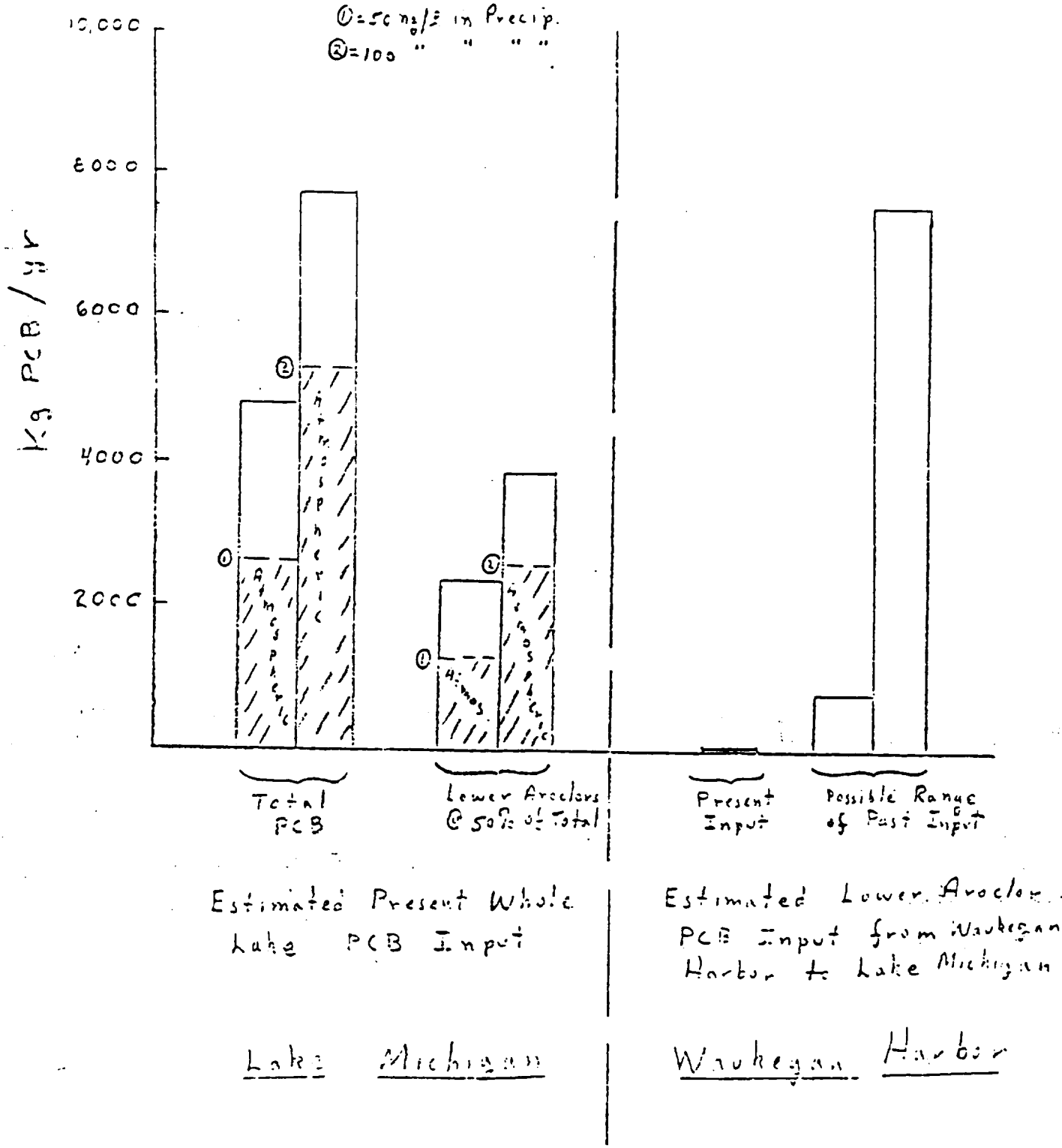
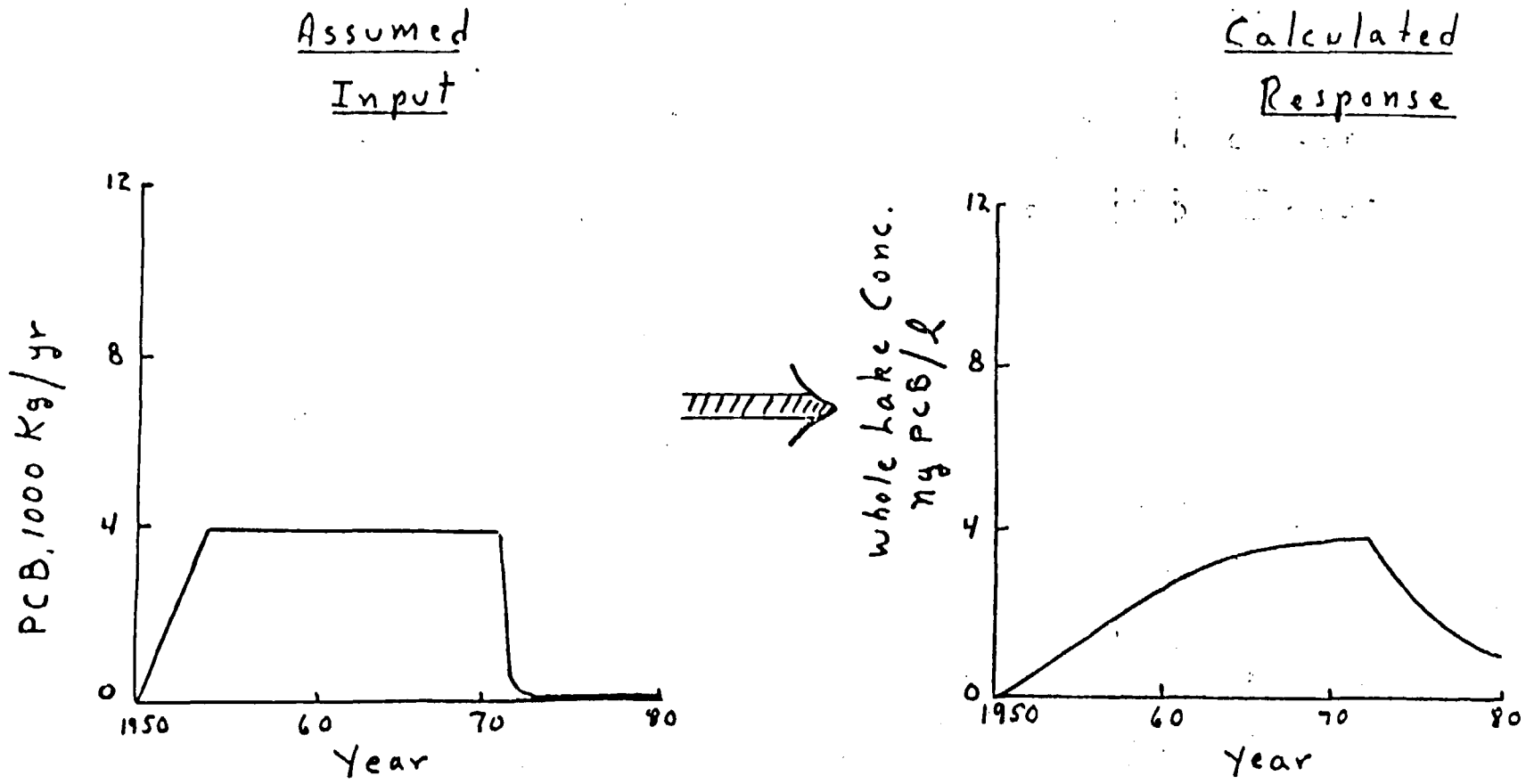
SDMS US EPA REGION V -1

SOME IMAGES WITHIN THIS DOCUMENT MAY BE ILLEGIBLE DUE TO BAD SOURCE DOCUMENTS.

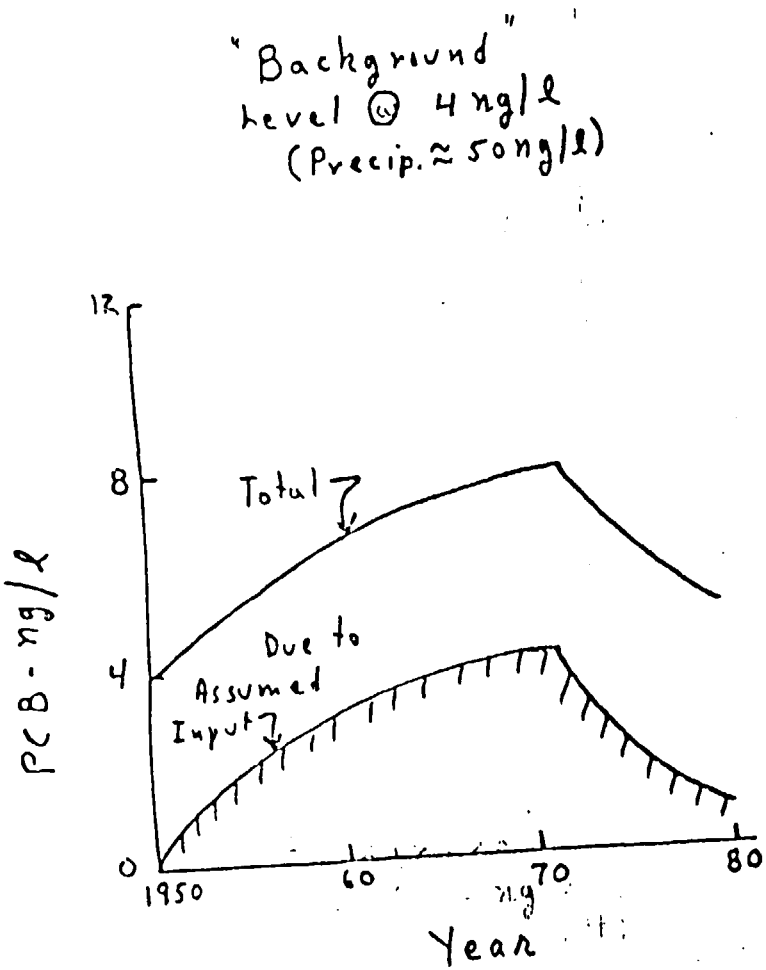


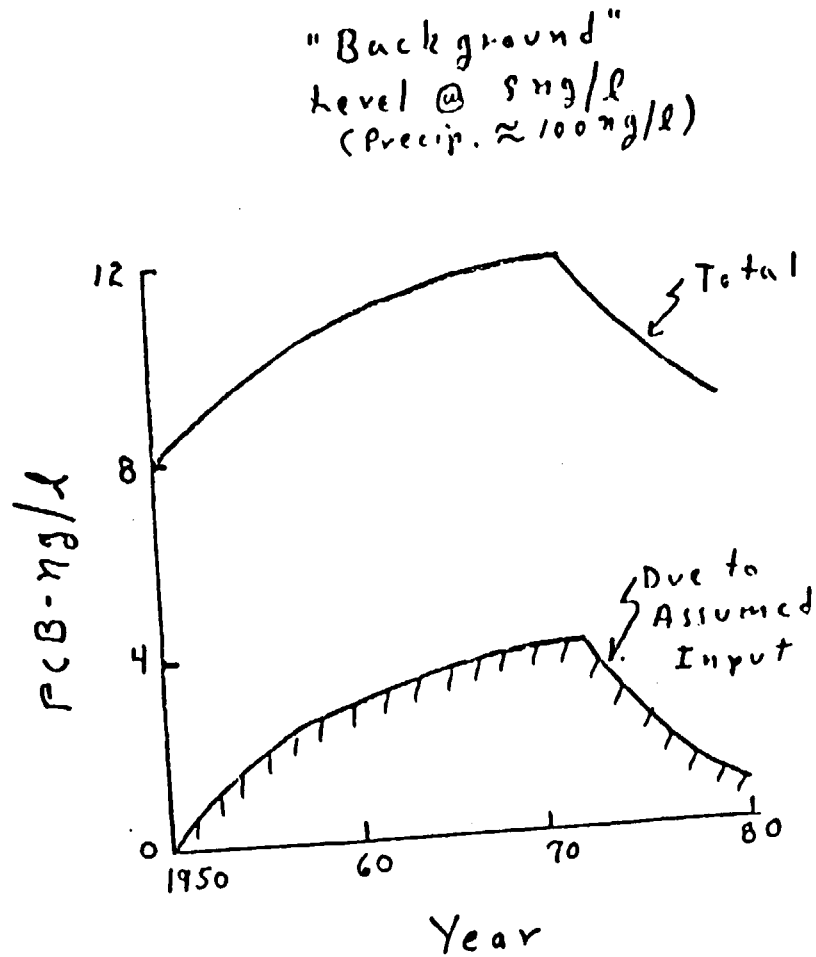
COMPARISON OF WAUKEGAN HARBOR INPUT TO PCB INPUT TO LAKE MICHIGAN

Lnb2h1

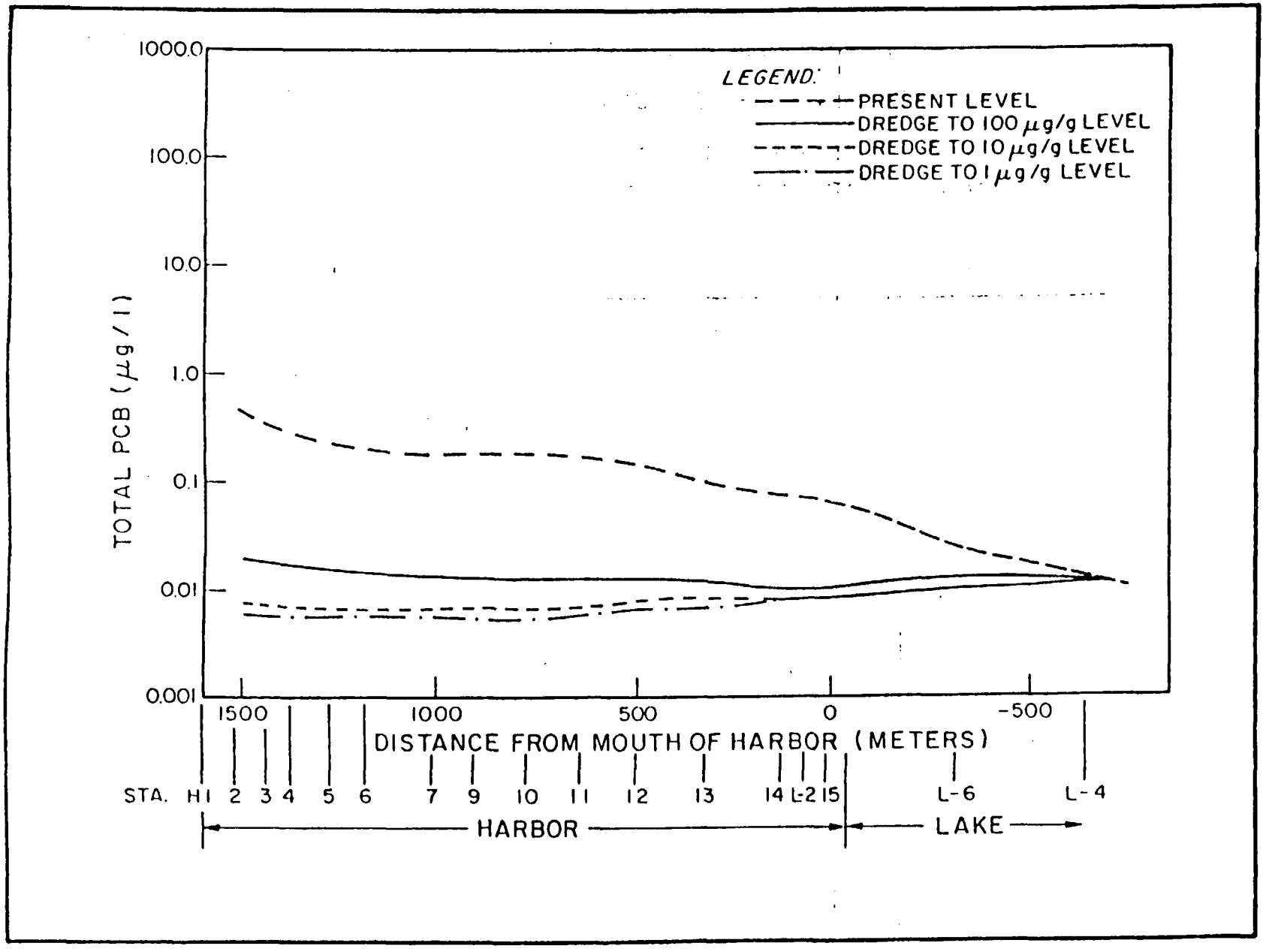


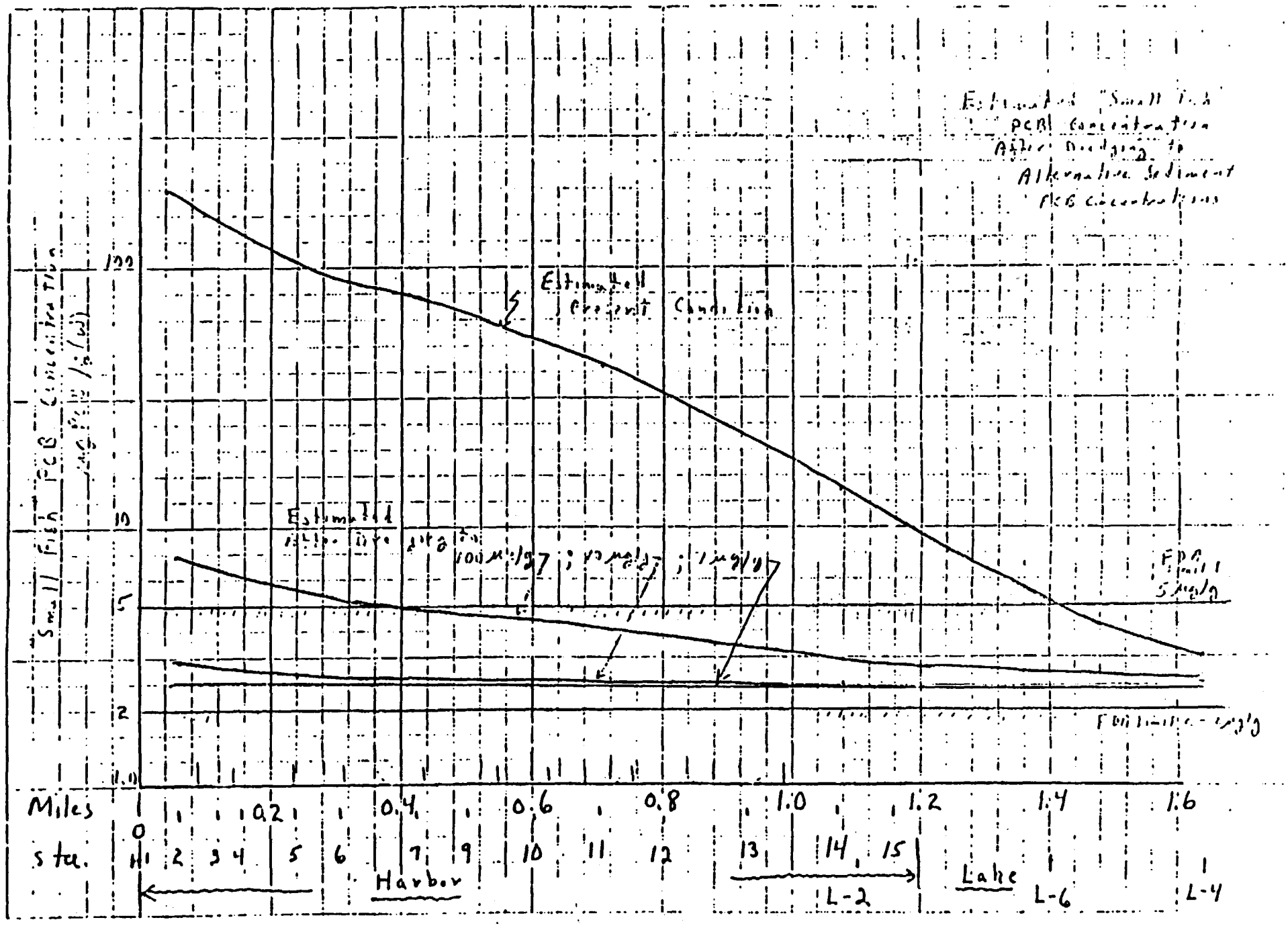
Long Term Response of Whole Lake Michigan to Assumed PCB Input





Calculated
Whole Lake Michigan Response due to
Assumed PCB Input
Plus
"Background" Levels ( ) 4 ng/l & 8 ng/l


LEGEND:
PRESENT LEVEL
DREDGE TO 100 μg/g LEVEL
DREDGE TO 10 μg/g LEVEL
DREDGE TO 1 μg/g LEVEL
TOTAL PCB (μg/l)
1000.0
100.0
10.0
1.0
0.1
0.01
0.001
1500
1000
500
0
-500
DISTANCE FROM MOUTH OF HARBOR (METERS)
STA. H1 2 3 4 5 6 7 9 10 11 12 13 14 L-2 15 L-6 L-4
HARBOR
LAKE



Estimated "Small Fish" PCB Concentration After Dredging to Alternative Sediment PCB Concentrations
Small Fish PCB Concentration
Estimated Present Condition
Estimated After Dredging to 100 µg/g ; 10 µg/g ; 1 µg/g
FDA Limit 5 µg/g
FDA Limit - µg/g
100
10
5
2
1.0
Miles
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
sta.
1 2 3 4 5 6 7 9 10 11 12 13 14 15
Harbor
L-2
Lake
L-6
L-4

CONCLUSIONS

1. a) "Best estimate" - PCB mass: 79,000 kg
   ±1 std. dev.: 17,000 → 670,000 kg.

   b) From data alone: either
      i) all PCB still in harbor
      or ii) hundreds of thousands of kg of PCB unaccounted for.

2. a) Present total water column PCB: 0.6 → 0.1 μg/l
   Variability: ½ - 1 order magnitude

   b) About 40-60% in dissolved form.

3. a). Model calibration (chlorides, dye, solids):
Horizontal exchange flow at harbor mouth of approx. 6.5 m^3/s (230 ft^3/s)

b) Under present conditions, net exchange from Harbor to Lake: < 10 kg/yr

c). Under past direct PCB input condition, very preliminary calculation: 1000 $\frac{kg}{yr}$ → 7000 kg/yr.

4. Under present conditions, fish PCB concentration 10 - 20 times FDA allowable level.

5. a) Relative to whole Lake Michigan input presently at 5000-8000 kg PCB/yr, present input is insignificant.

b) Past input however may have ranged from 15% to 100% of PCB from other external sources.

c) For 4000 kg/yr for 1952-1972, peak whole Lake Michigan water concentration: 4 ng/l

d) For "background" levels of 4 to 8 ng/l, Waukegan Harbor may have accounted for 25-50% of whole Lake Michigan water concentration

6. a) Removal of PCB sediment to 100 μg/g: significant drop in within-Harbor fish PCB concentration

b) Removal to 10 μg/g: Fish PCB concentrations of 2-5 μg/g

c) Removal to 1 μg/g: No marked improvement beyond 10 μg/g removal level.

RECOMMENDATIONS

1. New sediment core data be analyzed with expanded bed sediment model (more than one sediment segment)

2. Long term calculations be conducted to approximately calibrate to sediment core data - estimate past flux from Harbor.

3. For past input condition, expand model spatially to estimate regional influence.

4. Obtain, compile + analyze PCB in fish for Harbor and surrounding waters.

5. For No Action alternative, estimate how long before Harbor would decline in PCB levels to acceptable fish concentrations.

071

U.S. Department of Justice

United States Attorney
Northern District of Illinois

ENFORCEMENT SENSITIVE

United States Courthouse
Chicago, Illinois 60604

JTH:ls
#78,0475

December 4, 1981

Michael Pope, Esquire
Phelan, Pope & John
30 North LaSalle Street
Chicago, Illinois 60602

Re: United States v. Outboard Marine Corporation and Monsanto Company
No. 78 C 1004 - (USDC ND IL ED)

Dear Michael:

Enclosed are copies of the worksheets of Dr. Thomann which you requested at his deposition. All of these documents relate to Dr. Thomann's final report. Dr. Thomann has been unable to locate any documents relating to preliminary drafts, so with the enclosed documents, we have produced all of his files except for the draft reports which we have previously declined to produce.

Very truly yours,

DAN K. WEBB
United States Attorney

BY: JAMES T. HYNES
Deputy Chief, Civil Division

Enclosures

cc: See Page Two.

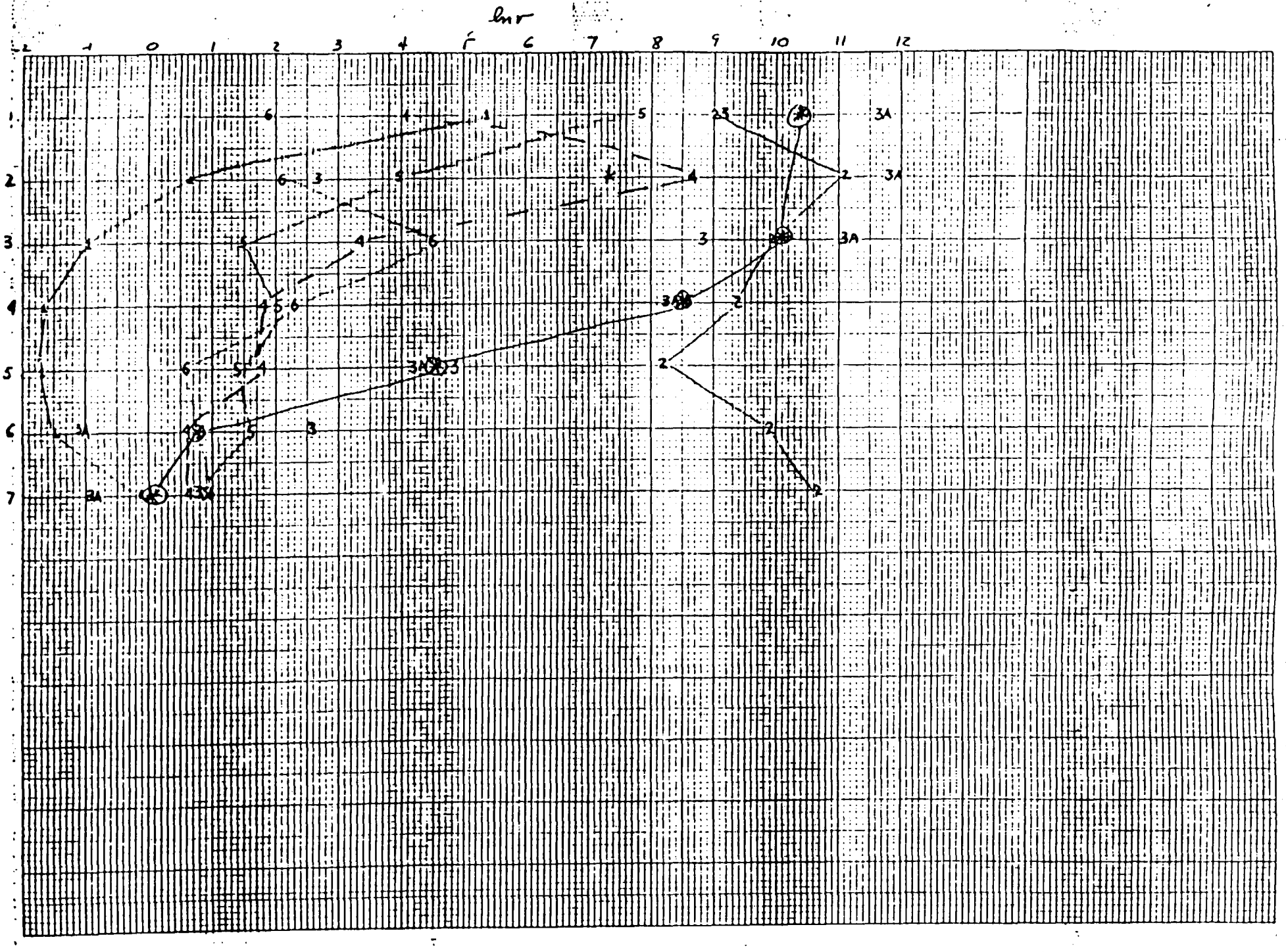
16-5V28.0/071

cc: Bruce Featherstone, Esquire (w/enc.)
Kirkland & Ellis
200 East Randolph Drive
Chicago, Illinois 60601

M. Kaye Jacobs, Esquire (w/enc.)
Water Enforcement Division
U.S. Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604

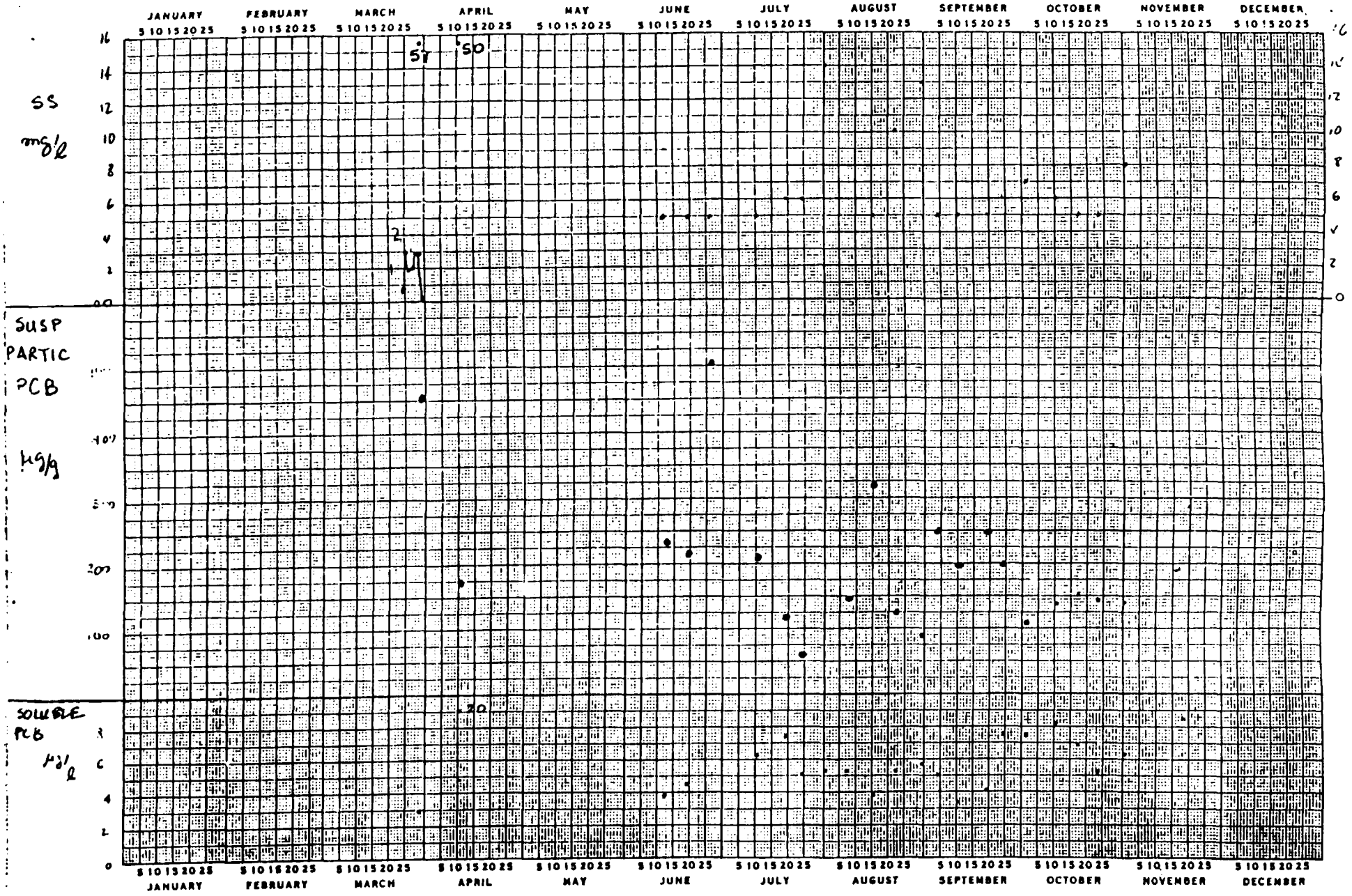
DATA & DATA PLOTS

K·E 10 X 10 TO ICH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1326



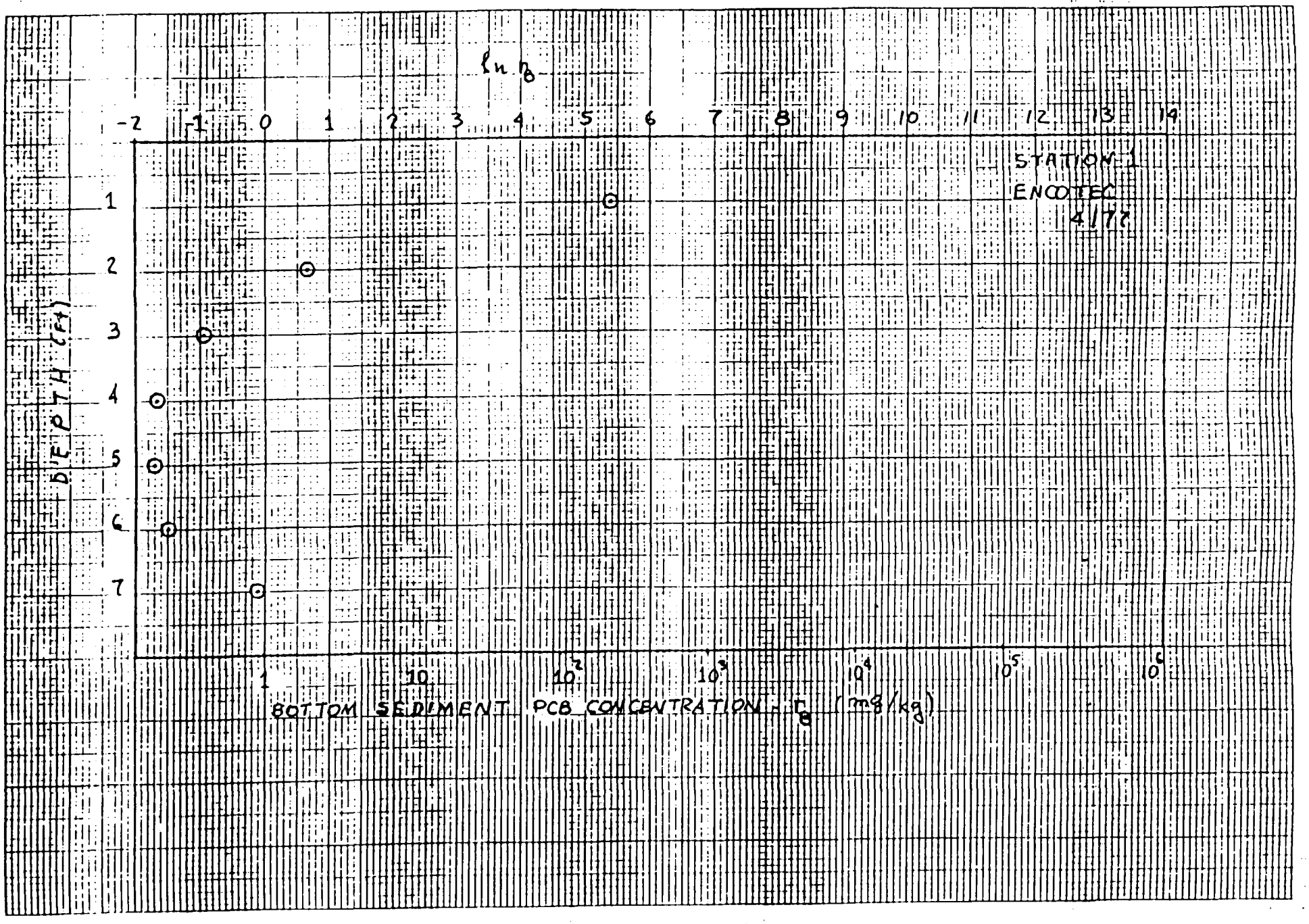
K+E 1 YEAR BY DAYS X 250 DIVISIONS KEUFFEL & ESSER 46 2890 MADE IN U.S.A.

DATA @ FOOTBRIDGE



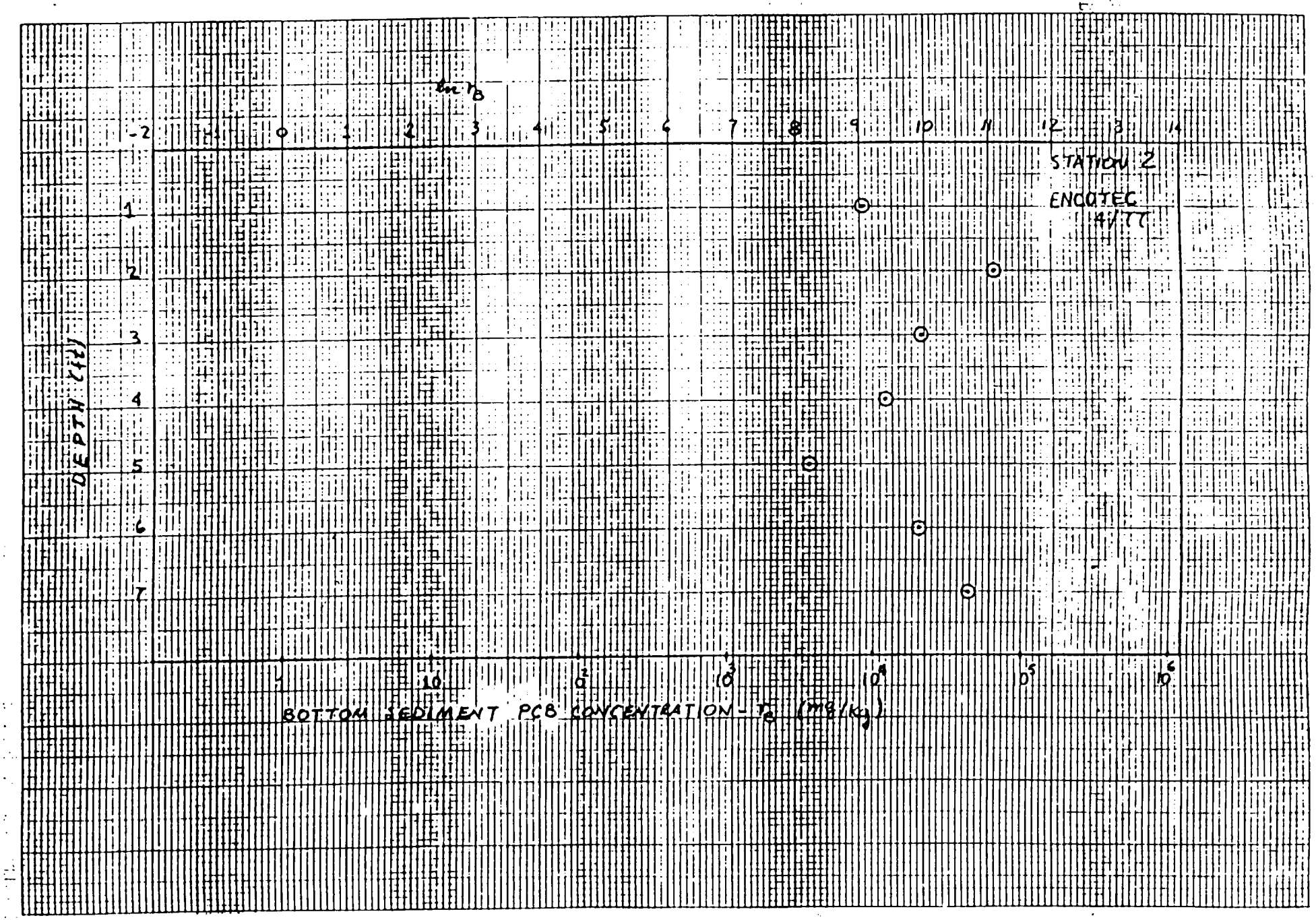
1979

K·E 10 X 10 TO 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1326



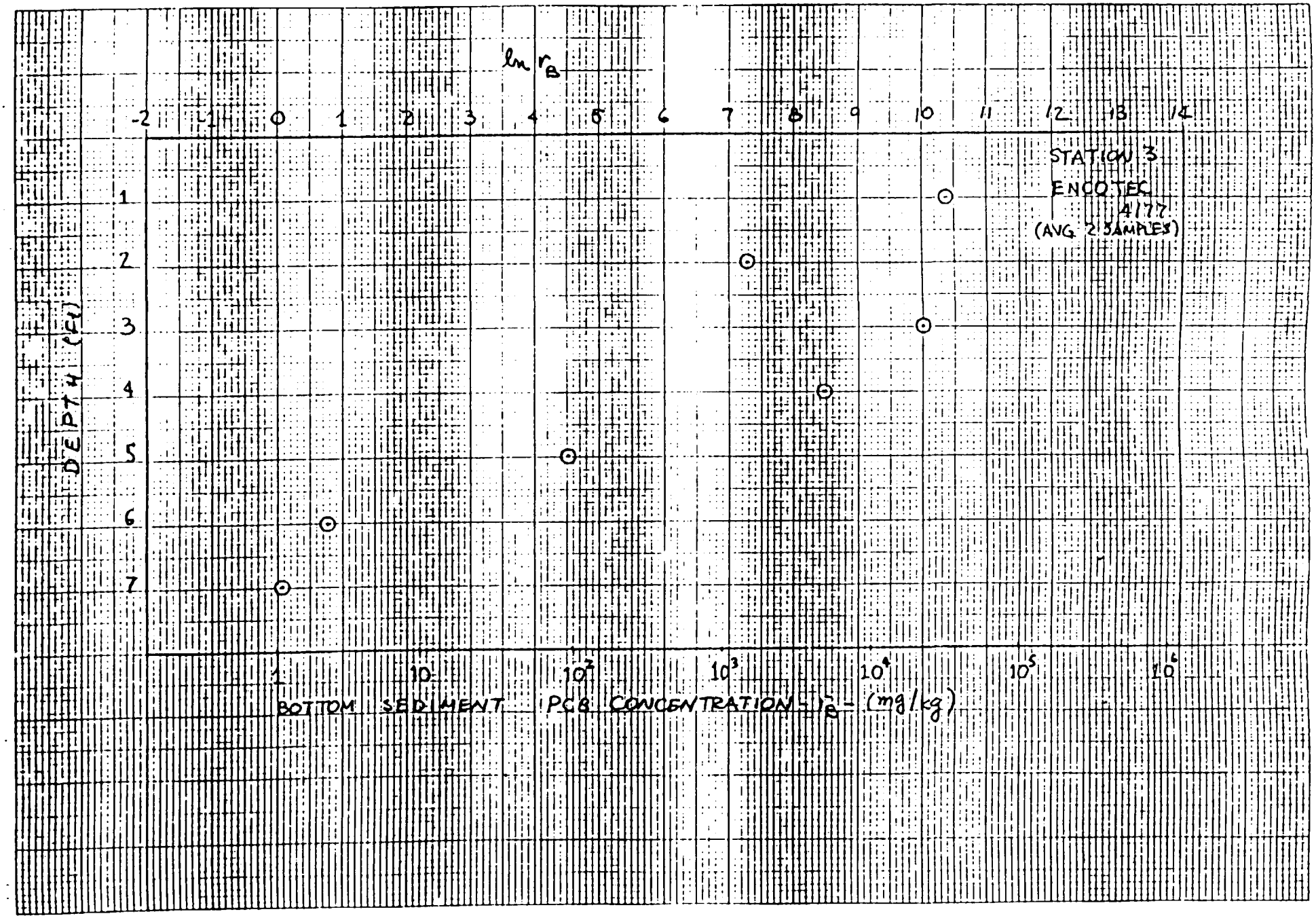
K·E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER MADE IN U.S.A.

'6 1326

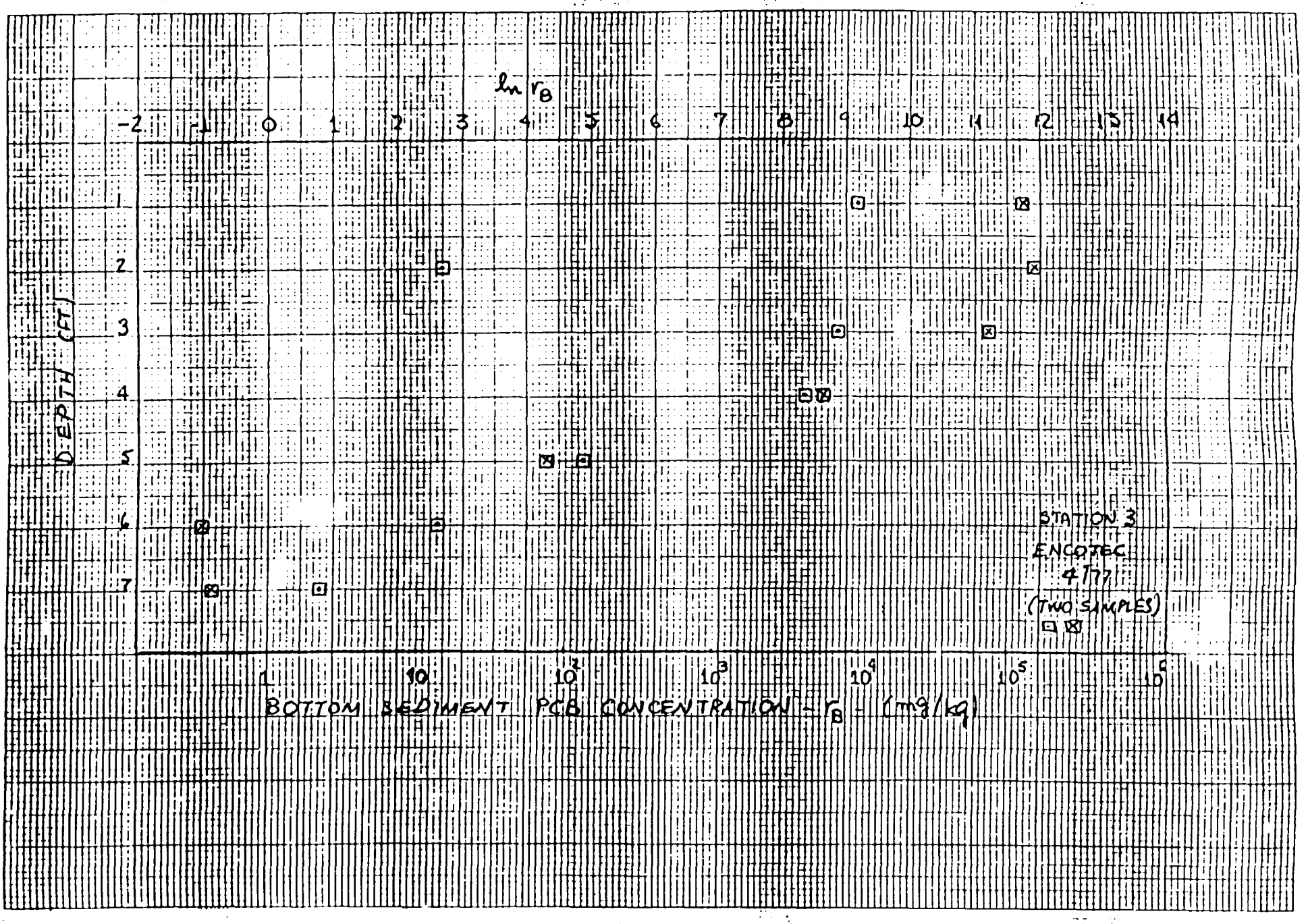


K+E 10 X 10 TO ... 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

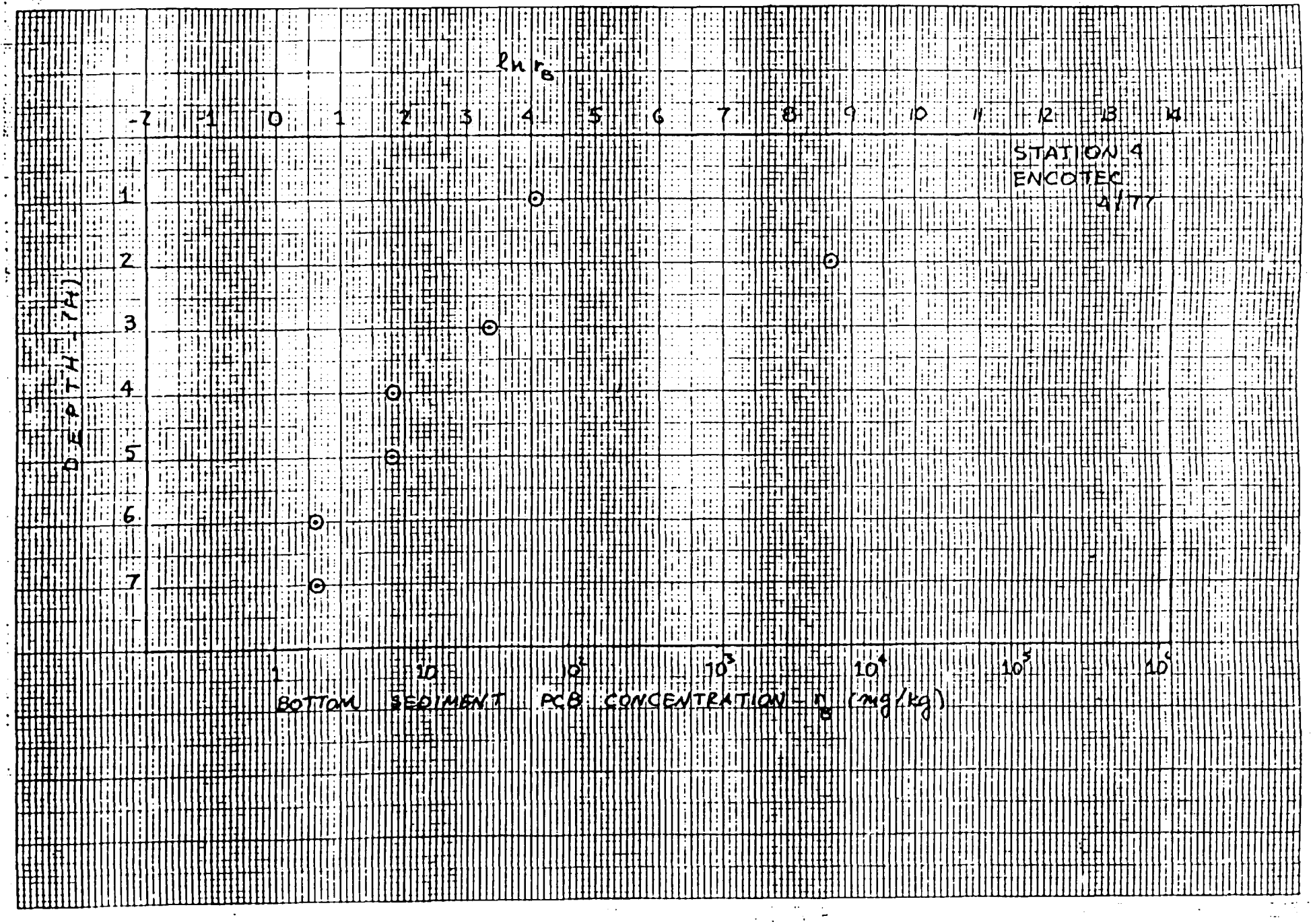
46 1326



K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

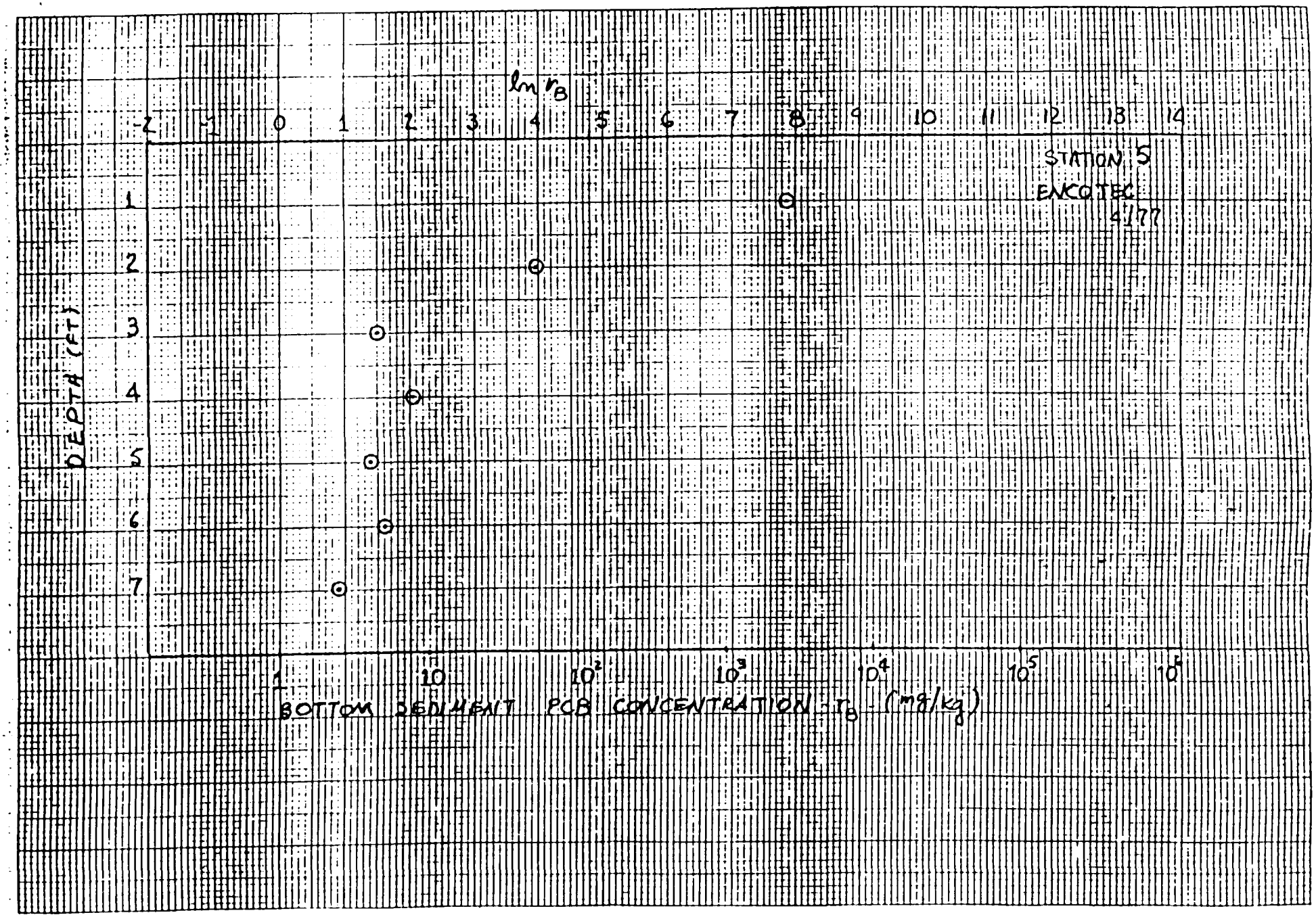


K-E 10 X 10 TO ICH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

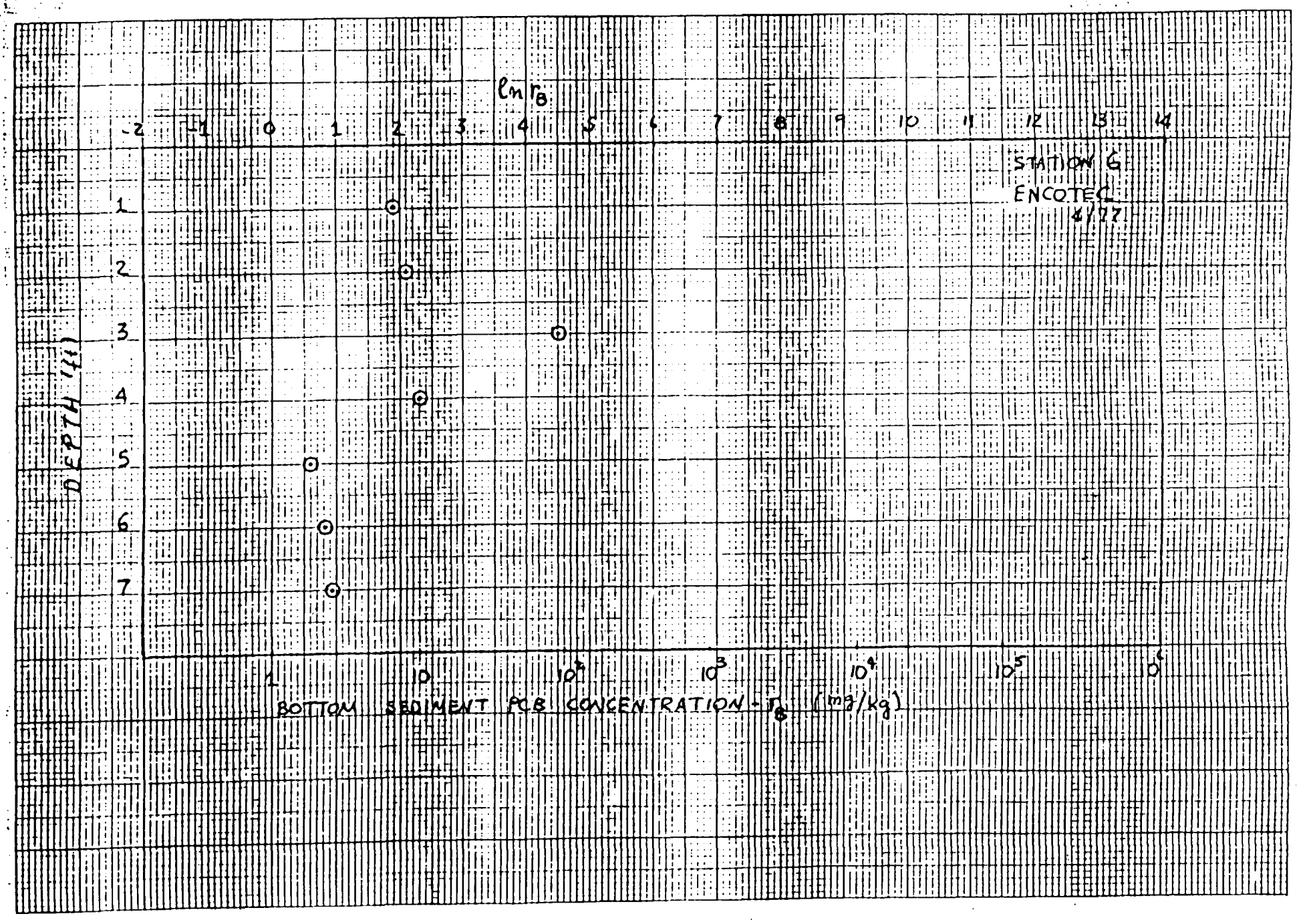


K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

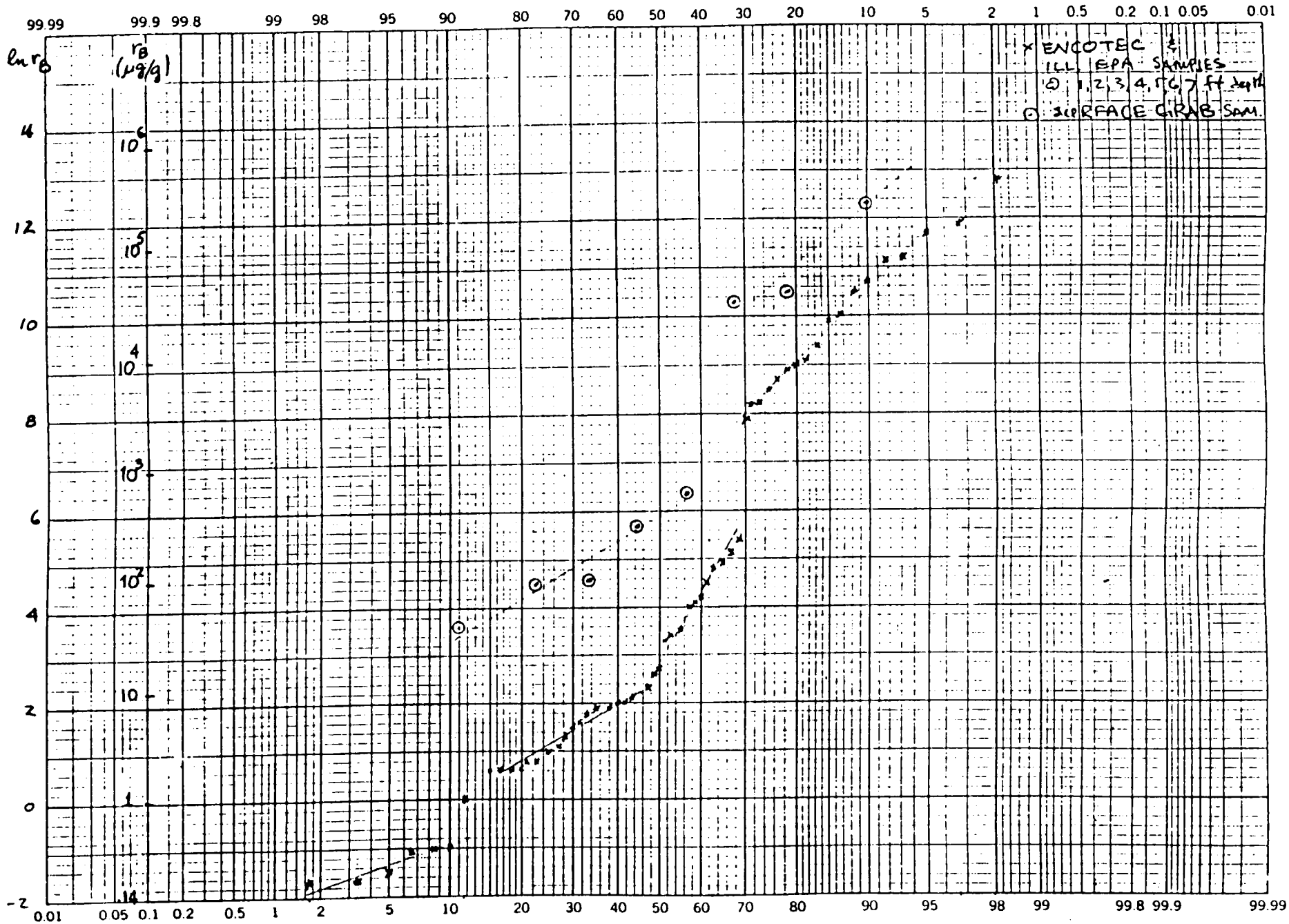
46 1326



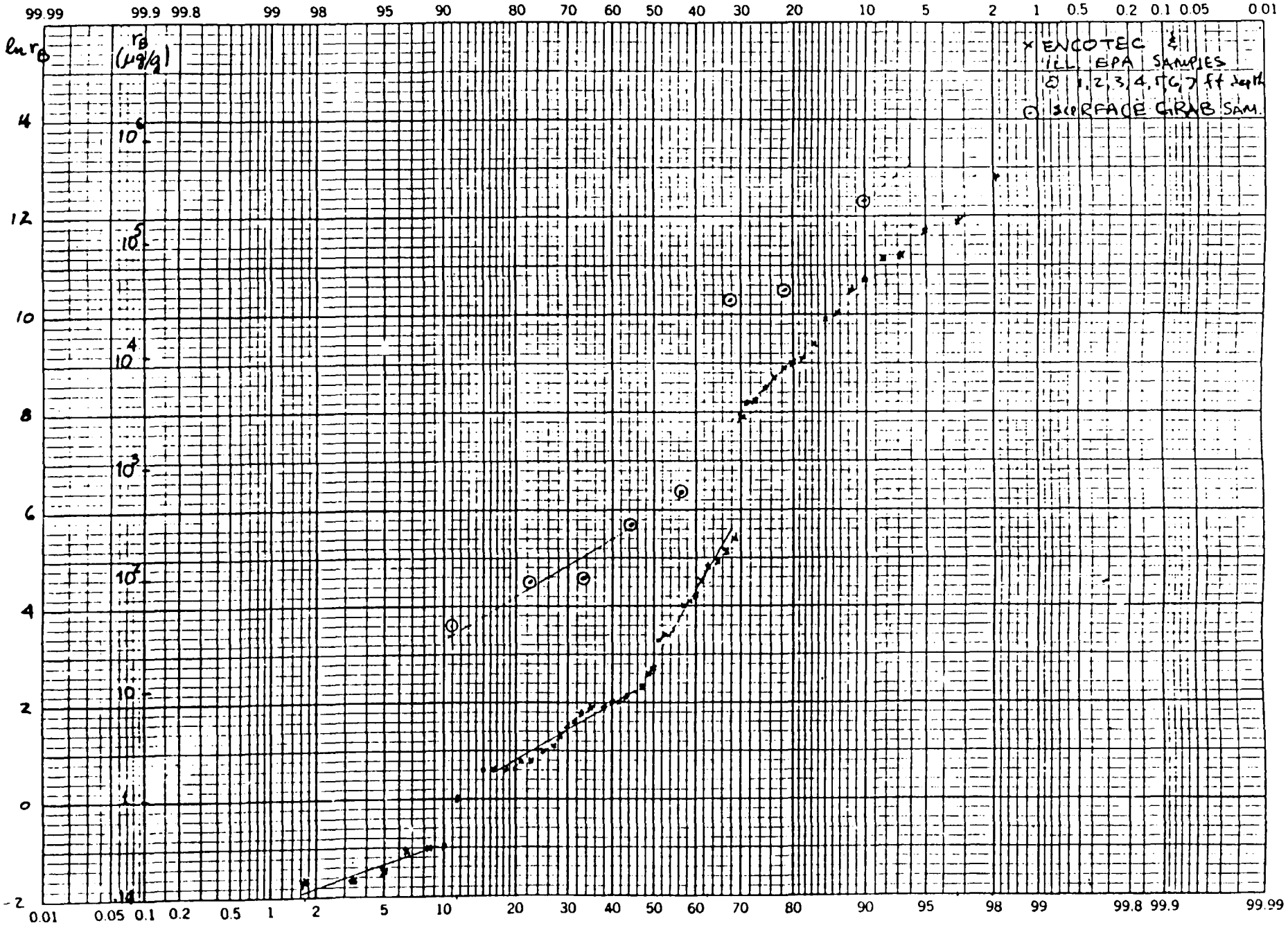
K·E 10 X 10 TO ICH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1326

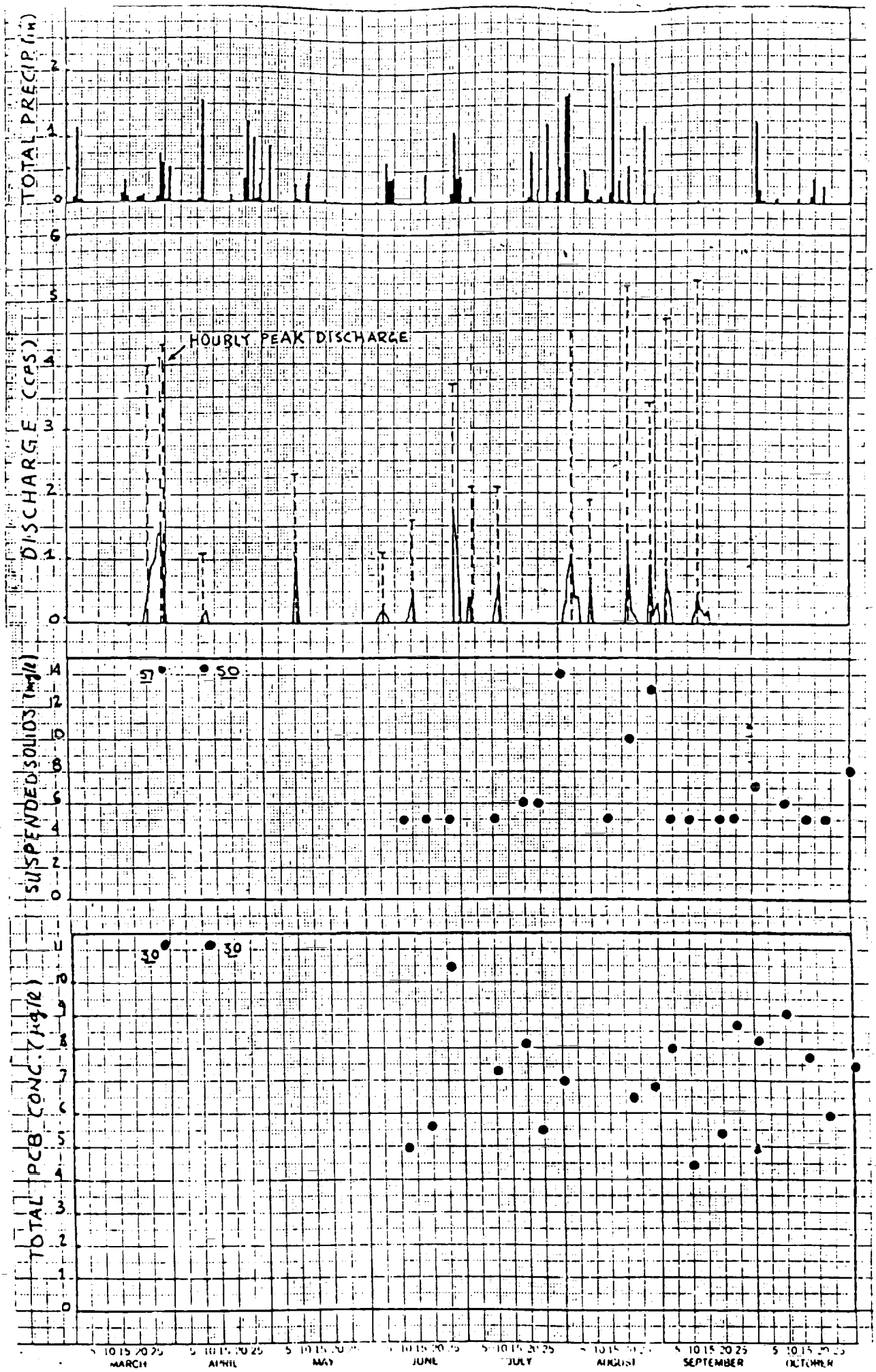


K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8000



K·E PROBABILITY 90 DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 46 8000




TOTAL PRECIP (in)
DISCHARGE (CFS)
HOURLY PEAK DISCHARGE
SUSPENDED SOLIDS (mg/l)
57
50
TOTAL PCB CONC. (µg/l)
30
30
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

Suspended solids & Tot PCB

m	C_T	Date
5	4.96	6/13
5	5.60	6/20 *
5	10.46	6/27
5	6.57	
5	7.25	7/11
6	8.1	7/20
6	5.45	7/25 *
14	6.97	8/1
5	5.36	8/16
10	6.54	8/23 *
13	6.8	8/30
5	7.95	9/5
5	4.39	9/11
5	5.34	9/20
5	8.63	9/25
7	8.21	10/2 *
6	9.05	10/11
5	7.705	10/18

m	C_T	Date
5	5.98	10/20
7	7.44	* 11/1
$\bar{x} = 6.5$	$\bar{x} = 6.938$	
$\sigma = 2.7$	$\sigma = 1.545$	
	$x + \sigma = 8.483$	
	$x - \sigma = 5.393$	

NORTH DITCH : BOTTOM SEDIMENT DATA

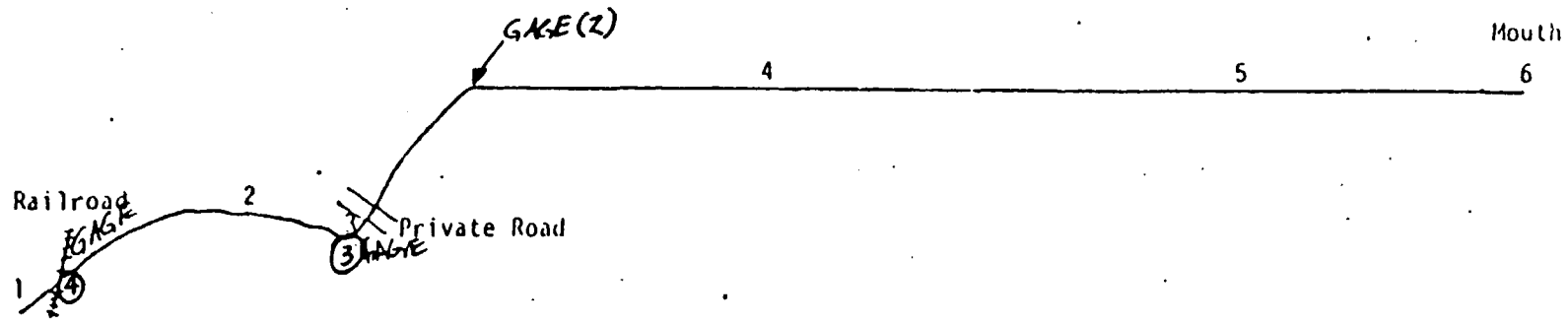
ENCOTEC and ILLINOIS (EPA) 2/77

		(STA ++)
	.18	(15)
	.19	(14)
	.23	(16)
	.33	(36)
	.37	(37)
	.38	(13)
	.99	(17)
(2)	1.8	(46) (65)
	1.9	(12)
	2.2	(57)
	2.3	(66)
	2.4	(37)
	2.5	(67)
	2.6	(47)
	3.0	
	4.1	(55)
	4.5	(52)
	5.0	(56)
	6.1	(45)
	6.5	(61)
(2)	6.6	(44)
	7.3	
	7.7	(54)
	8.4	(62)
(2)	9.9	(64)
	14.	(36)
	15.	(32)
	27.	
	29.	(43)
	33.4	
	54	52
	62	41
	67	(35)
	90	(63)
	122	
	130	(35)

40	172	
	220	(11)
42	2600	51
	3700	(25)
	3800	(34)
	5100	(34)
46	6000	(42)
	7100	
	8300	(21)
49	8700	(31)
10	12000	(24)
11	19000	26
12	21000	23
13	38000	
	44000	27
15	69000	(22)
16	73000	
17	115000	(31)
18	145000	(32)
	376000	

n = 59 Data pnts

n + 1 = 60 pts



PCB Concentration mg/kg-ppm	1	2	3	4	5	6	
Grab at Surface	▫ 36.7 ∘ 87	▫ 32,000 ∘ 246,000	∘ 34,900	∘ 300	▫ 100 ∘ 620	∘ 1.6	▫ 0.043 ∘ 1.2
Core at 0.3 m (1 ft)	• 220	• 8,300	Sample 3-3A • 8700-115,000	• 62	+33.41 +27.07 • 2600	• 6.5	
Core at 0.6 m (2 ft)	• 1.9	• 69,000	• 15-145,000	• 6000	+9.91	• 54	• 8.4
Core at 0.9 m (3 ft).	• 0.38	• 21,000 • 376,000	• 7100-73,000 +172	• 29	+6.56	• 4.5 7.3	• 90
Core at 1.2 m (4 ft)	• 0.19	• 12,000	• 5100-3800	• 6.6	+122	• 7.7	• 9.9
Core at 1.5 m (5 ft)	• 0.18	• 3,700 • 38,000	• 130-67	• 6.1		• 4.1 <1.0	• 1.8
Core at 1.8 m (6 ft)	• 0.23	• 19,000	• 14-0.33 +3	• 1.8		• 5.0	• 2.3
Core at 2.1 m (7 ft)	• 0.99	• 44,000 • 24,000	• 2.4-0.37	• 2.6		• 2.2	• 2.5

Scale: 1" = 300'

∘ USEPA June 9, 1976
▫ Illinois EPA June 9, 1976
+ Illinois EPA 2/16-18/1977
• ENCOTEC April 1977

FIGURE 14. PCB Concentration Profile in the North Ditch

NORTH DITCH SEDIMENT DATA

ENCOTEC DATA (BATTELLE)

Geom Avgs Across the Ditch for each depth for stations 1 throug 6

1 ft	1100 µg/g
2 ft	360 µg/g
3 ft	240 µg/g
4 ft	80 µg/g
5 ft	16 µg/g
6 ft	6 µg/g
7 ft	6 µg/g

Geom Avgs for each Station for 1 through 7 ft depths

sta 1	1.	µg/g
sta 2	17,200	µg/g
sta 3	366	µg/g
sta 4	21	µg/g
sta 5	16	µg/g
sta 6	6	µg/g

SURFACE PCB (µg/g)

①	②	③	④	⑤
55 µg/g	89000	35000	300	250

RAINFALL 1979

1979 ANALYSIS - Precipitation

From (365 - Feb) 337 days for which data exist.

Of the 337 days, 225 days of no rain .33 = 112/337
112 " of some rain

→ it rains or av. every 3rd d

For the 112 days of rain there is a total of 37.4 in or

av. tot. precip. every third day $\frac{37.4 \text{ in}}{112 \text{ d}}$ = .33 in/d.

Precip			
0		225	
.01	0.10	54	→ 48% of rainy days at max .1"/d .1 cfs @ 10 mg/l
.11	1.0	49	→ 44%
<1		9	8%

1979 Rainfall

WAUKEGAN, ILL

TOT in/day

D ↓	1	2	3	4	5	6	7	8	9	10	11	12
	.73			.01	.02		.42	⊗			.56	.05
	.02			.53						1.73		
			.10		.83			.51		.18		
			1.84				.08	.05		.02		
			.04	.02		.03	.01	1.63	⊗			
			.03	.03				1.66			.08	
											.12	.08
				.02		.63				.02	.06	.03
						.37		.51				
						.40		.38	⊗		.09	
				.07	.28	.01	⊗	.03		⊗		
	.05			1.56	.05						.11	.07
				.03	⊗	⊗		.04				
					.28			.10	.02			
					.43			⊗		.02	.05	
	.11											
	.04							.16				.1
			.16			.01		2.20		⊗		
			.33			.01		.01		.11		
			.09		.02	.45	⊗	.34	⊗	.32	.03	
				.11				.05			.96	
				.01			.07				.19	.01
		.3	.08		.01		.78	.57		.23	.11	.50
			.08				.01	.01		⊗		.31
			.12	.36			.19		⊗			.79
				1.23							.61	
				.01		⊗		.22			.08	
				.98		.14	1.45	.25			.05	
			.10	.05		1.92		.67				
			.73	.28		.37		⊗				
			.60				.15					

1.08 3.6 5.3 1.92 3.63 3.16 9.39 .02 2.15 3.57 3.18 = 36.32 in

✓ 4 5 (1) 13 16 8 11 9 19 1 8 14 9 = 117/365-30 = .33

W/d .276 .331 .24 .33 .35 .494 .02 .269 .255 .398

× 1

No Rain 28 × 18 14 23 19 22 12 29 23 16 22 = 225

26

RAINFALL 77

~~.258~~ .37	.01	(42)	.05	卌 卌 卌 卌 卌 卌 卌 卌 ||
~~.123~~ .12	.06	(14)	.10	卌 卌 ||||
.06	.10	(7)	.15	卌 ||
.05	.16	(6)	.2	卌 |
.03	.21	(3)	.25	|||
.04	.26	(4)	.3	||||
.04	.31	(4)	.35	||||
.04	.36	(5)	.40	卌
.03	.41	(3)	.45	|||
.01	.46	(1)	.50	|
.03	.51	(3)	.55	|||

.56	(3)	.60	|||	.03
.61	(1)	.65	|	.0
.66	(2)	.7	||	.02
.71	(2)	.75	||	.02
.76	(2)	.8	||	.02
.81	(1)	.85	|	.c
.86	(0)	.9		c
.91	(0)	.95		c
.96	(2)	1.0	||	.c

< 1

1.14 -
1.23 -
1.63 -
1.66 -
1.56 -
2.20 -
1.23 -
1.45 - 1/2

(9)

.01

RAINFALL 79

	0		214
.01		.1	56
.1		1.	49
	<1		9

1 2 3 4 5 6 7 8 9 10 11 12

RAINFALL 75

~~MARCH~~		dys R	dys N.R.	PPT
30	June	11		3.63
31	July	9		3.16
31	Aug	19		9.39
30	SEPT	1		.02
31	OCT	8		2.15
153		48	105	18.35

it rains approx every 3rd day => .38 in / day

.01	.10	𝍸 𝍸 𝍸 IIII	19	40
.11	1.0	𝍸 𝍸 𝍸 𝍸 III	23	48

<1

1.23 Oct 2
~~Oct~~
1.63 Aug 8
1.66 Aug 9
2.2 Aug 18
1.45 July 28
1.12 Jun 29

6
48

DRAFT COPY
SUBJECT TO REVISION

OFFICE CDO

SUBJECT NORTH DITCH AT OMC WAUKEGAN, IL LAKE MICHIGAN

COMPUTATION 79C138 - BM7 Where North Ditch Comes out east of Pcesting Rd

COLLECTED BY STREAM-INFLUENT

CHECKED BY

DATE 790330

PAGE

(1) Sample#	(2) TIME	(3) TEMP (°C)	(4) DEPTH	(5) Aroclor 1242 PCB	(6) Aroclor 1242 PCB	(7) Aroclor 1254 PCB	(8) Aroclor 1260 PCB	(9) SEDIMENT Aroclor 1242	(10) SS (105°C) mg/L
				WATER SAMPLES					
S01	1430		0.39	<0.1	0.3	<0.1	<0.1		10
S02	1430		0.39					20	
S03	1530	12.2	0.60	<0.1	0.5	<0.1	<0.1		26
S04	1530	12.2	0.60					28	
S05	1615	11.7	0.84	<0.1	0.5	<0.1	<0.1		30
S06	1615	11.7	0.84					<10	
S07	1650	11.4	0.85	<0.1	[illegible]	<0.1	<0.1		49
S08	1650	11.4	0.85					13	
S09	1730	11.4	0.83	<0.1	0.4	<0.1	<0.1		58
S10	1730	11.4	0.83					10	
S11	1835	11.0	0.76	<0.1	0.2	<0.1	<0.1		70
S12	1835	11.0	0.76					10	
S13	1945	10.2	0.72	<0.1	0.4	<0.1	<0.1		70
S14	1945	10.2	0.72					<1	
S15	2055	9.2	0.64	<0.1		<0.1	<0.1		59
S16	2055	9.2	0.64					<4	
S17	2205	8.5	0.58	<0.1	0.6	<0.1	<0.1		32
S18	2205	8.5	0.58					4.8	
S19	2255	7.6	0.56	<0.1	0.3	<0.1	<0.1		31
S20	2255	7.6	0.56					3.3	
R21				<0.1	<0.1	<0.1	<0.1		<5

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SUBJECT NORTH DITCH AT OMC WAUKEGAN, IL.

COMPUTATION 79 CL 37 - BM-2 at Footbridge

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(1) Sample#	(2) TIME	(3) °C Temp	(4) Depth	(5) WATER Aroclor 1242 PCB	(6) Aroclor 1248 PCB	(7) Aroclor 1254 PCB	(8) Aroclor 1260 PCB	(9) Sediment Aroclor 1221 PCB	(10) SS (105°C) mg/l
S01	1410		0.71	<1	6.5	<0.1	<0.1		11
S02	1410		0.71					400	
S03	1500	12	0.80	<1	12.2	<0.1	<0.1		34
S04	1500	13	0.80					160	
S05	1600	13.2	0.89	<1	70.0	<0.1	<0.1		175
S06	1600	13.2	0.89					77	
S07	1630	12.0	0.96	<1	30.0	<0.1	<0.1		134
S08	1630	12.0	0.96					290	
S09	1715	12.0	0.97	<1	94	<0.1	<0.1		84
S10	1715	12.0	0.97					915	
S11	1815	11.8	0.92	<1	40.2	<0.1	<0.1		34
S12	1815	11.8	0.92					390	
S13	1930	11.0	0.70	<1	10.8	<0.1	<0.1		20
S14	1930	11.0	0.70					130	
S15	2025	10.4	0.65	<1	9.2	<0.1	<0.1		24
S16	2025	10.4	0.65					1750	
S17	2130	9.6	0.60	<1	13.3	<0.1	<0.1		28
S18	2130	9.6	0.60					225	
S19	2225	9.5	0.56	<1	11.8	<0.1	<0.1		29
S20	2225	9.5	0.56					185	
R21				<0.1	<0.1	<0.1	<0.1		
D09				<1	100.6	<0.1	<0.1		101
D19				<1	8.8			790	26
D10								205	
D20									

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SUBJECT NORTH DITCH AT CMC WAUKEGAN, IL. BM 1 (Foot Bridge)

COMPUTATION 79C1 39 — (near East property line)

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DATE	(1) SAMPLE#	(2) TIME	(3) TEMP	(4) staff gauge Ht. (FLOW)	(5) WATER SAMPLES AROCLOR 1242	(6) AROCLOR 1248	(7) AROCLOR 1254	(8) AROCLOR 1260	(9) SLUDGE AROCLOR 1248	(10) mg/l SS (105°C)
4/11/79	S01	2030	4	1.72	<1.0	3.03	<0.1	<0.1	mg/l	<5
	S02	2030	4	1.72					201	
	S03	2130	4	1.79	<1.0	16.5	<0.1	<0.1		43
	S04	2130	4	1.79					236	
	S05	2240	4	1.58	<1.0	49.7	<0.1	<0.1		59
	S06	2240	4	1.58					115	
4/12/79	S07	0045	3	1.7	<1.0	[illegible]	<0.1	<0.1		57
	S08	0045	3	1.7					255	
	S09	0200	3	1.6	<1.0	21.2	<0.1	<0.1		40
	S10	0200	3	1.6					48.5	
	S11	0400	4	1.42	<1.0	11.7	<0.1	<0.1		71
	S12	0400	4	1.42					130	
	S13	0500	3	1.4	<1.0	9.42	<0.1	<0.1		77
	S14	0500	3	1.4					95	
	S15	0600	4	1.5-1.7	<1.0	20.0	<0.1	<0.1		51
	S16	0600	4	1.5-1.7					325	
	S17	0715	4.5	1.45	<1.0	6.64	<0.1	<0.1		
	S18	0715	4.5	1.45						
	S19	1030	7	0.99			<0.1	<0.1		
	S20	1030	7	0.99						
	R21				<0.1	<0.1	<0.1	<0.1		
	D09				<1.0	21.6	<0.1	<0.1		
	D19						<0.1	<0.1		

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SUBJECT NORTH DITCH AT OMC WAUKEGAN BM 7

COMPUTATION 79CL40- Upstream Location - at Pershing R

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(1) Sample #	(2) Time	(3) (°C) Temp	(4) Depth	(5) Water Samples Aroclor 1242 PCB	(6) Aroclor 1248	(7) Aroclor 1254	(8) Aroclor 1260	(9) Sediment Aroclor 1248 mg/kg	(10) SS (105°C) mg/l
S01	2045	5	0.43	<0.10	0.72	<0.10	<0.10		334
S02	2045	5	0.43					5.5	
S03	[illegible]	3	[illegible]	<0.10	0.28	<0.10	<0.10		121
S04	[illegible]	3	[illegible]					0.8	
S05	2320	2.5	1.35	<0.10	0.23	<0.10	<0.10		141
S06	[illegible]	2.5	1.35					2.3	
S07	120	[illegible]	1.08	<0.10	0.19	<0.10	<0.10		122
S08	120	3	1.08					2.5	
S09	230	2	1.00	<0.10	0.10	<0.10	<0.10		85
S10	230	2	1.00					<3.5	
S11	425	4	0.9	<0.10	0.11	<0.10	<0.10		57
S12	425	4	0.9					<2.0	
S13	520	4	0.75	<0.10	0.10	<0.10	<0.10		50
S14	520	4	0.75					<2.0	
S15	625	4	0.64	<0.10	<0.10	<0.10	<0.10		37
S16	625	4	0.64					<7.0	
S17	730	4	0.59	<0.10	<0.10	<0.10	<0.10		30
S18	730	4	0.59					<3.5	
S19	1018	8	0.53	<0.10	<0.10	<0.10	<0.10		19
S20	1018	8	0.53					<5.5	
R21				<0.10	<0.05	<0.10	<0.10		
B09				<0.10	0.15	<0.10	<0.10		
D19				<0.10	<0.10	<0.10	<0.10		21
D20								<5.5	

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FILE NO.

SUBJECT OMC - NORTH DITCH (FOOTBRIDGE) SAMPLING

COMPUTATION

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(1) Sample #	(2) Date	(3) Time	(4) Temp	(5) (Gage height) Depth	(6) S.S. mg/l	(7) Chloride mg/l	(8) * ug/l ** mg/kg Aroclor 1248	(9) Lead ug/l	(10)
79CL53									
S01	5-11-79	1207	19.0	1.13					
S02	5-11-79	1207	19.0	1.13					
S03	5-11-79	1207	19.0	1.13					
S04	5-11-79	1207	19.0	1.13					
S05	5-11-79	1207	19.0	1.13					
S06	5-11-79	1207	19.0	1.13					
79CL54									
S01	5-17-79	1315	18.6	1.19			4.02		
S02	5-17-79	1315	18.6	1.19			4.14		
R03	5-17-79	1315	~~18.6~~	~~1.19~~			< 0.2		
79CL55									
S01	5-23-79	1105	17.5	0.3			4.00		
S02	5-23-79	1105	17.5	0.3			3.68		
R03	5-23-79	1110	~~17.5~~	—			< 0.1		
79CL56									
S01	5-30-79	1411	19.	2.07	6	59	4.14		
S02	5-30-79	1411	19.	2.07			3.32		
R03	5-30-79	1411	—	—			<0.1		
79CL57									
S01	6-6-79	1030	19.	2.24	7	54	3.60		
S02	6-6-79	1030	19.	2.24			3.50		
R03	6-6-79	1030	—	—			<0.1		
79CL58									
S01	6-13-79	1345	22.0	1.	K5	51	3.82*	K2	
S02	6-13-79	1345	22.0	1.			229**		
R03	6-13-79	1345	—	—			<0.19*	K2	
79CL59									
S01	6-20-79	1355	23.	2.72	K5	33	4.53*	K2	
S02	6-20-79	1355	23.	2.72			214**	K2	
R03	6-20-79	1355	—	—			<0.10*	K2	
79CL60									
S01	6-27-79	1015	20.	2.86	K5	34	7.93*	K2	
S02	6-27-79	1015	20	2.56			505**		
R03	6-27-79	1015	—	—			<0.12*	K2	
79CL61									
S01					K5	65	5.98*		
S02							117**		
R03							<0.16*		

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FILE NO.

SUBJECT OMC NORTH DITCH (FOOTBRIDGE) SAMPLING

COMPUTATION

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(1) Sample #	(2) Date	(3) Time	(4) Temp	(5) Gage Height	(6) Suspended Solids mg/l	(7) Chloride mg/l	(8) * µg/l ** mg/kg Aroclor 1248	(9) Lead µg/l	(10)
79CL62									
S01	7-11-79	1505	25	1.74	K5	48	6.2 *		
S02	7-11-79	1505	25	1.74			210 **		
R03	7-11-79	1505	—	—			K0.1 *		
79CL63									
S01	7-20-79	1134	19.	1.32	6	38	7.4 *		
S02	7-20-79	1134	19.	1.32			116.0 **		
R03	7-20-79	1134	—	—			K0.1 *		
79CL64									
S01	7-25-79	0940	24.	1.64	6	27	5.1 *		
S02	7-25-79	0940	24.	1.64			58 **		
R03	7-25-79	0940	—	—			K0.1 *		
79CL65									
	8-1-79	1049	20	1.76	14	49	5.33 *		
	8-1-79	1049	20	1.76			117 **		
	8-1-79	1049	—	—			K0.1 *		
79CL88									
S01	8-8-79	1407	25	1.46			5.3 *	4.9	
S02	8-8-79	1407	25	1.46			146 **		
R03	8-8-79	1407	—	—			K0.05 *	K2	
79CL89									
S01	8-16-79	1030	17	2.00	K5	48	3.8 *	6.3	
S02	8-16-79	1030	17	2.00			312 **		
R03	8-16-79	1030	—	—			K0.08 *	K2.0	
79CL90									
S01	8-23-79	1017	21	1.40	10	39	5.3 *	8.0	
S02	8-23-79	1017	21	1.40			123.7 **		
* R03	8-23-79	1017	—	—			K0.08 *	K2	
79CL92									
S01	9-5-79	1310	23.5	1.49	K5	64	6.7 *	K2	
S02	9-5-79	1310	23.5	1.49			249 **		
R03	9-5-79	1310	—	—			K0.1 *	K2	
79CL98									
S01	9-11-79	1125	21	2.82	K5	38	3.4 *	K2	
S02	9-11-79	1125	21	2.82			197.5 **	[illegible]	
R03	9-11-79	1125	—	—			0.4 *	K2	
79CL99									
S01	9-20-79	1225	17	2.16	K5	39	4.1 *	K2	
S02	9-20-79	1225	17	2.16			248.3 **		
R03	9-20-79	1225	—	—			K0.1 *	K2	

OFFICE

FILE NO.

SUBJECT OMC - NORTH DITCH (FOOTBRIDGE) SAMPLING

COMPUTATION

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(1) SAMPLE #	(2) DATE	(3) TIME	(4) TEMP	(5) GAGE HEIGHT	(6) SUSPENDED SOLIDS mg/l	(7) CHLORIDE mg/l	(8) * ug/l, ** mg/kg Aroclor 1249	(9) Lead ug/l	(10)
79CR01									
S01	9-25-79	1145	18	1.08	K5	44	7.6 *	K2	
S02	9-25-79	1145	18	1.08			205 **		
R03	9-25-79	1145	—	—			K=.1 *	K2	
80CL01									
S01	10-2-79	1530	15	2.50	7	18	7.45 *	11	
S02	10-2-79	1530	15	2.50			108 **		
R03	10-2-79	1530	—	—			K=.1 *	K2	
80CL02									
S01	10-11-79	1022	12	1.20	6	50	8.2 *	K2	
S02	10-11-79	1022	12	1.20			142 **		
R03	10-11-79	1022	—	—			K=.15 *	K2	
80CL03									
S01	10-18-79				K5	28	6.94 *	14	
S02	10-18-79						153 **		
R03	10-18-79						K=.1 *	K2	
80CL22									
S01	10-24-79	1000	8	2.14	K5	20	5.25 *	2.7	
S02	10-24-79	1000	8	2.14			146 **		
R03	10-24-79	1000	--	—			K=.1 *	K2	
80CL23									
S01	11-1-79	935	9	2.54	8	24	6.3 *	5.1	
S02	11-1-79	935	9	2.54			143 **		
R03	11-1-79	935	—	—			K=.1 *	K2	
80CL24									
S01	11-8-79	1005	6	2.54	K5	16		259	
S02	11-8-79	1005	6	2.54					
R03	11-8-79	1005	—	—				K2	
80CL25									
S01	11-15-79				5	38		K2	
S02	11-15-79								
R03	11-15-79							K2	
79CL91									
S01	8-30-79				13	83	5.7 *	<2	
S02	8-30-79						98.1 **		
S03	8-30-79						<0.1 *	<2	

NORMAL MONTHLY Precipitation
(chicago) (inch)

J	1.80
F	1.5
M	2.7
A	3.0
M	3.85
J	4.
J	3.5
A	3.25
S	2.75
O	2.80
N	2.25
D	2.00

~~Runoff~~ Surface Runoff

~ 8 inch

GS

Drainage Area 0.11mi²

Battelle (ENCOTEC)

260,000 m² 65 Acres

~~Dry weather flow 0.05 cfs~~

Flow: outfalls (Ind & Drainage

Area: -

Dry weather flow .05 cfs

3hr/5year storm 75 cfs

PRELIMINARY
SUBJECT TO REVISION

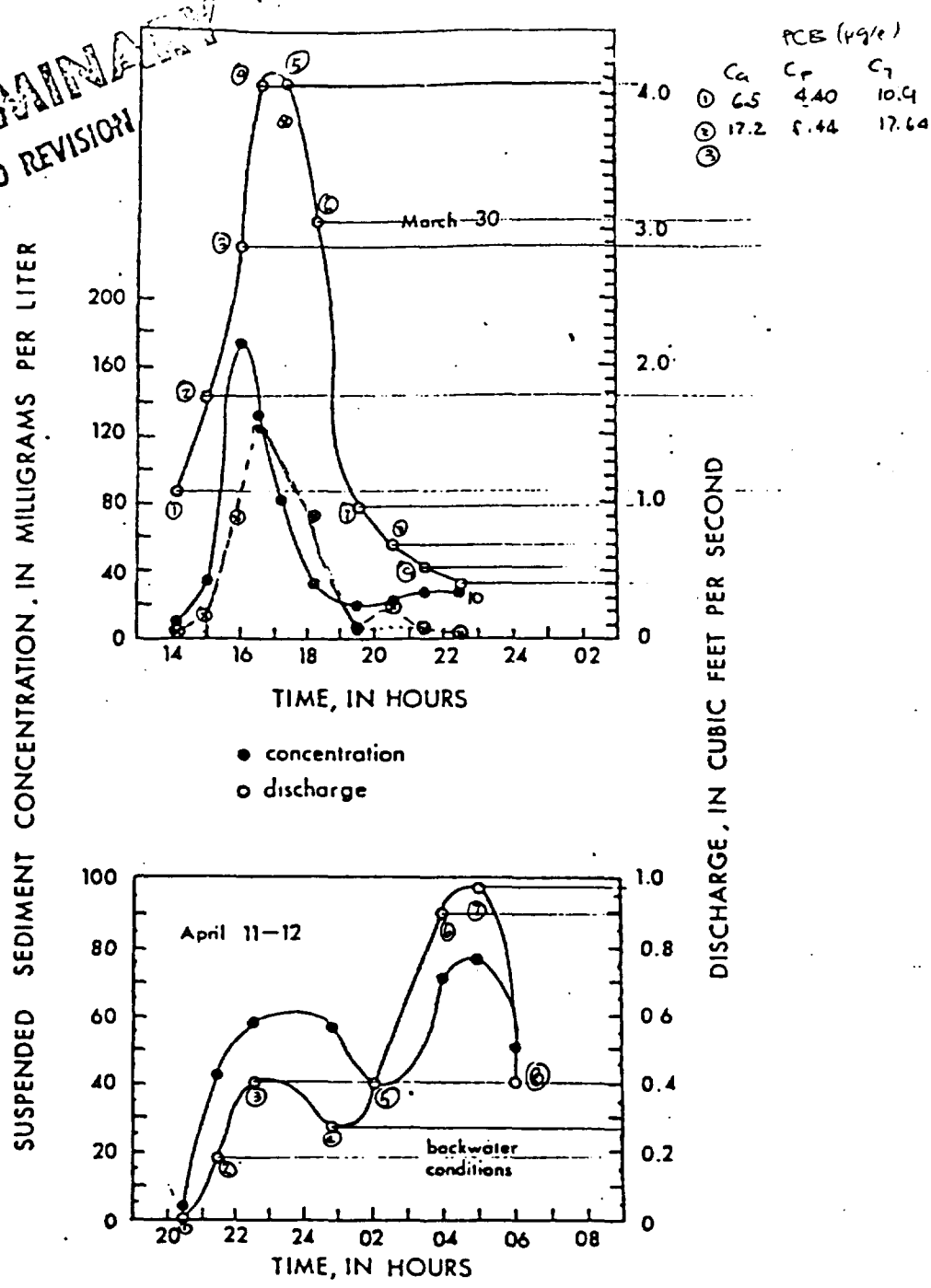


Figure 4. Sediment concentration and stream discharge at gage 1 during two runoff periods.

HUDSON-TYPE CALCULATION

CMA-TYPE CALCULATIONS

MARCH 30 and APRIL 11, 12, 1979

AVG DATA AT PERSHING ROAD (UPST) & FOOTBRIDGE (DOWNSTR).

MARCH 30.

UPSTREAM

m_{ss} = 144 mg/l

C_Q = 0.38 μg/l

r = 10 μg/g

C_P

C_T = .78 μg/l

DOWNSTREAM

m_{ss} = 57 mg/l ✓

C_Q = 30 mg/l ✓

r = 452 μg/g ✓

C_P =

C_T

APRIL, 11, 12

UPSTREAM

m_{ss} = 104 mg/l

C_Q = 0.2 μg/l

r = 3.5 μg/g

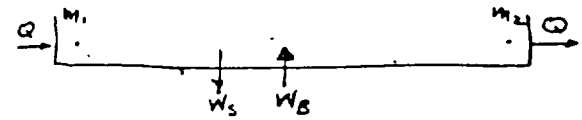
DOWNSTREAM

m_{ss} = 50 mg/l

C_Q = 19 μg/l

r = 173 μg/g

SOLIDS BALANCE



$$Q m_1 + W_B = W_s + Q m_2$$

$$Q(m_2 - m_1) = W_B - W_s$$

if $m_1 < m_2 \rightarrow$ net scouring
if $m_2 < m_1 \rightarrow$ net deposition

Net amount of sedim. load

$$Q(m_2 - m_1)$$

Amount of sediment settled

$$W_s = v_s A \langle m \rangle$$

Amount of resuspended sediment

$$W_B = v_s A \langle m \rangle + Q(m_2 - m_1).$$

Amount of sediment discharged

$$Q m_2$$

Application to March 30

$\langle Q \rangle = 1.5$ cfs

$m_1 = 44$ mg/l

$m_2 = 57$ mg/l

$\langle m \rangle = 51$ mg/l

$H = 1$ ft

$A = 3300$ ft $\times$ 20ft $\qquad v_s = 1$ ft/d

$A = 66000 \text{ ft}^2$

$A_\perp = 1\text{ft} \times 20\text{ft} = 20\text{ft}^2 \rightarrow v = \frac{Q}{A_\perp} = \frac{1.5 \text{ ft}^3}{20\text{ft sec}} = .075 \text{ ft/sec}, \quad t = \frac{V}{Q} = \frac{66000 \text{ ft}^2 \times 1\text{ft}}{1.5 \text{ft}^3} = .51$

$m_2 > m_1$ net scouring

Net amount of sedim load to water col. $= 5.4Q(m_2 - m_1) = 5.4 \times (1.5)(57-44)$

$= 105$ lb/d

Amount incomming $5.4 \times Q m_1 = 5.4 \times 1.5 \times 44 =$

$= 365$ lb/d

Amount settling @ $v_s = 1$ ft/d: $5.4 v_s A \langle m \rangle = 5.4 \frac{\text{ft}}{\text{d}} \times 66000 \text{ ft}^2 \times 51 \text{ mg/l} =$

$= 18.2 \times 10^6$ lb/d

Amount resuspended $+ 5.4 \{ v_s A \langle m \rangle + Q(m_2 - m_1) = 18.2 \times 10^6 \text{ lb/d} + 105$

$\simeq 18.2 \times 10^6$ lb/d

Amount sediment discharged $= 5.4 \times Q \times m_2 = 462$ lb/d

Amount of incomming $PCB_T = 5.4 \times Q \times C_T = 5.4 \times 1.5 \times .78 \times 10^{-3}$

$C_T = .78 \mu g/l$

$= .006$ lb/d

Amount of PCB resuspended $r_B W_B = 18.2 \times 10^6 \times 7.5 \times 10^{-3}$

$r_B = 7500 \mu g/g$

$= 7.5 \times 10^{-3}$ g/g $\qquad = 136.5 \times 10^3$ lb/d

PCB BALANCES MARCH 30

Tot. PCB from upstream → $5.4 \times Q \times C_{T_1} = 5.4 \times 1.5 \times .78\ mg/l \times 10^{-3} = 6.3 \times 10^{-3}$ lb/d

Tot PCB lost to lake = $5.4 \times Q \times C_{T_2} = 5.4 \times 1.5 \times 55.76\ mg/l \times 10^{-3} = .45$ lb/d

Net transfer across water sed interface

From sed to water = $.45 - 6.3 \times 10^{-3}$ lb/d = .44 lb/d

The bottom solids influx to water 18.2×10^6 lb/d
@ $r_B = 2400\ \mu g/g = 2.4 \times 10^{-3}\ g/g$

PCB from bottom to water $18.2 \times 10^6\ lb/d \times 2.4 \times 10^{-3} = 4.37 \times 10^4$ lb PCB/d
43700

The return to bottom through settling 18.2×10^6 lb/d
then the r_p of the settling material should be near r_B

$$C_{T1} = \frac{W_T / Q_1}{1 + K_T t_{o1}} \qquad \frac{r_2}{r_1} = 1$$

$$K_T = K_1 + B(r_2/r_1)(K_2 + K_c) \quad ; \quad r_2 = r_1$$

$K_1 = K_2 = 0$; $K_T = BK_s$

$K_s = 1 \text{ mm/yr} / .5 \text{ ft} = (10^{-3} \text{ m/y})/.5\text{ft} = \frac{10^{-3}}{.5}\frac{m}{y\,ft} = \frac{10^{-3}\, 3.3\text{ ft}}{.5\text{ ft } 365 \times 24 \times 3600} = 2.1 \times 10^{-10} \frac{1}{sec}$ (10cm) $= 2.1 \times 10^{-8} \frac{1}{spc}$

$t_o = \frac{3000\text{ft} \times 35\text{ft} \times 1\text{ft}}{1\text{cfs}} = 105 \times 10^3 \text{ sec} = 1.2\text{ d}$

$$B = \frac{m_2 H_2 f_{p1}}{m_1 H_1 f_{p2}} = \frac{10^5 (.5)(.71)}{10\ (1)\ (1)} = 3500$$

$$t_o K_T = B K_s t_{o1} = 3500 \times \underset{2.1\times10^{-8}}{2.1\times10^{-10}} \frac{1}{sec} \times 105\times10^3 = .077 \quad 7.7$$

$$C_{T1} = \frac{W_T/Q}{1 + .077} = \frac{W_T/Q}{1 + \underset{7.7}{.077}}$$

Flux out

$$Q C_{T1} = \frac{W_T}{1.077 \quad 8.7}$$

$W_{TOT} = 1.7 \times 10^6 \text{ lb/}_{13y} = 360 \text{ lb/d}$ total leakage @ 50/50 (DITCH HARGO)

$W_T = 180 \text{ lb/d} \rightarrow C_{T1} = \frac{180/1}{1.077\ 8.7} = 167 \frac{lb/d}{cfs} = \frac{167}{5.4} \text{ mg/l} = \overset{3.8}{31} \text{ mg/l} = \overset{3800}{31000} \mu g/l$

$T_1 = f_{p1} C_{T1} \frac{1}{m_1} = \frac{\pi m_1}{\phi + \pi m_1} \cdot \frac{C_{T1}}{m_1} = \frac{.01 \times 250}{1 + .01 \times 250} \frac{31{,}000 \mu g/l}{.01 g/l} = \frac{2{,}214{,}285}{272{,}429} \frac{\mu g}{g} = 2.2 \text{ g/g} = .27 \text{ g/g}$

kind of absurd
not bad

$r_2 = 272{,}429$

CMA TYPE CALCULATION

$$C_{T1} = \frac{W/Q}{1 + K_T t_{01}}$$

$$C_{T1} = \frac{1}{5.4} \frac{180\,lb/d\,/\,1cfs}{(1 + 1.2 \times 114)} = .242\ mg/l = 242\ \mu g/l$$

$$C_{P1} = f_{P1} C_{T1} \frac{.01\ 250}{1 + .01 \times 250} = .714 \times 242\ \mu g/l = 173\ \mu g/l \rightarrow C_{d1} = 69\ \mu g/l$$

$$r_1 = \frac{C_{P1}}{m_1} = \frac{173\ \mu g/l}{.01} = 17{,}300\ \frac{\mu g}{g}$$

$$r_2 / r_1 = .895$$

$$r_2 = .895 \times r_1 = .895 \times 17300 = 15{,}500\ \mu g/g$$

$$C_{T2} = \frac{\phi + m_2 \pi_2}{m_2 \pi_2} C_{P2} = \frac{\phi_2 + \pi_2 m_2}{\eta_2 \pi_2} \eta_2 r_2 = \frac{.96 + 250 \times 100}{250} 15{,}500 = 1{,}550{,}069.52\ \mu g/l$$

LONG TERM FLUXES

LOAD IN (@ 20% leakage & 50/50 split) - 360 lb/d

Conc.	$C_{T1} = 242\ \mu g/l$	$r_1 = 17{,}300\ \mu g/g$	$C_{T2} = 1{,}550{,}060\ \mu g/l$
	$C_{P1} = 173\ \mu g/l$		$C_{P2} = 1{,}550{,}000$
	$C_{d1} = 69\ \mu g/l$	$r_2 = 15{,}500\ \mu g/g$	$C_{d2} = 60\ \mu g/l$

FLUX OUT $1.4\,Q(cfs) \times 242\ \mu g/l \times 10^{-3} = 1.3068\ lb/d$

		% of Load
Losses from water col decays	= .057 lb/d	.03
" " sedim. decays	= 177.82 lb/d	98.77
" " sedimentation	= .0974 lb/d	.05
Flux out	= 1.31 lb/d	.73

calculate r_2/r_1 with decays

$W_{rs} + W_s = 3$ mm/yr let $\pi_2 = \pi_1$ $f_d = \dfrac{1}{\phi + m_2 \pi_2} = .00004$

$$\frac{r_2}{r_1} = \frac{(W_{rs}+W_s) - (W_{rs}+W_s-K_L) f_{d2}}{(W_{rs}+W_s) - (W_{rs}+W_s-K_L) f_{d2} + H_2 (K_{d2}-K_{p2}) f_{d2} + H_2 K_{p2}}$$

for $f_{d2} \to 0 \Rightarrow \dfrac{r_2}{r_1} = \dfrac{W_{rs}+W_s}{W_{rs}+W_s+H_2 K_{p2}} = \dfrac{3\text{ mm/yr}}{3\text{ mm/yr} + 1\text{ cm} \times .001 d^{-1}}$

$1\text{ cm/d} = \dfrac{10\text{ mm}}{d} \times \dfrac{365 d}{y} = 3650$ m/yr $\dfrac{r_2}{r_1} = .0008$

Input "best" guesses

$$\frac{r_1}{r_2} = 1 + \frac{(K_{d2}-K_{p2}) f_{d2} + K_{p2}}{(W_{rs}+W_s) - (W_{rs}+W_s-K_L) f_{d2}} H_2$$

$-K_{d2} = K_{p2} = .0001$ 1/d
$H_2 = 1$ cm

$$= 1 + \frac{.0001 \text{ cm/d} = .365\text{ mm/yr}}{(3\text{ mm/yr}) - (3\text{ mm/y} - 3000\text{ mm/yr})(.00004)}$$

$\dfrac{1\text{ cm}}{d} = 10$

$$= 1 + \frac{.365\text{ mm/yr}}{3.12}$$

$\dfrac{r_1}{r_2} = 1.117 \rightarrow \dfrac{r_2}{r_1} = .895$

then

$$K_T = K_1 + B\left(\frac{r_2}{r_1}\right)(K_s + K_2)$$

$K_1 = K_{p1} f_{d1} + K_{p1} f_{d1} = .0001$ 1/d
$= 0.0365$ 1/d

$K_1 = .0365$ 1/d
$K_2 = .0355$ 1/d
$K_s = \dfrac{W_s}{H_2} = \dfrac{1\text{ mm}}{365 d} \dfrac{.5 ft}{} = \dfrac{.1\text{ cm}}{365 d \times 6 \times 2.54\text{ cm}} = .00002 \dfrac{1}{d}$

$K_T = .0365 \frac{1}{d} + (3500)(.895)(.00002 + .0365)\frac{1}{d} = 114$ 1/d

Now let $\frac{r_2}{r_1}$ be dictated by the data

$r_1 = 50\ \mu g \rightarrow$

$$\frac{r_2}{r_1} = \frac{1500\ \mu g/l}{50\ \mu g/l} = 30$$

$t_{o1} = 1.2\ d$

Let $k_1 = k_2 = 0$ but $k_s = \frac{1\ mm/yr}{.5\ ft} = .00002\ \frac{1}{d}$

$$K_T = 8\ \frac{r_2}{r_1}(k_s) = (3500)(30)(.00002) = 2.1\ \frac{1}{d}$$

$$C_{T1} = \frac{W_T/Q}{1 + t_o K_T} = \frac{180}{[1 + (2.1)(1.2)]\,5.4} = 9.47\ mg/l$$

Flux out = 51.14 lb/d or 28.4 % of W

PCB IN SEDIMENTS

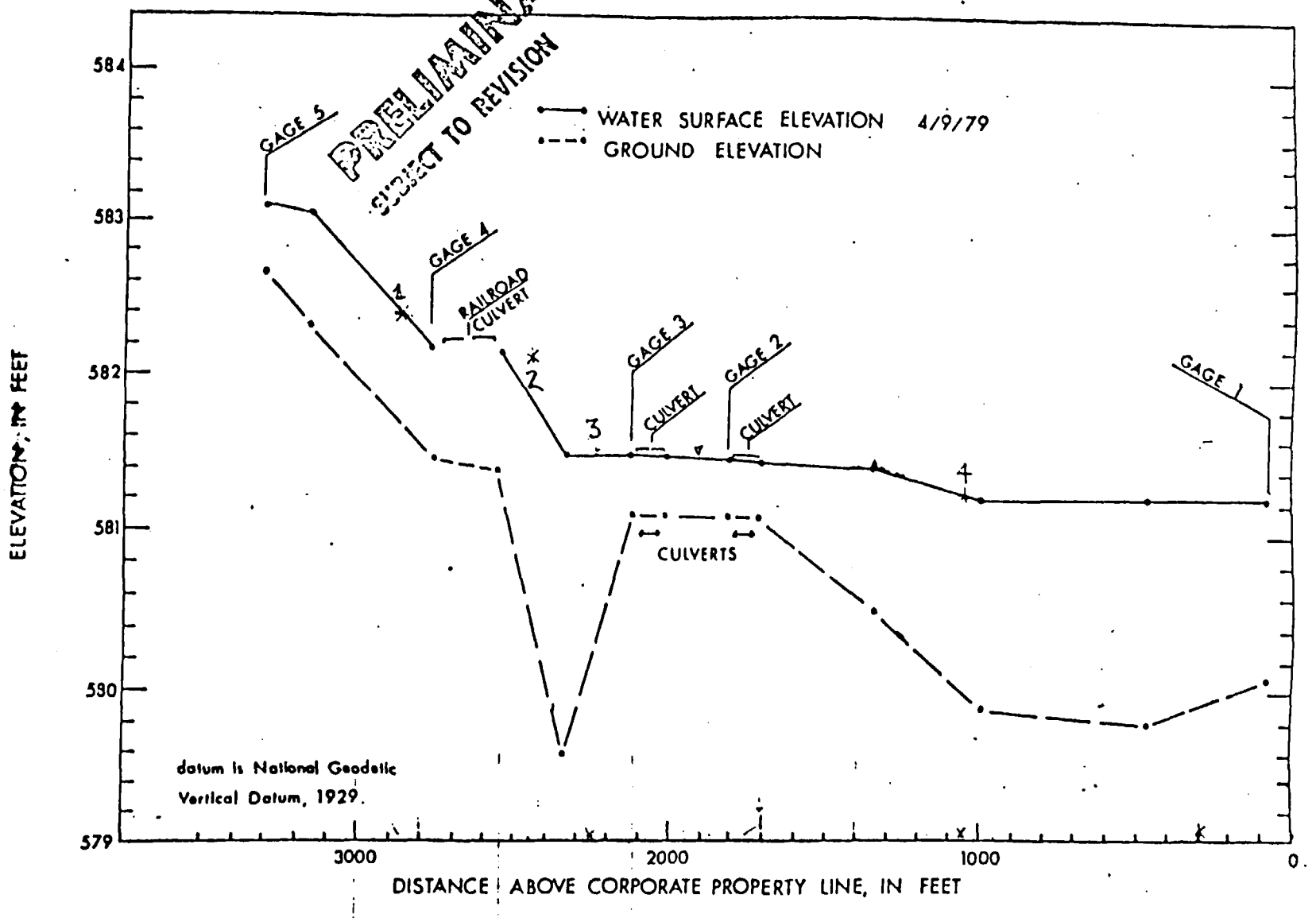
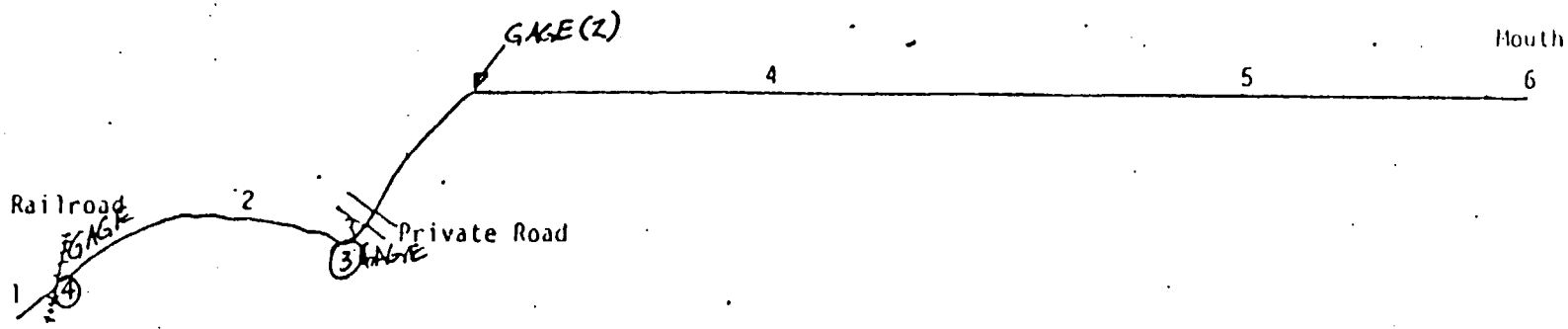


Figure 2. Profile of North Ditch.



PCB Concentration mg/kg-ppm	1	2	3	4	5	6	
Grab at Surface	▫ 36.7 ∘ 87	▫ 32,000 ∘ 246,000	∘ 34,900	∘ 300	▫ 100 ∘ 620	∘ 1.6	▫ 0.043 ∘ 1.2
Core at 0.3 m (1 ft)	• 220	• 8,300	Sample 3-3A • 8700-115,000	• 62	+33.41 +27.07 • 2600	• 6.5	
Core at 0.6 m (2 ft)	• 1.9	• 69,000	∘ 15-145,000	• 6000	+9.91	• 54	• 8.4
Core at 0.9 m (3 ft).	• 0.38	• 21,000 +376,000	• 7100-73,000 +172	• 29	+6.56	• 4.5 7.3	• 90
Core at 1.2 m (4 ft)	• 0.19	• 12,000	• 5100-3800	• 6.6	+122	• 7.7	• 9.9
Core at 1.5 m (5 ft)	• 0.18	• 3,700 +38,000	• 130-67	• 6.1		• 4.1 <1.0	• 1.8
Core at 1.8 m (6 ft)	• 0.23	• 19,000	• 14-0.33 +3	• 1.8		• 5.0	• 2.3
Core at 2.1 m (7 ft)	• 0.99	• 44,000 • 24,000	• 2.4-0.37	• 2.6		• 2.2	• 2.5

Scale: 1" = 300'

∘ USEPA June 9, 1976
▫ Illinois EPA June 9, 1976
+ Illinois EPA 2/16-18, 1977
• ENCOTEC April 1977

FIGURE 14. PCB Concentration Profile in the North Ditch

NORTH DITCH (Kg PCB)

841,812

115,370

54,466

HARBOR

Loc 1	ln Data	r_B (μg/s) BEST	Hi	Low	BEST	Hi	L
D 0-1	4.487 ± .896	89	218	36	74	181	3
1-2		1.9			2.		
2-3		.38			.3		
3-4		.19			.2		
4-5		.18			.2		
5-6		.23			.2		
6-7		.99			.9		

~~V = 50×30×300 ft³ = 1460 m³~~

~~1 ft V = 300~~ L=750

1 ft $V = 30f \times 1 \times 750$

$= 637.2\ m^3$

$M = r_B \times .0013 \times V(m^3)$
(kg)

$V_3 = 30ft \times 1ft \times 500 = 15000 ft^3 \times .02832 = 425 m^3$ $V_r = 850 m^3$

$V_t = 30ft \times 1 \times 650 = 552 m^3$ $V_c = 85$

Loc 3	Au data	BEST	V_B Hi	Low
D				
0-1	10.395 ± 1.292 ✓	32696	119014	8982
1-2	7.296 ± 6.489 R	1475	969950	2.
2-3	8.405 ± 3.052 ✓	4469	94561	211
3-4	8.390 ± .208	4403	5421	3576
4-5	4.536 ± .469	93	150	58
5-6	.876 ± 1.884 ✓	2.5	16	—
6-7	.942 ± 1.566	3	12	—

Loc 4				
0-1	4.660 ± 1.088 ✓	64	190	22
1-2	5.497 ± ~~8.655~~ 4.530	244	22629	2
2-3	2.624 ± 1.051	~~14~~ 14	~~30~~ 40	5
3-4	3.3455 ± 2.063	~~28~~ 28	~~134~~ 223	4
4-5		6.1		
5-6		1.8		
6-7		2.6		

Loc 5				
0-1	6.299 ± 1.632	544	2782	106
2-3	1.744 ± .342	6	8.0	4

6				
0-1	~~12~~ 7.171 ± .991	3	9	2

	L	W	D = .3048 m / 1 ft →	x .02832	x .0013	=	M_i
1	750	30					.828
2	300	↓					.331
3	500	↓					.552
4	650	↓					.712
5	1000	↓					1.104
6	100	↓					.110

M_i		.828 1	.331 2	.552 3	.712 4	1.4 5	.110 6	Σ
	H	181	73422	65696	135	3071	1	142,325
0-1	B	74	13331	18048	46	600	.3	32,099
	L	30	2420	4958	16	117	.2	7541
	H	–	–	535412	16112	–	–	574424
1-2	B	2	22839	814	174	60	1	23,890
	L	–	–	1	2	–	–	22905
	H	–	22585	52198	28	9	–	74830
2-3	B	.3	29412	2465	10	7	10	31,904
	L	–	3824	116	4	4	–	3955
	H	–	–	2992	159	–	–	7133
3-4	B	.2	3972	2430	20	9	1	6,432
	L	–	–	1972	3	–	–	5957
	H	–	~~756~~ 20189	83	–	–	–	~~850~~ 20281
4-5	B	.2	3925	51	4	5	.2	3,985
	L	–	~~20189~~ 756	32	–	–	–	797
	H	–	–	9	–	–	–	6299
5-6	B	.2	6289	1	1	6	.3	6,297
	L	–	–	–	–	–	–	
	H	–	16512	7	–	–		16520
6-7	B	.9	10756	2	2	2	.3	10,762
	L	–	7007	–	–	–		7014
	Σ	78	60571	23811	257	689	13	ΣB = 115,370

841812
~~822381~~

NORTH DITCH SEDIM

	Ln data	μg/g BEST	Hi	Low	LENGTH ft	V.
Loc 1	.920 ± 2.819	2.5	42	2.2	750	75
Loc 2	10.377 ± 1.312	32119	119217	8653	300	30
Loc 3	5.4667 ± 4.3247	237	17879	3	480	50
Loc 4	3.3017 ± 2.199	27	~~300~~ 245	4	600	65
Loc 5	3.229 ± 2.404	25	278	2	1000	100
Loc 6	1.6999 ± 1.337	5	21	1	100	10

	V (m³) for D=7.44, W=30.4		M (Kg)	
Loc 1	4460	14	244	5
Loc 2	2200	91880	341033	24752
Loc 3	2855	880	66350	11
Loc 4	3568	125	1137	19
Loc 5	5947	193	2149	15
Loc 6	594	4	16	1
	Σ	93096	410929	25057 Kg

$$M(Kg) = r_B(\mu g/g)\ 1.3\frac{g}{cm^3} \times V(m^3) \times 10^6\frac{cm^3}{m^3} \times 10^{-9}\frac{Kg}{\mu g} = r_B \times .0013V \quad r_B(Kg/g),\ V(m^3)$$

BEST 93,096 Kg

HIGH 410,929

LOW 25,057

NORTH DITCH SEDIM.

Loc. 1

.920 ± 2.8196

Loc 2

10.3772 ±1.3115

Combined 2 & 3

x

7.7199 ± 4.1523

Loc 3

5.4667 ± 4.3247

Loc 4

3.3017 ± 2.1990

Loc 5

3.2229 ± 2.4038

Loc 6

1.6999 ± 1.337

µg/g = mg/kg

	LOW	BEST	H.
Loc 1	.92	2.5	42
Loc 2	8653	32119	119217
Loc 3	3	236	17879
Loc 4	4	27	300
Loc 5	2	25	278
Loc 6	1	5	21

35 2253 1437

r_B^* (mg/kg)

LAYER ↓	①	②	③	④	⑤	⑥
SURFACE	55	89,000	35000	300	250	-
0-1	110	27,000	44,000	150	810	3
1-2	20	22,000	27,000	150	500	7
2-3	1.	36,000	24,000	70	15	12
3-4	0.3	17,000	11,000	12	6	10
4-5	0.2	8,000	550	6	6	3
5-6	0.2	11,000	15	3	6	2
6-7	0.4	27,000	1	2	3	2

* Surface conc. are geometric means of avail data; deeper layer conc. are gotten from data plots as the geom. means at the boundary depths

$$V_{SOLIDS} = \phi^* V_{bulk} \quad ; \quad \phi^* = \frac{\text{VOL SOLIDS}}{\text{VOL SOLIDS} + \text{VOL WATER}}$$

if m (g/l) the solids concn. then fraction of vol of solids in 1l $= \frac{m}{2.5} \frac{1}{1000}$
then

$$\phi^* = \frac{m}{2.5 \times 1000}$$

The mass of solids in V_{bulk}

$$M_{SOLIDS} = \rho_s V_{sol} = \rho \phi^* V_{bulk} \qquad \rho = 2.5 \frac{gr}{cm^3} \times 2.83 \times 10^4 \frac{cm^3}{ft^3} = 2.83 \times 2.5 \times 10$$

$$M_{SOLIDS} = 2.83 \times 2.5 \times 10 \frac{kg}{ft^3} \times \frac{m}{2.5 \times 1000} V_{bulk} = 2.83 \times 10^{-2} m \frac{kg}{ft^3} V_{bulk}$$

Thus the mass in 1 ft^3 bulk

$$M (kg/ft^3_b) = 2.83 \times 10^{-2} m$$

if the PCB concentr. were r_B mg/kg

then the mass of PCB in 1 ft^3 of bulk with m concen of solids and r_B conc of PCB

$$M_{PCB} (mg^{PCB}/ft^3_b) = 2.83 \times 10^{-2} m r_B$$

or in kg

$$M_{PCB} (kg/ft^3) = 2.83 \times 10^{-8} m r_B$$

Take an element of bulk volume 1 ft deep, 30 ft wide and 1 ft long

then the Mass of solids

$$M_v (kg) = .849 m$$

$$M_{PCB} (kg) = .849 m r_B \times 10^{-6}$$

	m	M_s (kg)	M_{PCB} (kg) ①	②	③	④	⑤
Surface ½ft	10	4.25	.000	.378	.149	.001	.001
0-1	100	84.9	.002	2.922	3.736	.013	.069
1-2	1000	849.	.001	18.678	22.923	.127	.425
2-3	↓	↓	.000	30.564	20.376	.059	.013
3-4				14.433	9.339	.010	.010
4-5				6.792	.467	.005	.010
5-6				9.339	.013	.003	.010
6-7			.000	22.923	.001	.002	.003
		Σ	.003	106.029	57.004	.220	.541
Lin ft			450	225	225	1100	1000
Tot PCB (kg)		→	2	23,860	12,830	242	541
				4%	34%	.6	1.4
				≈ 37500 kg			
L			450	225	900	425	1000
Tot PCB			2	23860	51300	94	541
				32%	68%	.1	.7
				≈ 75800 kg			

∴ A better estimate requires a better measure of the extent of infl. of station 3

Using horizontal slices

M_{ss} (Surface slice 1/2 ft) = $\frac{1}{2} \times 30 \times 3000 \times 1 \times 2.83 \times 10^{-2} \times 10$ kg = 12735 kg

$\langle r_s \rangle = 1700$ mg/kg

M_{PCB} (surface) = 1700 mg/kg × 12735 kg = 22 kg

0-1-ft slice = $1 \times 30 \times 3000 \times 2.83 \times 10^{-2} \times 100$ kg = 254,700 kg

$\langle r_0 \rangle = 1400$ mg/kg

M_{PCB}(0-1) = 1400 mg/kg × 254700 kg = 360

1-2 slice = $1 \times 30 \times 3000 \times 2.83 \times 10^{-2} \times 1000$ kg = 2,547,000 kg

$\langle r_{12} \rangle = 630$ mg/kg

M_{PCB} 1-2 = 630 × 2,547,000 × 10^{-6} = 917 kg

$\langle r_{23} \rangle = 300$

M_{PCB} 2-3 = 300 × 2,547,00 × 10^{-6} = 760 kg

$\langle r_{3-4} \rangle = 140$ mg/kg

M_{PCB} 34 = 140 × 2,547 = 360 kg

$\langle r_{4-5} \rangle = 35$ mg/kg

M_{PCB} 45 = 35 × 2,547 kg = 90 kg

$\langle r_{5-6} \rangle = 10$ mg/kg

M_{PCB} 5-6 = 10 × 2,547 kg = 25 kg

$\langle r_{6-7} \rangle = 6$ mg/kg

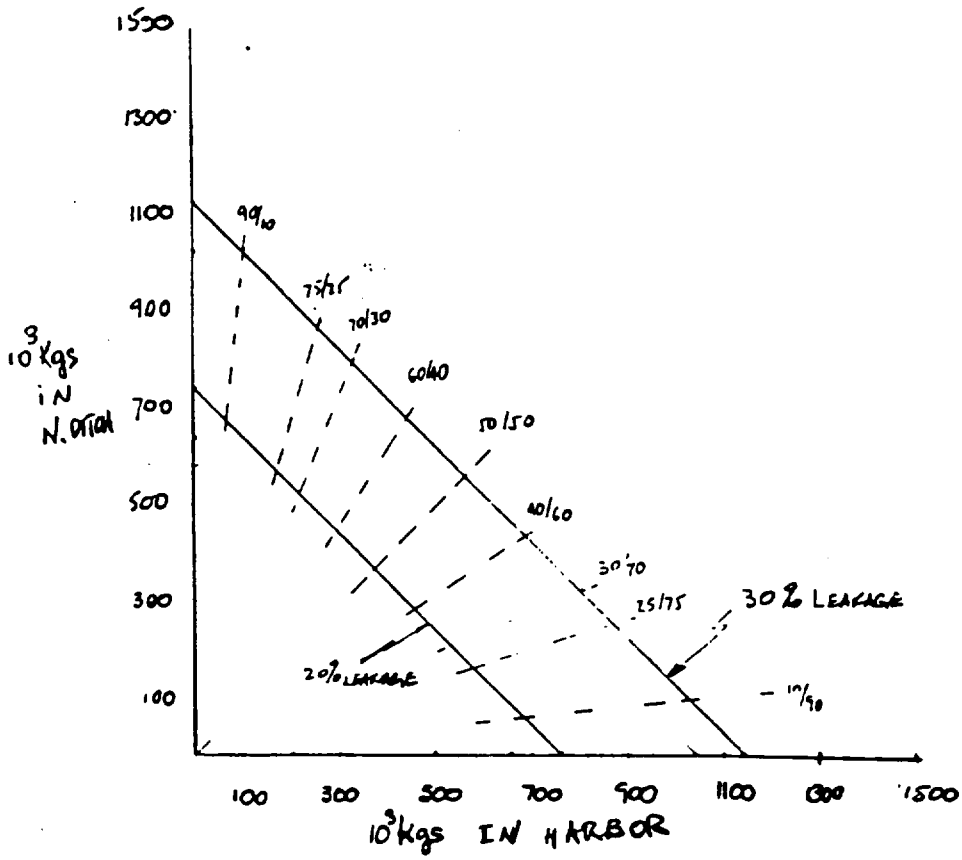
M_{PCB} 6-7 = 6 × 2,547 kg = 15 kg

Surface	22
0-1	360
1-2	1604
2-3	760
3-4	360
4-5	90
5-6	25
6-7	15
	= 3300 kg

USE, DISPOSAL, LEAKAGE

PYDRAUL PCB TYPE A-200

	USE (lb)	lb/d	20 % LEAKAGE	30 % LEAKAGE
59	10,000	27	2000	
60	224,000	614	44,800	
61	320,480	878	64,000	
62	570,005	1562	114,000	
63	597,960	1632	119,592	
64	828,205	2269	165,641	
65	752,270	2061	150454	
66	709,665	1944	141933	
67	851,350	2332	170270	
68	1,390,740	3810	278148	
69	1,123,900	3079	224780	
70	914,235	2504	182847	
71	78,720	216	15744	
Σ	8,371,530 lb		1,674,305 lbs	2,511,459 lbs
	3,805,241 kg		761,048 kgs	1,141,573 kg



USE OF PYDRAUL

TOT lbs A-200 PYDRAUL = 8,371,530*

If 20% - 30% Loss from Machinery (leakage) → 1,674,300 lb (20%) 759,320 Kg
2,511,400 lb (30% 1,140,000 Kg

*Marion assumes that A200B (1,936,820 lbs in 1970, 71, 72) was 100% PCB

		HYDRAUL USAGE		DISPOSAL		INTO ATMOSPHERE		INTO DRAINABLE LIQ.	
ATE	TYPE	LBS	GALLONS	LBS	GALLONS	LBS	GALLONS	LBS	GALL.
959	F-9		40,865	70% - 80%		10% - 15%		20% - 25%	
959	A-200	10,000		7,000 - 8,000		1,000 - 1,500		2000 - 2,500	
960	F-9		28,490						
960	A-200	224,000		156,800 - 179,200		22,400 - 33,600		44,800 - 50,400	
961	F-9		30,896						
961	A-200	330,480		224,336 - 256,384		32,048 - 48,072		64,096 - 80,120	
962	A-200	570,005		399,004 - 456,004		57,000 - 85,501		114,000 - 142,501	
963	A-200	597,960		418,572 - 478,368		59,796 - 89,694		119,592 - 149,490	
964	A-200	828,205		579,744 - 662,564		82,820 - 124,231		165,640 - 207,051	
965	A-200	752,270		526,589 - 601,816		75,227 - 112,840		150,454 - 187,867	
966	A-200	709,665		496,766 - 567,732		70,966 - 106,450		141,932 - 177,416	
967	A-200	851,350		595,945 - 681,080		85,135 - 127,702		170,270 - 212,837	
968	A-200	1,390,740		973,518 - 1,112,592		139,074 - 208,611		278,148 - 347,685	
969	A-200	1,123,900		786,730 - 899,120		112,390 - 168,585		224,780 - 280,975	
970	A-200	914,235	67,669	639,965 - 731,388		91,423 - 137,135		182,846 - 228,557	
970	A-200-B	10,800	812						
971	A-200	78,720	5,919	55,104 - 62,976		7,872 - 11,808		15,744 - 19,680	
971	A-200 B	923,450	69,398						
972	A-200 B	1,002,370	76,917						
972	SOE		43,705						
973	SOE		76,389						
974	SOE		72,316						
975	SOE		54,316						
								Also [illegible]	
[illegible]								1,174,[illegible]	

OPTES		TYPE	SOURCE	#'S	GALLONS
54	1/1/55	Not Specified	4/2-191 [illegible] Pg. 2		6,307
55	1/1/56				25,265
56	1/1/57				56,785
57	1/1/58				36,785
58	1/1/59				40,260
59	1/1/60				40,865
60	1/1/61				28,490
61	10/1/61				30,896
61	10/1/62				50,987
62	63				41,487
63	64				68,663
64	65				59,222
65	66				63,776
66	67				60,699
67	68				99,011
68	69				88,800
69	70				74,392
70	71				102,337
71	72				73,353
72	73				76,703
73	74				94,427
74	10/1/75				68,766
75	2/1/76				28,430

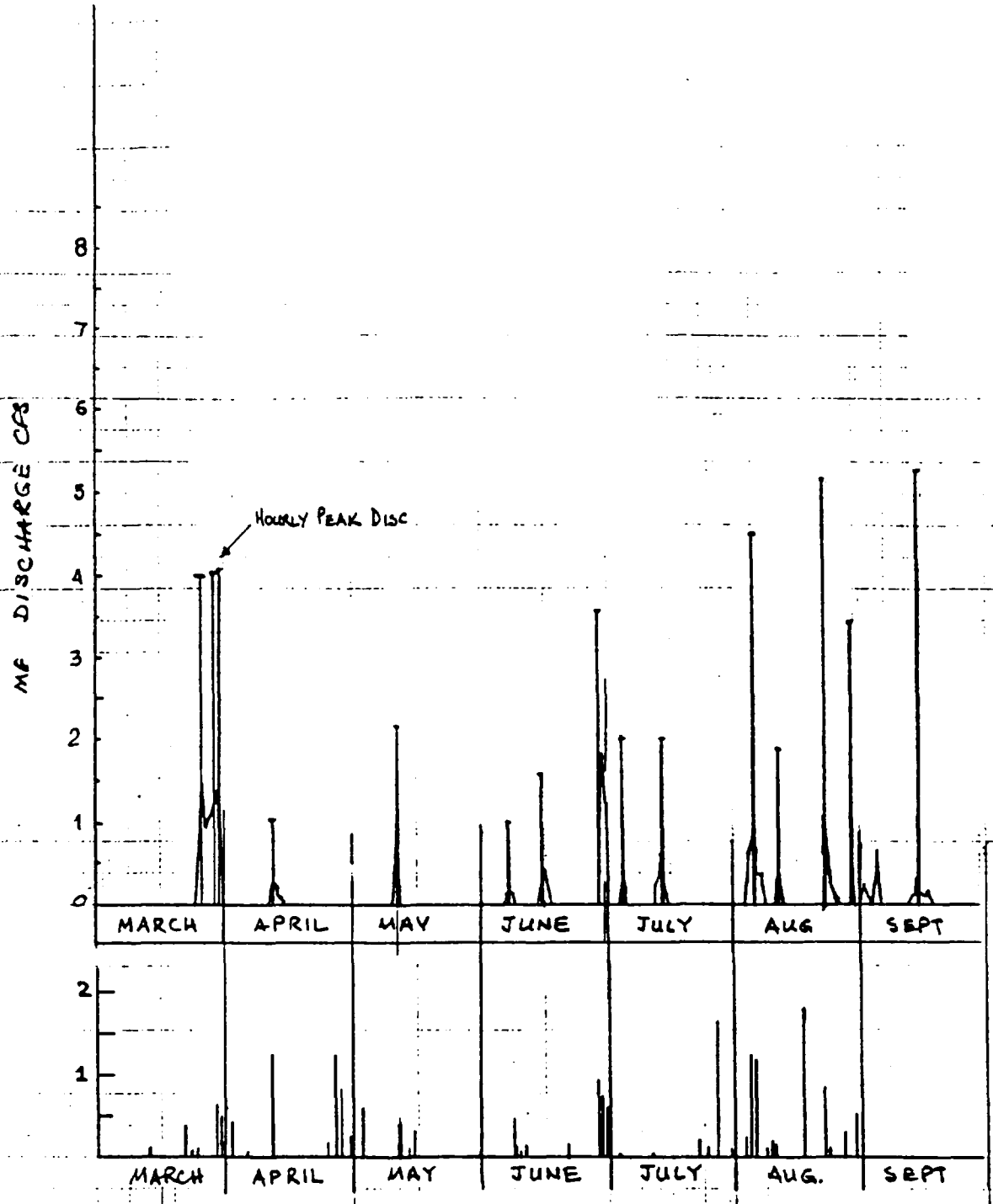
DATES	TYPE	SOURCE	#'S	GALLONS	#, % DISPOSAL A200	DISPOSAL SERVICE
1959	A200	4/2-730 3/2/76 P.5	10,000 ✓		70% - KITO 7,000 - 8,000	Century
1960			224,000 ✓		156,800 - 179,200	
1961		Jordan only	320,480 ✓		224,336 - 256,384	
1962			570,005		399,004 - 456,004	
1963			597,960		418,572 - 478,368	
1964			838,305		579,744 - 662,564	
1965			752,370		526,589 - 601,816	
1966			709,665		496,766 - 567,732	
1967	A~~200~~		851,350		595,945 - 681,080	
1968			1,390,740		973,518 - 1,112,592	
1969	A200		1,123,900		786,730 - 899,120	
1970	A200/A200B		914,235 / 10,800	[illegible]	639,965 - 731,388	
1971	A200/A200B		73,730 / 923,650	5/2/76	55,101 - 62,986	10/1/71 - 8/30/74 = T-K Disposal
1972	A200 B		1,002,370			
1970	A200/A200B	4/2-730 3/2/76 P.7		67,669 / 812		
1971				5,919 / 69,378		
1972	A200 B			76,917		
1973	SOE			43,705		
1973				76,389		
1974				92,316		
1975				54,316		

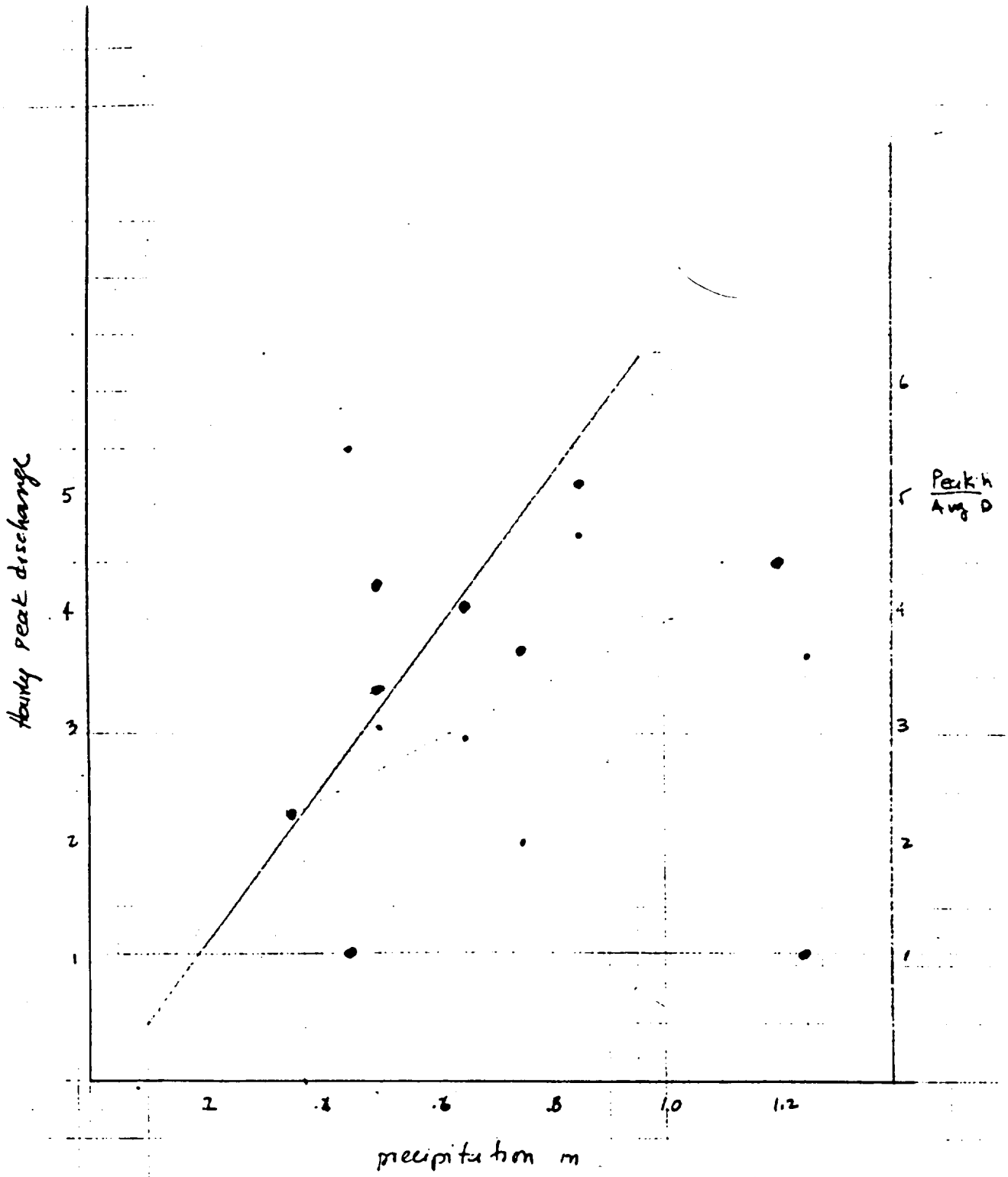
(1) 3/5/76 memo - 7/2-151
60% absorbed in sawdust

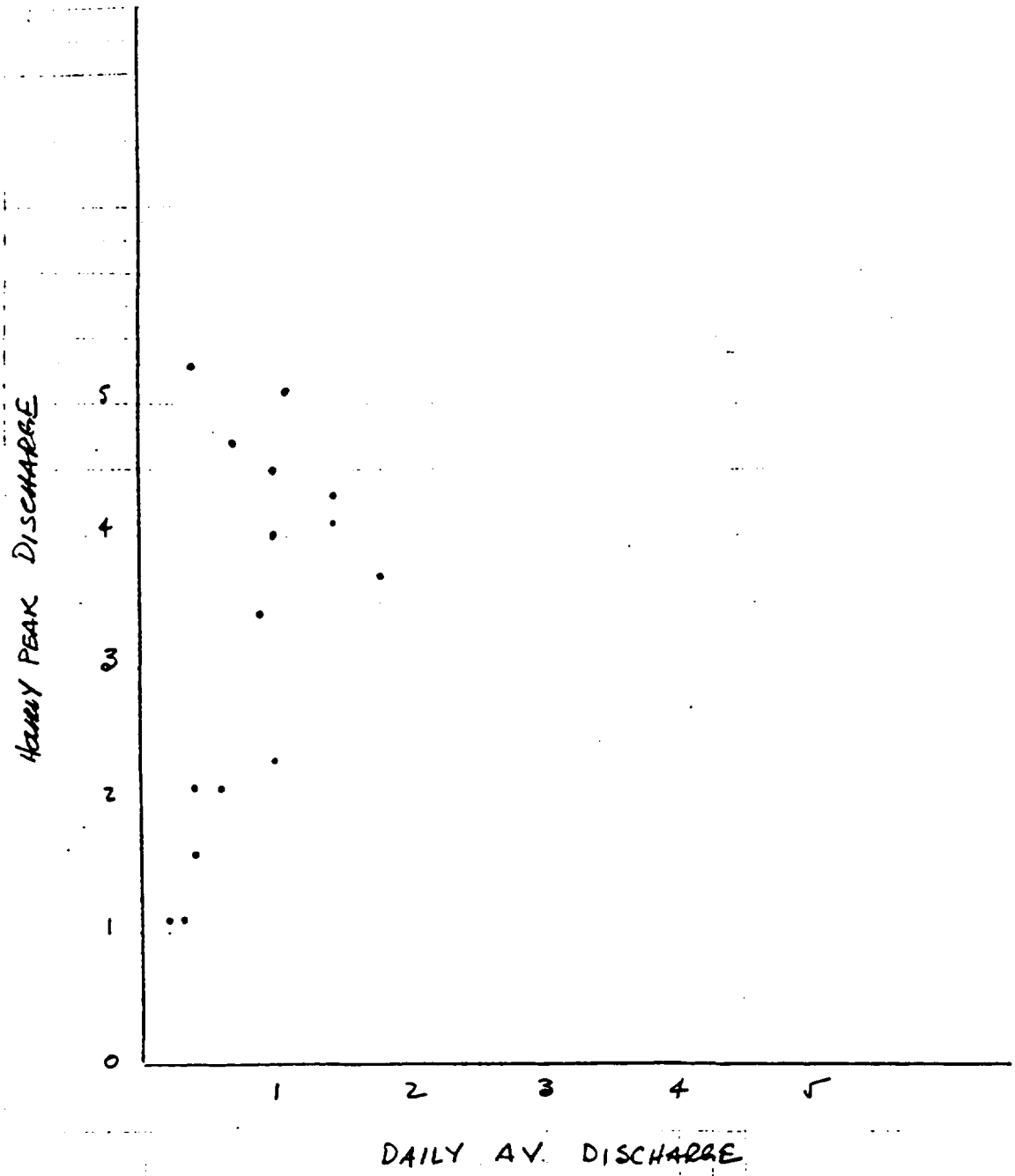
DATES	TYPE	SOURCE	#'s	13.2 #/gal	2/7/76 (Mt.) [illegible] 2-650 p.3 GALLONS		AVG. #/gallon	AVG. Gal/mo
1/1/61 - 10/1/62	A200	4/2-191 2/7/76			50,987	verified 4/2-731 ↔ 1/31/71	$2.85	4,249
1/1/62 10/1/63					41,487			3,457
1/1/63 10/1/64					68,663	& 5/2-175 1/4/61		5,721
1/1/64 10/1/65					59,222			4,935
1/1/65 10/1/66					63,776			5,315
1/1/66 10/1/67					60,699			5,058
1/1/67 10/1/68					99,011			8,250
1/1/68 10/1/69					88,800			7,400
1/1/69 10/1/70					74,393			6,199
1/1/70 2/1/71					101,07 29,065 ✓	verified @ 4/2-731 begun	2.85	8,694
1/1/71 10/1/71	A200 B				73,262	" " "	2.90	
1/1/71 1/1/72	"				17,830			
1/3/54 1/1/55	F-9	4/2-191 2/12/76			6,307			
1/1/55 1/1/56					25,265			
1/1/56 1/1/57					56,785			
1/1/57 1/1/58					36,785			
1/1/58 1/1/59					40,260			
1/1/59 1/1/60					40,865 ✓			
1/1/60 1/1/61					28,490 ✓			
1/1/61 10/1/61					30,896 ✓			

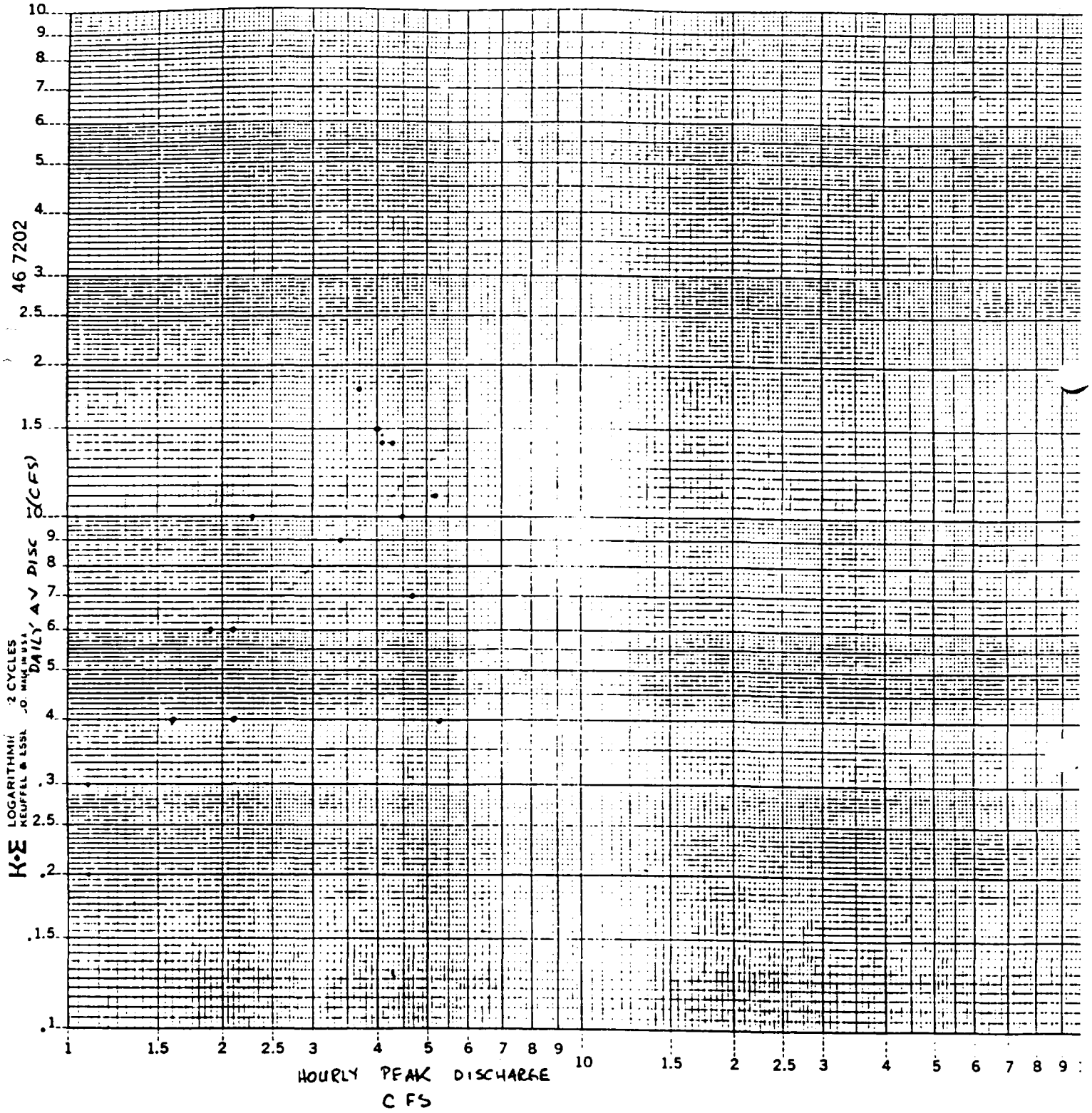
MARCH 30, 1979 EVENT

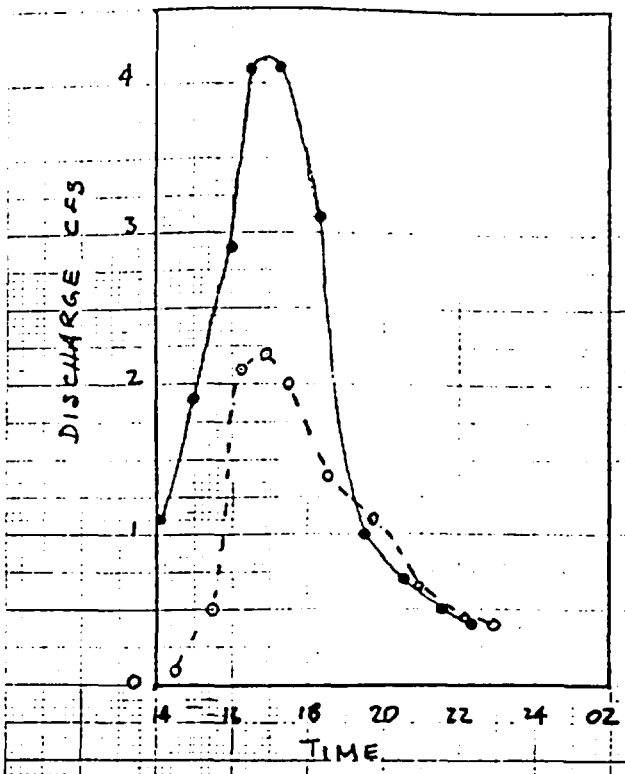
N. DITCH

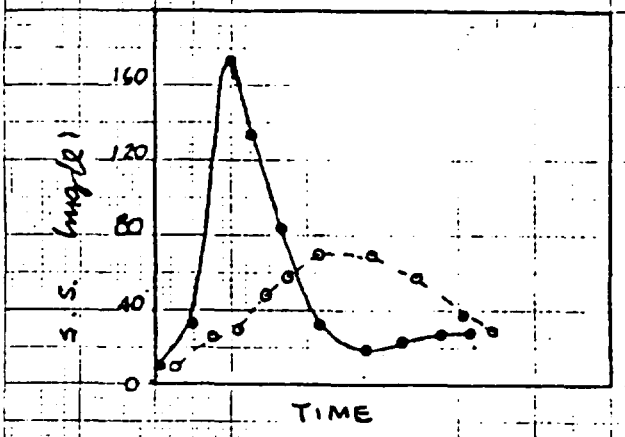

MF DISCHARGE CFS
8
7
6
5
4
3
2
1
0
HOURLY PEAK DISC
MARCH
APRIL
MAY
JUNE
JULY
AUG
SEPT
2
1
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT

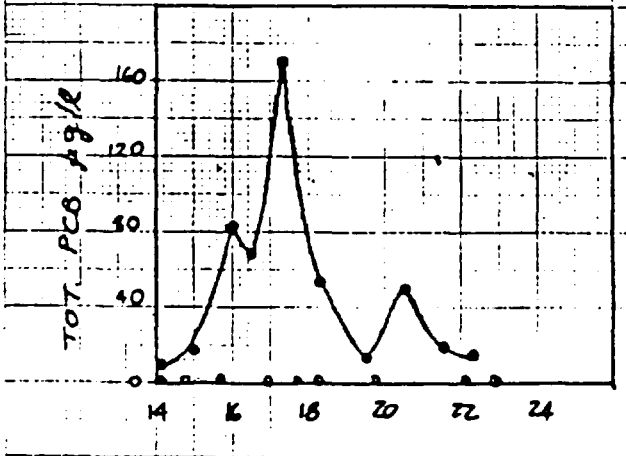

Hourly peak discharge
5
4
3
2
1
6
5
4
3
2
1
Peak h / Avg D
.2
.4
.6
.8
1.0
1.2
precipitation m

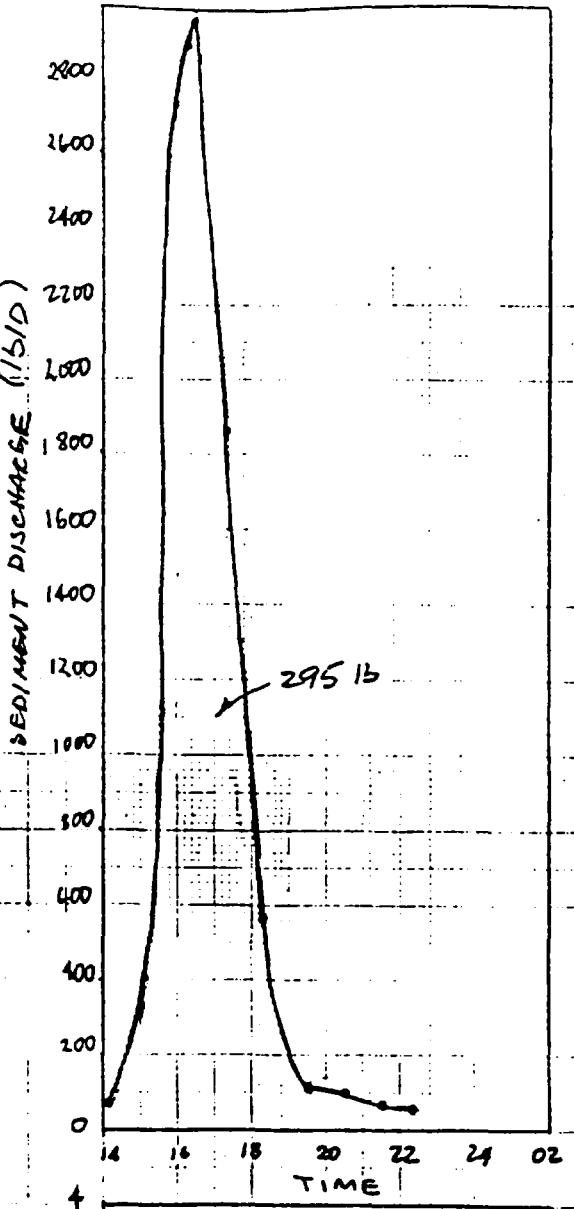

HOURLY PEAK DISCHARGE
0
1
2
3
4
5
1
2
3
4
5
DAILY AV. DISCHARGE

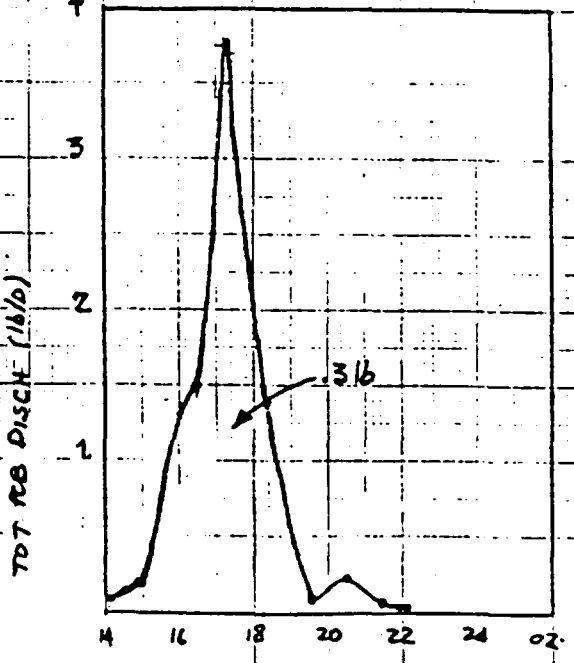

K+E LOGARITHMIC 2 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 7202
DAILY AV DISC (CFS)
HOURLY PEAK DISCHARGE
CFS

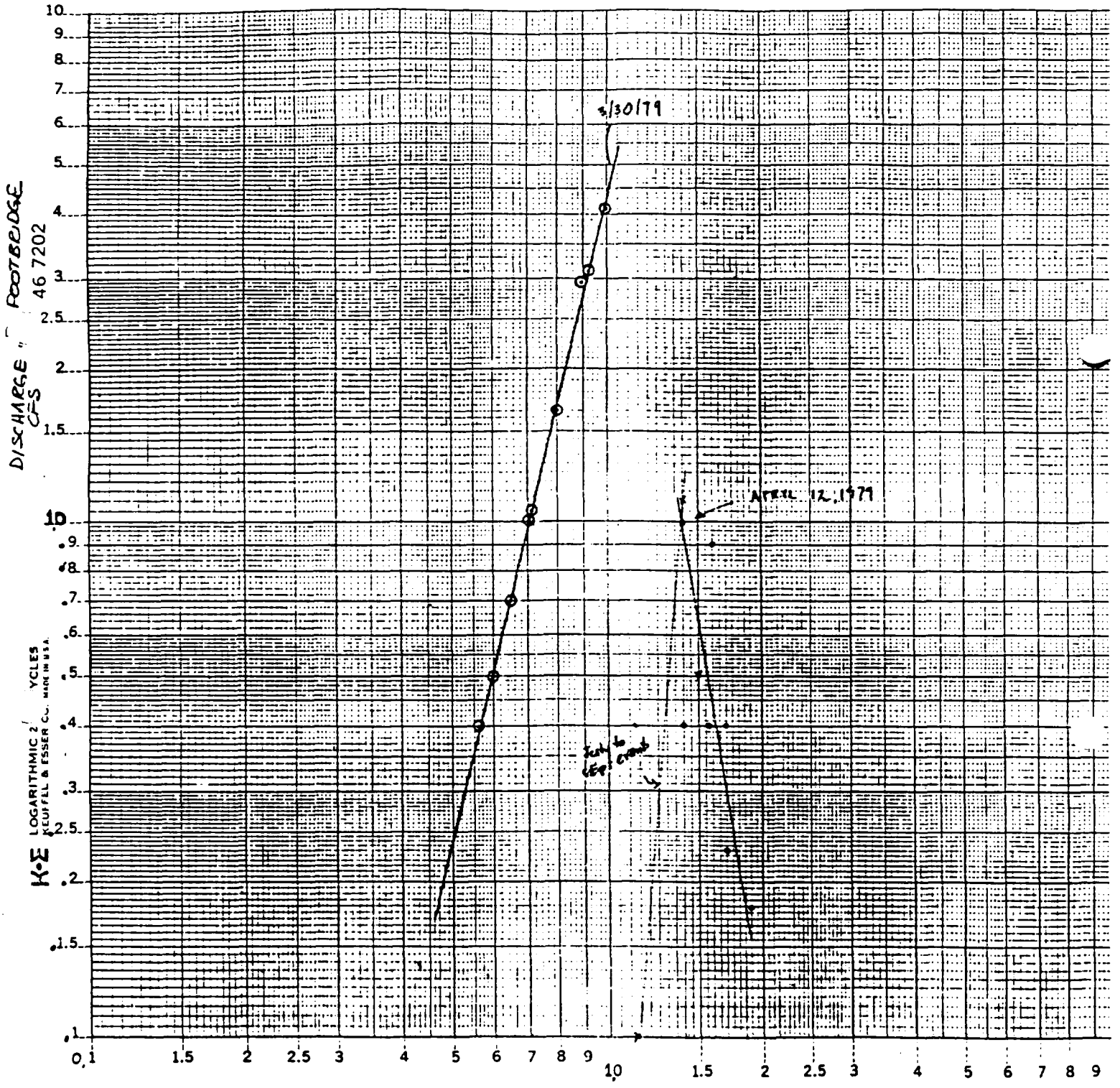

DISCHARGE CFS
0
1
2
3
4
14
16
18
20
22
24
02
TIME


S.S. (mg/l)
0
40
80
120
160
TIME


TOT PCB µg/l
0
40
80
120
160
14
16
18
20
22
24


SEDIMENT DISCHARGE (lb/D)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
295 lb
14
16
18
20
22
24
02
TIME


TOT PCB DISCH (lb/D)
1
2
3
4
.3 lb
14
16
18
20
22
24
02



@ FOOTBRIDGE

⊙ RATING CURVE FOR GAGE 1 FROM THE MARCH 30, 79 EVENT

Table 2. Daily sediment load, mean daily discharge for selected days during the study period, and hourly peak discharge.

PRELIMINARY
SUBJECT TO REVISION

Date	Sediment Load (lbs)	Peak/Av	%	Discharge (ft³/s) Mean Daily		Peak	Precip. (inch) on date of peak	Hourly
March 25	56		2.5	0.3	.12	--		
March 26	370	2.67		1.5	x	4.0		
March 27	220			0.9	x	--		
March 28	260			1.0	x	--		
March 29	360	2.93	14.	1.4	.1	4.1	1.7	.65
March 30	340	3.07	1.9	1.4	.73	4.3	1.3	.50
March 31	12		.17	0.1	.60	--		
April 12	66	3.67	.19	0.3	1.76	1.1	3.3	1.25
April 13	27		3.3	0.1	.03	--		
May 11	230	2.3	3.5	1.0	.78	2.3	.9	.35
June 6	13			0.1	x	--		
June 7	42	5.5		0.2	x	1.1	1.2	.45
June 8	21		.16	0.1	.63	--		
June 14	22			0.1	x	--		
June 15	84	4.0		0.4	x	1.6		NONE
June 29	450	2.06	1.6	1.8	1.12	3.7	2.0	.75
June 30	290		3.2	1.2	.37	--	1.6	.6
July 4	99	5.25	.5	0.4	.05	2.1		NONE
July 12	51			0.2	x	--		
July 13	140	3.50		0.6	x	2.1		NONE
August 3	72		.6	0.3	.11	--		
August 4	170		.14	0.7	.05	--	3.3	1.25
August 5	250	4.5	.6	1.0	1.63	4.5	2.2	1.2
August 6	97		.24	0.4	1.66	--		
August 7	96			0.4	x	--		
August 11	140		20	0.6	.03	1.9		NONE
August 23	280	4.73	1.9	1.1	.57	5.2	2.2	.85
August 24	30		20	0.2	.01	--		
August 25	15		--	0.1		--		
August 29	210	3.78	1.3	0.9	.17	3.4	1.3	.5
August 30	24			0.1	x	--		
September 1	71			0.3	x	--		
September 4	180	6.71		0.7	x	4.7		NONE
September 5	130			0.5	x	--		
September 13	28			0.1	x	--		
September 14	100	13.25	20	0.4	.02	5.3		NONE
September 15	45			0.2	x	--		
September 16	20			0.1	x	--		
September 17	34			0.2/39	x	--		
Total	5100			21.4				

MARCH 30, 1979

UPSTREAM

C_a	C_p	C_T	m (mg/l)
.3	.20	.5	10
.5	.73	1.23	26
.5	.30	.80	30
.2	.62	.82	48
.4	.58	.98	58
.2	.70	.90	70
.4	.24	.64	70
.6	.18	.78	38
.3	.10	.40	31

$\langle C_T \rangle = .78\ \mu g/l$ $\bar{x}$ 43.75

$C_T = .78 \pm .25$ → 1.03, 0.53

$m = 43.75 \pm 21.03$ 65.38, 22.12

Q -

DOWNSTREAM

C_a	C_p	C_T	m (mg/l)
6.5	4.40	10.9	11
12.2	5.44	17.64	34
70.0	13.48	83.48	175
30.0	38.86	68.86	134
94.	76.86	170.86	84
40.2	13.26	53.46	34
10.8	2.60	12.6	20
9.2	42.0	57.2	24
13.3	6.30	19.6	28
11.8	5.34	17.14	29

$\langle C_T \rangle$ 50.52

$C_T = 50.57 \pm 46.98$ μg/l → 97.73, 3.77

$m = 57.3 \pm 55.61$ mg/l → 112.91, 1.69

Q = 1.7 ± 1.3 cfs

MARCH 30, 79

	Time	Gage Ht	Q_d (cfs)	m (mg/l)	c_s (mg/l)	W (lb/d)	m%/kg	W_{KD} (lb/d)
①	14.10	0.71	1.1	11	6.5	65.34	400	.039 .026 .0
②	15:00	0.80	1.8	34	12.2	330.48	160	.119 .053 .1
③	16:00	0.89	2.9	175	70.0	2740.50	77	1.096 .212 1.
④	16.30	0.96	4.1	134	30.0	2966.76	290	.664 .860 1.
⑤	17:15	0.97	4.1	84	94	1859.76	915	2.081 1.702 3.
⑥	18:15	0.92	3.1	34	40.2	569.16	390	.673 .222 .1
⑦	19:30	0.70	1.0	20	10.8	108	130	.058 .014 .
⑧	20:31	0.65	0.7	24	9.2	90	1750	.035 .158 .
⑨	21:30	0.60	.5	28	13.3	75.6	225	.036 .017 .
⑩	22:21	0.56	.4	29	11.8	62.8	185	.025 .0002

①	1.72	0
②	1.79	.18
③	1.58	.4
④	1.7	.23
⑤	1.7	.4
⑥	1.6	.9
⑦	1.42	1.0
→ ⑧	1.4	.4
⑨	1.5-1.7	
⑩	1.25	
⑪	.99	

MARCH 30, 1970

	Q (cfs) FOOT BRIDGE	C_a	C_p	C_T	W_{PCB}	m (mg/l	W_{SS}
①	1.1	6.5	4.4	10.9	.065	11	65.34
②	1.8	12.2	5.44	17.64	.171	34	330.6
③	1.9	70.	13.48	83.48	.857	175	~~2795.1~~ 2740
④	4.7	30.	38.86	68.86	1.525	134	2966.8
⑤	4.1	94.	76.86	170.86	3.783	84	1859.8
⑥	3.1	40.2	13.26	53.46	.895	34	569.2
⑦	1.0	10.8	2.6	12.6	.068	20	108
⑧	.8	9.2	42.	51.2	.221	24	103.7
⑨	.5	13.3	6.3	19.6	.053	28	75.6
⑩	.4	11.8	5.3	17.14	.037	29	62.6

MARCH 30

UPSTREAM

UPSTREAM GAGE

TIME	GAGE	Q (FROM GAGE ① OP. CURVE)	C_a	C_p	C_T
14.30	.39	.1	.3	.2	.5
15.30	.60	.5	.5	.73	1.23
16.15	.84	2.1	.5	.3	.80
16.50	.85	2.2	.2	.62	.82
17.30	.83	2.0	.4	.58	.98
18.35	.76	1.4	.2	.7	.90
19.45	.72	1.1	.4	.24	.64
× 20:55	.64	.66			
22:05	.58	.45	.6	.18	.78
22:55	.56	.4	.3	.10	.40

MARCH 30, 1979

Bet 14:00- 2200hrs discharge of ~~242~~ 295 lb of sed

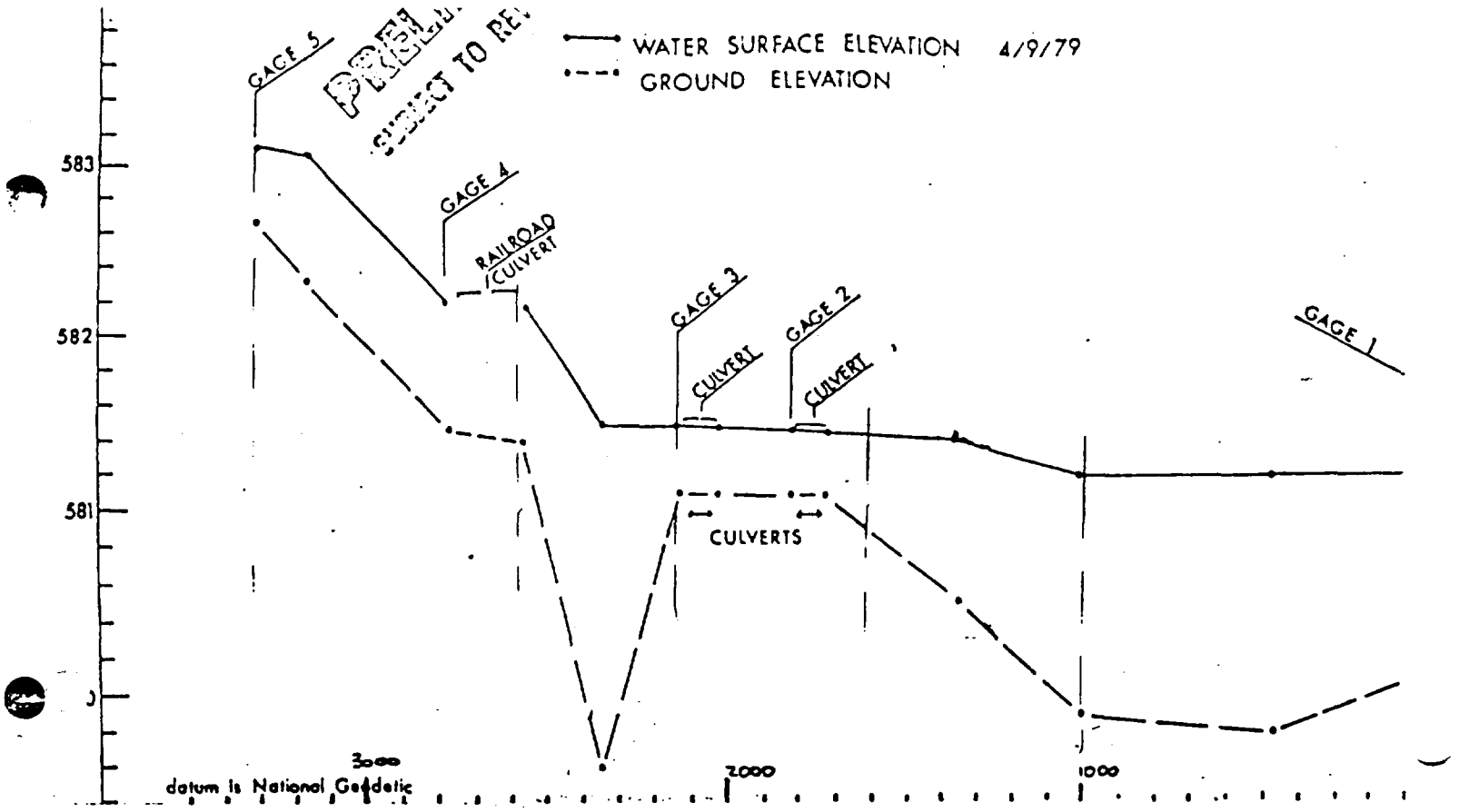
" " " .30 lb of Tot PCB

CUMM DISCHARGE (lb)

TIME (hr)	SED.	TOT. PCB
14-15	8	0.01
15-16	33	0.03
16-17	144	0.09
17-18	212	0.22
18-19	229	0.27
19-20	236	0.28
20-21	240	0.29
21-22	242	0.30

N. DITCH MODEL INPUT

PRELIM.



SEGMENTS / WATER	1	2	3	4	5
BED	6	7	8	9	10

ENCOTEC DATA ① ② ③ ④ ⑤

SEG NO	DEPTH (ft)	WIDTH (ft)	LENGTH (ft)	VOLUME (10^6 ft^3)	CRS SEC UPST (ft^2)	CRS SEC DNST (ft^2)
1	0.7	25.	750	0.01313	(01) 11.3	(12) 14.5
2	1.3	25	420	0.01365	(12) 19.5	(23) 14.0
3	0.4	35	520	0.00728	(23) 14.0	(34) 21.0
4	1.0	35	610	0.02135	(34) 21.0	(45) 49.0
5	1.3	40	1000	0.0520	(45) 49.0	(50) 52.0
6	0.5	25	750	0.00938	(06) 12.5	(67) 12.5
7	0.5	25	420	0.00525	(67) 12.5	(78) 17.5
8	0.5	35	520	0.00910	(78) 17.5	(89) 17.5
9	0.5	35	610	0.01068	(89) 17.5	(910) 17.5
10	0.5	40	1000	0.02000	(910) 17.5	(100) 20.

(16)	18750
(27)	10500
(38)	18200
(49)	21350
(510)	40000

ADDITIONAL SEGMENT DATA

SEG.	SOLIDS (mg/l)	POROSITY	$\mathbb{P}$ μg/g/μg/l	U_{set} (m/D)	r_B μg/g	C_T (mg/l)
1	5	1	250	1.		
2	5	1	250	1.		
3	5	1	250	1.		
4	5	1	250	1.		
5	5	1	250	1.		
6	100,000	.96	250	V_{sed} (m/d) (1 m/yr) 0.00002740	55 *①	5.5
7	100,000	.96	250	.00002740	65000 *①	6500
8	100,000	.96	250	.00002740	1000 *②	100
9	100,000	.96	250	.00002740	300 *②	30
10	100,000	.96	250	.00002740	250 *①	25

For bottom segments

$$c_p = \frac{\mathbb{P}m}{\phi + \mathbb{P}m} c_T \rightarrow \frac{c_p}{m} = \frac{\mathbb{P}}{\phi + \mathbb{P}m} c_T \Rightarrow r_B = \frac{c_p}{m} = \frac{\mathbb{P}\, c_T}{\phi + \mathbb{P}m} \rightarrow c_T = \left(\frac{\phi + \mathbb{P}m}{\mathbb{P}}\right) r_B$$

$$\frac{\phi + \mathbb{P}m}{\mathbb{P}} = \frac{.96 + (250)(100)}{250} = 100.004 \frac{\mu g/l}{\mu g/g} \qquad c_T(mg/l) = \frac{100.004}{1000} \times r_B(\mu g/g) \simeq 0.1\, r_B\left(\frac{\mu g}{g}\right)$$

* From ENCOTEC DATA IN BATTELLE

* ① G. Ave. @ ①
② " " @ ② & ③
③ " " assumed
④ Ac " @ ④
⑤ G. Av @ ⑤

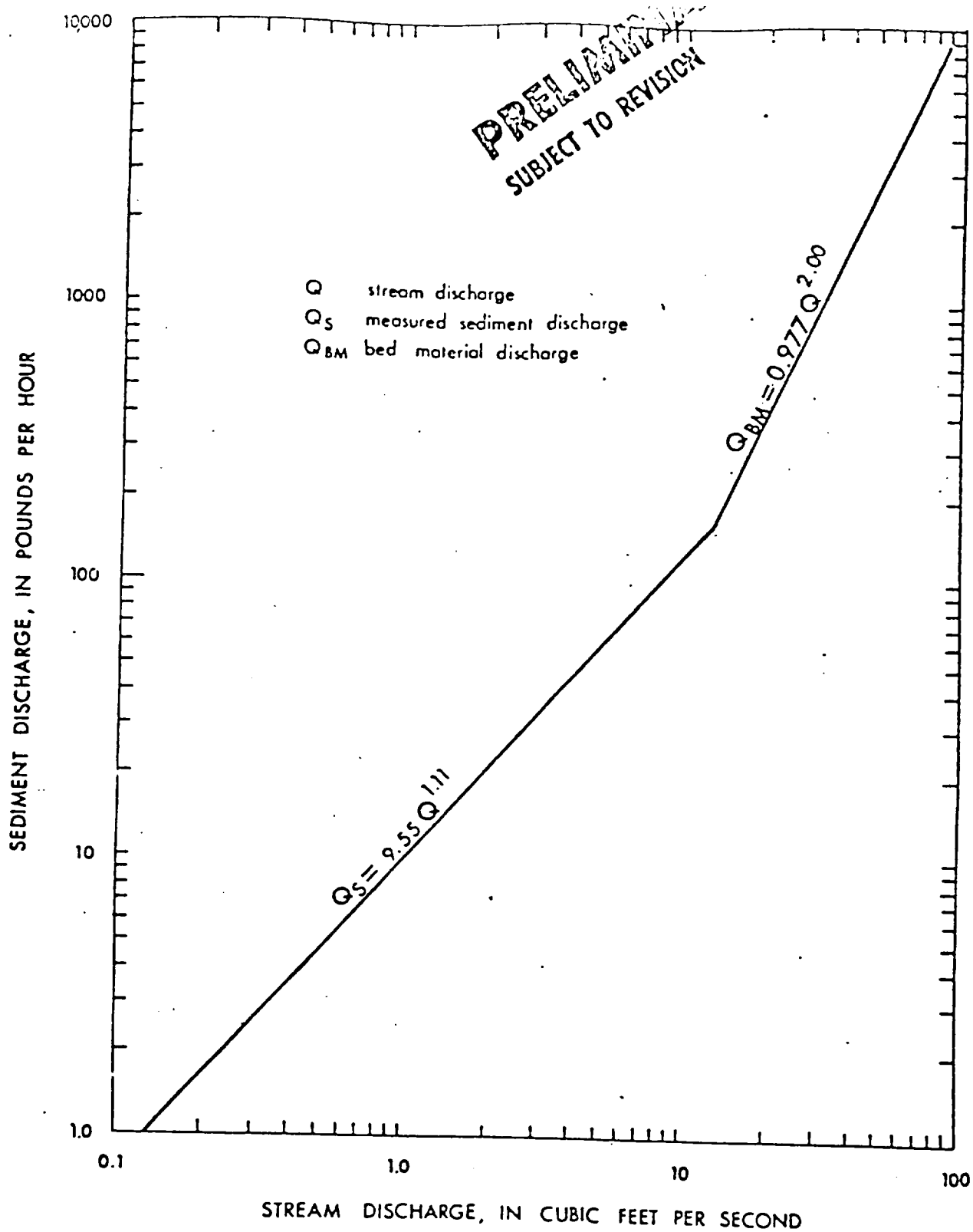
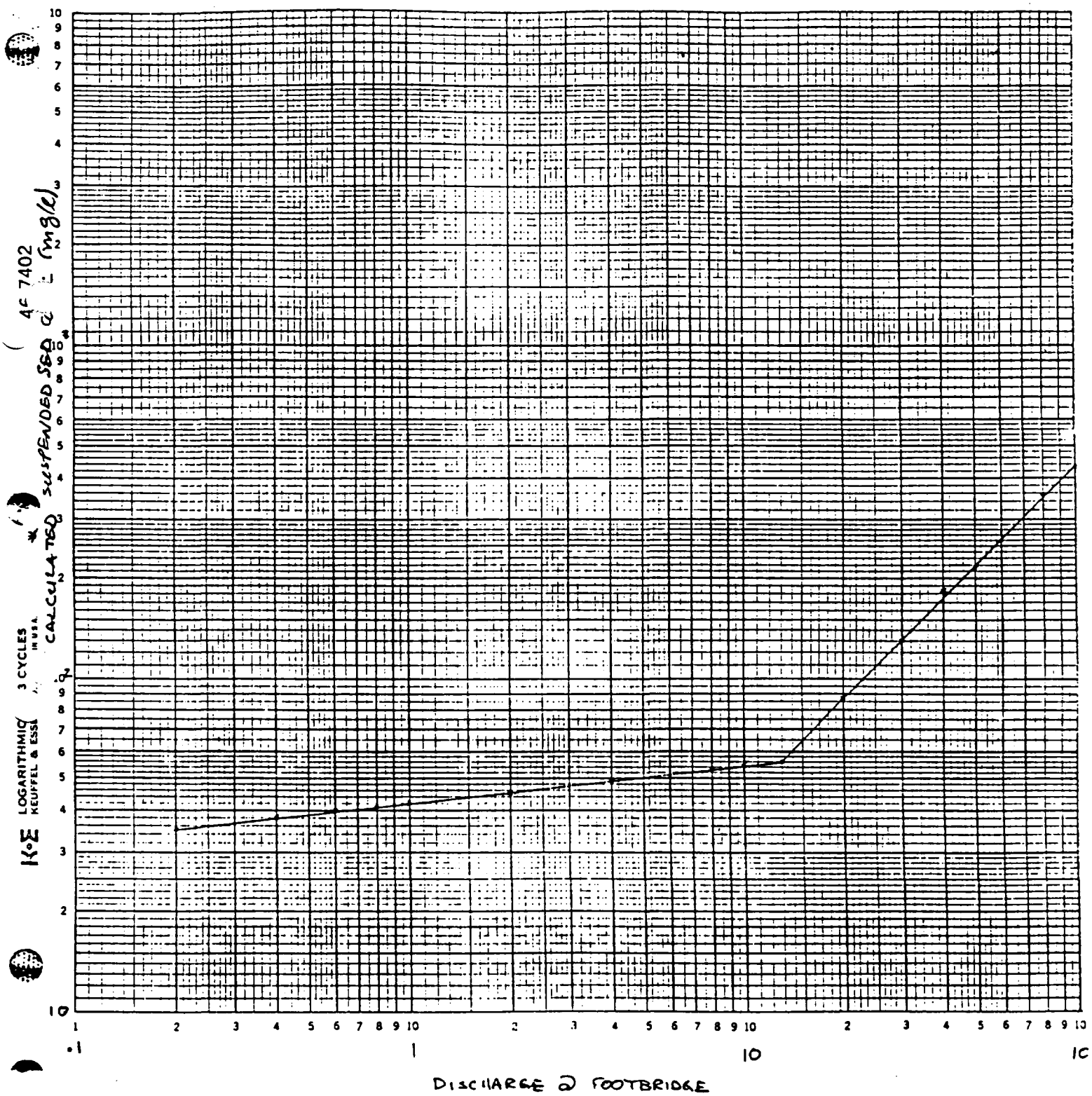


Figure 7. Composite sediment transport curve.



$W(lb/hr) = 9.55\,Q^{1.11}$ {Q .1-13 cfs} → $m_{ss} = 42.4\,Q^{.11}$

$W(lb/hr) = .977\,Q^{2}$ {Q 13-100 cfs} → $m_{ss} = 4.34\,Q$

SOLIDS conc @ given Q

From U.S.G.S. for $Q_s(lb/hr) = 9.55\,Q^{1.11}$ for $Q = .1 - 13$ cfs

$Q_s(lb/hr) = 0.977\,Q^{2.0}$

$Q_s(lb/d) = 24\,Q_s(lb/hr)$

$Q_s(lb/d) = 5.4\,m_{ss}(mg/l) \times Q(cfs)$

$5.4\,m_{ss}Q = 24 \times 9.55\,Q^{1.11}$

$m_{ss}(mg/l) = 42.4\,Q^{.11}$. $Q = .1 - 1$

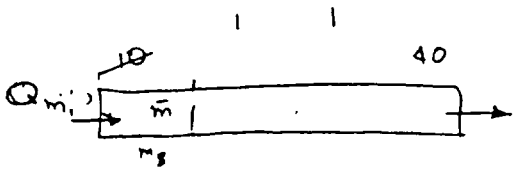
m_{ss}

$m_{ss}(mg/l) = 4.34\,Q$ $Q = 13 - 1$

Q(cfs)	m (mg/l)
.1	33
.2	36
.4	38
.8	41
1.	42
4.	49
6	52
8	53
10	55
13	56
20	87
30	130
40	174
50	217
80	347
100	434

CALCULATION OF E_{wb} FOR SOLIDS WITH GIVEN Q, m_1, m_2

NO HORIZONTAL E's, NO EXCHANGE WITH LAKE



$v_s = 1$ ft/d

$Qm_1 + v_s A$

$R = r^* \frac{EA}{L}$

$\boxed{1^{st} = 6}$ Sfg

$$Qm_1 - \bar{m} v_s A + R(m_B - \bar{m}) = Q\bar{m}$$

$$R(m_B - \bar{m}) = Q(\bar{m} - m_1) + \bar{m} v_s A$$

$$R_{16} = Q\frac{(\bar{m} - m_1)}{m_B - \bar{m}_1} + \frac{\bar{m}}{m_B - \bar{m}_1} v_s A$$

$R = Q\,(10-$

$$R = 1\,\frac{10-5}{100{,}000-10}\ \text{cfs}\ \frac{mg}{\ell} + \frac{10}{\quad}$$

$$R = \frac{1\,(10-5)^{cfs} + 10\ ft/d\ 18750\ ft^2}{100{,}000} = \frac{5\ cfs + 2.17\ cfs}{100{,}000} = 7.17 \times 10^{-5}$$

$$r^* \frac{EA}{L} = r^* E\,\frac{18750\ ft^2}{\frac{1}{2}(.7+.5)\ ft} = r^*[E] = r^*[E]\,\frac{18750 \times 1.076 \times 10^{-3}}{\frac{1}{2}(.7+.5)}\ \frac{ft^3}{sec} = 33.6\ ft^3$$

$$[E] = \frac{cm^2}{sec} = \frac{1.076 \times 10^{-3}\ ft^2}{sec}$$

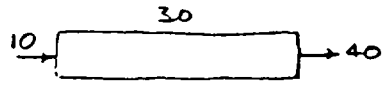
$$r^* E\ 33.6\ \frac{ft^3}{sec} = 7.17 \times 10^{-5}\ ft^3/sec$$

$$r^* E = 2.1 \times 10^{-6}$$

if $r^* = 1$ $\quad E = 2.1 \times 10^{-6}\ \frac{cm^2}{sec}$

2

For Remainder



$$R_{resi} = \frac{\overset{30}{(40-10)}}{100000-30} + \frac{30}{100000-30} \; \overset{31}{ft/2473600} \times 90050 = \frac{30+31}{100000} = 61\times10^{-5}$$

$$r^*E = r^*[E]\,\frac{90050 \times 1.076\times10^{-3}}{\frac{1}{2}\times(1+.5)} = r^*[E]\;\overset{130}{129}\text{ cfs}$$

$$r^*[E]\,130 = 60\times10^{-5} \rightarrow r^*[E] = 4.6\times10^{-6}$$

$$\text{if } r^*=1 \quad [E] = 4.6\times10^{-6}$$

$\Rightarrow$ These E's $\quad E_{16} = 2.1\times10^{-6}\ cm^2/sec$

$$E_{27} = E_{38} = E_{49} = S_{510} = 4.6\times10^{-6}\ cm^2/sec$$

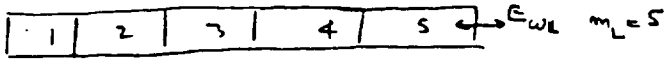
give the "observed" m's without emptying the bottoms

~~RUN 1~~ NDW03

3

Now Let E_{SL} to.

① Just put E_{SL} and see what happens to solids profile in seg 5



$E_{SL} = 1\ mi^2/d$

$$R = \frac{EA}{L} = [E]\ \frac{mi^2/d \times 52\ ft^2}{1/2\ 2{,}000\ ft} = [E]\ \frac{52 \times \frac{27.88 \times 10^6\ ft^2}{d}}{\frac{1}{2} \times 2000\ ft} = [E]\ \frac{52 \times 27.88 \times 10^6}{\frac{1}{2} \times 1000} = [E]\ 1.45 \times 10$$

$$R = [E]\ 1.45\ \frac{MCF}{D}$$

Now Repeat NDW03 with $E_{SL} = .1$ RUN NDW04

$R_{SL} = .145\ \frac{MCF}{d}$

and $m_L = 5$

" " NDW03 & with $E_{SL} = .01$ RUN NDW05 $\left\{ \begin{array}{l} \text{scale factor} \\ -1 \\ R = .145 \end{array} \right.$

$R_{SL} = .0145\ \frac{MCF}{d}$

and $m_L = 5$

" " NDW05 WITH $E_{12} = E_{23} = E_{34} = E_{45} = E_{50} = .0145$

For 1-6 interface require $m_0 = 5$ mg/l $m_1 = 10$ mg/l

for any Q $\quad r^* E\,(cm^2/sec) = (1.487Q + .644) \times 10^{-6}$; Q (cfs)

and take $r^* = 1$

For 2-7 $\quad$ .1 - 13 cfs

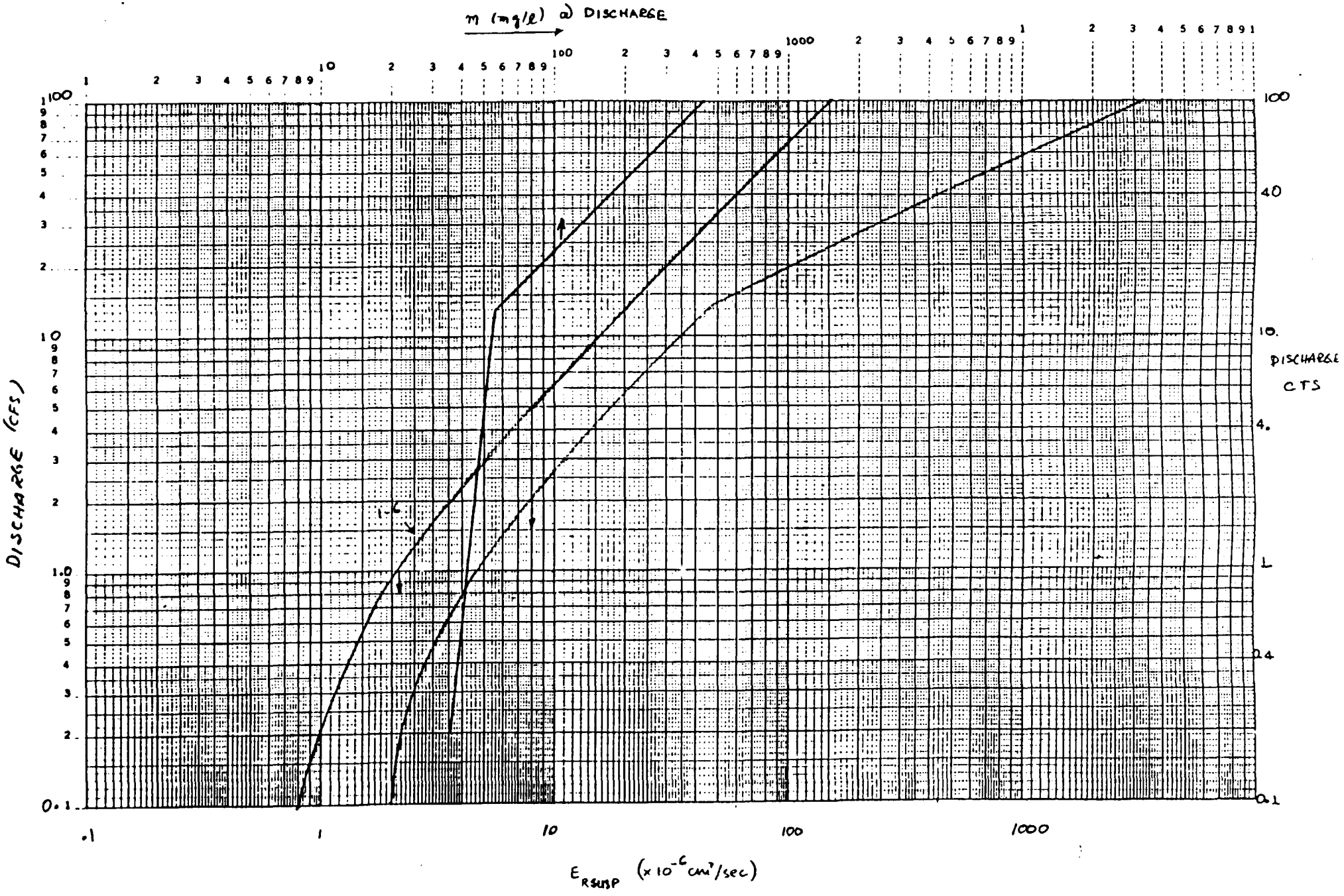
3-8 $\quad r^* E\,(cm^2/sec) = \{.403 + 1.71 Q^{.11} - .774 Q + 3.31 Q^{1.11}\} \times 10^{-6}$

4-9

5-10 $\quad r^* E\,(cm^2/sec) = \{.403 - .6 Q + .336 Q^2\} \times 10^{-6}$

Q	E_{1-6} $\times 10^{-6}$ cm²/sec	$E_{\text{ALL others}}$
.1	.8	1.91
.5	1.4	3.14
.9	1.7	
1		4.6
2.	3.6	
3		11.2
5.	8.1	
9.	14.	32.7
13	20.	[illegible]
30	45	[illegible]
70	104	[illegible]
100	150	[illegible]

K·E LOGARITHMIC 3 x 5 CYCLES KEUFFEL & ESSER MADE IN U.S.A. 46 7520



FLUXES TO LAKE

FLUX FROM N. DITCH WITH 1 SEG CALC.

$$C_{T_1} = \frac{W/Q}{1+K_T t_{01}} \quad \rightsquigarrow \quad \frac{Q c_I}{W_T} = \frac{1}{1+K_T t_{01}}$$

$$K_T = K_1 + B\left(\frac{r_2}{r_1}\right)(K_2 + K_s) \quad ; \quad B = \frac{m_2 H_2 f_{p_1}}{m_1 H_1 f_{p_2}}$$

Take $r_2 = r_1$; $K_2 = K_1 = 0$

$K_s = 10\,\overset{w_s}{cm/yr} = 2.1 \times 10^{-8}\ sec^{-1}$ $\qquad K_s = \frac{w_s}{H_2} f_{ps}$

$V = 3\times10^3\,ft \times 35\,ft \times 1\,ft = 10.5\times10^4\,ft^3$

for $Q = 1\,cfs \Rightarrow$ $\quad t_{01} = 10.5\times10^4\,sec = 1.22\,d$; for $Q = .1\,cfs$ $t_{01} = 10.5\times10^5 = 12.2\,d$

for $m_2 = 10^5\,mg/l$; $H_2 = .5\,ft$, $H_1 = 1\,ft$ $\qquad m = 30\,mg/l$

B = 3550	($m_1 = 10\,mg/l$)	
1467	($m_1 = 30\,mg/l$)	B = 1467
1022	($m_1 = 45\,mg/l$)	

$$K_T t_{01} = B K_s t_{01} = 3550 \times \underbrace{2.1\times10^{-8} \times 10.5\times10^4}_{2.2\times10^{-3}} = 7.827 \sim 7.83$$

$K_T t_{01} = 1467 \times 2.1\times10^{-8} \times 10.4\times10^5$	1467	= 3.23
= 32.	1022	= 2.25

TOTAL load at 20% leakage $W_T = 67\times10^6\,lb/13y = 365\,lb/d = 60{,}500\,kg/yr$

let f_h the fraction of W_T dicharged to harbor → $(1-f_h)$ was discharged to Ditch (assuming no other losses) then the flux from ditch $\quad (FLUX)_D = (1-f_h)\dfrac{W_T}{1+K_T t_{01}}$

To compare with harbor results.

Assume 10^6 kg over 20 y $\Rightarrow$ 50,000 kg/y

$$(FLUX)_D^{1,45} = (1-f_h)\frac{50,000}{3.25} = 15,400\,(1-f_h)$$

$$(FLUX)_B^{1,30} = (1-f_h)\frac{50,000}{33} = 1500\,(1-f_h)$$

<u>Report p. 54</u> if all of 10^6 kg over 20 years discharged in harbor

$(FLUX)_H = 7000$ kgr/y

HARBOR SED DATA

SEG #1 OF MODEL (0-1)FT

	Area (m^2)	$\bar{x}$	< PCB* >	Hi	Low	
1	228	380	34.3			
2	228	33140	2994			
3	878	1238	431			
5	372	4333	639			
6	325	1230	158			
7	1583	1156	1450			
8	1583					
			5706	49,000	571	
			2527	13,603	465	{ Figs from Harbor rep

* PCB (kg) = $\bar{x}$ (µg/g) A (.0003962)

SEG 2 OF MODEL 1 FOOT

	A/2 (m^2)	$\langle \bar{X} \rangle$	$\langle PCB \rangle$ kg	Hi	Low
10	2598	404	416		
11	2598	40	41	5	
			457	393	53
			616	4100	93

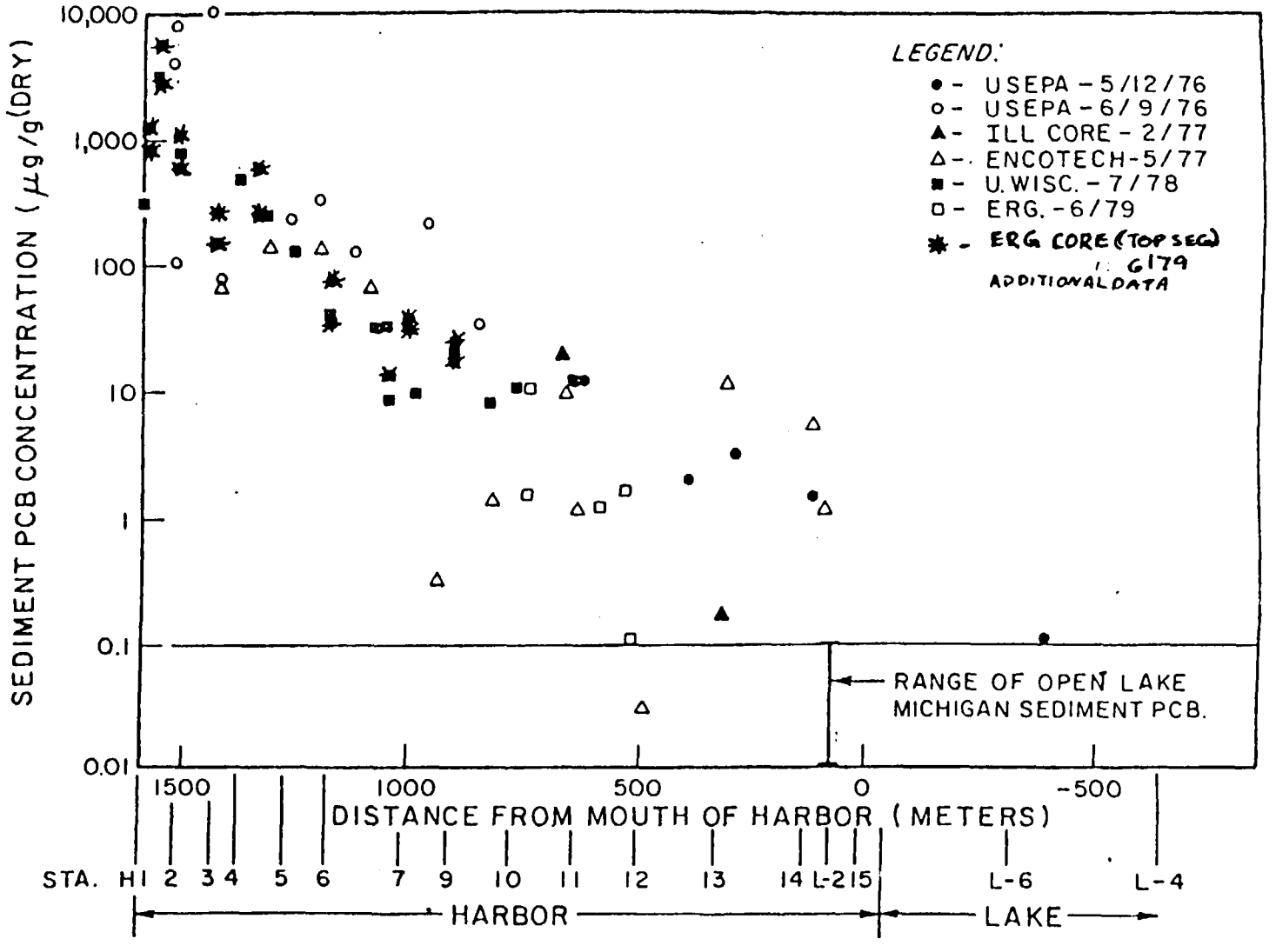


Figure 3. Surface sediment total PCB concentrations

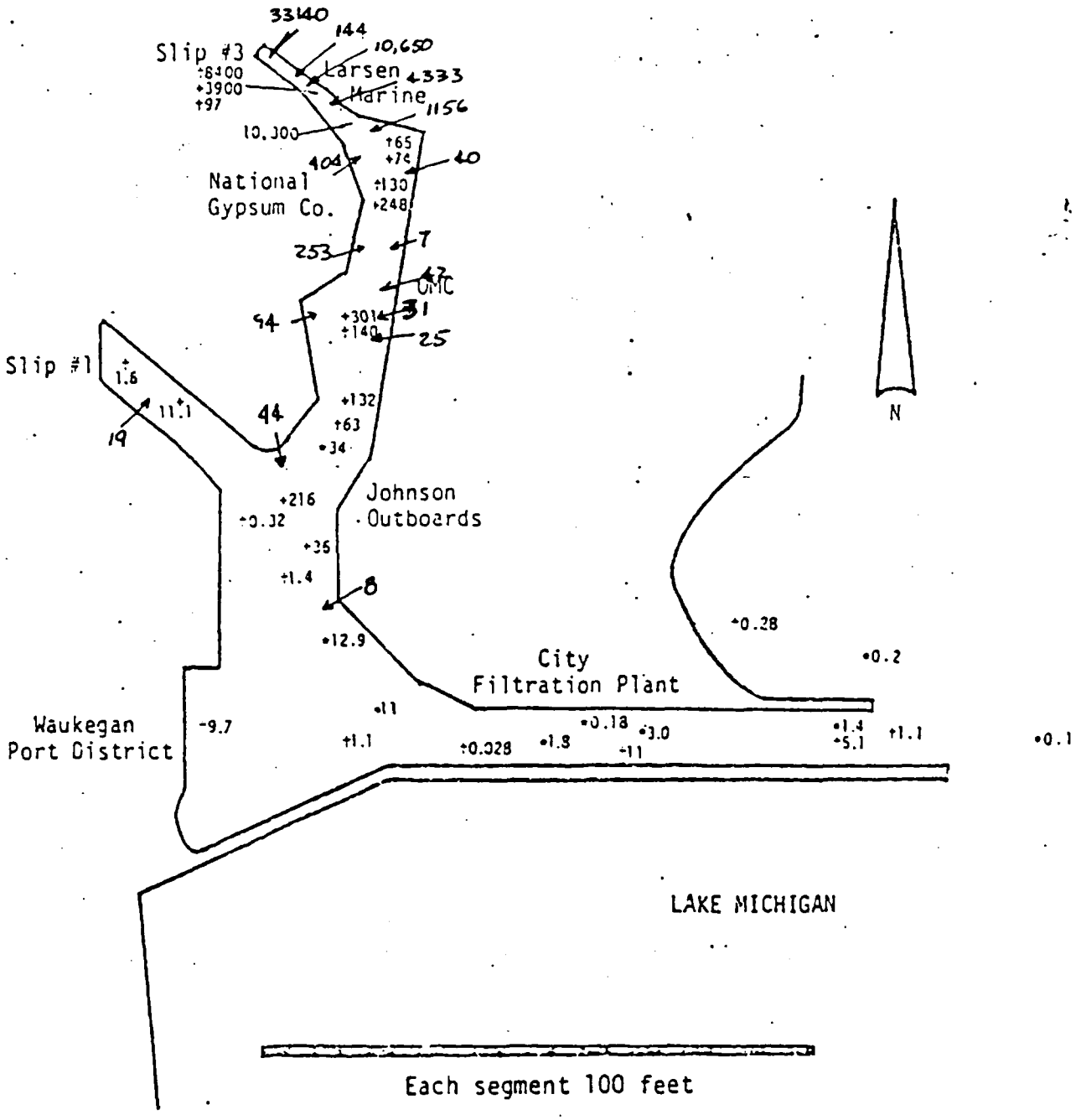
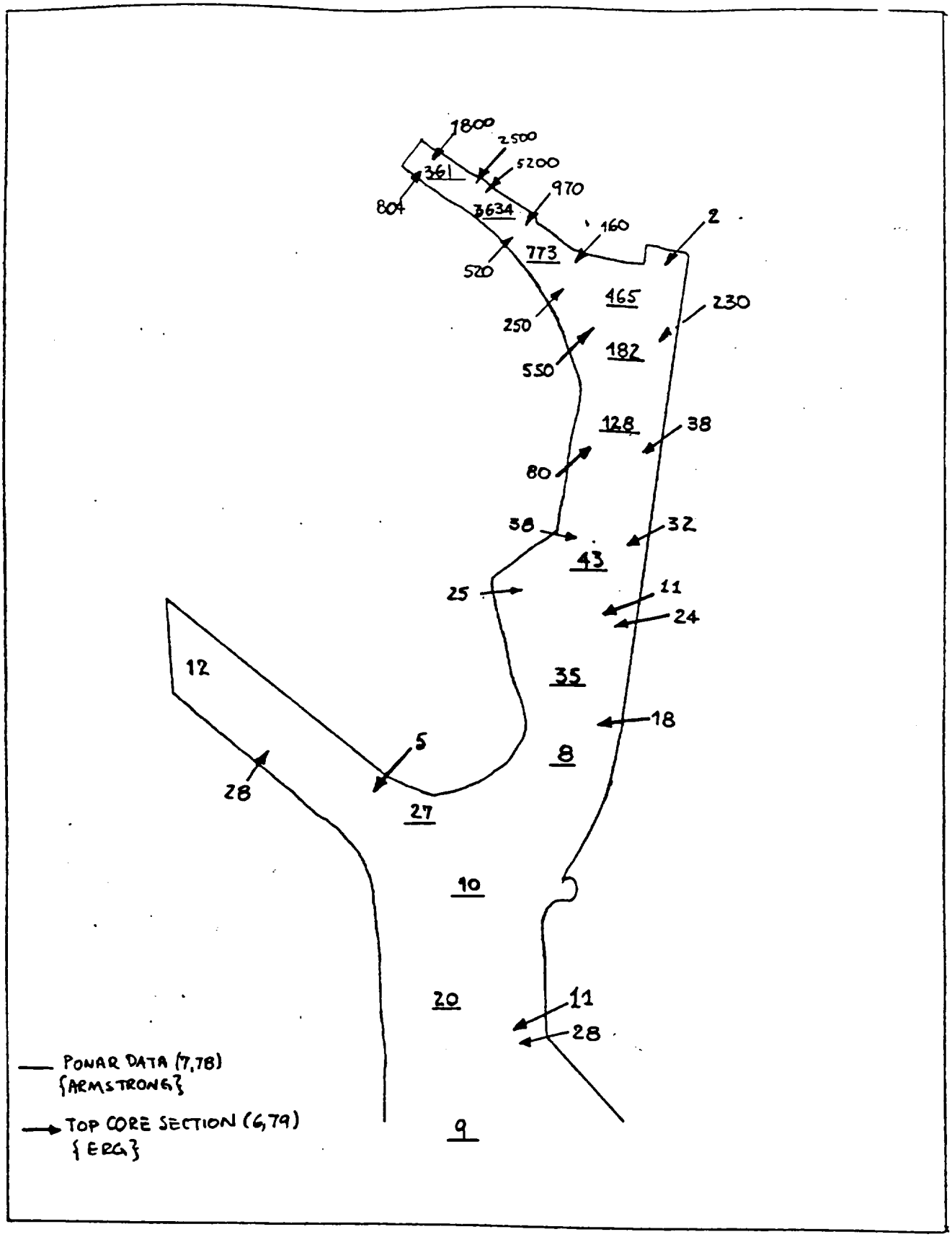


FIGURE 3. PCB Concentrations in the Top 1 Ft of Sediments (mg/kg-ppm)
o U.S. EPA Grab Samples, 5/12/76
+ U.S. EPA Grab Samples, 6/9/76
* Illinois EPA Core Samples, 2/16-18/77
† ENCOTEC Core Samples, April, 1977

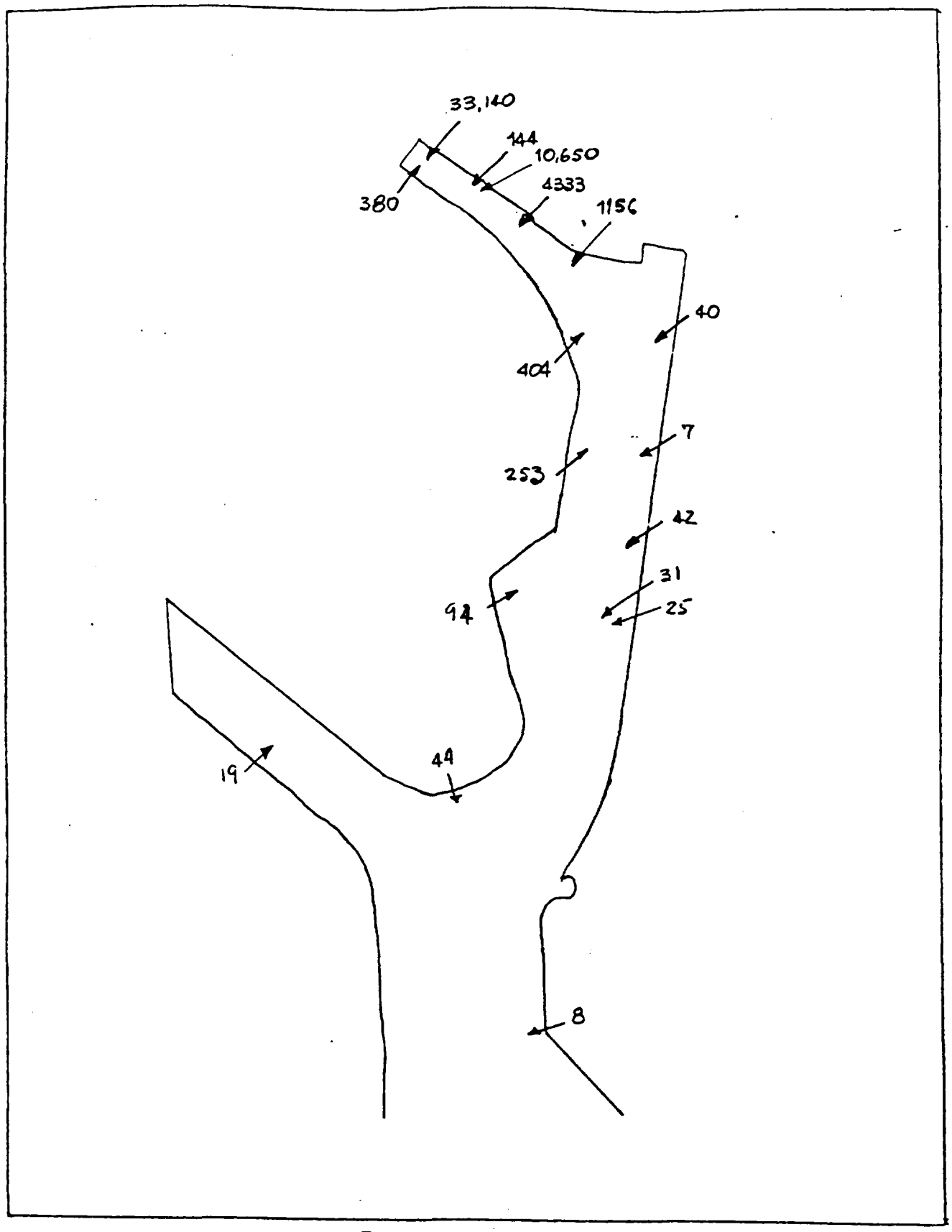
← ERG DATA June 79



FIG

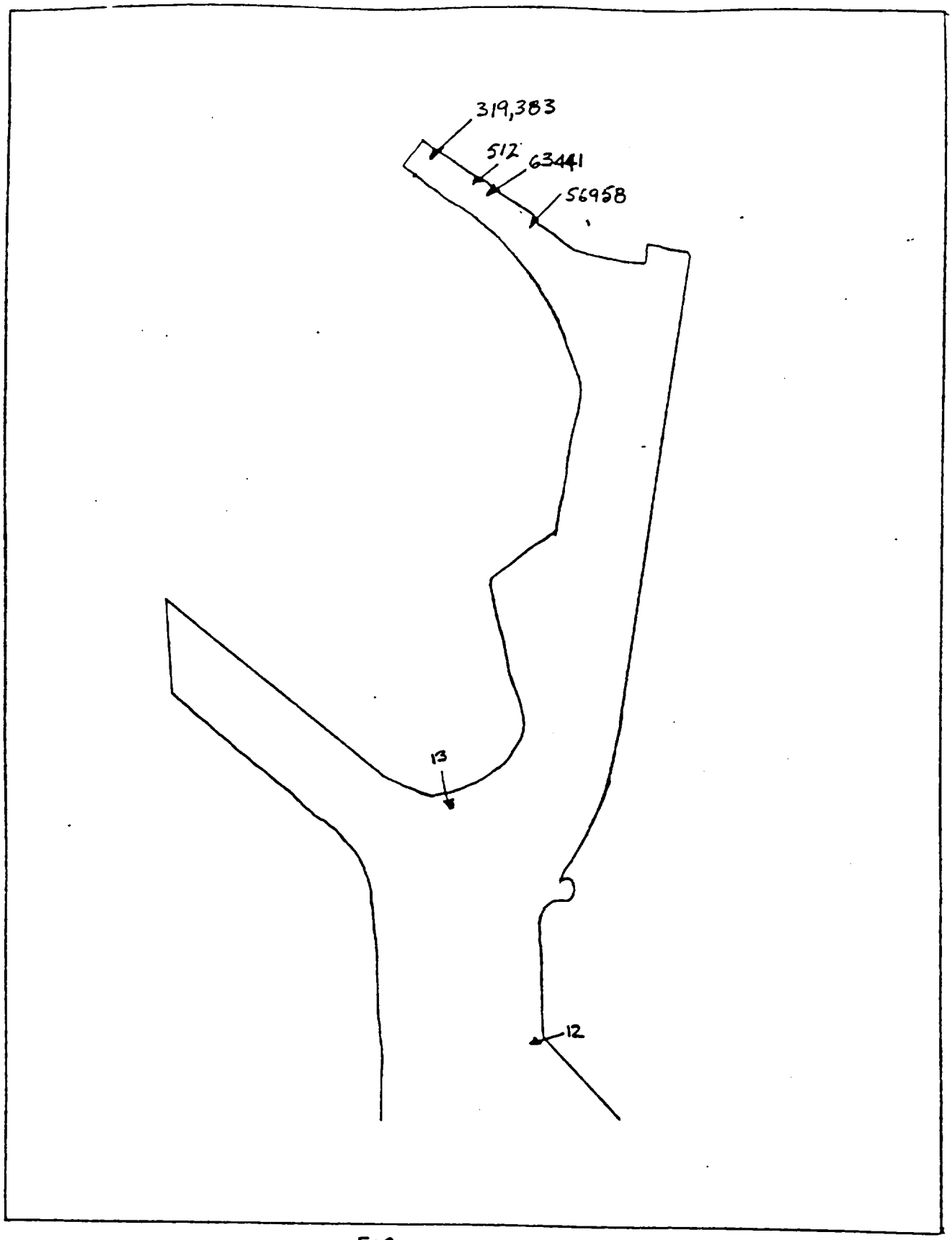
SURFACE SEDIMENT TOTAL PCB CONCENTRATION (mg/kg)

WAUKEGAN HARBOR



FIG

AVERAGE TOTAL PCB CONCENTRATION (mg/kg):
(0-1 FT) SEDIMENT SAMPLES - WAUKEGAN HARBOR



FIG

AVERAGE TOTAL PCB CONCENTRATION (mg/kg)

(1-2 FT) SEDIMENT SAMPLES - WAUKEGAN HARBOR

TABLE 1

COMPARISON OF CORES S03 & D03

CORE	Depth of Avg D (ft)	Avg over D $\bar{x}$ (mg/kg)	core Pooled Avg $\bar{\bar{x}}$ (mg/kg)	$(\bar{x}/\bar{\bar{x}})$
S03	0 - 3	988	4371	0.226
D03	0 - 3	19339		4.424
S03	0 - 1	144	1238	0.116
D03	0 - 1	10650		8.603
S03	1 - 2	512	5699	0.090
D03	1 - 2	63441		11.131
S03	2-3	12960	11776	1.101
D03	2-3	10700		0.909

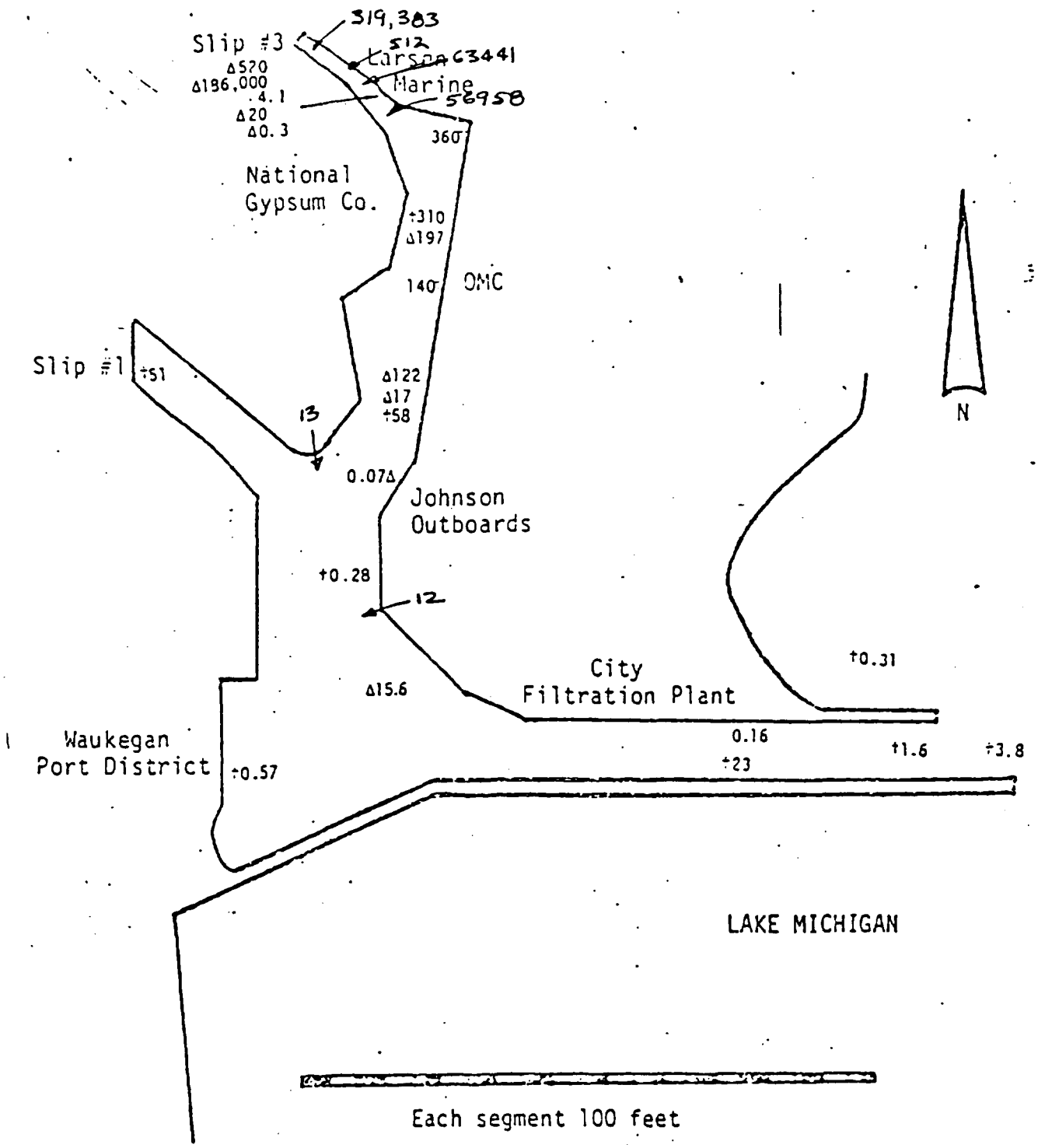


FIGURE 4. PCB Concentrations at 1 to 2 Ft Depth in Sediments (mg/kg-ppm)
Δ Illinois EPA Core Samples, 2/15-18/77
† ENCOTEC Core Samples, April, 1977

EPG DATA, June 79

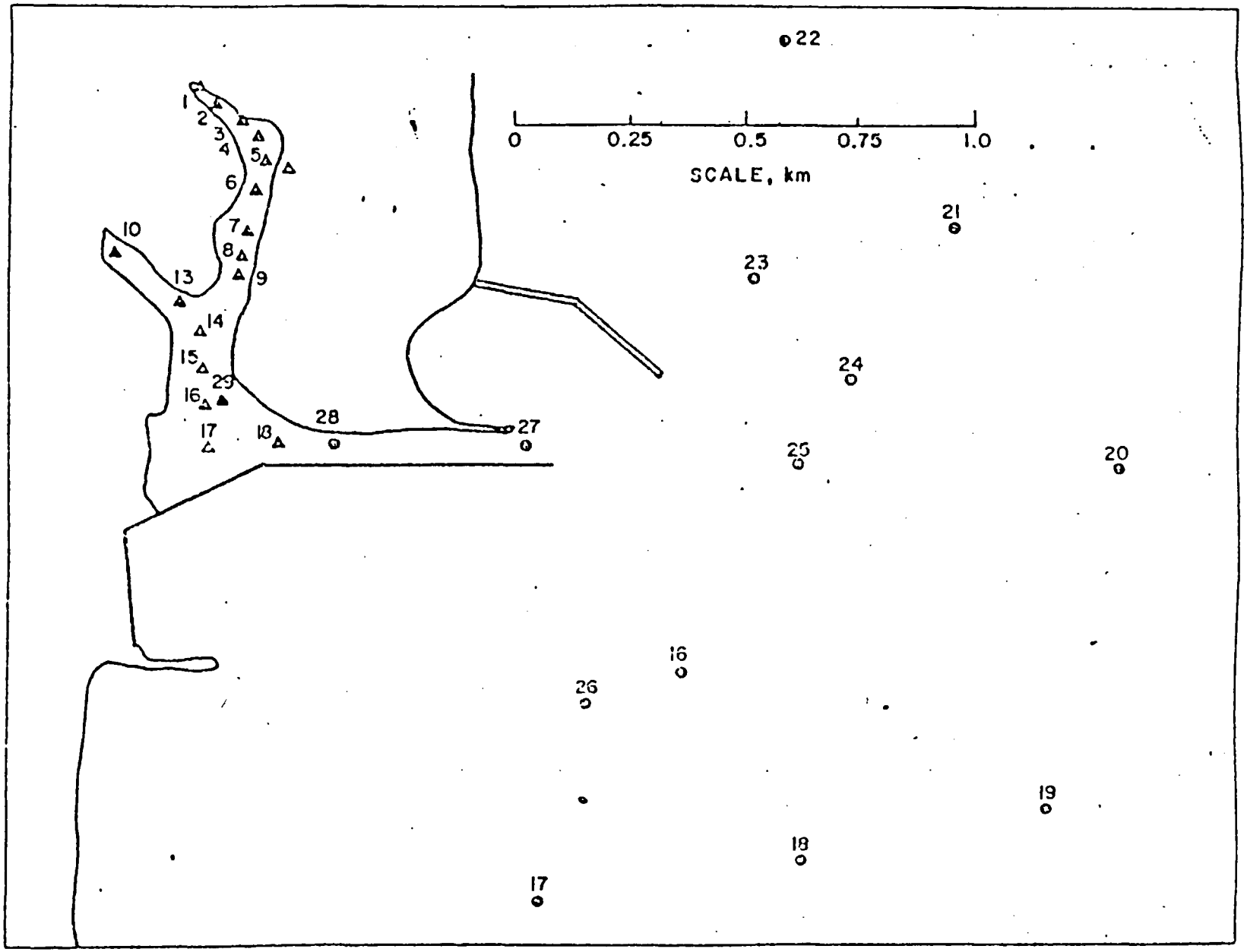


Figure 1. Waukegan Harbor and near-harbor stations. Harbor stations indicated with W in text.

WAUKEGAN HARBOR CONTAMINATION DATA

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois
Date Obtained: June 1979

Analysis performed by: Environmental Research Group
Date Performed: July 1979

Information obtained from: Report-Sampling and Analysis of Water and Sediment Samples Taken from Waukegan Harbor Before, During and After Maintenance Dredging, performed for USEPA Region V on behalf of JRB Associates, Inc., McLean, Virginia, June, 1979

Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	~~SOIL TYPE~~ GEM AV 144	PERCENT MOISTURE	SAMPLE LENGTH
S01	S01-1	579.6	574.4	840			6"
S01	S01-2		574.35	5,000			Total
S01	S01-3		574.27	780			
S01	S01-4		574.18	94			
S01	S01-5		574.10	110			
S01	S01-6		573.77	89	380		
S02	S02-1		569.1	1,800			1'-10"
S02	S02-2		568.93	24,800			Total
S02	S02-3		568.77	79,000			
S02	S02-4		568.60	70,400			
S02	S02-5		568.43	55,000			
S02	S02-6		568.27	97,000	33,140	92811	
S02	S02-7		568.1	165,000			
S02	S02-8		567.93	470,000			
S02	S02-9		567.77	537,000			
S02	S02-10		567.6	570,000			
S02	S02-11		566.89	140,000	319383		
S03	S03-1		572.53	2,500			3'-0"
S03	S03-2		572.36	25			Total
S03	S03-3		572.19	20			
S03	S03-4		572.02	1,000			
S03	S03-5		571.85	110			
S03	S03-6		571.68	64	144		
S03	S03-7		571.51	100		488	
S03	S03-8		571.34	90			
S03	S03-9		571.17	34,000			
S03	S03-10		571.00	46			
S03	S03-11		570.83	72			
S03	S03-12		570.66	19,000	512		
S03	S03-13		570.49	59,000			
S03	S03-14		570.32	46,000			
S03	S03-15		570.15	17,000			
S03	S03-16		569.98	440,000			
S03	S03-17		569.81	630			
S03	S03-18		569.64	370	12960		
S07	S07-1		569.64	160			1'-3"
S07	S07-2		569.48	1,200			Total
S07	S07-3		569.32	620			
S07	S07-4		569.16	1,300			
S07	S07-5		569.00	14,000			
S07	S07-6		568.84	11,000	1156		
S07	S07-7		568.68	3,300			
S07	S07-8		568.52	21			
S08	S08-1		569.8	250			
S08	S08-2		569.8	1,600			
S08	S08-3		569.8	4,400			
D03	D03-1	579.6	572.53	5,200			3'-0"
D03	D03-2		572.36	3,100			Total
D03	D03-3		572.19	27,000			
D03	D03-4		572.02	21,000			
D03	D03-5		571.85	19,000			
D03	D03-6		571.68	8,400	10650		
D03	D03-7		571.51	14,000		19339	
D03	D03-8		571.34	120,000			
D03	D03-9		571.17	21,000			
D03	D03-10		571.00	330,000			
D03	D03-11		570.83	200,000			
D03	D03-12		570.66	28,000	63441		
D03	D03-13		570.49	52,000			
D03	D03-14		570.32	74,000			
D03	D03-15		570.15	420,000			
D03	D03-16		569.98	9,100			
D03	D03-17		569.81	330			

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

Date Obtained: June 1979

Analysis performed by: Environmental Research Group

Date Performed: July 1979

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Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S05	S05-1		568.1	970			3'-0" Total
S05	S05-2		567.93	2,900			
S05	S05-3		567.76	2,800			
S05	S05-4		567.59	3,500			
S04	S05-5		567.42	8,000			
S05	S05-6		567.25	30,000	4333 ✓		
S05	S05-7		567.08	60,000			
S05	S05-8		566.91	80,000			
S05	S05-9		566.74	52,000			
S05	S05-10		566.57	120,000			
S05	S05-11		566.40	76,000			
S05	S05-12		566.23	15,000	56958 ✓		
S06	S06-1		569.4	520			
S06	S06-2		569.3	8,000			
S06	S06-3		569.2	220			
S06	S06-4		569	2,500	1230		
S10	S10-1		566.27	550			2'-4" Total
S10	S10-2		566.04	270			
S10	S10-3		565.81	240			
S10	S10-4		565.58	290			
S10	S10-5		565.35	300			
S10	S10-6		565.12	1,400	404 ✓		
S10	S10-7		564.89	330			
S10	S10-8		564.66	350			
S10	S10-9		564.43	700			
S10	S10-10		564.20	950			
S12	S12-1		561.50	80			1'-7" Total
S12	S12-2		561.32	180			
S12	S12-3		561.14	260			
S12	S12-4		560.96	480			
S12	S12-5		560.78	580			
S12	S12-6		560.60	250	253 ✓		
S12	S12-7		560.42	40			
S12	S12-8		560.24	4.9			
S12	S12-9		560.06	0.99 (Bottom)			
S11	S11-1		563.5	230			1'-7" Total
S11	S11-2		563.34	95			
S11	S11-3		563.18	18/15*			
S11	S11-4		563.02	110			
S11	S11-5		562.86	3			
S11	S11-6		562.70	30	40 ✓		
S11	S11-7		562.54	2.5			
S11	S11-8		562.38	2.7			
S11	S11-9		562.22	0.80			
S11	S11-10		562.06	0.40 (Bottom)			
S07	S07		568.55	59 (Bottom)			1'-3" Total
S09	S09-1		571.1	1.7			0'-6" Total
S09	S09-2		570.8	0.14			
S09	S09-3		570.6	0.31			
S13	S13-1		560.9	38			1'-6" Total
S13	S13-2		560.58	21			
S13	S13-3		560.26	8.0			
S13	S13-4		559.94	2.3/3.4*			
S13	S13-5		559.3	0.71 (Bottom)	7		
S14	S14-1		561.6	38			0'-10"

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

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Lake elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S15	S15-1		559.3	32			1'-11"
S15	S15-2		559.0	17			Total
S15	S15-3		558.71	20			
S15	S15-4		558.50	17			
S15	S15-5		558.20	64			
S15	S15-6		557.90	130			
S15	S15-7		557.4	150(Bottom)		42'	
S16	S16-1		564.8	25			
S16	S16-2		564.5	34			
S16	S16-3		562.4	120			
S16	S16-4		563.9	230			
S16	S16-5		563.6	170			
S16	S16-6		563.3	77/150/170*		94'	
S16	S16-7		563.0	31			
S16	S16-8		562.7	25			
S17	S17-1		558	11			1'-6"
S17	S17-2		557.8	58			Total
S17	S17-3		557.6	70/130*			
S17	S17-4		557.3	64			
S17	S17-5		557.1	7.7			
S17	S17-6		556.9	22/31/33*		31'	
S17	S17-7		556.7	120			
S17	S17-8		556.5	23	Clay Plug		
D17	D17-1		558	24			1'-8"
D17	D17-2		557.8	25			Total
D17	D17-3		557.5	46			
D17	D17-4		557.3	38			
D17	D17-5		557.0	6.2			
D17	D17-6		556.8	42		25'	
D17	D17-7		556.5	110			
D17	D17-8		556.3	27	Clay Plug		
S19	S19-1		559.9	26/30*			
S19	S19-2		559.7	13			
S19	S19-3		559.5	19/9.5*			
S19	S19-4		559.3	20/16*			
S19	S19-5		559.1	29/12*			
S19	S19-6		558.9	25		19'	
S20	S20-1		556	5.4			
S20	S20-2		555.8	37/12.6*			
S20	S20-3		555.5	23			
S20	S20-4		555.2	13/13*			
S21	S21-1		556.6	26/12*			
S21	S21-2		556.4	23/17*			
S21	S21-3		556.2	47/43/48*			
S22	S22-4		556.20	78			1'-8"
S22	S22-5		556.05	61/48*			Total
S22	S22-6		555.9	22		~ 44'	
S22	S22-7		555.75	11			
S22	S22-8		555.6	3.4/8.8*			
S22	S22-9		555.45	52			
S22	S22-10		555.3	13/12/12*			
S22	S22-11		555.15	9.5			
S22	S22-12		555.0	18		13'	
S22	S22-13		554.85	6.5			
S22	S22-14		554.7	12			
S22	S22-15		554.5	8			
S25	S25-20		564.20	1.6			1'-8" Total

Sampling performed by: Environmental Research Group, Inc., (ERG), Ann Arbor, Michigan and Bridgeview, Illinois

Date Obtained: June 1979

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Lake Elevation: 579.6 USGS Datum

BORING NUMBER	SAMPLE NUMBER	WATER ELEVATION	SAMPLE DEPTH	PCB CONCENTRATION	SOIL TYPE	PERCENT MOISTURE	SAMPLE LENGTH
S27	S27-1		555.0	11			1'-8"
S27	S27-7		554.6	13			Total
S27	S27-10		554.2	25			
S27	S27-11		553.8	9.6			
S27	S27-15		553.4	6.4			
D27	D27-1		555.0	14/56*			1'-8"
D27	D27-2		554.9	28/8.8*			Total
D27	D27-3		554.8	11			
D27	D27-4		554.7	14			
D27	D27-5		554.6	11.0/6.8*			
D27	D27-6		554.5	5.8/6.8*		8	
D27	D27-7		554.4	8.1/13*			
D27	D27-8		554.3	6.7			
D27	D27-9		554.2	53			
D27	D27-10		554.1	12			
D27	D27-11		553.0	4.1			
D27	D27-13		553.1	16		12	
D27	D27-14		553.2	9.5/6.8*			
D27	D27-16		553.3	13			
D27	D27-17		553.3	27			
D27	D27-Bottom		553.3	41		10	

* Duplicates

Table 3. Concentrations of PCBs (Aroclors) in Waukegan Harbor sediment samples (see Figure 1 and Appendix A for locations).

Station	Aroclor concentration(s) 1242	1248	Total	r^2
	— ppm[1] —			%
W-1	146.2(45.0)	215.1(30.9)	361.3(24.1)	91.1
W-2	1876.0(527)	1758.0(353)	3634.0(295)	88.7
W-3	755.1(18.1)	18.1(74.2)	773.3(129.3)	81.6
W-4	385.5(41.4)	79.4(40.1)	464.9(49.8)	91.1
W-5	162.2(17.0)	19.3(16.6)	181.5(11.6)	88.6
W-6	110.2(12.1)	17.5(12.1)	127.7(14.6)	91.6
W-7	28.0(7.5)	14.5(4.8)	42.5(4.7)	86.1
W-8	19.8(5.0)	15.3(3.3)	35.1(3.0)	87.4
W-9	3.0(1.2)	5.2(1.1)	8.2(0.8)	89.2
W-10	2.9(1.5)	8.6(1.0)	11.5(0.9)	93.6
W-13	6.9(2.0)	19.6(2.0)	26.5(2.0)	87.8
W-14	4.78(.74)	4.82(.59)	9.6(.54)	94.7
W-15	6.84(1.02)	12.74(.85)	19.6(.7)	97.1
W-16	2.34(.72)	7.15(.58)	9.49(.44)	95.4
W-17	3.14(.27)	7.48(.55)	10.6(.4)	96.7
W-18	3.70(.69)	7.89(.61)	11.6(.5)	95.9

[1]Values are the mean concentration for duplicate analyses; preliminary analyses indicated Aroclor 1254 concentrations were negligible in Harbor samples, and only Aroclor 1242 and 1248 were used as standards in the regression analysis. Concentrations are expressed in μg/g(ppm) on a dry-weight basis; s is the standard error of estimate and r^2 the correlation coefficient.

ITCR 0135

NEW HARBOR CORE DATA
FROM ERG REPORTS

TOTAL PCB (mg/kg)

SECTIONS @ every 5cm from top ↓		SECT No.	6" S01	22" S02	36" S03	36" D03	S05	15" S06	15" S07	S08	6" S09	2 S10
0-5		1	804	1800	2500	5,200	970	520	160	250	1.7	550
5-10		2	5,000	24,800	25	3,100	2900	8000	1200	1600	0.14	270
10-15		3	780	79,000	20	27,000	2800	220	620	4400	0.71	240
15-20	1F	4	94	70,400	1,000	21,000	3500	2500	1300			290
20-25		5	110	55,000	110	19,000	8,000		14,000			300
25-30		6	89	97,000	64	8,400	30,000		11,000			1400
30-35		7		165,000	100	14,000	60,000		3300			330
35-40		8		470,000	90	120,000	80,000		21			350
40-45		9		530,000	34,000	21,000	52,000		bottom 59			700
45-50	2FT	10		570,000	46	330,000	120,000					950
50-55		11		140,000	72	200,000	76,000					
55-60		12			19,000	28,000	15,000					
60-65		13				52,000						
65-70		14			46,000	74,000						
70-75		15			17,000	420,000						
75-80		16			440,000	9,100						
80-85		17			630	330						
85-90		18			370	310						
90-95		19										
95-100		20										

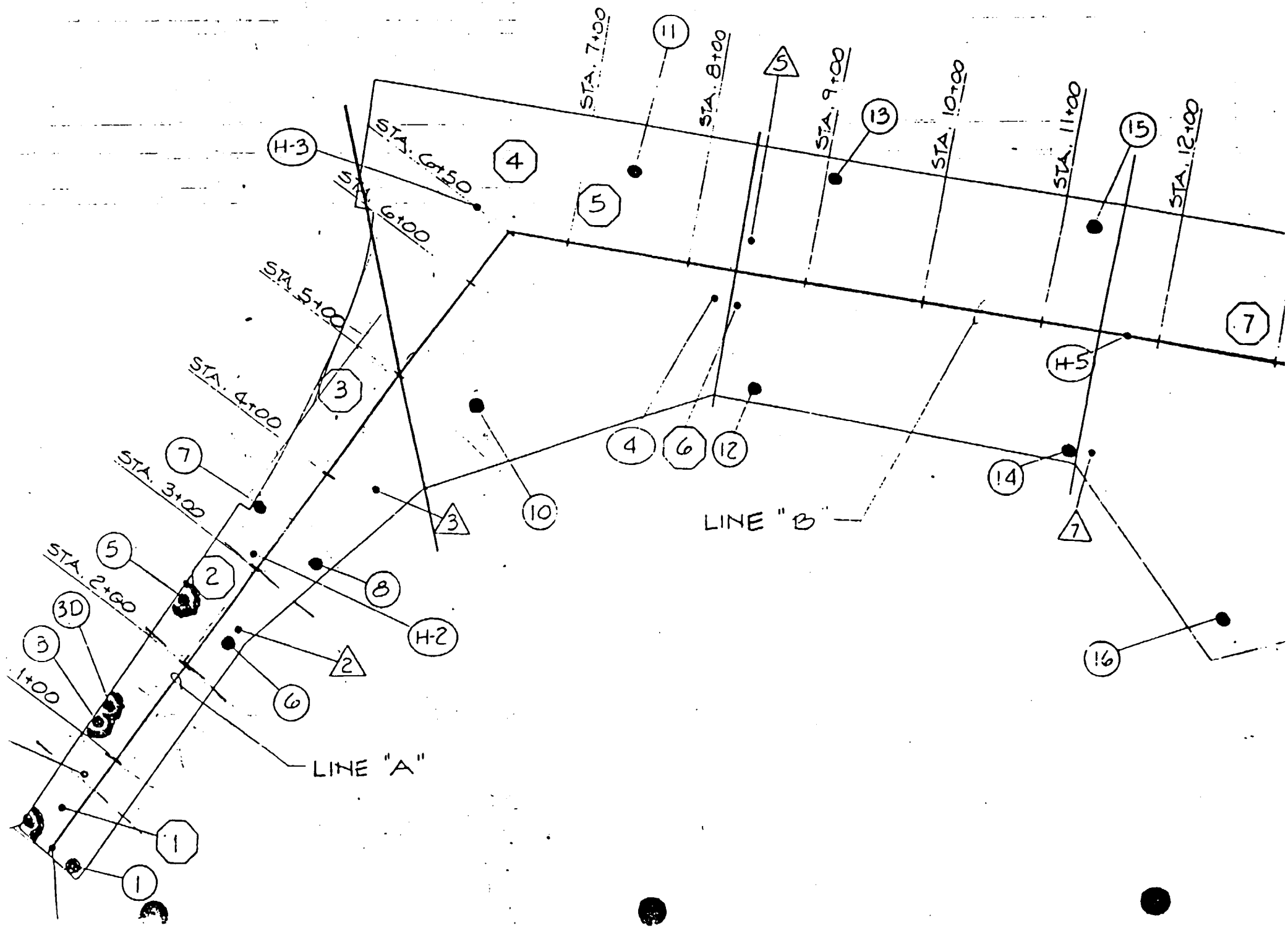
	20"	19"	8"
	S11	S12	S13
1	230	80	38
2	95	180	21
3	12	260	8
4	11.0	480	2.8
5	3.0	580	bottom .71
6	30.	250	
7	2.5	40	
8	2.7	4.9	
9	0.8	bottom .99	
10	bottom .48		
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

	10"	23"		18"	20"			
	S14	S15	S16	S17	D17	S23	S21	S18
1	38	32	25	11	24		18	
2	48	17	34	58	25		20	
3		20	130	95	46		45	
4		17	230	64	38			
5		64	170	7.7	6.2			
6		130	125	28	42			
7		bottom 150	31	120	110			
8			8	23	27			
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

3	S19	S20	20' S22	S24	20' S25
	28	5.4			
	13	22.			
	13	23			
	18	13	78		
	19		54.		
	25		22		
			11		
			5.		
			52		
			12		
			9.5		
			18		
			6.5		
			12.0		
			8.0		
					1.6

	20' S26	20' S27	20' D27			
1		11	28			
2			16			
3			11			
4			14			
5			9			
6			6			
7		13	10			
8			6.7			
9			53			
10		25	12			
11		9.6	4.1			
12						
13			16			
14			8			
15		6.4				
16			13			
17			27			
18			bottom 41			
19						
20	bottom 33					

	20'	20'	20"
	S26	S27	D27
		11	28
			16
			11
			14
			9
			6
1		13	10
3			6.7
9			53
0		25	12
1		9.6	4.1
2			
13			16
14			8
5		64	
6			13
17			27
18			bottom 41
19			
20	bottom 33		


STA. 1+00
STA. 2+00
STA. 3+00
STA. 4+00
STA. 5+00
STA. 6+00
STA. 6+50
STA. 7+00
STA. 8+00
STA. 9+00
STA. 10+00
STA. 11+00
STA. 12+00
LINE "A"
LINE "B"
H-2
H-3
H-5
1
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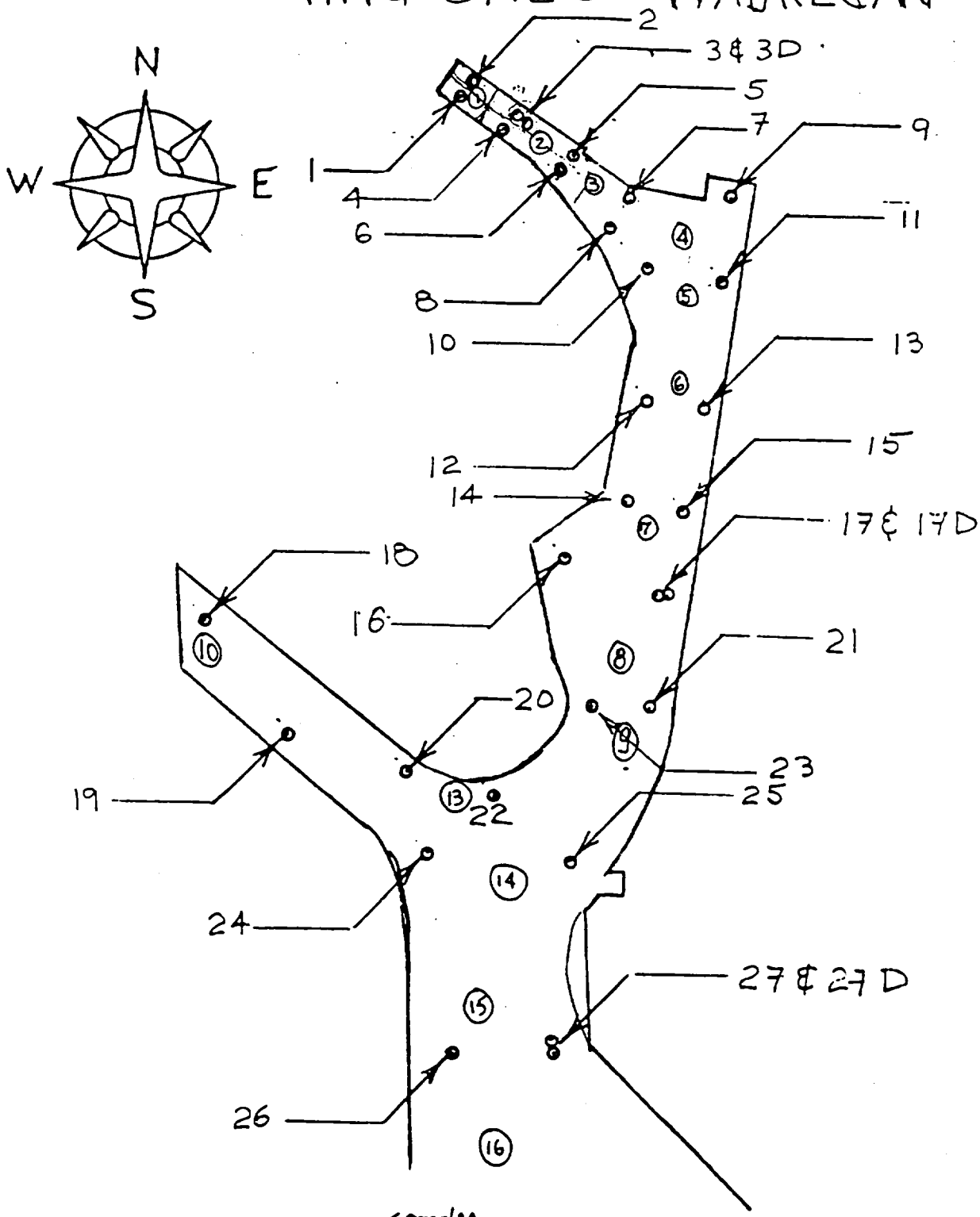
ROUGH LOG

CORING SITES - WAUKEGAN



O Approximate position of ~~cores~~ samples in the report to JRB Associates by D.E. Armstrong // [Samples are ponar dredge "cores"] / July 17, 78

ROUGH LOG

CORING SITES IN WAUKEGAN HARBOR

79100/

SAMPLE NUMBER	CORE NUMBER	CORE LENGTH	DATE	TIME	WATER DEPTH	REMARKS
BOCL04S01	1	6"	791114	1330	1.6 M	2cm f/ Bottom in Jar
BOCL04S02	2	20"+2"	791114	1420	3.2 M	~~20 [illegible] no Sample~~
BOCL04S03	3	36"	791114	1405	2.1 M	3cm F/Bottom in Jar
BOCL04D03	3D	36"	791114	1415	2.1 M	3cm F/Bottom in Jar
BOCL04S04	4	No Sample		1355		
BOCL04S05	5		791114	1445	3.5 M	
BOCL04S06	6	15"	791114	1430	3.1 M	10cm F/ Bottom in Jar
BOCL04S07	7	15"	791114	1450	3.0 M	2cm F/ Bottom in Jar
BOCL04S08	8		791114	1125	3.0 M	2cm from Bottom in Jar
BOCL04S09	9	6"	791114	1100	2.6 M	Vegatation in tube
BOCL04S10	10	28"	791114	1110	4.0 M	8cm F/Bottom in Jar
BOCL04S11	11	20	791114	1045	4.9 M	2cm F/ Bottom in Jar
BOCL04S12	12	19"	791114	1020	5.7 M	2cm F/ Bottom in Jar
BOCL04S13	13	8"	791114	1030	5.7 M	2cm F/ Bottom in Jar
BOCL04S14	14	10"	791114	1005	5.5	10 cm in Jar
BOCL04S15	15	23"	791114	0950	6.2 M	5cm in Jar
BOCL04S16	16		791002	1145	4.5 M	5cm F/ Bottom in Jar
BOCL04S17	17	18"	791114	0910	6.6 M	Clay plug on Bottom
BOCL04D17	17D	20"	791114	0930	6.6 M	Clay Plug on Bottom
BOCL04S18	18		791001	1345	6.0 M	
BOCL04S19	19		791001	1200	6.0 M	
BOCL04S20	20		791001	1420	7.2 M	
BOCL04S21	21		791002	1430	7.0 M	
BOCL04S22	22 1/	>20"	791001	1500	5.3 M	Sediment >24"
BOCL04S23	23		791002	1125	6.2 M	
BOCL04S24	24		791001	1425	7.2 M	
BOCL04S25	25	>20" 1/	791002	1415	4.7 M	Sediment >24"
BOCL04S26	26	>20" 1/	791002	1330	6.3 M	Sediment > 24"
BOCL04S27	27	>20" 1/	791002	1400	7.5 M	Sediment > 24"
BOCL04D27	27D	>20" 1/	791002	1400	7.5 M	Sediment > 24"

USAGE & DISCHARGE

(1) R.V.T. 11/28/80

Estimates of OMC PCB Discharge During 1950's - 1970's

From Records provided by discovery + transmitted via EPA to R.V.T.

Yr	Type	Total Usage lbs	Total Usage kg		Input to Harbor @ 1% of Total See pg 4	Flux to Lake @ 38% of Input to (see pg 4)
1955	Not known	333,500	151,400			575
56	" "	749,600	340,300			1293
57	" "	485,600	220,500			838
58	" "	531,400	241,200			916
59	F9	539,400	244,900	249,400		948
	A200	10,000	4500			
60	F9	376,100	170,700	272,400		1035
	A200	224,000	101,700			
61	F9	275,800	125,200	270,700		1028
	A200	320,500	145,500			
62	A200	570,000	258,800			983
63	A200	598,000	271,500			1032
64	" "	828,200	376,000			1429
65	" "	752,300	341,500			1298
66	" "	709,700	322,200			1224
67	" "	851,300	386,500			1469
68	" "	1,390,700	631,400			2399
69	" "	1,123,900	510,200			1939
70	" "	914,200	415,000			1577
	A-200B (Ter-phenyl)	10,800	4910			
71	A200	78,700	35,700			136
	A-200B (Ter-phenyl)	923,600	419,300			
72	A-200B (" ")	1,002,400	455,100			
	Total of F9, A200 + Unknown		5,294,700			20,118
	Total " " " w/o 1955-58		4,341,300			

Average for 1955-1970 = 328,687 kg/yr

From Harbor Model: Flux to Lake ≈ 38 % of input to Harbor

From Fig. 8 of Hyd. Rept.: PCB in Sed. of Harbor = 9200 kg "best"
= 78000 kg "high"

Dredge Mass out of Harbor (see dredging notes)

1957-1977 = 539 kg @ 1.0 μg/g } say 1000 kg
= 5390 kg @ 10 μg/g }

∴ Total accounted for = sed mass + mass leaving due to dredging

"Best" = 9200 + 1000
= 10,200 kg.

"High" = 78,000 + 1000
= 79,000 kg.

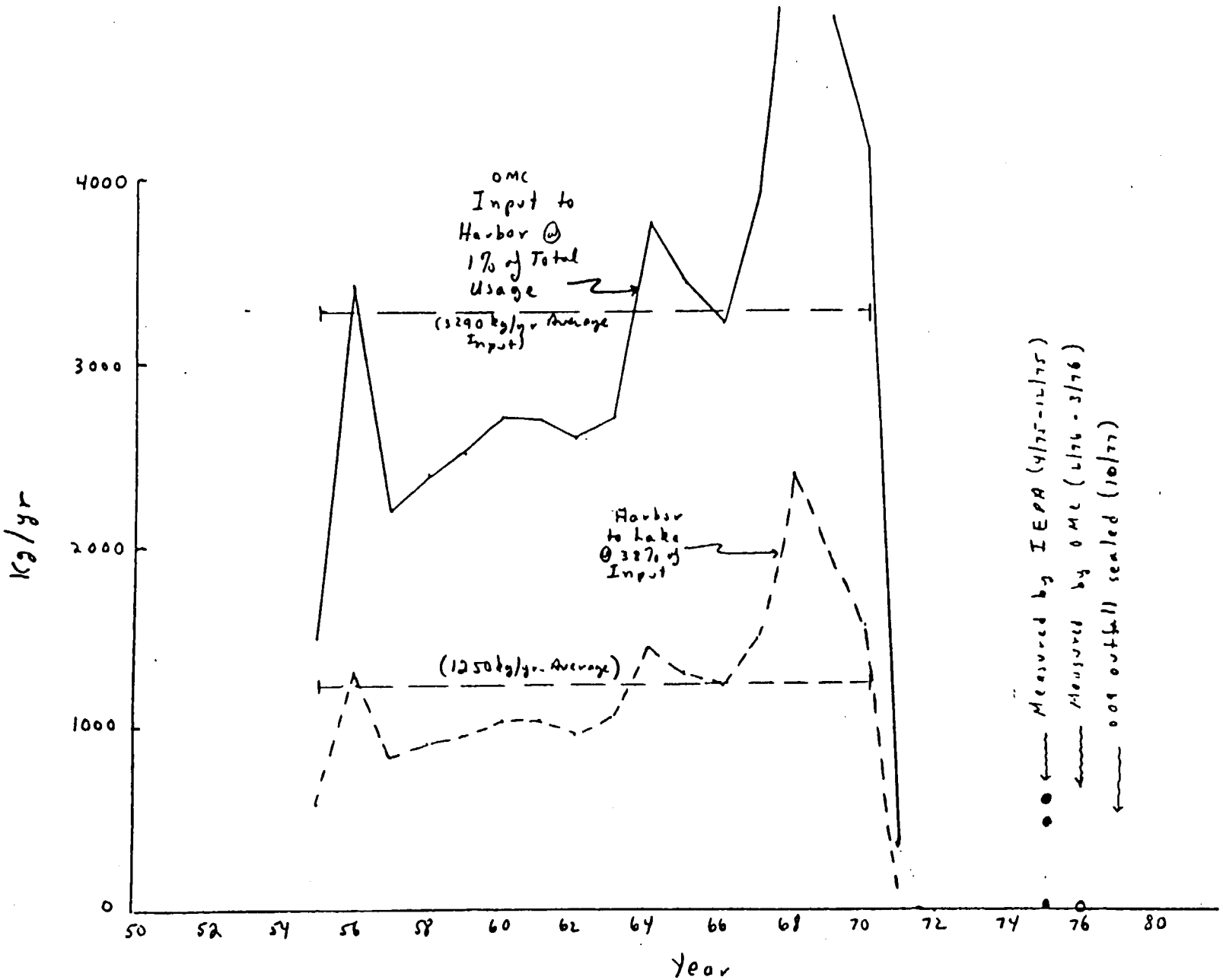
Total Discharged: "Best" = 10,200 / 0.62 = 16,450 kg @ 16 yrs = 1028 kg
"High" = 79,000 / 0.62 = 127,420 kg @ 16 yrs = 7963 kg

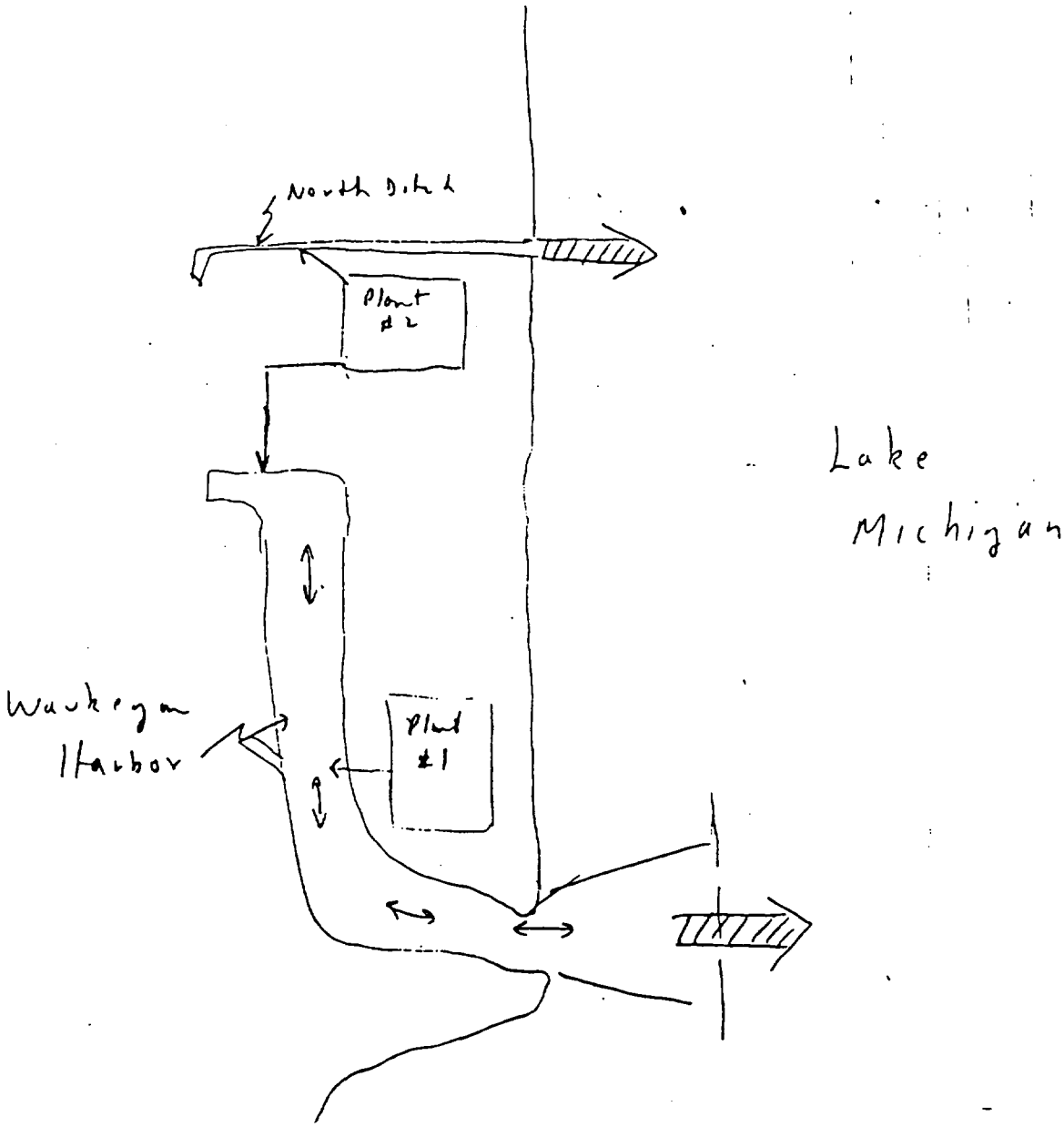
Summary:

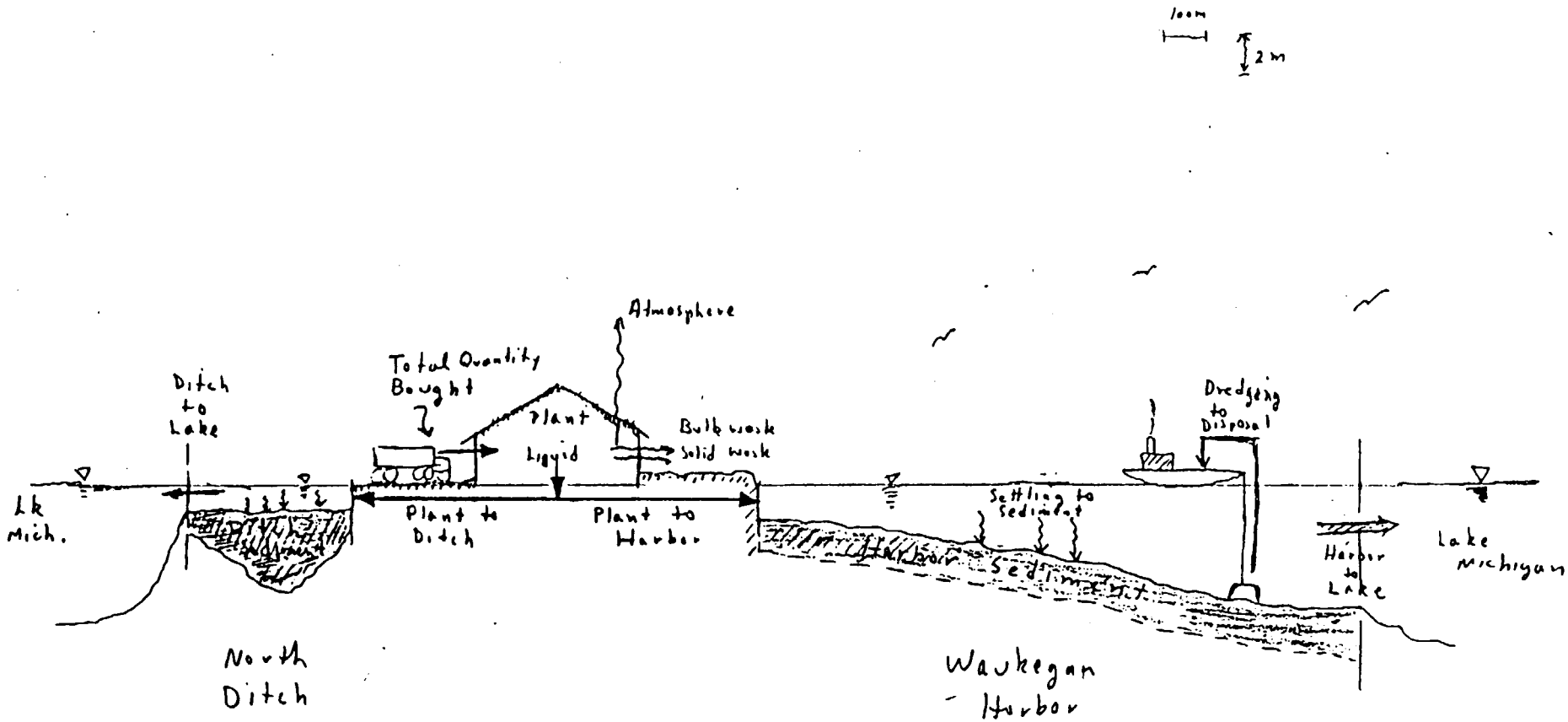
	Sed. Mass kg	Mass Out due to Dredging kg	Input (kg/y) 1955-70 (16 yr)	% of total Use (1)	Flux to Lake (kg/yr)
"Best"	9200	1000	1028	0.31	391
"High"	78000	1000	7963	2.42	3026

(1) Total use average = 329,000 kg/yr

∴ If use 1% of total use to Harbor: Input = 3290 kg/yr
Flux to Lake = 1250 kg/yr


OMC Input to Harbor @ 1% of Total Usage
(3290 kg/yr Average Input)
Harbor to Lake @ 32% of Input
(1250 kg/yr. Average)
Measured by IEPA (4/75-11/75)
Measured by OMC (1/76 - 3/76)
OOS outfall sealed (10/77)
kg/yr
4000
3000
2000
1000
0
50
52
54
56
58
60
62
64
66
68
70
72
74
76
80
Year


North Ditch
Plant #2
Lake Michigan
Waukegan Harbor
Plant #1



Elements of PCB Budget for Waukegan Harbor & North Ditch

11/28/80

Evidence that Pydraul was discharged in waste:

Ref. Pogue, D.R. 1970. Call Report No. JF-3 Monsanto Memo of March 23, 1970 6 pp.

"water effluent discharges have evident Pydraul content."
"Johnson roughly estimated waste content at less than 5% Pydraul, ..." (This is for liquid waste effluent)

(Note: 5% Pydraul ≈ 50,000 mg/l)

The 009 outfall (outfall from Plt. II to Harbor)

Ref Johnson Outboards Div. of Outboard Marine Corp. Findings & compliance plans for correction of outfalls 001, 006, 007, 009, 012, 013, and 014. March 10, 1976. 18 pp.

	Data cited as follows			lbs/yr @ Flow = .04 MGD	
By IEPA	4/8/75	419 mg/l	Geom. Mean = 3342 mg/l	51	@ 3342 mg/l = 407 lb/yr = 185 kg
	10/14/75	8100 "		986	
	12/10/75	11,000 "		1339	
By one contractor	2/3/76	6240 "	Geom. Mean = 244 mg/l		
	2/3/76	150 "			
	2/3/76	190		30	
	"	20			
	2/11/76	36		4.4	
	2/15	113		13.8	
	3/4/76 (rain)	3.9		0.5	

Outfall sealed in October, 1977. (Ziemba, 1978 Memo)

(3)

The 014 Outfall (From Plant II to North Ditch)

Ref 3/10/76 JOD of OMC Memo Flow = 0.119 MGD

		µg/l	lb/yr
By IEPA	1/31/75	1.8	0.6
	4/8/75	7.1	2.5
	10/14/75	420.0	152.0
	12/10/75	5.3	1.9
By OMC	2/3/76	2150	779
	2/25	30	10.9
	2/27	14	5.1
		4.2	1.5
		3.6	1.3
	3/4/76 (24hr)	15	5.4

Ziembe, 1978 Memo – Flow = 0.207 MGD
April 1978 PCB = 11 µg/l } = 6.9 lb/yr

ROBERT V. THOMANN
227 SUNSET AVE., RIDGEWOOD, N. J. 07450

PROF. ENV. ENG.
MANHATTAN COLLEGE
(212) 548-1400 (Ext. 276)

HOME:
(201) 652-5285

49 cont'd

September 24, 1981

ENFORCEMENT SENSITIVE

Mr. James T. Hynes
Assistant U. S. Attorney
Office of United States Attorney
United States Court House
219 S. Dearborn Street
Chicago, Illinois 60604

Dear Mr. Hynes:

As requested by Mr. Michael Pope at my deposition on September 17, 1981, in Chicago, I have prepared the following estimate of my consulting income and estimated percent of that income that was derived from projects that were directly or indirectly, funded by the U.S. government. The estimate begins from 1972, the earliest date for which I have records. For the period from 1966-1971, I would estimate my consulting income at about $6,000 in 1966 and increasing to about $10,000 in 1971. To the best of my recollection about 10% of this income was from projects funded by the U.S. government. The estimates for 1972-1980 are as follows:

Year	Total Est. Consulting Income ($)	Estimated % of Consulting from U.S. Gov't (Direct or Indirect) *
1972	11,600	10
1973	14,000	30
1974	17,000	10
1975	17,200	10
1976	19,600	20
1977	18,600	10
1978	18,600	10
1979	22,800	40
1980	21,000	60

*Direct = client was Federal government or an immediate contracting organization
Indirect = client was a non-federal agency receiving grants from U.S. Government.

16-5V28.0/071

DEPOSITION EXHIBIT
Thomann-OMC
16-ID
11-14-81

I have also enclosed an updated resumé as requested.

Sincerely yours,

ROBERT V. THOMANN, Ph.D
Enclosure

Vitae: Dr. Robert V. Thomann

Personal:

Born: September 1, 1934, New York, New York
Married: Joan P. Coyle - Seven Children

Education:

1955-BCE - Manhattan College, Bronx, New York
Undergraduate Major - Sanitary Engineering
1960-MCE - New York University, New York, New York
Major - Sanitary Engineering
1963-Ph.D. - New York University, New York, New York
Major - Physical Oceanography
Minor - Waste Disposal
Thesis - The Use of Systems Analysis to Describe the Dissolved Oxygen of a Tidal Stream
Advisor - Willard J. Pierson, Professor of Oceanography Department of Meteorology and Oceanography

Major Professional Expertise:

Application and utilization of mathematical modeling, systems analysis techniques, and economic and statistical analysis to water quality management and water pollution control of streams, estuaries, lakes and oceans.

Professional Experience:

9/66 - Present - Professor and Director, Environmental Engineering and Science Graduate Program, Manhattan College, Bronx, New York

Principal Consultant, HydroQual, Inc. (formerly consultant to Hydroscience, Inc.).

7/62 - 9/66 - Technical Director, Delaware Estuary Comprehensive Study, Federal Water Pollution Control Administration, Department of the Interior, Philadelphia, Pennsylvania.

7/60 - 7/62 - New York University Department of Meteorology and Oceanography, Ph.D. Training Assignment with USPHS, DHEW.

7/56 - 7/60 - Sanitary Engineer, U.S. Public Health Service, Division of Water Supply and Pollution Control

Learned and Professional Societies:

American Association for Advancement of Science
American Society of Civil Engineers
American Geophysical Union
Water Pollution Control Federation

DEPOSITION EXHIBIT
Thomann-OMC
17-1D
11-14-81

Learned and Professional Societies (continued)

American Society of Limnology and Oceanography
American Association of Professors in Environmental Engineering
Sigma Xi

Seminars:

Lectures have been given at (partial list):

MIT	VPI	U.of Florida	U.of Michigan
Harvard	Texas A&M	U.of Minnesota	Clarkson College
Cornell	U.of Wisconsin	Ohio State U.	U.of Connecticut
RPI	Rutgers	Columbia	Stanford U.
SUNY(Buffalo)	SUNY(Stony Brook)	U.of Vermont	Int.Inst.Applied Systems Analysis
Purdue U.	Resources for the Future	U.of British Columbia	FEEMA-Rio de Janeiro Brazil

Partial List of Other Talks and Presentations:

ASCE Annual Meeting - Atlanta, GA, 1963.
ASCE Annual Meeting - Salt Lake City, Utah, 1964.
Pollution Control Engineering Symposia AIChE, 1965.
Third International Water Pollution Research Conference, Munich, Germany, 1966.
National Conference on Pollution, Canadian Council of Resource Ministers, Plenary Session, Montreal, Canada, 1966.
National Council for Stream Improvement, Annual Meeting, New York, 1966.
American Public Health Association Annual Meeting, Miami, Florida, 1967.
National Academy of Science, Committee on Oceanography, Seattle, Washington, 1968.
Engineering Foundation Resources Conference, Deerfield, Massachusetts, 1969.
Annual Northeastern Region Antipollution Conference, University of Rhode Island, 1969.
30th Annual Water Conference, Engineering Society of Western Pennsylvania, Pittsburgh, Pennsylvania, 1969.
ASCE Environmental Engineering Conference in St. Louis, Missouri, October, 1971.
International Association for Statistics in Physical Science Symposium on the Statistical Aspects of Pollution Problems, Harvard University Graduate School of Business Administration, 1971.
New York Water Pollution Control Federation Meeting, January, 1971.
Workshop on Mathematical Modeling in Environmental Engineering, December, 1972, Bahamas.
Symposium in Ecological Modeling in a Resource Management Framework, Resources for the Future, Washington, D.C., September, 1974.
Conference on Persistence of Chemicals in the Environment, Ottawa, May, 1974.
International Conference on Great Lakes Research - McMaster University, August, 1974.
New York Water Pollution Control Federation Meeting, Lake Placid, New York, 1975.

Partial List of Other Talks and Presentations (continued)

AAAS Annual Meeting, New York, January, 1975.
Symposium on Potomac Estuary, Int. Comm. on Potomac River Basin, February, 1975.
New York Water Pollution Control Federation at Lake Placid, New York, 1975.
International Conference on Great Lakes Research - SUNY, Albany, New York, May, 1975.
Annual Meeting of International Joint Commission, Windsor, Ontario, Canada, 1975.
American-Soviet Symporium on Use of Mathematical Models to Optimize Water Quality Management - Kharkov and Rostov-on-Don, USSR, December, 1975.
International Conference on Great Lakes Research, Guelph, Ontario, May, 1976.
International Symposium on Eutrophication, Karl Marx Stadt, German Democratic Republic, September, 1976.
International Conference on Great Lakes Research, Ann Arbor, Michigan, May, 1977.
International Conference on Great Lakes Research, Windsor, Ontario, May, 1978.
Annual Meeting, New York Academy of Sciences, New York, 1978.
Co-Chairman National Workshop on Verification of Water Quality Modeling, West Point, March, 1979.
Symposium on Phosphorus Management Strategies for Great Lakes, Rochester, New York, April, 1979.
International Conference on Great Lakes Research, Rochester, New York, May, 1979.
National Symposium on Toxic Substances Water Quality Criteria and Standands, Washington, D.C., July, 1980.

Consulting Work:

Water Quality analysis and management studies on a variety of geographical locations and problem contexts. Partial list includes Sacramento, San Joaquin Delta, Mohawk River Basin, Tampa Bay, Delaware Estuary, Boston Harbor, Potomac Estuary and Offshore waste disposal problems.

Publications:

"A Three Cycle Analysis of Water Quality Variables in Tidal Estuaries," preprints - International Oceanographic Congress, 1955, pp. 709-711.

"Mathematical Model for Dissolved Oxygen" ASCE San. Eng'g. Div. Journal, October, 1963, pp. 1-30.

"Estuarine Water Quality Management and Forecasting," Senior author, ASCE San. Eng'g. Div. Journal, October, 1964, pp. 9-36.

"Use of Systems Analysis in Estuarine Water Pollution Control," Western Resource Conference Proceedings, University of Colorado, Boulder, Colorado, 1964.

"Recent Results from a Mathematical Model of Water Pollution Control in the Delaware Estuary," Water Resources Research Journal, Vol. 1, Third Quarter, 1965, pp. 349-359.

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R.V.T.
12/4/76

LAKE MICHIGAN LOAD HISTORY #1

kg/yr.

Year	Atmos	Trib	M&I	Wauchusett	Total
1950	0	0	900	0	900
51	212	34	↓	2000	2246
2	424	68		2000	3392
3	636	102		3000	4638
4	848	136		4000	5884
55	1060	170		↓	6130
6	1272	204			6376
7	1484	238			6622
8	1696	272			6868
9	1908	306			7114
1960	2120	340			7360
61	2332	374			7606
2	2544	408			7852
3	2756	442			8098
4	2968	476			8344
65	3180	510			8590
6	3392	544			8836
7	3604	578			9082
8	3816	612			9328
9	4028	646			9574
1970	4240	680			9820
1	4452	714		500	10666
2	4664	748		50	6512
3	4876	782		10	6608
4	5088	816		10	6814
75	5300	850		10	17260
6	5300	850		10	7060
7	5300	850		10	7060
8	5300	850		10	7060
9	5300	850	900	10	7060

DEPOSITION EXHIBIT
Thomann-DMC
18-TD 11-15-81

Long Term Loading to Lake Mich.

1950 - 1975 Assume atmospheric in 1975 = 5300 kg/yr.

And atmospheric in 1950 = 0

∴ Total linear increase of $\frac{5300}{25}$ = 212 kg/yr

Assume Mun + Ind = constant @ 900 kg/yr.

Tot = $\frac{716}{4611}$ = 16% of Atmospheric.

PCB Loading to G.L.S. (kg/yr)

LOADING TYPE	Superior	Michigan	Huron	Erie	Ontario
Atmospheric					
Rain	3280 (6553)	2306 (4611)	2266 (4532)	996 (1992)	800 (1600)
Dry	500 (1000)	352 (704)	347 (694)	151 (302)	118 (236)
Manu. & Ind.	4	883	45	340	800
Other	–	898	–	2694	
Tributary a	495 (991)	358 (716)	769 (1083)	(2038) (1865)	255 (509)
Total	4279 (8548)	4797 (7812)	3427 (6354)	2042 (7366)	1983 (3246)
% Atmos.	88 (88)	55 (69)	76 (72)	19 (31)	76 (58)

1 60 ng/l in rainwater, parentheses are 100 ng/l loadings.

a Tributary loading based on 1/10 of rainwater concentration except Erie.

PCb LOADS For all segments (lbs/day)

SEG #	50 mg/l LDG	%A*	100 mg/l Ldg.	%A
1	7.68	80	15.37	80
2	8.05	91	16.08	91
3	10.12	92	20.19	92
4	2.68	48	4.51	57
5	12.33	56	20.05	69
6	13.84	56	22.63	69
7	.51	96	1.00	98
8	3.42	100	6.84	100
9	2.03	100	4.07	100
69	6.24	87	12.28	89
10	3.26	27	3.37	15
11	5.23	74	10.42	74
12	20.17	4	21.46	8
13	41.50	40	15.91	55
14	5.15	34	7.13	49
15	2.55	100	5.10	100
16	1.03	100	2.06	100
17	8.34	24	21.87	33

* Percent Atmospheric Loading

Revised PCB Loadings to G.L.S. all # kg/yr

ATMOSPHERIC LOADINGS calculated from 50-100 ng/l on rainwater.

ATM. LOAD = (MEAN CONC.)(ANNUAL PRECIP)(SA)

LAKE Superior (kg/yr)

#	ATMOS 50	100	MI	TRIBS # 100	50	L# Dry 100	50
1	884.6	1769.3	1.1	503.9	252	270.0	135
2	1048.5	2096.4	1.3	243.6	121.8	320.0	160.
3	1346.9	2686.8	1.6	243.5	121.8	410.0	205
TOTALS	3280	6553.1	4	991	495	1000.	500

	SEG # 1	2	3
50 ng/l Ldg = 4279	1241	1332	1695
100 ng/l Ldg = 8548	2544	2662	3342

LAKE Michigan

	Atmos 50	100	MI #5	Tribs 100	50	Dry #4 100	50	OTHER
4	184	369	71	179	90	56	28	71
5	992	1982	380	268	134	303	152	386
6	1130	2260	432	269	134	345	172	441
	2306	461	883	716	358	704	352	89.

	SEG # 4	5	6
50 ng/l Ldg = 4796 kg/yr	444	2044	2308
100 ng/l Ldg = 7811 kg/yr	746	3319	3746

#1 Assume 1/10 of rainwater conc. ie 10 ng/l for 1.0 yr
#2 From "Eisenreich & Hubbd" paper use any amount
#3 From Murphy 1/2 of tribs loading
#4 Based on Superior, Dry Deposition
#5 Extracted from Murphy load

Revised PCB contd. Lake Huron

#	ATMOS 100	50	M+I	TRIBS #1 100	50	Dry 100	50
7	140	70	3	0	0	22	11
8	983	492	0	0	0	150	75
9	585	292	0	0	0	89	45
10	146	73	0	456	456	22	11
11	1110	555	6.5	439	219	170	85
69	1568	784	56.5	188	94	241	1201
	4532	2266	45	1083	769	694	347

50 mg/l Ldg: 3427 kg/yr

100 mg/l Ldg = 6354 kg/yr

SEC #	7	8	9	10	11	69
50 mg/L	84	567	337	540	866	1034
100 mg/L	165	1133	674	624	1725	2033

#1 - includes 85 mg/l from Sag. river
@ all other 10 mg/l for 100 mg/l rain.

Revised Dec Lake Erie (kg/yr)

#	ATMOS 100	50	M+I #4	#1 TRIBS 100	50	DRY 100	50	OTHER
12	239	120	204	1457	1381	36	18	1616
13	1255	677	85	430	374	190	95	673
14	498	249	51	151	110	76	38	405
	1992	996	340	2038	1865	302	151	2694

		SEG # 12	13	14
50 mg/l Ldg	= 6046	3339	1904	853
100 mg/l Ldg	= 7366	3552	2633	1181

Lake Ontario

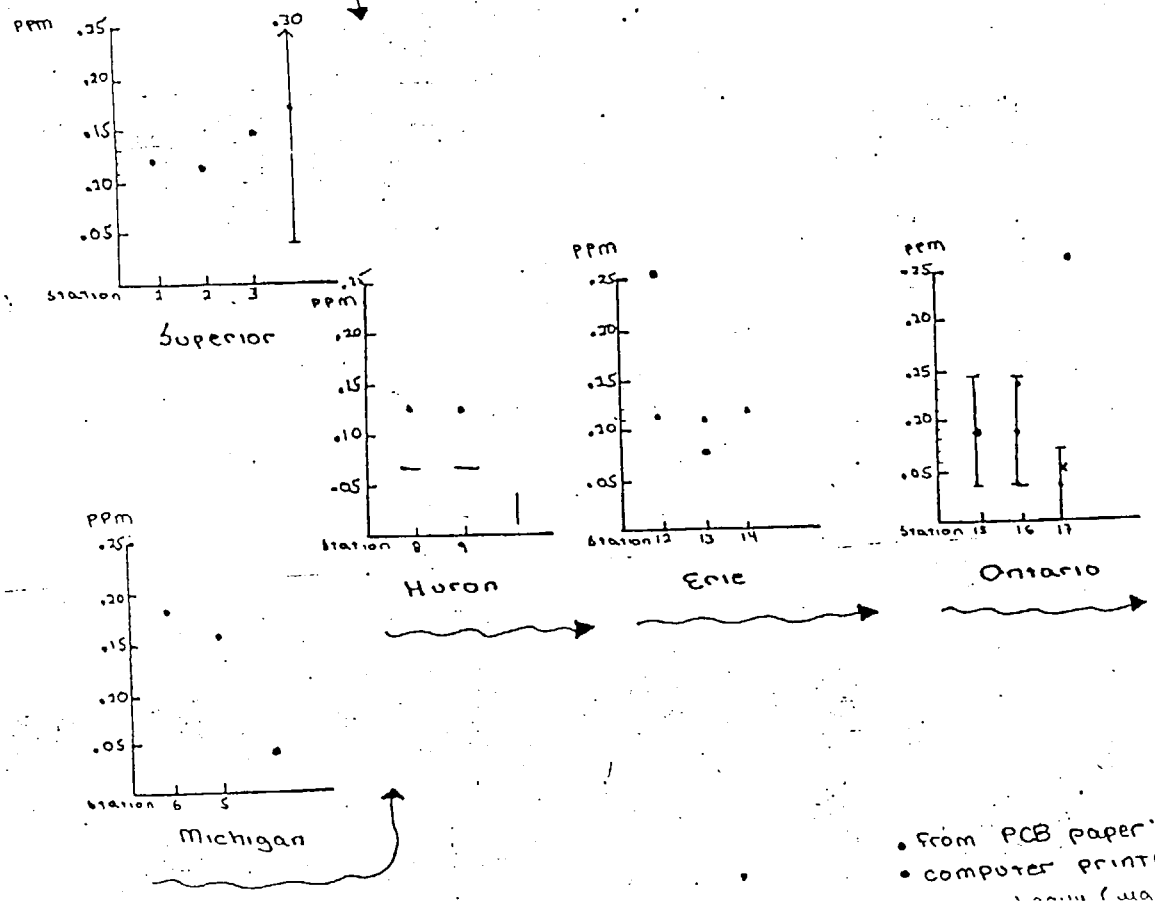
#	ATMOS 100	50	M+I	#1 TRIBS 100	50	Dry 100	50	OTHER
15	736	368		–	–	1108	54	–
16	296	148	–	–	–	43	22	–
17	568	284	800	510	255	84	42	[illegible]
	1600	800	800	510	255	230	118	

		SEG # 15	16	17
50 mg/l Ldg	= 1983	422	170	1381
100 mg/l Ldg	= 3146	844	339	1965

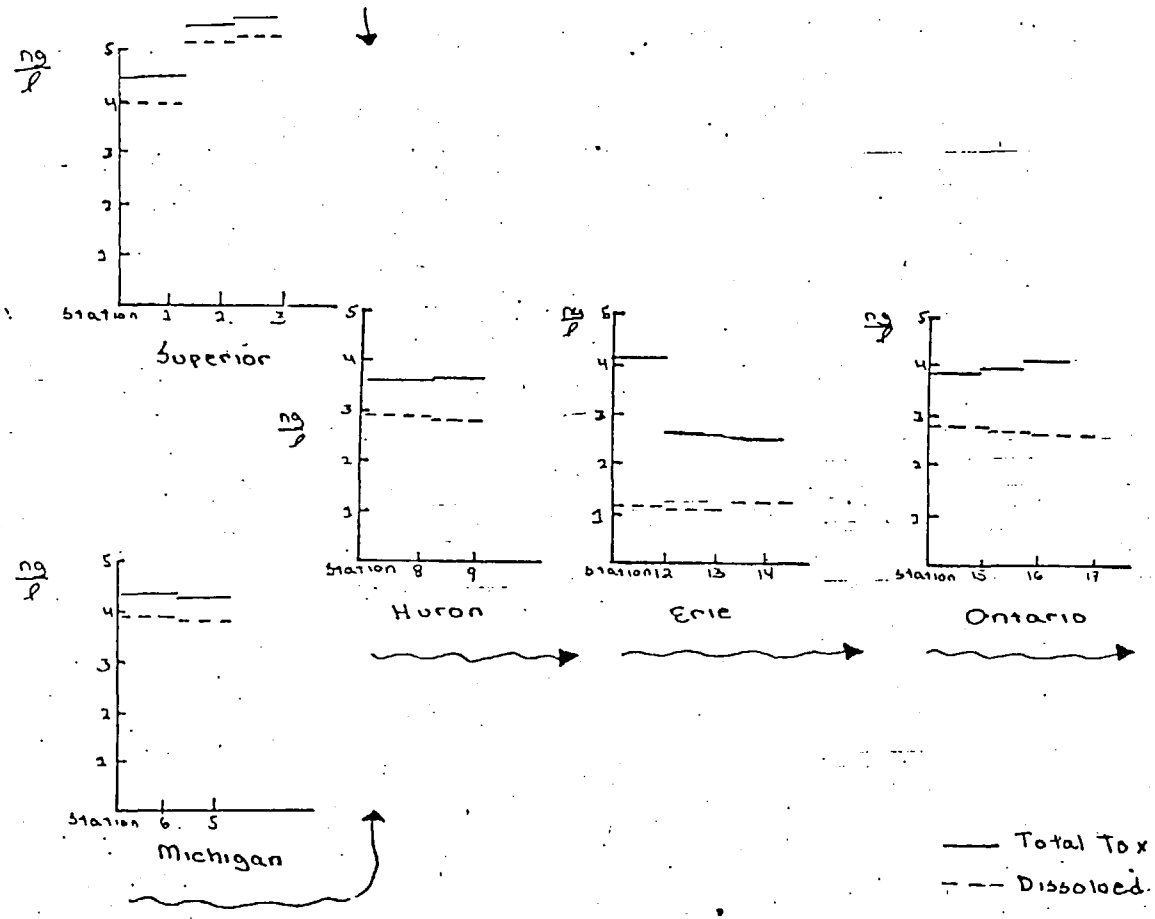
For Ont. M+I, Buffalo (100) + Ontario (250) + N.Y. (250) = 1200 kg/yr Insanity

#1 FROM PLUARS LAND MANAGEMENT pg 44 NOTE SPLIT OF TRIB weighted to ocd. distribution.
#2 ASSUME 4% LAKE MICHIGAN OTHER = 60% of this load goes into 12, the rest 25% to 13, 15% to 14
#3 Ontario Other fairly well accounted for in M+I #4 Detroit, Cleveland, Toledo W.W. Pass f (Pop)

PCB



- from PCB paper
- computer printout ug/mo/liter


ng/l
Station 1 2 3
Superior
Station 8 9
Huron
Station 12 13 14
Erie
Station 15 16 17
Ontario
Station 6 5
Michigan
Total Tox
Dissolved Conc.

HydroQual, Inc.

SUBJECT: PCB HARBOR RUNS

JOB NO. | SHEET 1 OF | FILE | BY | DATE

FINAL VERIFICATION (Run to give PCB in Harbor in blue report)

① Exchange Coeffi. : The same as in chlorides and Dye Runs
WATER COLUMN

② FLOWS: Same as in chlorides and Dye Runs

③ BOUDY COND. : TOT PCB

SEG	PCB (µg/l)	SEG	SS (mg/l)
2	0.	2	10
28	0.005	29	10
29	0.005	29	10
30	0.005	30	10
31	0.005	31	10
32	0	32	0
59	0.	59	0
60	0	60	0
61	0.	61	0
62	0	62	0
5	0	5	0

④ NO LOADS

⑤ PARAMETERS

PARAMETERS	UNITS
1 - DEPTHS - SEGMENT DEPTHS	FEET
2 - PORSTY - SEGMENT POROSITY ... FOR WATER COLUMN SEGMENTS THE POROSITY SHOULD BE = 1.0 ...FOR SEDIMENT SEGMENTS THE POROSITY SHOULD BE	NONE
POROSITY = L**3 (H2O) / L**3 (SS+H2O)	
3 - SETLES - SEGMENT INTO WHICH SUSPENDED SOLIDS FROM THIS SEGMENT WILL SETTLE INTO	NONE

DEPOSITION EXHIBIT
Thomann
19-1D OMC
11-IV-81

1.0	1.0	1.0	1.0 ← SCALE FACTORS
DEP01	7.0POR01	1.0SET01	32.
DEP02	13.0POR02	1.0SET02	33.
DEP03	16.0POR03	1.0SET03	34.
DEP04	18.0POR04	1.0SET04	35.
DEP05	19.0POR05	1.0SET05	36.
DEP06	19.0POR06	1.0SET06	37.
DEP07	20.0POR07	1.0SET07	38.
DEP08	9.0POR08	1.0SET08	39.
DEP09	17.0POR09	1.0SET09	40.
DEP10	20.0POR10	1.0SET10	41.
DEP11	19.0POR11	1.0SET11	42.
DEP12	18.0POR12	1.0SET12	43.
DEP13	21.0POR13	1.0SET13	44.
DEP14	23.0POR14	1.0SET14	45.
DEP15	17.0POR15	1.0SET15	46.
DEP16	7.0POR16	1.0SET16	47.
DEP17	13.0POR17	1.0SET17	48.
DEP18	18.0POR18	1.0SET18	49.
DEP19	20.0POR19	1.0SET19	50.
DEP20	22.0POR20	1.0SET20	51.
DEP21	16.0POR21	1.0SET21	52.
DEP22	8.0POR22	1.0SET22	53.
DEP23	18.0POR23	1.0SET23	54.
DEP24	26.0POR24	1.0SET24	55.
DEP25	27.0POR25	1.0SET25	56.
DEP26	20.0POR26	1.0SET26	57.
DEP27	14.0POR27	1.0SET27	58.
DEP28	16.0POR28	1.0SET28	59.
DEP29	34.0POR29	1.0SET29	60.
DEP30	34.0POR30	1.0SET30	61.
DEP31	14.0POR31	1.0SET31	62.
DEP32	0.656POR32	.667SET32	0.
DEP33	0.656POR33	.667SET33	0.
DEP34	0.656POR34	.667SET34	0.
DEP35	0.656POR35	.667SET35	0.
DEP36	0.656POR36	.667SET36	0.
DEP37	0.656POR37	.667SET37	0.
DEP38	0.656POR38	.667SET38	0.
DEP39	0.656POR39	.667SET39	0.
DEP40	0.656POR40	.667SET40	0.
DEP41	0.656POR41	.667SET41	0.
DEP42	0.656POR42	.667SET42	0.
DEP43	0.656POR43	.667SET43	0.
DEP44	0.656POR44	.667SET44	0.
DEP45	0.656POR45	.667SET45	0.
DEP46	0.656POR46	.667SET46	0.
DEP47	0.656POR47	.667SET47	0.
DEP48	0.656POR48	.667SET48	0.
DEP49	0.656POR49	.667SET49	0.
DEP50	0.656POR50	.667SET50	0.
DEP51	0.656POR51	.667SET51	0.
DEP52	0.656POR52	.667SET52	0.
DEP53	0.656POR53	.667SET53	0.
DEP54	0.656POR54	.667SET54	0.
DEP55	0.656POR55	.667SET55	0.
DEP56	0.656POR56	.667SET56	0.
DEP57	0.656POR57	.667SET57	0.
DEP58	0.656POR58	.667SET58	0.
DEP59	0.656POR59	.667SET59	0.
DEP60	0.656POR60	.667SET60	0.
DEP61	0.656POR61	.667SET61	0.
DEP62	0.656POR62	.667SET62	0.

P2

18 19 20 21 22 23 24 25 26 27 28 29

HydroQual, Inc.

SUBJECT

JOB NO. | SHEET 3 OF | FILE | BY | DATE

(6) CONSTANTS

13
RNPS 5.KDCAY 0.0PC1 250.VS1 1.00PC2 0.
VS2 1.00PC3 0.VS3 3.00PC4 0.VS4 3.00
PC5 0.VS5 3.00VSED .00000481

```
C
C     CONSTANTS                                          UNITS
C     ---------                                          -----
C
C        1 - RNPS   - NUMBER OF PARTICLE SIZE CLASSES
C                     TO BE USED (MAX=5)
C        2 - KDCAY  - DECAY RATE FOR PCB                  /DAY
C        3 - PC1    - PARTITION COEFFICIENT FOR          UG PCB/GM SS
C                     PARTICLE SIZE NO.1                  ------------
C                                                         UG PCB/L H20
C        4 - VS1    - SETTLING VELOCITY OF PARTICLE        M/DAY
C                     SIZE NO.1
C        5 - PC2    - PARTITION COEFFICIENT FOR          UG PCB/GM SS
C                     PARTICLE SIZE NO.2                  ------------
C                                                         UG PCB/L H20
C        6 - VS2    - SETTLING VELOCITY OF PARTICLE        M/DAY
C                     SIZE NO.2
C        7 - PC3    - PARTITION COEFFICIENT FOR          UG PCB/GM SS
C                     PARTICLE SIZE NO.3                  ------------
C                                                         UG PCB/L H20
C        8 - VS3      SETTLING VELOCITY OF PARTICLE        M/DAY
C                     SIZE NO.3
C        9 - PC4    - PARTITION COEFFICIENT FOR          UG PCB/GM SS
C                     PARTICLE SIZE NO.4                  ------------
C                                                         UG PCB/L H20
C       10 - VS4      SETTLING VELOCITY OF PARTICLE         M/DAY
C                     SIZE NO.4
C       11 - PC5    - PARTITION COEFFICIENT FOR           UG PCB/GM SC
C                     PARTICLE SIZE NO.5                  ----------
C                                                         UG PCB/L H20
C       12 - VS5      SETTLING VELOCITY OF PARTICLE         M/DAY
C                     SIZE NO.5
C       13 - VSED     SEDIMENTATION VELOCITY                M/DAY
C
```

32
33
34
35
36
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

SUBJECT

MISC. TIME FUNCTIONS

1				
RSUSP	2			
	1.0	0	1.0	20.0

```
C
C     PIECEWISE LINEAR FUNCTIONS
C     --------------------------
C        1 - RSUSP - SOLIDS RESUSPENSION SCALE FACTOR
C                    .NE. 1.  SUSPENDED SOLIDS RESUSPEND FROM SEDI-
C                    MENT AT -ES(I)-*(RSUSP)
C                    =0. NO RESUSPENSION (EFFECTIVELY ACTS TO
C                    SET -ES(I)- = 0.)
C
```

INITIAL CONDITIONS (TOT. PCB μg/l)

PCB01	.7274PCB02	.3958PCB03	.3054PCB04	.2153
PCB05	.1447PCB06	.1268PCB07	.1203PCB08	.1093
PCB09	.1073PCB10	.0883PCB11	.0707PCB12	.0483
PCB13	.0292PCB14	.0219PCB15	.0229PCB16	.0142
PCB17	.005PCB18	.005PCB19	.005PCB20	.005
PCB21	.005PCB22	.005PCB23	.005PCB24	.005
PCB25	.005PCB26	.005PCB27	.005PCB28	.005
PCB29	.005PCB30	.005PCB31	.005PCB32	2400000.
PCB33	400000.PCB34	160000.PCB35	64000.PCB36	32000.
PCB37	20000.PCB38	8000.PCB39	5600.PCB40	4800.
PCB41	4000.PCB42	3200.PCB43	2400.PCB44	1600.
PCB45	1600.PCB46	1600.PCB47	1600.PCB48	800.
PCB49	800.PCB50	800.PCB51	800.PCB52	800.
PCB53	800.PCB54	800.PCB55	800.PCB56	800.
PCB57	800.PCB58	800.PCB59	800.PCB60	800.
PCB61	800.PCB62	800.		

INITIAL CONDITIONS (1 PARTICLE SIZE SOLID PHASE, mg/l, the OTHERS 0.)

BOL01	2.BOL02	2.BOL03	2.BOL04	2.
BOL05	2.BOL06	2.BOL07	2.BOL08	2.
BOL09	2.BOL10	2.BOL11	2.BOL12	2.
BOL13	2.BOL14	2.BOL15	2.BOL16	2.
BOL17	10.BOL18	10.BOL19	10.BOL20	10.
BOL21	10.BOL22	10.BOL23	10.BOL24	10.
BOL25	10.BOL26	10.BOL27	10.BOL28	10.
BOL29	10.BOL30	10.BOL31	10.BOL32	800000.
BOL33	800000.BOL34	800000.BOL35	800000.BOL36	800000.
BOL37	800000.BOL38	800000.BOL39	800000.BOL40	800000.
BOL41	800000.BOL42	800000.BOL43	800000.BOL44	800000.
BOL45	800000.BOL46	800000.BOL47	800000.BOL48	800000.
BOL49	800000.BOL50	800000.BOL51	800000.BOL52	800000.
BOL53	800000.BOL54	800000.BOL55	800000.BOL56	800000.
BOL57	800000.BOL58	800000.BOL59	800000.BOL60	800000.
BOL61	800000.BOL62	800000.		

HydroQual, Inc.

SUBJECT 5

CRITERIA FOR STABILITY & ACCURACY, INTEGRATION INFO

```
9000000.  9000000.  9000000.  9000000.  9000000.  9000000.   STABILTY
  0.001     0.001     0.001     0.001     0.001     0.001     ACCURACY
      5.          PRINT INTERVAL
 1  1  1  5  1 14  1 32  2  1  2  5  2 14  2 32
 2 0                 STEP, POSITIVE PLANE ONLY
     1.0        0        TZERO
   2    NO. OF INTEGRATION STEP SIZES
    .02        0        .02        50.
```

WATER COLUMN- BOTTOM SEDIMENT INTERACTION

```
C*****************************************************************
C
C       DUE TO THE DIFFERENT PARTICLE SIZE CLASSES,THE VERTICAL
C       TRANSPORT BETWEEN THE WATER COLUMN-SEDIMENT AND SEDIMENT-
C       SEDIMENT INTERFACES REQUIRE SEPARATE EXCHANGE COEFFICIENTS
C       FOR EACH PARTICLE SIZE CLASS.  SINCE AESOP DOES NOT PRES-
C       ENTLY PERMIT DIFFERENT TRANSPORT REGIMES FOR EACH SYSTEM,
C       THIS WILL HAVE TO BE ACCOMPLISHED WITHIN THE PCPCB KINETIC
C       SUBROUTINE
C
C       ADDITIONAL INPUT REQUIRED  (TO BE READ AFTER THE INTEGRATION
C       HISTORY, AND BEFORE THE DUMP/PLOT CARDS)
C
C  CARD NO.1
C       CARD
C     COLUMNS
C     -------
C       1- 5    THE NUMBER OF WATER COLUMN-SEDIMENT -AND-
C               SEDIMENT-SEDIMENT EXCHANGE COEFFICIENTS TO BE READ
C
C  CARD(S) NO.2 (AND AS NECESSARY)
C       CARD                                                    UNITS
C     COLUMNS                                                   -----
C     -------
C       1- 5    (I,J) SEGMENTS BETWEEN WHICH EXCHANGE WILL
C       AND     TAKE PLACE          I - FROM SEGMENT
C       6-10                        J - TO SEGMENT
C      11-20    CROSS-SECTIONAL AREA                            SQ.FEET
C      21-25    DEPTH OF SEGMENT I                                FEET
C      26-30    DEPTH OF SEGMENT J                                FEET
C      31-38    DISPERSION COEFFICIENT FOR DISSOLVED PCBS       CM**2/SEC
C      39-46    DISPERSION COEF FOR PARTICLE SIZE NO.1          CM**2/SEC
C      47-54    DISPERSION COEF FOR PARTICLE SIZE NO.2          CM**2/SEC
C      55-62    DISPERSION COEF FOR PARTICLE SIZE NO.3          CM**2/SEC
C      63-70    DISPERSION COEF FOR PARTICLE SIZE NO.4          CM**2/SEC
C      71-78    DISPERSION COEF FOR PARTICLE SIZE NO.5          CM**2/SEC
```

INPUT FOR WAT. COL. BOT. INTERACTION

ON NEXT PAGE

HydroQual, Inc.

SUBJECT

6

JOB NO. | SHEET OF | FILE | BY | DATE

32	55944.	7.	.656	0.	25E-8	0.0	0.0	0.0	0.0
33	55944.	13.	.656	0.	1E-10	0.0	0.0	0.0	0.0
34	97903.	16.	.656	0.	1E-10	0.0	0.0	0.0	0.0
35	167833.	18.	.656	0.	1E-10	0.0	0.0	0.0	0.0
36	181819.	19.	.656	0.	1E-10	0.0	0.0	0.0	0.0
37	167833.	19.	.656	0.	1E-10	0.0	0.0	0.0	0.0
38	202799.	20.	.656	0.	1E-11	0.0	0.0	0.0	0.0
39	419583.	9.	.656	0.	1E-11	0.0	0.0	0.0	0.0
40	167833.	17.	.656	0.	1E-11	0.0	0.0	0.0	0.0
41	104895.	20.	.656	0.	1E-11	0.0	0.0	0.0	0.0
42	118882.	19.	.656	0.	1E-11	0.0	0.0	0.0	0.0
43	167833.	18.	.656	0.	1E-11	0.0	0.0	0.0	0.0
44	111889.	21.	.656	0.	1E-11	0.0	0.0	0.0	0.0
45	279722.	23.	.656	0.	1E-11	0.0	0.0	0.0	0.0
46	636368.	17.	.656	0.	1E-11	0.0	0.0	0.0	0.0
47	671333.	7.	.656	0.	1E-11	0.0	0.0	0.0	0.0
48	3279743.	13.	.656	0.	35E-7	0.0	0.0	0.0	0.0
49	2475542.	18.	.656	0.	35E-7	0.0	0.0	0.0	0.0
50	1328680.	20.	.656	0.	35E-7	0.0	0.0	0.0	0.0
51	909097.	22.	.656	0.	35E-7	0.0	0.0	0.0	0.0
52	923083.	16.	.656	0.	35E-7	0.0	0.0	0.0	0.0
53	4986048.	8.	.656	0.	35E-7	0.0	0.0	0.0	0.0
54	5986055.	18.	.656	0.	35E-7	0.0	0.0	0.0	0.0
55	5986055.	26.	.656	0.	35E-7	0.0	0.0	0.0	0.0
56	7986069.	27.	.656	0.	35E-7	0.0	0.0	0.0	0.0
57	8083972.	20.	.656	0.	35E-7	0.0	0.0	0.0	0.0
58	7265784.	14.	.656	0.	35E-7	0.0	0.0	0.0	0.0
59	20958186.	16.	.656	0.	35E-7	0.0	0.0	0.0	0.0
60	20181957.	34.	.656	0.	35E-7	0.0	0.0	0.0	0.0
61	13384708.	34.	.656	0.	35E-7	0.0	0.0	0.0	0.0
62	20419721.	14.	.656	0.	35E-7	0.0	0.0	0.0	0.0

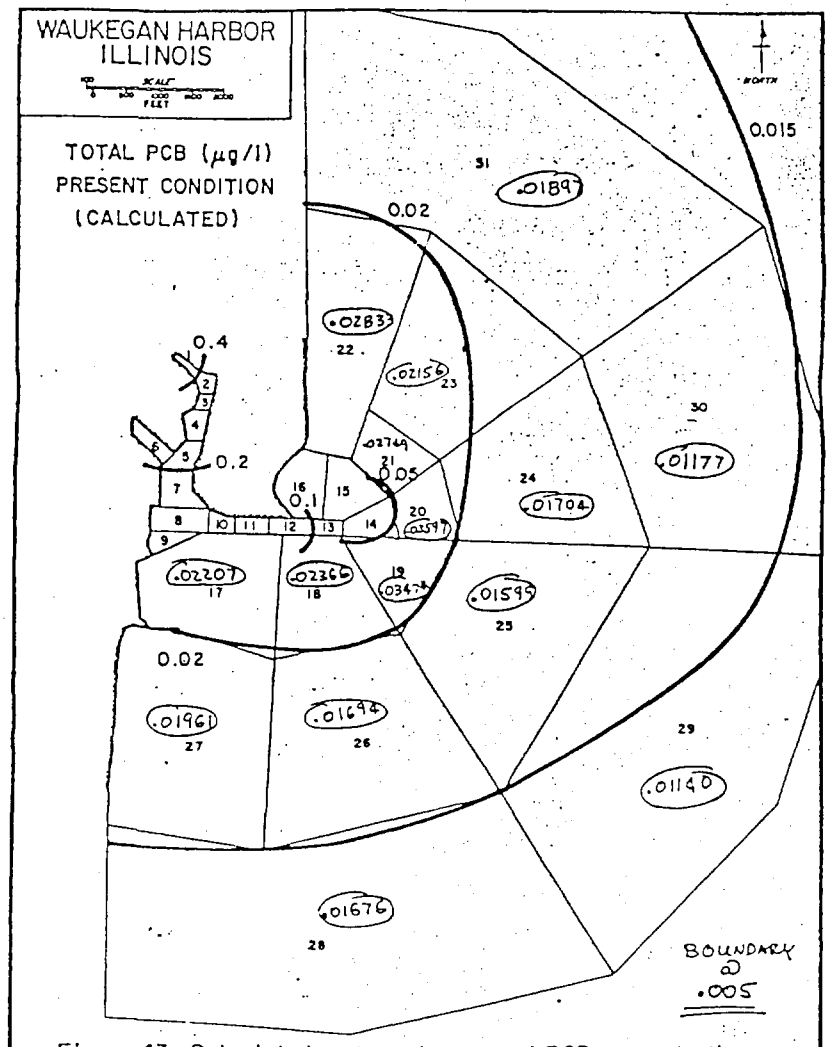


Figure 43. Calculated water column total PCB concentrations
Present condition

HydroQual, Inc.

CHLORIDES & DYE INPUT TABULATION

NOTES:

① ALL chlorides and dye runs have the same E's in water column. The chloride runs are AESOP steady state runs in which the accuracy criteria are violated. The residual error is small, not more than 2. mg/l. The solutions however do not converge all that well. There appears to be a scale error in the Fig 23 of the draft report or 29 of the final report. the Feb & April chloride plots are o.k.

② The dye was released in seg 3, so the 0. mile point in Distance scale is at seg 3, or 1250 fig 2, Although sense of direction bet. figures 25 and 23 is incosistent, # segs 1,8,17,14 were located in Fig 25 and the values of the dye con. were marked. Some scale problem seems to exist in the dye plots.

③ The markings and dates on the available chlorides and dye runs are not consistent with the sequence indicated on page 47 of blue report, i.e. first the chlorides runs and then the dye.

	Dates on runs
Dye	10/30/79
chloride (Feb 77)	11/01/79
" (Apr 77)	11/01/79
" (5/29/79)	11/02/79

DEPOSITION EXHIBIT
THOMANN-CHE
20-TD
11-17-81

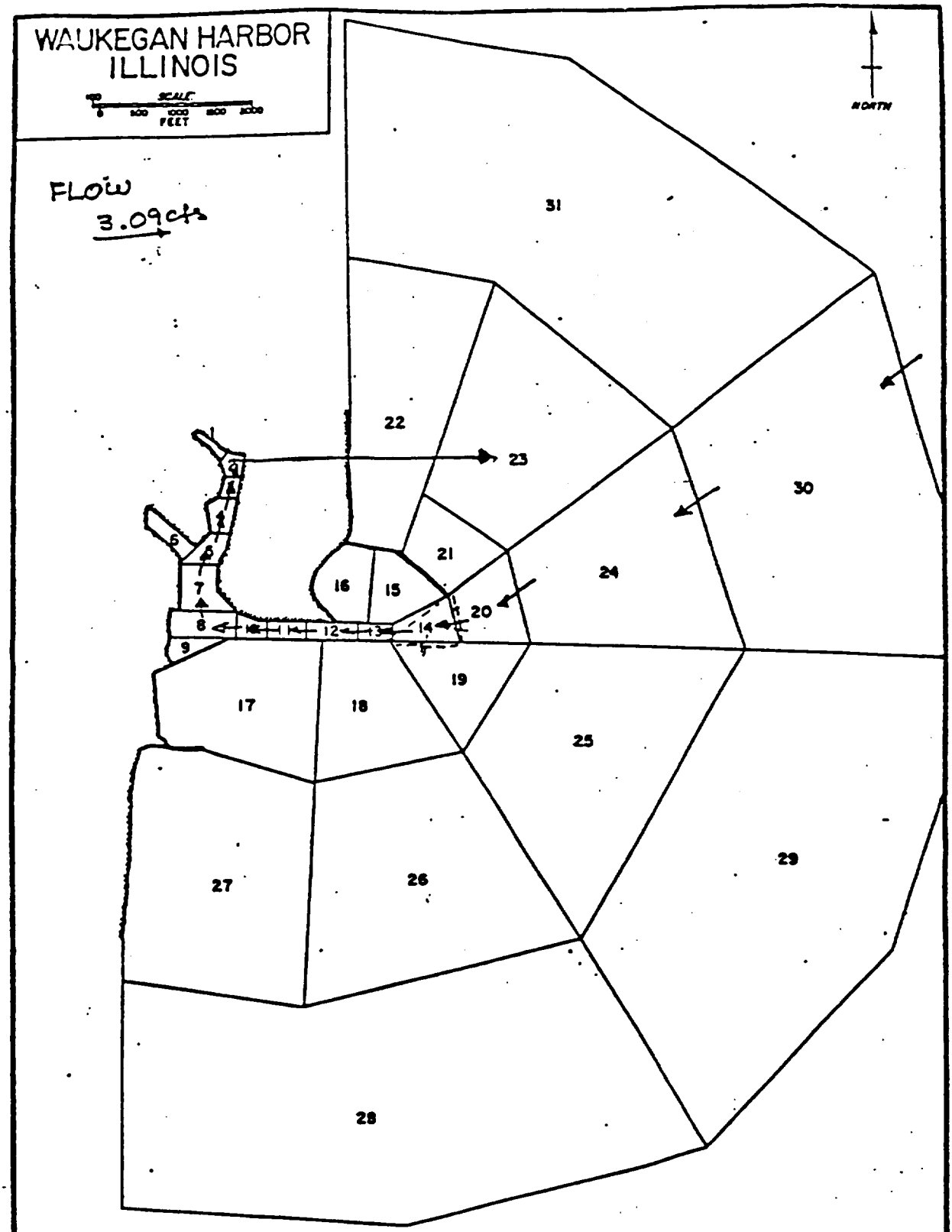
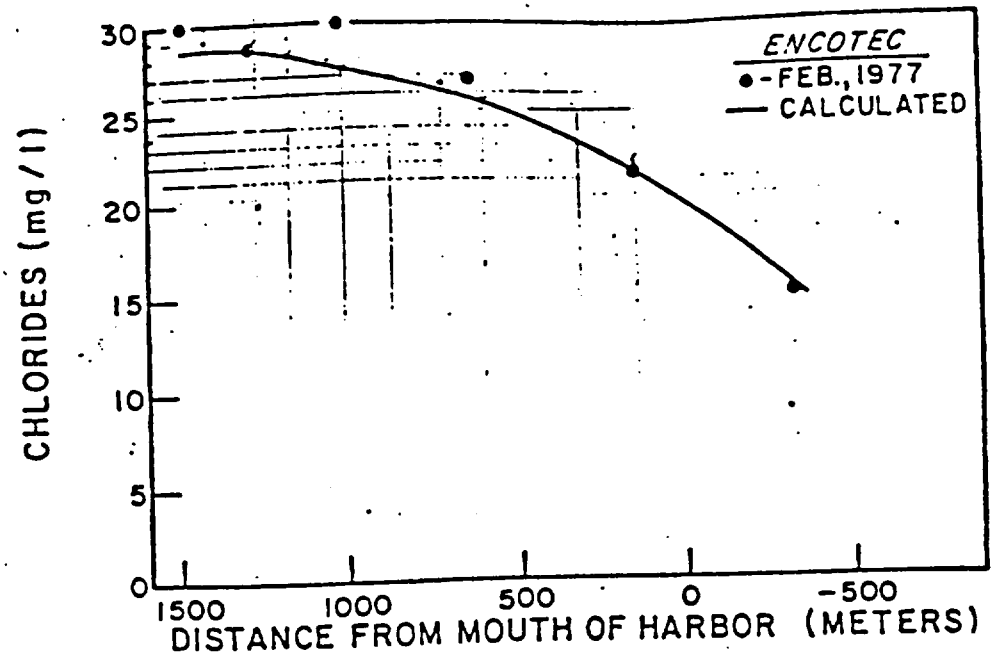


Figure 27. ~~Segmentation of mathematical model~~

HydroQual, Inc.

WATER COLUMN DISPERSION COEF

SEG		CHLORIDES 5/12-5/19/79	CHLORIDE FEB 77	CHLORIDES APRIL 77	DYE RUN #7
2	0	0.0			
1	2	0.12	S	S	S
2	3	0.12	A	A	A
3	4	0.12	M	M	M
4	5	0.12	E	E	E
5	6	0.12			
5	7	0.12			←
7	8	0.12	A	A	AS
8	9	0.10	S	S	
8	10	0.10			
10	11	0.10	E'	E'	E'
11	12	0.10			
12	13	0.10	O	OF	OF
13	14	0.10	F		
13	15	0.10			
14	15	0.10	CHLORIDES 5/12-9/79	CHLORIDES 5/12-9/79	CHLORIDES 5/12-9/79
14	19	0.01			
14	20	0.01			
15	16	0.01			
17	18	0.01			
17	27	0.01			
18	19	0.01			
18	26	0.01			
19	20	0.01			
19	25	0.01			
20	21	0.01			
20	24	0.01			
21	22	0.01			
21	23	0.01			
22	23	0.01			
22	31	0.01			
23	24	0.01			
23	31	0.01			
24	25	0.01			



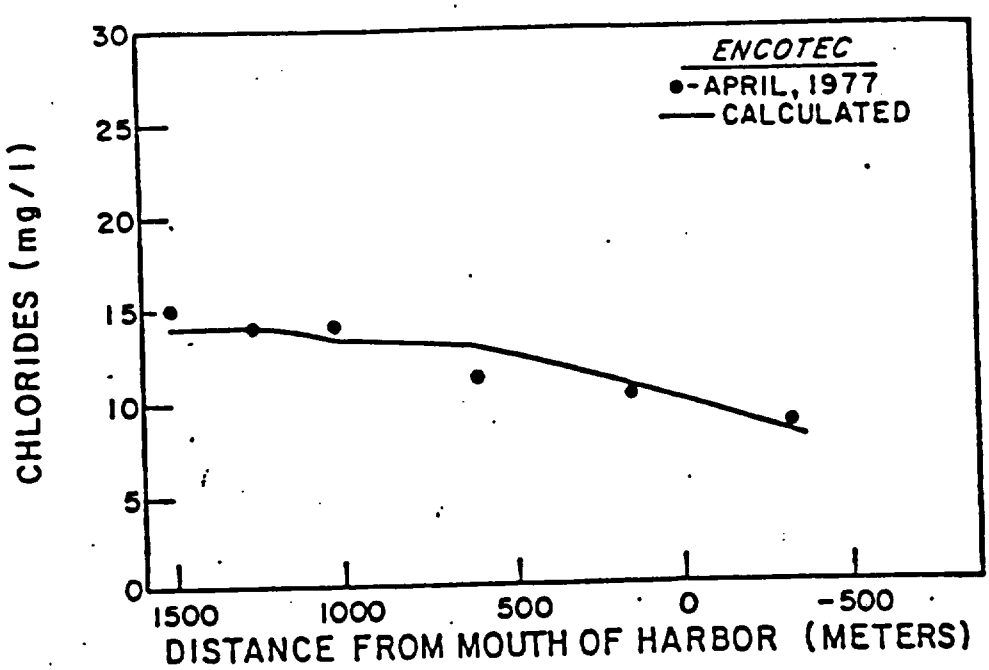


Figure 22. Comparison of observed and calculated chloride data

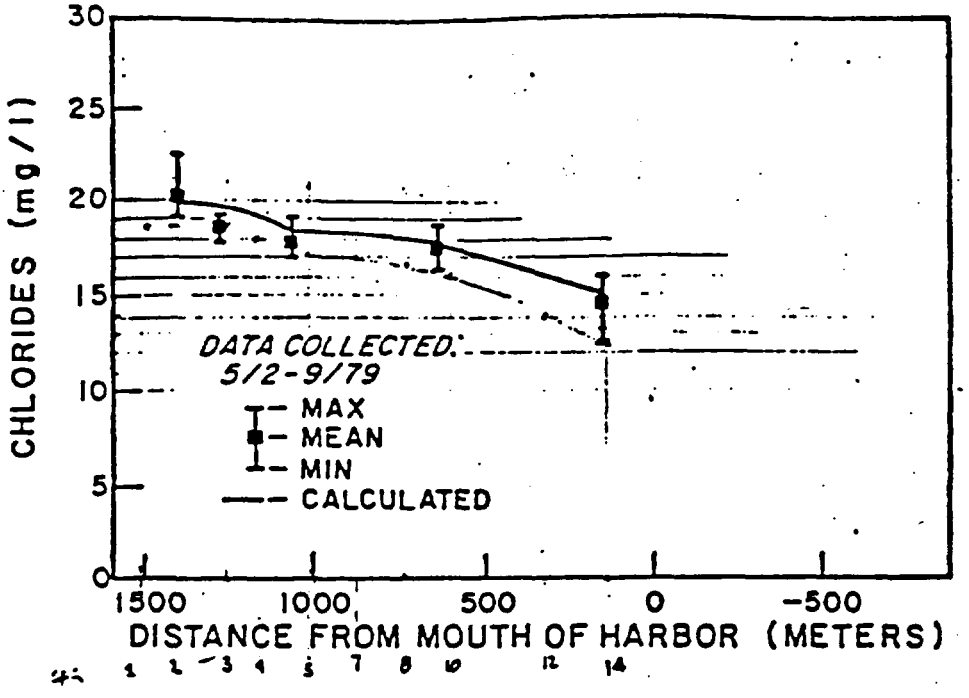


Figure 23. Comparison of observed and calculated chlorides

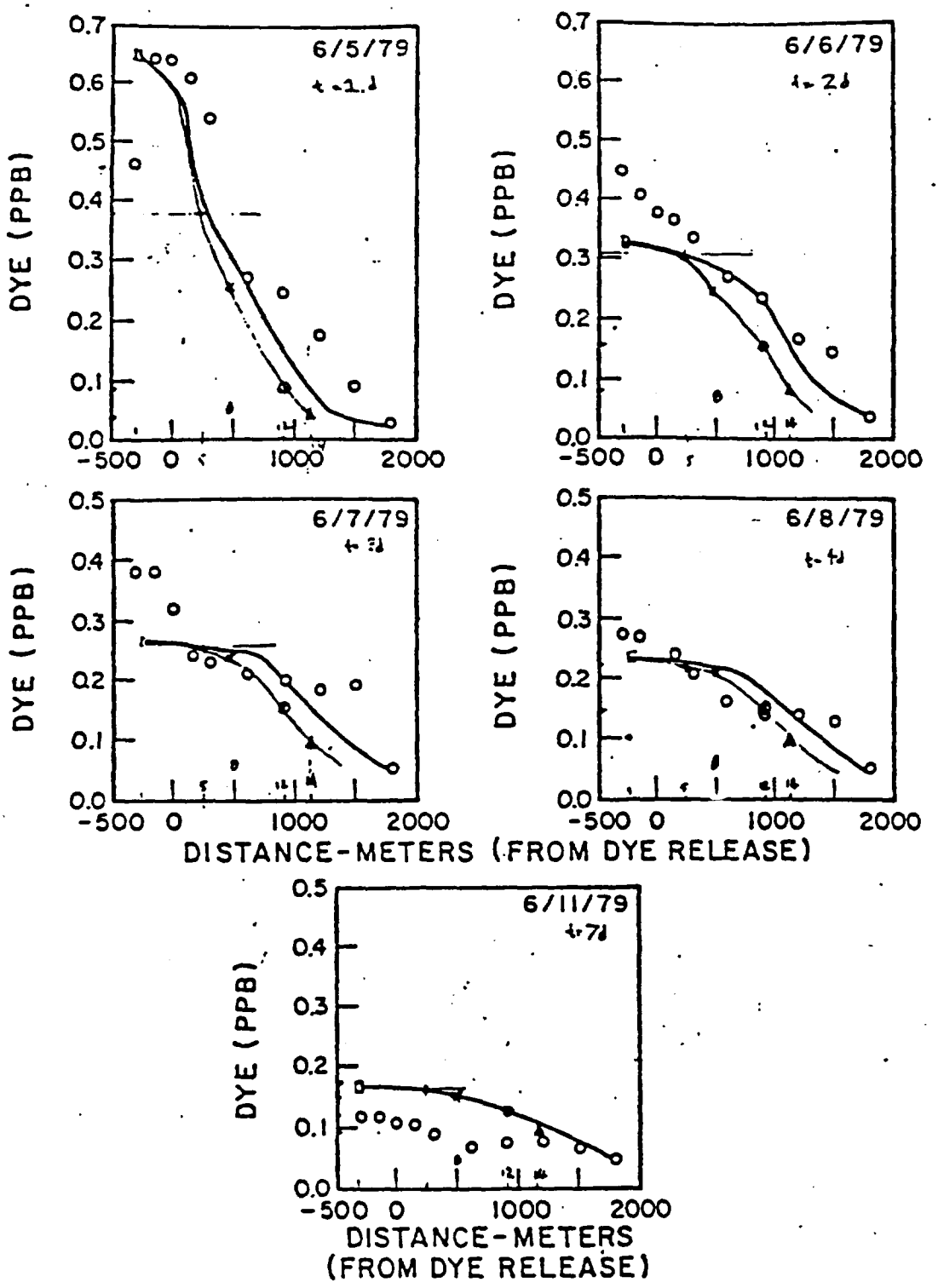


Figure 25. Comparison of observed and calculated dye concentration

SUBJECT

BOUNDARY CONDITIONS

JOB NO. | SHEET OF | FILE | BY | DATE

	CHLORIDES 5/18-5/19/79	CHLORIDES FEB 77	CHLORIDES APRIL 77	DYE RUN 7
SEB3				
2	0.	0	0	0.03
28	7.	14.	7.5	0.03
29	7.	14.	7.5	0.03
30	7.	14.	7.5	0.03
31	7.	14.	7.5	0.03
5	0.	0.	0	0.03

SUBJECT

LOADS

JOB NO. | SHEET OF | FILE | BY | DATE

CHLORIDES 5/2-9/77		CHLORIDES FEB 77		CHLORIDES APRIL 77	
SEG	lb/d	SEG	lb/d	SEG	lb/d
3	1200	3	1700	3	400

DYE RUN 7

SEG 3	t	W(t) Forcing function
	0.	0
	0.5	0.
	0.5002	151000.
	0.5036	151,000.
	0.6038	0.
	12.0	0.

9/15/81

Notes

INPUTS: PCB used: Pydraul F-9 + A-200 Prior to 1961
A-200 Post 1961
Mixture of Aroclor 1016 + 1248

Huteinger
Uses: 1016 - capacitors
1248 - Hydraulic fluids (solubility ≈ 43-100 μg/l

Criteria Document:

Property	1016	1248
cl %	41	48
Spec. Grav.	~1.36	~1.40
Solubility (μg/l)	225-250	54

Molecular Composition 1248
1-23% of $C_{12}H_8Cl_3$
21-50% of $C_{12}H_7Cl_4$
20-48% of $C_{12}H_6Cl_5$
1-23% of $C_{12}H_5Cl_6$

DEPOSITION EXHIBIT
Thomann-CMC
11-17-81

SUBJECT

	SHEET	FILE	BY	DATE
				Disp ①

Dispersion:

i) Examined chloride data Feb 1977 some ice cover
good gradient indicates
not too much mixing
April 1977 - small gradient - probably
more mixing
May 1979 - 5/2-5/9 show gradient
then rapid mixing

Procedure: [illegible]
Feb 1977 Fixed concentration @ upper end
(Equivalent to putting in a load)
(Did it by exchanging seg #5 with a boundary fixed at no. 5)
Fixed concentration at lower end
Adjusted dispersion until good fit obtained

April 1977 + May 1979 Kept same dispersion coef.
Fixed upper + lower conc
Obtained good fit

Loads equiv to
Feb 1977 - 1700 lbs/d
April 1977 - 400 " "

Value estimated @ $E = .05 \frac{mi^2}{d}$ across harbor - Lake boundary

$$E' = \frac{EA}{L} = .05 \frac{mi^2}{d} \left(\frac{5520\ ft^2}{635\ ft}\right) \cdot \frac{(5280)^2 ft^2}{mi^2}$$

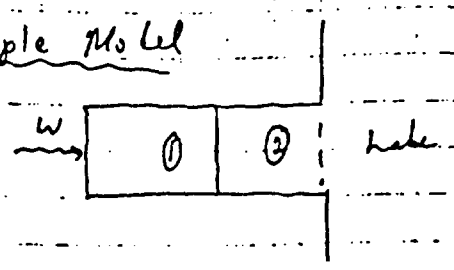
$$= 12 \cdot 10^6\ ft^3/d \approx 140\ cfs = 90\ MGD$$

$$= 3.9\ m^3/sec$$

Disp (1A)

A Simple Model

to illustrate mag. of load



@ SS:

$$E_{2B} = \frac{W}{C_2 - C_B} \qquad E_{12} = \frac{W}{C_1 - C_2}$$

Feb 1977 $C_1 = 28$ mg/l $\qquad E_{2B} = \frac{W}{10} \frac{m^3}{g}$

$C_2 = 20$

$C_B = 10$

If $E_{2B} \approx .05 \frac{mi^2}{d} = 12 \cdot 10^6 \frac{ft^3}{d} \cdot \frac{m^3}{(3.28)^3}$

$= 340{,}00 \frac{m^3}{d}$

$\therefore W = 10 \frac{g}{m^3} \cdot \frac{340{,}000\ m^3}{d} = 3{,}400{,}000 \frac{g}{d}$

$\approx 3400 \frac{kg}{d} \cdot 2.2 \frac{lb}{kg} = 7480 \frac{lb}{day}$

April 1977 $C_1 = 15$ $\qquad$ @ $E = .05\ mi^2/d$

$C_2 = 10$ $\qquad \therefore W = \frac{2}{10}\left[3400 \frac{kg}{day}\right] = 680 \frac{kg}{d} \approx 1500\ lb/d$

$C_B = 8$

Note: Nauhegan may use 1000 - 2000 $\frac{tons\ NaCl}{Season} \cdot \frac{35}{58} \frac{Cl}{NaCl} \cdot \frac{season}{150\ d} = 4 - 8 \cdot \frac{tons\ Cl}{d}$

$= 8000 - 16{,}000 \frac{lbs\ Cl}{d}$

Disp ②

2) Dye Data: obtained after chloride data were analyzed

a) Simplified analysis (see note) yielded
$E' = 5.4\ m^3/sec = 191\ cfs$

b) Model (time variable) of dye release used E's of chloride conc. & reproduced dye data quite well.
∴ concluded $E \approx .05\ \frac{mi^2}{d}$ across boundary.

SUBJECT

JOB NO. | SHEET OF | FILE | BY | DATE

KINETICS: 1) Used, Sus. Solids to calibrate net settling + resuspension

Note that Harbor acts as a sedimentation basin

2) PCB: Used $a = 250$ µg/g ÷ µg/l from data.

Note in Sed. of Slip #3 PCB = 1000 → 10,000 µg/g = Y

@ $a = 250$ µg/g ÷ µg/l + M = 500,000 mg/l

f_{sd} = fraction diss. in sediment $= \frac{1}{1 + 250(500)} = 8 \times 10^{-6}$

$c_T = YM = 1000 \rightarrow 10{,}000 \frac{\mu g}{g}, \; 500 \frac{g}{l} = 500{,}000 \rightarrow 5{,}000{,}000 \frac{\mu g}{l}$

Diss. in Sediment:

$c_D = f_{sd}\, c_T = 8 \cdot 10^{-6} \left[500{,}000 \rightarrow 5{,}000{,}000 \text{ µg/l} \right]$

$= 4 \rightarrow 40$ µg/l ∴ may have some significant dissolved exchange.

Summary

Mass : 1) "Best" Harbor : 207,000 kg (450,000 lbs) 95% in Slip #3
Ditch : 277,000 kg (611,000 lbs)
Total 484,000 kg 1,061 000 lbs

2) Present PCB water col : Harbor : 0.6 → .01 ng/l
Ditch : 7 ng/l peak ≈ 80-100 ng/l

3) Dispersion : ≈ 3.9 m³/s

4) Discharge to Lake : Harbor : 10 kg/yr (22 lb/yr)
(4 kg/yr - Average
(6 kg/yr - Transient events bi-weekly flushout)

Ditch : Ave : 2 kg/yr (4.4 lb/yr) {Include events
Max storm : 3 kg/yr

Total : 15 kg/yr
Harbor + Ditch

5) Fish 5-10 times FDA level

6) Input into Harbor : 62% of sediment + 38% → Lake
Ditch : 71% of " " + 29% → Lake

7) a) 1955-1971 - 5,300,000 kg of PCB purchased
[4% → 24%] entered Harbor/Ditch
14% best

Summary (2)

b) 5% "best estimate" of amount purchased entered Lake
Range 1-7 %
5% ⇒ 15,000 kg/yr { Range 4300 → 26,600 kg/yr.

8. Total present Load to Mich from all sources (Precip: 20 → 100 ng/l)
1400 → 5600 kg/yr Total PCB

∴ Present Load: < 1-2% of total PCB to entire Lake
1-6% of precip only of lower Aroclors (account for uncertainty in tributary input)

Past Load 15,000 kg/yr ⇒ 7-15 ng/l
"Background" ≈ 1-3 ng/l

∴ Past Load ≈ 50-90% of concentration
∴ 50-90% of fish body burden.

SUBJECT

JOB NO	SHEET OF	FILE	BY	DATE

Dredging Estimated ≈ 304 kg/yr
or for 16 years ≈ 4900 kg.

Small compared to estimated mass of 207,000 kg
" " " purchase " " 5,300,000 kg.

2/6/80

Dr. Thomann -

I have enclosed the last of the Harbor data, as well as all the information we have been able to gather on dredging activities in and around the Harbor. Note that little information was found for the area north of the Federal project area.

We expect that Harbor core analysis will be completed in mid-march; I will transmit results to you.

We have John Paul's draft report, and understand you were sent one directly.

I talked to St. John & we are OK through 3/1/80, with some budget adjustment -

Please call if clarification is needed

Ed D'Domenico

DEPOSITION EXHIBIT CMC
Thomann
22-1D 11-30-81

P.S. - Are you aware that we found a new area of PCB contamination on OMC property It is partially <u>under the parking lot</u>!

SUBJECT LAKE MICHIGAN WAUKEGAN HARBOR STUDY

COMPUTATION

COMPUTED BY 79CL50 | CHECKED BY D.S. 752 | DATE 790626-27 | PAGE OF PAGES

(1) Sample #	(2) STATION	(3) TIME	(4) DEPTH	(5) TEMP	(6) FILTERED	(7) S.S. mg/l	(8) Chlorine Mg/l	(9) Total Lead µg/l	(10) mg/Kg µg/l * Aroclor 1248/1[illegible]
S01	L-2	1040 6-27	1	14		K5	9.2	K2	.005 *
S02	L-2	1040	1	14	12 l				3.9
S03	L-2	1055	3.75	14		K5	8.8	K2	
S05	L-4	1230		13		K5	9.0	K2	.005 *
S06	L-4	1230		13	12 l				21
S07	L-4	1230	8	12		K5	9.2	K2	
S09	L-6	1310	1	14		K5	8.8	K2	.005 *
S10	L-6	1310	1	14	12 l				2.5
S11	L-6	1310	3.5	14		K5	9.2	K2	
S13	L-17	1335	1	14		K5	8.8	K2	.004
S14	L-17	1335	1	14	12 l				2.3
S15	H15	1545	1	15		K5	9.1	K2	.007 *
D15	H15	1545	1	15		K5	8.9	K2	.006 *
S16	H15	1550	1	14	12 l				K4
D16	H15	1550	1	14	12 l				2.2
S17	H15	1550	4.5	14		K5	8.9	K2	
S19	H14	1620	1	15		K5	9.3	K2	.025 *
S20	H14	1620	1	15	12 l				171
S21	H14	1620	1	13		K5	9.2	K2	
S23	H11	805 6-27	1	13		K5	9.3	K2	.016 *
S24	H11	805	1	13	4 l				38
S25	H11	805	6	12		K5	9.3	K2	.010 *
S26	H11	805	6	12	4 l				23.[illegible]
S27	H7	825	1	14		K5	9.2	K2	.020 *
S28	H7	825	1	14	4 l				17.8
S29	H7	825	5.5	13		K5	9.3	~~K2~~ 4.9	.019 *
S30	H7	825	5.5	13	4 l				K4
S31	H5	850	1	14		K5	9.8	K2	.052 *
S32	H5	850	1	14	4 l				10.1
S33	H5	850	5.0	13		K5	9.6	K2	.039 *
S34	H5	850	5.0	13	4 l				10.0
S35	H2	925	1	15		K5	10.5	K2	.180 *
D35	H2	925	1	15		K5	10.9	K2	.180 *
S36	H2	925	1	15	4 l				55.4
D36	H2	925	1	15	4 l				11.6
S37	H2	925	2.5	14		K5	10.3	K2	.140 *
S38	H2	925	2.5	14	4 l				259
R39		935							K .005
R41		935							

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A MATERIAL BALANCE STUDY OF POLYCHLORINATED BIPHENYLS IN LAKE MICHIGAN

W. BROCK NEELY

Environmental Sciences Research, The Dow Chemical Co., Midland, Mich. 48640 (U.S.A.)

(Received May 10th, 1976)

ABSTRACT

This paper integrates the known chemical and physical properties of polychlorinated biphenyls (PCB) derived in the laboratory with a mathematical model describing their behavior in Lake Michigan. The conclusion that emerges is that the observed levels of PCB both in Lake Michigan and the fish biomass are consistent with these laboratory measurements. In addition, it is concluded that it will take several years for this ecosystem to cleanse itself of the compounds even if no new input is made. The final sink for PCB is predicted to be degradation in the atmosphere, with some fraction being buried in the underlying sediments of the lake.

INTRODUCTION

Knowledge of the environmental fate of chemicals has always been important but with the increasing awareness of their potential environmental effects such studies have taken on even greater importance. With this in mind scientists must continue to improve their ability to make predictions based on the best data available. Ideally, we should be able to combine laboratory information with the anticipated environmental release of a chemical to forecast the fate and distribution of that compound in the environment. However, before we achieve this position we must establish the credibility of our prognosis. One method of increasing the confidence level is to use laboratory date to make predictions on some event that has already occurred. If the prognostications are close to what is actually observed, and the assumptions used are acceptable, then applying the same logic to another set of laboratory data will be more convincing.

The widespread distribution of PCB and the associated environmental concentration provides a data base for comparison with basic chemical and physical

DEPOSITION EXHIBIT OMC
Thomas
23-1D 11.12.81

F_O_I_EXEMPT

EVALUATION OF ALTERNATIVES FOR REMOVAL/DESTRUCTION OF PCB-CONTAMINATED SEDIMENTS IN WAUKEGAN HARBOR

FOR OFFICIAL USE ONLY

by
G. W. Dawson
J. L. Goodier

Contract No. 68-03-02552 (T 2010)
Battelle, Pacific Northwest Laboratories
Richland, Washington 99352

WORKING DRAFT

Project Officer

F. Freestone
Oil and Hazardous Materials Spill Branch
Industrial Environmental Research Laboratory
Edison, New Jersey 08817

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INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DEPOSITION EXHIBIT
24-D

DITCH

	M	M+δM	M−δM
0-1	123,746	224,694	22,798
1-2	56,017	92,689	19,345
2-3	62,393	141,973	4,315
3-4	29,081	58,910	333
4-5	6,118	9,217	3,019
Σ	277,360	527,480	49,810
	BEST (kg)	HIGH (kg)	LOW (kg)

	M	M+δM	M−δM
		(3-4)FT	
2	4762	9206	318
3	24294	49669	0(1)
4	2	3	1
5	23	32	14
Σ	29081	58910	333
		(45)FT	
2	1751	2130	1372
3	4351	7061	1641
4	4	7	1
5	12	19	5
Σ	6118	9217	3019

DITCH

	M	M + δM	M - δM
		0-1 FT	
2	22,137	24676	19598
3	100512	198128	2896
4	189	320	58
5	908	1570	246
Σ	123,746	224,694	22,798
		1-2 FT	
2	5728	7664	3792
3	50,163	84849	15477
4	13	19	7
5	113	157	69
Σ	56,017	92,689	19,345
		2-3 FT	
2	18922	33579	4265
3	43391	108284	0
4	6	7	5
5	74	103	45
Σ	62,393	141,973	4,315

N DITCH

BY LAYER - SEGMENT *

BEST = Σ 123,700 + 56,000 + 62,400 + 29,000 + 6100

BEST = 277,200

± 125,900

HIGH = 403,100

LOW = 151,300

* Based on assump $\sigma_{tot} = \left[\Sigma \sigma_i^2\right]^{1/2}$

N. DITCH

0 - 1 FT

SEG	N	$\hat{\mu}_x$	$\hat{\sigma}_x$	$\hat{\mu}_r$	$\hat{\sigma}_{\hat{\mu}_r}$	$\hat{M}_{\hat{\mu}_r}$	$(\delta M)_{\sigma_{\hat{\mu}_r}}$
2	22	9.4	1.1	22137	6577	22137	2539
3	9	10.3	1.8	150242	145913	100512	97616
4	8	4.5*	1.4*	240	167	189	131
5	9	5.3*	1.5*	617	450	908	662
					$\sum$	123746	$\sqrt{\sum()^2}$ = 97651
						123700	97650

BEST 123,700

HIGH 221,400

LOW 26,100

* revised

N. DITCH

1-2 FT

SEG	N	$\hat{\mu}_x$	$\hat{\sigma}_x$	$\hat{\mu}_r$	$\hat{\sigma}_{\hat{\mu}_r}$	$\hat{M}_{\mu_r}$	δM
2	17	9.0	1.1	14839	5015	5728	1936
3	10	10.1	1.5	74982	51848	50163	34686
4	6	2.3*	1.0*	16	8	13	6
5	4	4.1*	0.7*	77	30	113	44
						$\Sigma = 56017$	$\sqrt{\Sigma()^2} = 34740$

BEST = 56,000

HIGH = 90,740

LOW = 21,277

* Revised

N. DITCH

2-3 FT

SEG	N	$\hat{\mu}_x$	$\hat{\sigma}_x$	$\hat{\mu}_r$	$\hat{\sigma}_{\hat{\mu}_r}$	$\hat{M}_{\hat{\mu}_r}$	δM
2	20	8.8	2	49021	37971	18922	14657
3	10	8.2*	2.4*	64860	97000	43391	64893
4	6	2.1	0.2	8	1	6	1
5	5	3.6*	0.8*	50	20	74	29
						$\sum$ 62393	$\sqrt{\sum()^2}$ = 66528
						62400	66530

BEST 62,400

HIGH 128930

LOW 0.

*Revised

N. DITCH

3-4 FT

SEG	N	$\hat{\mu}_x$	$\hat{\sigma}_x$	$\hat{\mu}_r$	$\hat{\sigma}_{\hat{\mu}_r}$	M_r	δM
2	19	7.0*	2.2*	12336	11514	4762	4444
3	11	8.5	2.0	36316	37930	24294	25375
4	7	0.9	0.4	3.	1.	2	1
5	4	2.5	0.7	16	6	23	9
					$\sum$	29081	$\sqrt{\Sigma()^2} = 25761$
						29100	25760

BEST 29,100

HIGH 54,840

LOW 3,320

* Revised

N. DITCH

4-5 FT

SEG	N	$\hat{\mu}_x$	$\hat{\sigma}_x$	$\hat{\mu}_r$	$\hat{\sigma}_{\hat{\mu}_r}$	M	δM
2	18	8.1	.8	4537	983	1751	379
3	10	7.8*	1.4*	6503	4051	4351	2710
4	5	0.7	1.3	5	4	4	3
5	5	1.3*	1.2*	8	5	12	7
					$\sum$	6118 6100	$\sqrt{\sum()^2} = 2736$ 2740

BEST 6100

HIGH 8860

LOW 3380

* Revised

N. DITCH

ALL N.DITCH DATA = 237

	[-2.303, 0) [5]			[0, 2.303) [52]							
.42	-3.147		.5	0. (9)	16.98	6.30		2.213	55	92.45	23.11
.84	-1.715	16.67	.10	0.182	18.87	6.72	50	2.264		94.34	23.5
1.26	-1.661	33.33		0.278	20.75	7.14		2.293		96.23	23.9
1.68	-1.470	50.00		0.300	22.64	7.56		2.294	59	98.11	24.3
2.10	-1.109	66.67		0.365	24.53	7.98					
2.52	-0.010	83.33		0.470	26.42	8.40					
			22 .15	0.588 (2)	30.19	9.24					
				0.642	32.08	9.66					
				0.765	33.96	10.08					
			.25	0.788	35.85	10.50					
			.30	0.798	37.74	10.92					
				0.833	39.62	11.34					
				0.854	41.51	11.76					
			.38	0.871 (2)	45.23	12.61					
			.42	0.916 (2)	49.06	13.45					
				0.959	50.94	13.87					
			.35	1.008 (2)	54.72	14.71					
			.36	1.099	56.60	15.13					
			.37	1.109	58.49	15.55					
				1.241	60.38	15.97					
				1.361	62.26	16.39					
			.40	1.441	64.15	16.81					
			.35	1.504	66.04	17.23					
				1.528	67.92	17.65					
				1.609	69.81	18.07					
				1.671	71.70	18.49					
			.45	1.808	73.58	18.91					
			.46	1.872	75.47	19.33					
			.48	1.881 (2)	79.25	20.17					
				1.887	81.13	20.59					
			.50	1.989	83.02	21.01					
			.55	1.991	84.91	21.43					
				2.041	86.79	21.85					
				2.102	88.68	22.27					
				2.128	90.57	22.69					

N. DITCH

[2.303 - 4.605) 37

59	2.303	24.11	2.63	24.79
60	2.425		5.26	25.21
	2.460		7.89	25.63
	2.468		10.53	26.05
	2.549		13.16	26.47
	2.639		15.79	26.89
65	2.667		18.42	27.31
	2.708		21.05	27.73
	2.815		23.68	28.15
	3.054		26.32	28.57
	3.068	28.99	28.95	
70	3.091	29.41	31.58	
	3.161	29.83	34.21	
	3.298	30.25	36.84	
	3.300	30.67	39.47	
	3.325	31.09	42.11	
75	3.339	31.51	44.74	
	3.353	31.93	47.37	
	3.367	32.35	50.00	
	3.509	32.77	52.63	
	3.535	33.19	55.26	
80	3.538	33.61	57.89	
81	3.603	34.03	60.53	
	3.770	34.45	63.16	
	3.771	34.87	65.79	
	3.789	35.29	68.42	
85	3.947	35.71	71.05	
	3.953	36.13	73.68	
	3.989	36.55	76.32	
	4.127	36.97	78.95	
	4.205	37.39	81.58	
90	4.236	37.82	84.21	
	4.248	38.24	86.84	
	4.279	38.66	89.47	
	4.466	39.08	92.11	
	4.500	39.5	94.74	
95	4.575	39.92	97.37	

[4.605 - 6.908] 34

96	4.605	2.86	40.34
	4.615	5.71	40.76
	4.655	8.57	41.18
	4.754	11.43	41.60
100	4.762	14.29	42.02
	4.868	17.14	42.44
	5.037	20.00	42.86
	5.081	22.86	43.28
	5.112	25.71	43.70
105	5.242	28.57	44.12
	5.375	31.43	44.54
	5.394	34.29	44.96
	5.429	37.14	45.38
	5.438	40.00	45.80
110	5.447	42.86	46.22
	5.455	45.71	46.62
	5.479	48.57	47.06
114	5.583 (2)	54.29	47.90
115	5.704	57.14	48.32
	5.835	60.00	48.72
	5.905	62.86	49.16
	6.184	65.71	49.58
	6.234	68.57	50.00
120	6.260	71.43	50.42
	6.430	74.29	50.84
	6.482	77.14	51.26
	6.561	80.00	51.68
	6.576	82.86	52.10
125	6.646	85.71	52.52
126	6.702	88.57	52.94
	6.755	91.43	53.36
	6.882	94.29	53.78
129	6.891	97.14	54.20

[6.908 - 9.210) 43

130	7.030	2.27	54.62	9.072	70.17
	7.147	4.55	55.04	9.112	86.30
	7.208	6.82	55.46	9.125	70.59
	7.244	9.09	55.88	9.130	88.6
	7.415	11.36	56.30	9.163	71.01
135	7.539	13.64	56.72	9.193	90.9
	7.590	15.91	57.14	172	71.4
	7.596	18.18	57.56		93.1
	7.678	20.45	57.98		71.8
	7.764	22.73	58.40		95.4
140	7.860	25.00	58.82		72.2
	8.036	27.27	59.24		97.7
	8.163	29.55	59.66		
	8.216	31.82	60.08		
	8.242	34.09	60.50		
145	8.284	36.36	60.92		
	8.294	38.64	61.34		
	8.299	40.91	61.76		
	8.306	43.18	62.18		
	8.328	45.45	62.61		
150	8.385	47.73	63.03		
	8.396 (2)	52.27	63.87		
	8.529	54.55	64.29		
	8.537	56.82	64.71		
155	8.650	59.09	65.13		
	8.693	61.36	65.55		
	8.695	63.64	65.97		
	8.700	65.91	66.39		
	8.748	68.18	66.81		
160	8.855	70.45	67.23		
	8.868	72.73	67.65		
	8.901	75.00	68.07		
	8.993	77.27	68.49		
	9.011	79.55	68.91		
165	9.024	81.82	69.33		
	9.025	84.09	69.75		

N. DITCH

[9.210 - 11.513) 51

173	9.240	72.09	1.92
1	9.250	73.11	3.85
175	9.333	73.53	5.77
	9.393	73.95	7.69
	9.457	74.37	9.62
	9.480	74.79	11.54
	9.518	75.21	13.46
180	9.554	75.63	15.38
	9.557	76.05	17.31
	9.561	76.47	19.23
	9.568	76.89	21.15
	9.589	77.31	23.00
185	9.636	77.73	25.00
	9.674	78.15	26.92
	9.680	78.57	28.85
	9.780	78.99	30.77
	9.852	79.41	32.69
190	9.923	79.83	34.62
	9.952	80.25	36.54
	9.954	80.67	38.46
195	9.971(3)	81.93	44.23
24	9.975	82.35	46.15
25	10.012	82.77	48.08
	10.039	83.19	50.0
	10.082	83.61	51.92
200	10.090	84.03	53.85
	10.102	84.45	55.77
30	10.170	84.87	57.69
	10.207	85.29	59.62
	10.364	85.71	61.54
205	10.373	86.13	63.46
	10.425	86.55	65.38
35	10.437	86.97	67.31
	10.446	87.39	69.23
	10.460	87.82	71.15
210	10.543	88.24	73.08
39	10.545	88.66	75.00
40	10.621	89.08	76.92
1	10.727	89.50	78.85
	~~10.966~~		
215 43	10.996(2)	90.34	82.69
44	11.015	90.76	84.62
45	11.017	91.18	86.54
	11.064(2)	92.02	90.38
220	11.142	92.44	92.31
	11.198	92.86	94.23
50	11.201	93.28	96.15
233	11.392	93.70	98.08

[11.513 - 13.816) 14

224	11.617	6.67	98.12
225	11.653	13.33	94.54
	11.627	20.00	94.96
	11.712	26.67	95.38
	11.871	33.33	95.80
	11.884	40.00	96.22
230	12.073	46.67	96.64
	12.155	53.33	97.06
	12.269	60.00	97.48
	12.337	66.67	97.90
	12.413	73.33	98.32
235	12.421	80.00	98.74
	12.835	86.67	99.16
237	12.837	93.33	99.58

N. DITCH

[0 - 2.303)			
~~1.881~~	~~0.0~~	~~1.109~~	~~0.787~~
~~0.365~~	~~0.0~~	~~0.871~~	~~0.916~~
~~0.0~~	~~1.528~~	~~1.887~~	~~0.642~~
~~2.264~~	~~1.881~~	~~2.128~~	
~~0.798~~	2.294	~~1.504~~	
~~0.278~~	~~1.991~~	~~2.041~~	
~~0.916~~	~~0.765~~	~~0.833~~	
~~0.854~~	~~1.008~~	~~0.182~~	
~~0.871~~	~~0.300~~	~~1.988~~	
~~1.241~~	~~2.102~~	~~2.293~~	
~~1.099~~	~~0.959~~	~~0.588~~	
~~1.671~~	~~1.808~~	~~1.609~~	
~~1.361~~	~~0.588~~	~~0.470~~	
~~0.0~~	~~2.213~~	~~1.411~~	
~~0.0~~	~~1.008~~	~~1.872~~	

[2.303 - 4.605)		
2.425	2.708	2.815
2.549	4.205	3.538
3.091	2.639	3.770
3.353	3.339	3.068
3.325	3.775	3.161
3.789	3.298	4.500
2.460	3.509	3.603
4.236	3.947	4.466
3.054	4.208	
2.468	4.127	
3.953	~~5.242~~	
2.667	3.367	
3.535	3.989	
2.303	4.278	
4.585	3.300	

[4.605 - 6.908)	
4.655	4.868
4.714	5.583
4.762	6.184
4.615	7.576
6.891	5.704
5.081	6.561
5.112	6.234
5.375	4.605
5.835	5.429
6.646	5.583
5.479	6.260
5.905	6.430
5.242	5.394
6.882	5.447
6.482	6.755
5.455	
5.037	
6.702	
7.438	

[6.908 - 9.210)		
~~6.755~~	8.284	9.011
7.030	9.119	8.328
7.576	8.385	8.693
7.754	8.036	7.678
8.299	8.396	8.700
9.024	9.025	7.860
8.855	8.529	
9.125	8.748	
8.901	8.163	
9.163	7.415	
9.130	7.537	
8.695	9.193	
7.208	8.306	
7.570	8.396	
8.993	8.242	
7.244	7.147	
8.216	8.868	
8.650	8.537	
9.072	8.294	

N. DITCH

[9.210 - 11.513)		[11.513 - 13.816
		12.337 ✓
9.518 ✓	11.064 ✓	12.835 ✓
9.250 ✓	9.971 ✓	12.421 ✓
9.680 ✓	10.460 ✓	11.617 ✓
9.561 ✓	10.364 ✓	11.687 ✓
9.554 ✓	11.017 ✓	12.837 ✓
9.780 ✓	10.437 ✓	12.913 ✓
9.674 ✓	10.446 ✓	11.653 ✓
9.636 ✓	9.557 ✓	12.073 ✓
9.971 ✓	11.392 ✓	12.155 ✓
9.923 ✓	11.198 ✓	11.871 ✓
9.457 ✓	9.240 ✓	11.712 ✓
9.852 ✓	10.012 ✓	11.884 ✓
9.971 ✓	9.568 ✓	12.269 ✓
9.975 ✓	10.543 ✓	
9.480 ✓	11.201 ✓	
10.102 ✓	10.996 ✓	
10.090 ✓	10.966 ✓	
11.142 ✓		
9.954 ✓		
9.333 ✓		
10.727 ✓		
10.170 ✓		
9.952 ✓		
9.393 ✓		
9.589 ✓		
10.373 ✓		
10.207 ✓		
10.082 ✓		
10.425 ✓		
11.015 ✓		
10.039 ✓		
10.545 ✓		
10.621 ✓		
11.064 ✓		

OVERALL

$\mu_x = 6$

$\mu_x + \sigma_x = 10.6 \Rightarrow \sigma_x = 4.6$

$V_x = 1.$

$\underline{1-10}$

$\mu_x = 1.0$

$\mu_x + \sigma_x = 2.0 \Rightarrow \underline{\sigma_x = 1.0}$

$\underline{10-10^2}$

$\mu_x = 3.2$

$V_x = 0.31$

$\mu_x + \sigma_x = 4.2 \Rightarrow \sigma_x = 1.0$

$\underline{10^2-10^3}$

$\mu_x = 5.7$

$V_x = .16$

$\mu_x + \sigma_x = 6.6 \Rightarrow \sigma_x = 0.9$

$\underline{10^3-10^4}$

$\mu_x = 8.4$

$V_x = .08$

$\mu_x + \sigma_x = 9.1 \Rightarrow \sigma_x = 0.7$

$\underline{10^4-10^5}$

$V_x = .07$

$\mu_x = 10.1$

$\Rightarrow \sigma_x = 0.7$

$\mu_x + \sigma_x = 10.8$

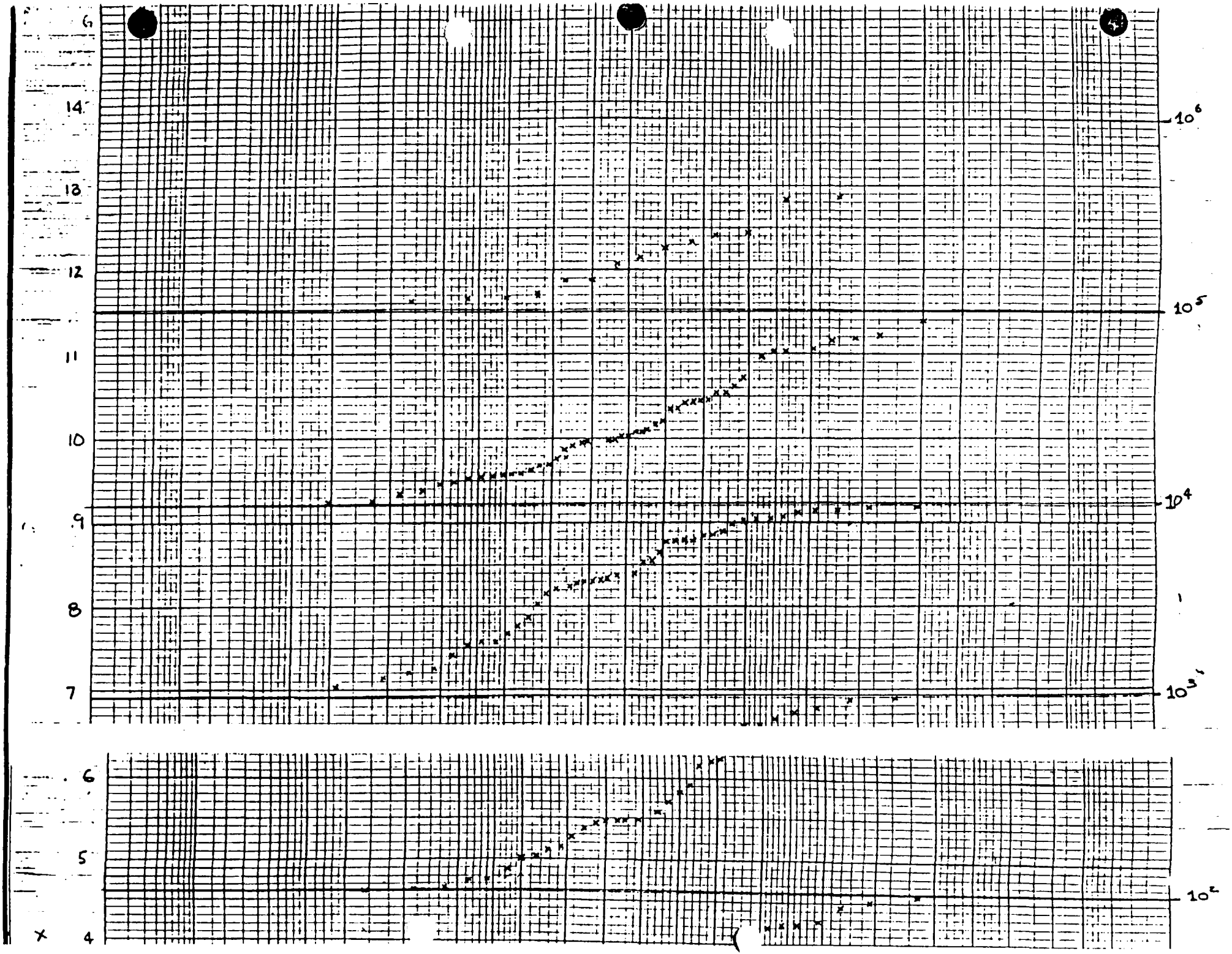
$\underline{10^5-10^6}$

$V_x = .04$

$\mu_x = 12.1$

$\Rightarrow \boxed{\sigma_x = 0.5}$

$\mu_x + \sigma = 12.6$


6
14
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6
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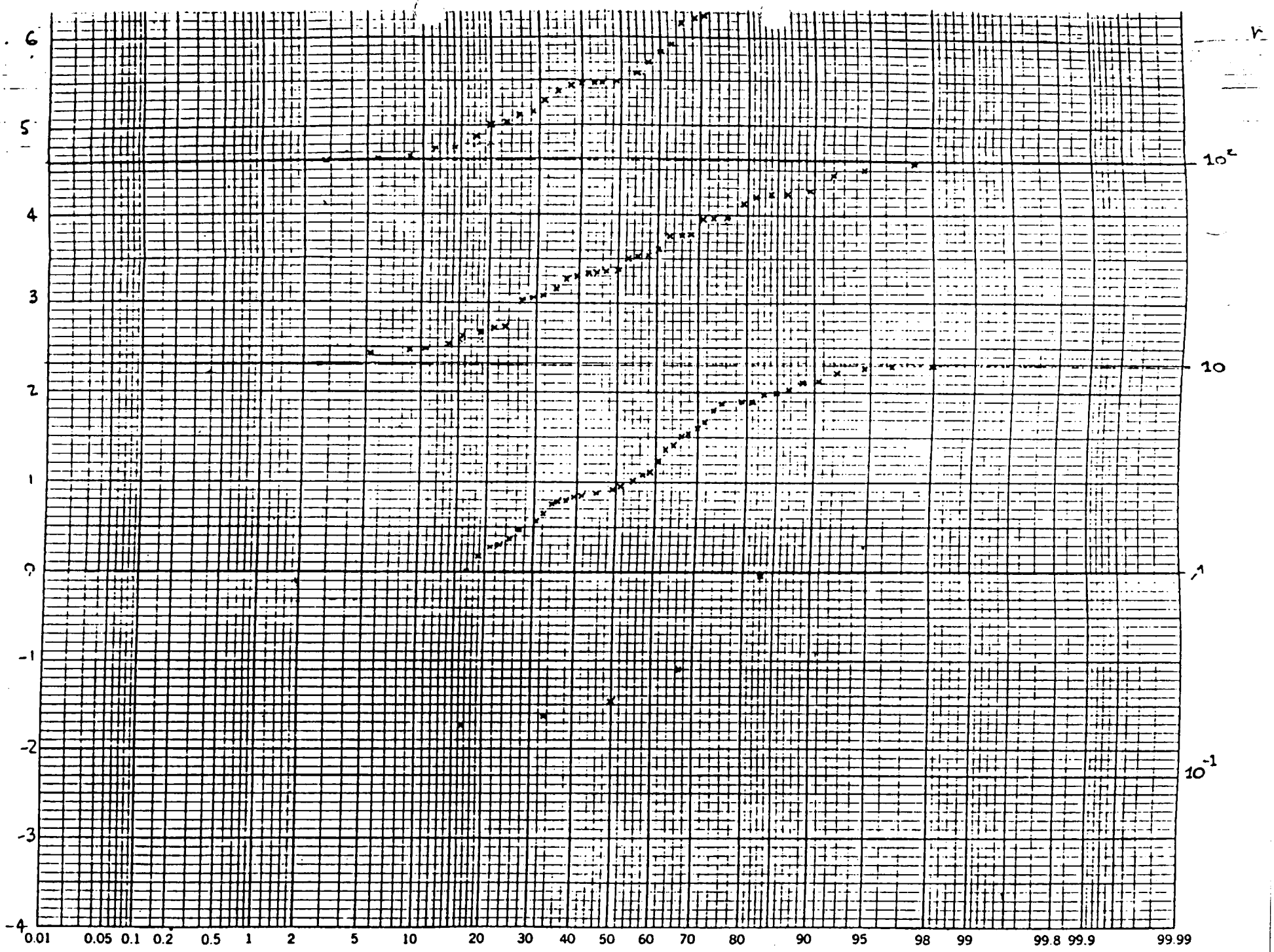
4
10^6
10^5
10^4
10^3
10^2


x
6
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3
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-4
0.01
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2
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10
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50
60
70
80
90
95
98
99
99.8
99.9
99.99
10^2
10
1
10^{-1}

N. DITCH

0-1	129,443
1-2	56,223
2-3	198,728
3-4	49,906
4-5	197,070
	631,370 kg

N DITCH 0-1FT

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	AA	δM
2	9.4	10.5	22137	33960	8556	
3	10.3	12.1	150242	744170	100647	
4	4.3	6.4	668	6026	525	
5	3.4	7.5	133920	TOO LARGE	19715	
				$\sum$	129443	

	N	μ_x	μ_r BEST	μ_r HIGH	μ_r LOW	M BEST	M HIGH	M LOW
2	22	9.4	15450	17930	13300	5968	6926	5138
3	9	10.3	37990	47970	30,100	25452	21532	20166
4	8	4.3	95	120	74	75	94	58
5	9	3.4	38	48	30	56	71	44
					$\sum$	31,550	28620	25400

N. DITCH

1-2

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	δM
2	9.0	10.1	14839	22764	5735	
3	10.1	11.6	74982	218450	50230	
4	3.8	9.6	901×10^6 !!		!!	
			45	-	35	
5	4.2	6.7	1518	34511	223	
					56223	

	N	μ_x	μ_r Best	μ_r High	μ_r Low	M Best	M High	M Low
2	17	9.0	10350	12268	8736	4000	4740	3370
3	10	10.1	31,100	38800	24925	20,840	26000	16700
4	6	3.8	57	76	43	45	60	34
5	4	4.2	85	121	60	125	180	90
					$\sum$	25000	30,880	20,200

N. DITCH

2-3

SEG	μ_x	$\mu_x + \sigma_x$	σ_x	μ_r	σ_r	M	δM
2	8.8	10.8	(2)	49021	358885	18947	
3	8.0	11.0	(3)	268337	24×10^8	179759	
4	2.1	2.3	(.2)	8	2	6	
5	3.1	4.9	(1.8)	112	555	16	
						198728	

	N	μ_x	μ_r Best	μ_r High	μ_r Low	M BEST	M HIGH	M LOW
2	29	8.8	8476	9912	7248	3274	3830	
3	10	8.0	3800	4752	3052			
4	6	2.1	10	14	8			
5	5	3.1	28	39	3			

N. DITCH

3-4

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	δM
2	6.6	9.6	66171	$.6 \times 10^2$	25575	
3	8.5	10.5	36315	265868	24327	
4	.9	1.3	3	1	2	
5	2.5	3.2	16	12	2	
					49906	

N. DITCH

4-5

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	δM
2	8.1	8.9	4537	4297	1754	
3	6.8	10.2	290686	$.94 \times 10^8$	194731	
4	.7	2.0	5	10	4	
5	1.8	5.4	3944	$.26 \times 10^8$	581	
					Σ 197070	

N. DITCH

5-6

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	δM
2	7.1	10.7	790 167	5.2×10^8 1212	305 400 468(Σ)	
3	3.8	8.1	462777	48×1	3100143	
4	.3	.8	1	.8	1	
5	2.0	4.1	67	604	10	

Σ 3,100,622

N. DITCH

SEG/SEG	A (ft^2)	A (m^2)		F
1,6	18750	1742		
2,7	10500	975	-	0.386
3,8	18200	1691	-	0.669
4,9	21350	1983	-	0.786
5,10	40,000	3716	-	1.472

$$M_{PCB}(Kg) = \mu_r \left(\frac{\mu g}{g}\right) \underbrace{A(m^2)\,(0.0003962)}_{F}$$

Cum Freq. dist

Seg - 2

0-1	1-2	2-3	3-4	4-5	5-6
2.549 - 4.6484	2.425 - 5.6	3.091 - 4.8	1.881 - 5.0	0.365 - 5.3	0. - 5
6.755 - 9.090	3.353 - 11.1	3.325 - 9.5	2.264 - 10.0	0.788 - 10.5	0.278 - 1.
7.030 - 13.636	4.615 ~~4.754~~ - 16.3	3.789 - 14.3	2.460 - 15.0	0.916 - 15.8	0.854 - 1.
7.576 - 18.181	4.754 ~~4.762~~ - 22.2	4.236 - 19.0	3.054 - 20.0	2.468 - 21.1	0.871 - 2.
7.724 - 22.727	4.762 ~~4.675~~ - 27.8	4.615 - 23.8	3.453 - 25.0	2.667 - 26.3	1.241 - 2.
8.299 - 27.272	6.891 - 33.3	5.081 - 28.6	5.112 - 30.0	3.535 - 31.6	2.303 - 3.
9.024 - 31.818	8.855 - 38.9	5.275 - 33.3	5.835 - 35.0	4.575 - 36.8	6.646 - 4.
9.125 - 36.363	8.901 - 44.4	5.479 - 38.1	5.965 - 40.0	5.242 - 42.1	6.282 - 4
9.163 - 40.909	9.130 - 50.	8.675 - 42.9	6.482 - 45.0	7.208 - 47.4	7.570 - 5.
9.512 - 45.454	9.250 - 55.6	8.913 - 47.6	7.244 - 50.0	8.216 - 52.6	8.650 - 5
9.680 - 50.	9.561 - 61.1	9.072 - 52.4	7.415 - 55.0	8.284 - 57.9	9.554 - 6
9.780 - 54.545	9.674 - 66.7	9.177 - 57.1	7.539 - 60.0	8.385 - 63.2	9.636 - 7
9.971 - 59.090	9.923 - 72.2	9.457 - 61.9	[illegible] - 65.0	8.396 - 68.4	9.852 - 7
9.971 - 63.636	9.925 - 77.8	9.480 - 66.7	9.050 - 70.0	8.529 - 73.7	10.002 - 7
10.090 - 68.181	11.142 - 83.3	9.954 - 71.4	[illegible] - 75.0	8.745 - 78.9	10.727 - 8
10.170 - 72.727	12.337 - 88.9	9.952 - 76.2	9.393 ~~7.551~~ - 80.0 85.0	9.589 - 84.2	12.825 - 9
10.273 - 77.272	12.421 - 94.4	10.201 - 81.0	~~[illegible] - 86.0~~	10.072 - 89.5	
10.425 - 81.818		11.015 - 85.7	10.039 - 90.0	10.595 - 94.7	
10.621 - 86.363		11.617 - 90.5	11.064 - 95.0		
11.677 - 90.909		11.721 - 95.2			
12.413 - 95.454					

6 - 7

1) 10.086 - 33.3

2) 10.692 - 67.7

Cum freq. distrib.

Sec. 3

0-1	1-2	2-3	3-4	4-5	5-6
8.163 – 10.0	2.708 – 9.1	5.147 –	3.996 – 8.3	2.451 –	-1.109 –
9.071 – 20.0	5.583 – 18.2	5.455 –	5.037 – 16.7	4.205 –	1.099 –
9.193 – 30.0	6.620 – 27.3	5.455 –	5.198 – 25.0	4.284 –	1.556 –
9.971 – 40.0	8.306 – 36.4	6.702 –	5.435 – 33.3	4.868 –	2.624 –
10.460 – 50.0	10.364 – 45.5	8.376 –	8.242 – 41.7	7.147 –	3.339 –
11.017 – 60.0	10.437 – 54.5	8.868 –	8.537 – 50.0	8.294 –	3.775 –
11.653 – 70.0	10.446 – 63.6	9.557 –	9.011 – 58.3	8.328 –	5.553 –
12.073 – 80.0	11.292 – 72.7	11.192 –	9.240 – 66.7	8.543 –	6.184 –
12.155 – 90.0	11.871 – 81.8	11.712 –	10.072 – 75.0	1.562 –	7.678 –
	11.884 – 90.9	12.269 –	10.543 – 83.3	11.201 –	10.946 –
			10.946 – 91.7		

6-7

1) .916 – 5.5

Sec. 4

0-1	1-2	2-3	3-4	4-5	5-6
1.671 – 1.2 11.1	1.361 – 1.6 16.7	0. –	0. – 1.4 12.5	0. – 1.8 16.7	0. –
3.298 – 2.4 22.2	1.528 – 3.1 33.4	1.851 –	0. – 2.8 25.	0. – 2.7 33.3	0. –
3.509 – 3.7 33.3	2.294 – 4.7 44.5	1.991 –	0.765 – 4.1 37.5	1.608 – 5.5 50.	0.300 –
3.947 – 4.9 44.4	4.248 – 6.3 55.6	2.102 –	0.959 – 5.5 50.0	1.808 – 7.3 66.7	0.588 –
4.127 – 6.1 55.5	7.576 – 7.9 77.8	2.213 –	1.008 – 6.9 62.5	1.109 – 8.2 83.3	0.871 –
5.443 – 7.3 66.	8.700 – 9.4 85.7	3.367 –	1.887 – 8.3 75		
5.704 – 8.6 77.			4.807 – 9.6 87.5		
6.561 – 9.8 88					

6-7

1) .756 – 5.5

Sec. 5

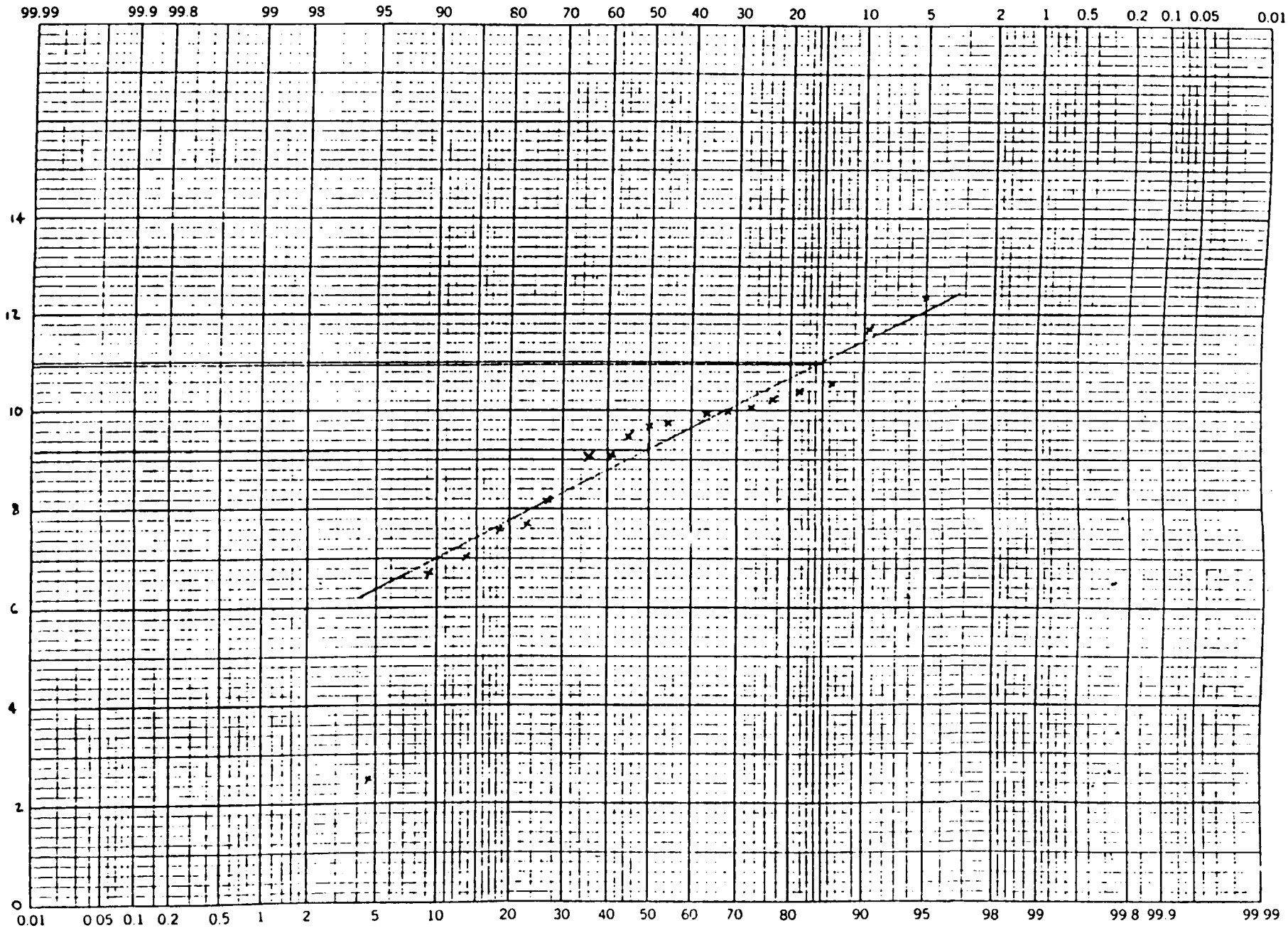
0-1	1-2	2-3	3-4	4-5	5-6
-3.147 – 1.1 10	2.128 – 2.2 20	1.564 – 1.8	2.641 – 2.2 20	0. – 1.8	5.833 –
0.182 – 2.2 20	3.989 – 4.4 40	1.988 – 3.7	2.292 – 4.4 40	0.588 – 3.7	1.609 – 5
0.470 – 3.3 30	4.278 – 6.6 60	3.200 – 5.5	2.815 – 6.6 60	1.411 – 5.5	3.538 – 6
1.872 – 4.4 40	6.734 – 8.8 80	3.770 – 7.3	3.068 – 7.8 70	3.161 – 7.3	
4.605 – 5.5 50		4.5 – 9.2		5.429 – 9.2	5-6
5.373 – 6.6 60					
6.260 – 7.7 70					0.787 –
6.430 – 8.8 80					0.916 –
7.860 – 9.9 90					6-7

0-1 1-2 2-3 3-4 4-5

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO.

46 8000

SEG. 2 0-1 F1



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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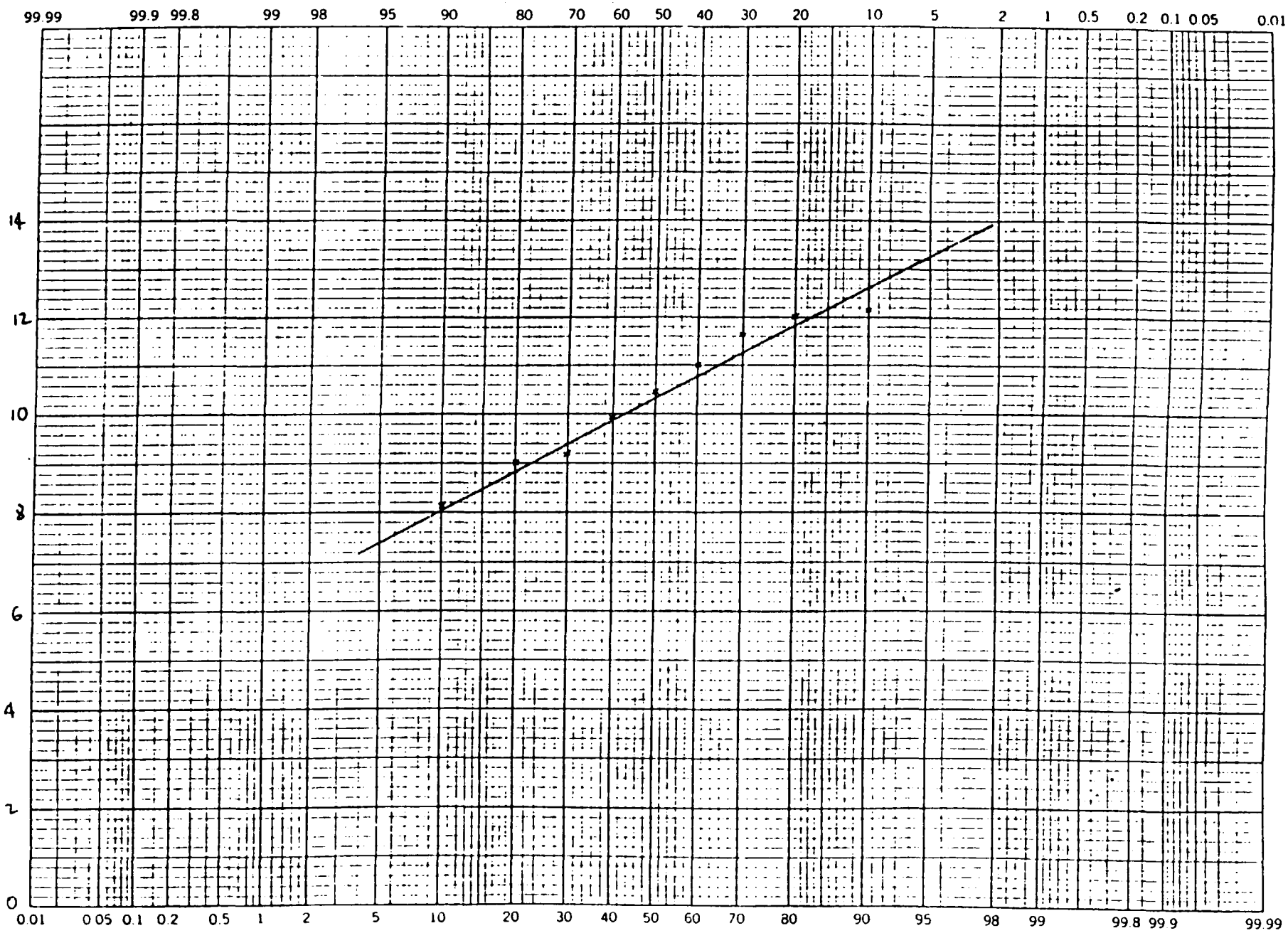
SEG 3
0-1 FT



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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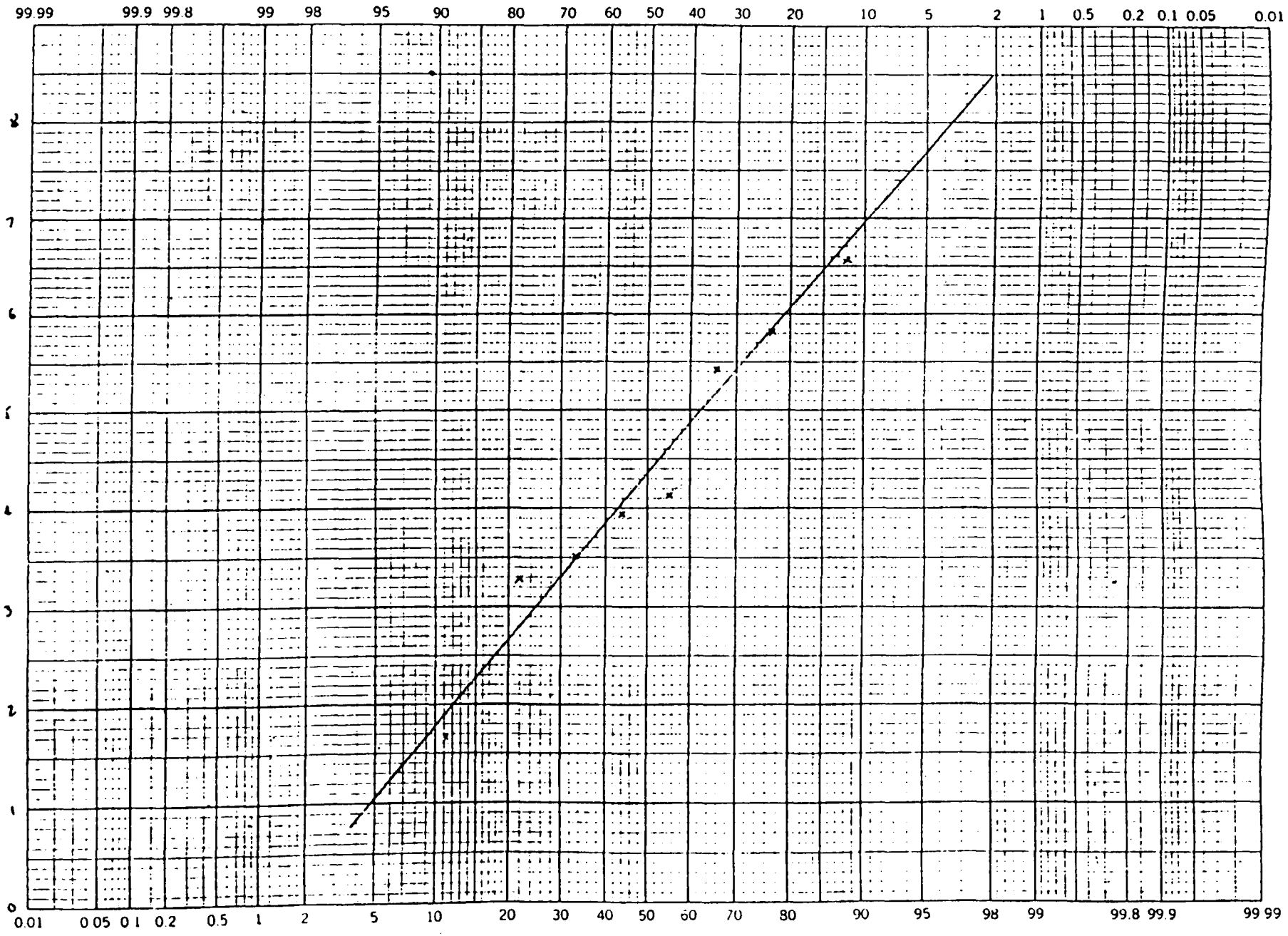
SEG 4

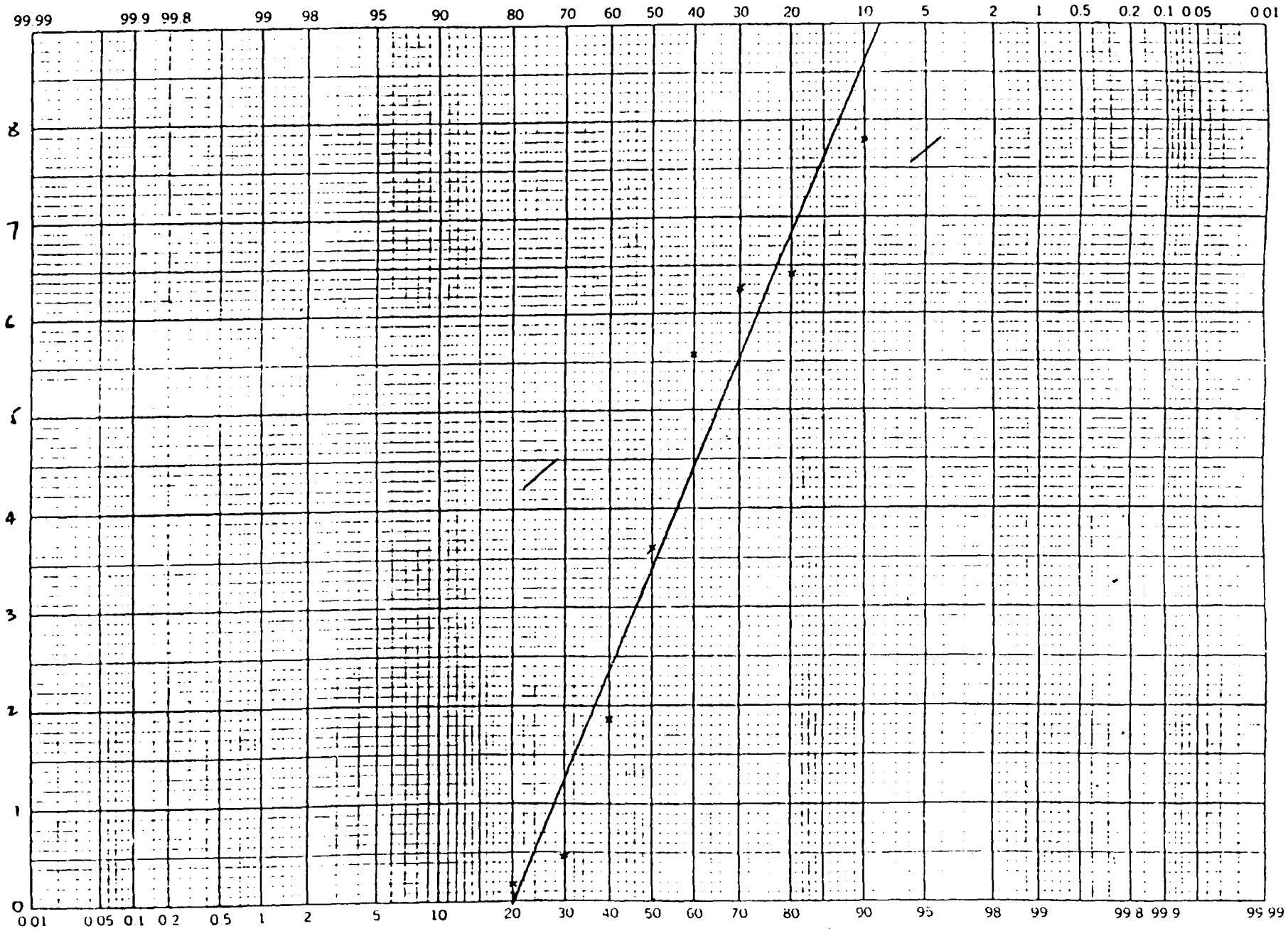
0-1 FT



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEG 5
0-1FT

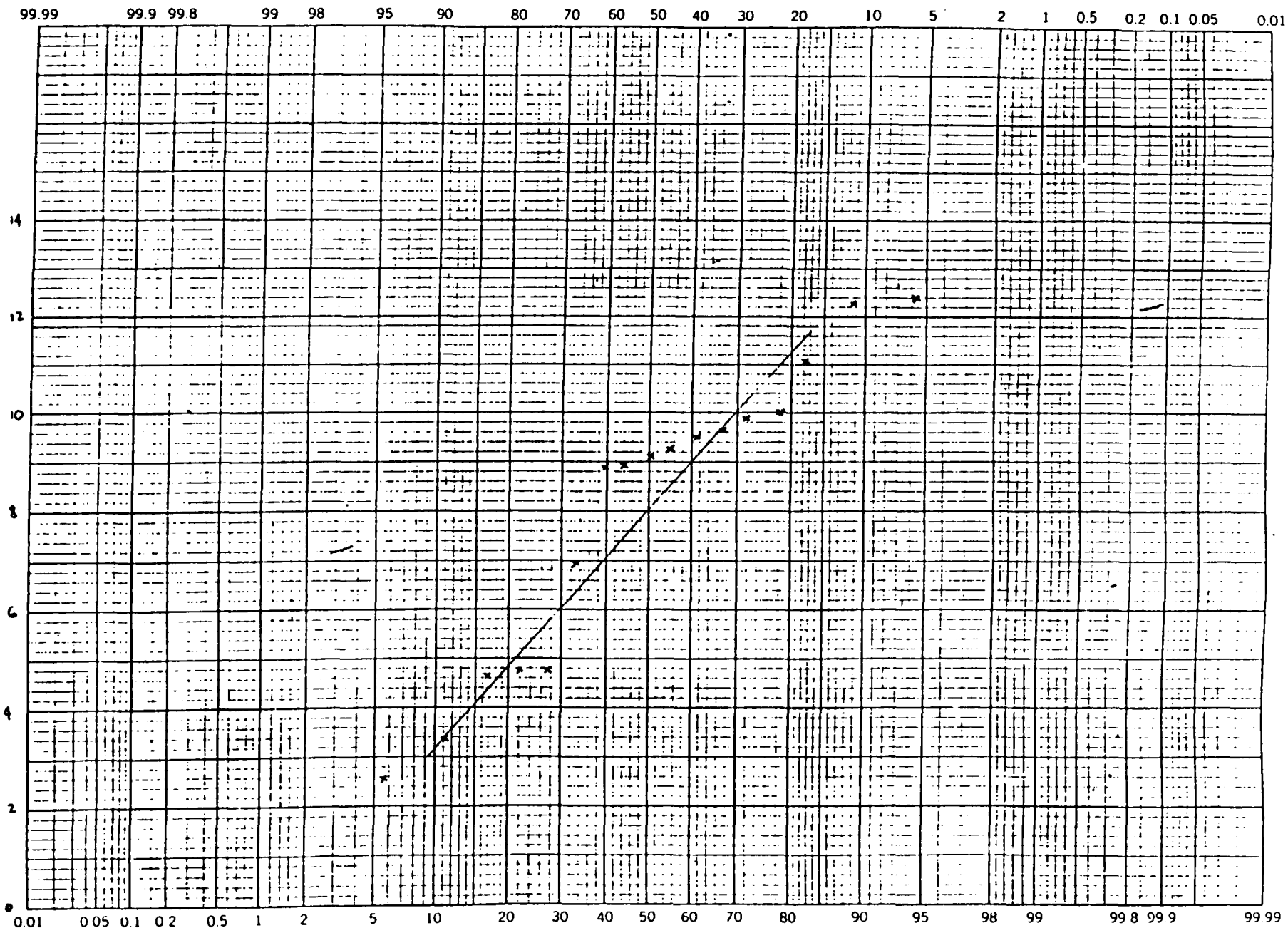


K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SER 2

1-2 H



K•E PROBABILITY X 90 DIVISIONS
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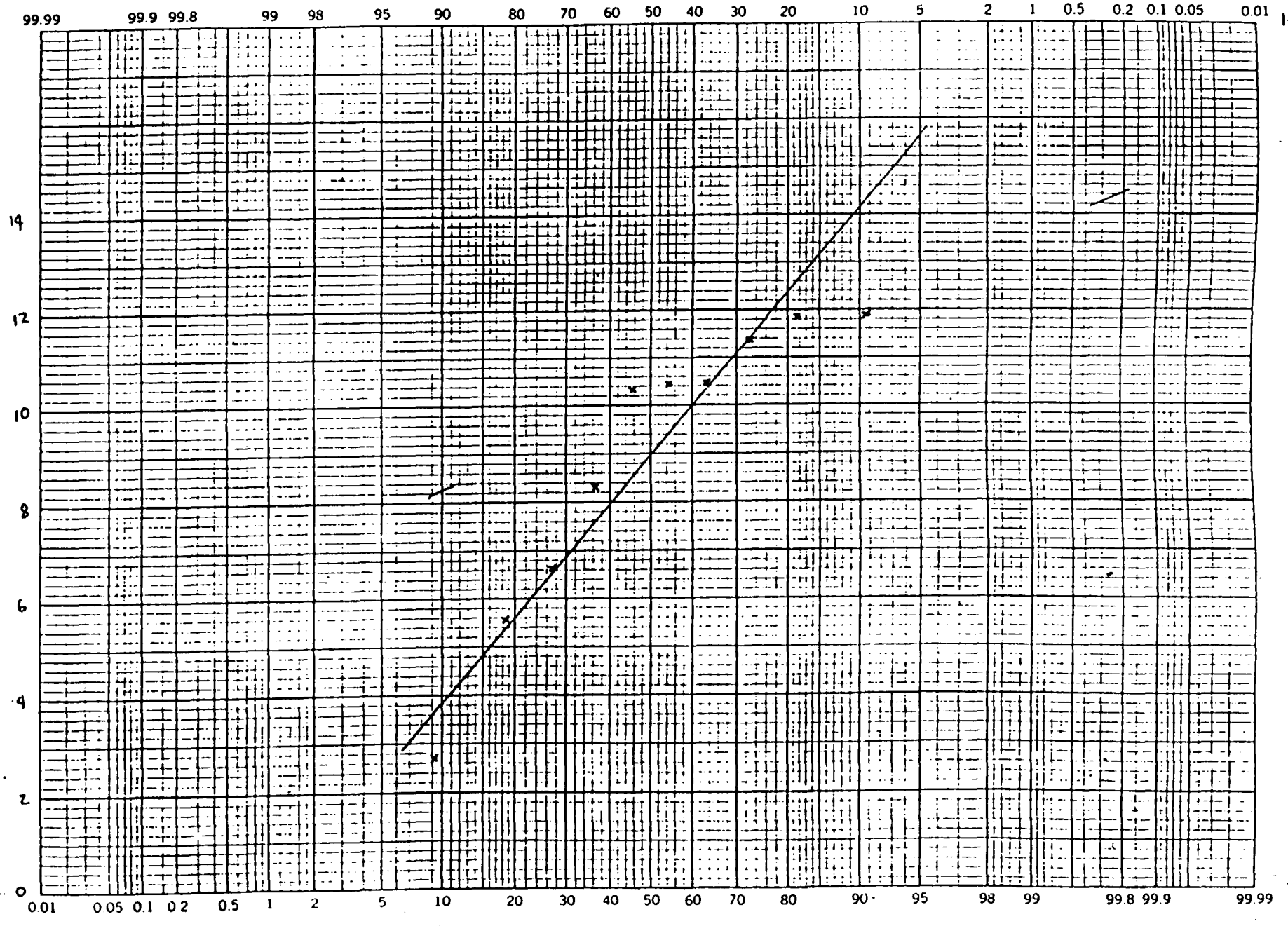
SEG 3
1-2 FT



K·E PROBABILITY X 90 DIVISIONS
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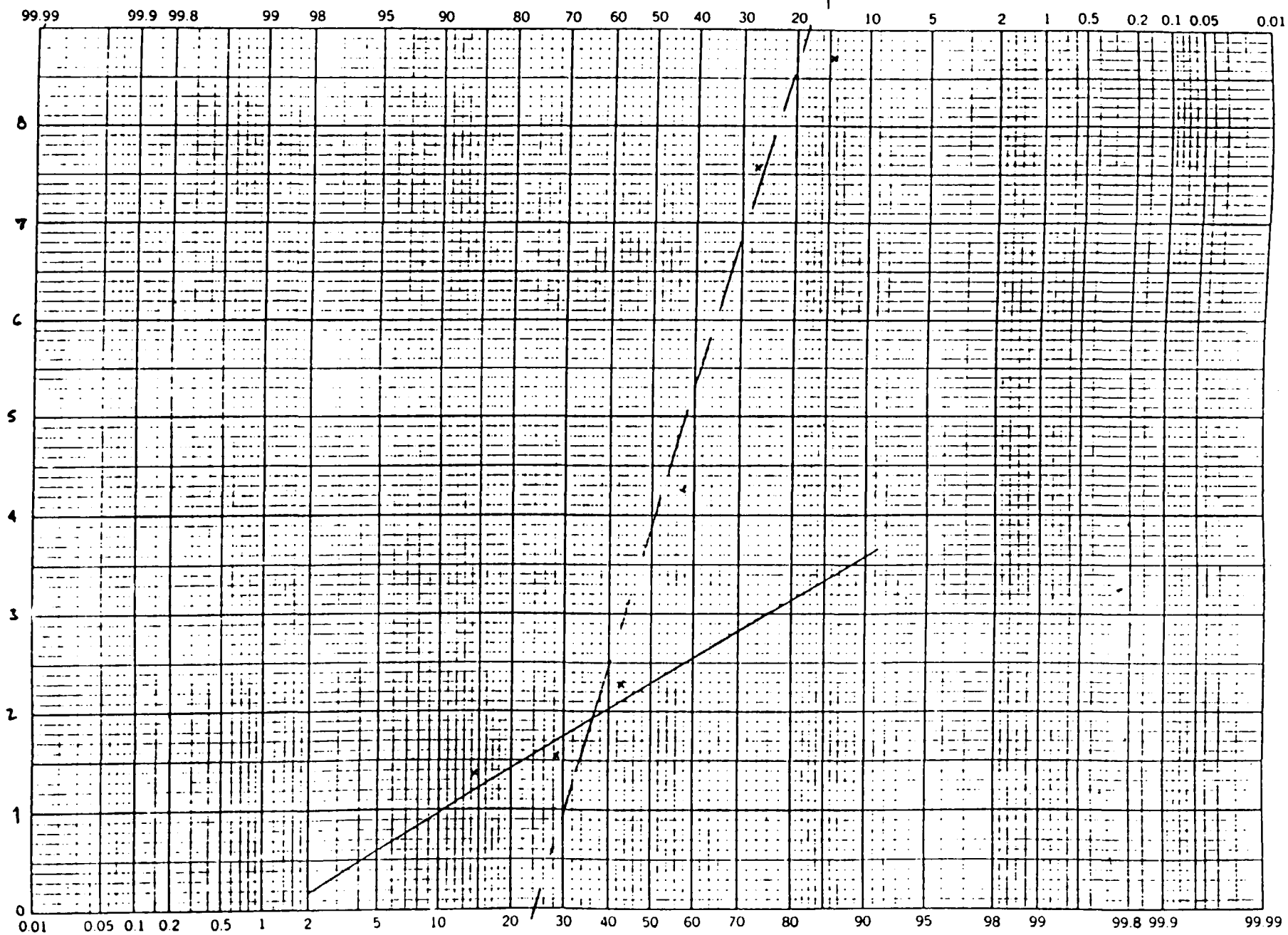
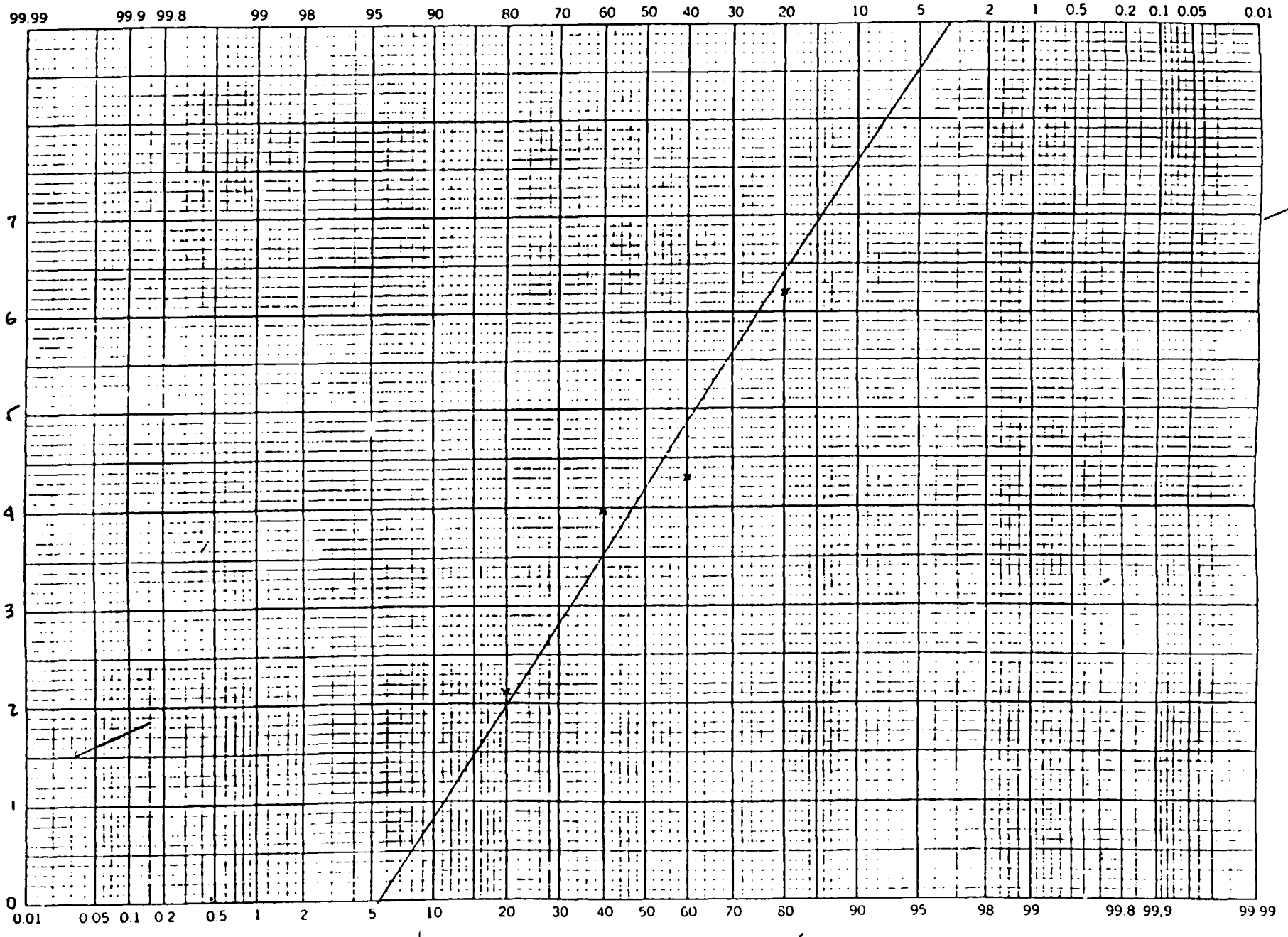
SEG 4
1-2



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEC 5
1-2



K+E PROBABILITY X 90 DIVISIONS
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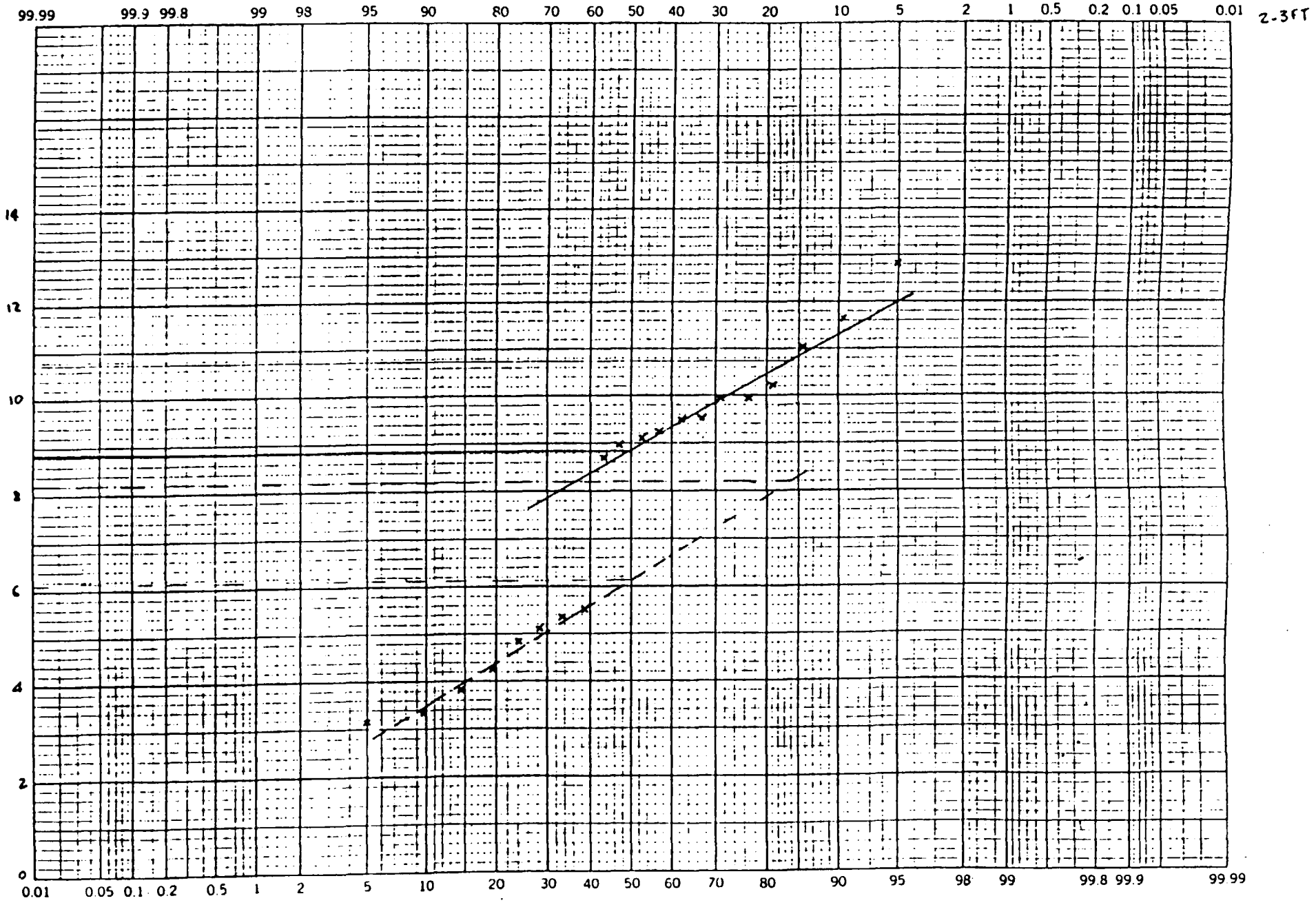
SEG 2



K•E PROBABILITY X 90 DIVISIONS
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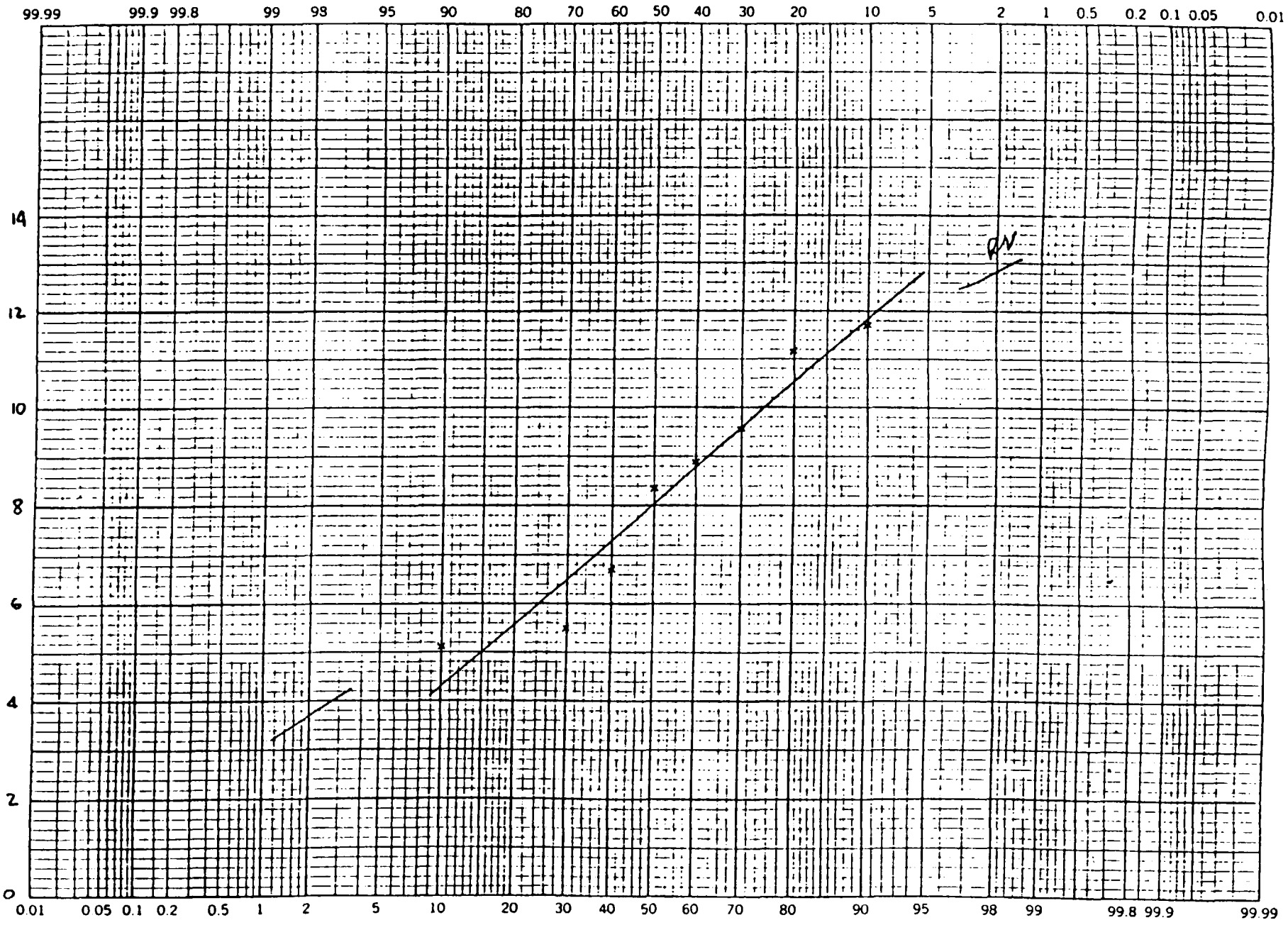
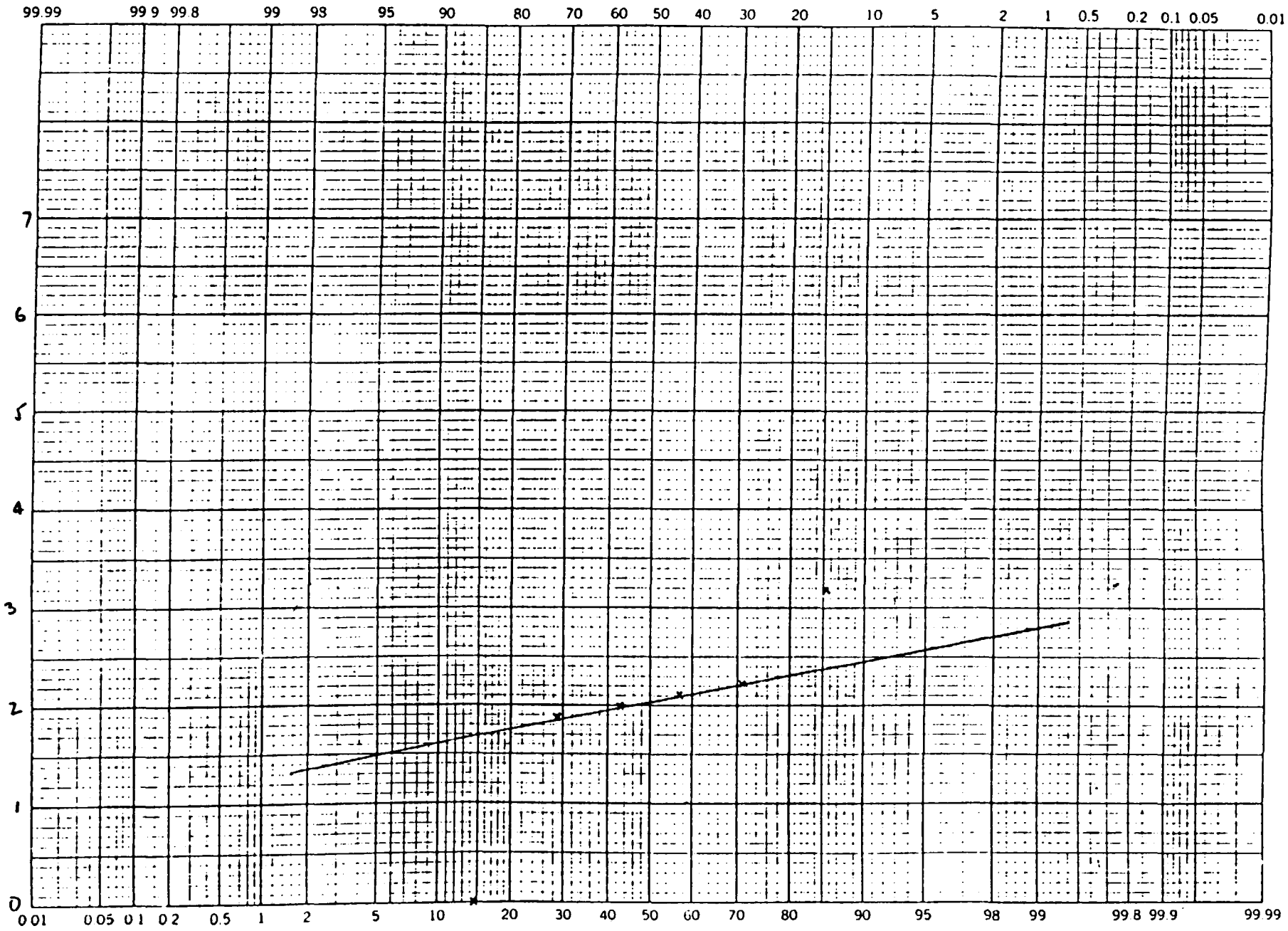
SEG 3
2-3



K-E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

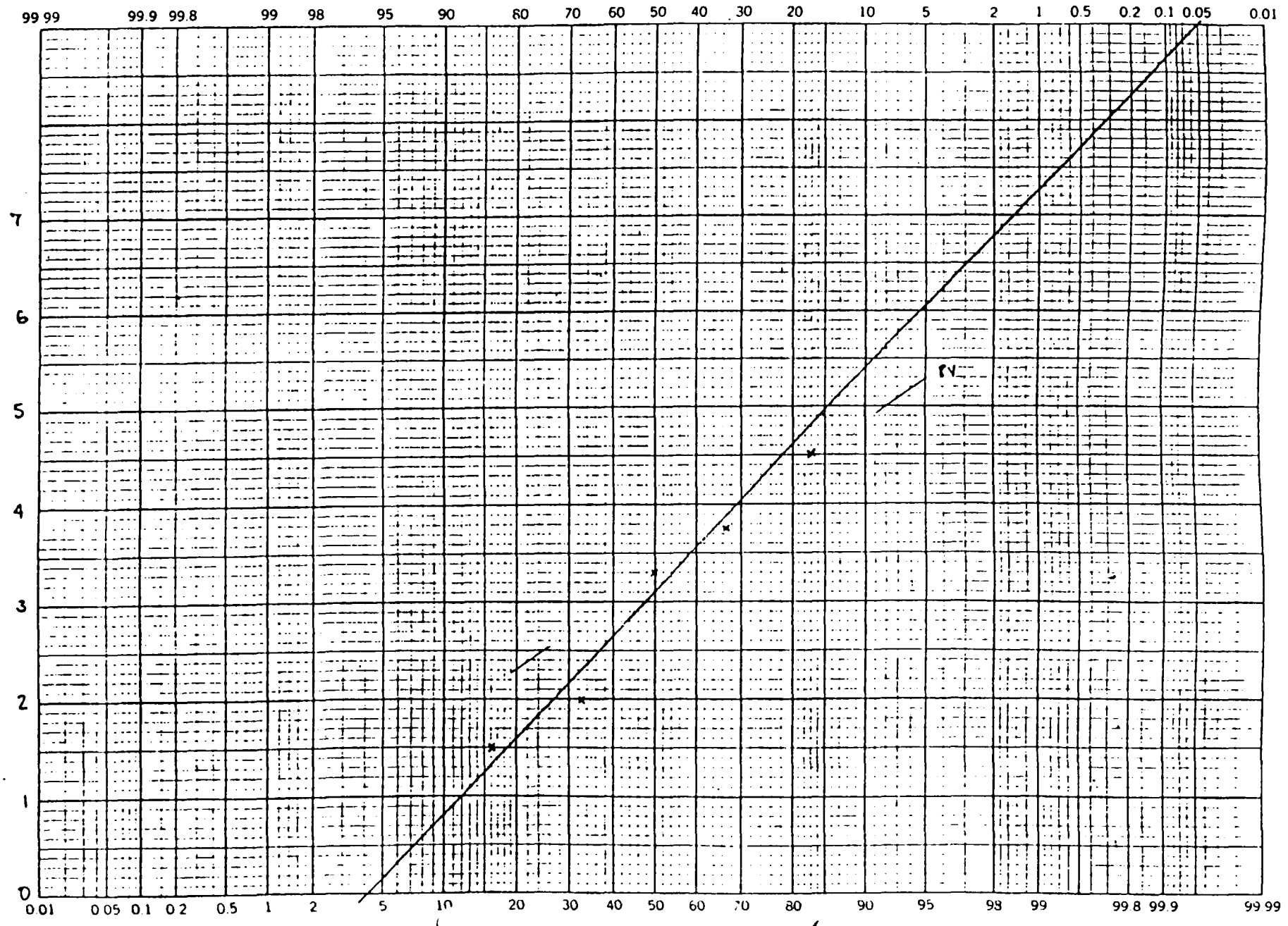
SEQ 1
2-3



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO.

46 8000

SEC 5
2-3

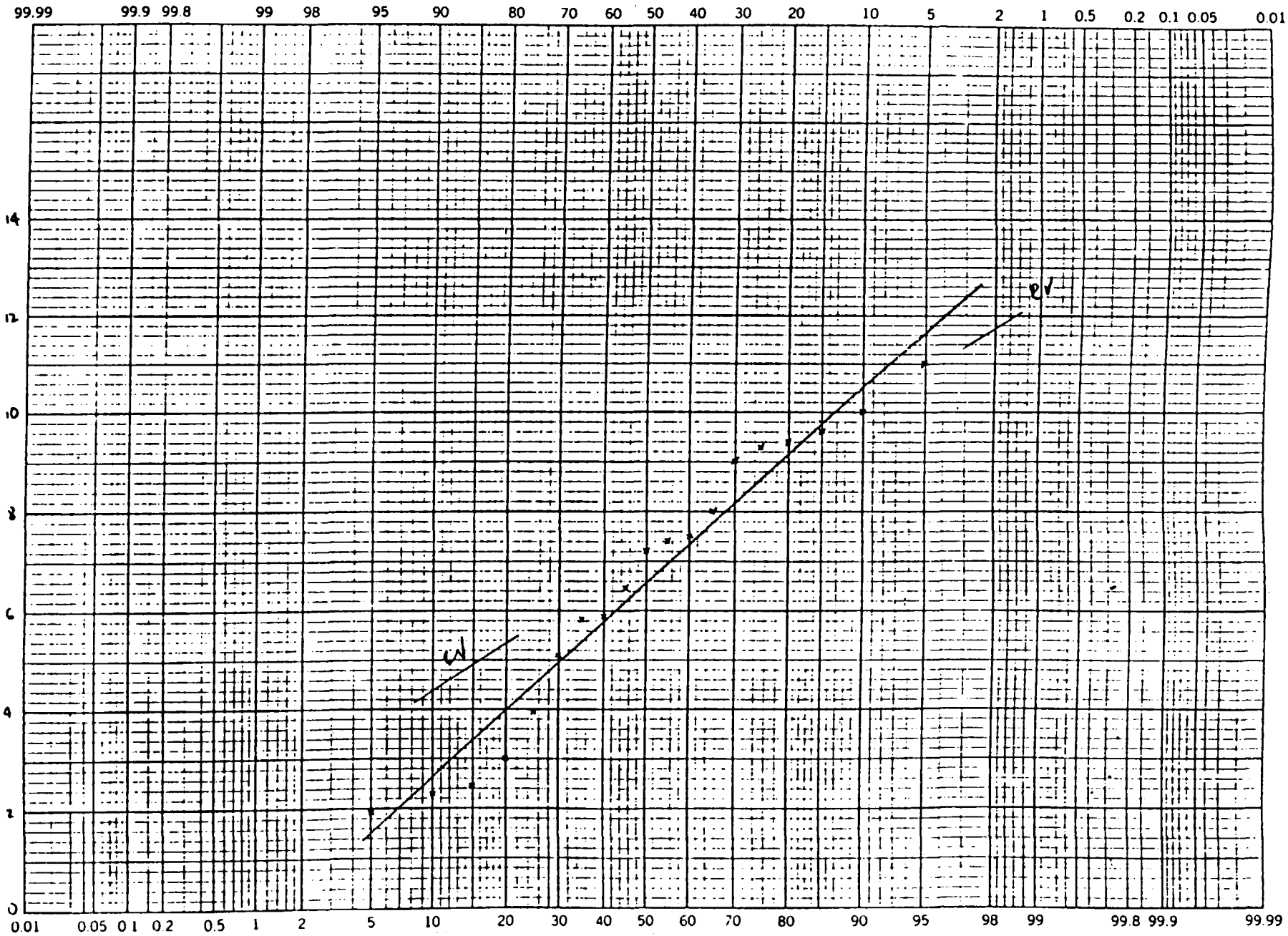


K-E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEG 2

3-4FT



K•E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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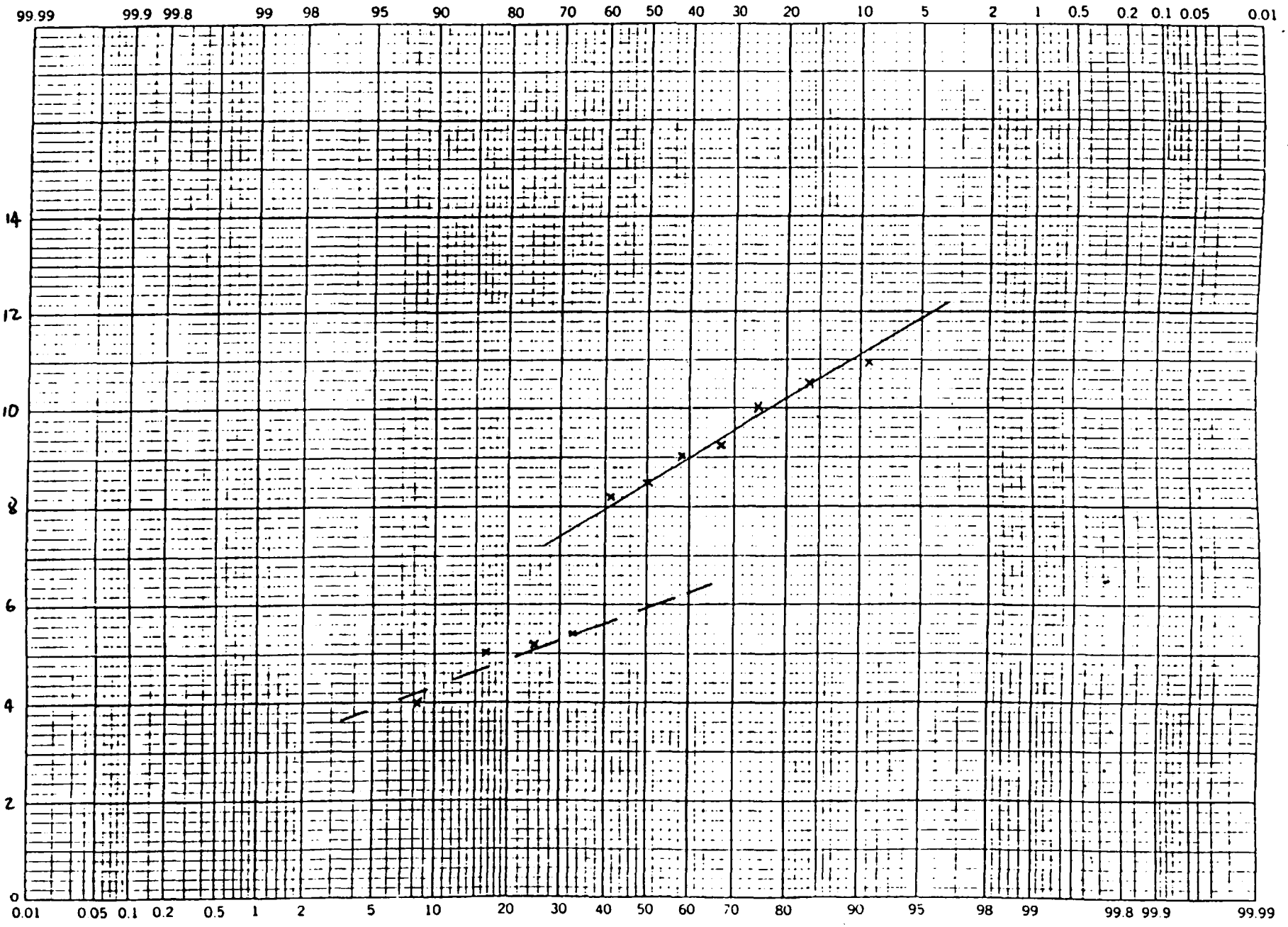
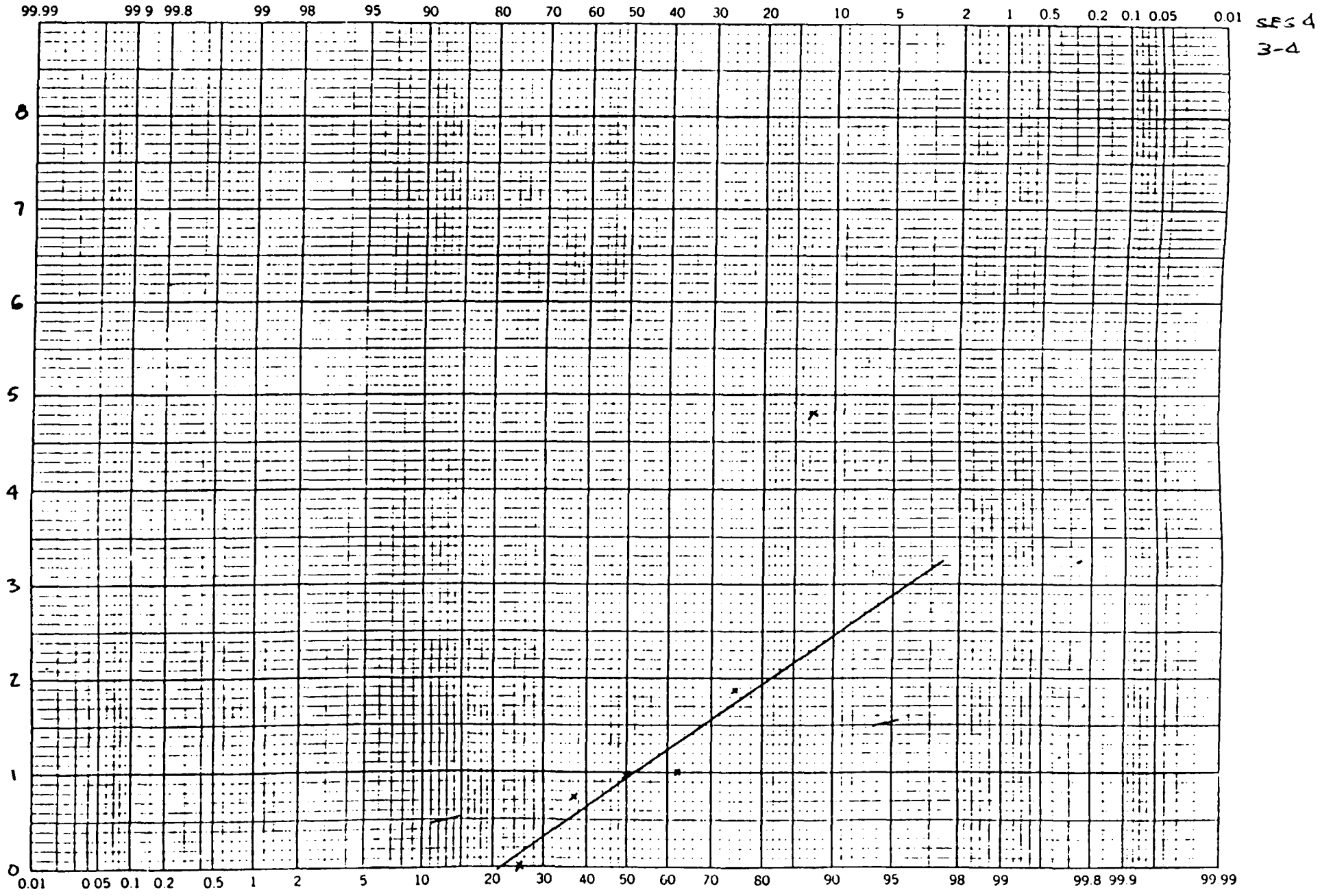
SEG 3
3-4FT



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

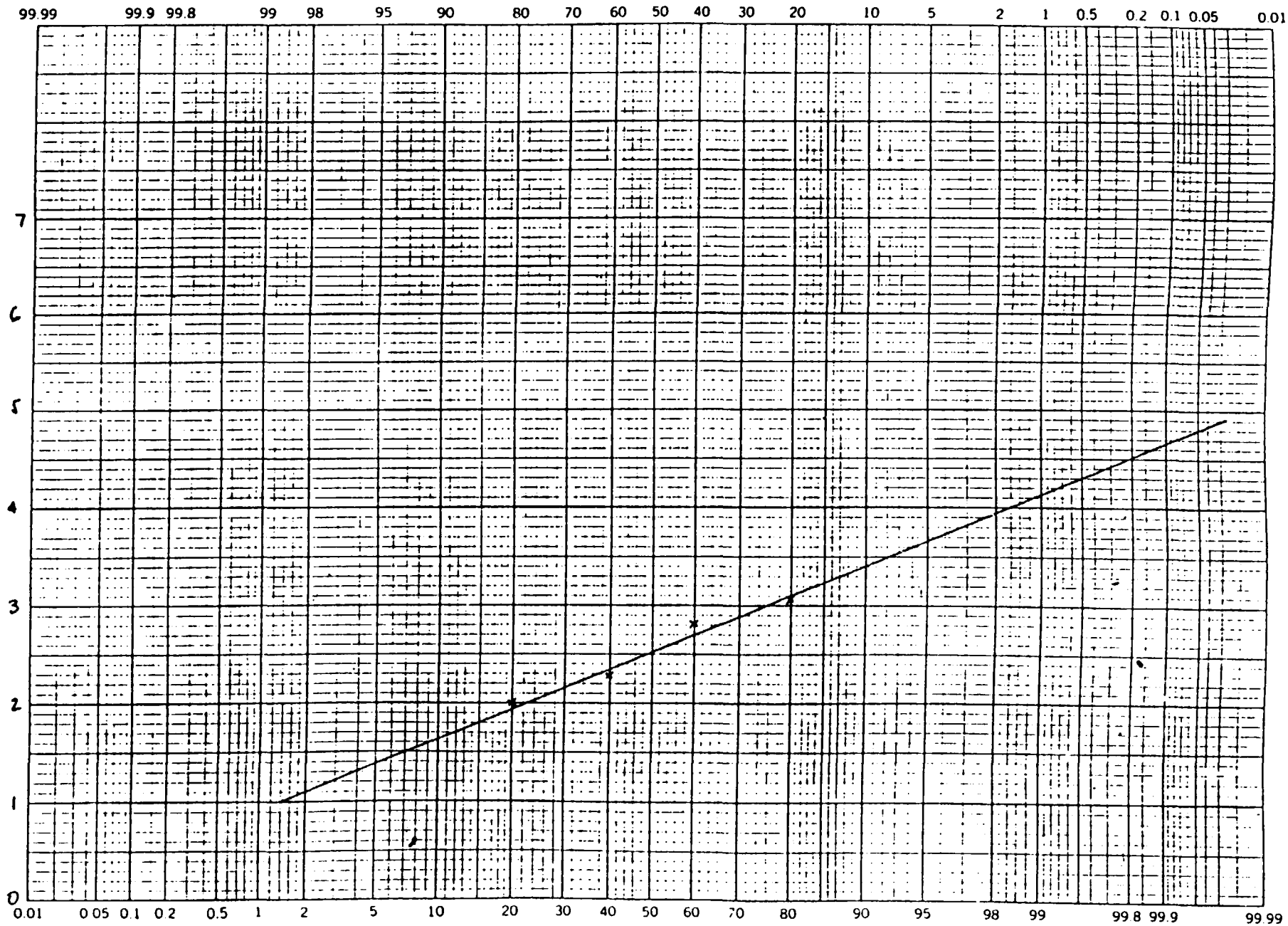


SES 4
3-4

K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SES
3-4

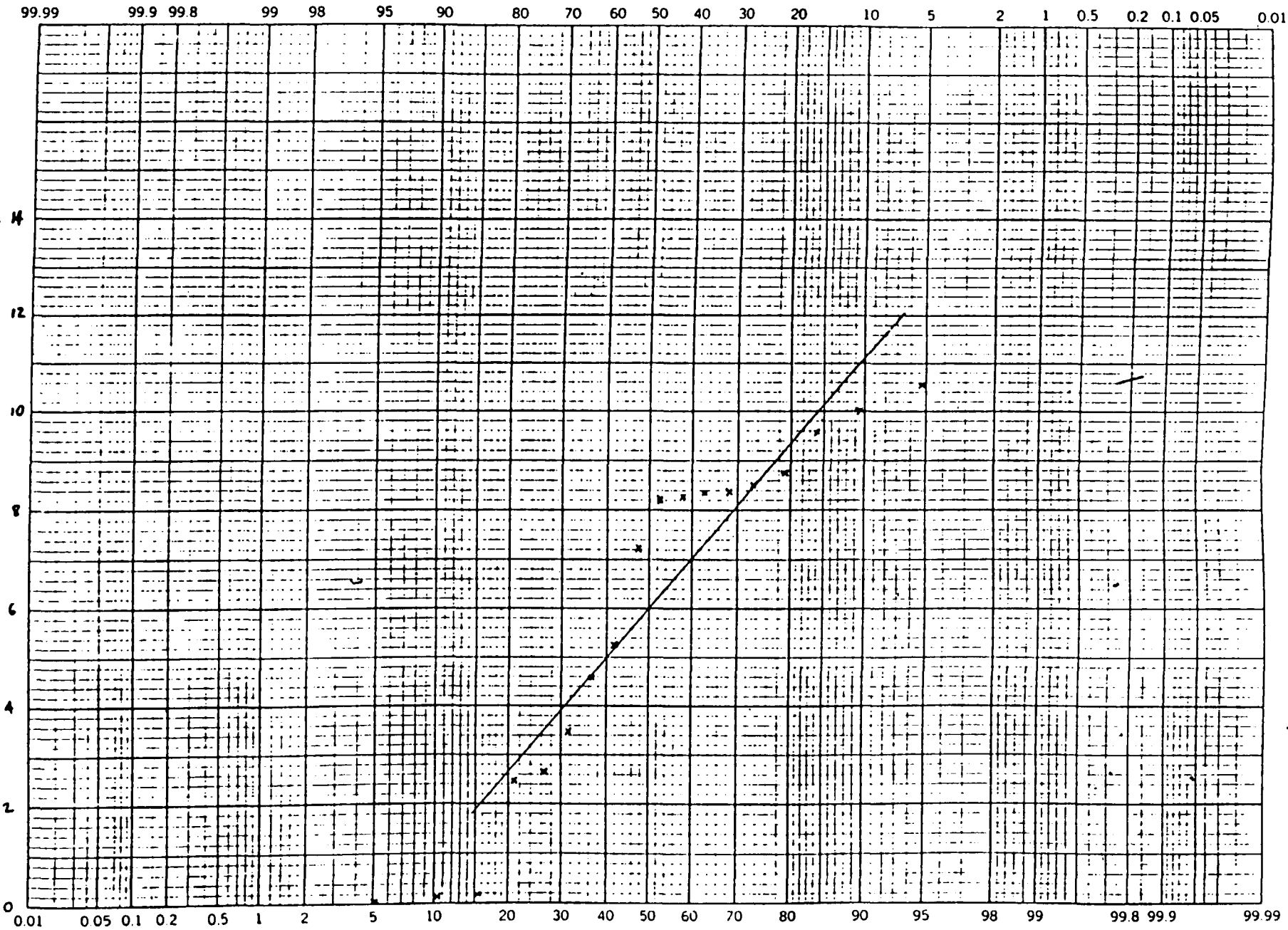


K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

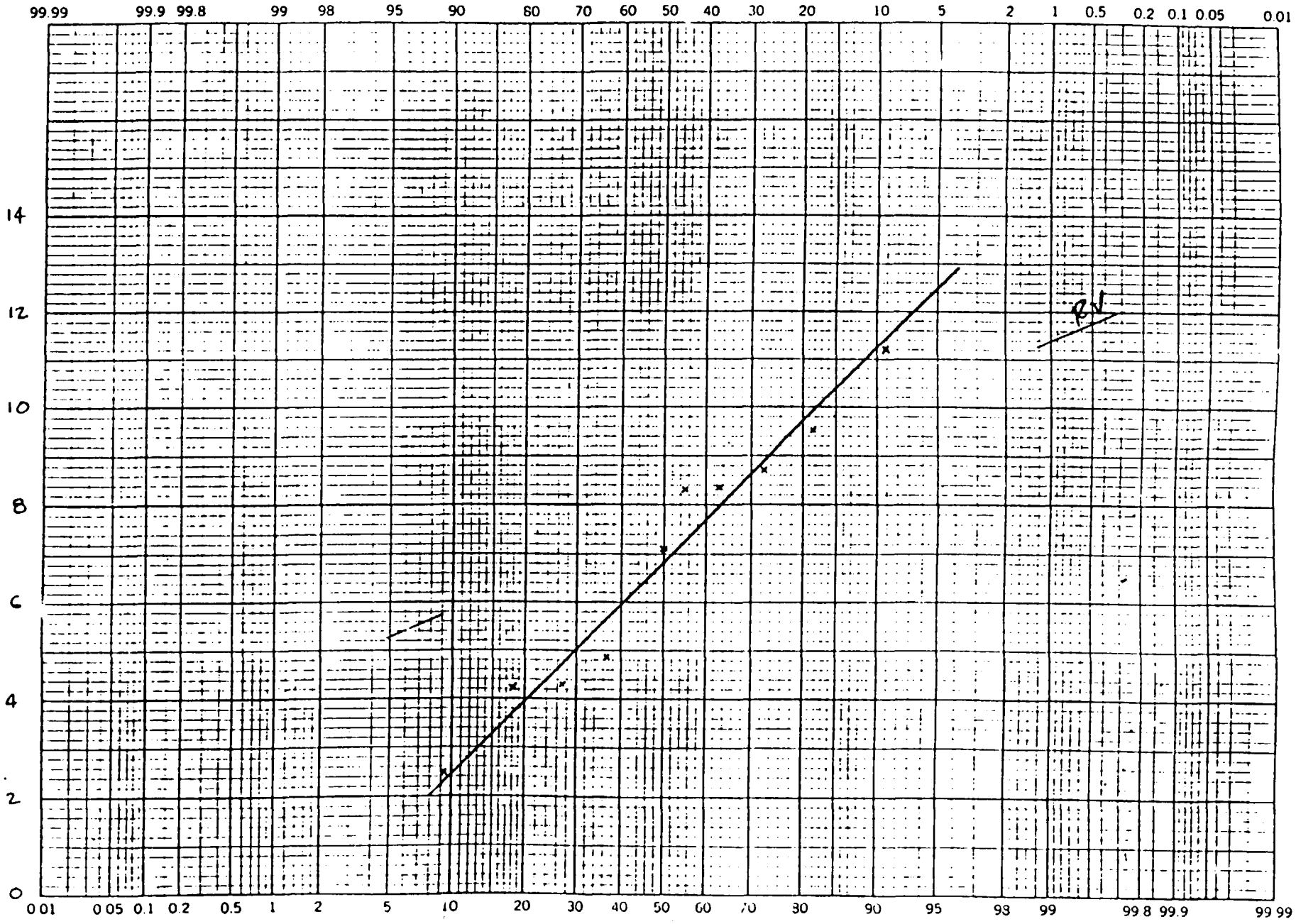
SEQ2

4-SFT



K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

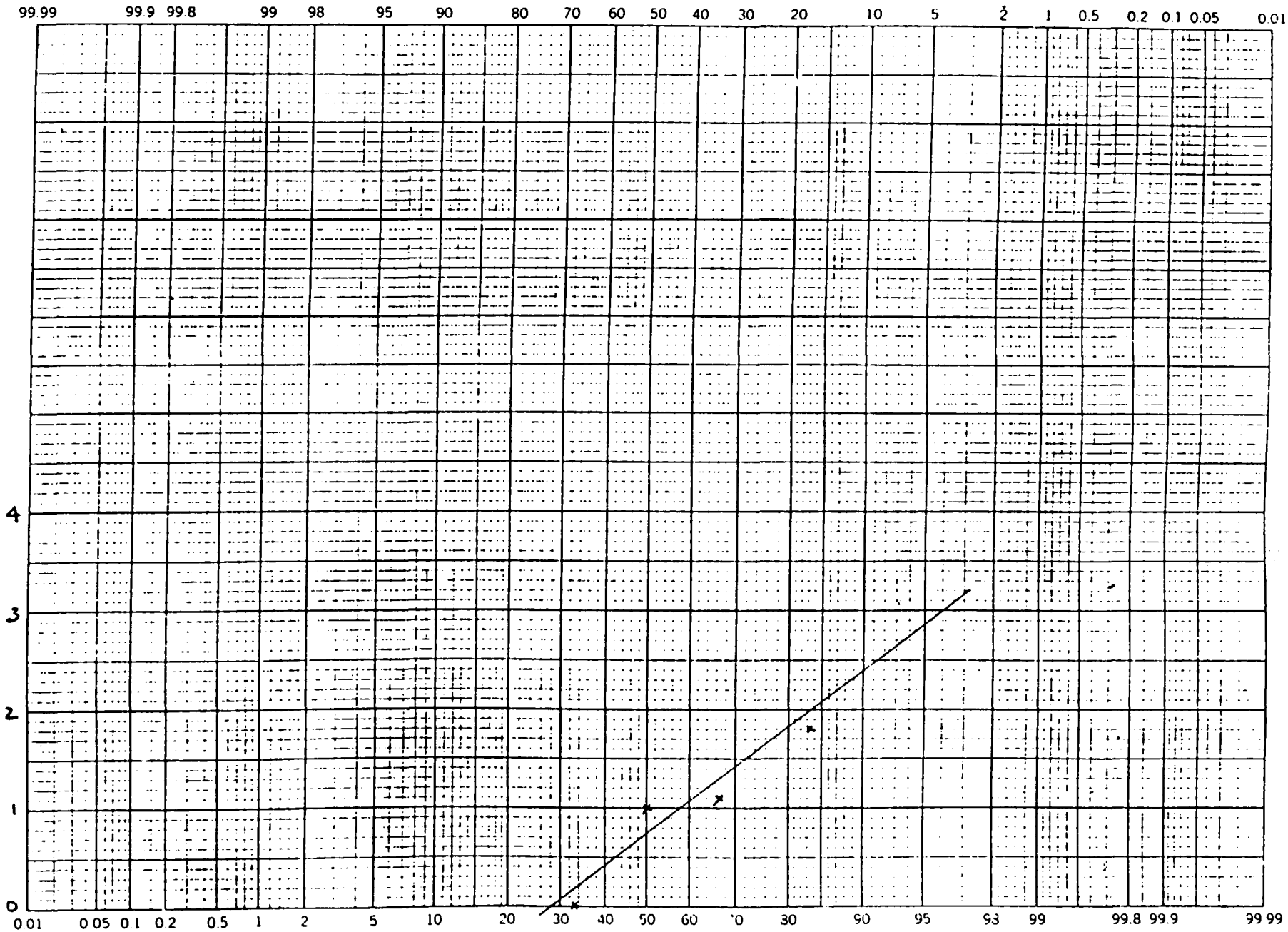


SEG 3
4-5 FT

K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

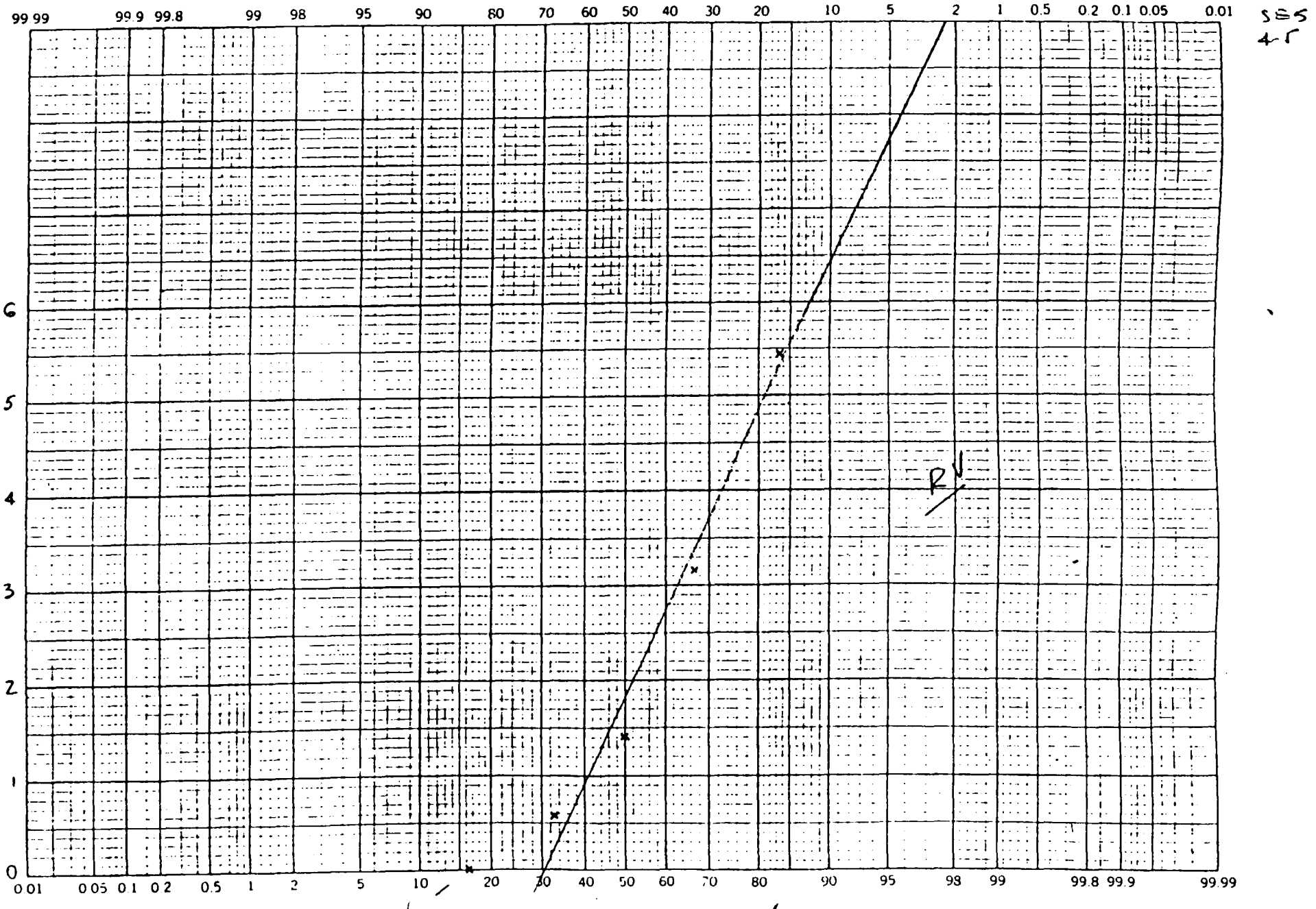
46 8000

SFG 4
4-5



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

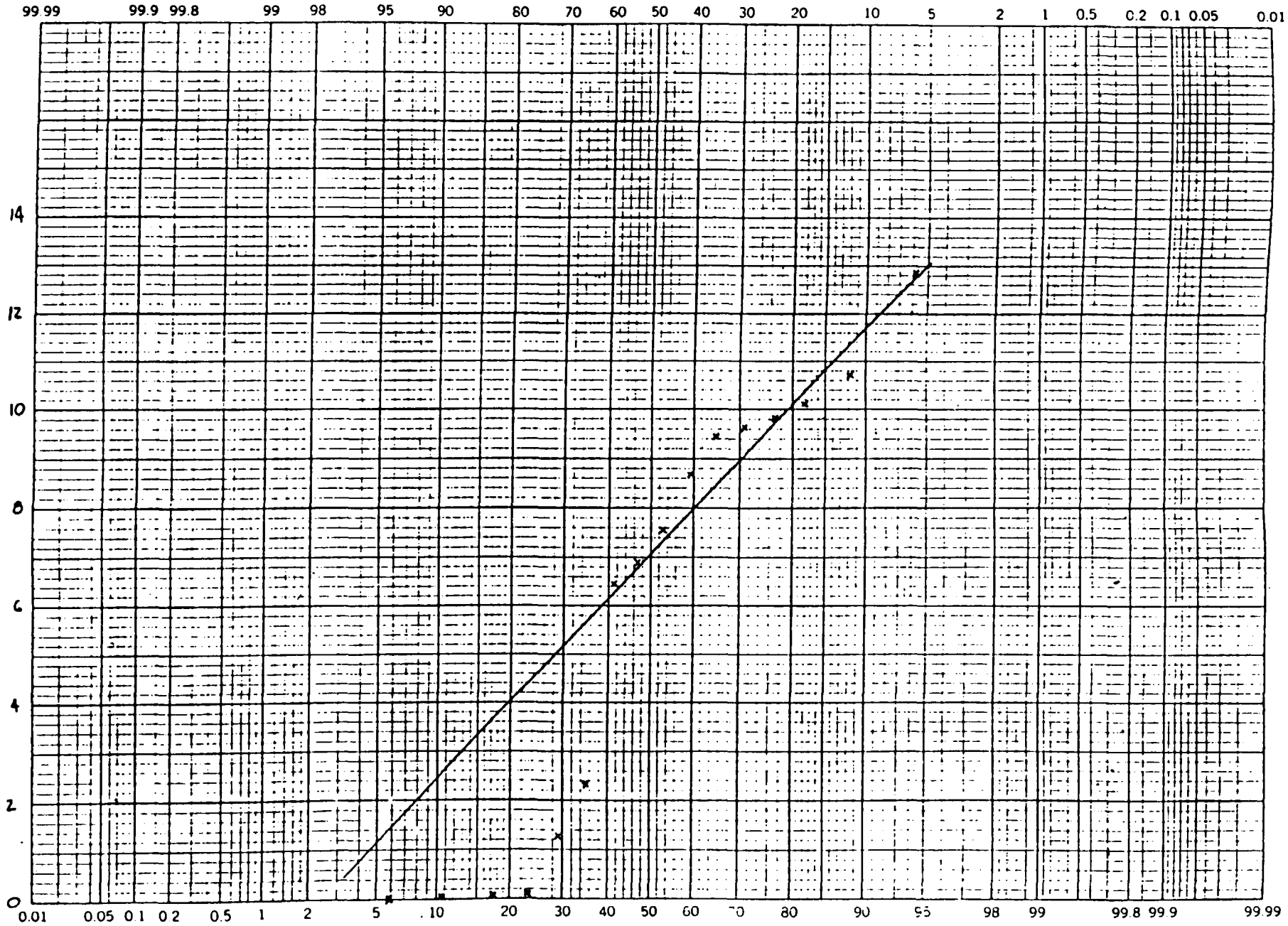


K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEG 2

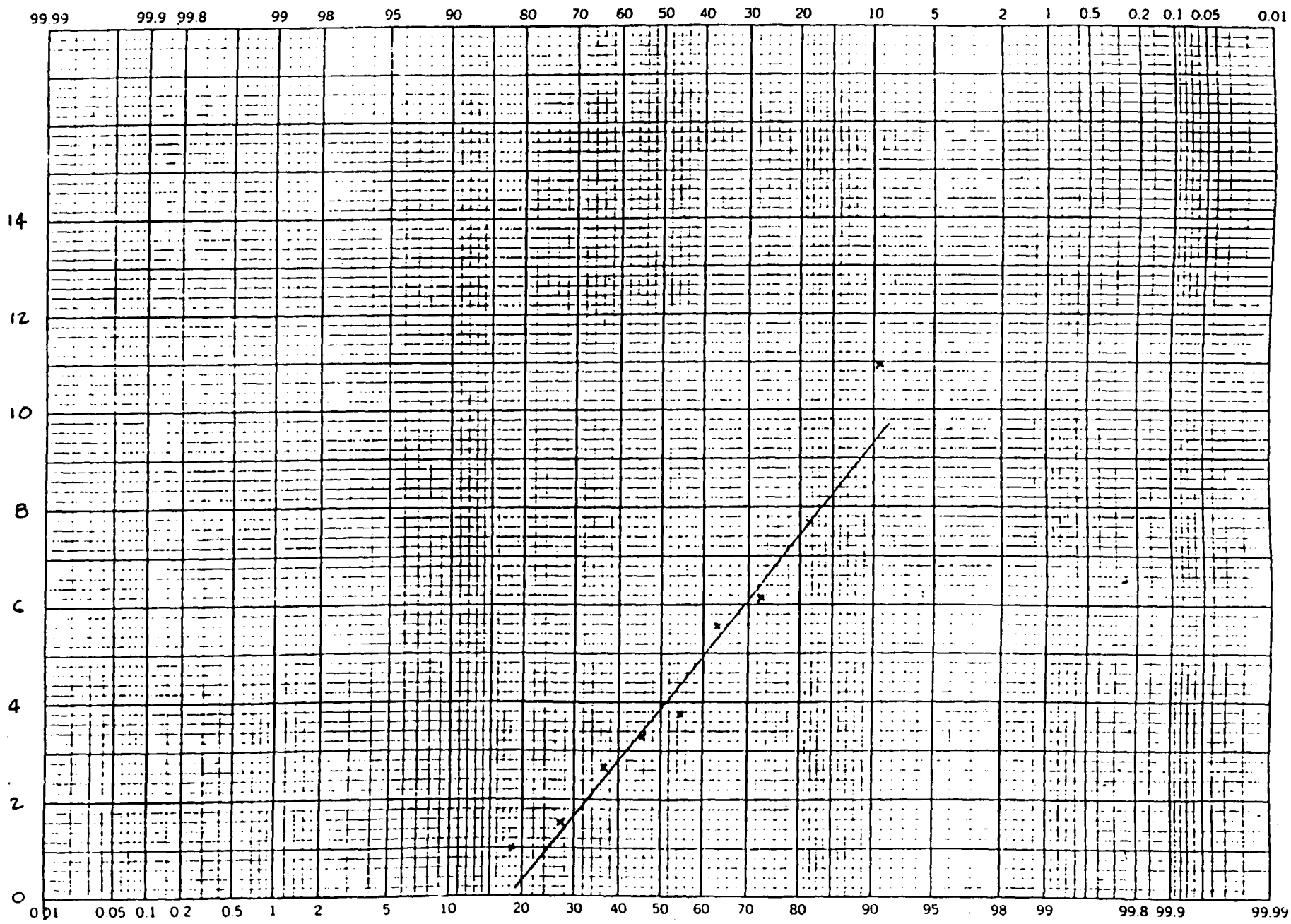
5-6 FT



K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

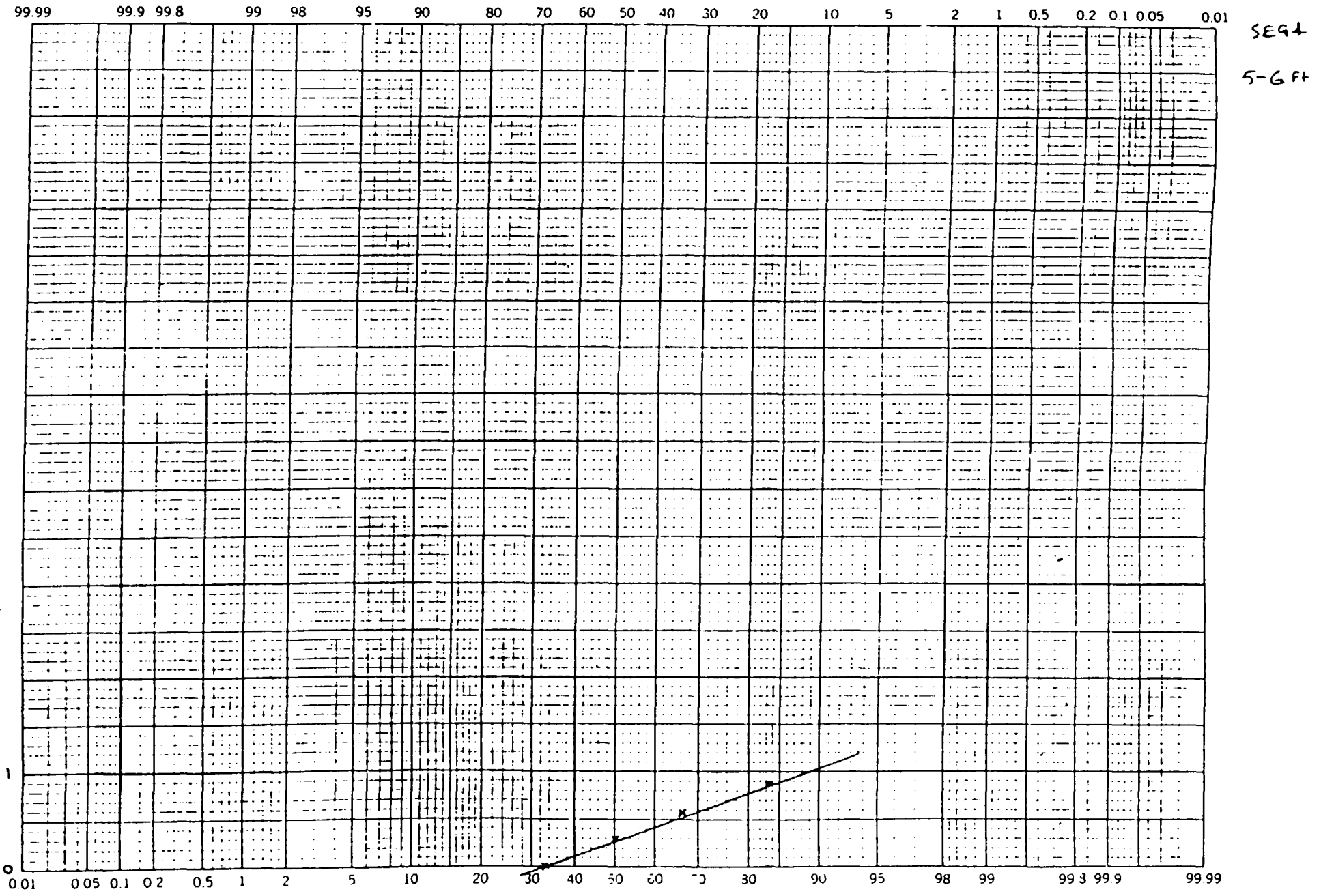
46 8000

SEG3
5-6 FT



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

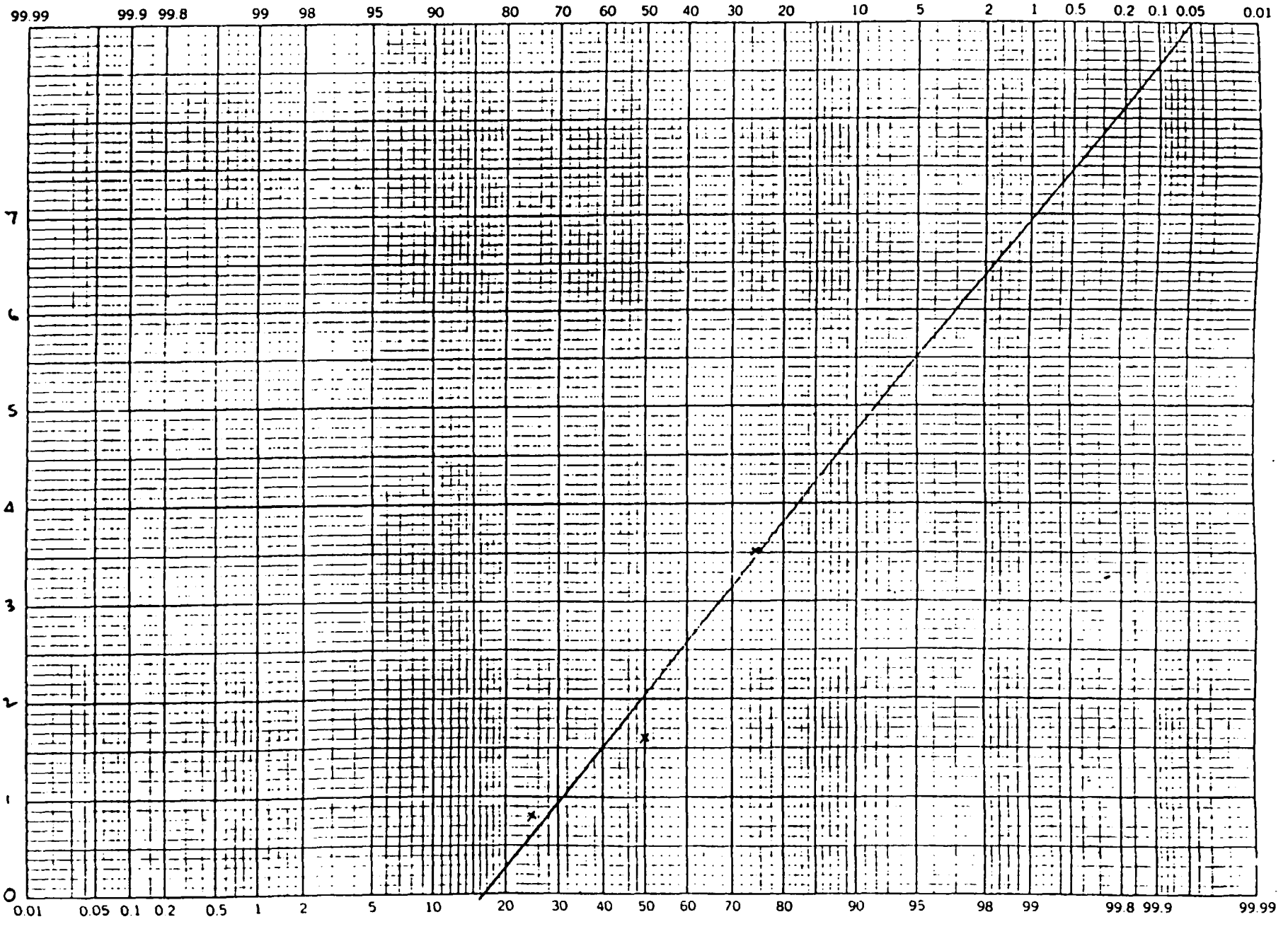


SEG 1

5-6 FT

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

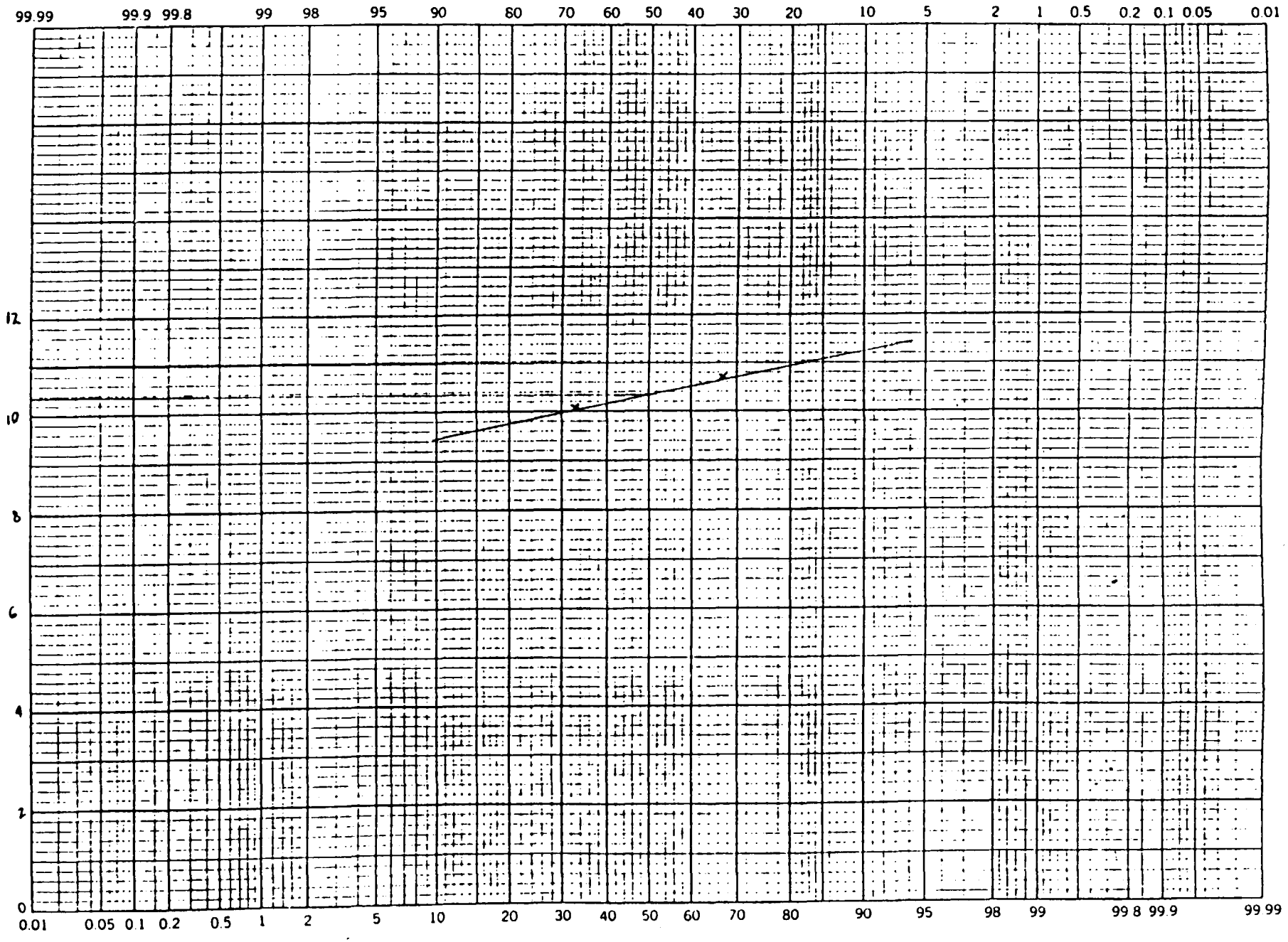


K•E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEG 2

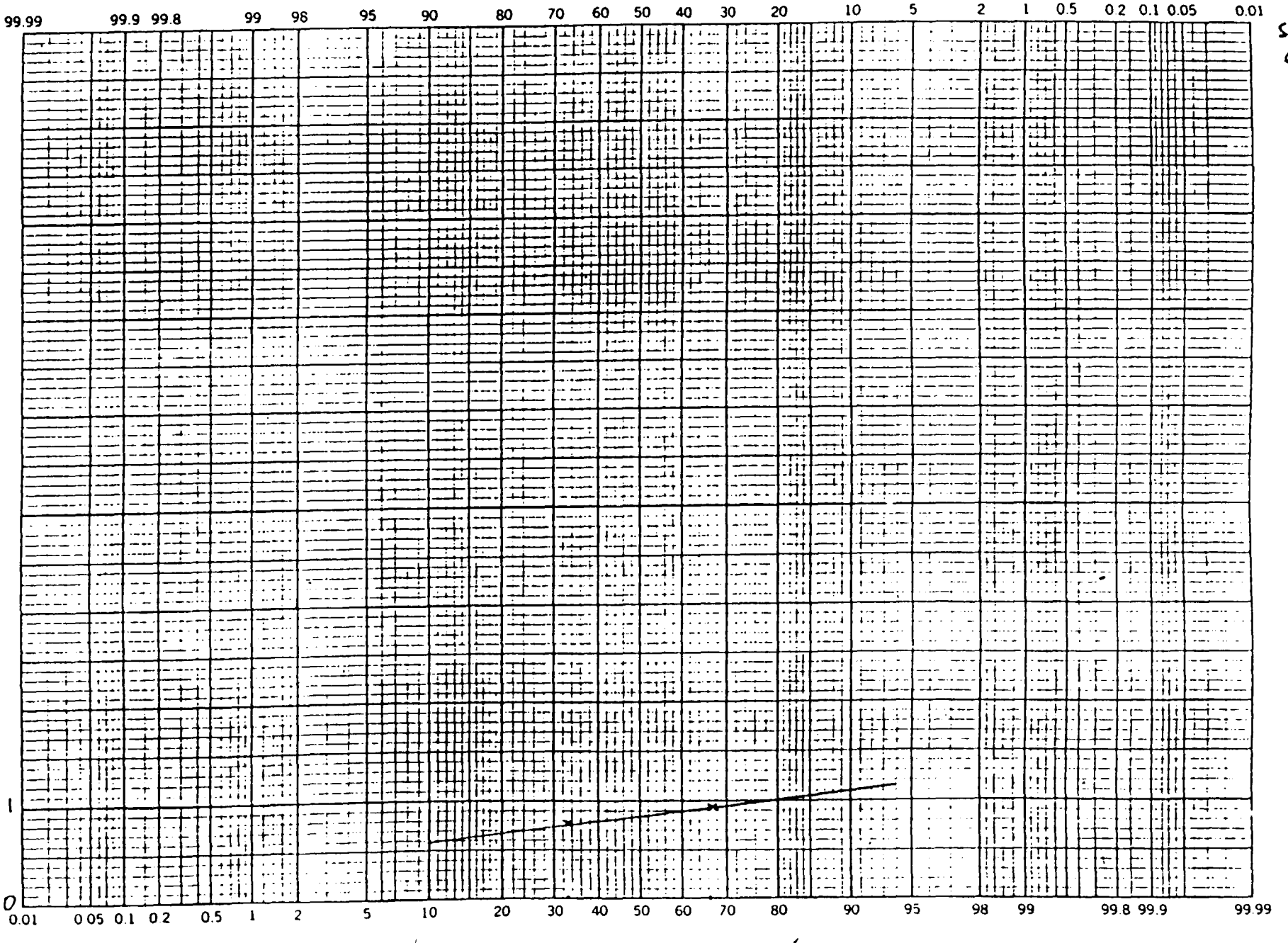
6-7 FT



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

SEG 5
6-7



ln {r_B}

SEG 2

	0-1 Ft	1-2 Ft	2-3 Ft	3-4 Ft	4-5 Ft	5-6 Ft	6-7 Ft
MISSOURI & HANGER	6.755	2.425	3.091	2.460	3.535	0.	
	2.549	3.353	3.785	1.881	2.667	10.102	
	9.163	9.250	3.325	9.333	7.208	9.554	
	8.299	9.975	9.480	−10.039	8.356	6.882	
	9.125	4.754	8.695	5.835	4.575	0.871	
	7.030	4.762	4.236	5.112	2.468	1.241	
	7.576	8.901	5.479	3.953	8.529	9.636	
	9.780	8.855	9.199	7.244	8.748	7.570	
	10.425	9.923	10.207	7.415	8.585	2.303	
	9.971	9.130	9.457	8.036	8.284	10.727	
	10.170	12.421	8.993	9.050	5.247	12.835	
	9.971	12.337	9.072	5.905	9.589	8.650	
	10.090	9.561	11.617	9.359	10.082	6.646	
	9.518	9.674	11.015	−11.064	0.916	0.854	
	9.680	6.891	9.554	3.054	0.798	0.278	
	10.621	6.683	4.615	2.264	0.365		
	11.687		5.081	7.539			
	7.754		5.375	6.4829			101
FIG 4 EXCOTEC	9.024		9.952		8.216		10.086
	10.373	11.142	12.837	9.393	10.545	9.852	10.692
	12.413						
	21	17	20	19	17	16	2

12

113

SFG (3)

0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT	5-6 FT	6-7 FT
11.017 6	10.364 5	9.957 7	10.543 [illegible]	10.201 10	11.065 11	
12.073 8	10.437 7	11.712 [illegible]	10.012 7	4.284 [illegible]	5.583 7	
9.193 3	10.446 5	6.702 [illegible]	5.037 [illegible]	2.451 1	3.339 5	
8.163 1	11.392 6	12.269 [illegible]	3.996 1	9.568 [illegible]	10.946 10	
12.155 9	11.871 9	8.396 5	9.011 7	8.294 [illegible]	1.576 [illegible]	
9.971 4	5.583 [illegible]	5.455 [illegible]	5.198	8.693 [illegible]	3.775 6	
	8.306 4	5.455	10.966 [illegible]	7.147 [illegible]	7.678 9	
	6.620 [illegible]		9.240 5	8.328 [illegible]	6.184 8	
			5.438 [illegible]			46

9.071 2	2.708 1	5.147 1	8.243 [illegible]	4.205 [illegible]	-1.109 1	.097
10.460 5	11.884 [illegible]	8.868 [illegible]	8.537 [illegible]	4.868 1	1.099 [illegible]	
11.653 [illegible]		11.198			2.639 4	
						16
9	10	10	11	12		

62

SEG 4

0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT	5-6 FT	
6.561 8	7.576 5	1.991 3	0.0 1	0.0	0.0 1	
5.447 6	4.248 4	0. 1	0.0 2	0.0 2	0.0 2	
3.947 4	1.528 2	2.102 4	1.008 5	2.005 3	.871 5	
1.671 1	1.361 1	2.213 5	.959 4	1.109 5	.300 3	25
			.765 3			
3.298 2	2.294 3	1.881 2	1.887 6			
3.509 3	8.700 6	2.367 6	2.804 7	1.808 4	0.588 4	.956
4.127 5						
5.704 7						13

SEG 5

5.583 6	6.234 4	3.300 3	2.815 3	3.161 4	2.538 3	11
6.260 7	4.278 3	3.770 4	3.062 4	5.429 5		
-3.147 1	2.128 1	1.504 1	2.041 1	0.0 1	.833 1	
0.182 2	3.989 2	1.988 2	2.293 2	1.441 3	1.609 3	0.788 1
0.470 3		4.5 5		0.586 2		0.916 2
1.872 4						
4.605 5						
6.430 8						
7.860 9						

BATTELLE

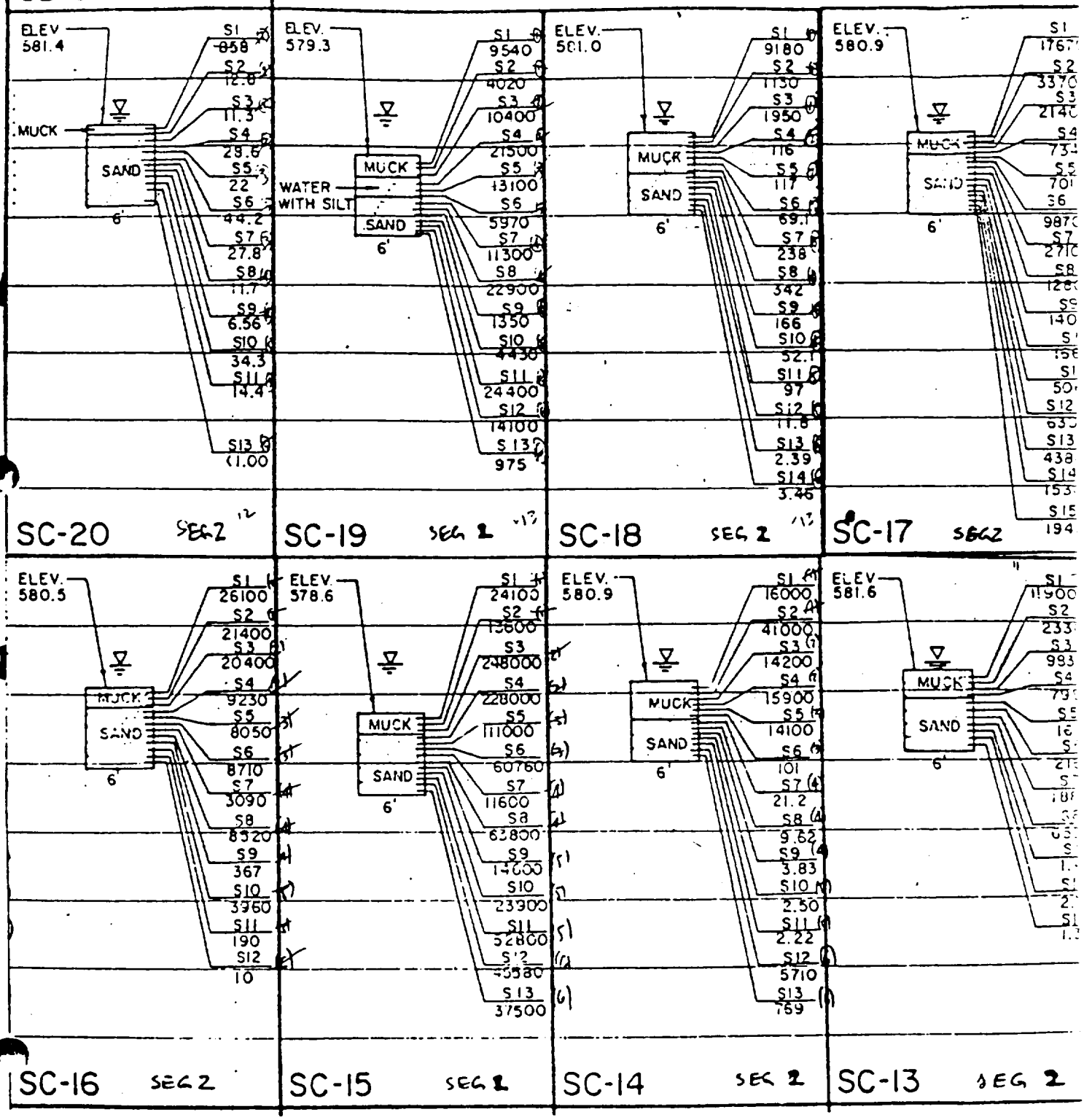
ln {data} Fig 14 ~~ENCOTEC~~

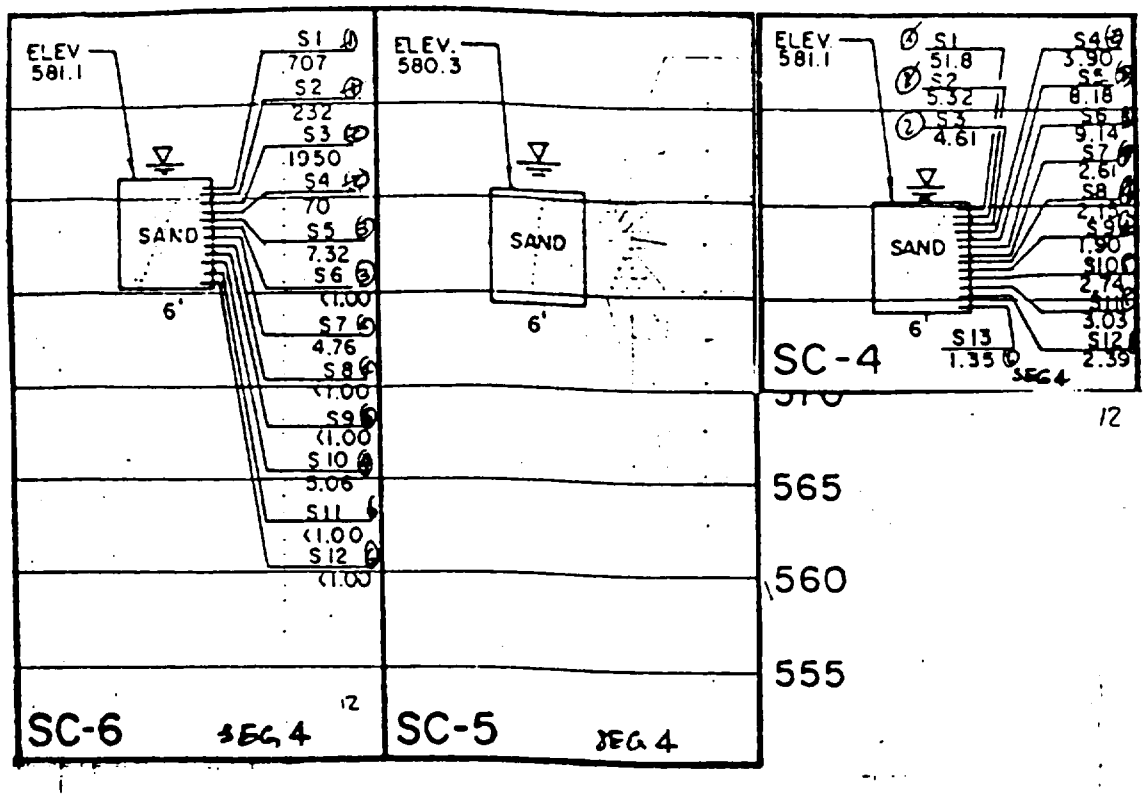
71

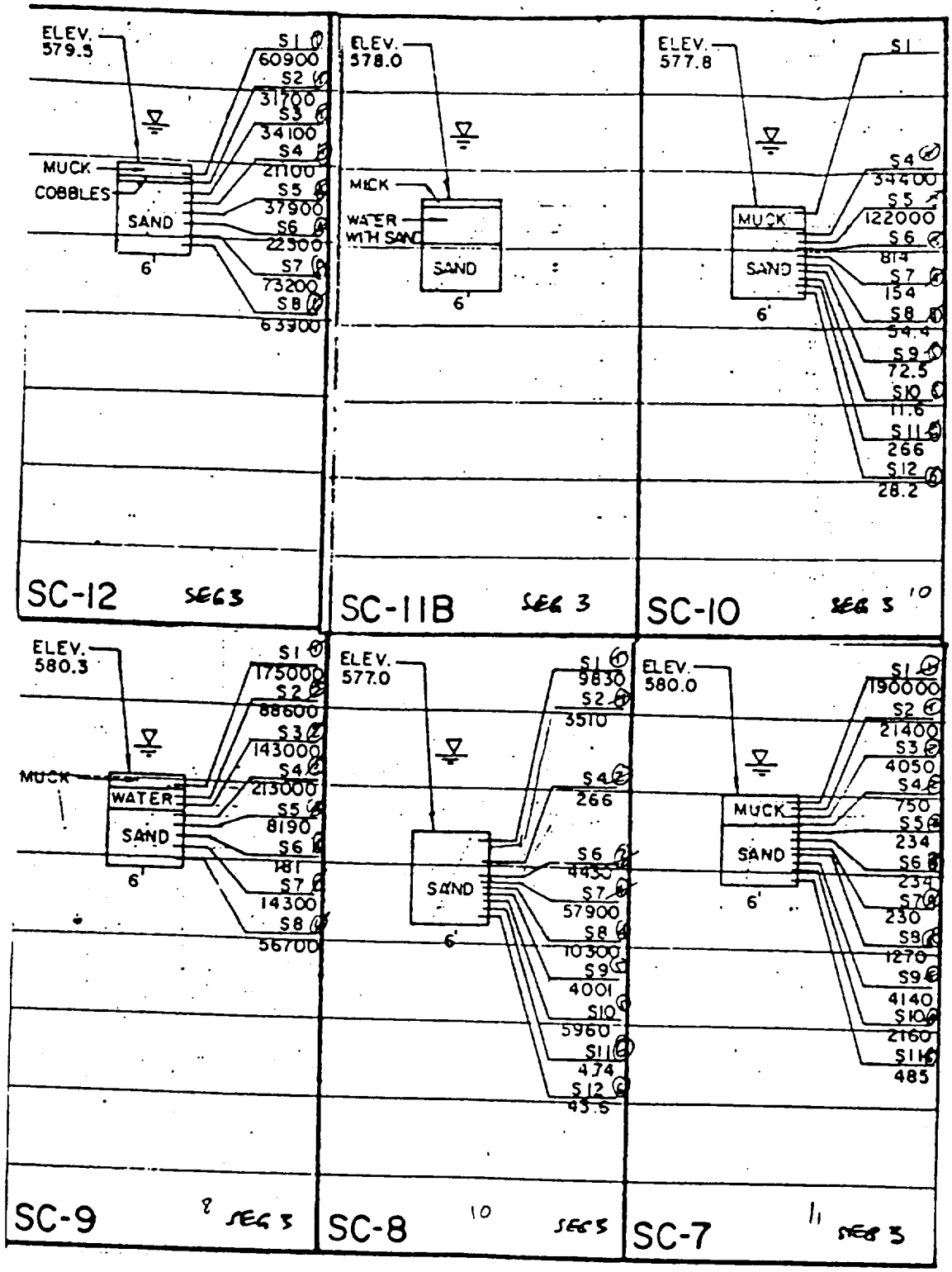
	SFG 1	SF 2	SFG 3	SFG 4	SFG 5	
	STA 1	STA 2	STA 3	STA 4	STA 5	STA
0 - 1				3.298	.4605	-3.1
	3.603	9.024	9.071	3.509	.6430	0.18
	4.466	10.373	10.460	4.127	7.860	0.4
	5.394	12.413	11.653	5.704		1.8
1 - 2	.642	11.142	2.708	2.294	3.989	2.1
			11.884	8.700		
2 - 3			5.147	1.881	1.504	
		9.952	8.868	3.367	1.988	
	-0.968	12.837	11.198			
3 - 4						
		9.393	8.243	1.887	2.041	2.2
			8.537	4.804		
	-1.661					
4 - 5					0.0	
		8.216	4.205	1.808	1.411	5
		10.545	4.868			
	-1.715					
5 - 6						
		9.852	-1.109			
	-1.470		1.099	.588	1.609	.8
			2.639			
		10.086				
6 - 7	-0.010	10.692	0.956	0.958	0.788	0.9
	9	12	16	13	12	1

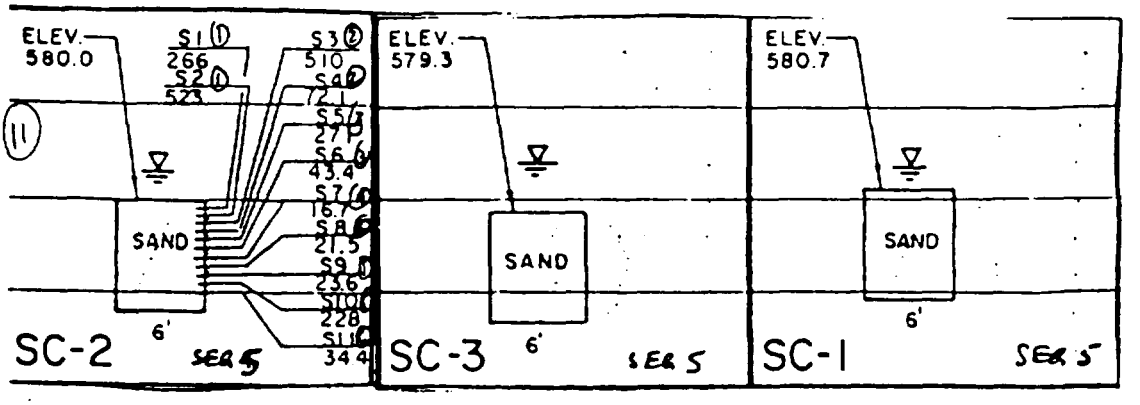
555

SB-3


ELEV 581.4
MUCK
SAND
6'
S1 858
S2 12.8
S3 11.3
S4 28.6
S5 22
S6 44.2
S7 27.8
S8 11.7
S9 6.56
S10 34.3
S11 14.4
S13 11.00
SC-20 SEG 2
ELEV. 579.3
MUCK
WATER WITH SILT
SAND
6'
S1 9540
S2 4020
S3 10400
S4 21500
S5 13100
S6 5970
S7 11300
S8 22900
S9 1350
S10 4430
S11 24400
S12 14100
S13 975
SC-19 SEG 2
ELEV. 581.0
MUCK
SAND
6'
S1 9180
S2 1130
S3 1950
S4 116
S5 117
S6 69.1
S7 238
S8 342
S9 166
S10 52.1
S11 97
S12 11.8
S13 2.39
S14 3.46
SC-18 SEG 2
ELEV. 580.9
MUCK
SAND
6'
S1 1767
S2 3370
S3 2140
S4 734
S5 701
S6 9870
S7 2710
S8 1280
S9 140
S11 50
S12 630
S13 438
S14 153
S15 194
SC-17 SEG 2
ELEV. 580.5
MUCK
SAND
6'
S1 26100
S2 21400
S3 20400
S4 9230
S5 8050
S6 8710
S7 3090
S8 8320
S9 367
S10 3960
S11 190
S12 10
SC-16 SEG 2
ELEV. 578.6
MUCK
SAND
6'
S1 24100
S2 13600
S3 248000
S4 228000
S5 111000
S6 60760
S7 11600
S8 63800
S9 14000
S10 23900
S11 52800
S12 45580
S13 37500
SC-15 SEG 2
ELEV. 580.9
MUCK
SAND
6'
S1 16000
S2 41000
S3 14200
S4 15900
S5 14100
S6 101
S7 21.2
S8 9.62
S9 3.83
S10 2.50
S11 2.22
S12 5710
S13 169
SC-14 SEG 2
ELEV 581.6
MUCK
SAND
6'
S1 11900
S2 233
S3 993
S4 793
SC-13 SEG 2


ELEV 581.1
SAND
6'
S1 .707
S2 232
S3 .1950
S4 70
S5 7.32
S6 <1.00
S7 4.76
S8 <1.00
S9 <1.00
S10 5.06
S11 <1.00
S12 <1.00
SC-6
SEG 4
12
ELEV. 580.3
SAND
6'
SC-5
SEG 4
ELEV 581.1
SAND
6'
S1 51.8
S2 5.32
S3 4.61
S4 3.90
S5 8.18
S6 9.14
S7 2.61
S8 2.19
S9 1.90
S10 2.74
S11 3.03
S12 2.39
S13 1.35
SC-4
SEG 4
12
565
560
555


ELEV. 579.5
MUCK
COBBLES
SAND
6'
S1 60900
S2 31700
S3 34100
S4 21100
S5 37900
S6 22300
S7 73200
S8 63300
SC-12
SEG 3
ELEV. 578.0
MUCK
WATER WITH SAND
SAND
6'
SC-11B
SEG 3
ELEV. 577.8
MUCK
SAND
6'
S1
S4 34400
S5 122000
S6 814
S7 154
S8 54.4
S9 72.5
S10 11.6
S11 266
S12 28.2
SC-10
SEG 3
10
ELEV. 580.3
MUCK
WATER
SAND
6'
S1 175000
S2 88600
S3 143000
S4 213000
S5 8190
S6 181
S7 14300
S8 56700
SC-9
8
SEG 3
ELEV. 577.0
SAND
6'
S1 9830
S2 3510
S4 266
S6 4450
S7 57900
S8 10300
S9 4001
S10 5960
S11 474
S12 43.5
SC-8
10
SEG 3
ELEV. 580.0
MUCK
SAND
6'
S1 190000
S2 21400
S3 4050
S4 750
S5 234
S6 234
S7 230
S8 1270
S9 4140
S10 2160
S11 485
SC-7
11
SEG 3


ELEV. 580.0
S1 266
S2 523
S3 510
S4 72.1
S5 27.1
S6 43.4
S7 16.7
S8 21.5
S9 23.6
S10 228
S11 34.4
SAND
6'
SC-2
SEA 5
ELEV. 579.3
SAND
6'
SC-3
SEA 5
ELEV. 580.7
SAND
6'
SC-1
SEA 5

HARBOR - DITCH COMPLEX

	BEST	HIGH	LOW
HARBOR	207,100	343,300	75,640
	456,650	756,980	166,780
N. DITCH	277,360	527,480	49,810
	611,580	1,163,100	109,830
Σ (kg)	484,460	870,780	125,450
(lbs)	1,068,230	1,920,080	276610

$$\{r_i\} \xrightarrow{\ln} \{x_i\}$$

If $\{r_i\}$ lognormally distributed and <u>if</u> $\{r_i\}_{\text{seg, depth}}$ still normally distributed then $\{x_i\}$ normally distributed, then the best estimator of the mean of $\{r_i\}$, μ_r, is

$$\mu_r = e^{\mu_x + \frac{1}{2}\sigma_x^2} \qquad (1)$$

where μ_x and σ_x^2 are the mean and variance of the transformed data, $\{x_i\}$. The (best) estimator of the variance σ_r^2 is

$$\sigma_r^2 = e^{2\mu_x + 2\sigma_x^2} - e^{2\mu_x + \sigma_x^2} \qquad (2)$$

Thus (1) transform data (2) plot tranformed data on normal probability paper, (3) draw line of visual (?) best fit, (4) enter @ 50% go to line and read probability, this is the μ_x, (5) enter @ 84% (this is the prob for $\mu+\sigma$-val in the random variable), go to line and read probability, this is the $\mu_x+\sigma_x$ value (6) subt. value obtained in (4) from value obtained in (5) the remainder is σ_x

Eq. can be rewritten as

$$\sigma_r^2 = e^{2(\mu_x+\sigma_x^2)} - e^{2(\mu_x+\frac{1}{2}\sigma_x^2)} = \left[e^{\mu_x+\sigma_x^2}\right]^2 - \left[e^{\mu_x+\frac{1}{2}\sigma_x^2}\right]^2 = \left[e^{\mu_x+\sigma_x^2}\right]^2 - \mu_r^2$$

$$Var(f(x,y)) = Var\,x \left(\frac{\partial f}{\partial x}\right)^2 + Var\,y \left(\frac{\partial f}{\partial y}\right)^2$$

$$Var(\bar{x}(\mu_{lnx}, \sigma^2_{lnx}) = Var\,\mu_{lnx}\left(\frac{\partial \bar{x}}{\partial \mu_{lnx}}\right)^2 + Var\,\sigma^2_{lnx}\left(\frac{\partial f}{\partial \sigma^2_{lnx}}\right)^2$$

σ^2

$$\bar{x} = e^{\mu + \frac{1}{2}\sigma^2}$$

$$\frac{d\bar{x}}{d\mu} = e^{\mu + \frac{1}{2}\sigma^2} = \bar{x}$$

$$\frac{d\bar{x}}{d\sigma^2} = \frac{\bar{x}}{2}$$

Also $Var\,\sigma^2_{lnx} = \dfrac{2\,\sigma^4_{lnx}}{N}$

Sub:

$$Var(\bar{x}(\mu, \sigma^2)) = \frac{\sigma^2_{lnx}}{N}(\bar{x})^2 + \frac{2\,\sigma^4_{lnx}}{N}\left(\frac{\bar{x}}{2}\right)^2$$

$$= \frac{\bar{x}^2\,\sigma^2_{lnx}}{N}\left[1 + \frac{\sigma^2_{lnx}}{2}\right]$$

$$\sigma_{\bar{x}} = \bar{x}\left[\frac{\sigma_{lnx}}{\sqrt{N}}\right]\underbrace{\left[1 + \frac{\sigma^2_{lnx}}{2}\right]^{1/2}}_{1.116 \text{ for } \sigma_{lnx} = 0.7}$$

If $\sigma_{lnx} = 0.7$

$N = 10$

$$\sigma_{\bar{x}} = 0.25\,\bar{x}$$

2nd LbL A $- \hat{\mu}_r$

STO 01

R/S

2nd LbL B $- N$

STO 02

R/S

2nd LbL C $- \hat{\sigma}_x$

STO 03

R/S

$$\hat{\sigma}_{\hat{\mu}_r} = \hat{\mu}_r \left[\frac{\hat{\sigma}_x}{\sqrt{N}} \right] \left[1 + \frac{\hat{\sigma}_x^2}{2} \right]^{1/2}$$

[[RCL03 x^2 ÷ 2 + 1] √ × RCL01 × RCL03 × RCL02 $\frac{1}{x}$ √] STO 04

R/S

$\mu_r = 10{,}000$

$N = 10$

$\sigma_x = 2.1$ $\qquad \sigma_{\mu_r} \Rightarrow 11{,}888.67108$

NOTE

Conditions for $\hat{\mu}_r - \hat{\sigma}_{\hat{\mu}_r} < 0$

Since $\hat{\sigma}_{\hat{\mu}_r} = \frac{\sigma_x \hat{\mu}_r}{\sqrt{N}} \left\{ 1 + \frac{\sigma_x^2}{2} \right\}^{1/2} \rightarrow \frac{\hat{\sigma}_{\mu_r}}{\hat{\mu}_r} = \frac{\sigma_x}{\sqrt{N}} \left\{ 1 + \frac{\sigma_x^2}{2} \right\}^{1/2}$

for $\hat{\mu}_r - \hat{\sigma}_{\mu_r} < 0 \rightarrow \frac{\hat{\sigma}_{\mu_r}}{\hat{\mu}_r} > 1$ or $\frac{\sigma_x}{\sqrt{N}} \left\{ 1 + \frac{\sigma_x^2}{2} \right\}^{1/2} > 1$

or

$$\sigma_x^2 \left\{ 1 + \frac{\sigma_x^2}{2} \right\} > N$$

$$\sigma_x^4 + 2\sigma_x^2 - 2N > 0$$

or

$$[\sigma_x^2]^2 + 2[\sigma_x^2] - 2N > 0$$

let $\sigma_x^2 = y \qquad y \geq 0$

$$y^2 + 2y - 2N > 0$$

the corresp eq $y^2 + 2y - 2N = 0$ has 2 real roots $y_1 = -(1 + \sqrt{1+2N})$, $y_2 = -1 + \sqrt{1+2N}$

and $y_1 < y_2$ and $y_1 < 0$, $y_2 > 0$. Thus ~~for~~ $y \geq$ $y < y_1$ and $y > y_2$

but since $y > 0$ and $y_1 < 0$ then the range of y is

or

$$y_2 < y$$

$$-1 + \sqrt{1+2N} < \sigma_x^2$$

or

$$\sqrt{-1 + \sqrt{1+2N}} < \sigma_x$$

HARBOR

	M	M+δM	M−δM	
0 − 1	63148	138,100	2384	
1 − 2	118824	175,187	62582	
2 − 3	20862	30,046	10,670	
3 − 4	4273	-	-	(From prev. calc
Σ (n)	207,100 BEST (kg)	343,300 HIGH (kg)	75,640 LOW (kg)	

HAR 0-1 FT

SEC	M		M + δM		M - δM	
1	61,100		133,140		2280	
2	556		1285		0 (<)	
3	162		375		0 (<)	
4	457	1489	970	3599	0 (<)	
5	314		969		0 (<)	
6	173		334		12	
7	149	476	343	893	0 (<)	104
8	154		216		92	
9	-		-		-	
10	58		406		0 (<)	
11	-	83	-	468	-	
12	25		62		0 (<)	
Σ	63148		138,100		2384	

HAR 1-2 FT

SEC	M		M + δM		M - δM	
1	116380		170530		62200	
2	844		1777		O(<)	
3	818	2119	1254	4088	382	382
4	457		1057		O(<)	
5	-					
6	154		352		O(<)	
7	105	305	217	569	O(<)	
8	46					
9	-					
10	8					
11	-	30				
12	12					
Σ	118824		175187		62582	

HAR 2-3 FT

SEC	M		M + δM		M - δM
1	20,120		29570		10670
2	124		-		-
3	192	316	-		-
4	-				
5	-				
6	111		259		-
7	112	419	217	476	-
8	29		-		-
9	167		-		-
10	-				
11	7	7			
12	-				
Σ	20862		30046		10670

HARBOR **SEG 1**

F(11)

	N		μ_x	σ_x	$\hat{\mu}_r$	σ_x	$\hat{M}$	$\hat{\delta M}$		
1,1	26	0-1	7.8	2.8	123,000	149816	53,216	64,818		133140
1,2	18	0-1	7.8	1.3	5681	2364	3910	1627	61,100	
1,3	4	0-1	6.9	1.7	4210	5595	3950	5596		2280
1,1	18	1-2	10.8	1.6	176310	100400	76280	43438		170530
1,2	10	1-2	10.7	0.7	56667	14000	39000	9635	116,380	62200
1,3	17	1-2	5.6	1.7	1147.	1152	1076	1080		→ same as SEG 2 (1-2) conc.
1,1	13	2-3	10.5	0.7	46397	10050	20,100	9429	20,120	29570
1,2	1 (a)	2-3	1.	1.3	~ 10	8	6	6		10670 combined with conc of SEG 2 (1-2)
1,3	1 (a)	2-3	1.	1.7	~ 12	16	10	15		
1,1	2	3-4		.7						333240
1,2	1	3-4							197,600	75150

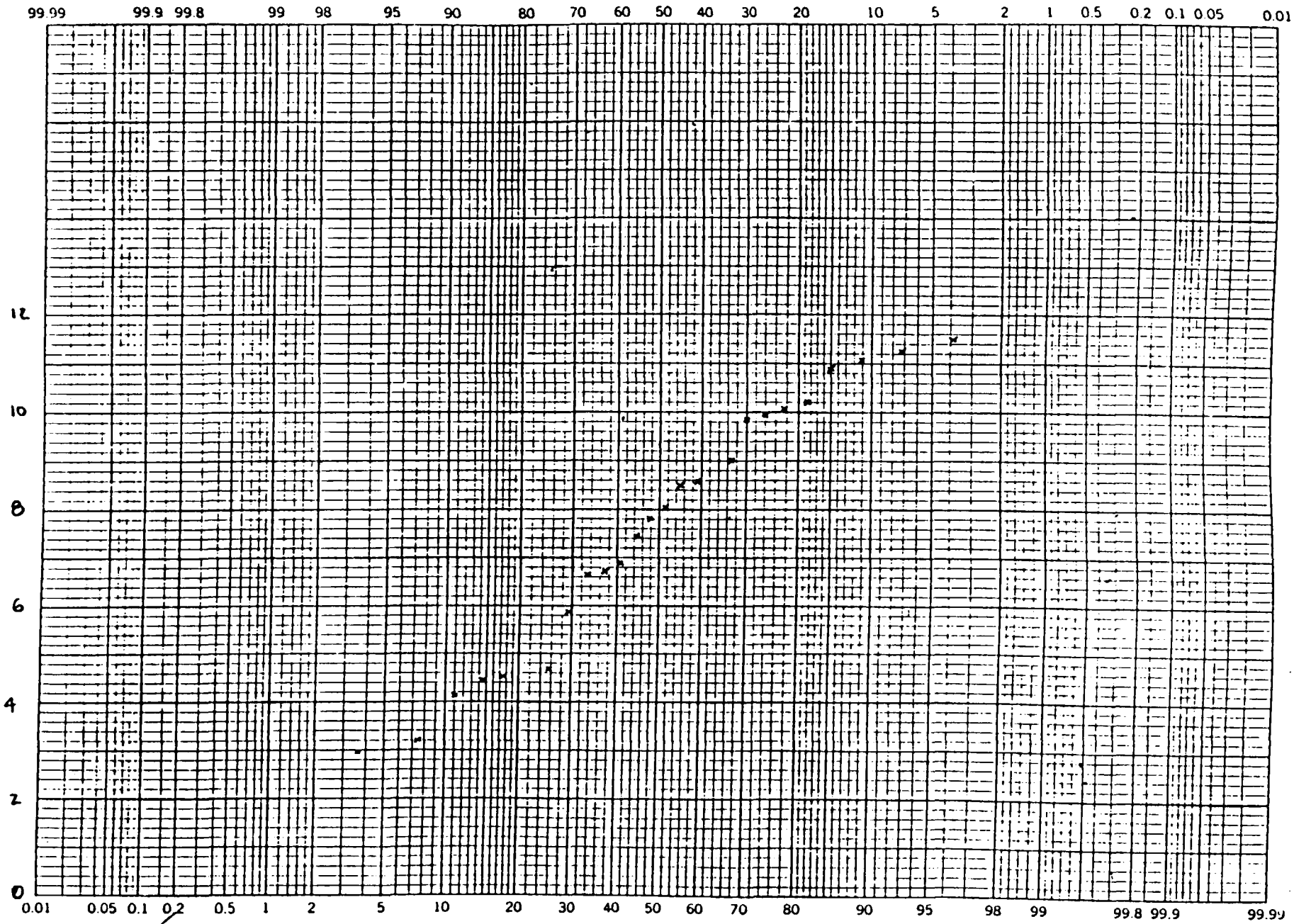
HARBOR

FC11)

	N		μ_x	σ_x	$\hat{\mu}_r$	σ_x	$\hat{M}$	$\hat{\delta M}$		
1,1	26	0-1	7.8	2.8	123,000	149816	53,216	64,818		133 140
1,2	12	0-1	7.8	1.3	5681	2364	3,910	1627	61,100	
1,3	4	0-1	6.9	1.7	4210	5595	3950	5596		2280
1,1	18	1-2	10.8	1.6	176310	100400	76280	43438		170530
1,2	10	1-2	10.7	0.7	56667	14000	39000	9655	116,380	62200
1,3	17)	1-2	5.6	1.7	1147.	1152	1076	1080	→ same as SFG2 (1-2) conc.	
1,1	13	2-3	10.5	0.7	46397	10050	20,100	9429	20,120	29570
1,2	1 (a)	2-3	1.	1.3	~ 10	8	6	6	combined with conc of SFG2 (1-2)	10670
1,3	1 (a)	2-3	1.	1.7	~ 12	16	10	15		
1,1	2 <	3-4		0.7						
1,2	1	3-4								

K+E PROBABILITY X DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A. .6 8000

0-1 FT 1,1

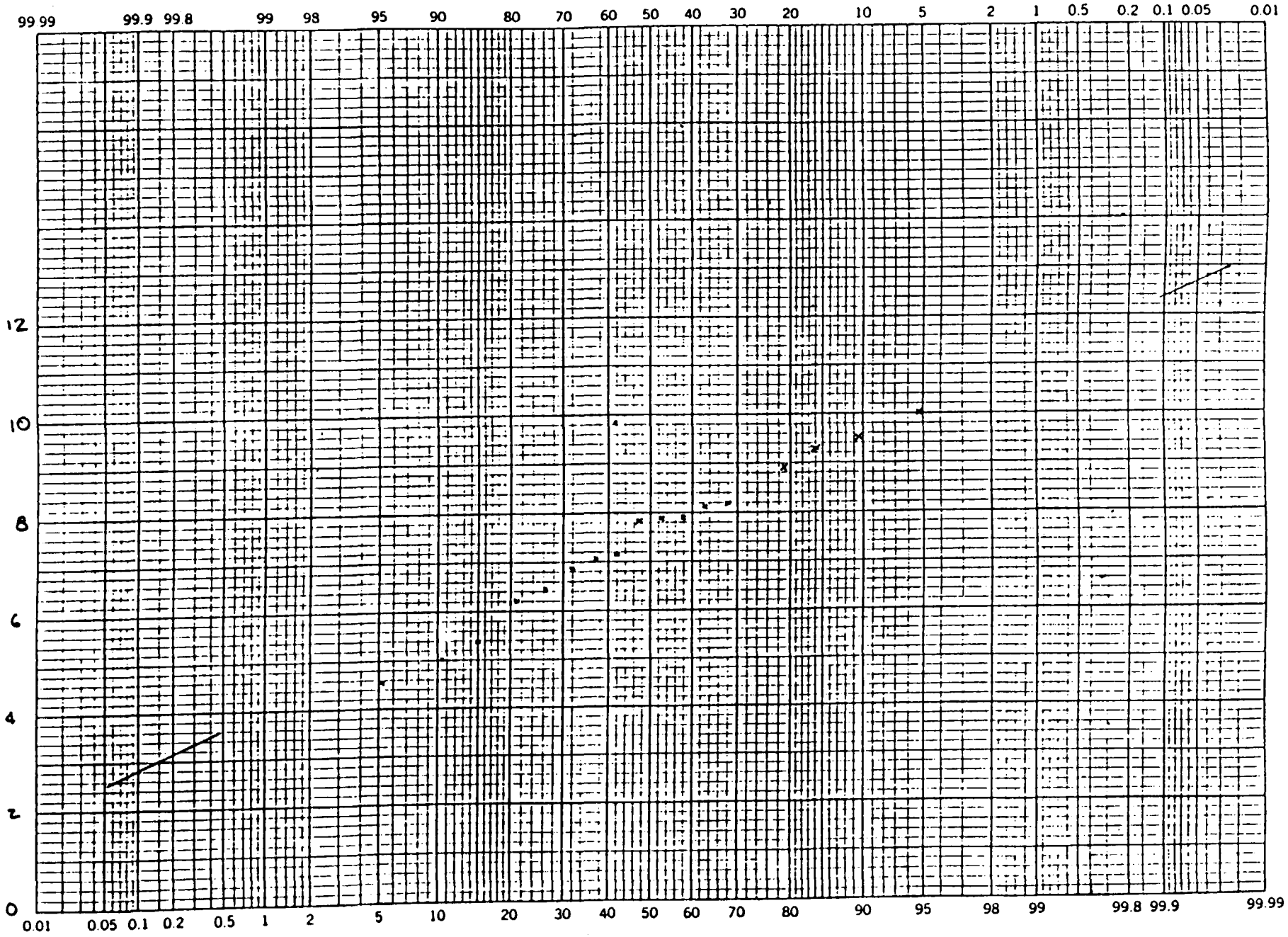


K&E KEUFFEL & ESSER MADE IN U.S.A.

6 8000

0-1 FT

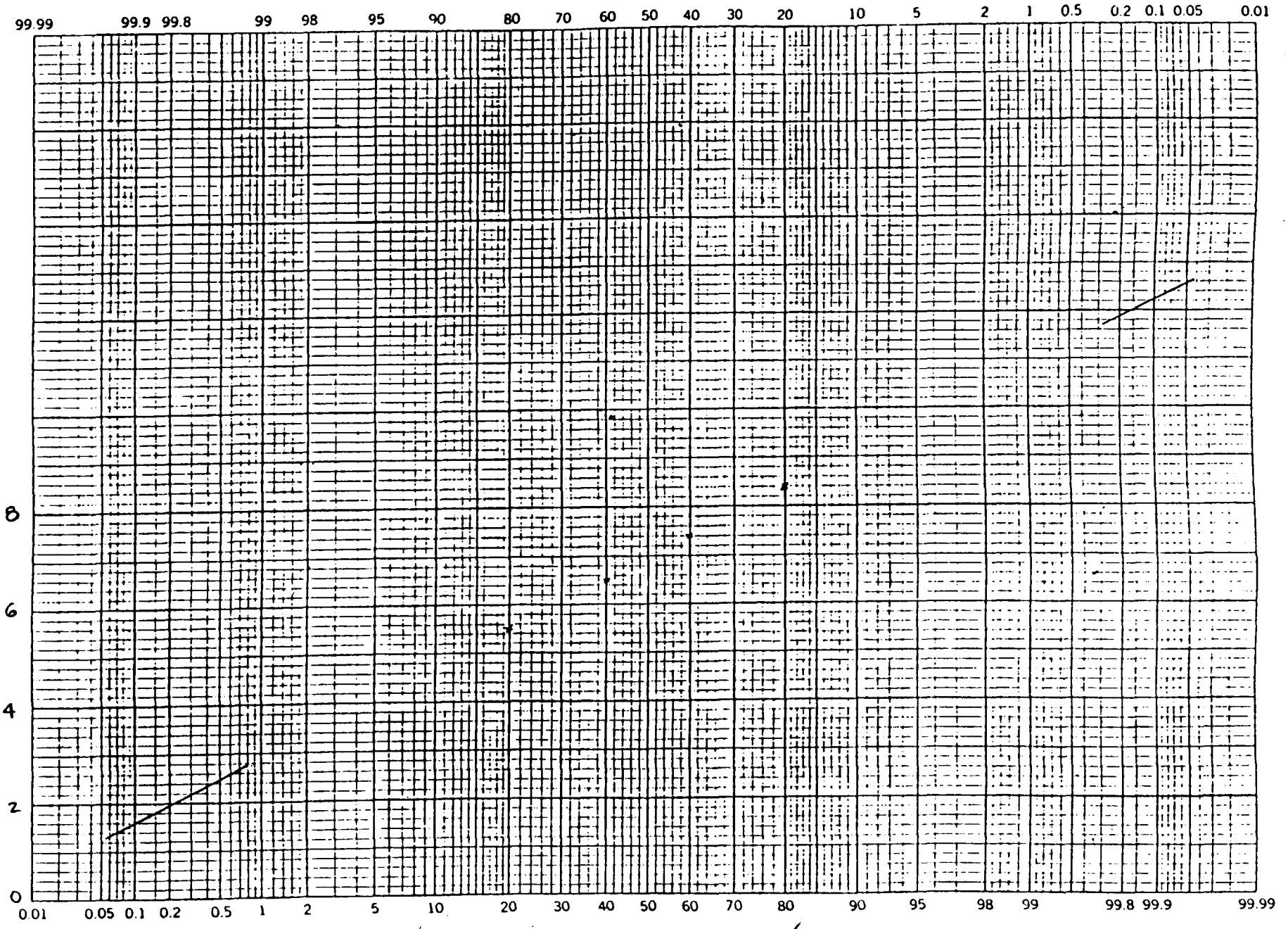
1,2



K&E PROBABILITY X SC DIVISIONS KEUFFEL & ESSER CO. MADE IN USA

46 8000

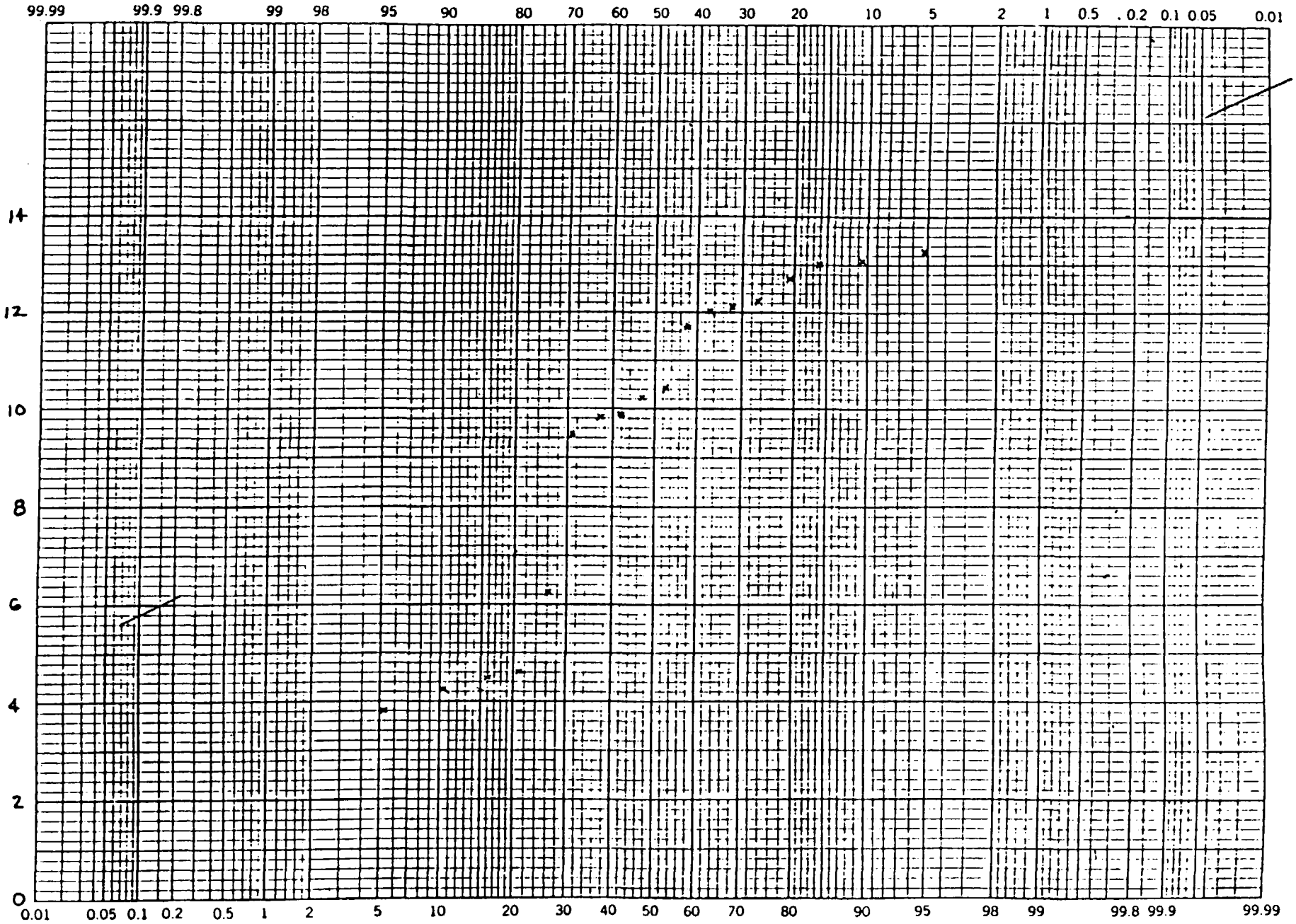
0-1 FT 1,3



K-E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

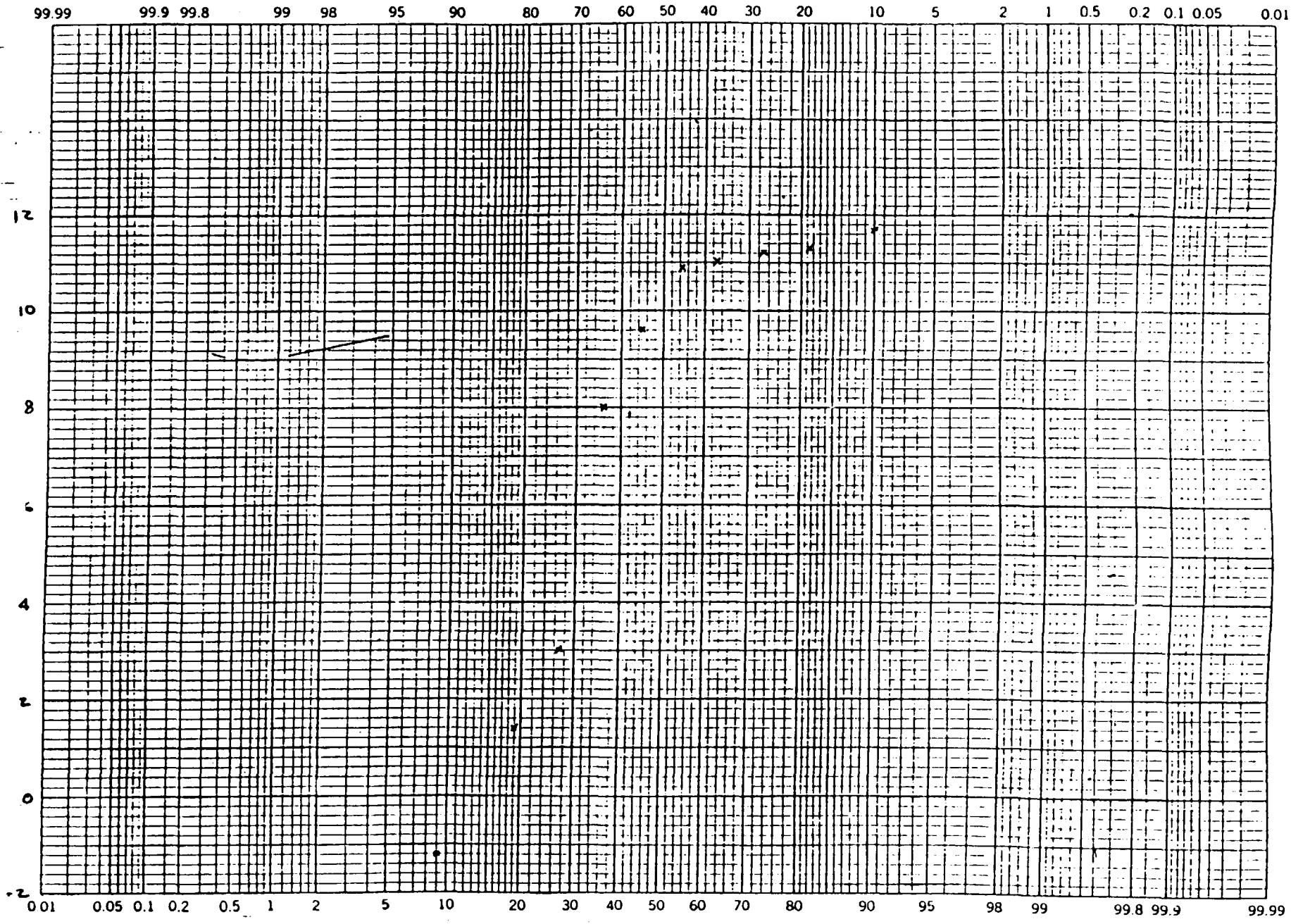
1,1 1-2 Ft



K+E PROBABILITY X 93 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

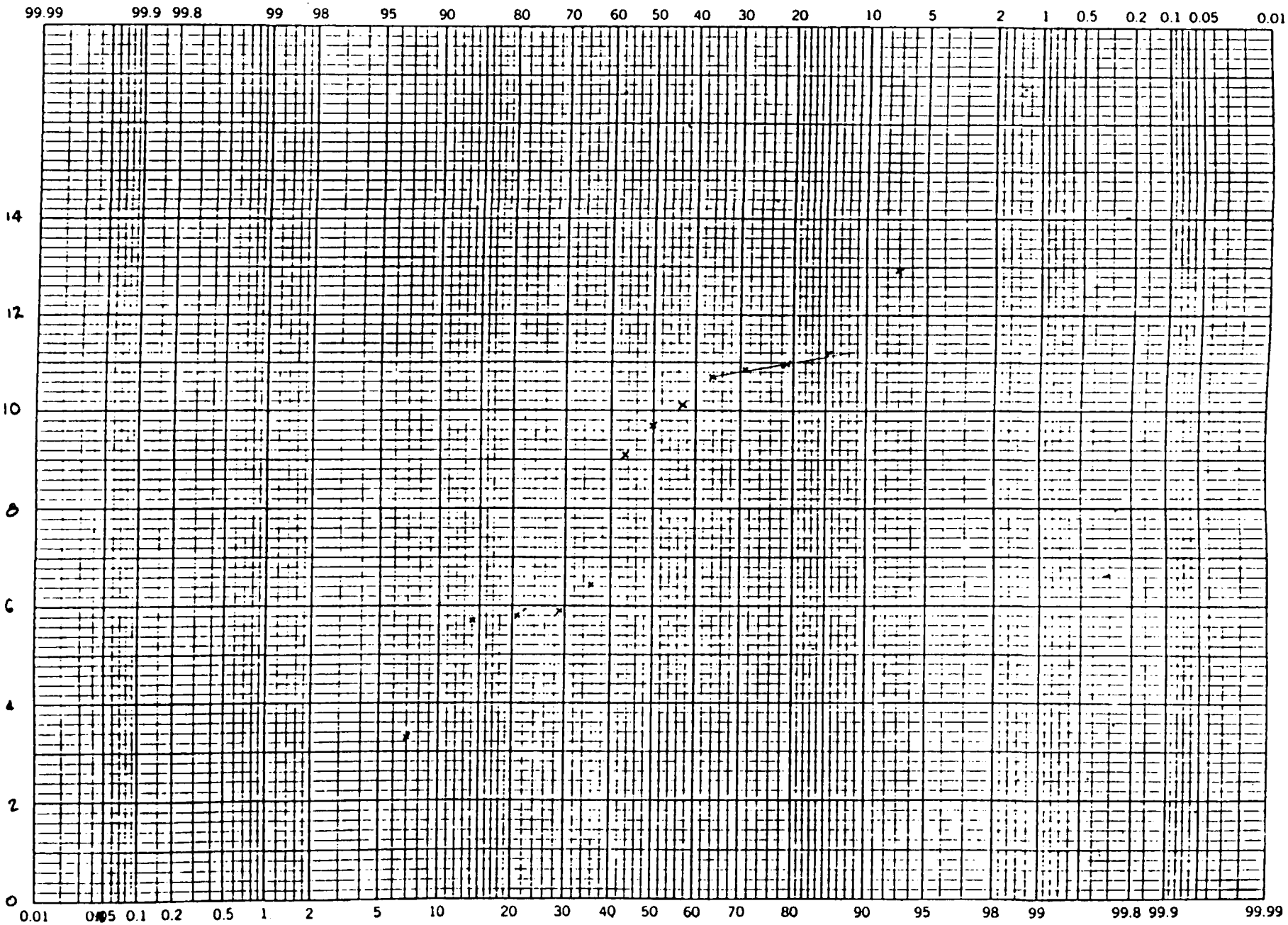
1,2 1-2 FT



K+E PROBABILITY & 90 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

1,1 2-3 FT



1, 1 0-1 FT

(26)

2.996	3.704
3.219	7.407
4.159	11.111
4.489	14.815
4.543	18.519
4.700 (2)	25.926
5.889	29.630
6.659	33.333
6.733	37.037
6.908	40.741
7.476	44.444
7.824	48.148
8.039	51.852
8.517	55.556
8.556	59.259
9.036 (2)	66.667
9.852	70.370
9.952	74.074
10.119	77.778
10.204	81.481
10.915	85.185
11.162	88.889
11.277	92.593
11.482	96.296

1,2 0-1 FT

(18)

4.575	5.263
5.075	10.526
5.394	15.789
6.254	21.053
6.430	26.316
6.877	31.579
7.090	36.842
7.170	42.105
7.824	47.368
7.937	52.632
7.972	57.895
8.161	63.158
8.198	68.421
8.572 (?)	78.947
9.306	84.211
9.546	89.474
10.309	94.737

1.3 0-1 FT

(4)

5.521	20
6.650	40
7.378	60
8.389	80

1.1 1-2 FT

(18)

3.829	5.263
4.277	10.526
4.500	15.789
4.605	21.053
6.254	26.316
9.547	31.579
9.852	36.842
9.952	42.105
10.240	47.368
10.434	52.632
11.695	57.895
12.014	63.158
12.134	68.421
12.206	73.684
12.707	78.947
13.060	84.211
13.194	89.474
13.253	94.737

1,2 1-2 FT

10

-1.204	9.091
1.411	18.182
3.045	27.273
8.102	36.364
9.616	45.455
10.859	54.545
11.002	63.636
11.238	72.727
11.290	81.818
11.695	90.910

1.3 1-2FT

.6

1,1 2-3

(13)

~~3.2882~~
5.

~~[illegible]~~

3.332 -5.737	7.143
5.799	14.286
5.914	21.429
	28.571
6.446	35.714
9.116	42.857
9.741	50,000
10.127	57.143
10.736	64.286
10.859	71.429
10.985	78.571
11.212	85.714
12.948	92.857

1-2 2-3

- .616

1-3 2-3 FT

-.511

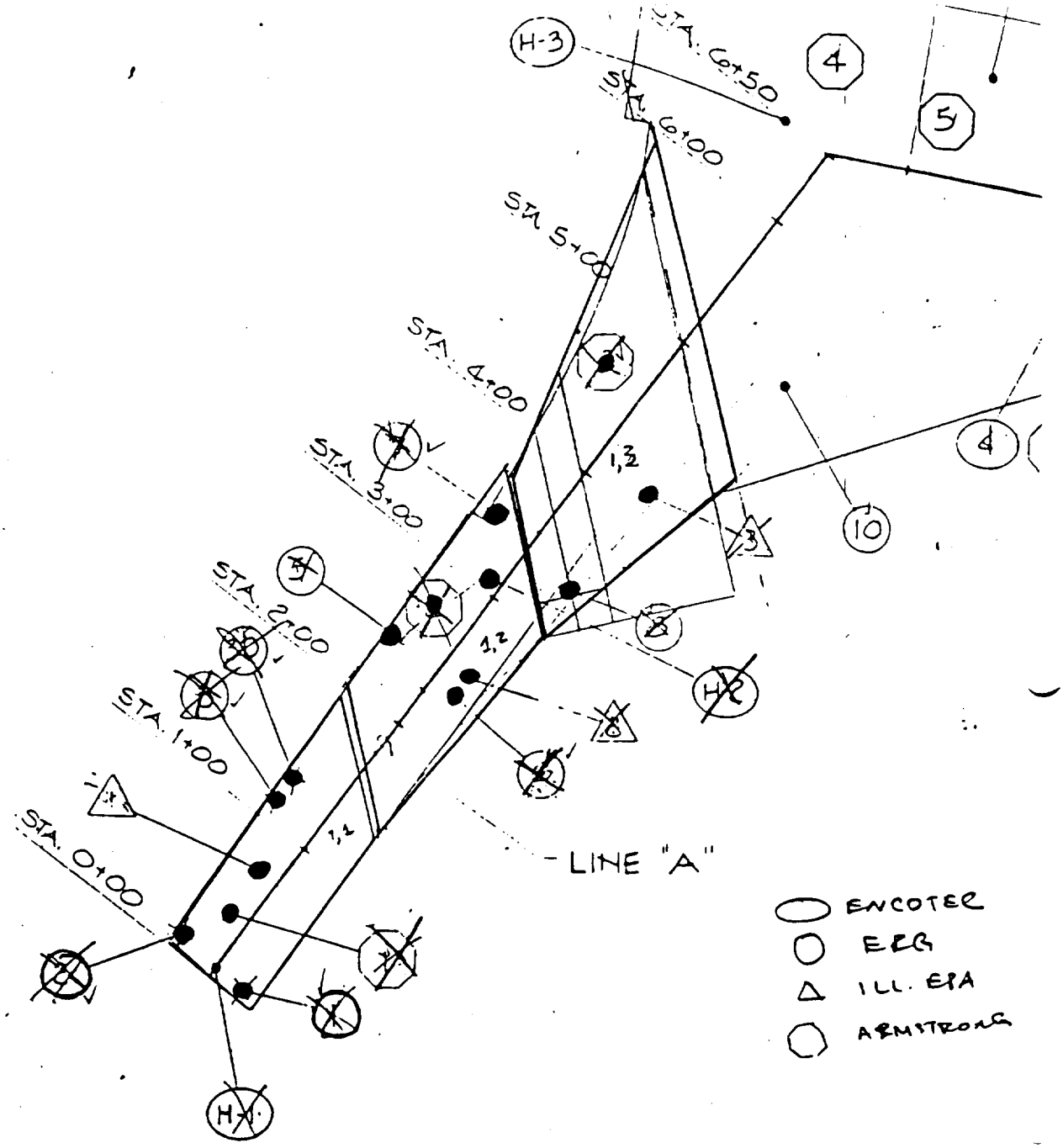
1;1 3-4

3.989
3,892

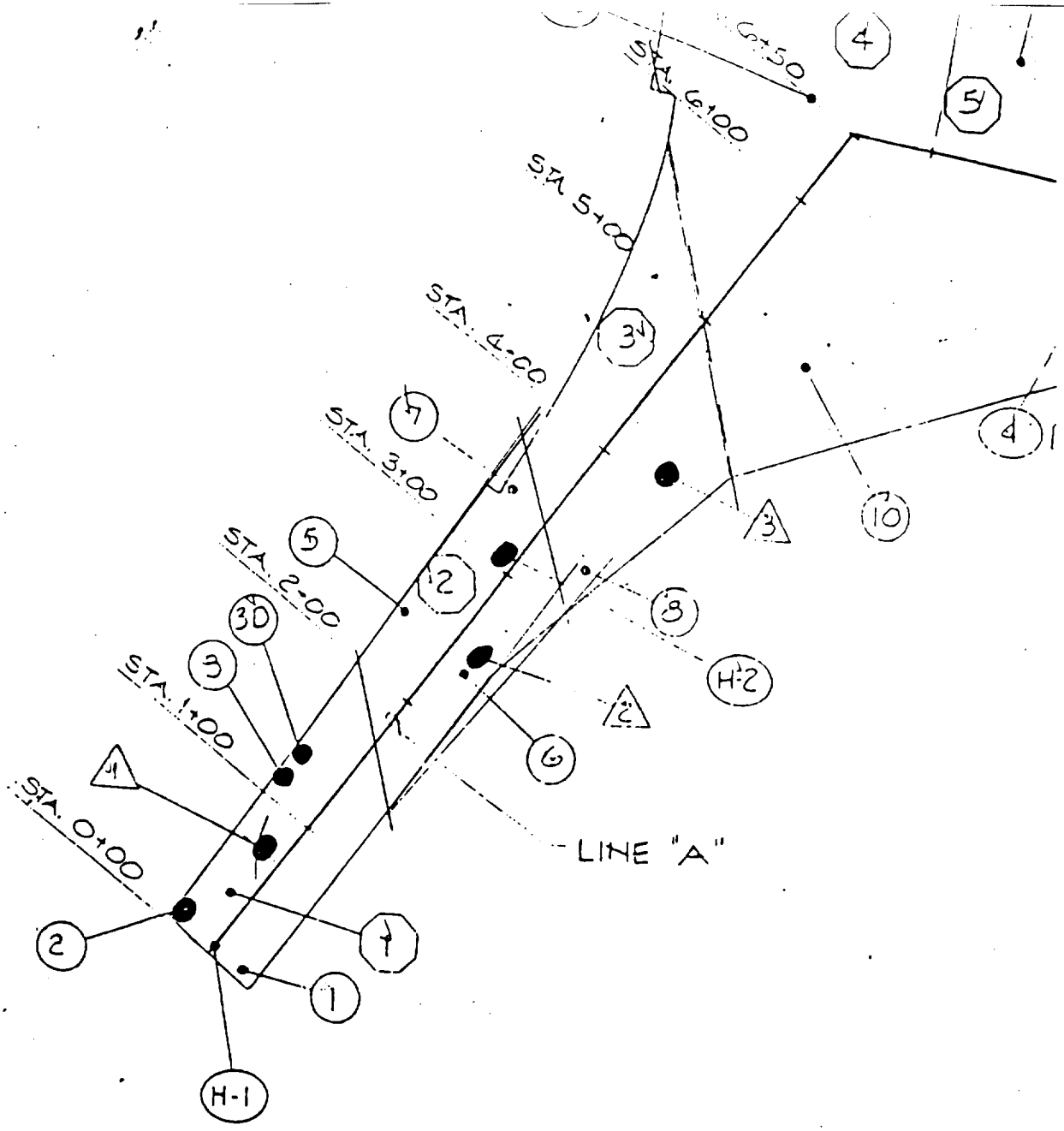
1.2 3-4

-1.609

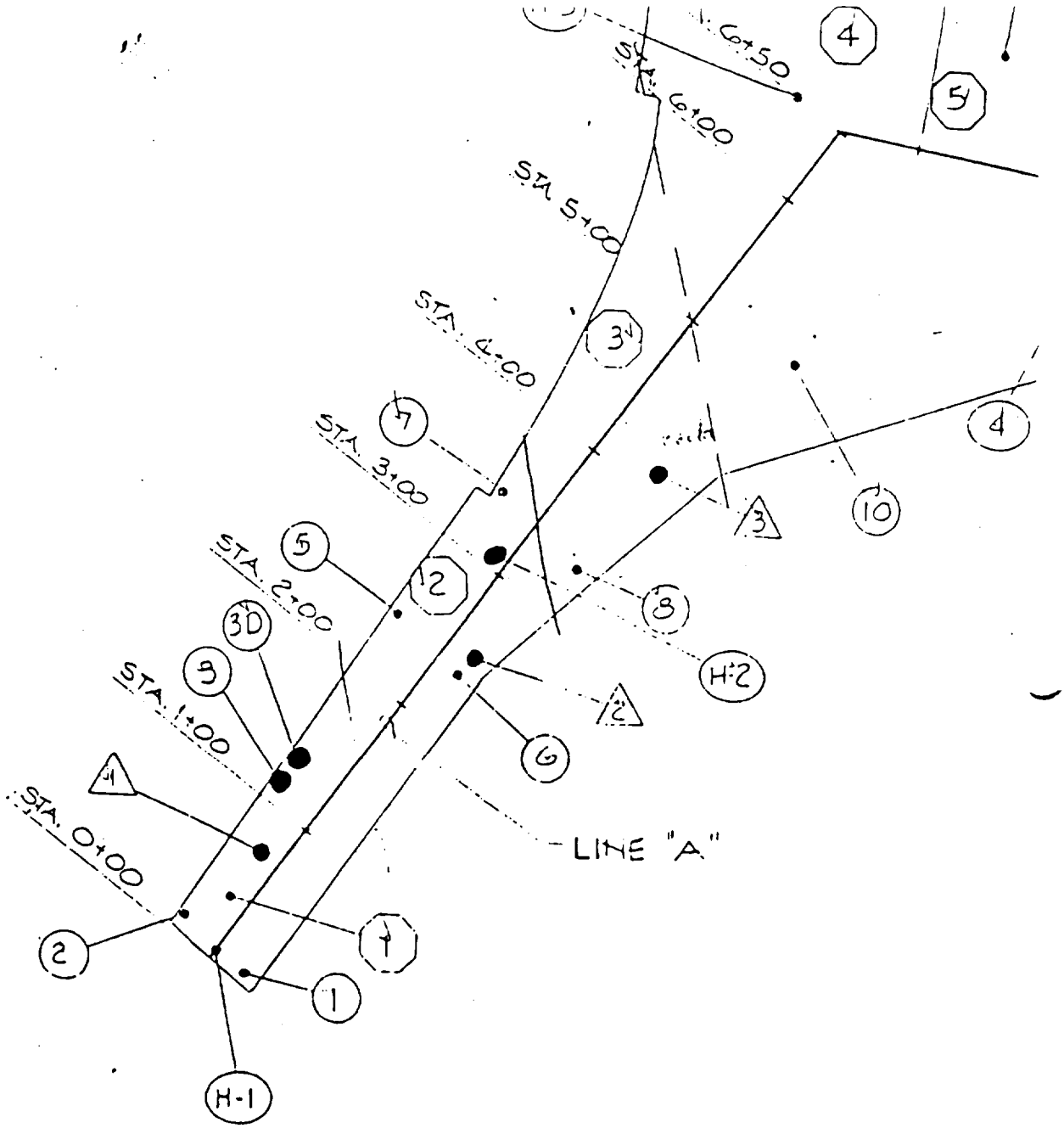
#	1, 1	11,750 (ft²)	1092	(m²)	.21 TOTA
	1, 2	18,700	1737		.33
	1, 3	25494	2368		.46
			5197		


STA. 6+50
STA. 6+00
STA 5+00
STA. 4+00
STA. 3+00
STA. 2+00
STA. 1+00
STA. 0+00
H-3
4
5
10
1,3
1,2
LINE "A"
ENCOTEC
ERG
ILL. EPA
ARMSTRONG

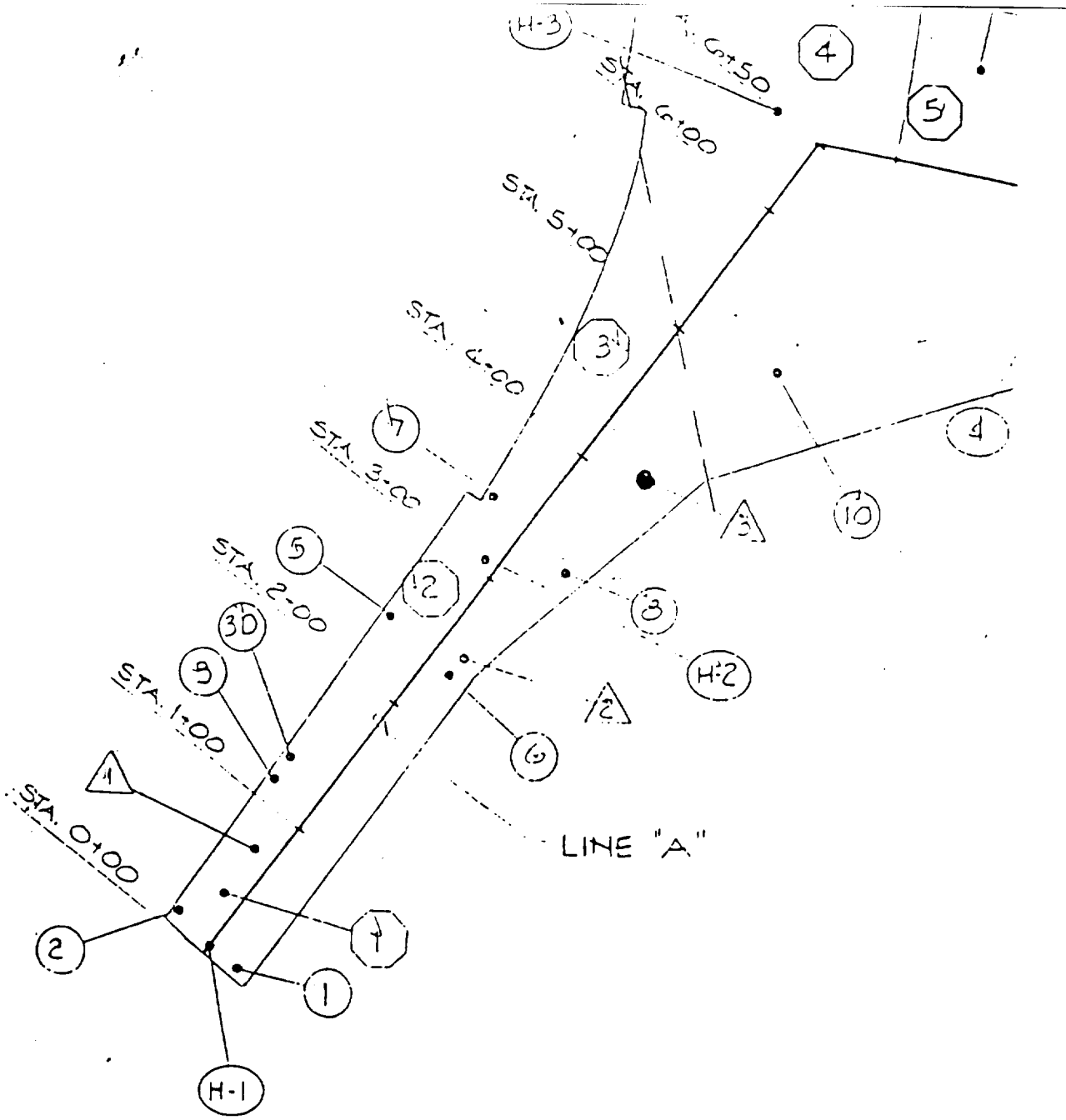
0-1


STA. 0+00
STA. 1+00
STA. 2+00
STA. 3+00
STA. 4+00
STA. 5+00
STA. 6+00
6+50
LINE "A"
H-1
H-2
1
2
3
3D
4
5
6
7
10

1-2


STA. 6+50
STA. 6+00
STA. 5+00
STA. 4+00
STA. 3+00
STA. 2+00
STA. 1+00
STA. 0+00
LINE "A"
4
5
3
7
4
10
3
5
12
8
3D
9
H-2
2
6
4
2
1
1
H-1

2-3



3-4 Poor Positioning of points

HARBOR

LAYER	Kg	σ
0 - 1	53,184	572792 = .6 x 10^6
1 - 2	389,856	1.6 x 10^6
2 - 3	154,363	0.76 x 10^6
3 - 4	4273	
4 - 5	247	
	601923	1.87 x 10^6

ESTIMATES OF TOTAL PCB MASS IN HARBOR

			IN DEP
BEST	ESTIMATE	602,000 kg	9,200
HIGH	ESTIMATE	2,472,000 kg	670,000

HARBOR SEGM

HORIZ. AREA

SEG	A(FT)² *	M²
	55944	5197
	55944	5197
	97903	9095
	167833	15592
	181819	16891
	167833	15592
	202799	18840
	419589	38979
	167833	15592
	104895	9745
	118882	11044
	167833	15592

*From Model Input WAUK1

$$M_{PCB}(kg) = \mu_r \left(\frac{\mu g}{g}\right) A(m^2)\,(.0003962)$$

HAR 0-1 FT

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	σ_M
1	7.7	9.9	24,835	278182	51,136	572791
2	5.1	6.1	270	354	556	729
3	3.3	4.3	45	59	162	213
4	3.9	4.8	74	83	457	513
5	3.0	4.3	47	98	314	655
6	3.0	3.8	28	26	173	161
7	2.5	3.5	20	26	149	194
8	2.2	2.6	10	4	154	62
9			.03		.2	
10	0.9	2.8	15	90	58	348
11			N.D.			
12	0.7	1.8	4	6	25	37

$M = \mu_r \times A(m^2) \times (0.0003962)$; $\sum$ 53,184 ± 572792

M (kg)

μ_r ($\frac{\mu g}{g}$)

HAR 1-2 FT

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	σ_M
1	10.7	12.4	188,151	775614	387412	$1,6 \times 10^6$
2	5.6	6.5	405	453	844	933
3	5.3	5.8	227	121	818	436
4	3.8	4.8	74	97	457	600
5	N.D					
6	2.7	3.7	25	32	154	198
7	2.2	3.1	14	15	105	112
8	1.0	4.6 (?)	1772 (-)+	(-)+		
			3*		46	
9	N.D				-	
10	.7	6.4 (?)	(-)+	(-)		
			2*		8	
11	N.D					
					-	
12	.9	1.9 (?)	28	4		
			2*		12	

(?) 2 data points only, -
(-)+ Artifically large
* geom mean

Σ 389,856

HAR 2-3 FT

SEG	μ_x	$\mu_x + \sigma_x$	μ_r	σ_r	M	σ_M
1	9.6	11.4	74608	369543	153,621	760,908
2 (?)			60*		124	
3			N.D.		-	-
4	3.4	7.5	133920	5.9×10^8		
5			31*		192*	
			13(!)			
6	2.4	3.4	18	24	111	148
7	2.4	3.2	15	14	112	105
8			1.9(!)		29	
9			27(!)		167	
10			N.D.		-	
11 (?)			1.6*		7	
12 (!)			.06*		.4	

(?) Two data points only
* Geom. mean
(!) Only one data pnt

$\sum$ 154363

HAR 3-4 FT

In all segments there are ≤ 4 data points or less, thus the log-normal distribution and its parameters cannot be determined reasonably thus use geom. average of data.

SEG	$\langle \mu \rangle_g$	(dat pnts)	M
1	8	(3)	16
2	4	(4)	8
3	43	(2)	155
4	643	(1)	3972
5	N.D		
6	.07	(1)	.4
7	13	(1)	97
8	1	(2)	15
9	1	(1)	6
10	N.D		–
11	.7	(2)	3.
12	.01	(1)	.06
		Σ	4273

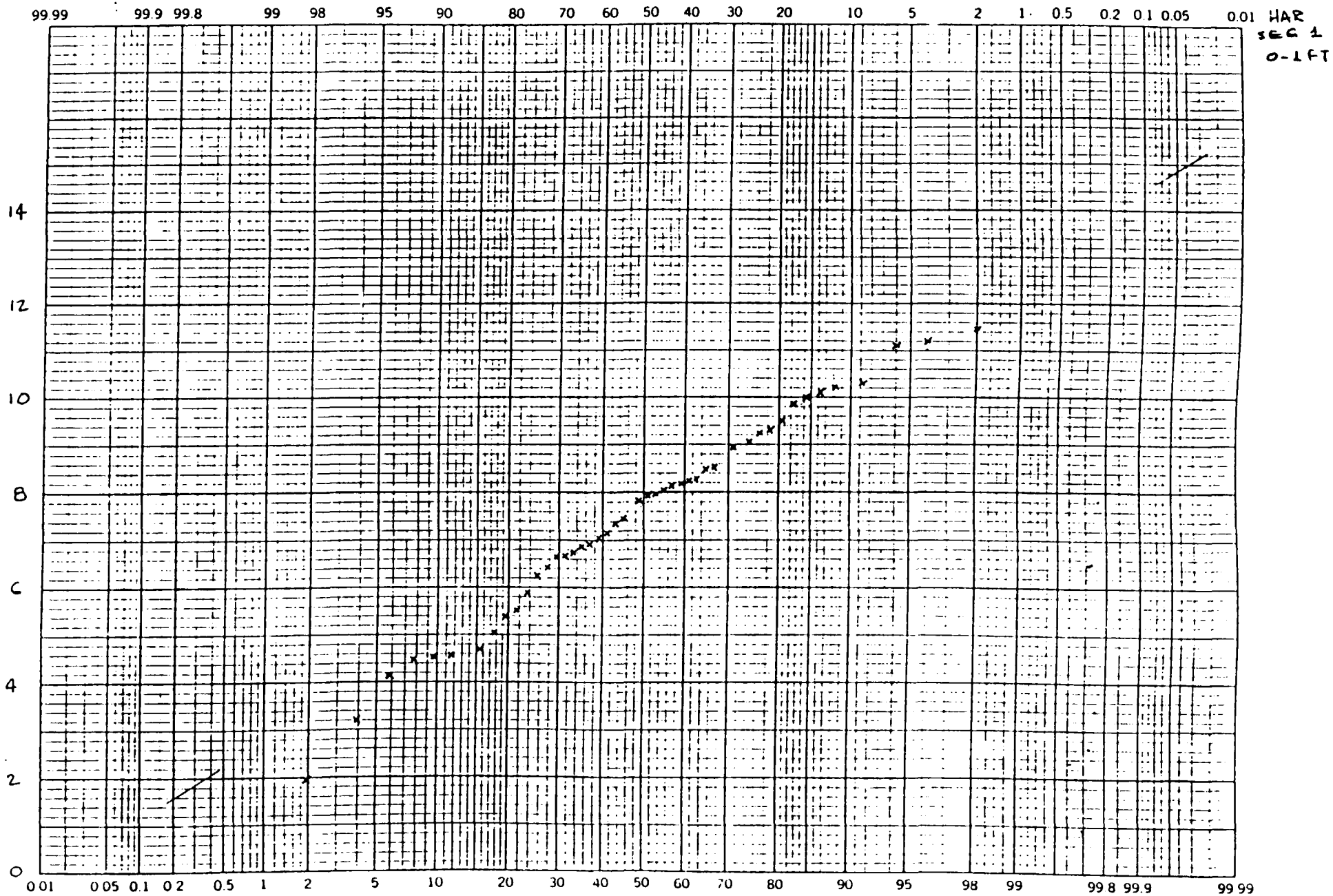
HAR 4-5 FT

The Comment for the 3-4 depth applies here as well

SEG	$\langle \mu_r \rangle_g$	(data points)	M
1	.45	(2)	1.
2	.3	(2)	1
3	1.	(2)	4.
4	N.D		–
5	N.D.		
6	.06	(1)	
7	32.	(1)	239
8	0.08	(1)	1
9	N.D.		–
10	N.D		–
11	0.2	(1)	.9
12	0.05	(1)	.3

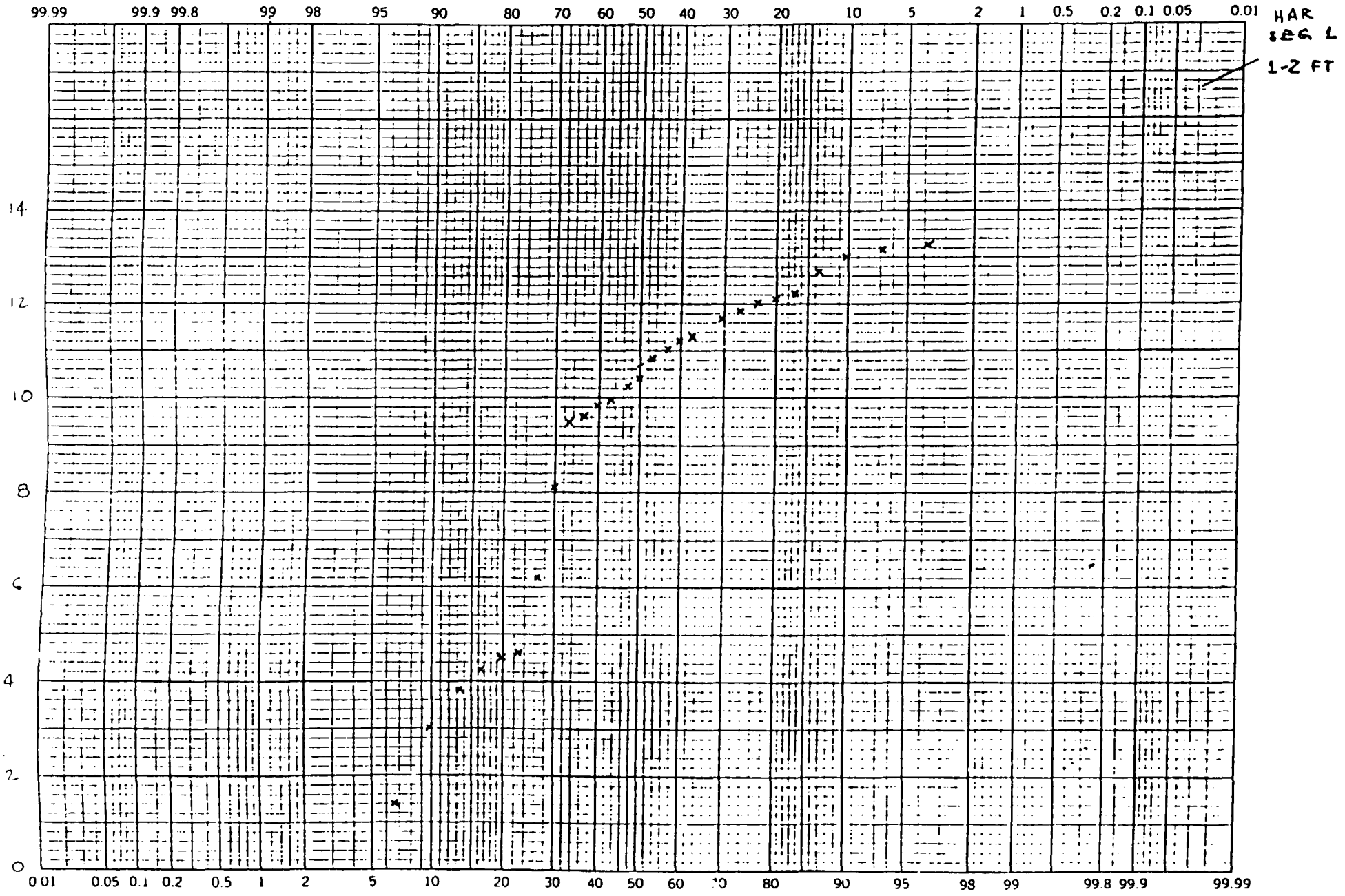
K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000



K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

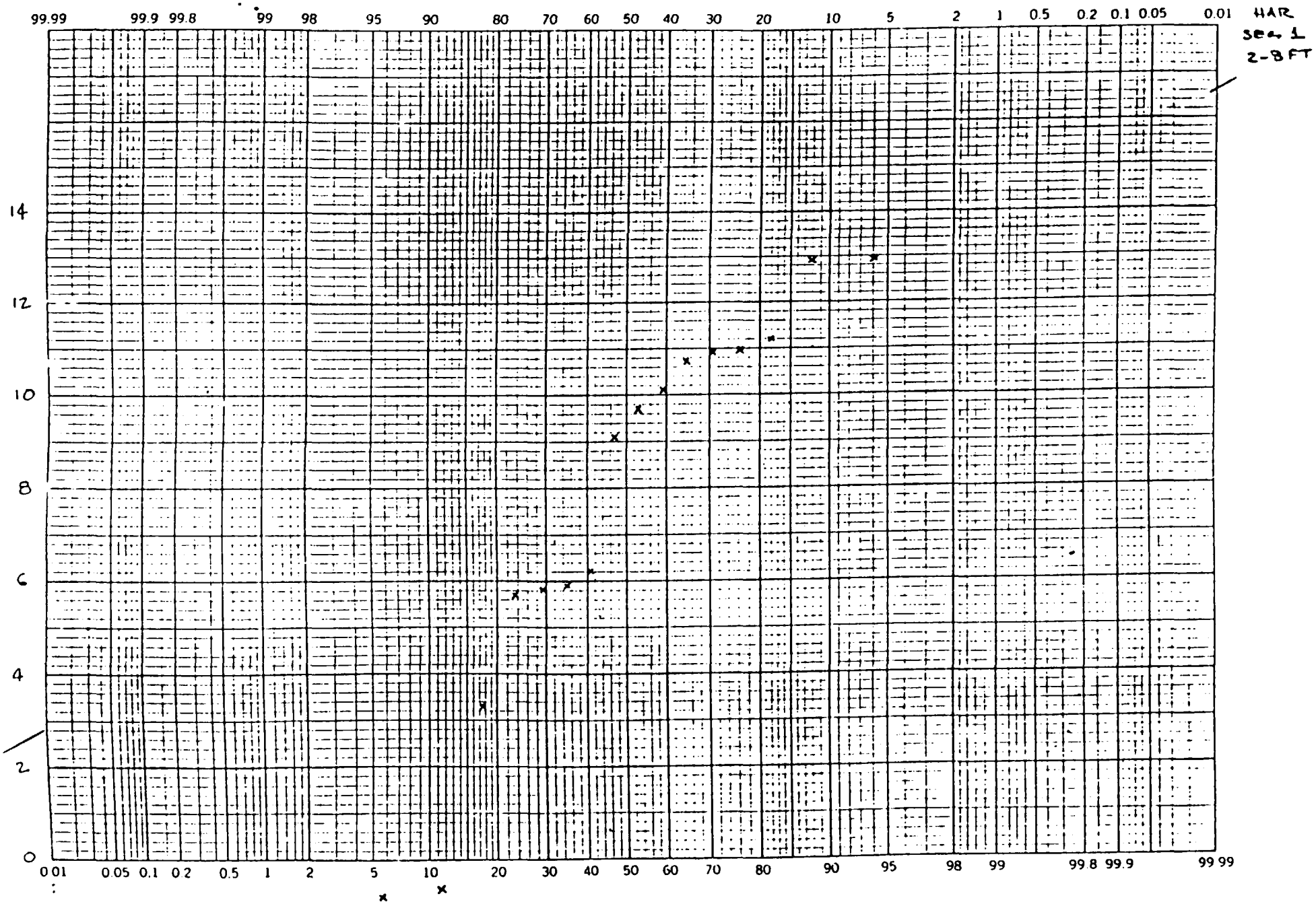
46 8000



-1.2 -

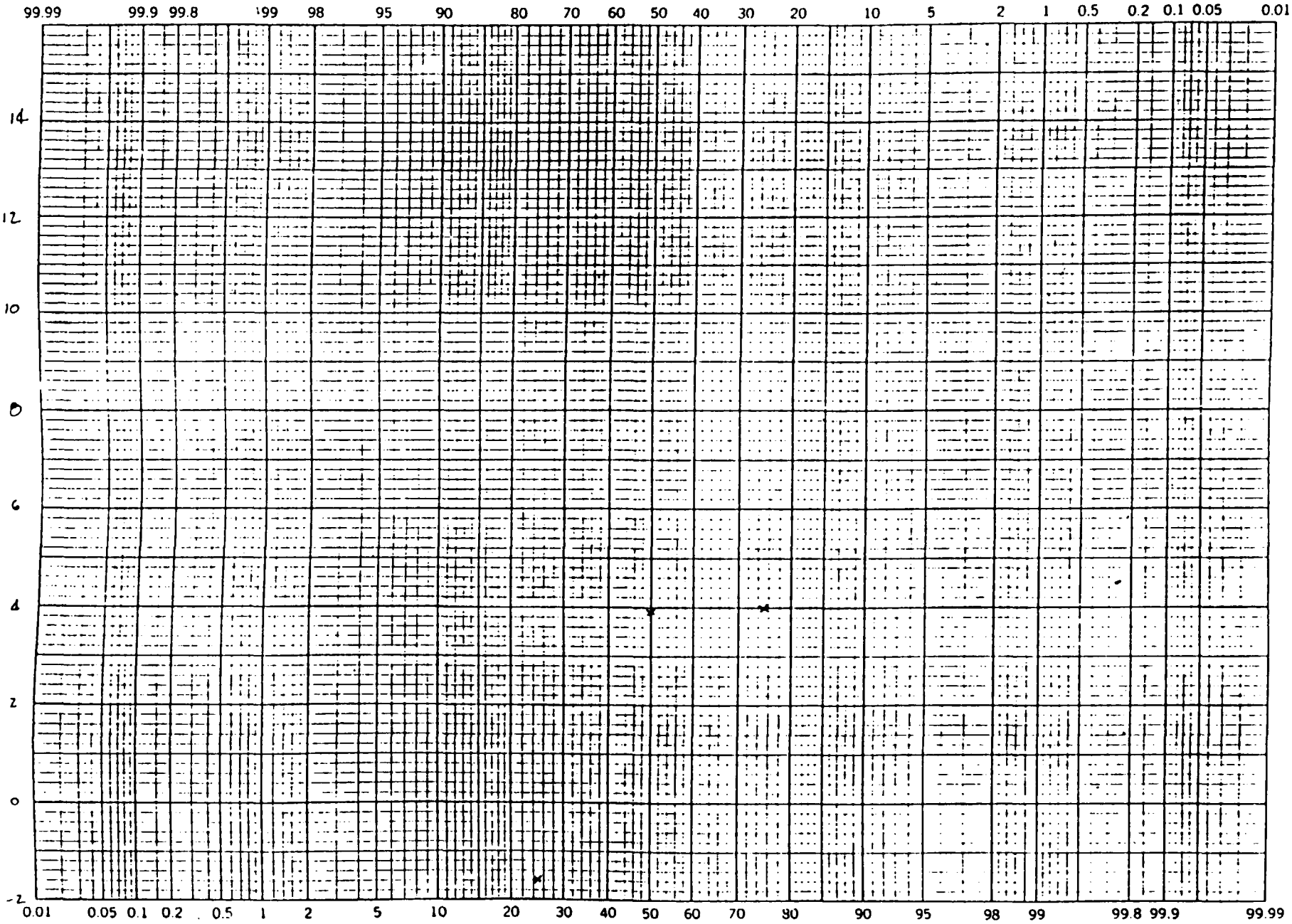
K•E PROBABILITY X 90 DIVISION KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

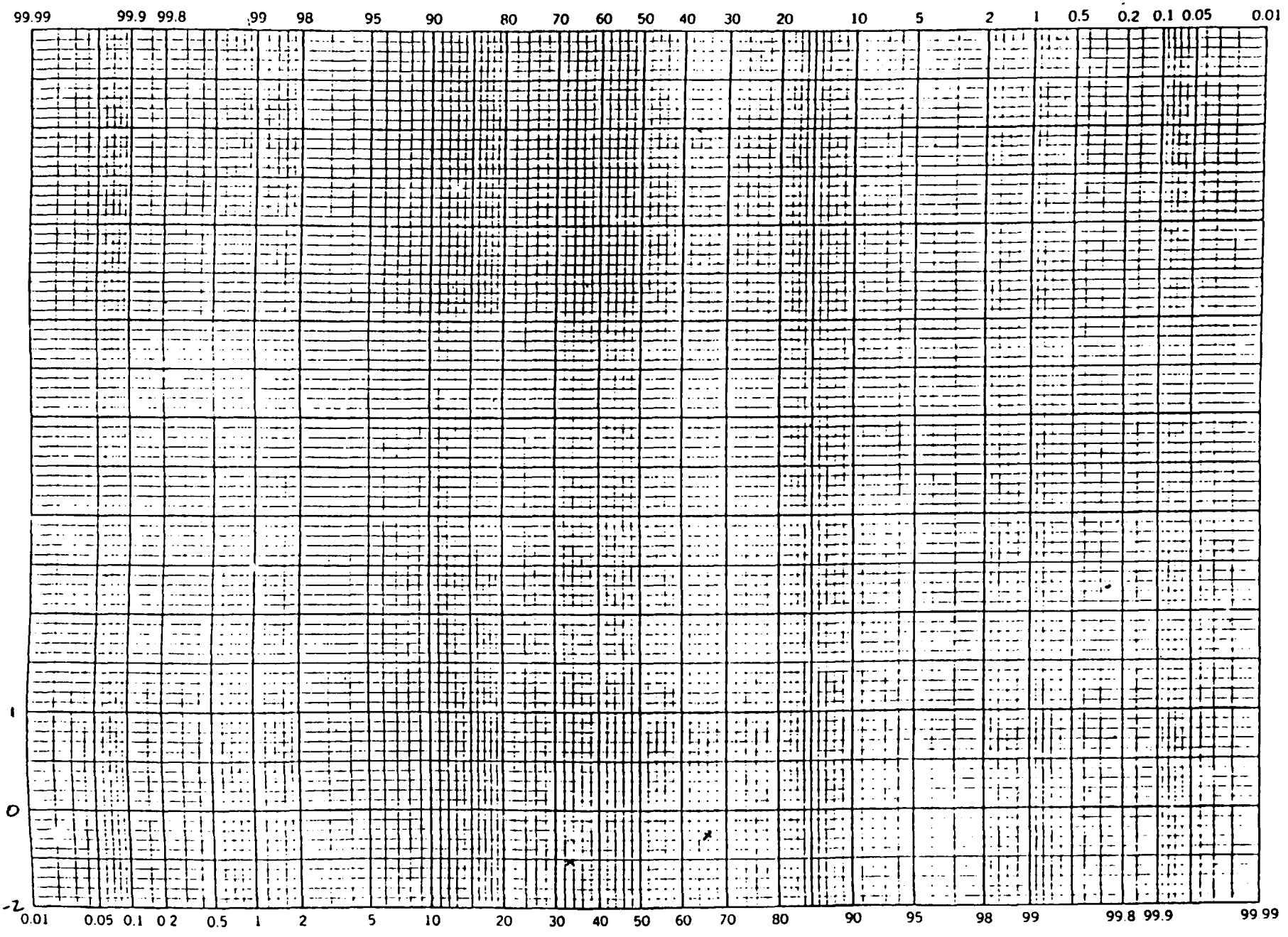
46 8000



HAR
SEQ 1
3-4

K•E PROBABILITY X 90 DIVISION KEUFFEL & ESSER CO. MADE IN U.S.

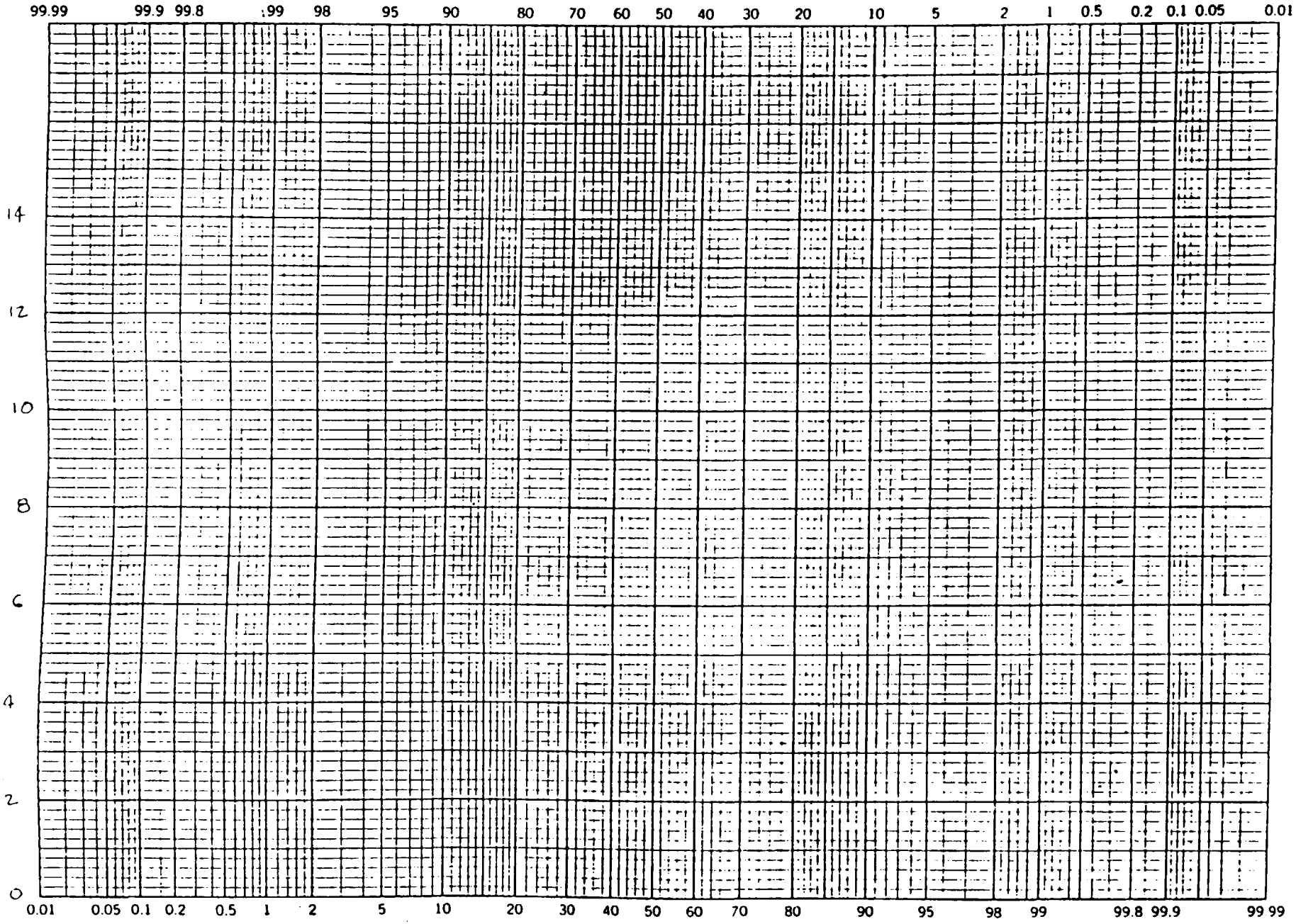
46 800



HAR
SEG L
4-5

K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

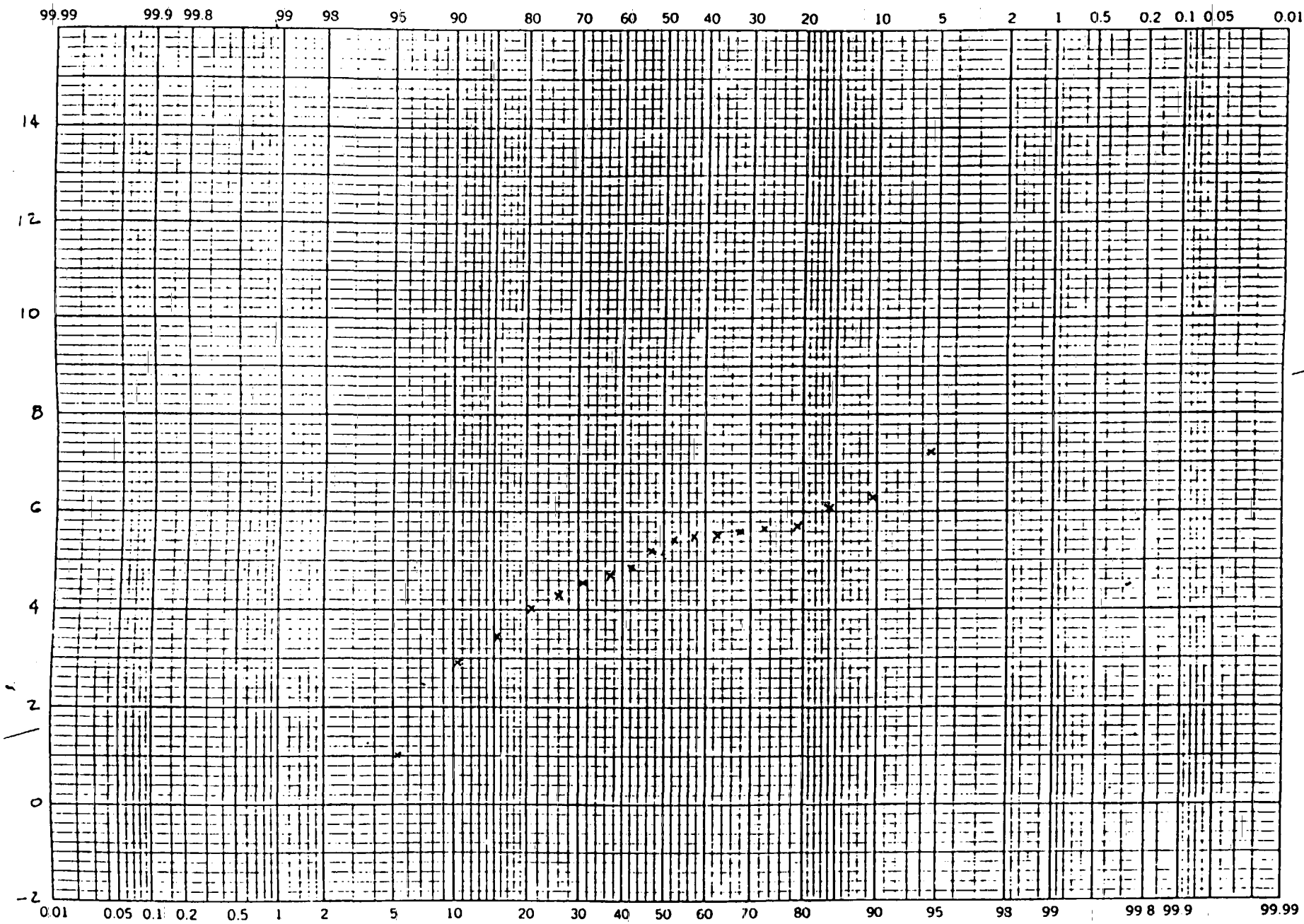
46 8000



K·E PROBABILITY X 90 DIVISION KEUFFEL & ESSER CO. MADE IN U.S.A.

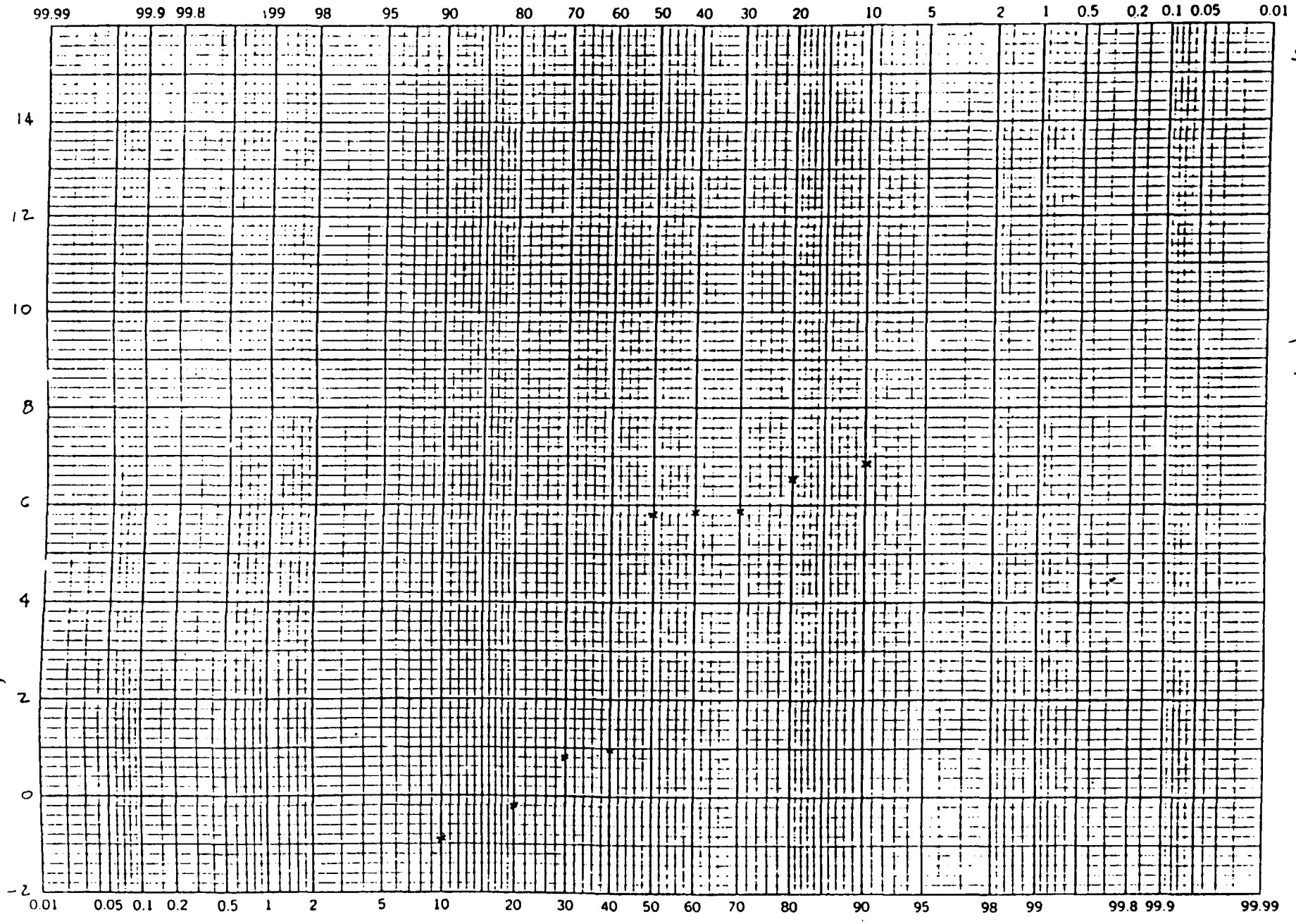
46 8000

HAR
SEC 2
0-1



K+E PROBABILITY X 90 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8000

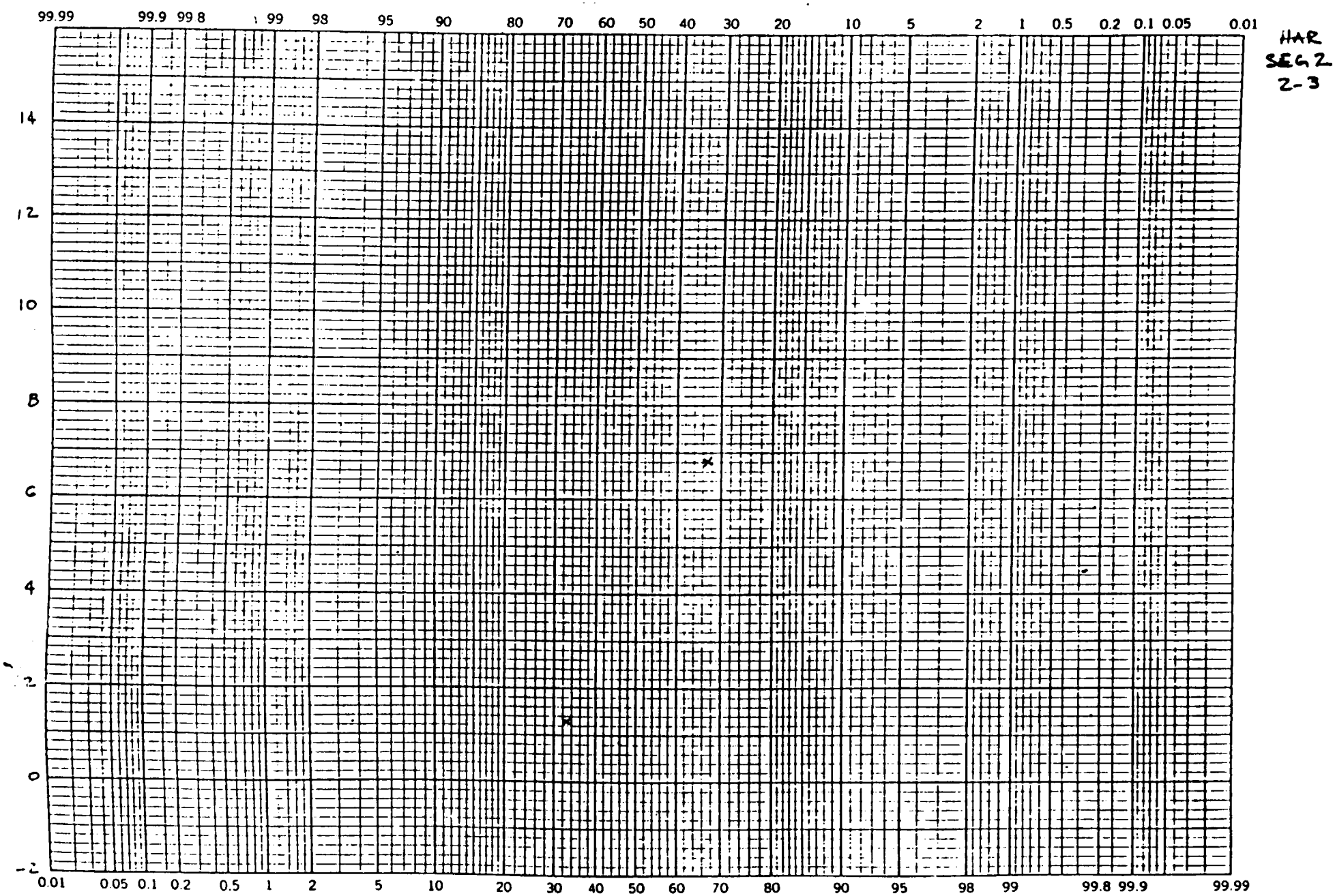


HAR
SEG 2
1-2

RV

K+E PROBABILITY X 90 DIVISION
KEUFFEL & ESSER CO. MADE IN U.S.A.

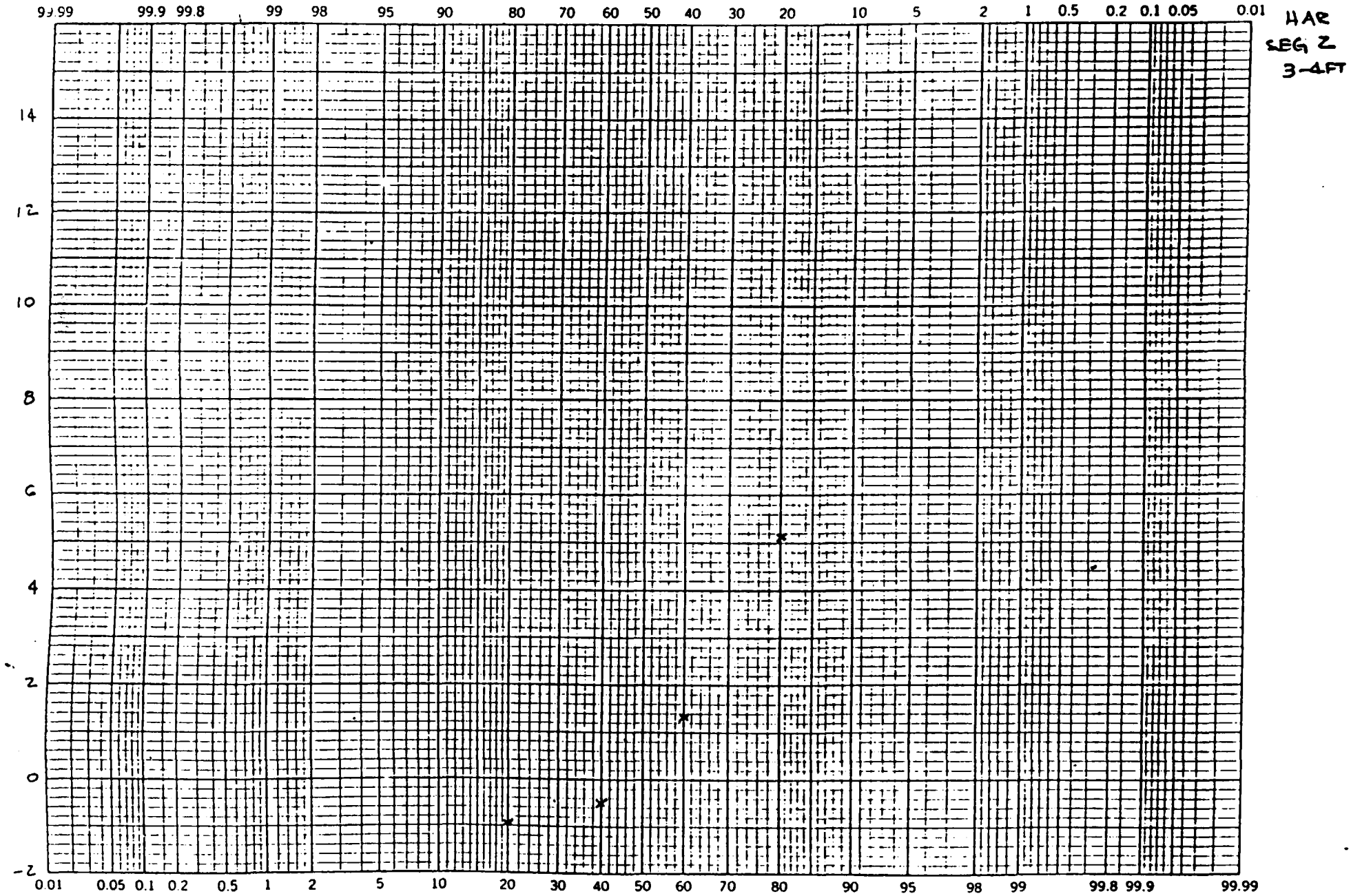
46 80



HAR
SEG 2
2-3

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

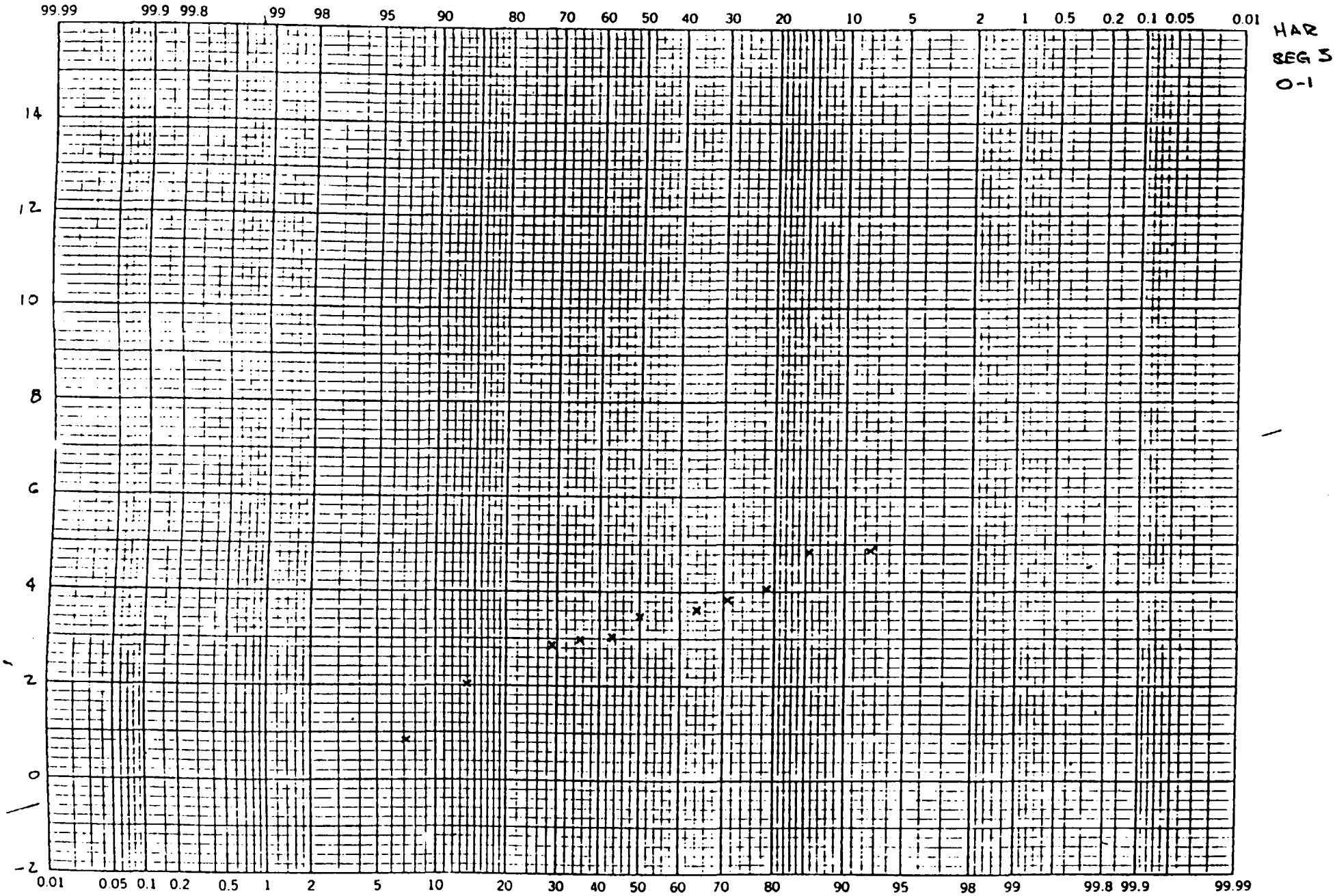
46 8000



HAR
SEG 2
3-4FT

K+E PROBABILITY X 90 DIVISIO. KEUFFEL & ESSER CO. MADE IN U.S.A.

46 80(

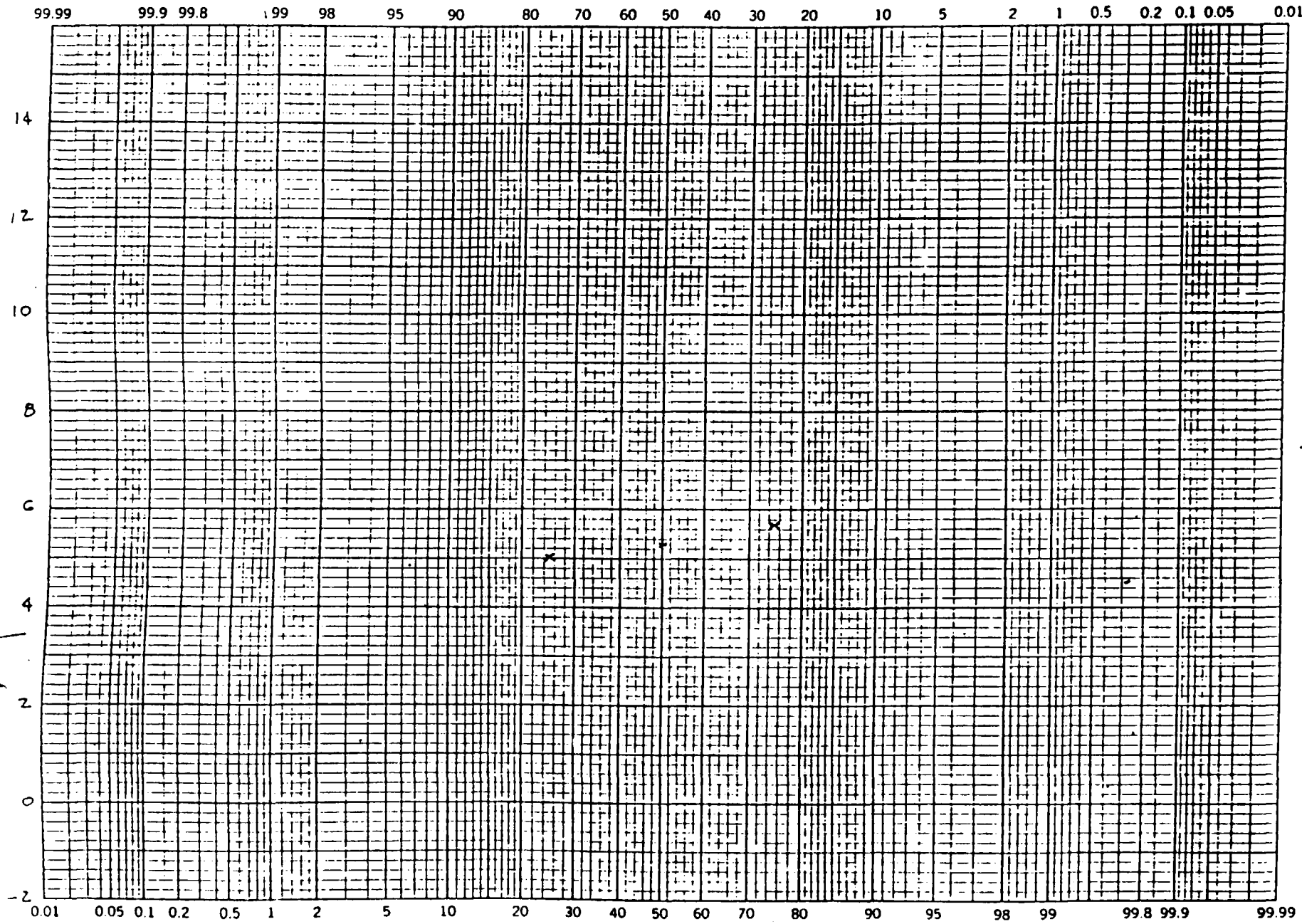


HAR
SEG 5
0-1

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

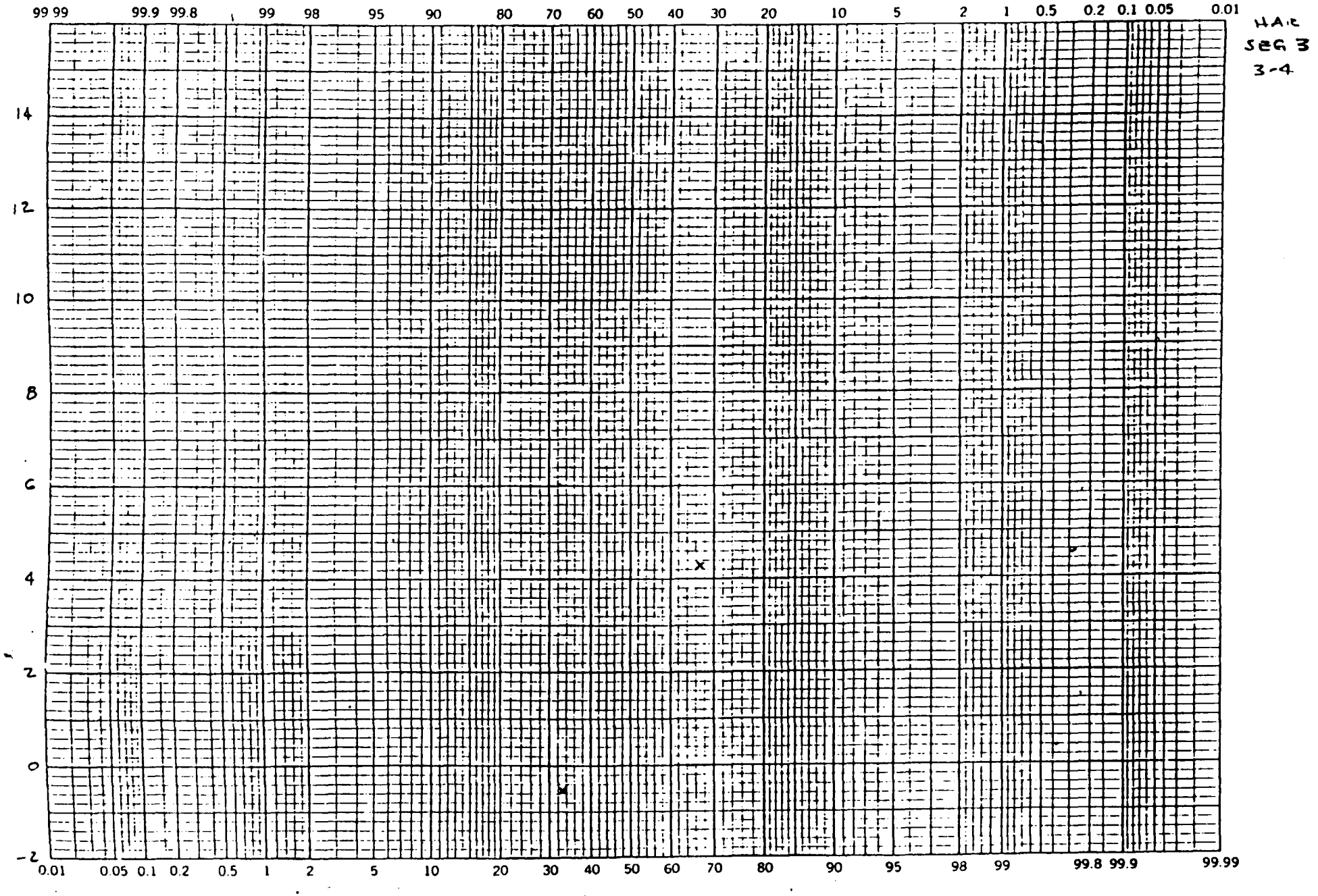
46 8000

HAR
SEG 3
1-2



K•E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

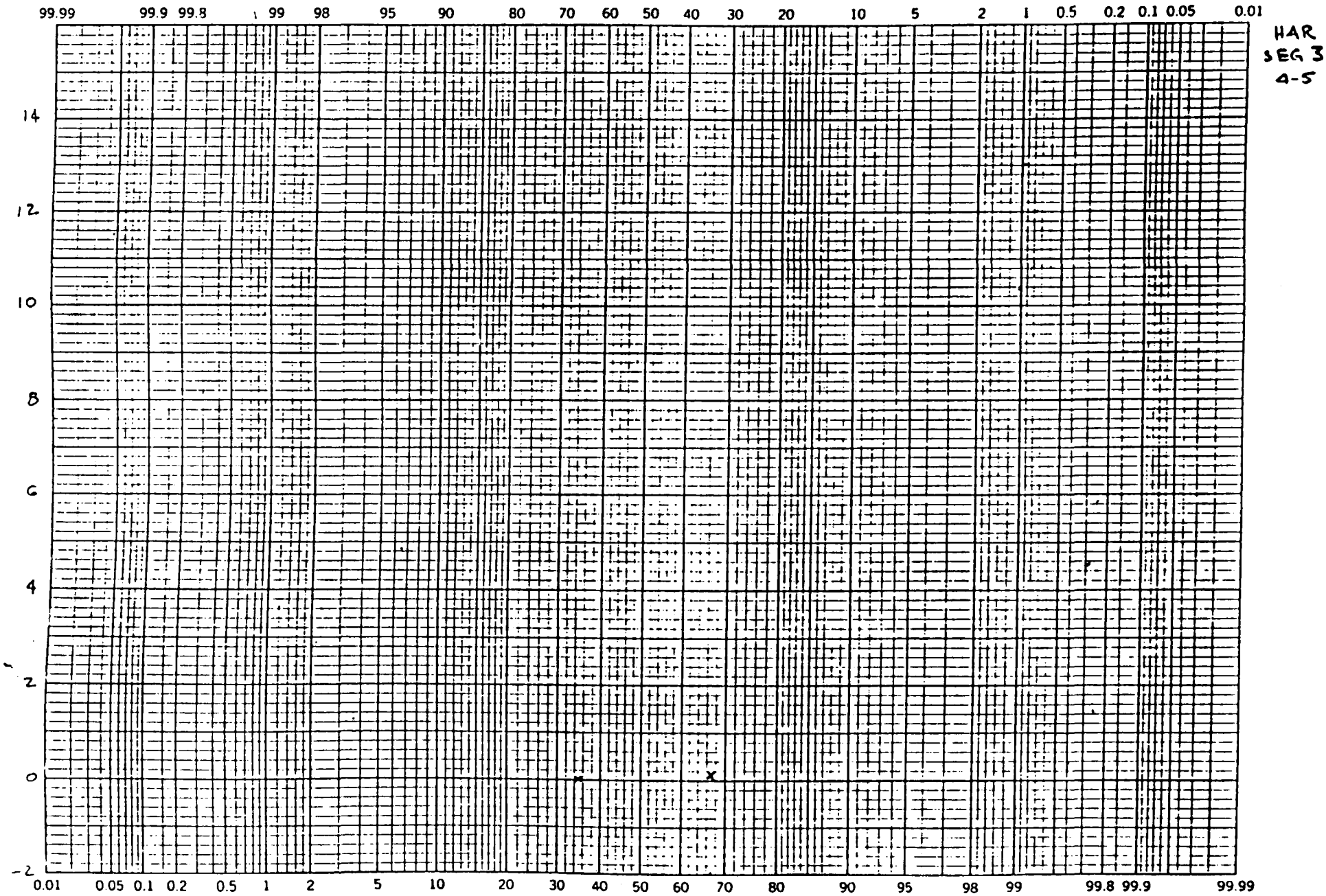
46 E 0



HAIR
SEG 3
3-4

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

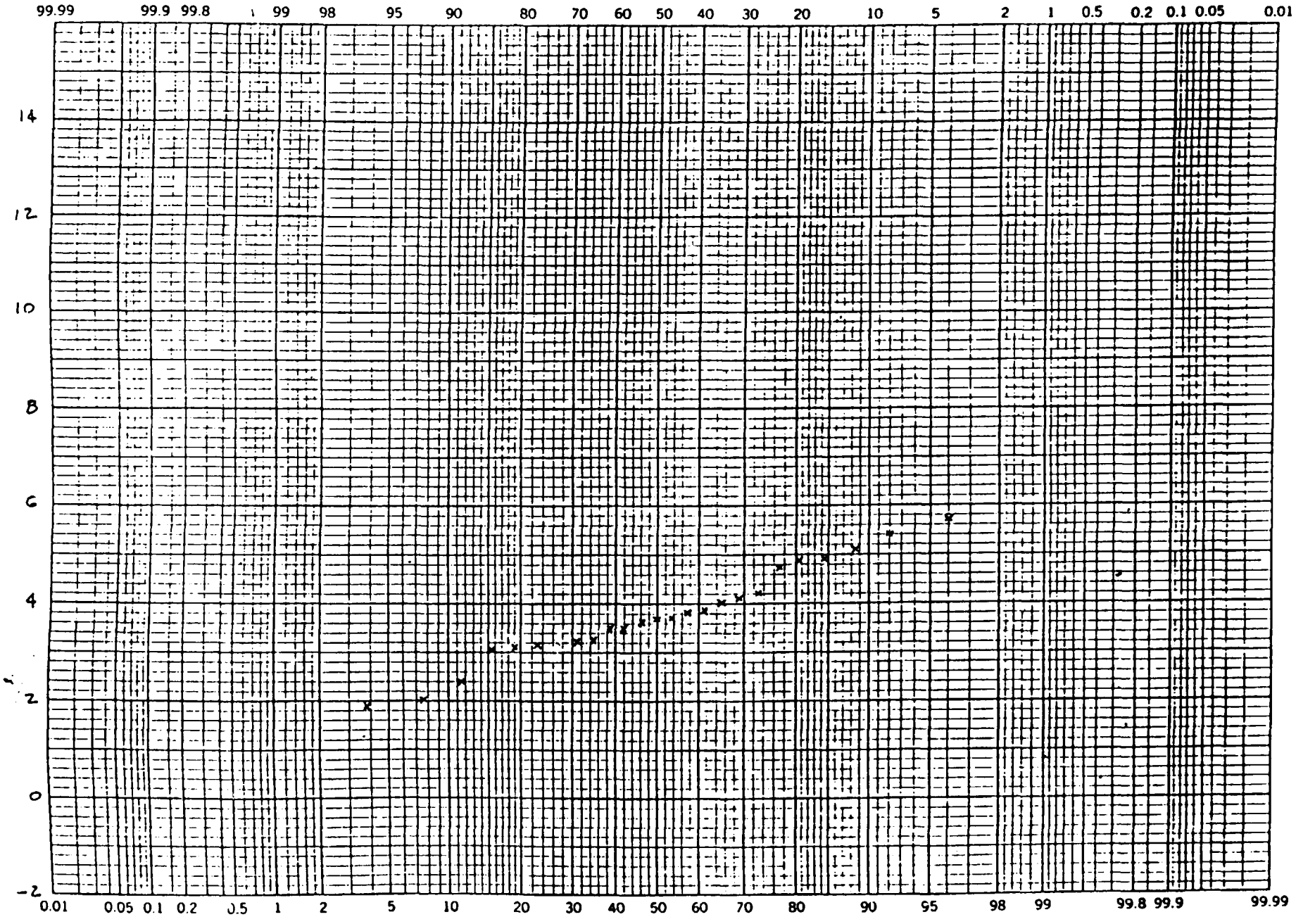
46 8000



HAR
SEG 3
4-5

K·E PROBABILITY X 90 DIVISI
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 8(



HAR
SEG4
0-1

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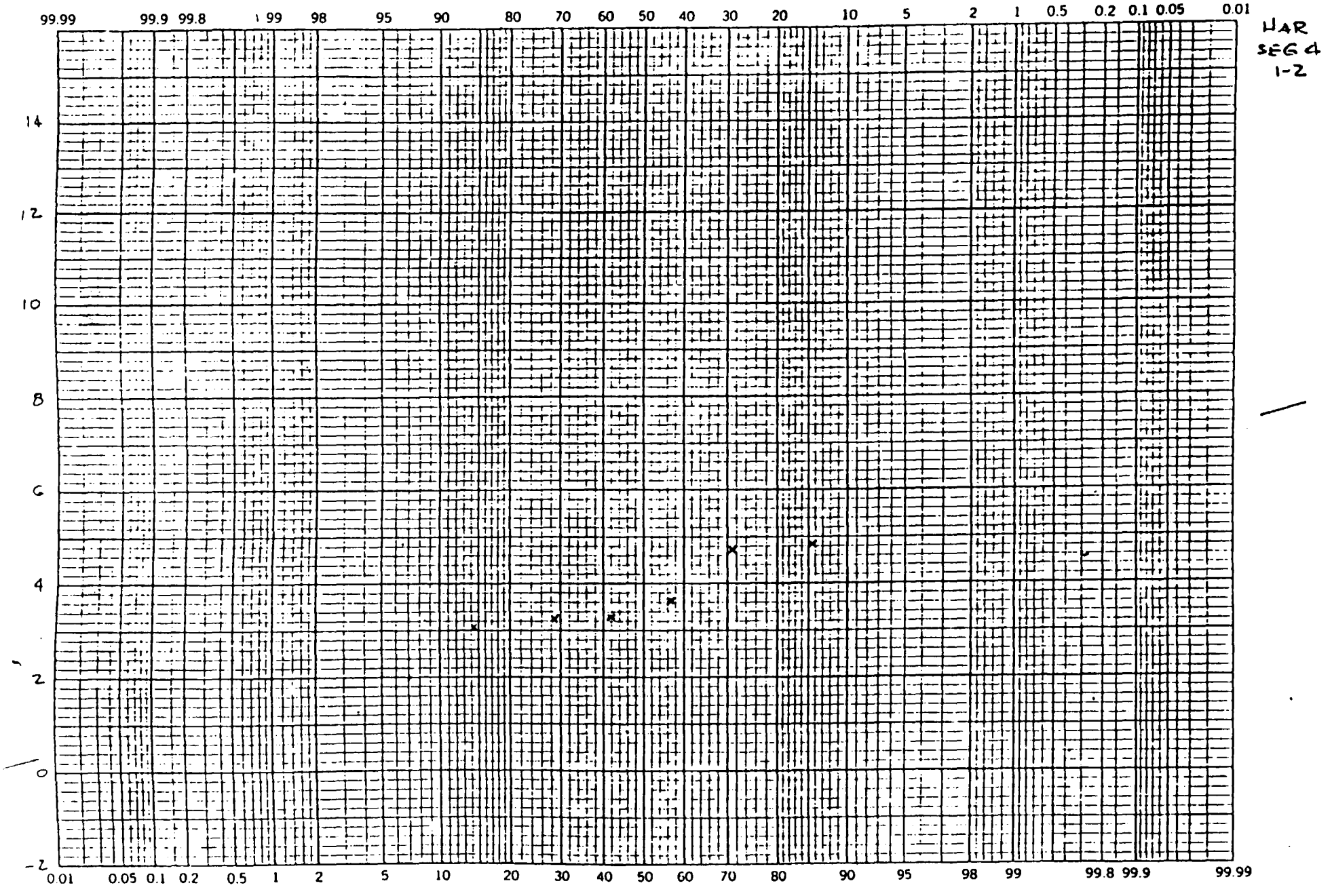
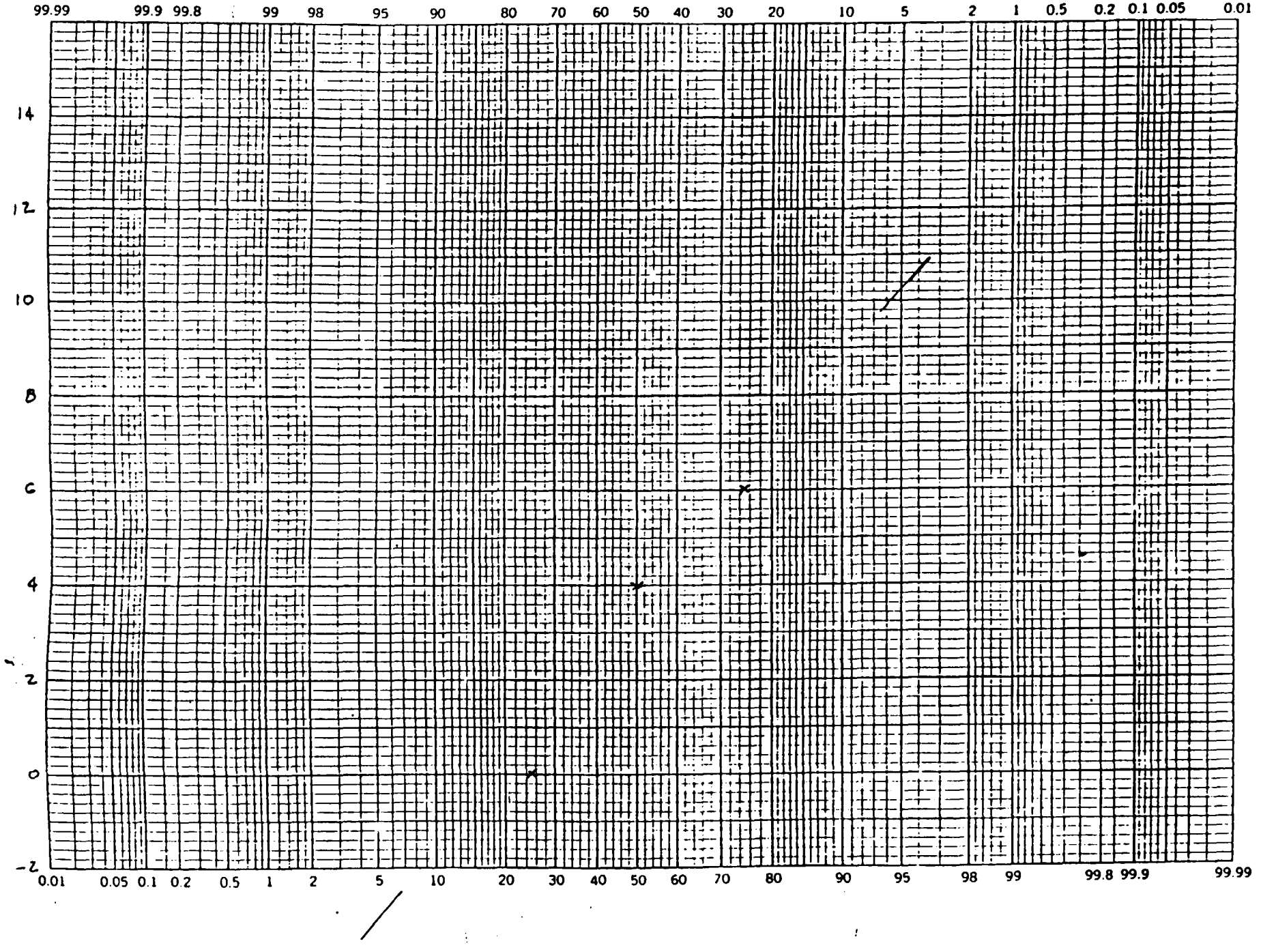
46 8000



HAR
SEG 4
1-2

K•E PROBABILITY X 90 DIVI 5
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 0



HAR
SEG 4
2-3

K•E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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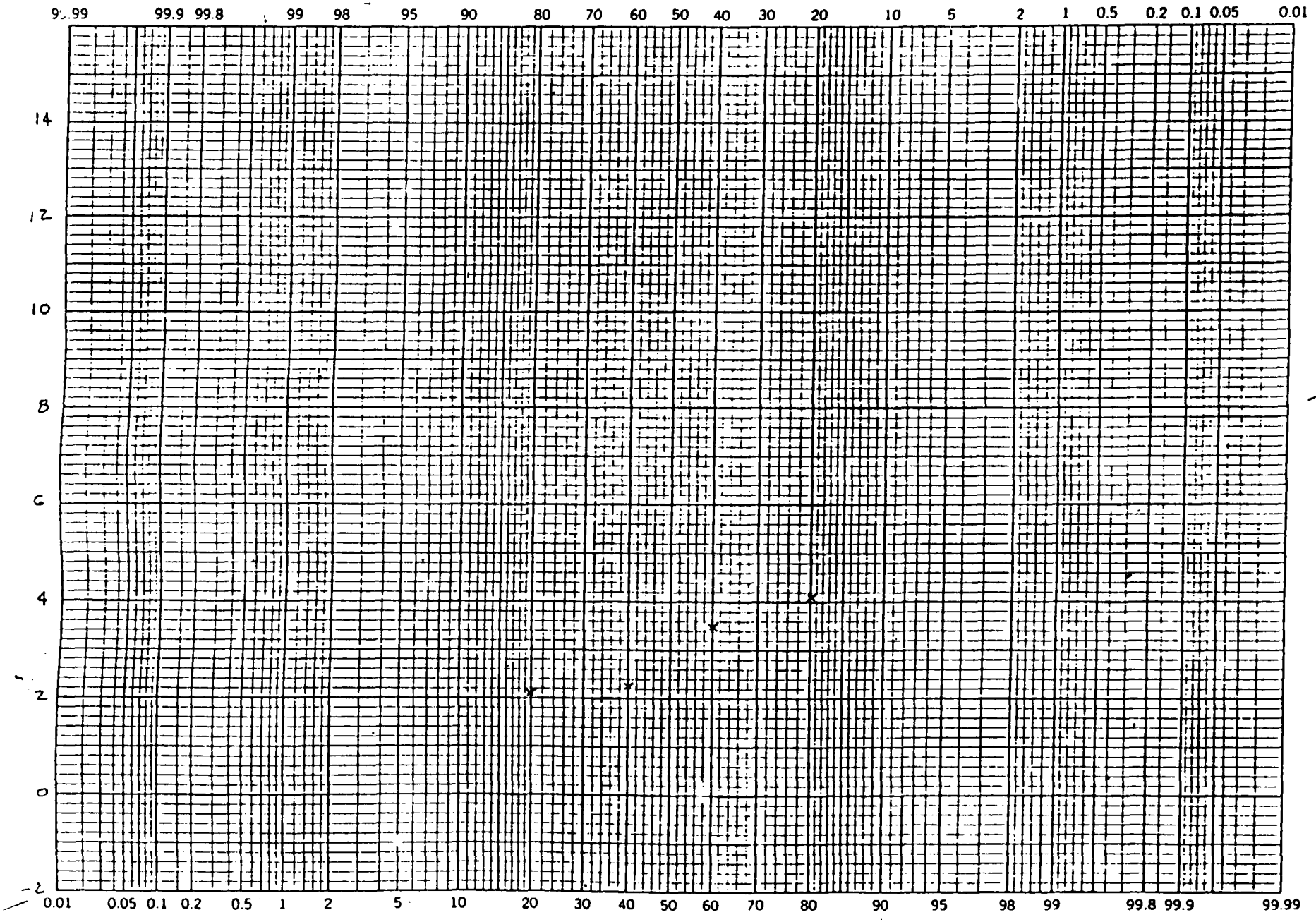
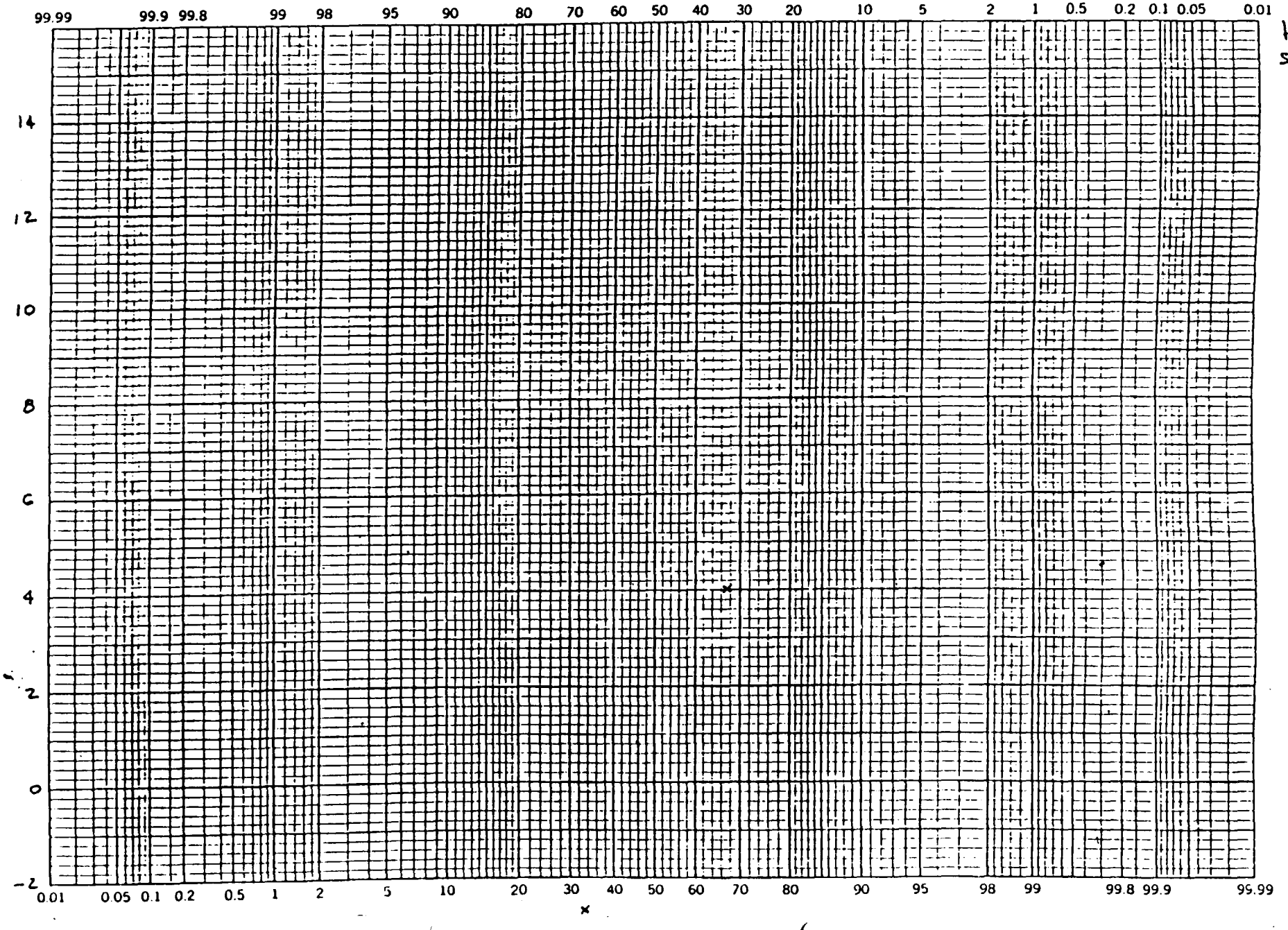


HAR
SEG 5
0-1

K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

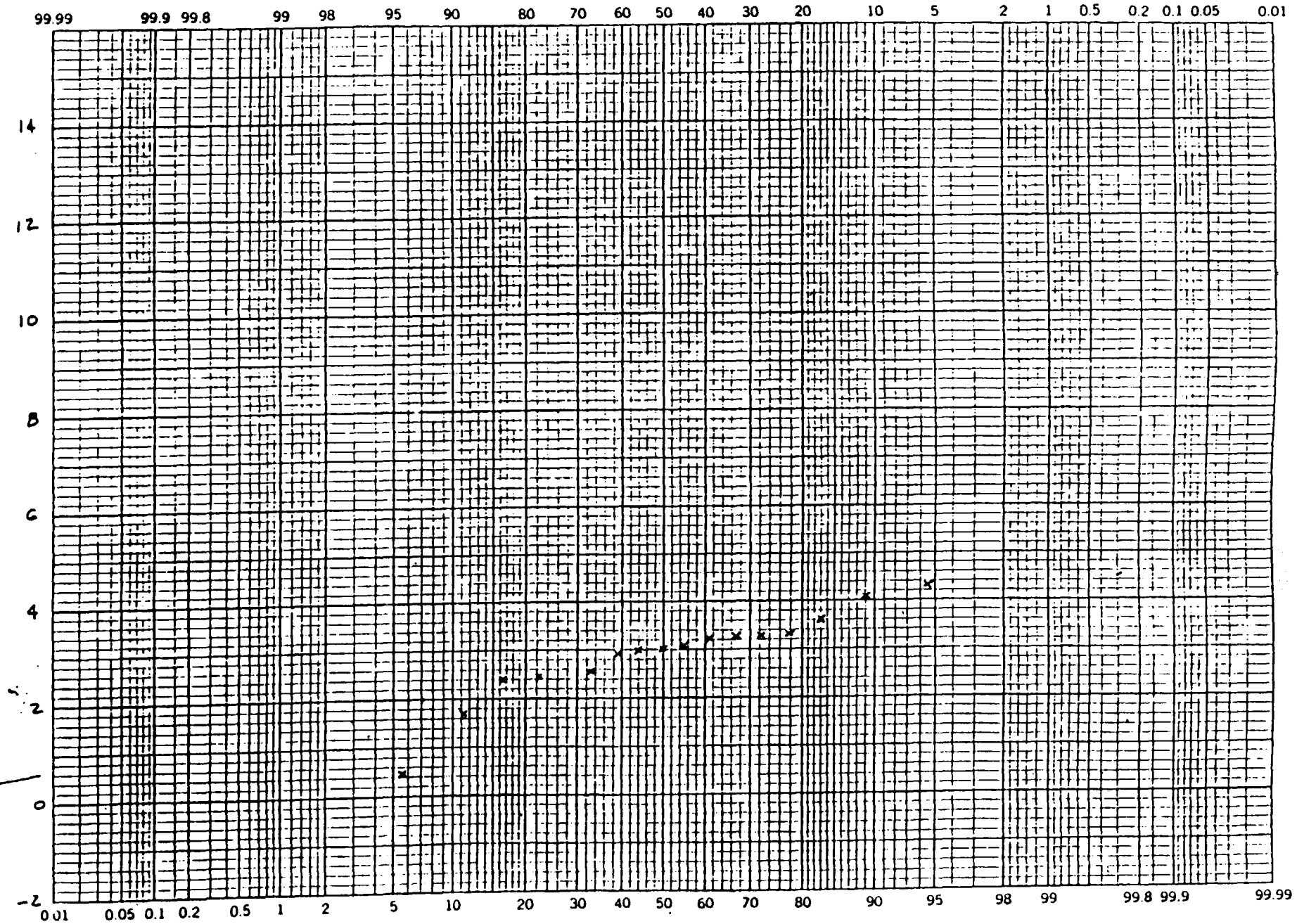
46 8000



HAR
SEG 5
1-2

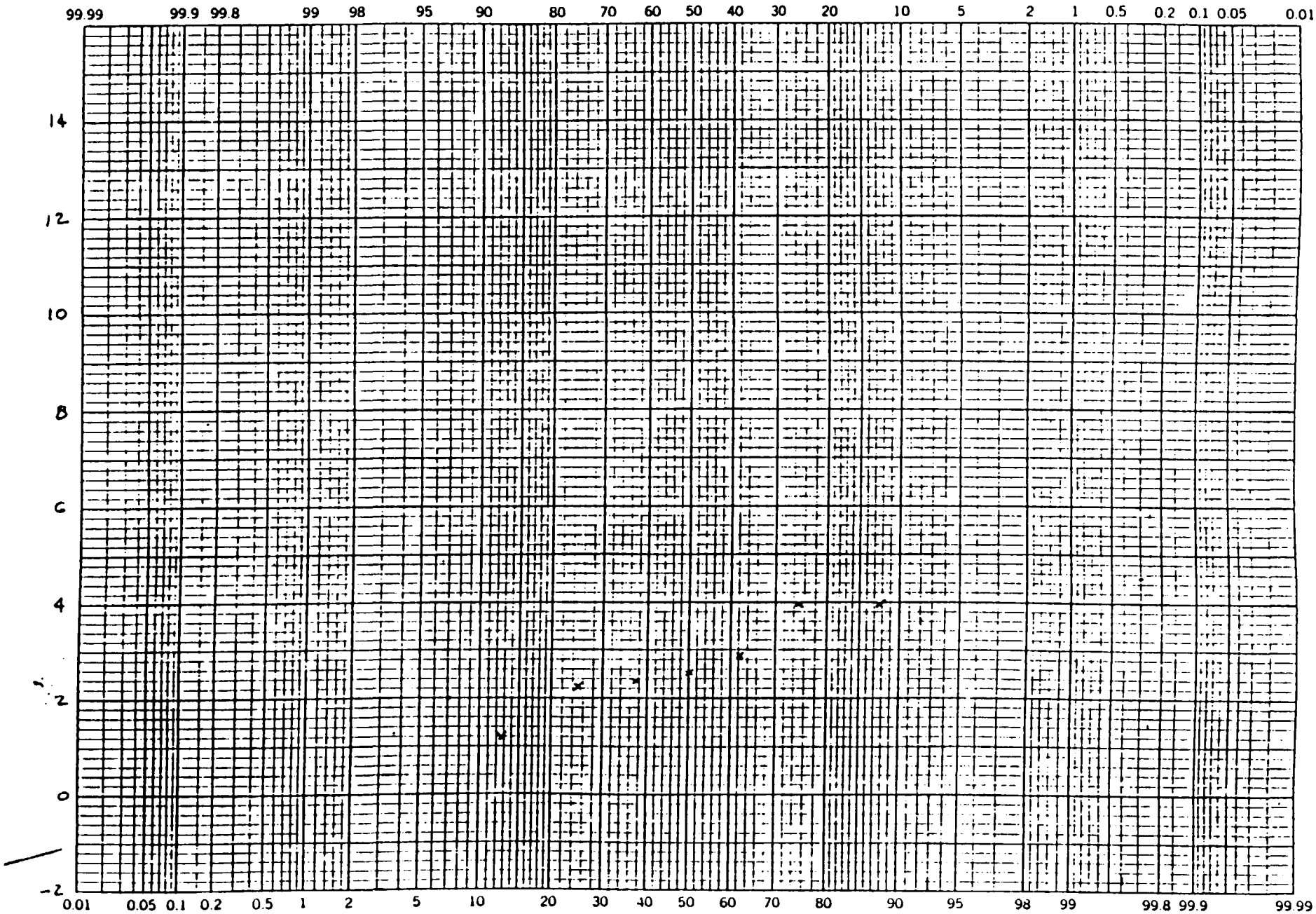
K·E PROBABILITY X DIVISIONS KEUFFEL & ESSER MADE IN USA

6 8000



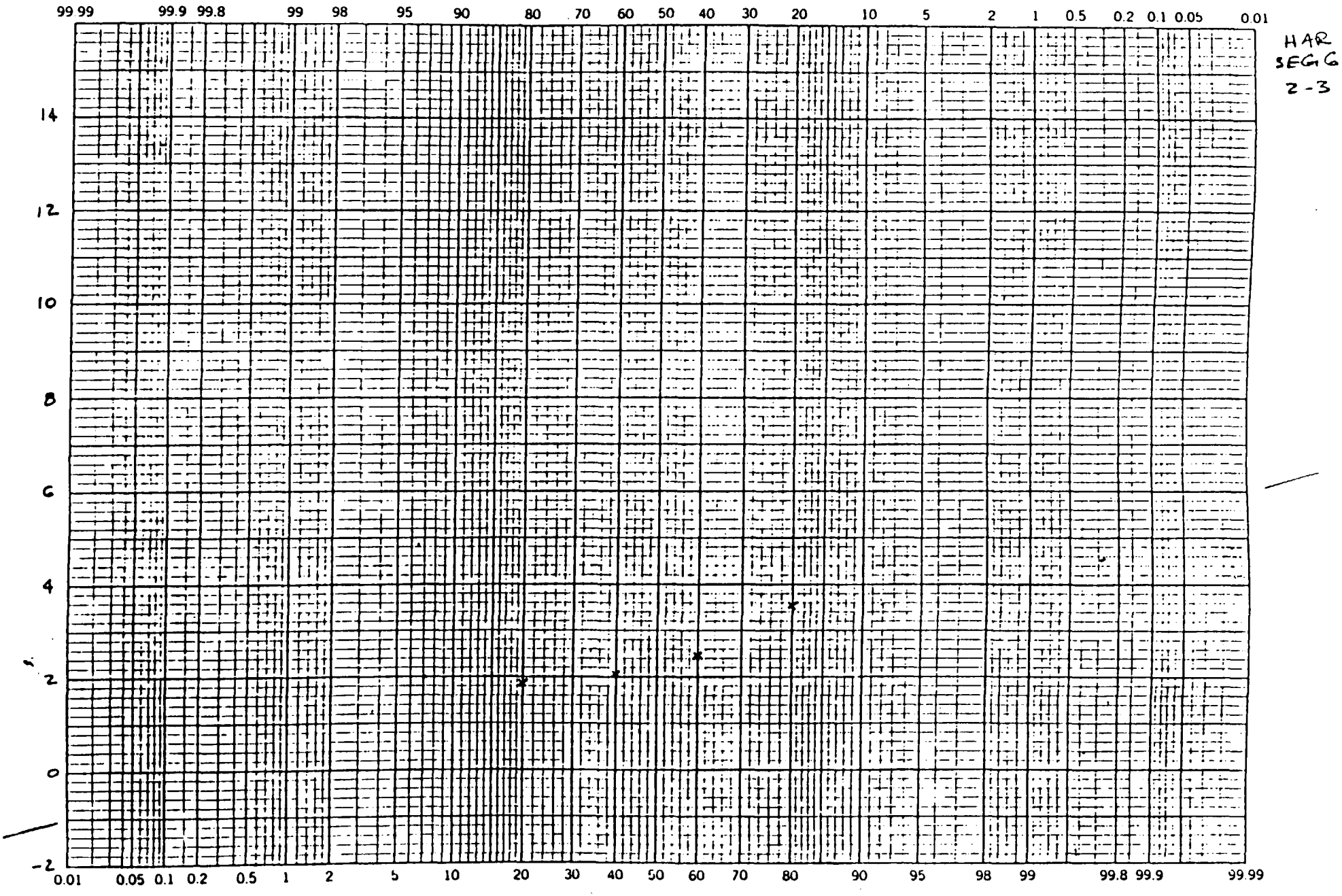
HAR
SEG 6
0-1

K·E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 46 8000



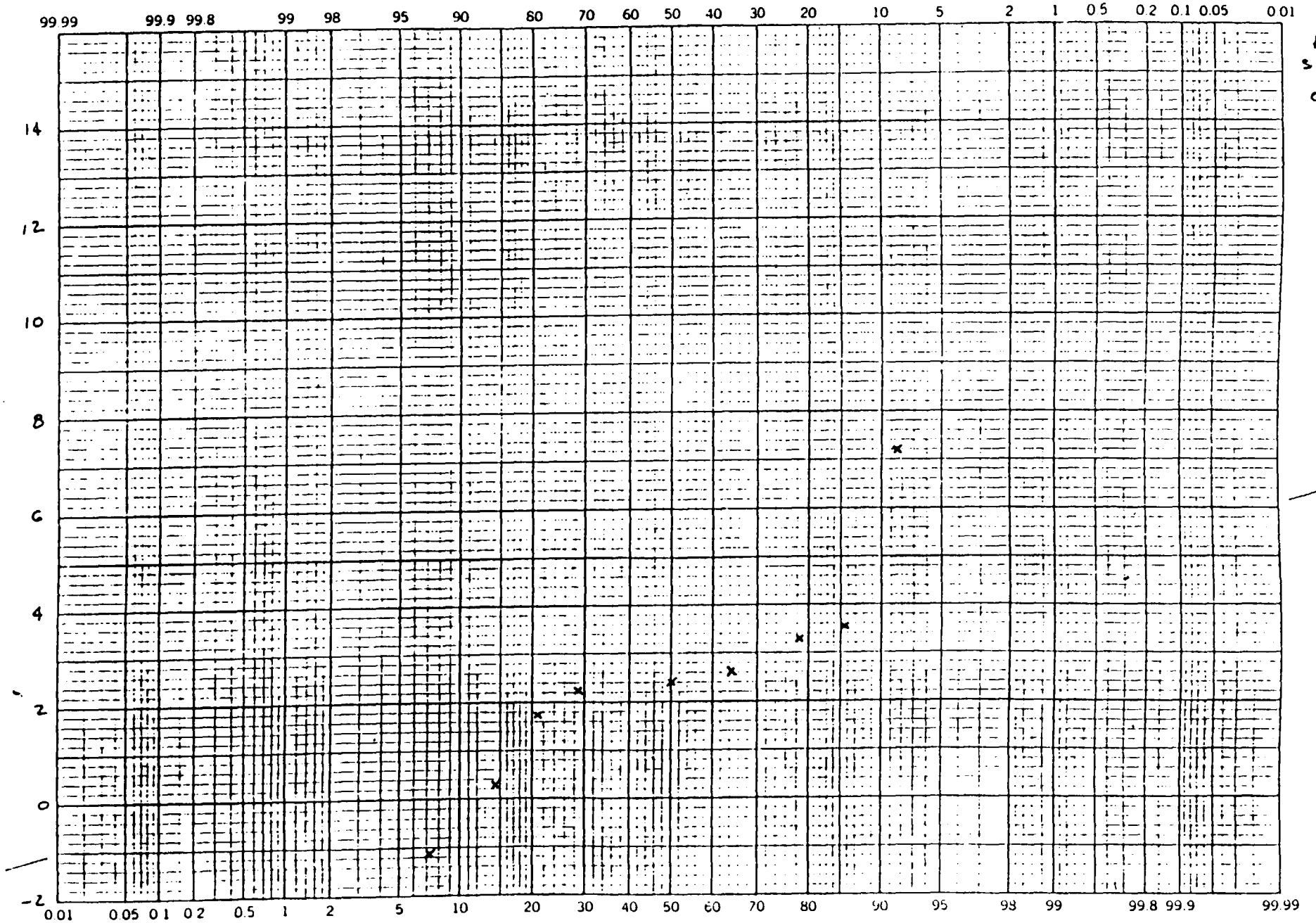
HAR
SEG6
1-2FT

K·E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 46 8000



HAR
SEGG
2-3

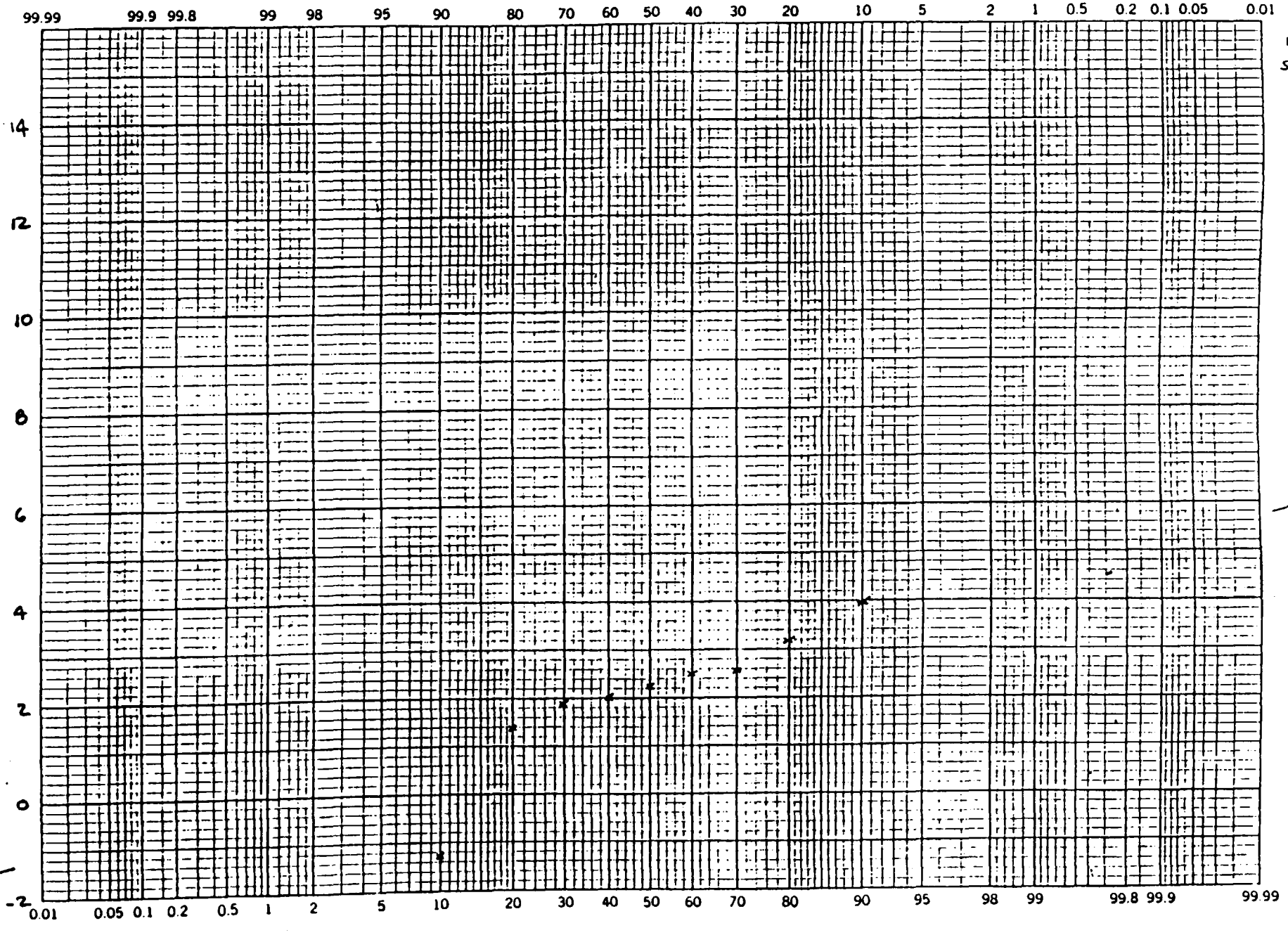
K•E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN USA 6 8000



HAR
SEG 7
0-1

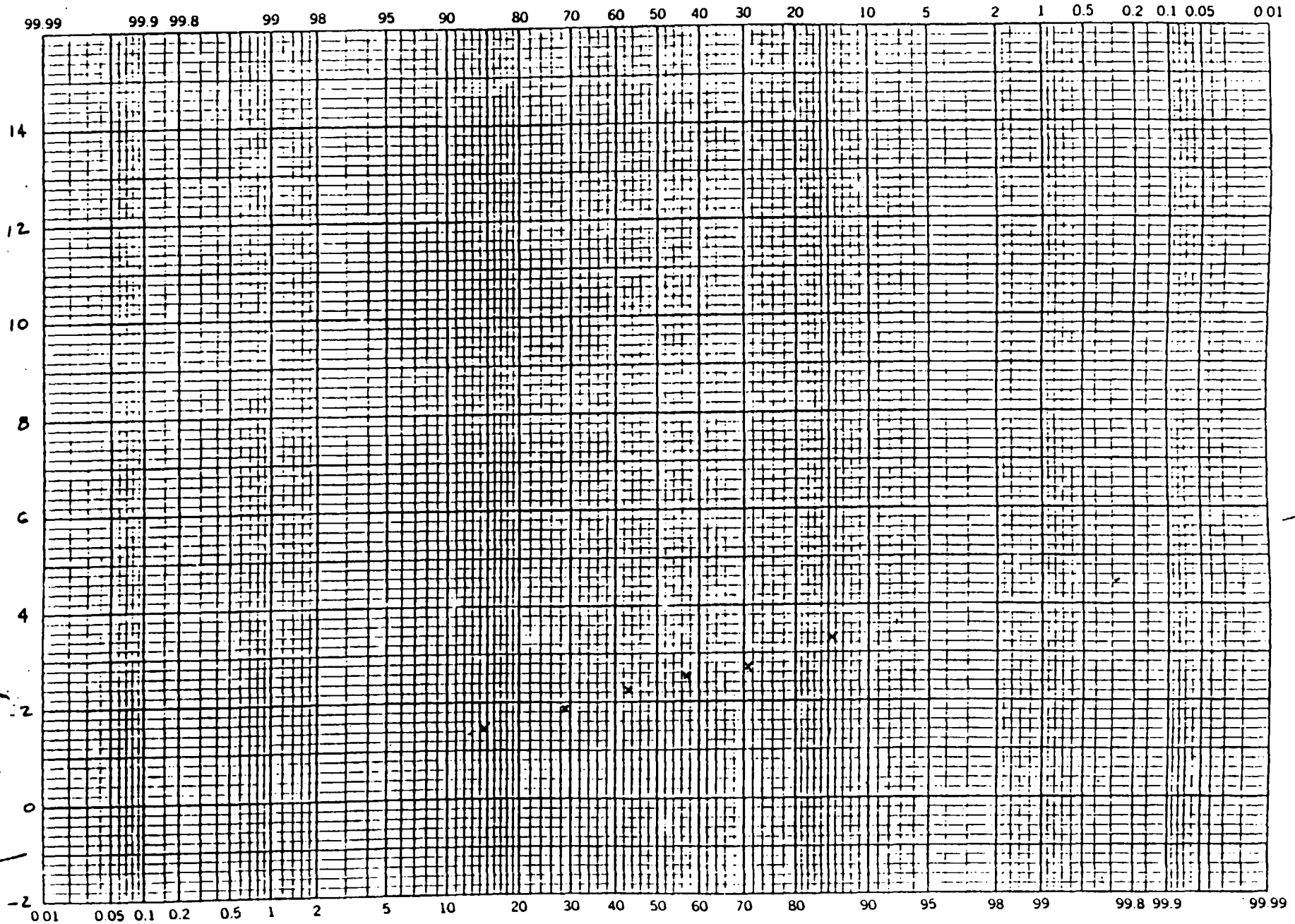
K•E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN USA 6 8000

HAR
SEG 7
1-2

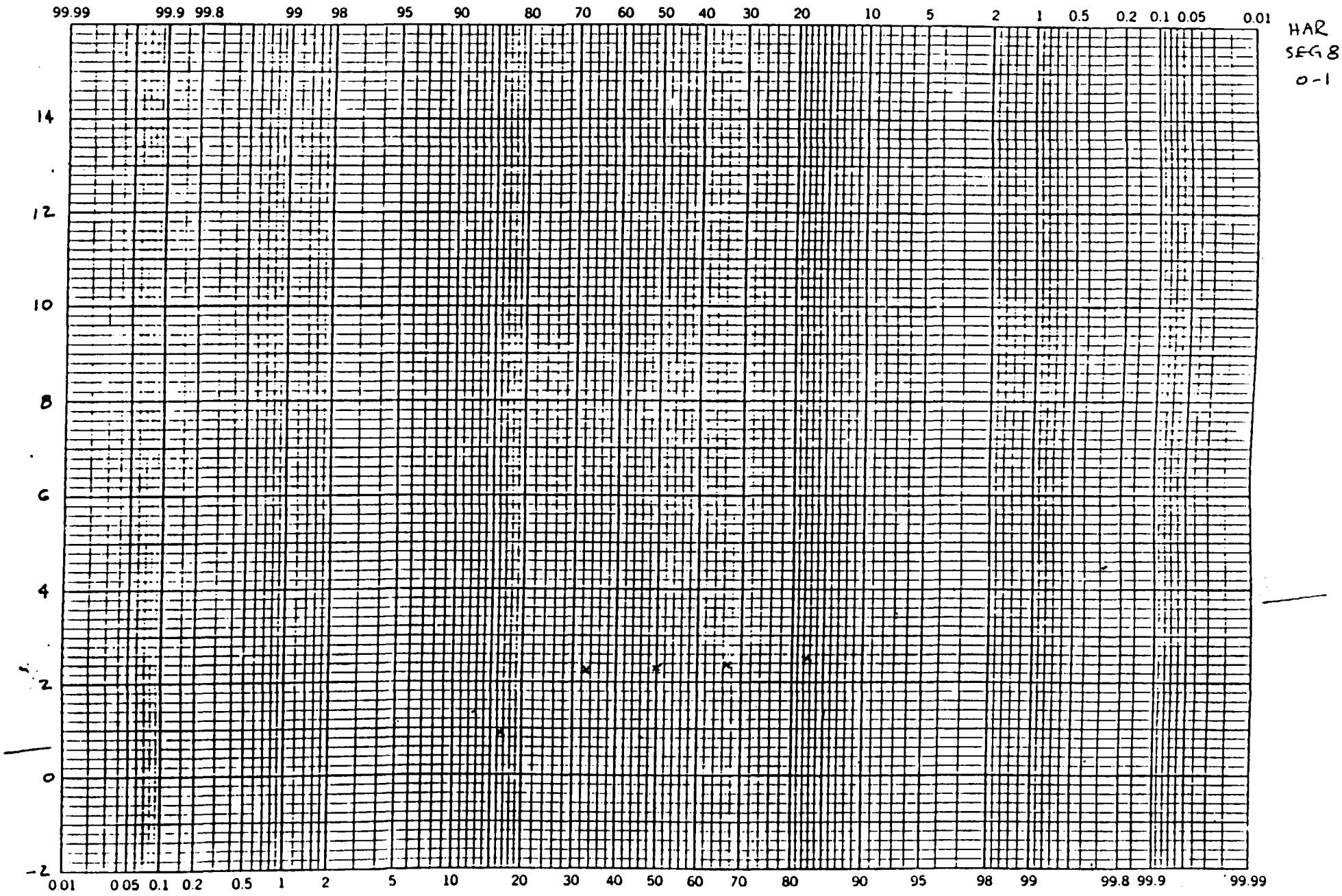


K•E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 6 8000

HAR
SEG7
2-3



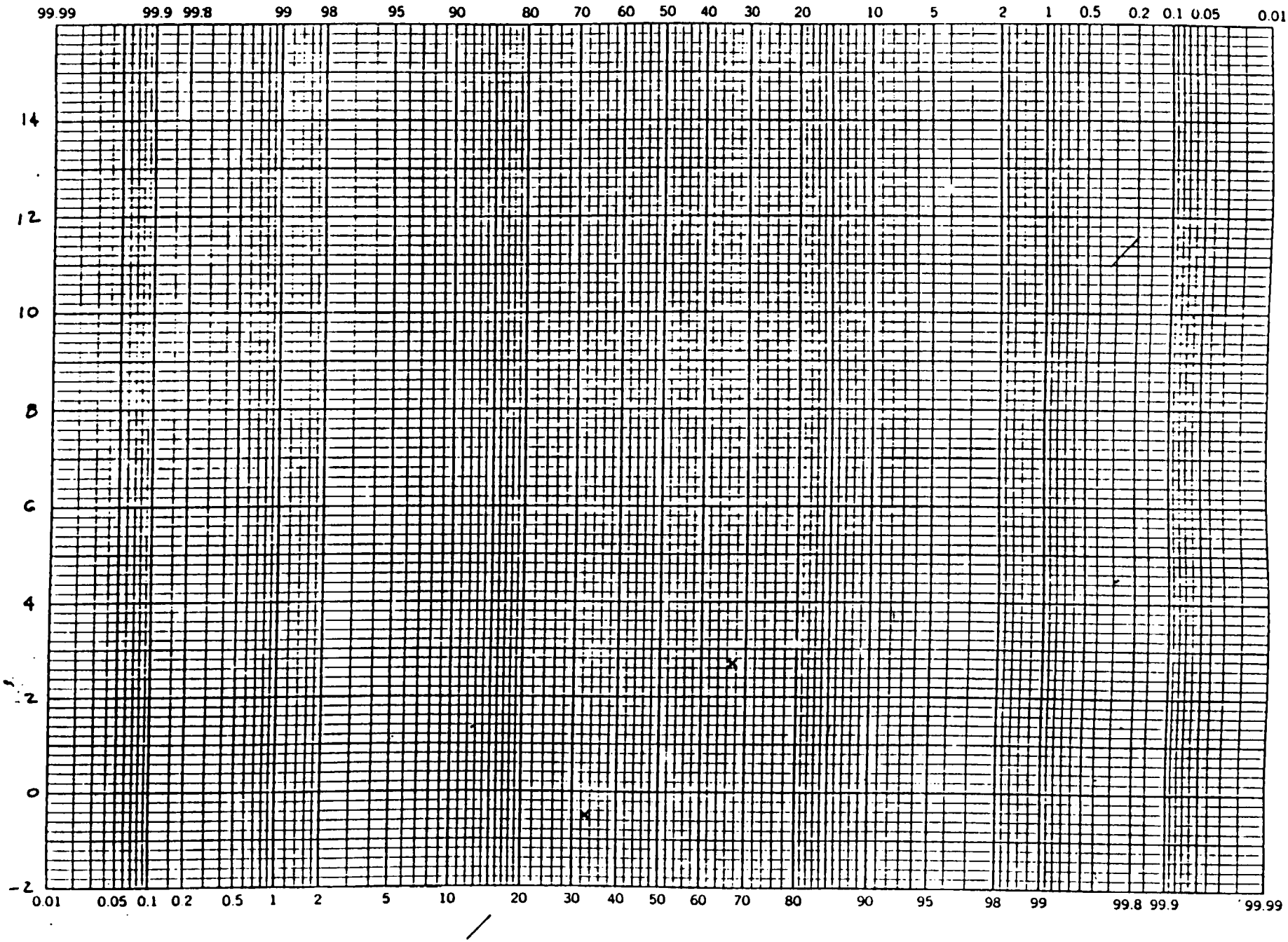
K•E PROBABILITY X, IVISIONS KEUFFEL & ESSER MADE IN U.S.A. 8000



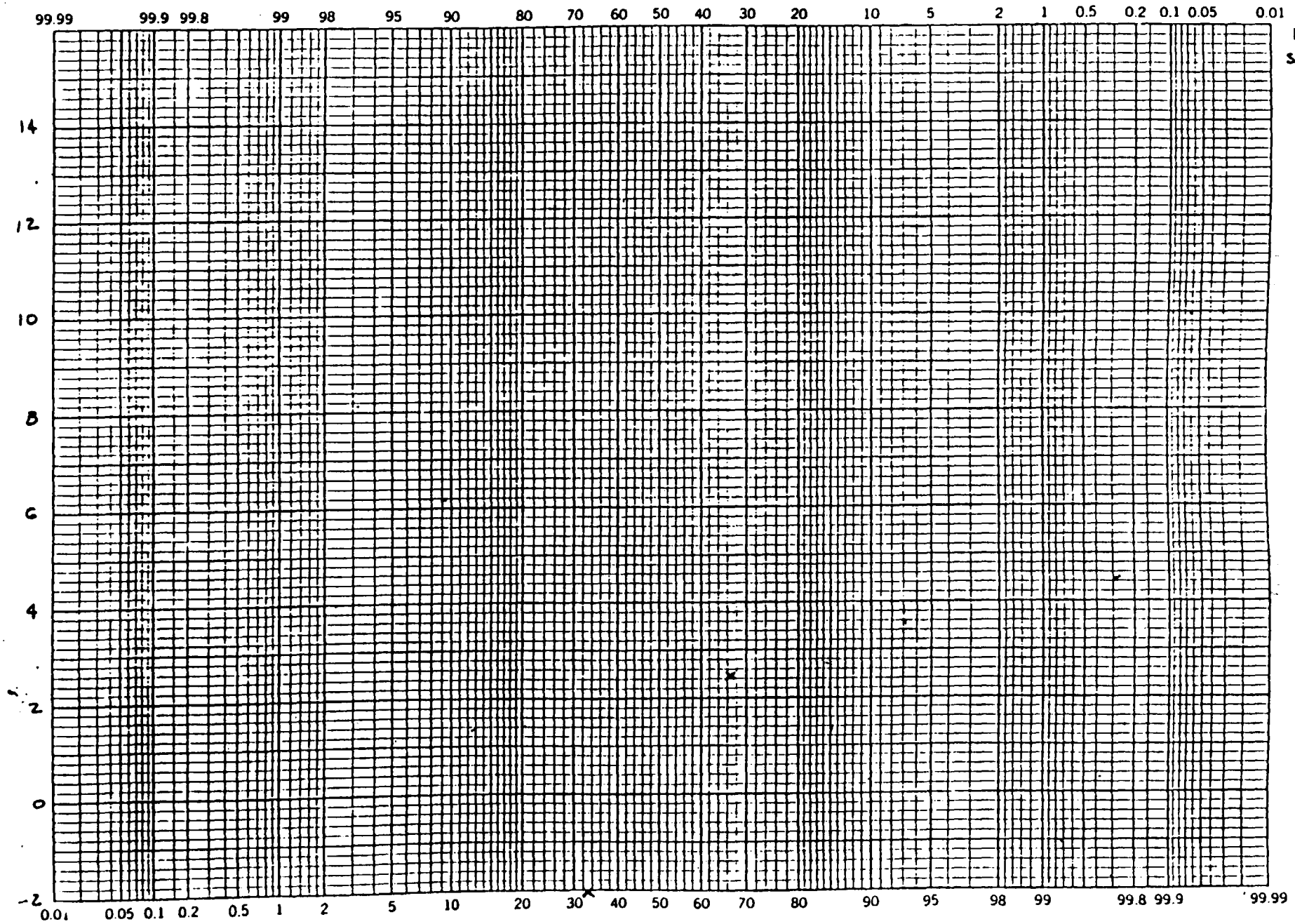
HAR
SEG 8
0-1

K·E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 46 8000

HAR
SEG 2
1-2

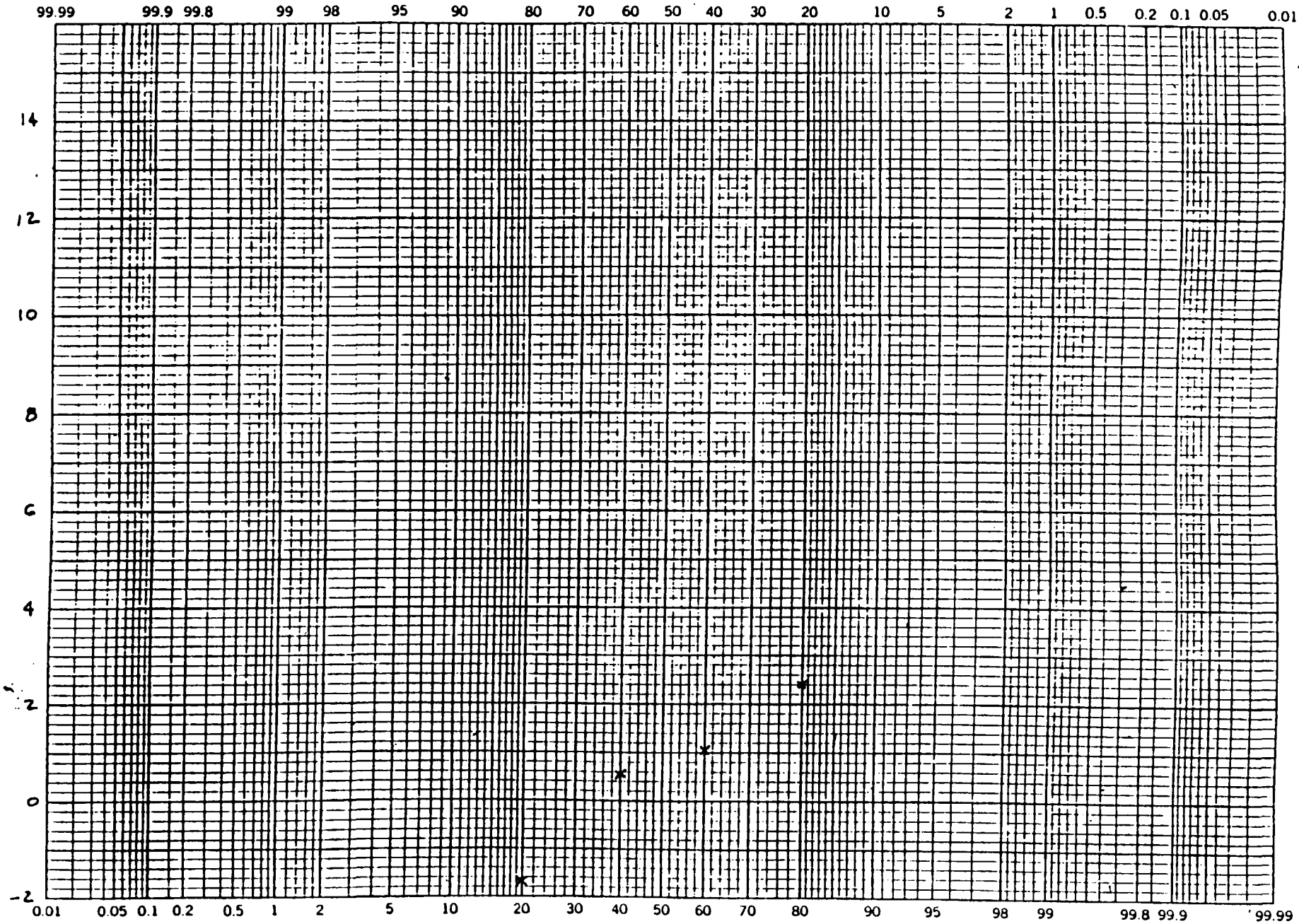


K•E PROBABILITY X DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 5 8000



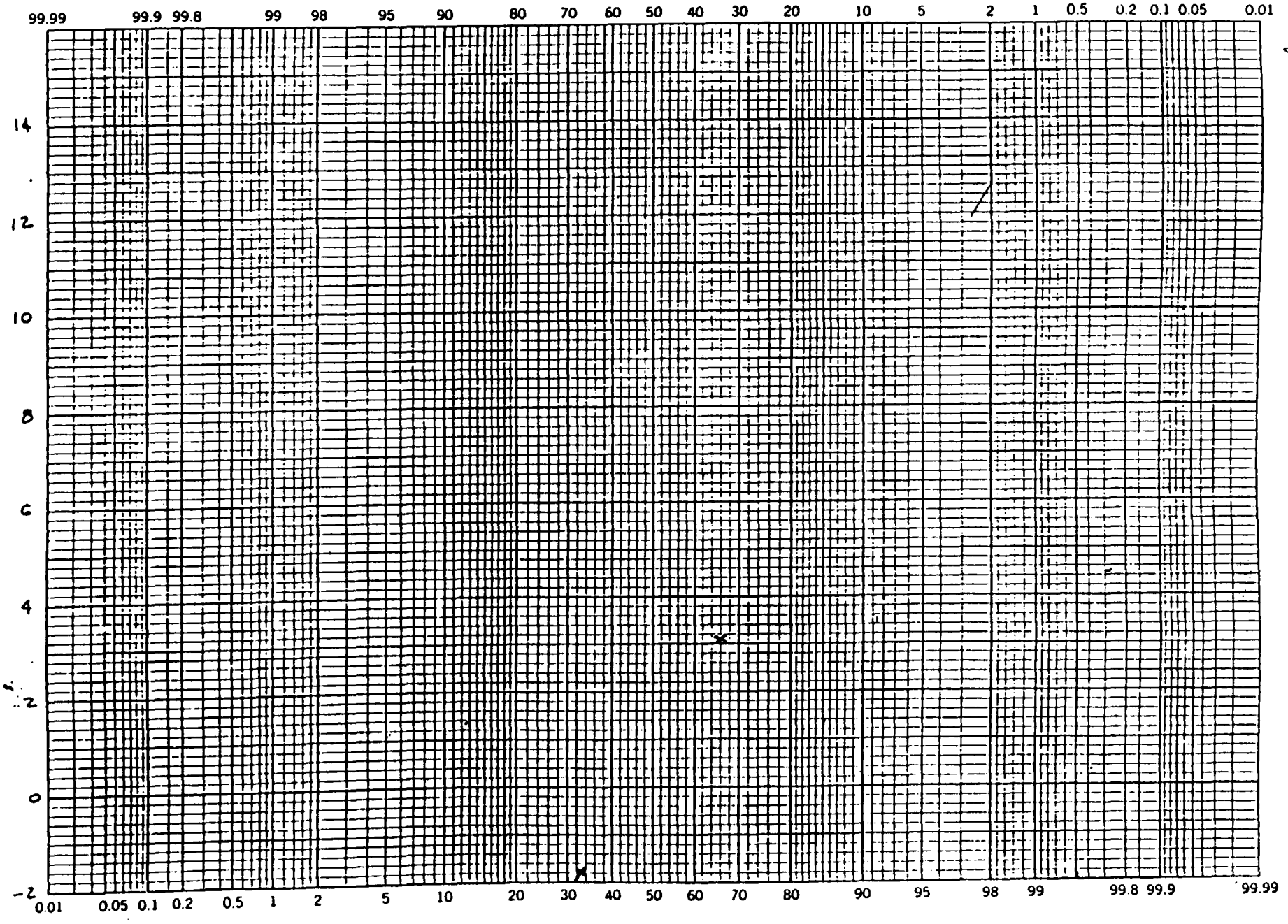
HAR
SEG 8
3-4

K•E PROBABILITY X DIVISIONS KEUFFEL & ESSER MADE IN USA 6 8000



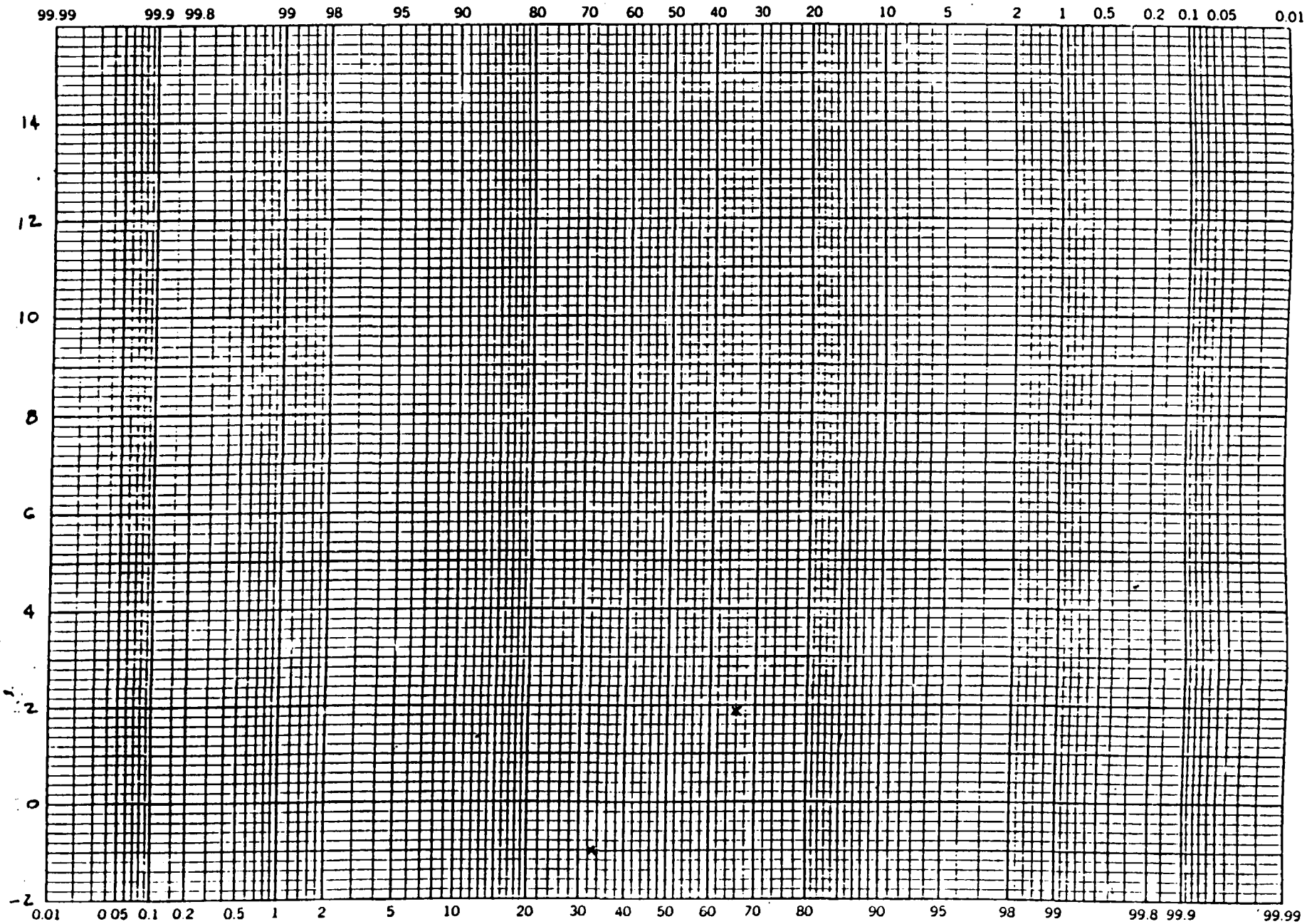
HAR
SEA 10
0-1

K·E PROBABILITY/ KEUFFEL & ESSER DIVISIONS MADE IN U.S.A. 46 8000



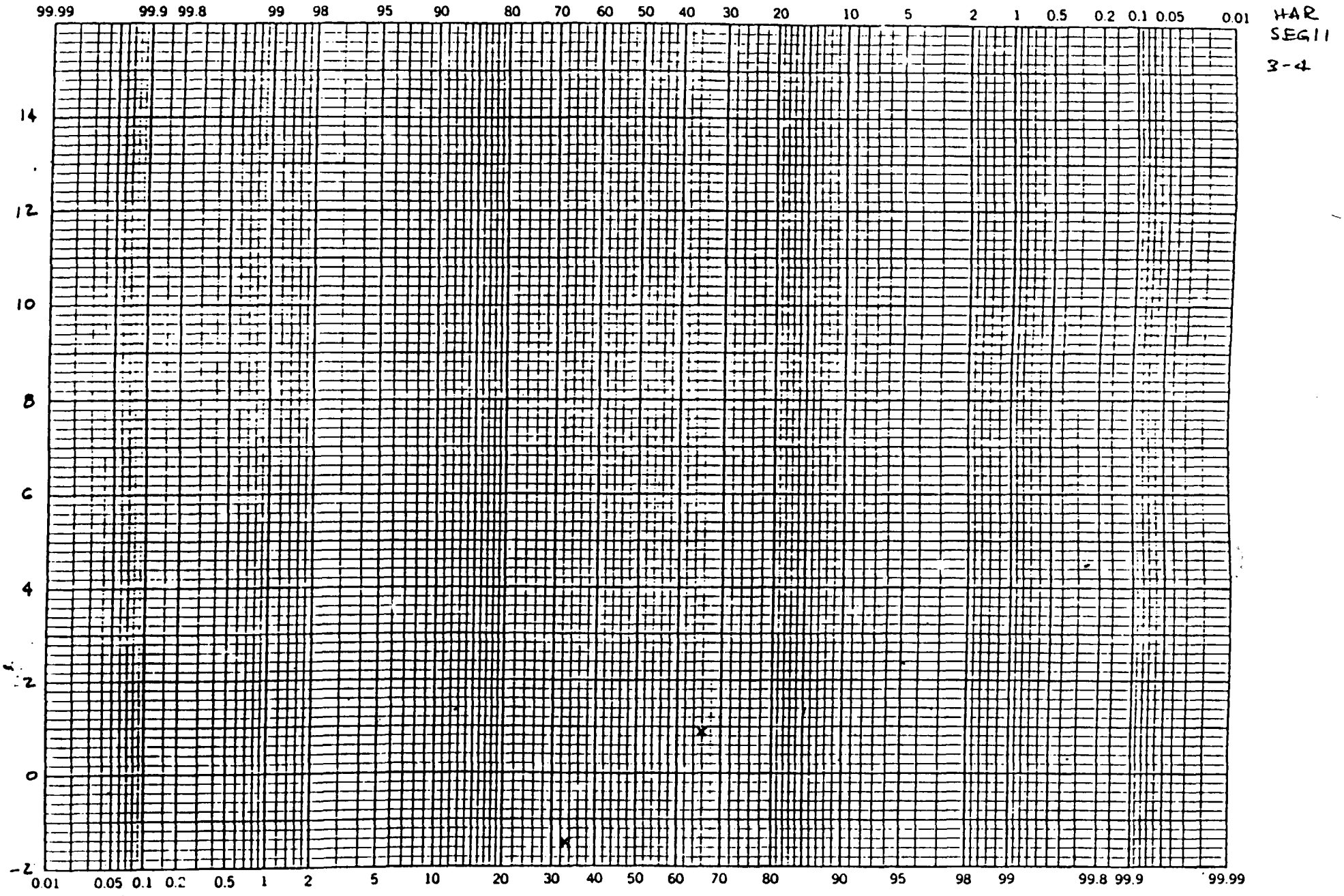
HAR
SEGIC
1-2

K•E PROBABILITY DIVISIONS KEUFFEL & ESSER MADE IN U.S.A. 6 8000

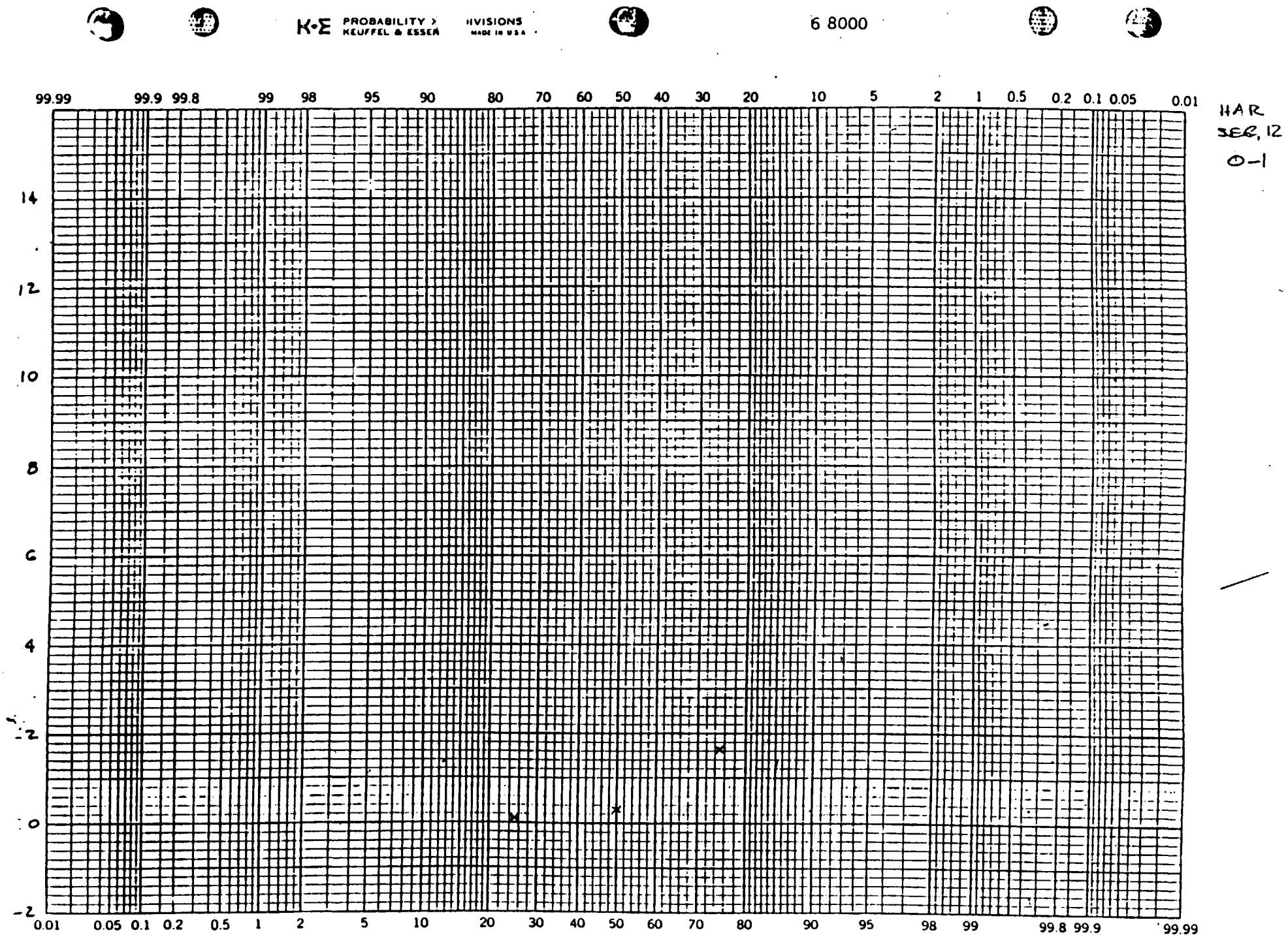


HAR
SEG 11
2-3

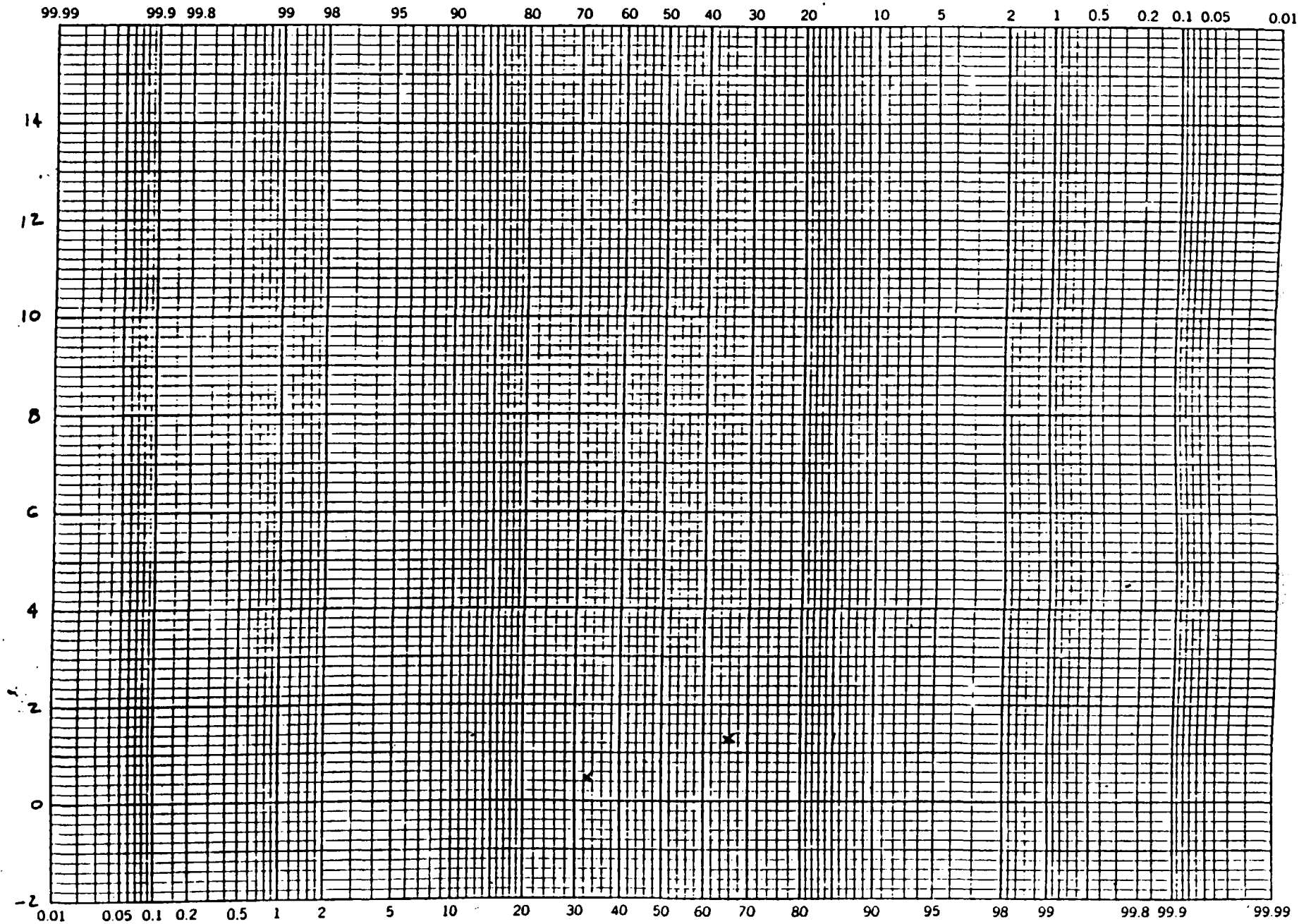
K·E PROBABILITY X VISIONS KEUFFEL & ESSER MADE IN U.S.A. 8000



HAR
SEG11
3-4

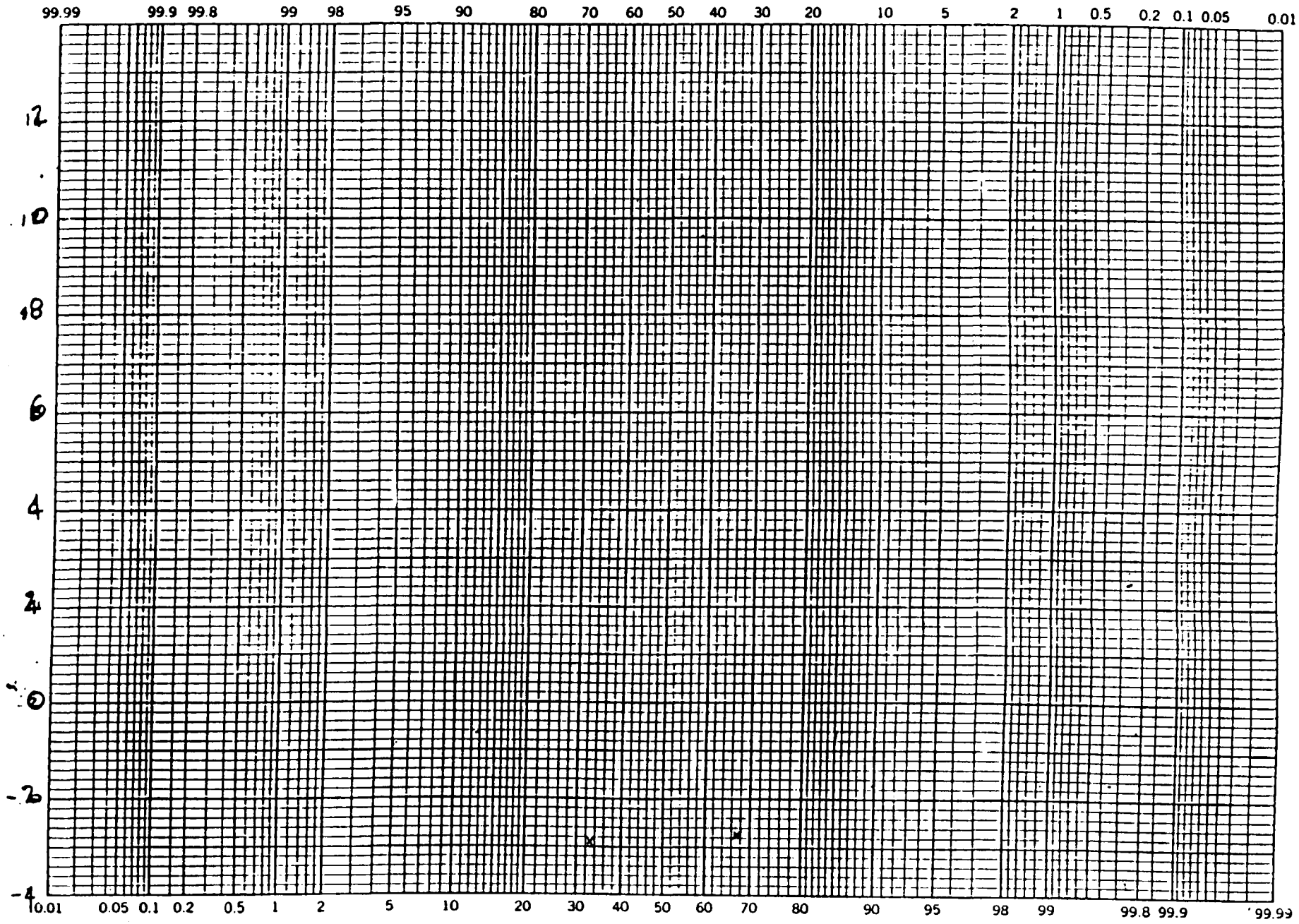

K·E PROBABILITY DIVISIONS
KEUFFEL & ESSER MADE IN U.S.A.
6 8000
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
14
12
10
8
6
4
2
0
-2
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
HAR
SEG, 12
O-1

K·E PROBABILITY X/ VISIONS KEUFFEL & ESSER MADE IN U.S.A. 8000



HAR
SEG 12
1-2

K•E PROBABILI... X ... VISIONS
KEUFFEL & ESSER C... MADE IN U.S.A.
8000



HAR
SEG12
2-3

HARBROR SEG 1 0-1FT [50]

2.996	1.96
3.219	3.92
4.159	5.88
4.489	7.84
4.543	9.8
4.575	11.76
4.70032 *	15.68
5.075	17.64
5.394	19.6
5.521	21.56
5.889	23.52
6.254	25.48
6.430	27.44
6.651	29.40
6.659	31.36
6.733	33.32
6.877	35.28
6.908	37.24
7.050	39.2
7.170	41.16
7.378	43.12
7.476	45.08
7.82432 *	49.
7.837	50.96
7.972	52.92
8.039	54.88
8.161	56.84
8.198	58.80
8.269	60.76
8.389	62.72
8.517	64.68
8.556	66.64
8.98732 *	70.56
9.03632 *	74.48
9.240	76.44
9.306	78.40
9.547	80.36
9.852	82.32
9.952	84.28
10.119	86.24
10.204	88.2
10,309	90.16
10,915	92.12
11.162	94.08
11.277	96.04
11.482	98.

HARBOR

SEG 1

[16]

2-3 FT	
-.611	5.88
-.511	11.76
3.332	17.65
5.737	23.53
5.799	29.41
5.914	35.29
6.446	41.18
9.116	47.06
9.741	52.94
10.127	58.82
10.736	64.71
10.859	70.59
10.985	76.47
11.212	82.35
12.948	88.24
12.995	94.12

[3]

3-4	
-1.609	25.
3.892	50
3.989	75.

[2]

4-5	
-0.580	66
-1.022	33.

HAR SEG 1 1-2 FT

[29]

-1.204	3.33
1.411	6.66
3.045	9.99
3.829	13.32
4.277	16.65
4.500	19.98
4.605	23.31
6.254	26.64
8.102	29.97
9.587	33.30
9.616	36.63
9.852	39.96
9.952	43.29
10.240	46.62
10.434	49.95
10.859	53.28
11.002	56.61
11.238	59.94
11.290	63.27
11.695	—
11.695	69.93
11.849	73.26
12.014	76.59
12.134	79.94
12.206	83.25
12.707	86.58
13.060	89.91
13.194	93.24
13.253	96.57

HARBOR

SEG 2

0-1 FT [18]		1-2 FT [9]		2-3 [3]	
1.099	5.26	-0.916	10	1.335	33.3
2.890	10.53	-0.223	20	6.835	66.6
3.401	15.79	0.916	30		
4.025	21.05	0.993	40		
4.304	26.32	5.799	50		
4.554	31.58	5.858	60		
4.700	36.84	5.886	70		
4.868	42.11	6.551	80		
5.201	47.37	6.856	90		
5.438	52.63				
5.481	57.89				
5.513	63.16				
5.598	68.42				
5.670	73.68				
5.704	78.95				
6.142	84.21				
6.310	89.47				
7.244	94.74				

3-4 FT [4]		4-5 [5]
-0.942	20	
-0.511	40	-1.309
1.351	60	
5.193	80	

HAR SEG 5

0-1	13	1-2	3	2-3	3-4FT [2]		4-5FT [2]	
0.833	7.14	5.011	25		-0.528	33.3	.00	33.3
2.079	14.29	5.283	50		4.290	66.6	.056	66
2.833	—	5.737	75					
2.833	28.57							
2.996	35.71							
3.045	42.86							
3.486	50.00							
3.638	[illegible]							
3.638	64.29							
3.871	71.43							
4.159	78.57							
4.852	85.71							
4.868	92.86							

HARBOR Seg 4

[25]		[6]		[3]		[1]	
0-1 FT.		1-2		2-3		3-4	
1.825	3.85	3.135	14.29	0.00	25	6.466	–
2.041	7.69	3.219	28.57	4.234	50		
2.398	11.54	3.296	42.86	6.064	75		
3.091	15.38	3.434	57.14				
3.135	19.23	4.700	71.43				
3.178	23.08	4.787	85.71				
3.219	26.92						
3.219	30.77						
3.258	34.62						
3.526	38.46						
3.55	42.31						
3.638	46.15						
3.738	50.0						
3.761	53.85						
3.829	57.69						
3.850	61.54						
4.060	65.38						
4.159	69.23						
4.248	73.08						
4.787	76.92						
4.882	80.77						
4.542	84.62						
5.711							
5.136	88.46						
5.438	92.31						
5.707	96.15						

N.

HARBOR SEG 4

[25]		[6]		[3]		[1]	
0-1 FT.		1-2		2-3		3-4	
1.825	3.85	3.135	14.29	0.00	25	6.466	N
2.041	7.69	3.219	28.57	4.234	50		
2.598	11.54	3.296	42.86	6.064	75		
3.091	15.38	3.434	57.14				
3.135	19.23	4.700	71.43				
3.178	23.08	4.787	85.71				
3.219	26.92						
3.219	30.77						
3.258	34.62						
3.526	38.46						
3.55	42.31						
3.638	46.15						
3.738	50.0						
3.761	53.85						
3.829	57.69						
3.850	61.54						
4.060	65.38						
4.159	69.23						
4.248	73.08						
4.787	76.92						
4.882	80.77						
4.942	84.62						
[illegible]							
5.136	88.46						
5.438	92.31						
5.707	96.15						

HAR SEG 6

0-1 FT [16]		1-2 FT [7]		2-3 FT [4]		3-4	4-5
0.470	5.56	1.224	12.50	1.872	20	-2.718	-2.847
1.686	11.11	2.251	25.00	2.079	40		
2.407	16.67	2.398	37.5	2.485	60		
2.447	22.22	2.565	50.0	3.555	80		
2.565		2.890	62.5				
2.565	33.33	3.932	75.0				
2.944	38.89	3.951	87.5				
2.996	44.44						
3.091	50.00						
3.135	55.56						
3.219	61.11						
3.258	66.67						
3.277	72.22						
3.367	77.78						
3.611	83.33						
4.111	88.89						
4.357	94.44						

HAR SEG7

0-1 FT	[13]	1-2 FT	[9]	2-3	[6]	3-4	[1]	4-5	[1]
-1.139	7.14	-1.273	10	1.459	14.29				
0.336	14.29	1.411	20	1.856	28.57	2.595		3.466	
1.758	21.43	1.702	30	2.251	42.86				
2.250	28.57	2.092	40	2.565	57.14				
2.394	–								
2.398	–	2.262	50	2.773	71.43				
2.398	50.00	2.485	60	3.296	85.71				
2.639	–	2.565	70						
2.639	64.29	3.219	80						
2.976	71.43	3.970	90						
3.332	78.57								
3.584	85.71								
5.375	92.86								

HAR SEG 8

5		2		1		2		1
0-1		1-2		2-3		3-4		4-5
.095	16.67	-.562	33	0.642		-2.040	33	-2.571
2.272	33.33	2.747	66			2.485	66	
2.361	50.00							
2.398	66.66							
2.451	83.3							

HARSEG 9

1				
-3.576	N.D	3.296	0.00	N.D

HAR SEG 10

4		2				
-1.715	20	-1.833	33	N.D	N.D	N.D
0.588	40	3.185	66			
1.099	60					
2.398	80					

HARSEG 11

		2		2		1
N.D	N.D	-1.994	33	-1.561	33	-1.661
		1.902	66	0.956	66	

HAR SEG 12

3		2		2		1	1
0.095	25	0.470	33	-2.957	33	-4.269	-2.996
0.336	50	1.335	66	-2.781	66		
1.629	75						

ln {Erg data} {193}

S01 1	S02 1	S03 1	D03 1	S07 1	S08 1	S05 1	S06 1	S10 2	
6.733	7.496	7.824	8.556	5.075	5.521	6.877	6.254	6.310	
8.517	10.119	3.219	8.039	7.090	7.378	7.972	8.987	5.598	
6.659	11.277	2.996	10.204	6.430	8.389	7.937	5.394	5.481	
4.543	11.162	6.908	9.952	7.170		8.161	7.824	5.670	
4.700	10.915	4.700	9.852	9.547		8.987		5.704	4
4.489	11.482	4.159	9.036	9.306		10.509		7.244	
	12.014	4.605	9.547	8.102		11.002		5.799	
	13.060	4.500	11.695	3.045		11.290		5.858	
	13.194	10.434	9.952	Bot (4.078)		10.859		6.551	29
	13.253	3.829	12.707			11.695		6.856	
	11.849	4.277	12.206			11.238			
		9.852	10.740			9.616			
		10.985	10.869						
		10.736	11.212						
		9.741	12.948						14
		12.995	9.116						
		6.446	5.799						
		5.914	5.737						

S12 3	S11 2	S09	S13 3	S14 3	S15 3	S16 4	S17 4	D17 4	
4.382	5.438	0.531	3.638	3.638	3.466	3.219	2.398	3.178	
5.193	4.554	-1.966	3.045	3.871	2.833	3.126	4.060	3.219	
5.561	2.890	-1.171	2.079		2.996	4.787	4.248	3.829	4
6.174	4.700		0.833		2.833	5.438	4.159	3.638	
6.363	1.099		-0.342 (Bot)		4.159	5.136	2.041	1.825	
5.521	3.401				4.868	5.011	3.091	3.738	
3.689	0.916				5.011	3.234	4.787	4.700	14
1.589	0.993					3.219	3.135	3.296	
-0.010	-0.223								
	-0.916								

ln [ERG Data]

S19 6	S20 6	S21 4	S22 6	S25 7	S27 7	D27 7	
3.258	1.686	3.258			2.398	2.639	
2.565	3.611	3.135				3.332	S26 BOT 3.497
2.944	3.135	3.850				2.398	
2.996	2.565		4.357			2.639	
3.367			4.111			2.398	19
3.219			3.091			1.758	
			2.398		2.565	2.092	
			1.224			1.902	
			3.951			3.970	
			2.565		3.219	2.485	12
			2.251		2.262	1.411	
			2.890				
			1.872			2.773	
			2.485			2.251	8
			2.079		1.856		
						2.565	
						3.296	
						BOT 3.714	
				0.470			1

HARBOR SED

SEG 1

	0-1 ft	1-2 ft	2-3 ft	3-4 ft	4-5 ft
BATTELLE	9.036	6.254	3.332	3.989	-0.580
	8.269	12.134	10.127	3.892	-1.022
	4.575	1.411	-0.616	-1.609	
	9.240	-1.204	-0.511		
AZTEC	W-1 5.889				
	W-2 8.198				
	W-3 6.651				

HARBOR SEO

SFG 2

	0-1 ft	1-2 ft	2-3 ft	3-4 ft	4-5 ft
BATTELLE	4.025 ✓	5.886	1.335	-0.942	-1.309
	4.304 ✓		6.835	-0.511	
	4.868 ✓			1.351	
	5.513 ✓			5.193	
ARMSTRONG	6.142 ✓				
	5.201 ✓				

HARBOR SED

LEG 3

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE		5.283	NO DATA	-0.528	0.040
	NO DATA	5.737		4.290	0.096
ARMSTR	4.852				

SEG 4

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	5.707	4.942	4.234	6.466	ND
	4.942 ✓	4.804	6.064		
	4.882 ✓	2.833	0.0		
ARM	3.761				
	3.55 ✓				

SFC 5

	0-1 Ft	1-2 Ft	2-3 FT	3-4 Ft	4-T Ft
BATTELLE	4.143 3.526	4.060 -2.659	2.565	N.D	N.D
ARMSTR	2.1 2.262				

SFG 6

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTERIES	.470 2.407	3.932	3.551	-2.718	-2.847
ARMS	2.442 3.277				

SEG 7

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	-1.139 ✓				
	0.336 ✓	-1.273 ✓	1.459 ✓	2.595	3.466
	2.559 ✓				
	3.584 ✓				
	5.375				
ARMOTR	2.976 ✓				
	2.250 ✓				

SFG 8

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	0.095	-0.562	0.642	-2.040	-2.551
	2.272	2.747		2.485	
	2.398				
ARMS	2.361				
	2.451				

SEG 9

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
DET	-3.576	ND	3.296	0.00	ND

SFG 10

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	-1.718	-1.833	N.D.	N.D.	N.D
	0.588	3.135			
	1.099				
	2.398				

SEC 11

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	N.D	N.D	-0.994 1.902	-1.561 0.956	-1.661

SEG 12

	0-1 FT	1-2 FT	2-3 FT	3-4 FT	4-5 FT
BATTELLE	0.095	0.470	-2.957	-4.269	-2.996
	0.336	1.335	-2.781		
	1.629				