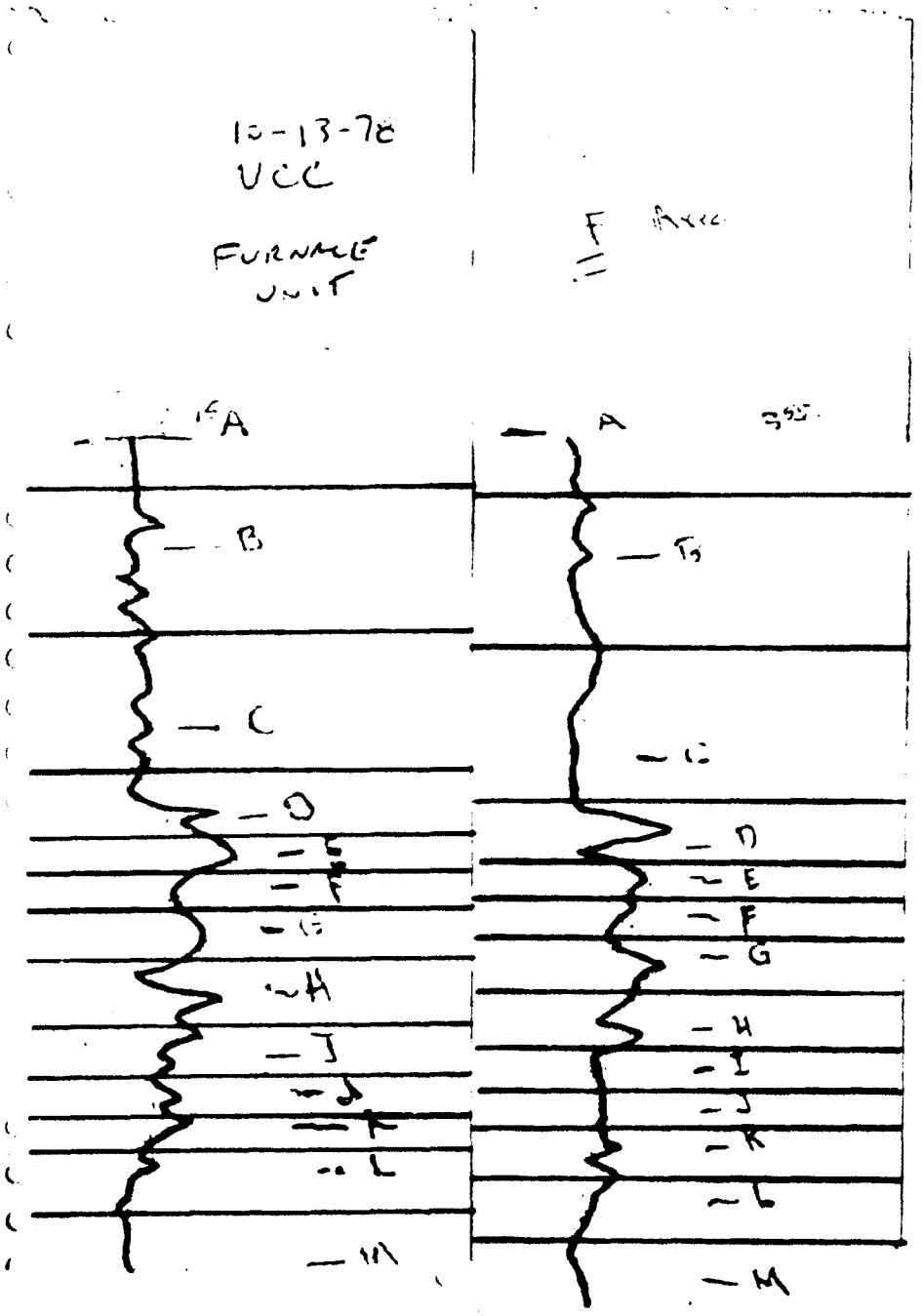

FIGURE 19 (Continued)

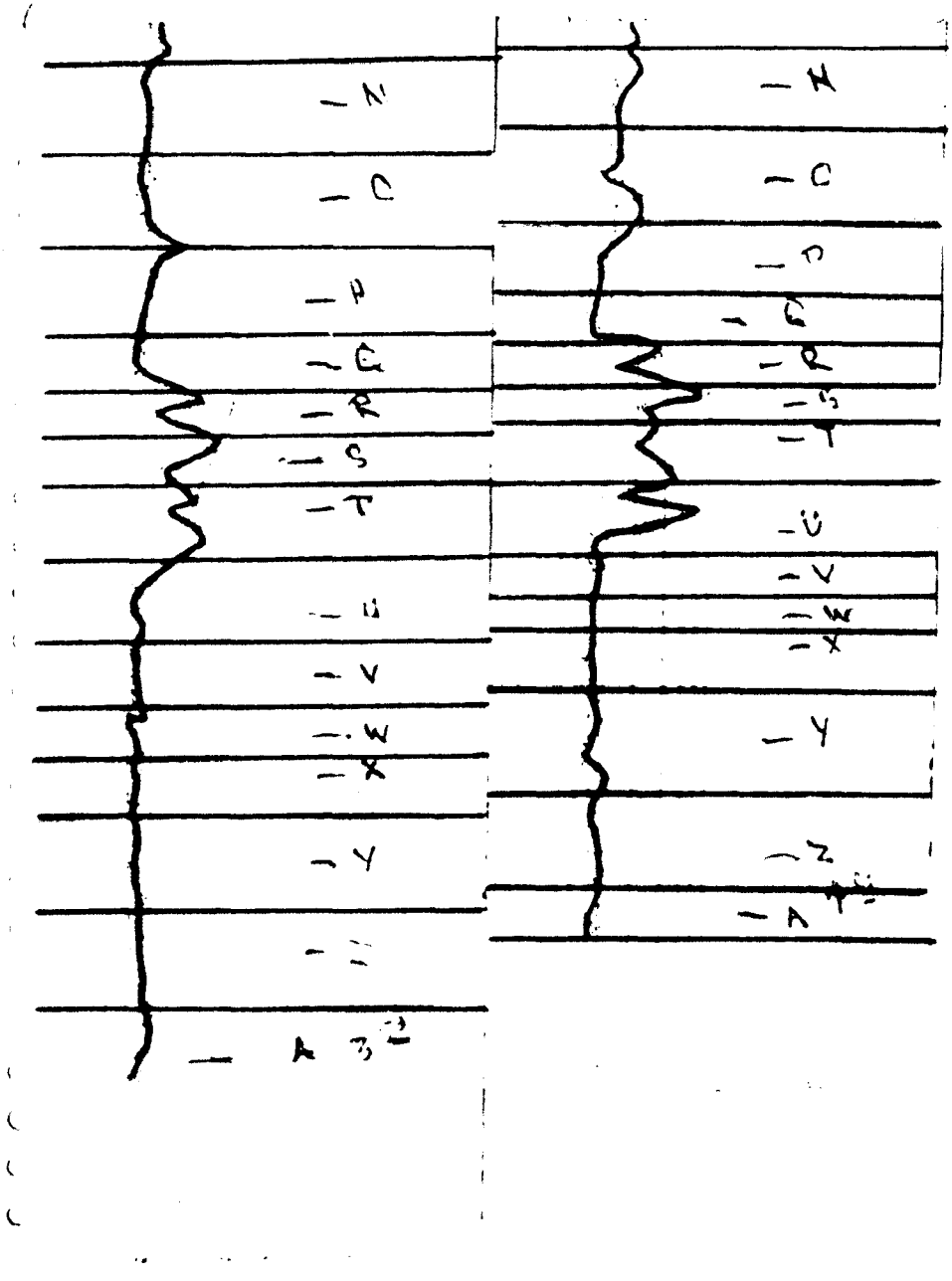

TABLE 11

Union Carbide
Torrance, California
Furnace Unit (Area #4)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	8	9	1
B	15	15	0
C	15	15	0
D	50	80	30
E	80	50	30
F	30	30	0
G	40	70	30
H	60	40	20
I	40	20	20
J	25	20	5
K	30	30	0
L	15	30	15
M	15	15	0
N	8	20	12
O	20	20	0
P	15	15	0
Q	17	30	13
R	30	50	20
S	40	90	50
T	30	50	20
U	15	90	75
V	8	9	1
W	9	9	0
X	7	9	2
Y	8	10	2
Z	9	10	1
A	10	10	0

FIGURE 20

Maximum Concentration (Survey A vs. Survey B)

(Union Carbide, Torrance, CA, Furnace Unit)

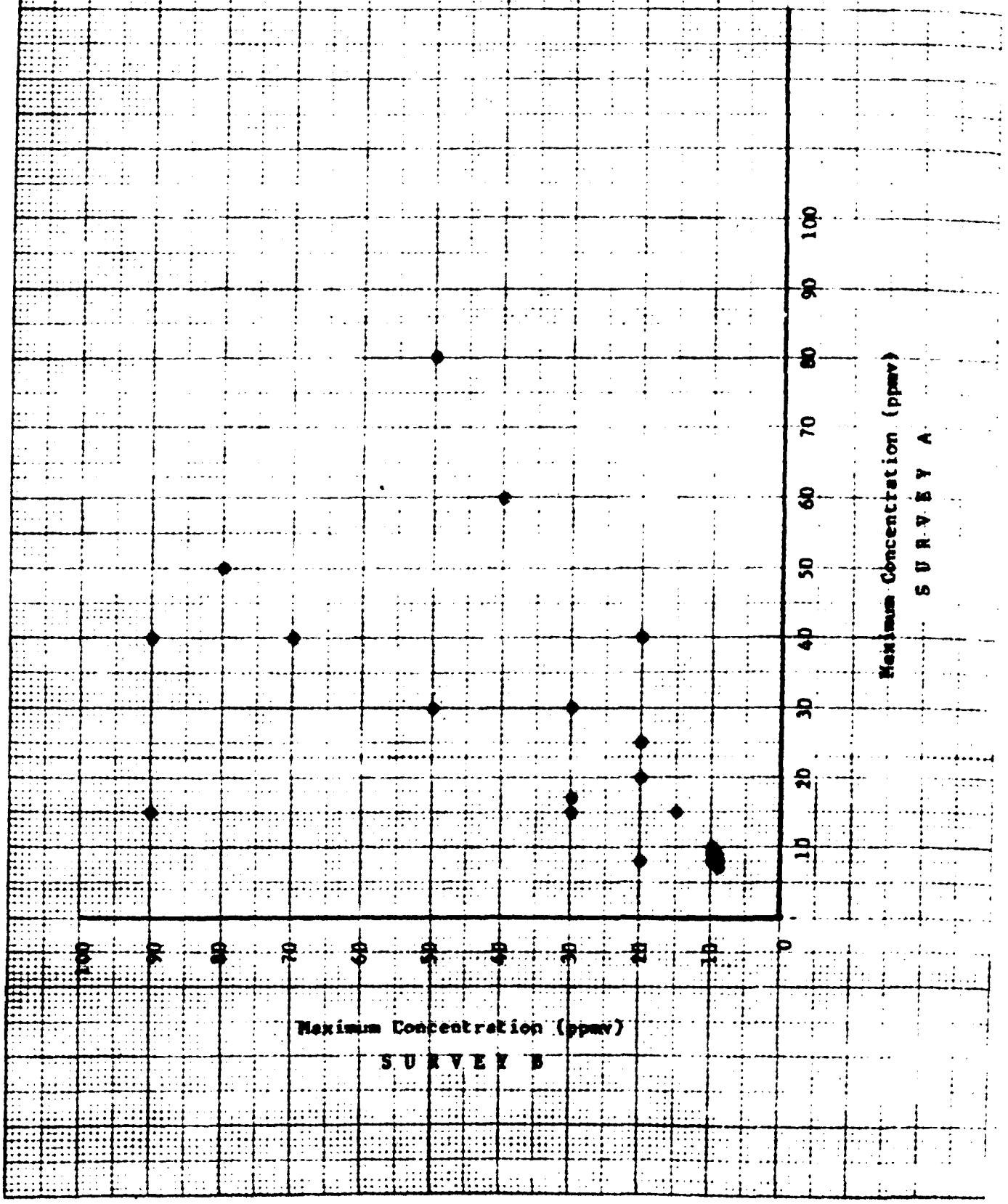

FIGURE 21

Strip Chart Recording
(Union Carbide, Torrance, CA, Separation Area)

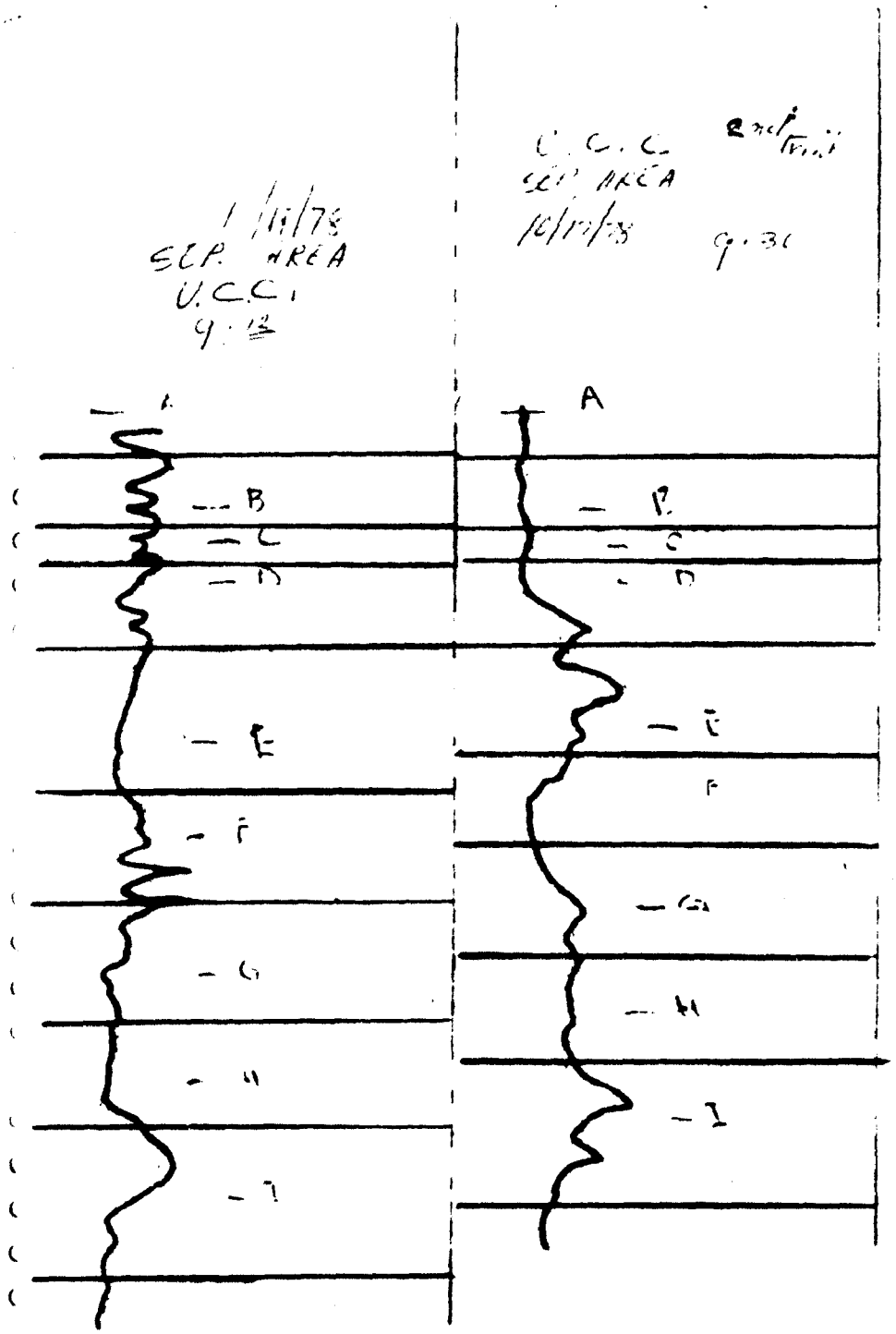

FIGURE 21 (Continued)

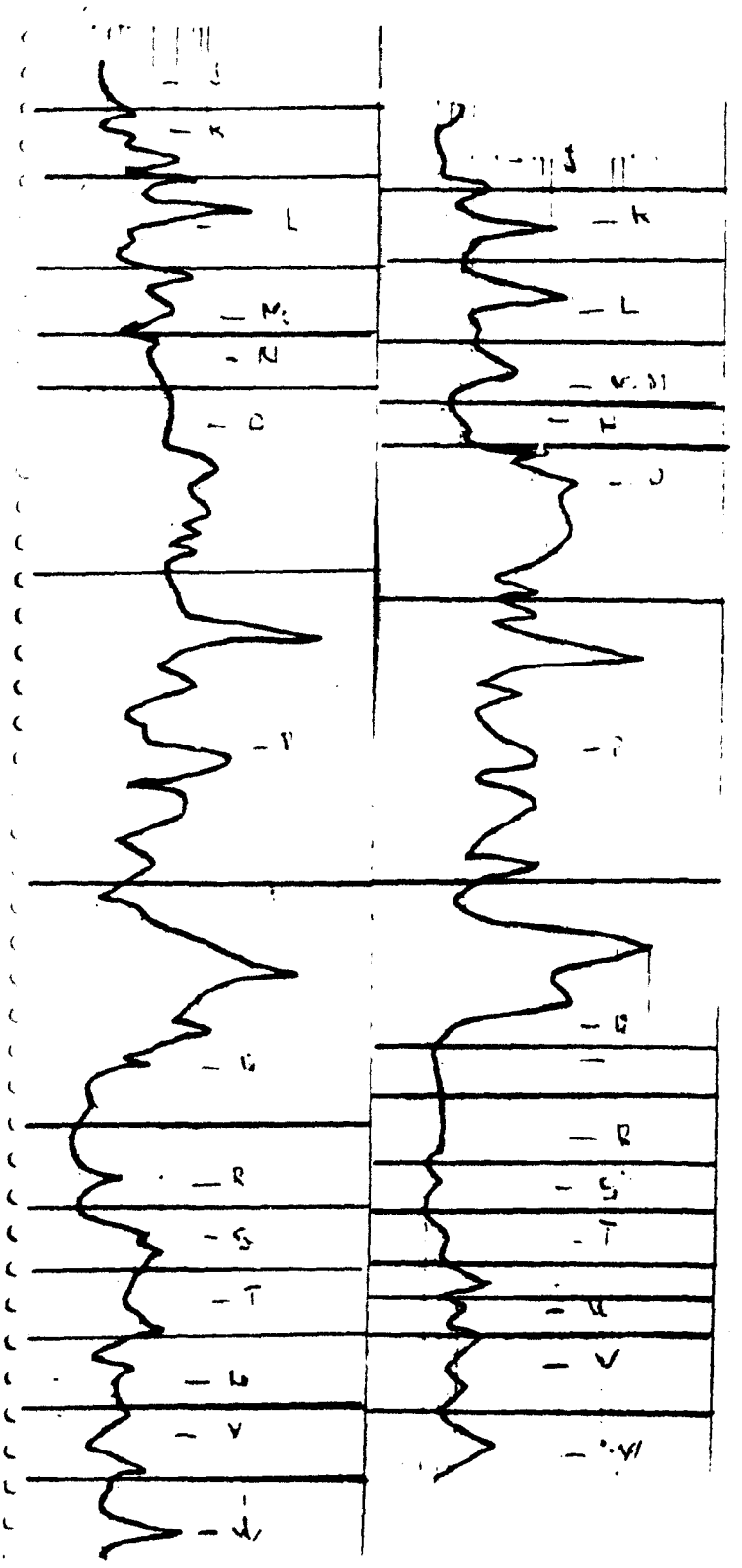

FIGURE 21 (Continued)

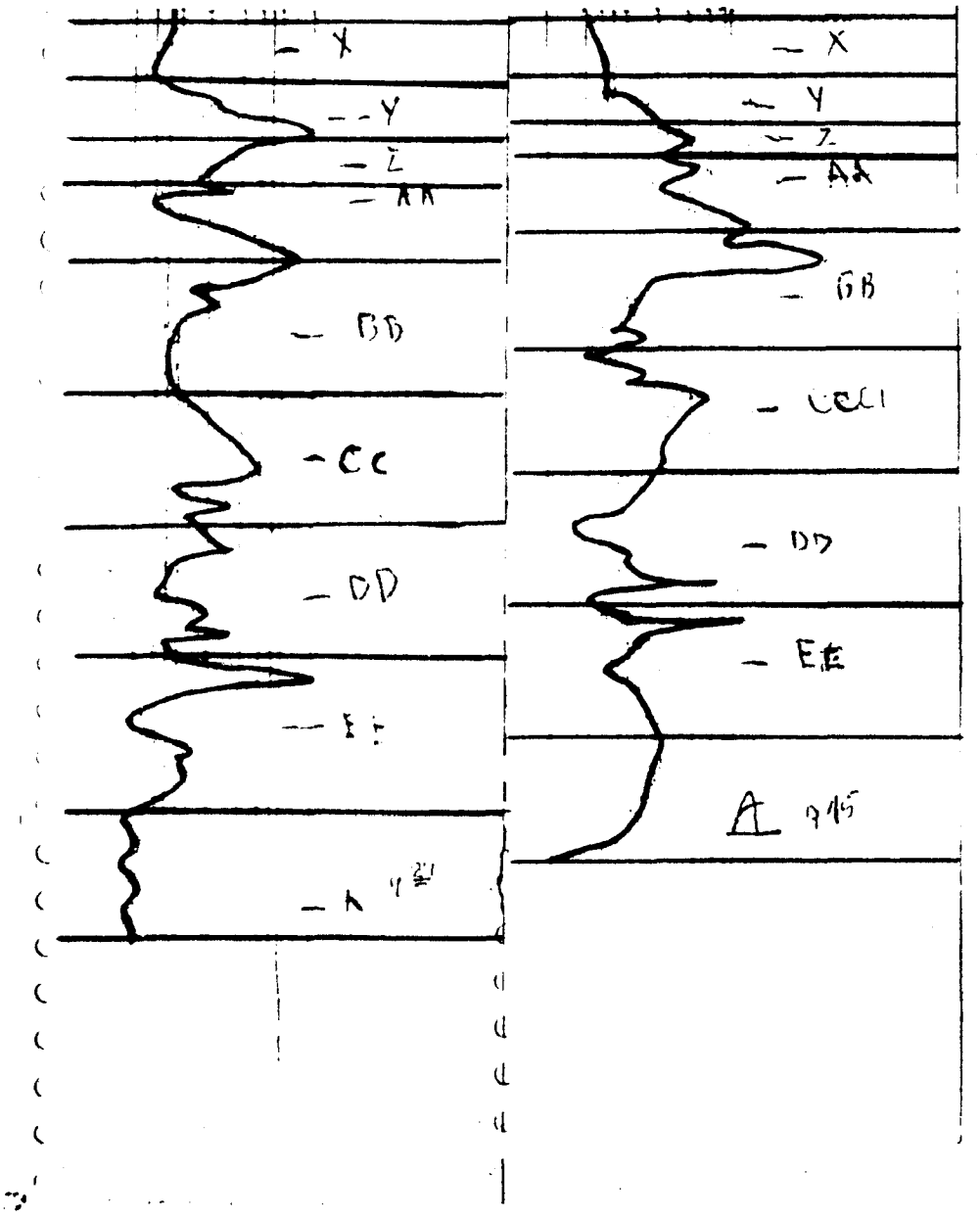

TABLE 12

Union Carbide
Torrance, California
Separation Area

Grid Location	maximum value (ppm) Survey A	Survey B	absolute value of the difference |(A-B)|
A	15	4	11
B	17	4	13
C	15	5	10
D	15	15	0
E	10	40	30
F	30	10	20
G	13	15	2
H	13	15	2
I	20	50	30
J	9	15	6
K	40	100	60
L	400	150	250
M	60	40	20
N	30	10	20
O	150	200	50
P	3000	1500	1500
Q	1500	2000	500
R	15	6	9
S	30	6	24
T	50	7	43
U	20	17	3
V	30	15	15
W	80	30	50
X	8	7	1
Y	200	20	180
Z	100	40	60

TABLE 12 (Continued)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
AA	150	150	0
BB	150	800	650
CC	60	60	0
DD	30	70	40
EE	200	150	50
A	5	20	15

FIGURE 22

Maximum Concentration (Survey A vs. Survey B)

(Union Carbide, Torrance, CA, Separation Area)

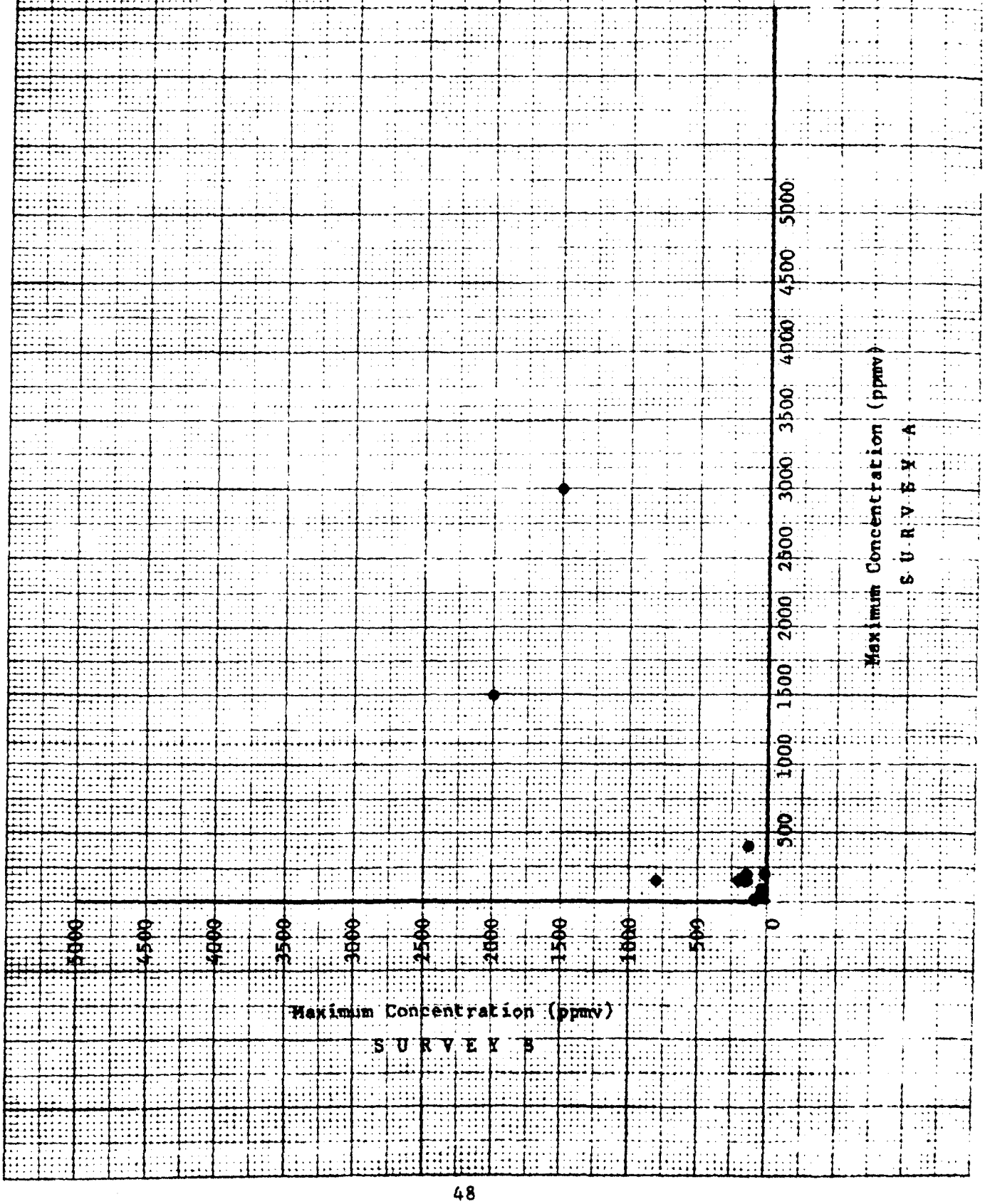

FIGURE 23

Strip Chart Recording
(Union Carbide, Torrance, CA, Olefins Separation)

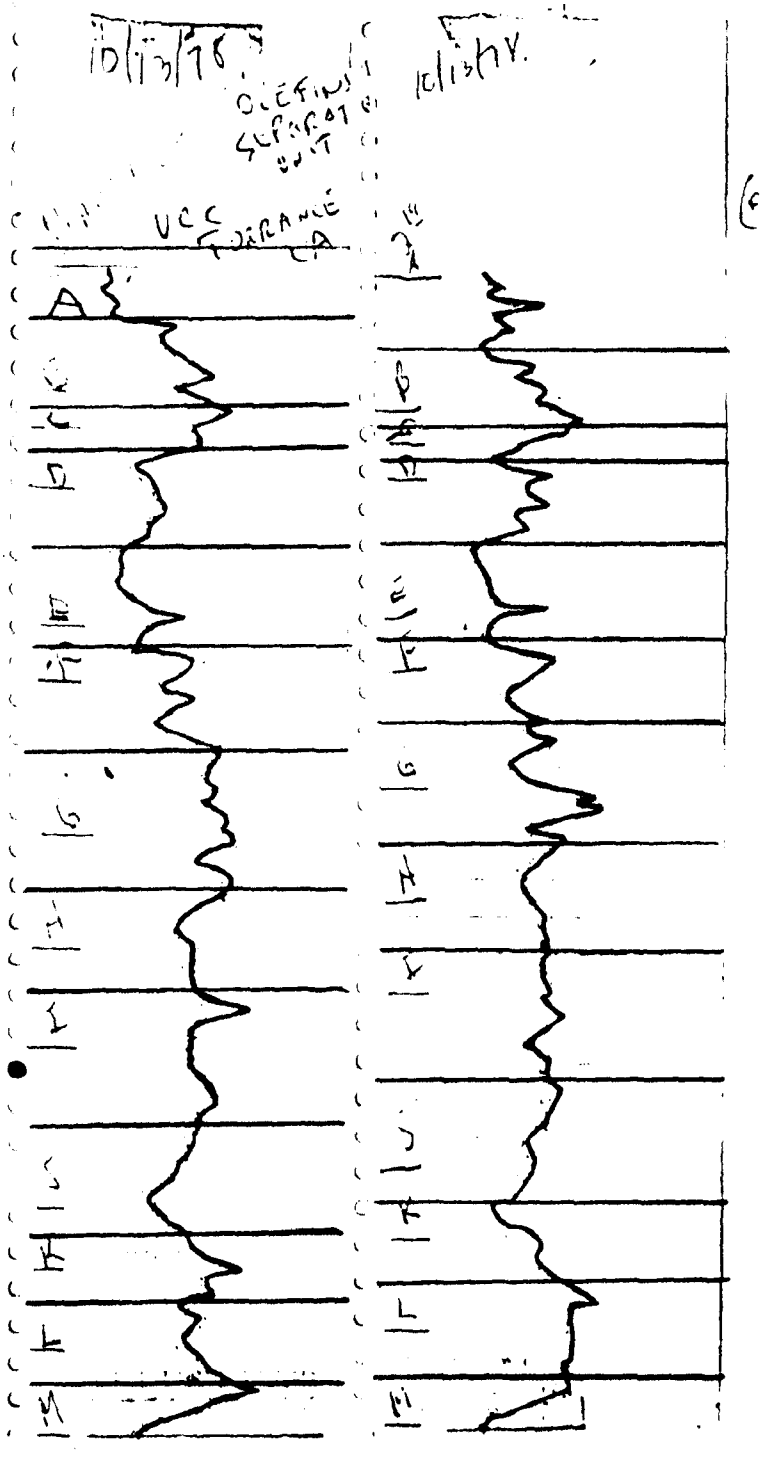

FIGURE 23 (Continued)

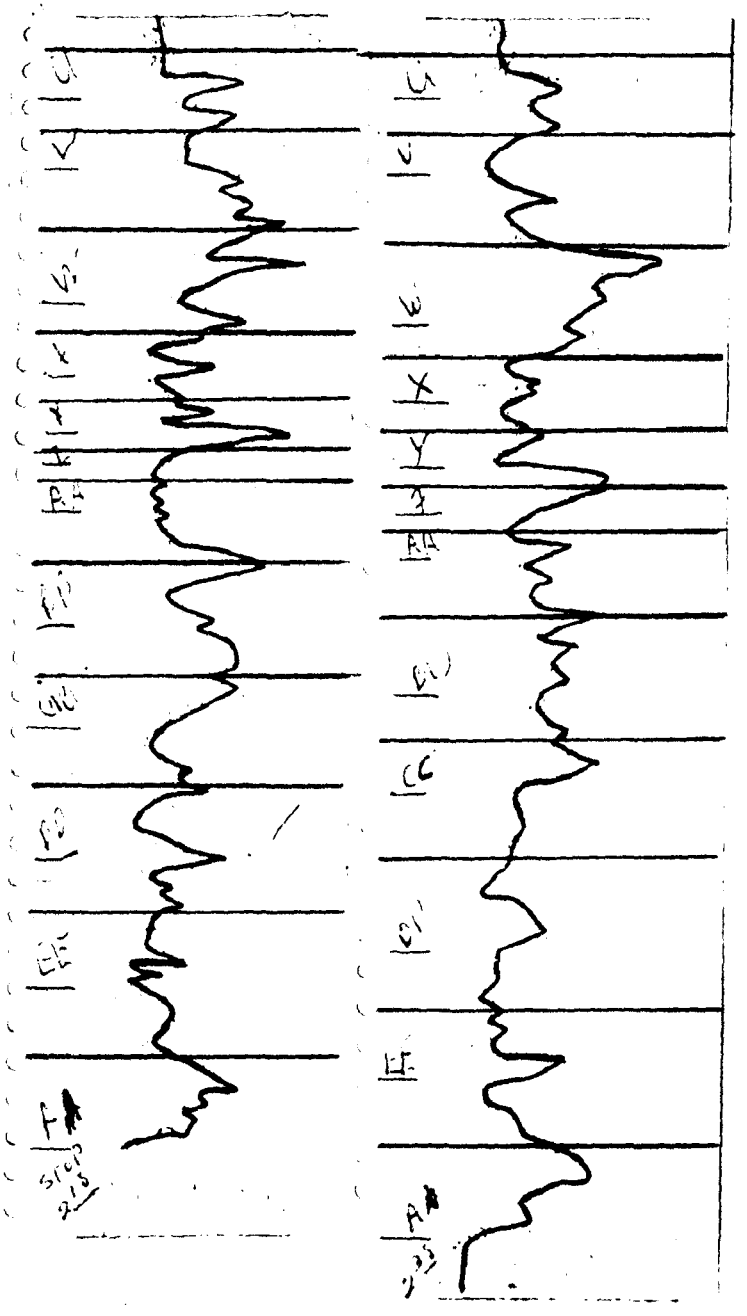

FIGURE 23 (Continued)

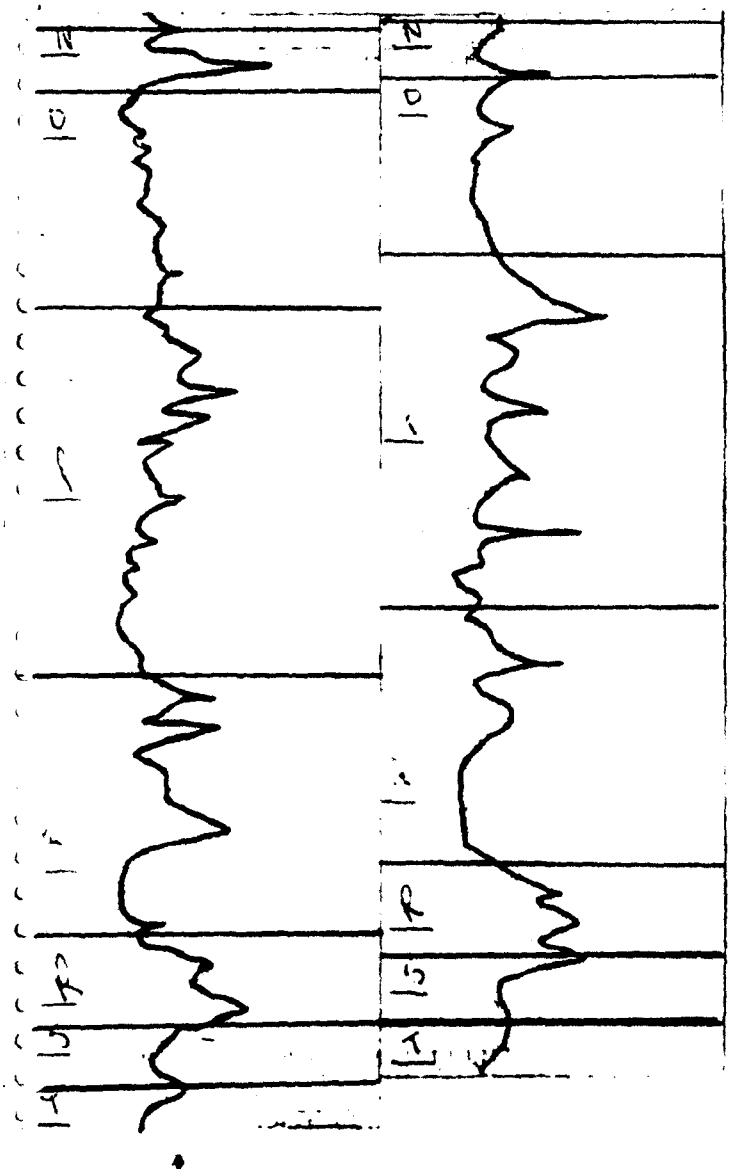

TABLE 13

Union Carbide
Torrance, California
Olefins Separation Plant (Area #1)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	20	90	70
B	200	300	100
C	250	150	100
D	100	100	0
E	60	100	40
F	200	150	50
G	300	500	200
H	200	150	50
I	400	150	250
J	100	150	50
K	400	200	200
L	300	500	200
M	500	200	300
N	600	100	500
O	60	40	20
P	300	600	300
Q	200	150	50
R	400	200	200
S	80	300	220
T	60	30	30
U	300	100	200
V	900	100	800
W	1500	2000	500
X	125	70	55
Y	1000	500	500
Z	40	400	360

TABLE 13 (Continued)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
AA	500	400	100
BB	600	400	200
CC	300	400	100
DD	200	100	100
EE	80	175	95
AA	300	400	100

FIGURE 24

Maximum Concentration (Survey A vs. Survey B)

(Union Carbide, Torrance, CA, Olefins Separation)

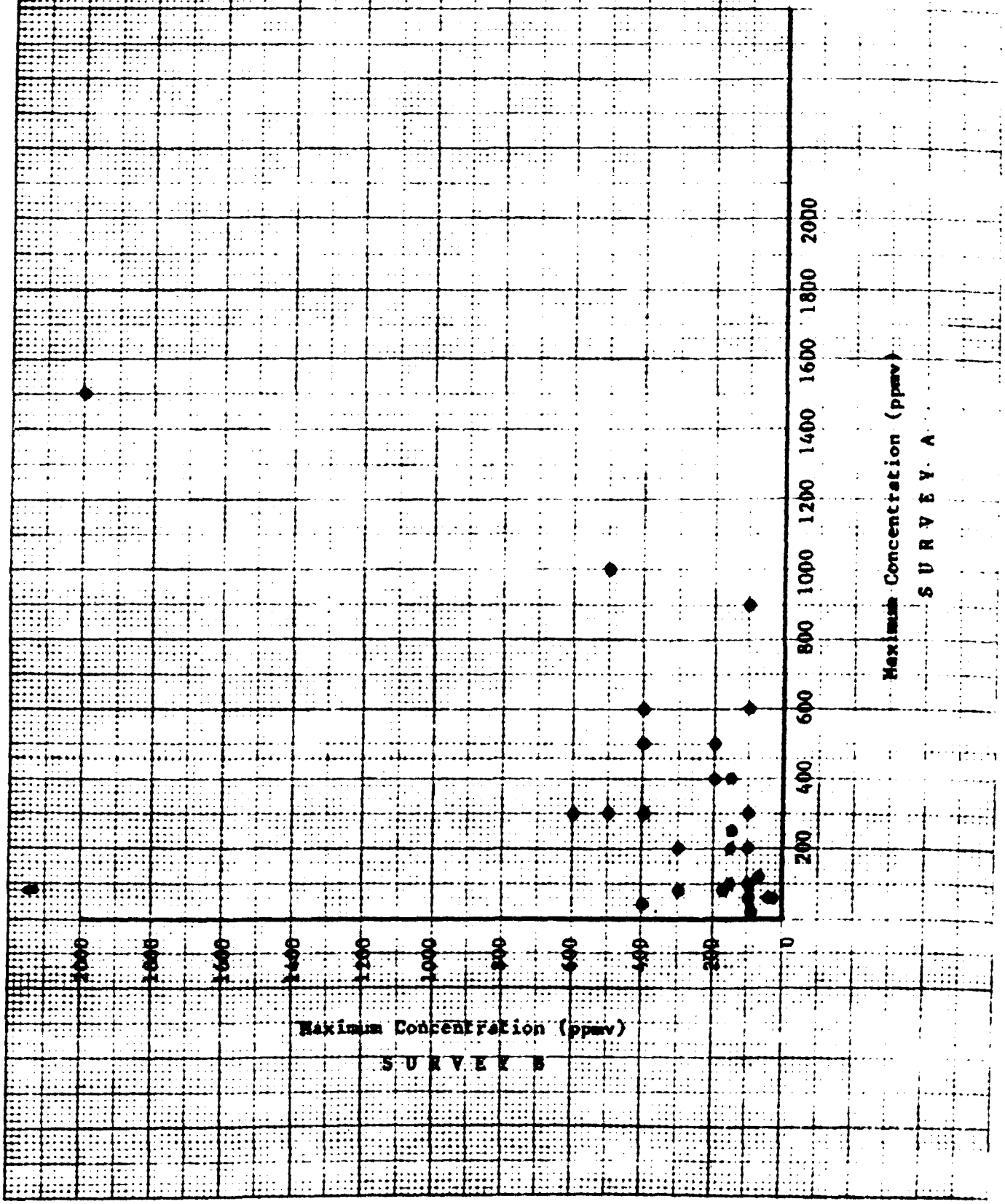

FIGURE 25

Strip Chart Recording
(Union Carbide, Torrance, CA, compressor building)

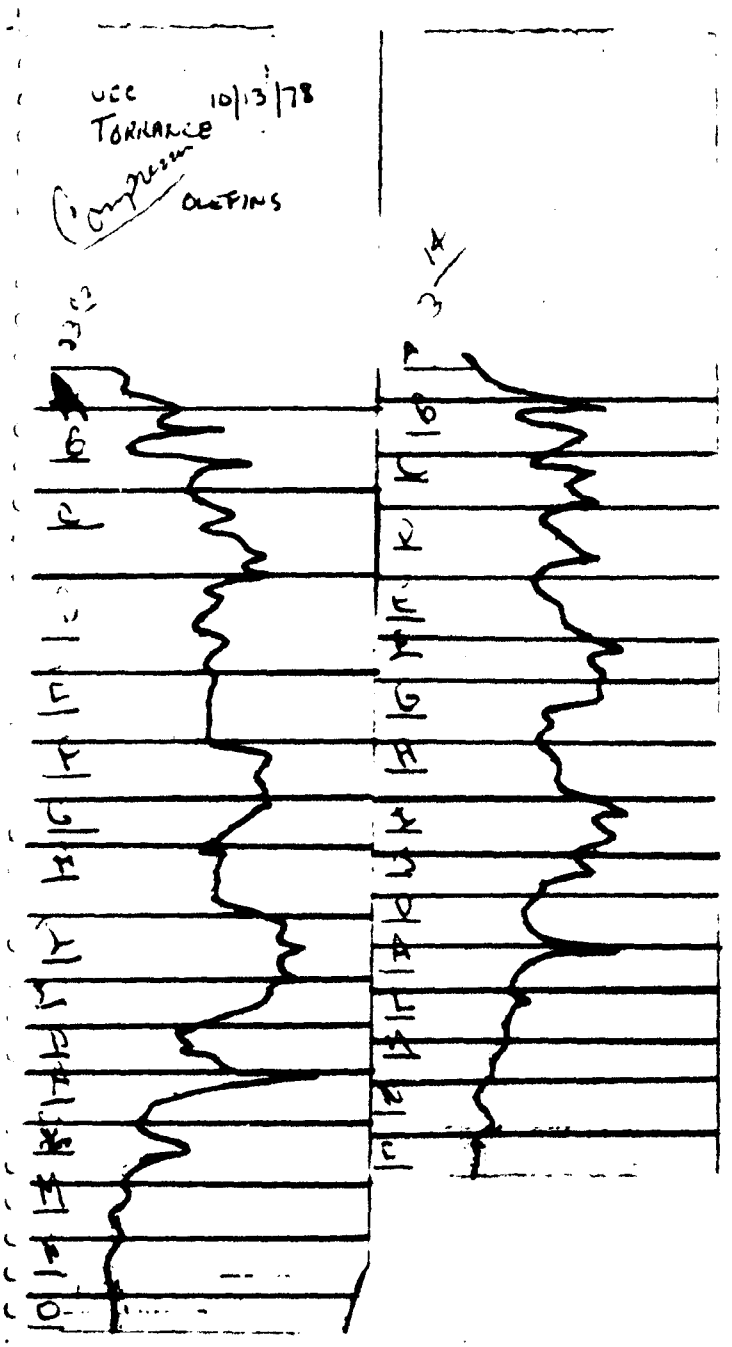

FIGURE 25 (Continued)

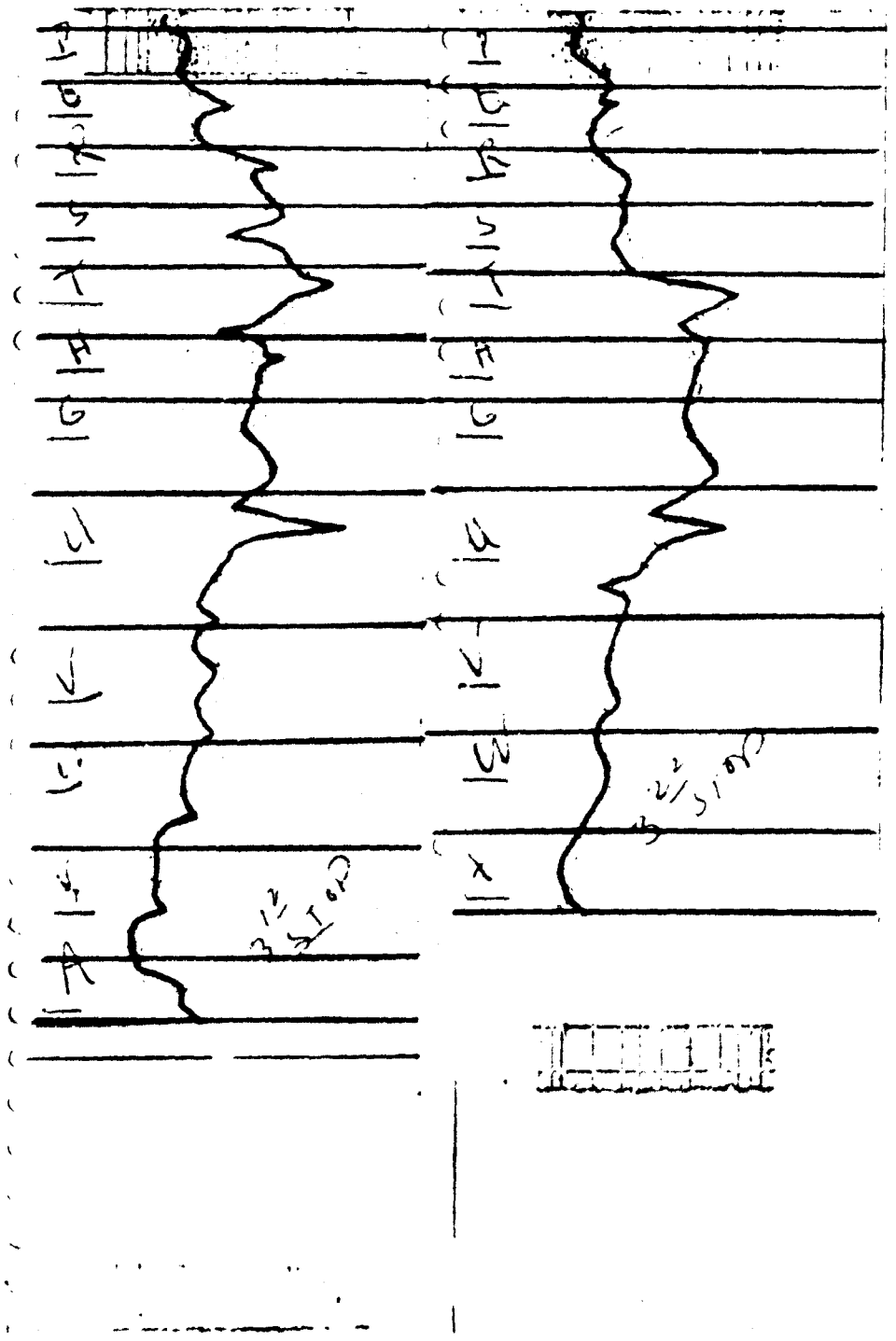

TABLE 14

Union Carbide
Torrance, California
Compressor Building (Area #3)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	50	200	150
B	400	600	200
C	600	500	100
D	600	500	100
E	150	400	250
F	800	1000	200
G	800	500	300
H	700	500	200
I	2000	1000	1000
J	900	450	450
D	300	200	100
A	3000	900	2100
L	80	70	10
M	15	35	20
N	15	30	15
O	10	15	5
P	30	30	0
Q	70	30	40
R	200	40	160
S	300	40	260
T	800	500	300
H	300	300	0
G	200	300	100
U	1000	400	600
V	50	40	10
W	30	30	0
X	17	15	2

FIGURE 26

Maximum Concentration (Survey A vs. Survey B)

(Union Carbide, Torrance, CA, Compressor Building)

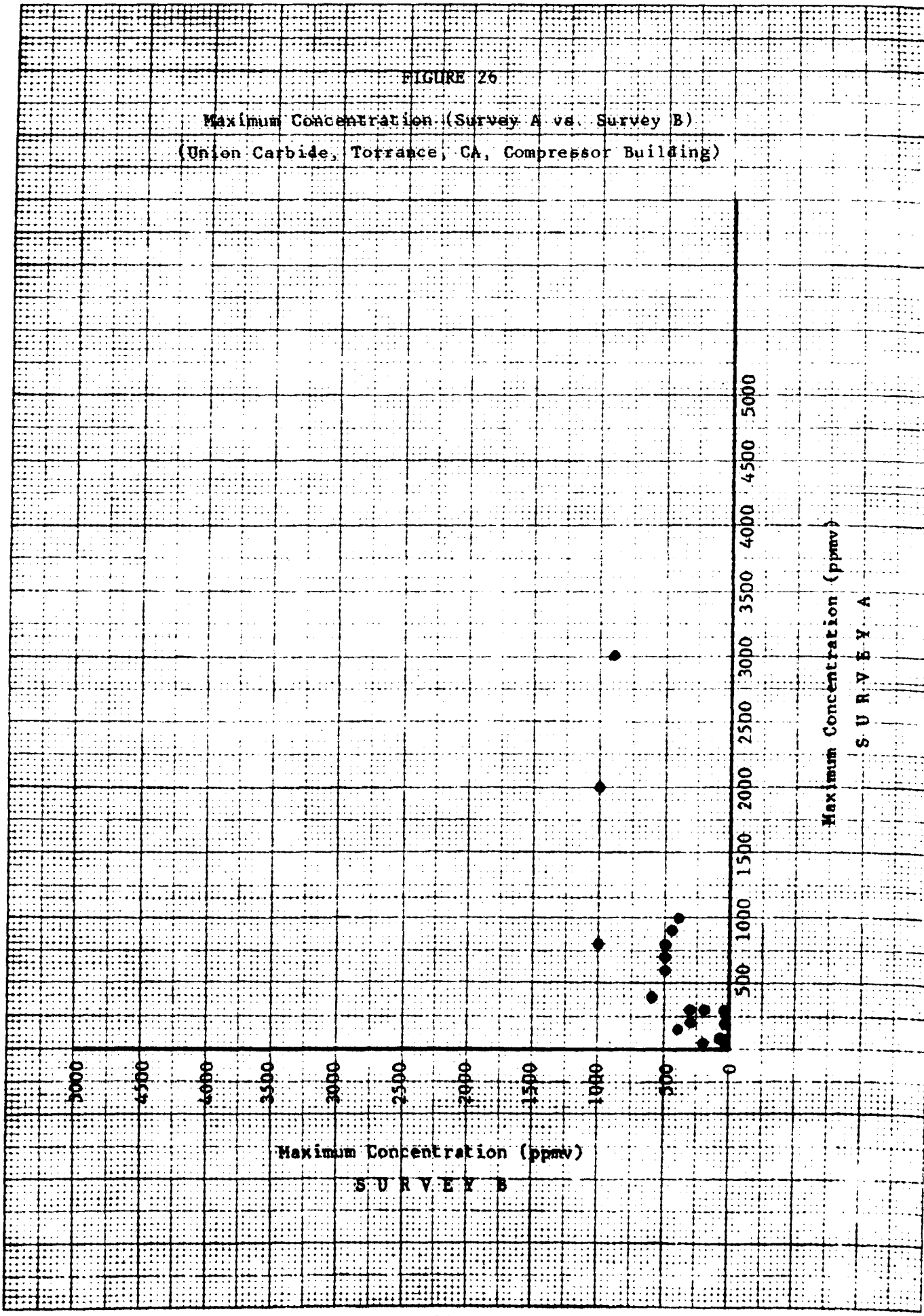

FIGURE 27

Strip Chart Recording
(Sun Oil, Toledo, OH, BTX unit)

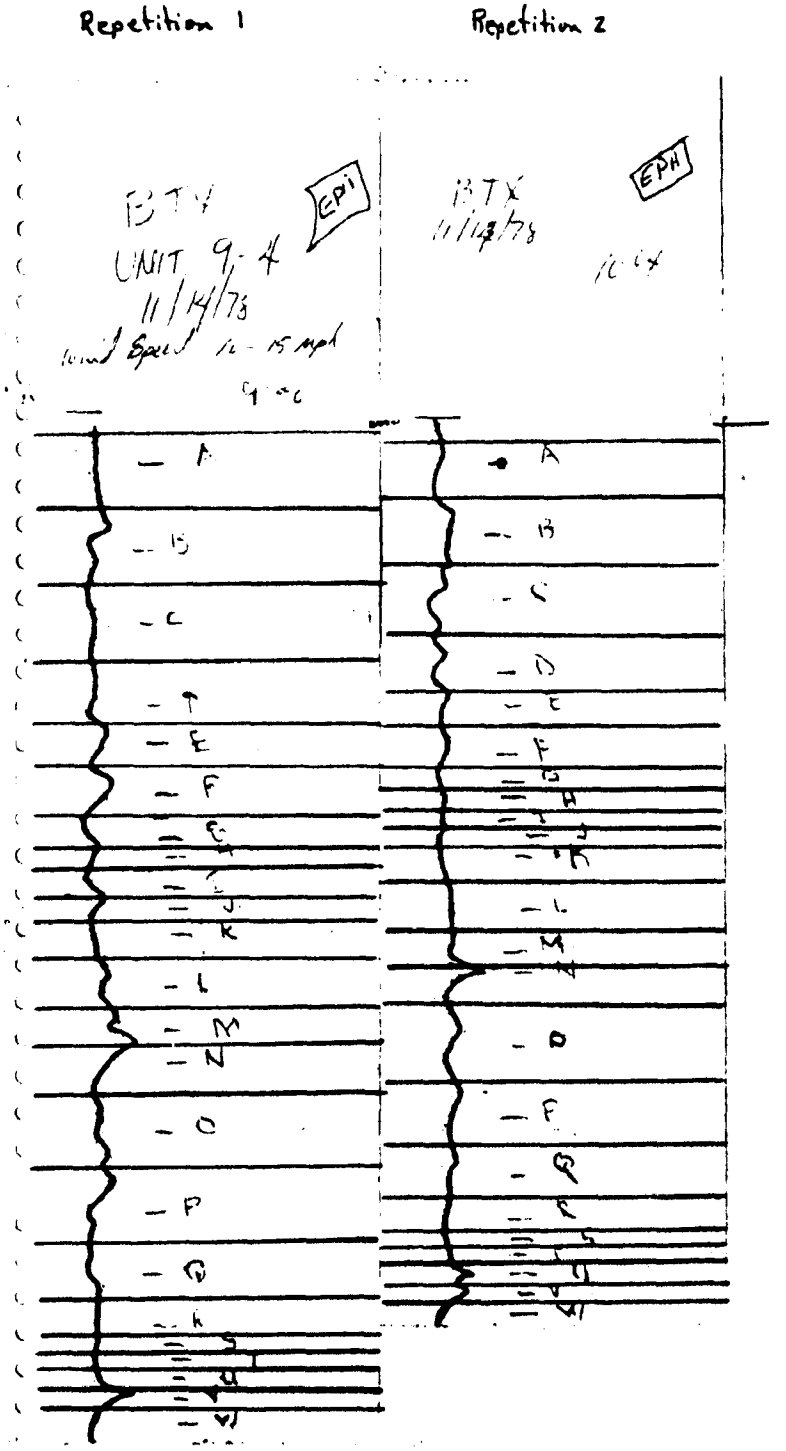

FIGURE 27 (Continued)

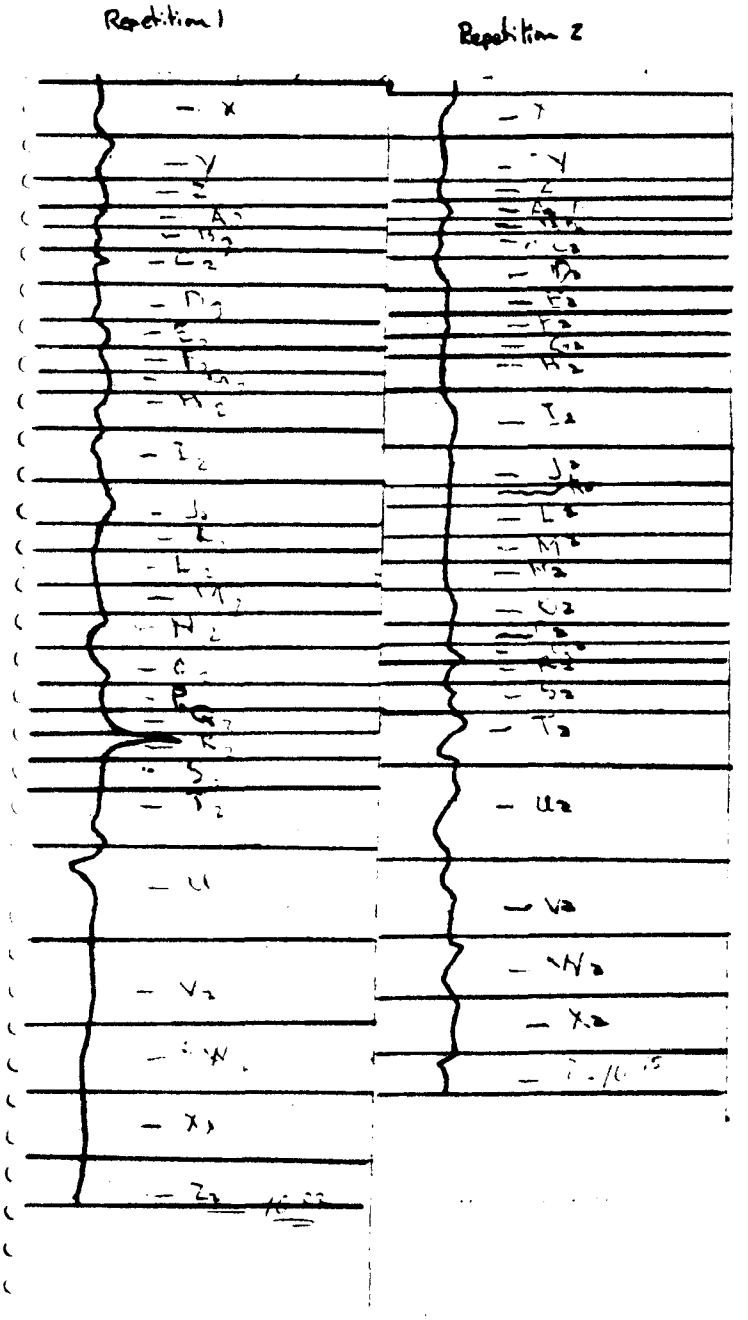

TABLE 15

Sun Oil Company
Toledo, Ohio
BTX Unit

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A	5	5	0
B	7	6	1
C	5	6	1
D	6	6	0
E	6	6	0
F	8	6	2
G	5	5	0
H	5	5	0
I	6	5	1
J	6	5	1
K	5	6	1
L	7	6	1
M	15	8	7
N	15	15	0
O	7	7	0
P	8	8	0
Q	5	7	2
R	5	5	0
S	5	6	1
T	5	6	1
U	6	10	4
V	15	10	5
W	5	5	0
X	5	6	1
Y	7	5	2
Z	5	4	1

TABLE 15 (Continued)

Grid Location	maximum value (ppm)		absolute value of the difference
	Survey A	Survey B	|(A-B)|
A_2	5	5	0
B_2	5	4	1
C_2	6	4	2
D_2	5	5	0
E_2	6	5	1
F_2	6	5	1
G_2	7	5	2
H_2	7	5	2
I_2	6	6	0
J_2	8	5	3
K_2	5	5	0
L_2	5	5	0
M_2	6	5	1
N_2	6	5	1
O_2	7	6	1
P_2	6	6	0
Q_2	9	8	1
R_2	60	7	53
S_2	6	7	1
T_2	7	9	2
U_2	6	8	2
V_2	5	6	1
W_2	5	8	3
X_2	5	8	3
Z_2	4	7	3

FIGURE 28

Maximum Concentration (Survey A vs. Survey B)

(Sun Oil, Toledo, OH, BTX Unit)