DATA

ZION/INDIAN POINT PROBABILISTIC RISK ASSESSMENT STUDY REVIEW BOARD MEETING

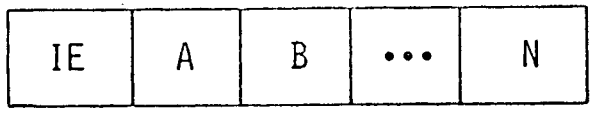
Prepared for
COMMONWEALTH EDISON COMPANY
Chicago, Illinois
June 23, 1980

PICKARD, LOWE AND GARRICK, INC.
CONSULTANTS - NUCLEAR POWER
IRVINE, CALIFORNIA WASHINGTON, D.C.

EARTHQUAKE METHODOLOGY

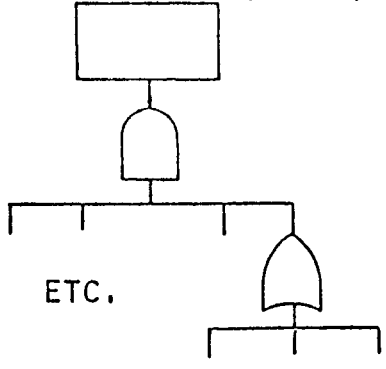
(SIMILAR FOR OTHER EXTERNAL CAUSE)

1. PLANT MODEL: $\{\mathcal{L}, S, \mathcal{L}_P\}$

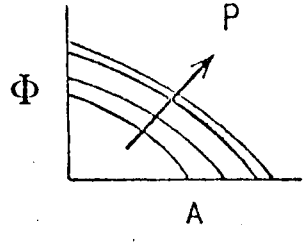


2. SYSTEM MODELS:

SYSTEM (OR IE) = $\{C, \mathcal{L}_S\}$,



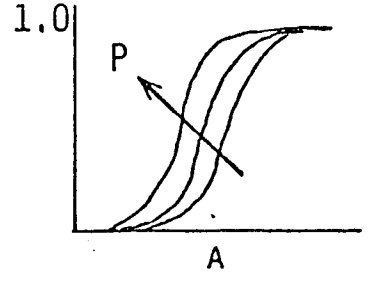
3. SEISMICITY:



, $\{\langle P_I, \Phi_I(A)\rangle\}$

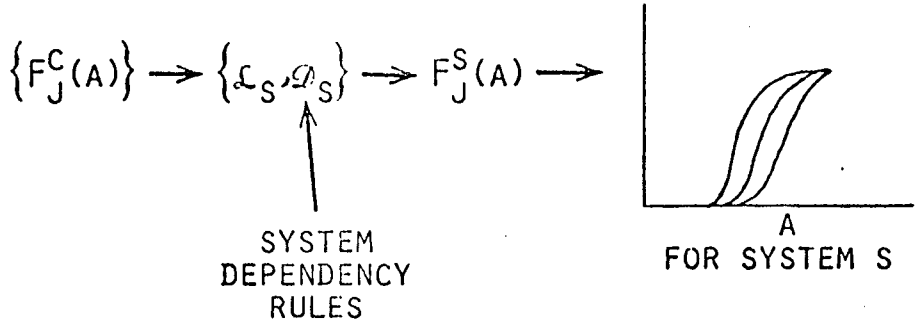
EARTHQUAKE METHODOLOGY (CONTINUED)

4. FRAGILITY:

(FOR COMPONENT C) F 

, $\{\langle Q_J^C, F_J^C(A)\rangle\}$

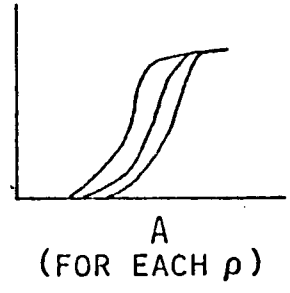
5. SYSTEM (OR IE) FRAGILITY:



EARTHQUAKE METHODOLOGY (CONTINUED)

6. PLANT FRAGILITY:

$$\left\{F_J^S(A)\right\} \rightarrow \left\{\mathcal{L}_P, \mathcal{D}_P\right\} \rightarrow F_J^\rho(A) \rightarrow F_J^\rho$$

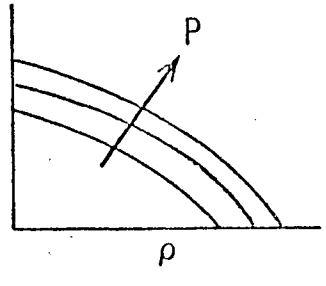


7. FREQUENCY OF RELEASE ρ

$$\phi_{IJ}(\rho) = \sum_A \phi_I(A)\, F_J^\rho(A)$$

$$\Longrightarrow \left\{\langle P_I Q_J, \phi_{IJ}(\rho)\rangle\right\}$$

$\longrightarrow \Phi(\rho)$



HANDLING DATA

DESIRE

$\lambda_m(a)$ FAILURE RATE FOR SPECIFIC MACHINE AT AGE a

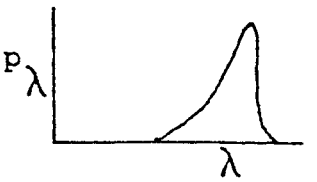
INFORMATION:

(1) PAST HISTORY OF MACHINE m

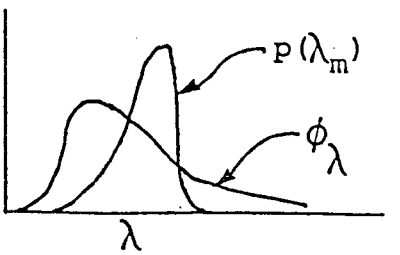
(2) PAST HISTORY OF SIMILAR MACHINES

DATA TREATMENT

MODEL I: UNIFORM POPULATION/NO AGING



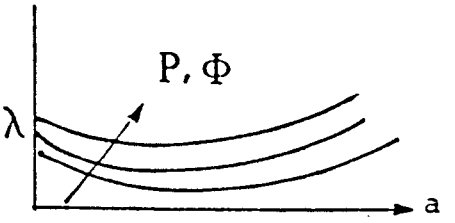
MODEL II: VARIABLE POPULATION/NO AGING



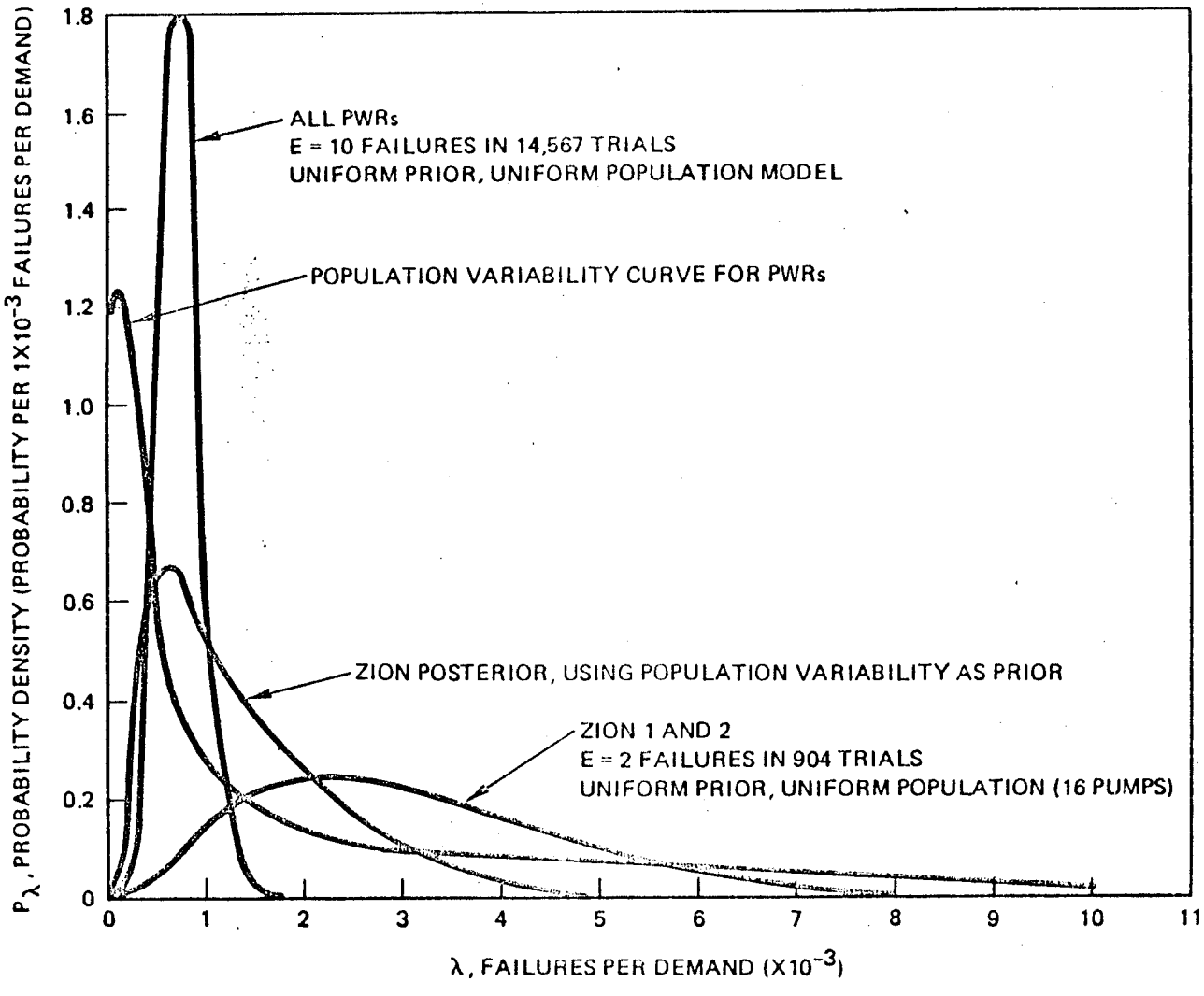
IIA: ϕ_λ BY WASH-1400 OR EQUIVALENT.

IIB: φ_λ BY EXPLICIT TREATMENT OF EVIDENCE (BAYES)

MODEL III: VARIABLE POPULATION WITH AGING

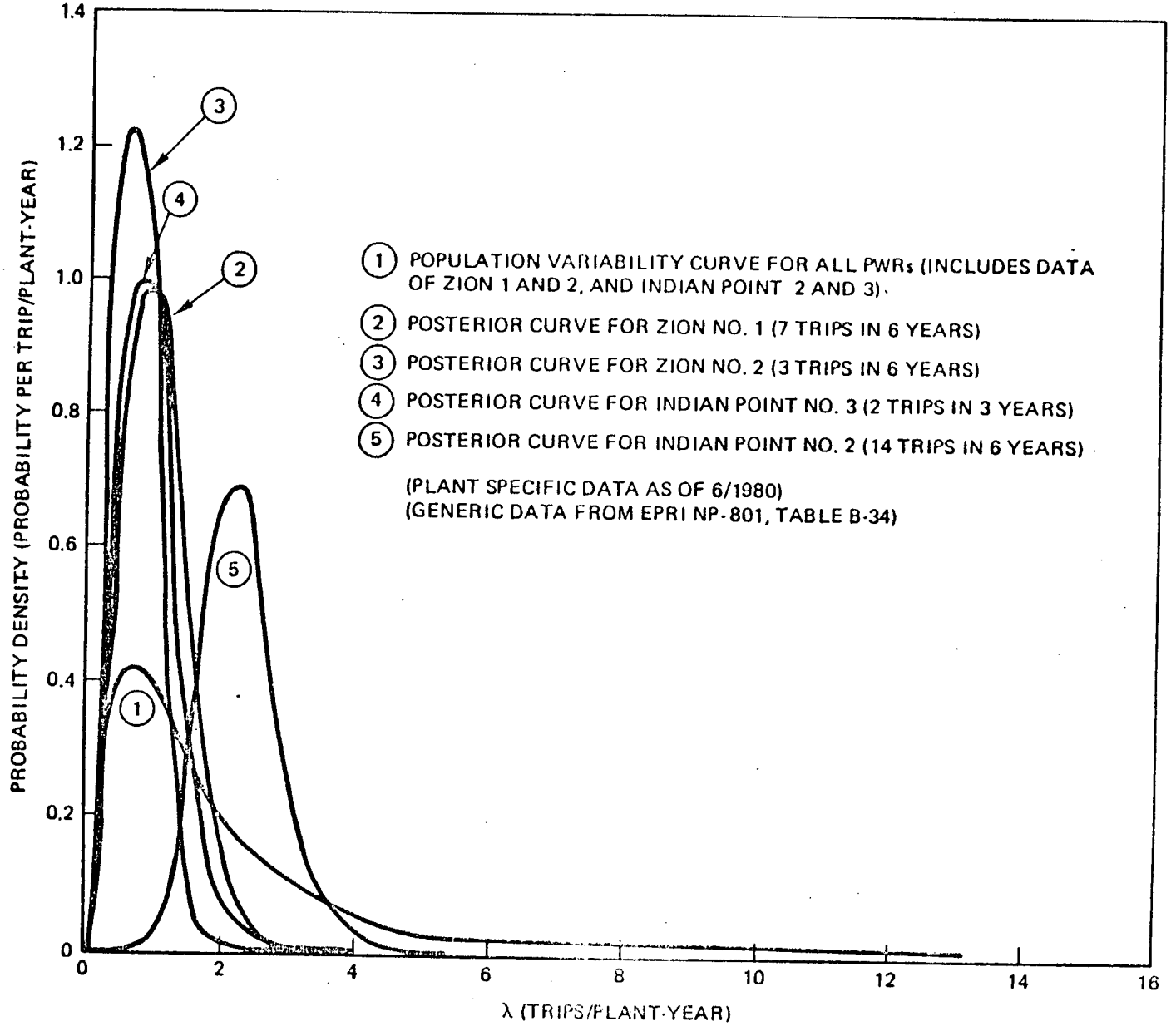


STATE OF KNOWLEDGE CURVES FOR STANDBY PUMPS MOTOR DRIVEN, FAILS TO START



Pickard, Lowe and Garrick, Inc.

FREQUENCY OF TURBINE TRIPS



(1) POPULATION VARIABILITY CURVE FOR ALL PWRs (INCLUDES DATA OF ZION 1 AND 2, AND INDIAN POINT 2 AND 3).

(2) POSTERIOR CURVE FOR ZION NO. 1 (7 TRIPS IN 6 YEARS)

(3) POSTERIOR CURVE FOR ZION NO. 2 (3 TRIPS IN 6 YEARS)

(4) POSTERIOR CURVE FOR INDIAN POINT NO. 3 (2 TRIPS IN 3 YEARS)

(5) POSTERIOR CURVE FOR INDIAN POINT NO. 2 (14 TRIPS IN 6 YEARS)

(PLANT SPECIFIC DATA AS OF 6/1980)
(GENERIC DATA FROM EPRI NP-801, TABLE B-34)

Pickard, Lowe and Garrick, Inc.

OBJECTIVES OF THE CONSEQUENCES MODELLING EFFORT

- THE CRAC PROGRAM
- CRACIT - THE MODIFIED CRAC PROGRAM FOR SITE SPECIFIC CALCULATIONS
- SITE CHARACTERISTICS
  - METEOROLOGY
  - POPULATION
  - EVACUATION ROUTES AND TIMES
- SPECIAL EFFECTS
  - TERRAIN INDUCED FLOW PATTERNS
  - LAKE EFFECTS
- APPLICATION TO EMERGENCY PLANNING
  - UNDERSTAND PLUME BEHAVIOR IN EMERGENCY PLANNING ZONES
  - POSSIBLE INCORPORATION OF MODEL RESULTS INTO EMERGENCY PLANS

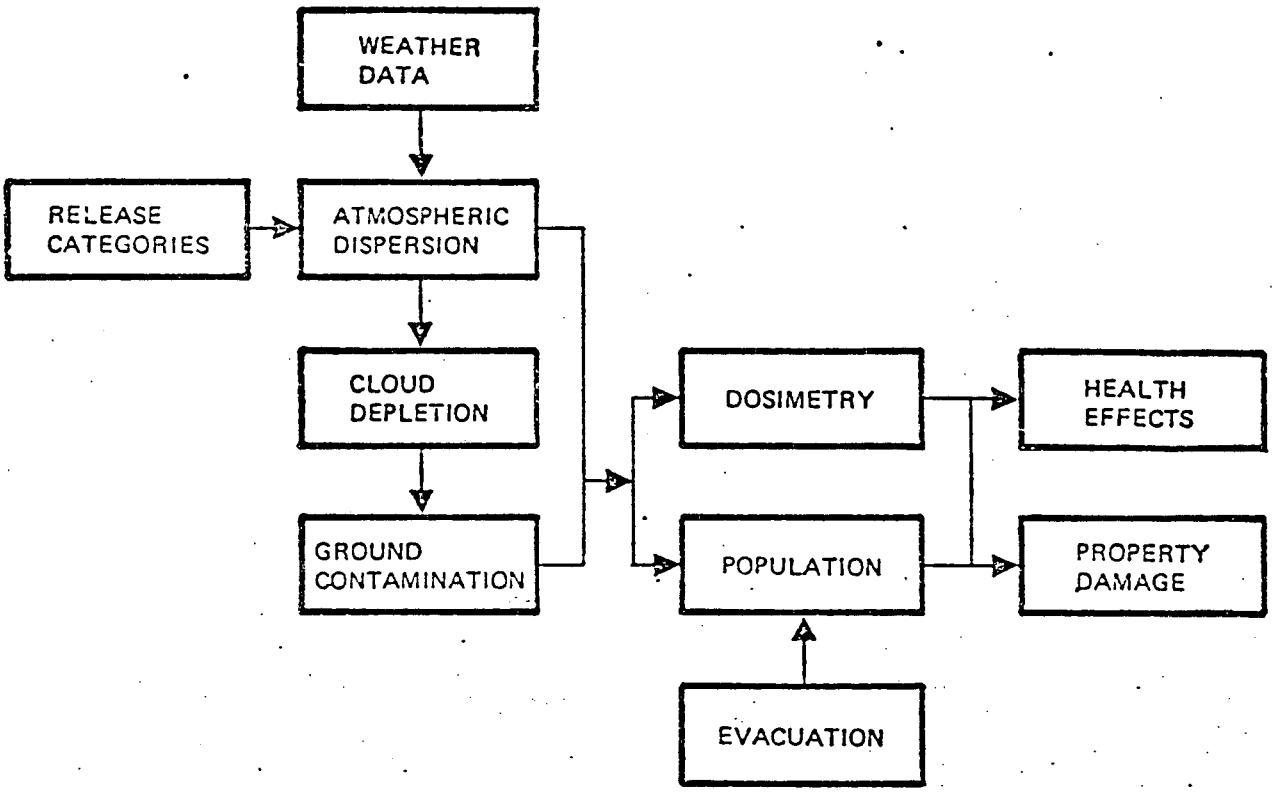
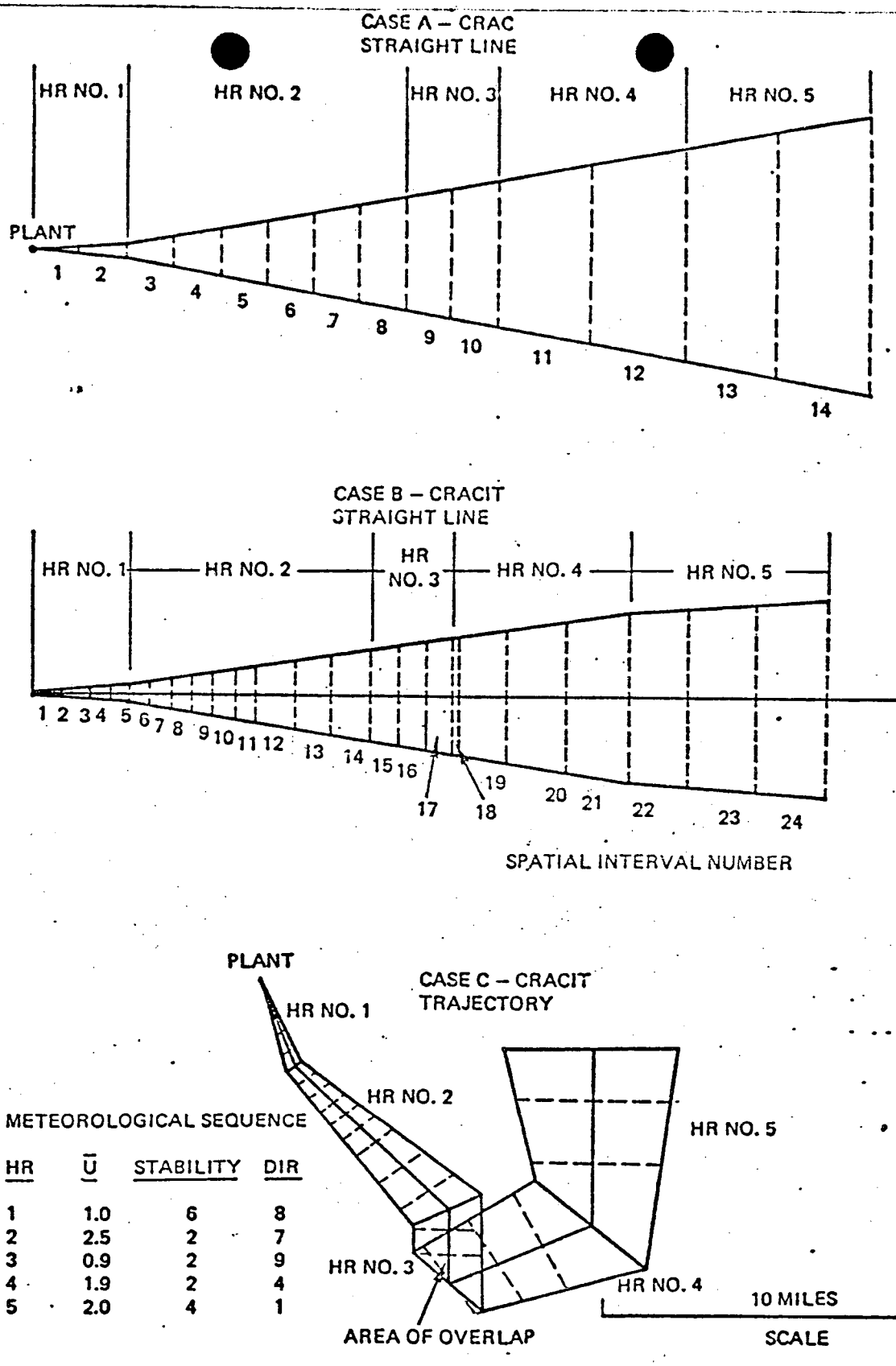


FIGURE 6-1. SCHEMATIC DIAGRAM OF CONSEQUENCE PROGRAM

DIFFERENCES BETWEEN CRAC AND CRACIT

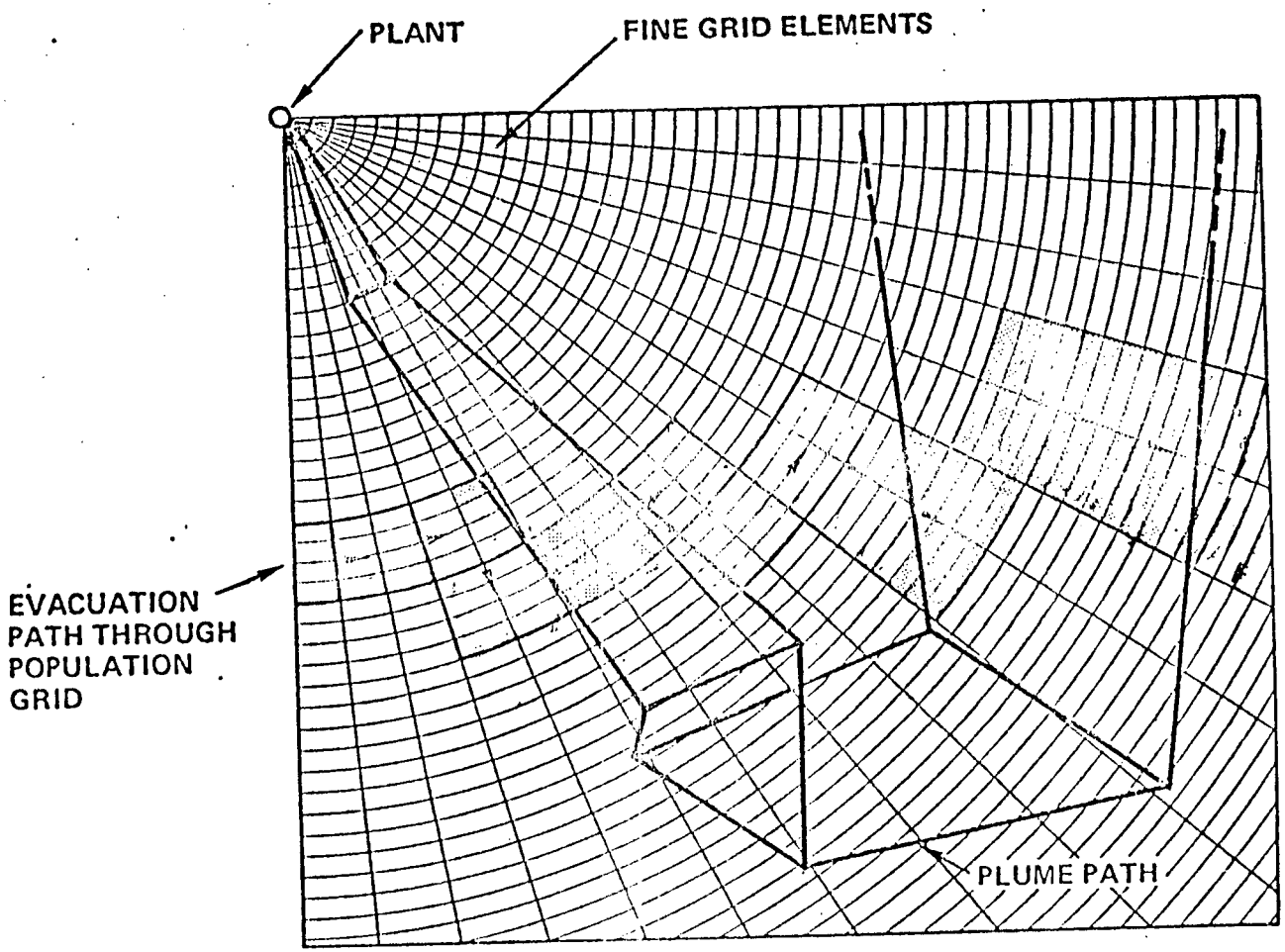
- STRAIGHT-LINE VERSUS TRAJECTORY
- EVACUATION MODEL - VARIABLE
- MORE THAN ONE MET SITE
- LID HEIGHT DETERMINATION USING UPPER AIR DATA EACH HOUR; NOT SEASONAL AVERAGE
- UPPER TOWER LEVEL MET DATA FOR RELEASE CATEGORY 1
- POPULATION GRID IS CHANGED TO A FINER MESH
- NUMBER OF METEOROLOGICAL SEQUENCES WAS INCREASED
- THERE IS NO WIND ROSE AVERAGING IN CRACIT
- SITE SPECIFIC POPULATION DISTRIBUTION, VARIES WITH SEASON
- SITE SPECIFIC METEOROLOGY
- DELETE CROPS OVER WATER
- LATENT EFFECTS USING BEIR REPORT (LINEAR HYPOTHESIS) VERSUS CONCAVE CURVE OF NRC



METEOROLOGICAL SEQUENCE

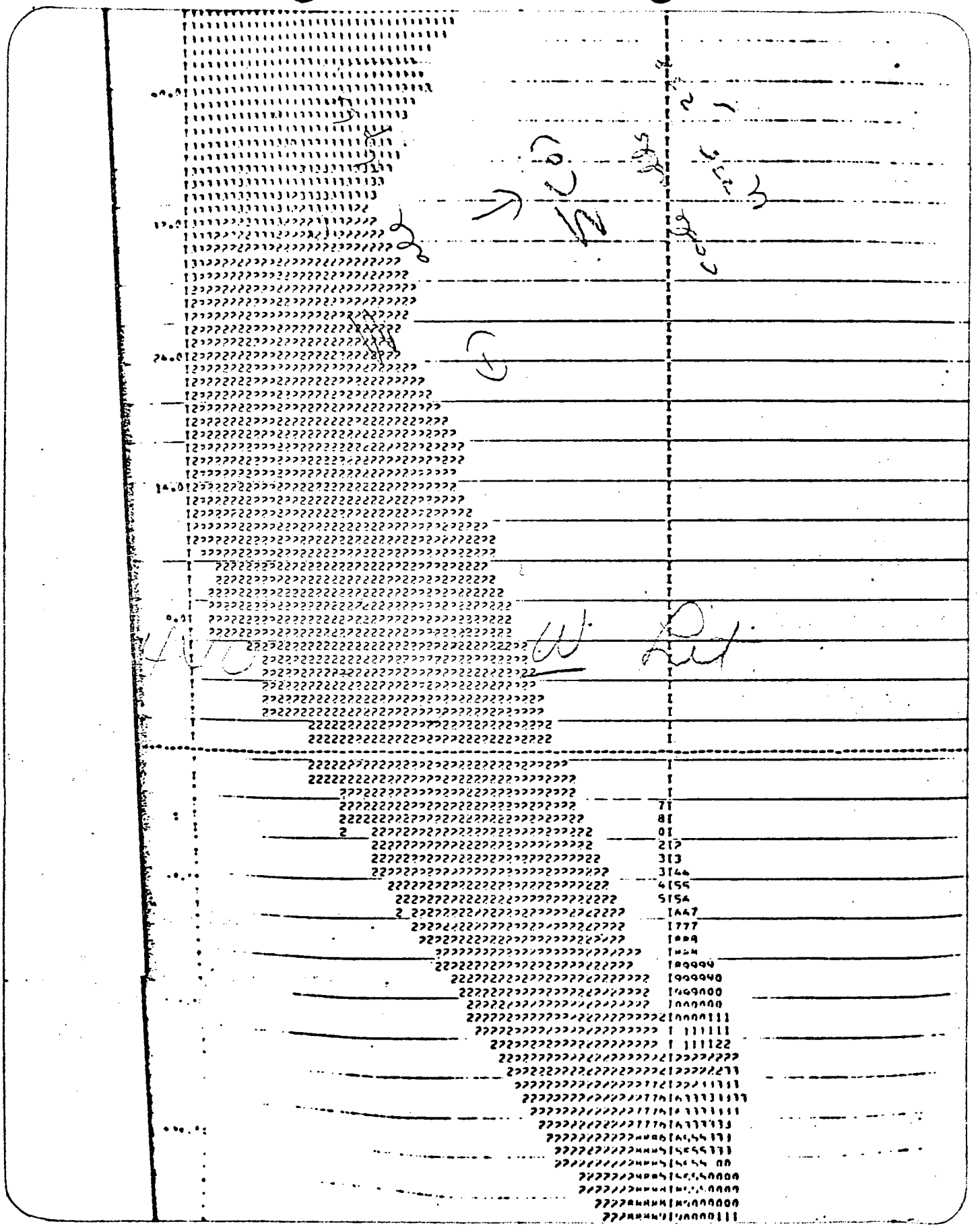
HR	$\bar{U}$	STABILITY	DIR
1	1.0	6	8
2	2.5	2	7
3	0.9	2	9
4	1.9	2	4
5	2.0	4	1

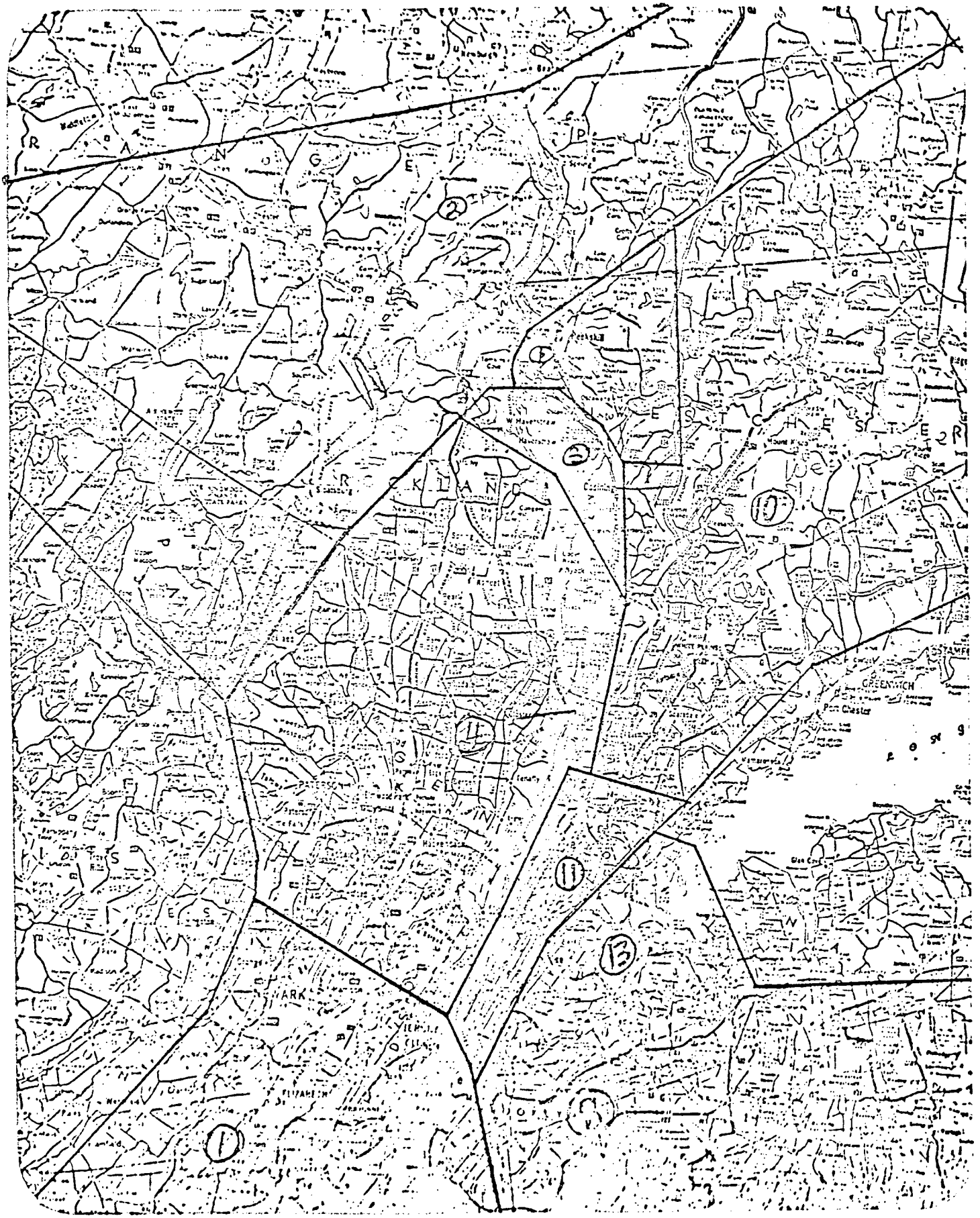
FIGURE 6-6. EXAMPLE OF SPATIAL INTERVAL DISTANCES FOR TYPICAL WEATHER SEQUENCE

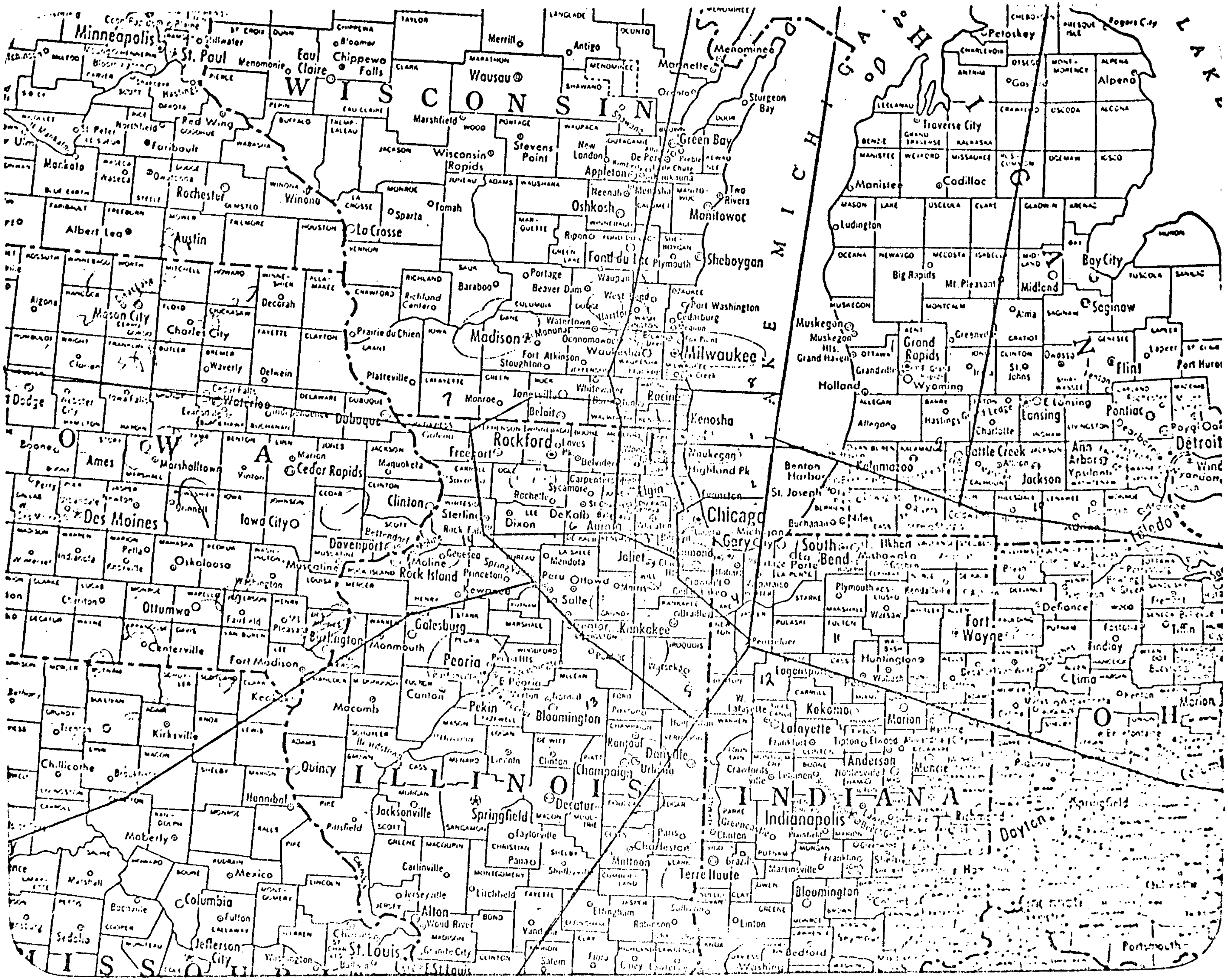


*WEATHER SEQUENCE IS SAME AS RIGHT COLUMNS OF TABLE 6-4

FIGURE 6-1. ILLUSTRATION OF PLUME AND EVACUATION PATHS ON FINE GRID*
(Dose Calculations Made in Shaded Fine Grid Areas)



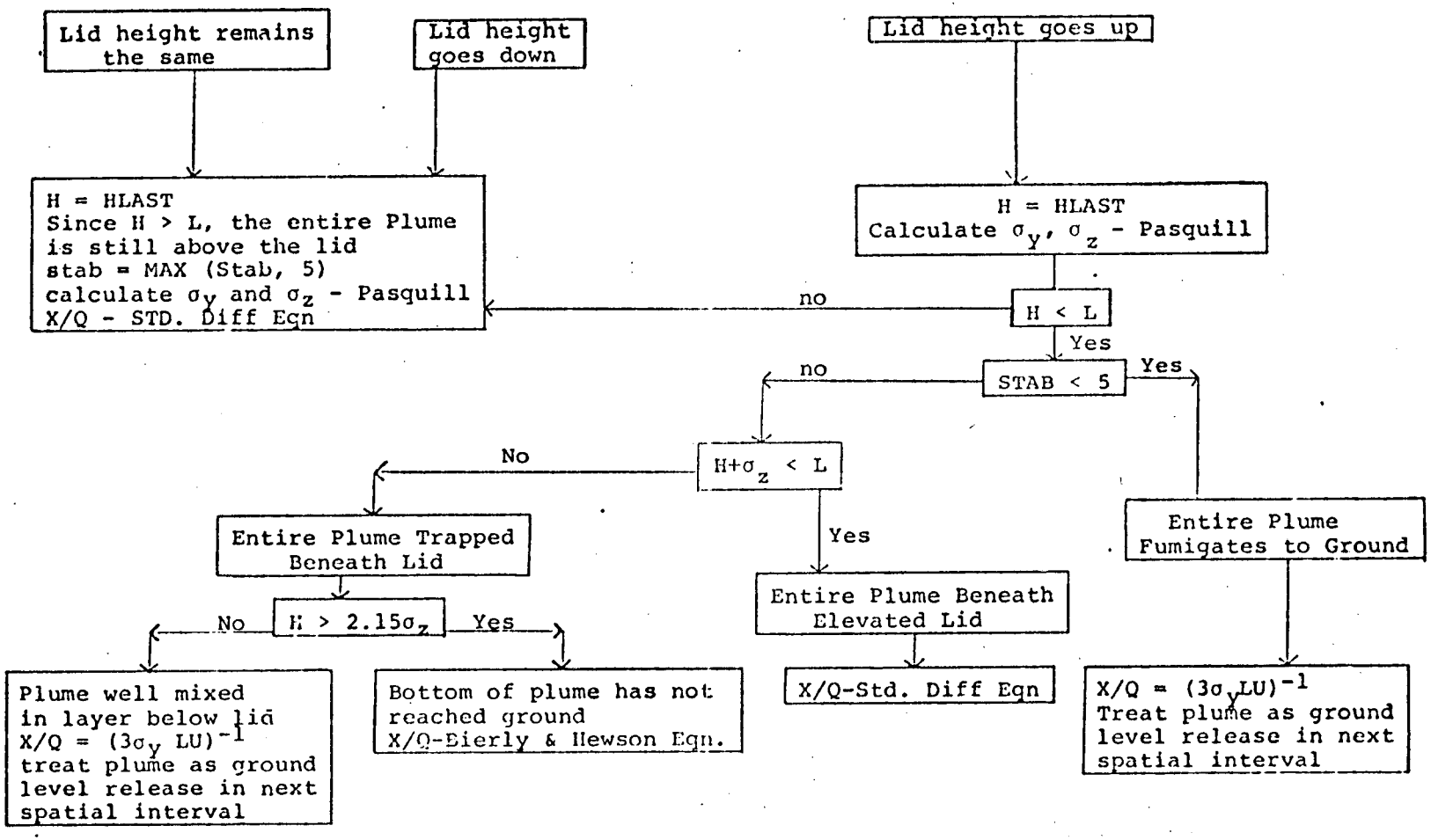

RANGE
PURCHASE
WESTCHESTER
ROCKLAND
ORANGE
PUTNAM
GREENWICH
Port Chester
PARK
1
2
3
4
5
6
7
8
9
10
11
12
13



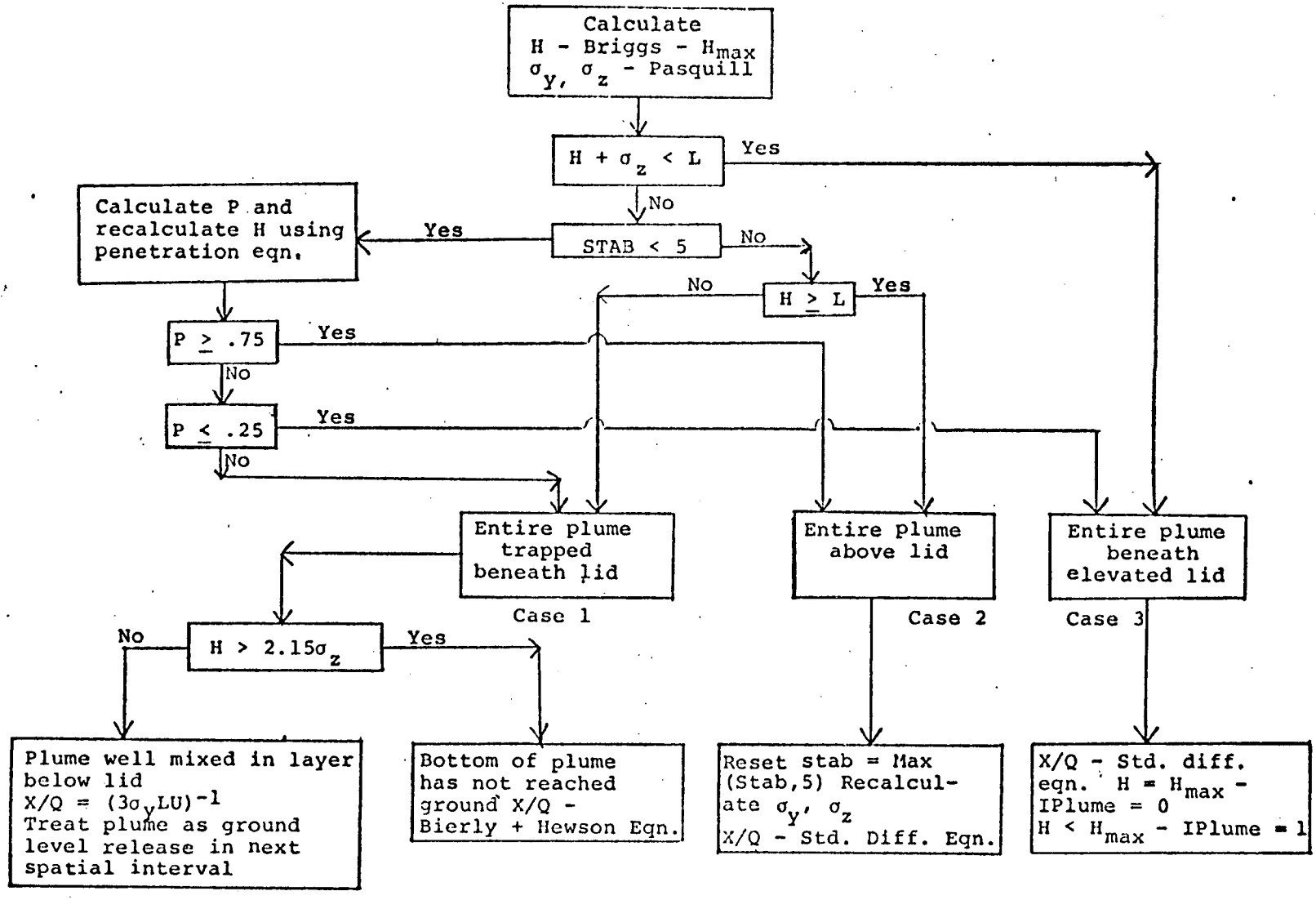
WISCONSIN
IOWA
ILLINOIS
INDIANA
MICHIGAN
LAKE MICHIGAN
OHIO
Minneapolis
St. Paul
Stillwater
Menomonie
Eau Claire
Chippewa Falls
Bloomer
Merrill
Antigo
Wausau
Marinette
Menominee
Oconto
Sturgeon Bay
Green Bay
Petoskey
Alpena
Traverse City
Red Wing
Hastings
Northfield
St. Peter
Faribault
Mankato
Waseca
Owatonna
Rochester
Winona
Albert Lea
Austin
La Crosse
Sparta
Tomah
Marshfield
Wisconsin Rapids
Stevens Point
New London
Appleton
De Pere
Neenah
Menasha
Oshkosh
Manitowoc
Two Rivers
Ripon
Fond du Lac
Plymouth
Sheboygan
Manistee
Cadillac
Ludington
Big Rapids
Mt. Pleasant
Midland
Bay City
Saginaw
Alma
Flint
Port Huron
Lapeer
Owosso
Grand Rapids
Wyoming
Grandville
Muskegon
Muskegon Hts.
Grand Haven
Holland
Allegan
Hastings
Charlotte
Lansing
Pontiac
Detroit
Ann Arbor
Ypsilanti
Jackson
Battle Creek
Kalamazoo
Benton Harbor
St. Joseph
Niles
Buchanan
Algona
Mason City
Charles City
Decorah
Waverly
Oelwein
Prairie du Chien
Richland Center
Baraboo
Portage
Beaver Dam
West Bend
Port Washington
Cedarburg
Madison
Watertown
Oconomowoc
Waukesha
Milwaukee
Fort Atkinson
Stoughton
Platteville
Monroe
Janesville
Beloit
Whitewater
Racine
Kenosha
Waukegan
Highland Pk
Evanston
Chicago
Fort Dodge
Webster City
Iowa Falls
Cedar Falls
Waterloo
Independence
Dubuque
Galena
Freeport
Rockford
Belvidere
Boone
Ames
Marshalltown
Marion
Cedar Rapids
Maquoketa
Clinton
Sterling
Rock Falls
Dixon
De Kalb
Rochelle
Sycamore
Aurora
Elgin
Joliet
Gary
Hammond
Michigan City
La Porte
South Bend
Mishawaka
Elkhart
Goshen
Des Moines
Newton
Grinnell
Iowa City
Davenport
Bettendorf
Moline
Rock Island
Muscatine
Geneseo
Princeton
Kewanee
Peru
Ottawa
La Salle
Mendota
Streator
Kankakee
Plymouth
Warsaw
Fort Wayne
Defiance
Findlay
Tiffin
Lima
Toledo
Indianola
Pella
Knoxville
Oskaloosa
Ottumwa
Washington
Fairfield
Mt. Pleasant
Burlington
Centerville
Fort Madison
Keokuk
Galesburg
Monmouth
Peoria
East Peoria
Macomb
Canton
Pekin
Bloomington
Normal
Logansport
Kokomo
Lafayette
W. Lafayette
Frankfort
Marion
Muncie
Anderson
Tipton
Elwood
Kirksville
Quincy
Hannibal
Chillicothe
Moberly
Jacksonville
Springfield
Decatur
Lincoln
Clinton
Champaign
Urbana
Rantoul
Danville
Crawfordsville
Indianapolis
Greencastle
Franklin
Shelbyville
Martinsville
Dayton
Springfield
Mexico
Marshall
Columbia
Fulton
Jefferson City
Sedalia
Pittsfield
Carlinville
Taylorville
Pana
Mattoon
Charleston
Paris
Terre Haute
Brazil
Bloomington
Bedford
Alton
Wood River
Jerseyville
Litchfield
Vandalia
Effingham
Robinson
Linton
Granite City
St. Louis
East St. Louis
Salem
Portsmouth
Chillicothe
Marion
Cincinnati
MISSOURI

SITE SPECIFIC ATMOSPHERIC TRANSPORT MODELS

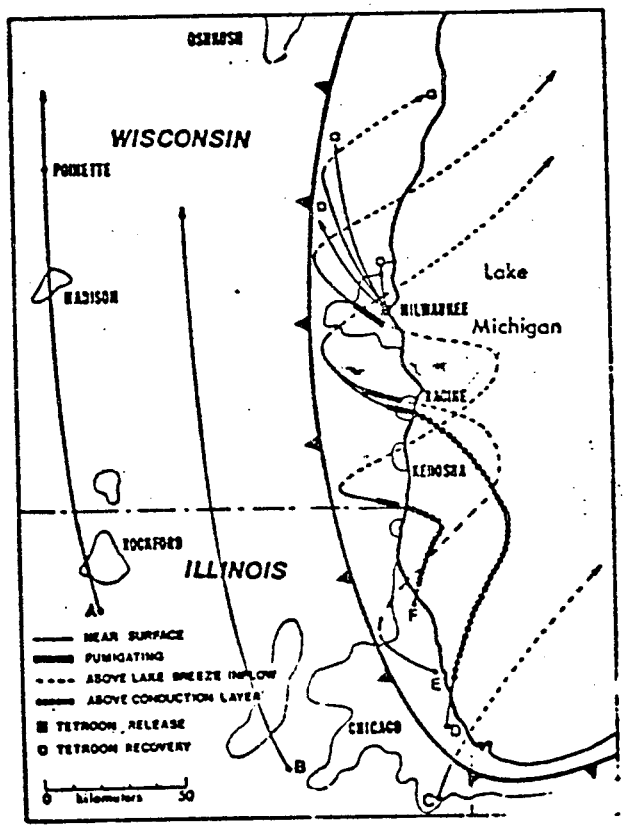
- GAUSSIAN PLUME MODEL
  - TERRAIN CORRECTION FOR ELEVATED RELEASES
  - LID PENETRATION AND TRAPPING
  - PLUME RISE
  - SPEED ADJUSTMENT WITH HEIGHT
  - DRY DEPOSITION
  - WET DEPOSITION (RAIN-RATE)
- MODIFIED POTENTIAL FLOW-NUMERICAL MODEL
  - USED FOR TERRAIN SITUATIONS THAT SIGNIFICANTLY AFFECT PLUME TRAJECTORIES AND DISPERSION
- LAKE EFFECT MODELS
  - FUMIGATION CAUSED BY BOUNDARY LAYER (TIBL) PLUME INTERACTION
- EXPERT JUDGEMENT - PLUME EDIT MODELS
  - CHANGE PLUME TRAJECTORIES
  - CHANGE DISPERSION CHARACTERISTICS
  - CHANGE PLUME GEOMETRIES



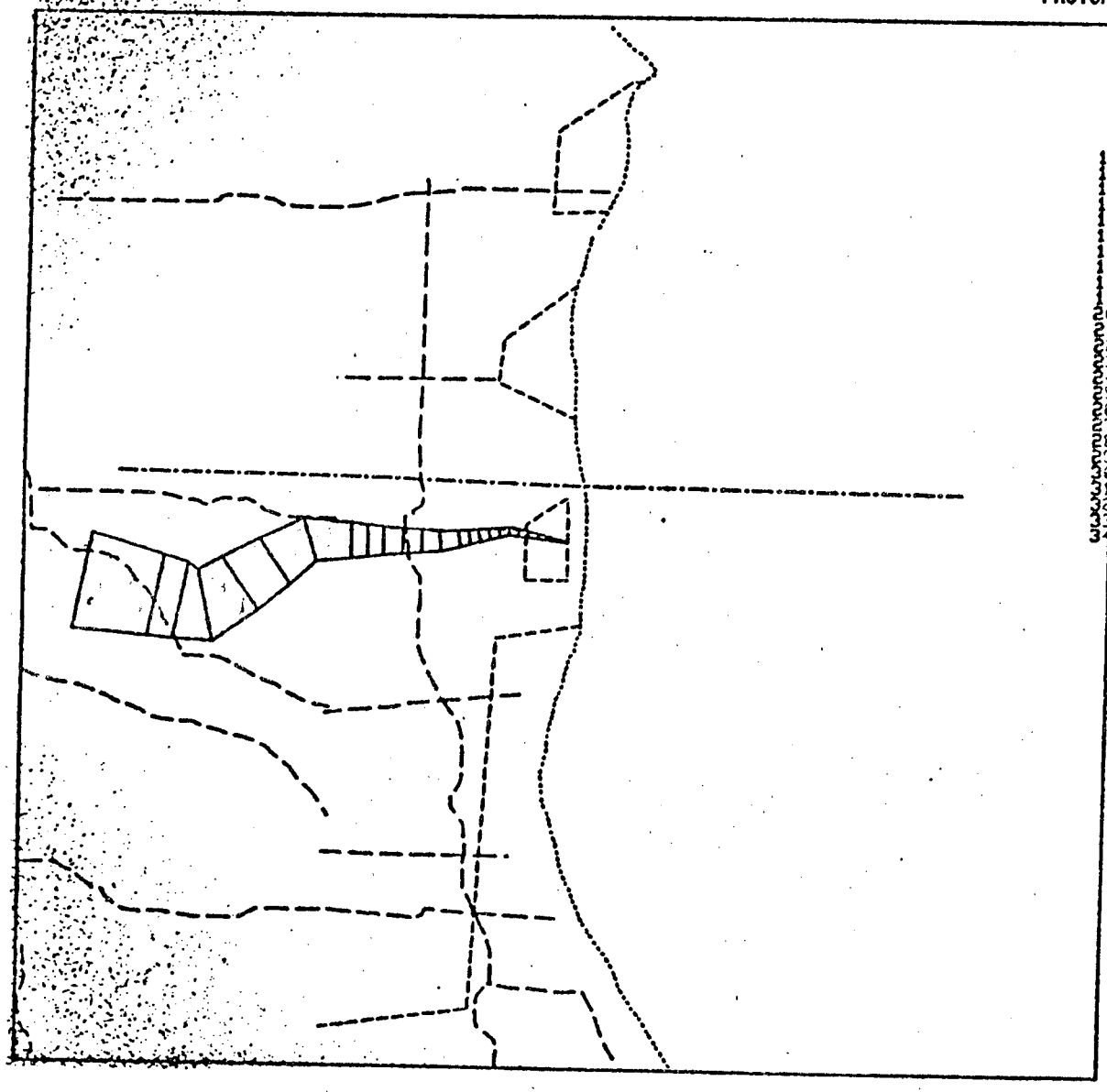
LOGIC FOR SUBSEQUENT SPATIAL INTERVAL (EXAMPLE GIVEN IS FOR CASE 1 WHERE ENTIRE PLUME WAS ABOVE THE LID IN THE PREVIOUS SPATIAL INTERVAL)



LOGIC FOR FIRST SPATIAL INTERVAL



Hypothetical trajectories of air parcels along western shore of Lake Michigan. See text for further details.

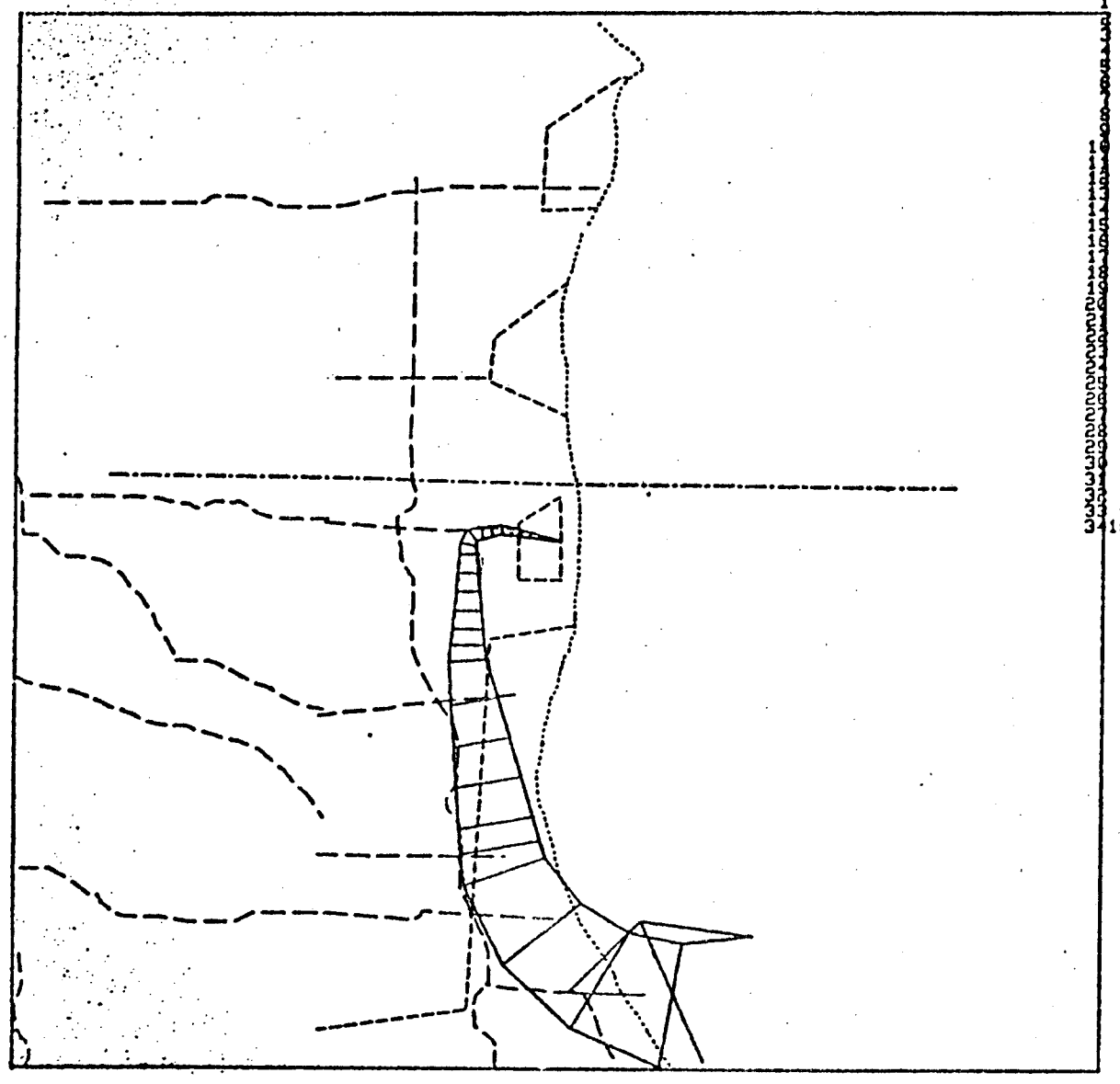


3 28 7

NAME	S	U	DIR	S	SP	DX	R	SZ	HT	TR	X/Q	LID
UNITS	P	M	DEG	T	M/S	M		M	M	M		M
FACTOR	1	10	TUD	B		10		10	10	10		10
1		20	281	5	1	1609	0	0	0	3	3E 01	0
2		30	281	5	1	1609	0	0	0	3	4E 01	0
3		40	281	5	1	1609	0	0	0	3	5E 01	0
4		49	281	5	1	1609	0	0	0	3	6E 01	0
5		58	281	5	1	1609	0	0	0	3	7E 01	0
6		67	281	5	1	1609	0	0	0	3	8E 01	0
7		81	260	4	2	1609	0	0	0	3	1E 02	0
8		94	260	4	2	1609	0	0	0	3	2E 02	0
9		107	260	4	2	1609	0	0	0	3	3E 02	0
10		118	260	4	2	1609	0	0	0	3	4E 02	0
11		133	260	4	2	1609	0	0	0	3	5E 02	0
12		156	260	4	2	1609	0	0	0	3	6E 02	0
13		179	270	4	2	1609	0	0	0	3	7E 02	0
14		202	270	4	2	1609	0	0	0	3	8E 02	0
15		224	270	4	2	1609	0	0	0	3	9E 02	0
16		252	270	3	4	1609	0	0	0	3	1E 03	0
17		280	270	3	4	1609	0	0	0	3	2E 03	0
18		308	270	3	4	1609	0	0	0	3	3E 03	0
19		419	236	3	4	1609	0	0	0	3	4E 03	0
20		486	236	3	4	1609	0	0	0	3	5E 03	0
21		553	236	3	4	1609	0	0	0	3	6E 03	0
22		592	281	3	5	1609	0	0	0	3	6E 03	0
23		632	281	3	5	1609	0	0	0	3	6E 03	0
24		749	281	3	5	1609	0	0	0	7	6E 03	0
25		863	281	3	5	1609	0	0	0	7	7E 03	0
26		976	281	3	5	1609	0	0	0	30	8E 03	0
27	1088		281	3	5	1609	0	0	0	30	9E 03	0
28	1198		281	3	5	1609	0	0	0	33	9E 03	0
29	1681		213	3	5	1609	0	0	0	36	4E 04	0
30	1346		213	3	5	1609	0	0	0	36	4E 04	0
31	1381		281	3	6	1609	0	0	0	36	1E 06	0
32	3881		326	3	4	1609	0	0	0	49	2E 07	0
33	5253		303	4	3	1609	0	0	0	58	2E 07	0
34	16169		303	3	2	1609	1	0	0	73	4E 07	0

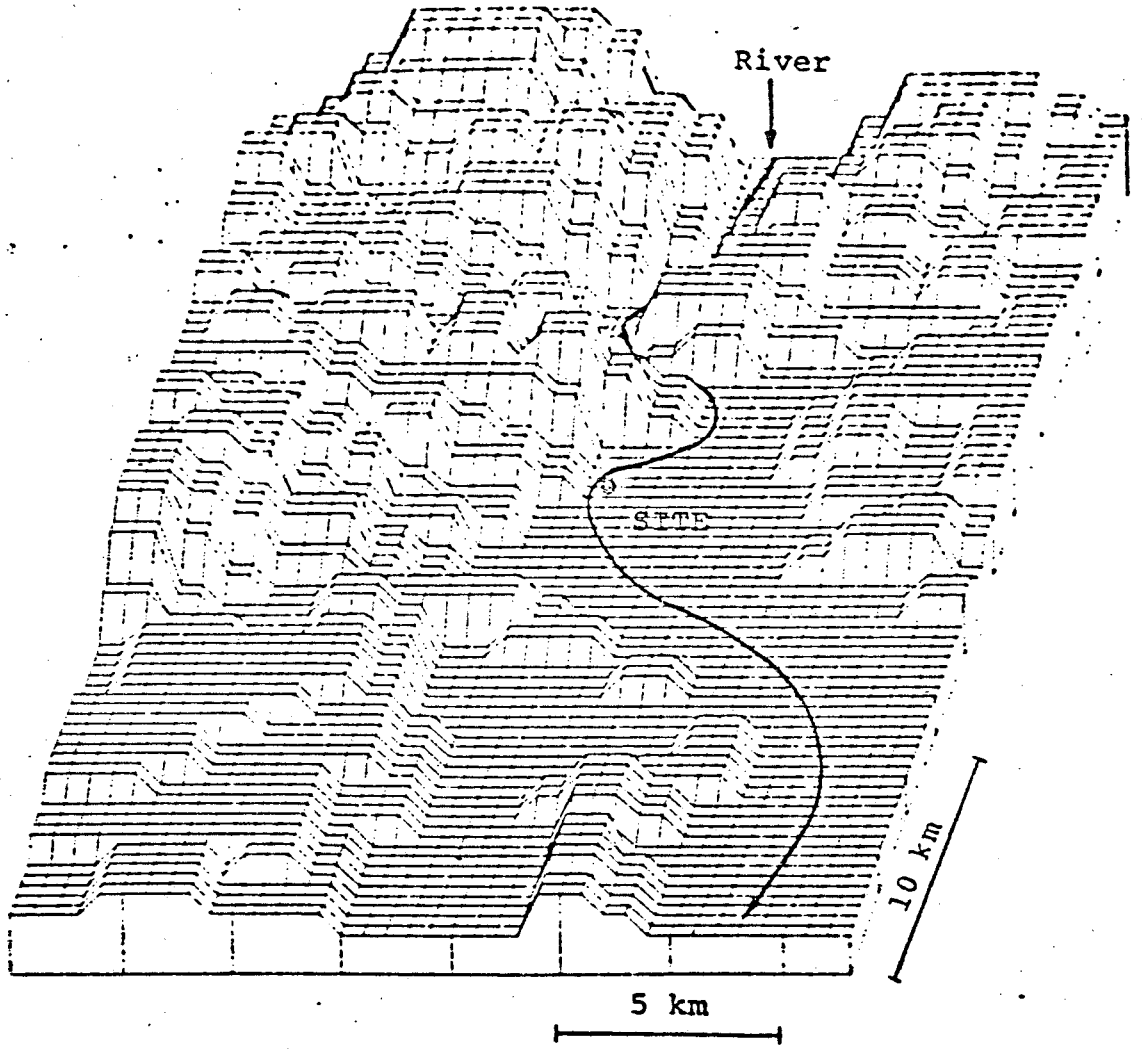
ENTER OPTION

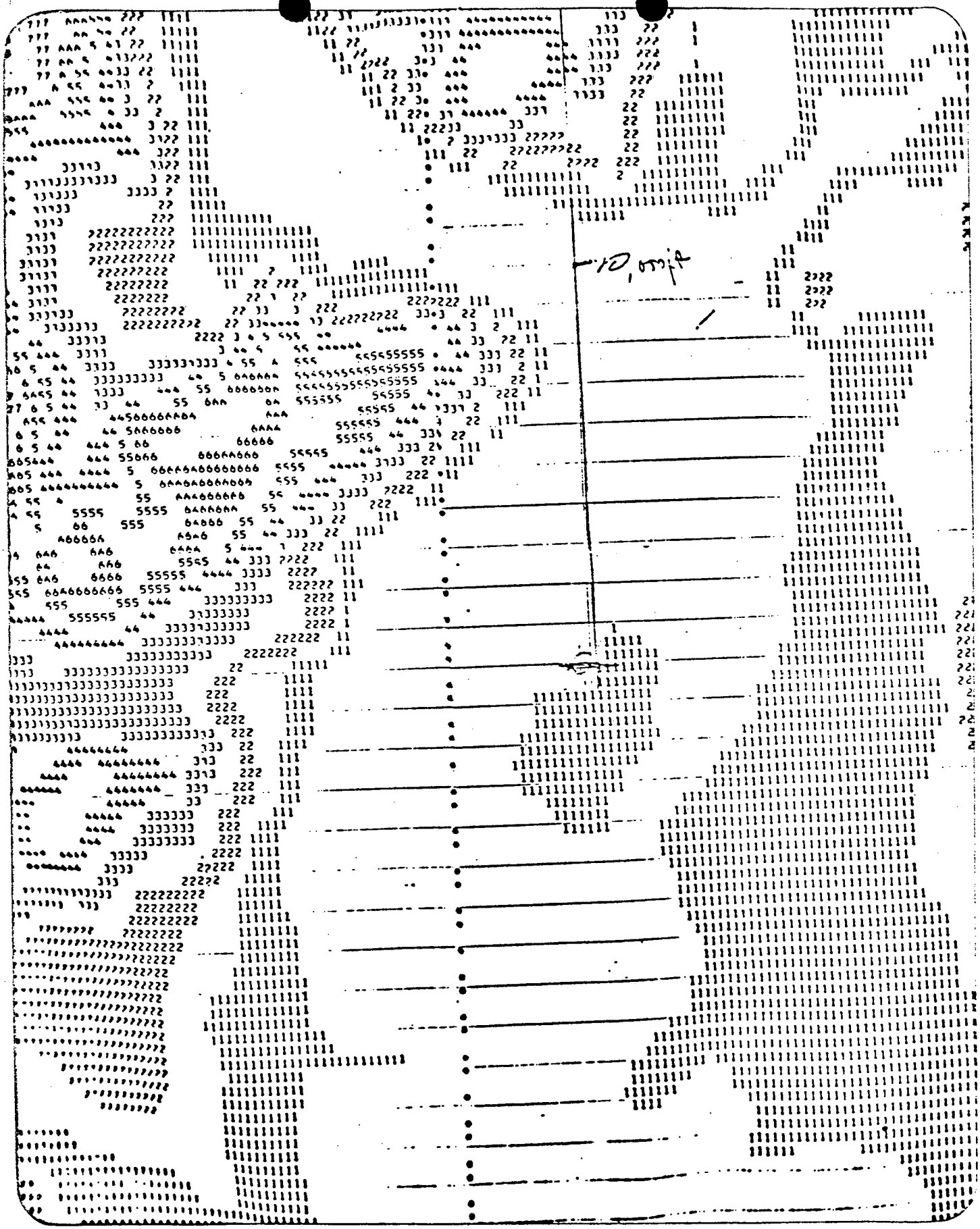
CRACIT-THI 3 28 7



NAME	S	W	DIR	S	SP	DX	R	SZ	HT	TR	X/Q	LID
UNITS	P	M	DEG	T	M/S	M		R	M	M		M
FACTOR	1	10	TUD	B		10		10	10	10		10
1		20	281	S	1	1609	0	0	0	3	.3E 04	0
2		30	281	S	1	1609	0	0	0	3	.4E 04	0
3		40	281	S	1	1609	0	0	0	3	.6E 04	0
4		49	281	S	1	1609	0	0	0	3	.8E 04	0
5		58	281	S	1	1609	0	0	0	3	.9E 04	0
6		67	281	S	1	1609	0	0	0	3	.1E 05	0
7		81	260	4	2	1609	0	0	0	3	.2E 05	0
8		94	260	4	2	1609	0	0	0	3	.3E 05	0
9		107	260	4	2	1609	0	0	0	3	.4E 05	0
10		119	203	4	2	1609	0	0	0	3	.4E 05	0
11		132	180	4	2	1609	0	0	0	3	.5E 05	0
12		156	180	4	2	1609	0	0	0	3	.6E 05	0
13		179	180	4	2	1609	0	0	0	3	.6E 05	0
14		202	180	4	2	1609	0	0	0	3	.7E 05	0
15		224	180	4	2	1609	0	0	0	3	.8E 05	0
16		252	180	3	4	1609	0	0	0	3	.1E 06	0
17		280	180	3	4	1609	0	0	0	3	.1E 06	0
18		350	170	3	4	1609	0	0	0	3	.2E 06	0
19		419	170	3	4	1609	0	0	0	3	.2E 06	0
20		486	170	3	4	1609	0	0	0	3	.3E 06	0
21		553	170	3	4	1609	0	0	0	3	.3E 06	0
22		592	170	3	5	1609	0	0	0	3	.5E 06	0
23		632	170	3	5	1609	0	0	0	3	.5E 06	0
24		749	150	3	5	1609	0	0	0	3	.6E 06	0
25		863	130	3	5	1609	0	0	0	3	.7E 06	0
26		976	110	3	5	1609	0	0	0	3	.8E 06	0
27	1088		90	3	3	1609	0	0	0	3	.5E 06	0
28	1198		281	3	3	1609	0	0	0	3	.5E 06	0
29	1281		213	3	3	1609	0	0	0	3	.4E 06	0
30	1046		213	3	2	1609	0	0	0	3	.4E 06	0
31	1381		281	3	0	1609	0	0	0	3	.1E 06	0
32	3881		326	3	4	1609	0	0	0	3	.2E 07	0
33	5253		303	3	3	1609	0	0	0	3	.2E 07	0
34	16169		303	3	2	1609	1	0	0	3	.4E 07	0

ENTER OPTION


River
SPTE
10 km
5 km



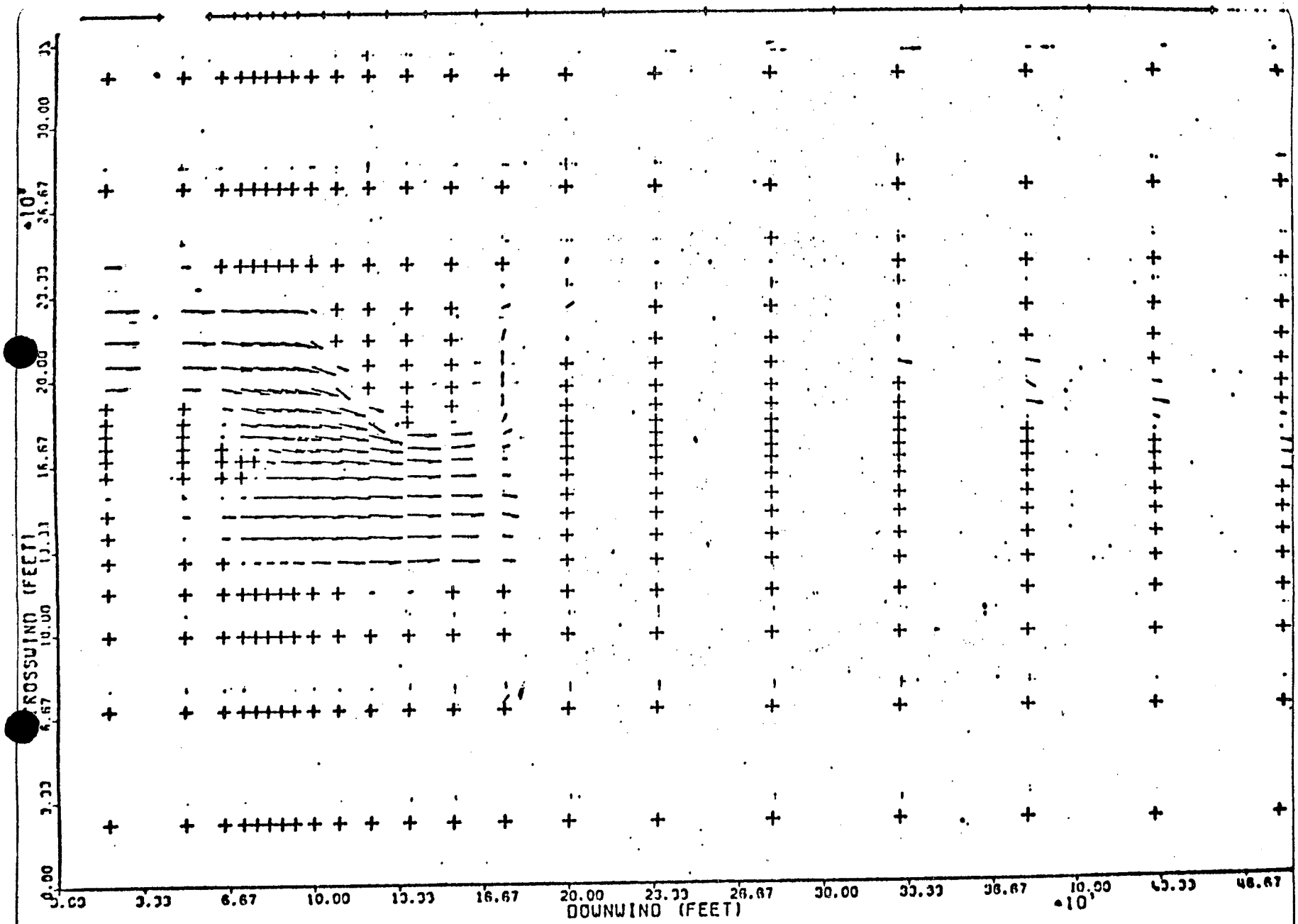
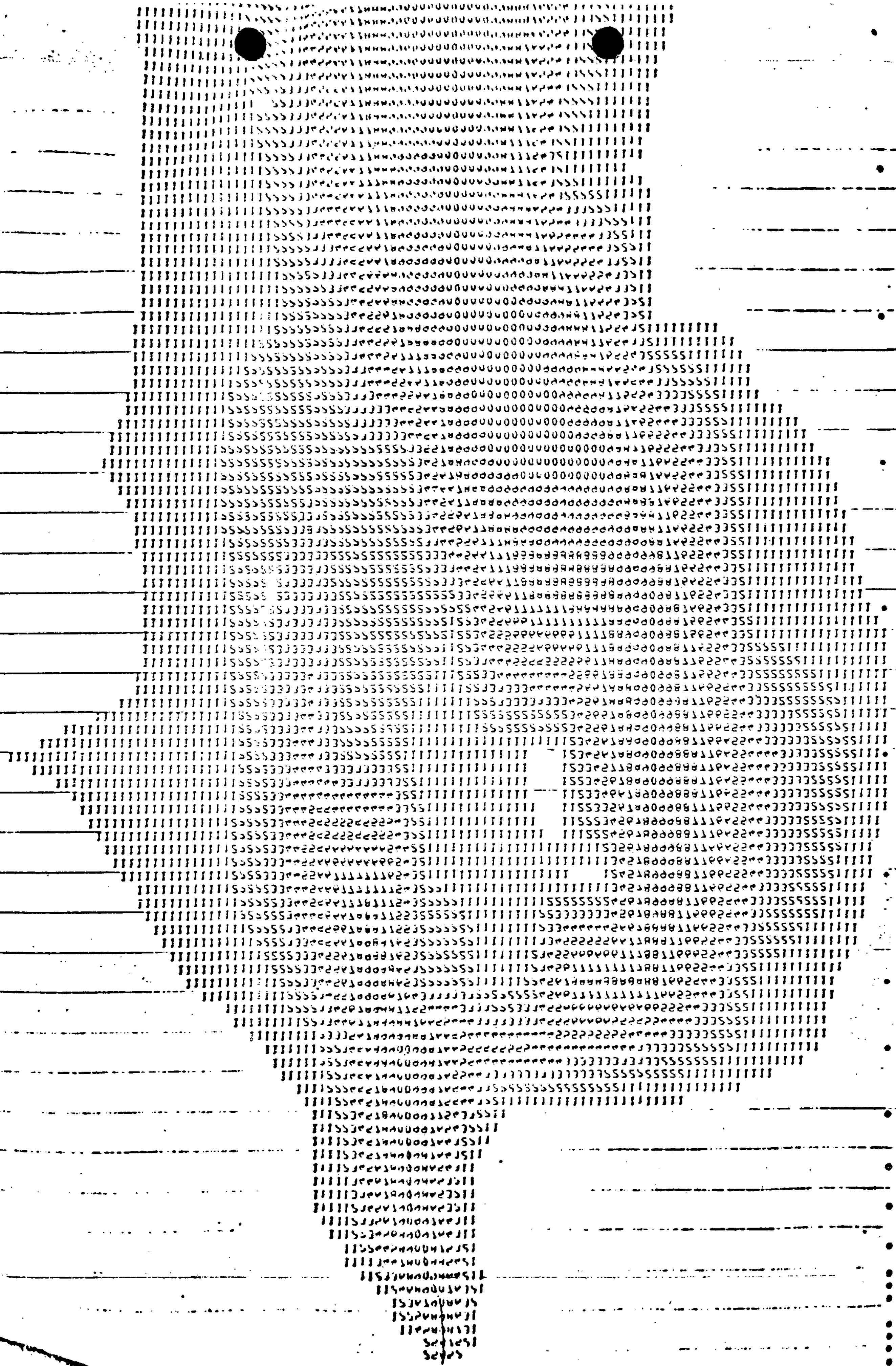
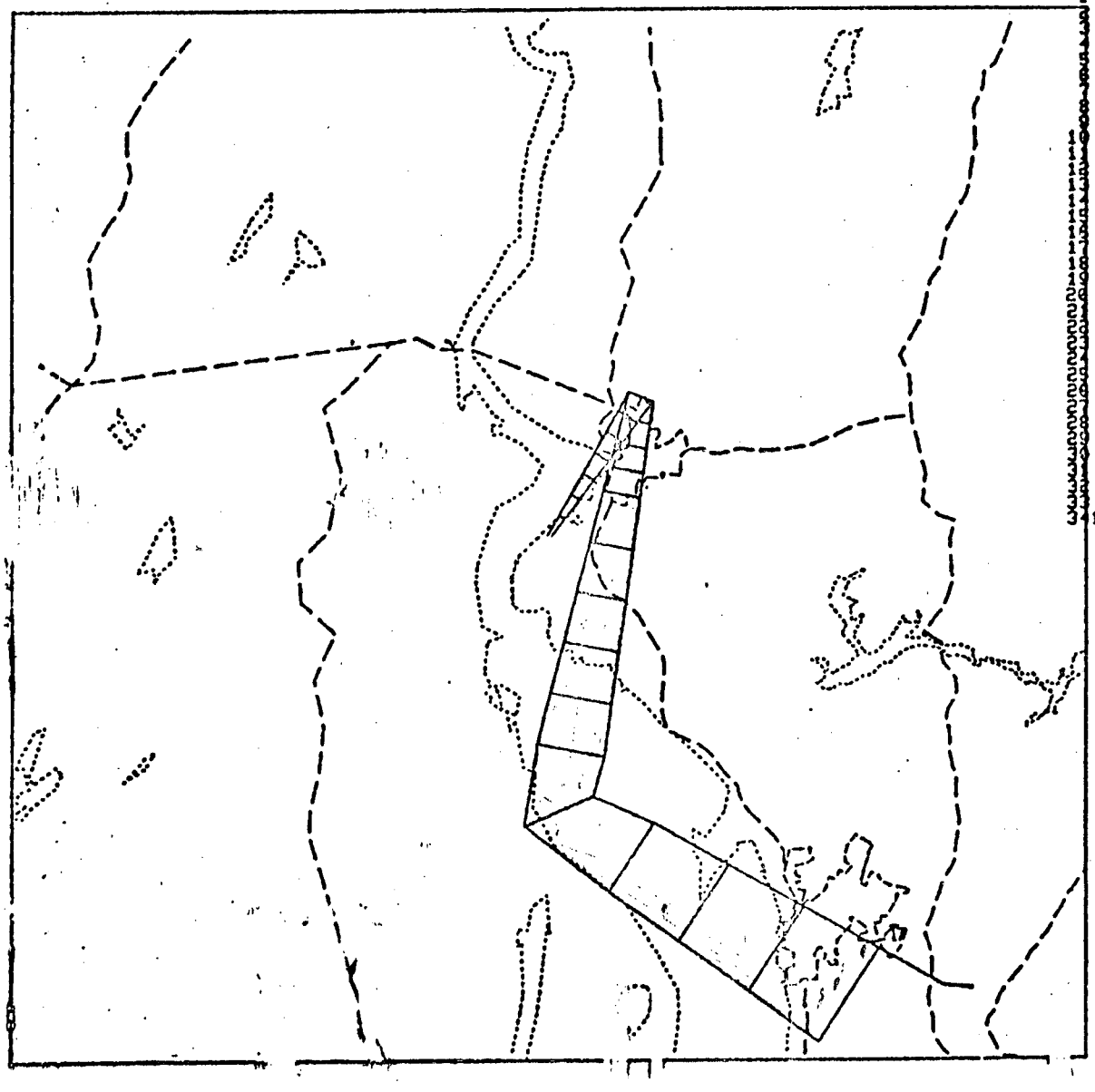


FIGURE 25 WIND DIRECTION = S, STABILITY = D, ELEVATION = 50 FEET , INDIAN POINT



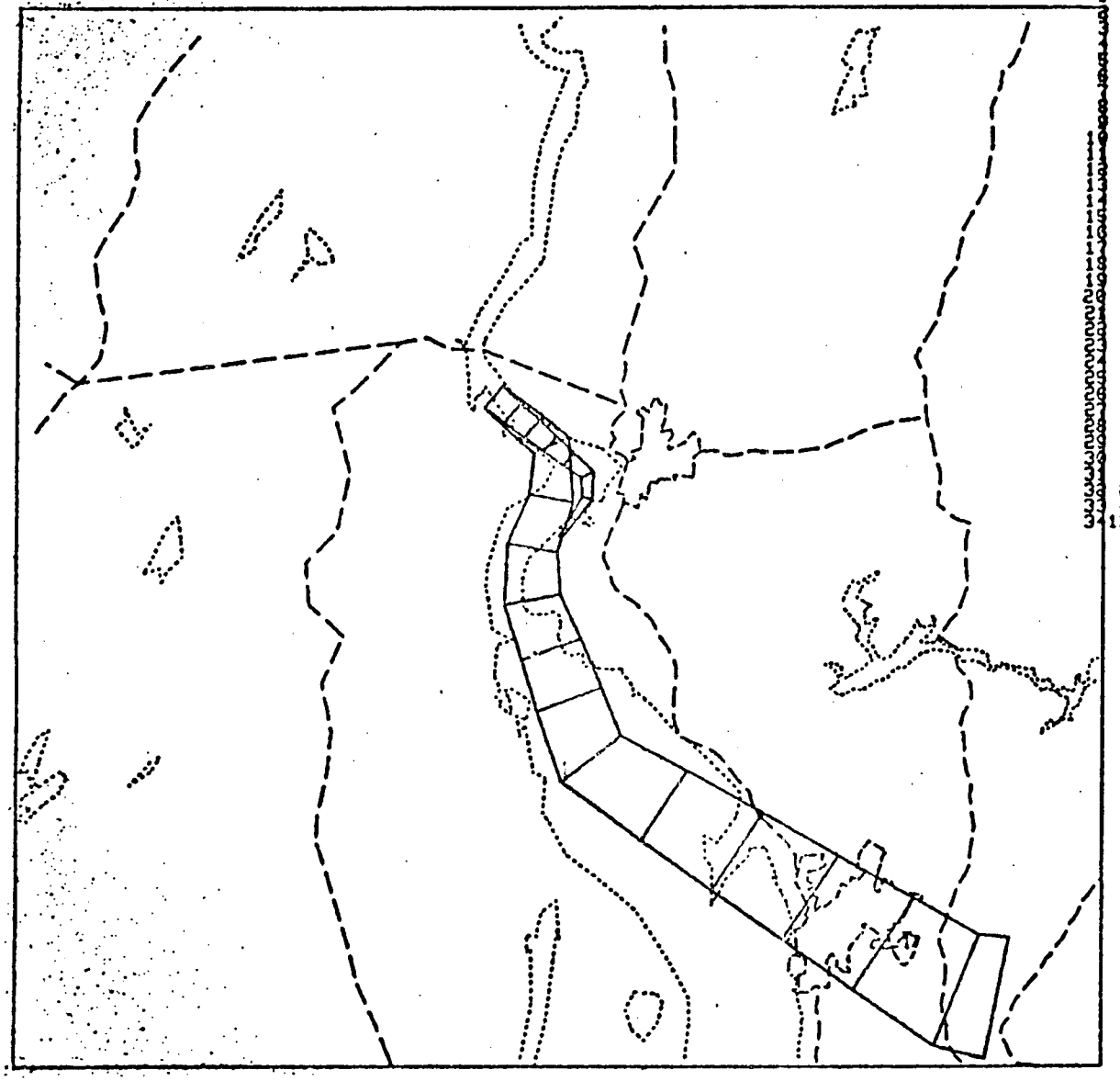
CRACIT TMI 3 31 22



NAME	S	W	DIR	S	SP	DX	R	SZ	HT	TR	X/Q	LID
UNITS	P	M	DEG	T	M/S	M		M	M	M		M
FACTOR	1	10	TWD			10		10	10	10		10
1		20	33	5	1	1609	0	0	0	3	.3E-04	0
2		30	33	5	1	1609	0	0	0	5	.5E-04	0
3		40	33	5	1	1609	0	0	0	7	.6E-04	0
4		49	33	5	1	1609	0	0	0	9	.6E-04	0
5		58	33	5	1	1609	0	0	0	11	.5E-04	0
6		67	33	5	1	1609	0	0	0	12	.5E-04	0
7		76	33	5	1	1609	0	0	0	14	.4E-04	0
8		85	191	5	3	1609	0	0	0	16	.4E-04	0
9		94	191	5	3	1609	0	0	0	17	.4E-04	0
10		103	191	5	3	1609	0	0	0	19	.3E-04	0
11		112	191	5	3	1609	0	0	0	21	.3E-04	0
12		131	191	5	3	1609	0	0	0	24	.3E-04	0
13		149	191	5	3	1609	0	0	0	27	.2E-04	0
14		168	191	5	3	1609	0	0	0	30	.2E-04	0
15		186	191	5	3	1609	0	0	0	33	.2E-04	0
16		204	191	5	3	1609	0	0	0	36	.2E-04	0
17		225	191	5	3	1609	0	0	0	40	.1E-04	0
18		253	123	5	3	1609	0	0	0	45	.1E-04	0
19		281	123	5	3	1609	0	0	0	50	.1E-04	0
20		308	123	5	3	1609	0	0	0	55	.1E-04	0
21		335	123	5	3	1609	0	0	0	60	.1E-04	0
22		362	123	5	3	1609	0	0	0	64	.1E-04	0
23		375	101	5	1	1609	0	0	0	67	.1E-04	0
24		429	101	5	1	1609	0	0	0	77	.1E-04	0
25		484	78	5	1	1609	0	0	0	87	.1E-04	0
26		531	101	5	1	1609	0	0	0	97	.9E-05	0
27		567	78	5	1	1609	0	0	0	104	.8E-05	0
28		606	78	5	1	1609	0	0	0	111	.8E-05	0
29		651	326	5	1	1609	0	0	0	120	.7E-05	0
30		696	146	5	1	1609	0	0	0	128	.7E-05	0
31		714	146	5	1	1609	0	0	0	131	.6E-05	0
32	2	2482	213	4	3	1609	0	0	0	457	.2E-05	0
33	4	4077	281	4	6	1609	0	0	0	521	.3E-06	0
34	13	13067	303	3	2	1609	1	12	0	671	.1E-06	0

ENTER OPTION

CRAC1T-TNI 3 31 22



NAME	S	W	DIR	S	SP	DX	R	SZ	HT	TR	X/Q	LID
UNITS	P	M	DEG	T	M/S	M		M	M	M		M
FACTOR	1	10	TWD	R		10		10	10	10		10
1		20	33	5	1	1609	0	0	0	3	3E 04	0
2		30	33	5	1	1609	0	0	0	3	5E 04	0
3		40	0	5	1	1609	0	0	0	3	5E 04	0
4		49	310	5	1	1609	0	0	0	3	9E 04	0
5		58	310	5	1	1609	0	0	0	3	1E 05	0
6		67	310	5	1	1609	0	0	0	3	1E 05	0
7		76	310	5	1	1609	0	0	0	3	1E 05	0
8		85	310	5	3	1609	0	0	0	3	1E 05	0
9		94	130	5	3	1609	0	0	0	3	1E 05	0
10		103	130	5	3	1609	0	0	0	3	1E 05	0
11		112	130	5	3	1609	0	0	0	3	1E 05	0
12		121	180	5	3	1609	0	0	0	3	1E 05	0
13		149	200	5	3	1609	0	0	0	3	1E 05	0
14		160	180	5	3	1609	0	0	0	3	1E 05	0
15		186	160	5	3	1609	0	0	0	3	1E 05	0
16		204	160	5	3	1609	0	0	0	3	1E 05	0
17		225	160	5	3	1609	0	0	0	3	1E 05	0
18		253	123	5	3	1609	0	0	0	3	1E 05	0
19		281	123	5	3	1609	0	0	0	3	1E 05	0
20		308	123	5	3	1609	0	0	0	3	1E 05	0
21		335	123	5	3	1609	0	0	0	3	1E 05	0
22		362	123	5	3	1609	0	0	0	3	1E 05	0
23		375	101	5	1	1609	0	0	0	3	1E 05	0
24		429	101	5	1	1609	0	0	0	3	1E 05	0
25		484	78	5	1	1609	0	0	0	3	1E 05	0
26		531	101	5	1	1609	0	0	0	3	1E 05	0
27		567	78	5	1	1609	0	0	0	3	1E 05	0
28		606	78	5	1	1609	0	0	0	3	1E 05	0
29		651	326	5	1	1609	0	0	0	3	1E 05	0
30		696	146	5	1	1609	0	0	0	3	1E 05	0
31		714	146	5	1	1609	0	0	0	3	1E 05	0
32		2482	213	4	3	1609	0	0	0	4	5E 06	0
33		4077	281	4	6	1609	0	0	0	5	3E 07	0
34		13067	303	3	2	1609	1	12	0	67	1E 09	0

ENTER OPTION

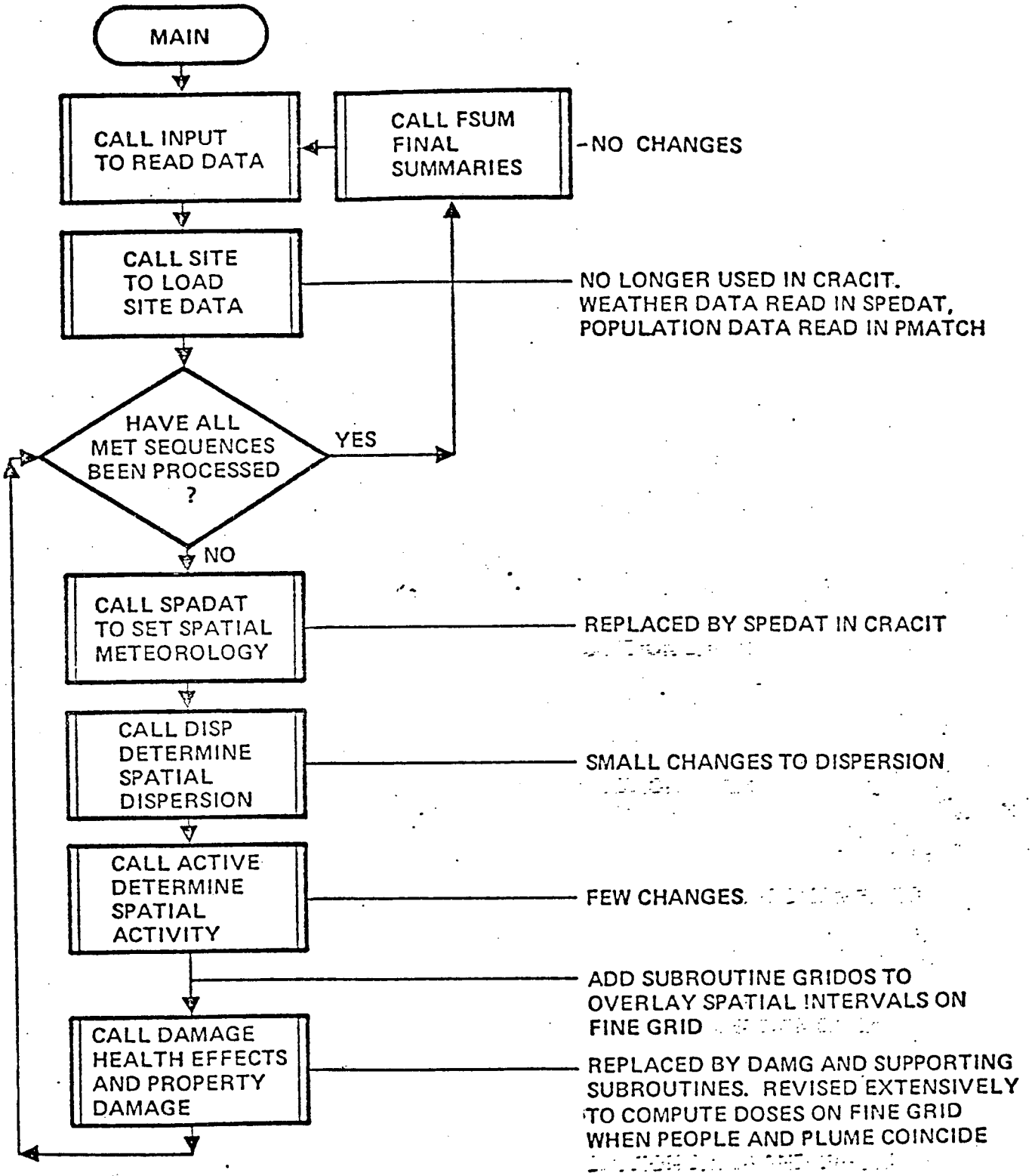


FIGURE 6-5. FLOW OF THE MAIN ROUTINE IN THE CONSEQUENCE MODEL (CRACIT)

A Comparison of April Through September 6-Hour Classifications with the Random Start Time Classifications

Classification	6-Hour		Random	
	Count	%	Count	%
Onshore Flow with Precipitation	45	6.2	10	6.8
Precipitation	78	10.6	13	8.8
Offshore Flow - Land Breeze	15	2.1	10	6.8
Onshore Flow - Lake Breeze	75	10.3	18	12.2
Onshore Flow - Fumigation	60	8.2	13	8.8
Onshore Flow - Plume Trapping	27	3.7	11	7.4
Channel Flow	17	2.3	6	4.1
Offshore Flow - synoptic, stable	214	29.2	34	23.0
No Lake Effect	201	27.4	26	17.6
TOTAL	732	100.0	148	100.0