Docket No. SA- 516

Exhibit No. 5-B

NATIONAL TRANSPORTATION SAFETY BOARD

Washington D.C.

Attachments

Meteorological Factual Report
[DCA96MA070]
(46 Pages)

SURFACE WEATHER OBSERVATIONS (METAR/SPEC)

LATITUDE	LONGITUDE	STATION ELEVATION FT (MSL)	TIME CONVERSION	DAY	MONTH	YEAR	SID	STATION (TYPE, NAME, STATE)
40°39'N	73°47'N	13	+5	17	07	1996	JFK	ASOS NEW YORK (JFK AP), NY

TYPE M/S	TIME (LST)	WIND DIR TRUE	WIND SPD KTS	WIND GUST KTS	WIND VARIABILITY TRUE	VISIBILITY SURFACE STATUTE MILES	PRESENT WEATHER	SKY CONDITION	TEMP °C	DEW POINT °C	ALTIMETER INS.	REMARKS AND SUPPLEMENTAL CODED DATA
1	2	3	4	5	6	7	9	10	11	12	13	14
M	0051	230	6			8		SCT120	23	21	A3007	SLP182 T02280206 10272 20222 56003 (RR)
M	0151	260	7			7		CLR	23	21	A3007	SLP182 T02330206 (RR)
M	0251	260	9			7		CLR	24	20	A3007	SLP182 T02390200 (RR)
S	0314										A	
S	0314										A	
M	0351	250	7			7		CLR	23	20	A3009	SLP188 T02330200 53006 (RR)
M	0451	250	9			6	HZ	SCT100	23	20	A3009	SLP189 T02280200 (RR)
M	0551	250	7			4	BR	FEW095	23	21	A3010	SLP193 T02280206 (RR)
S	0600										A	
M	0651	260	7			7		SCT037 SCT100	24	20	A3009	RAB11E27 SLP190 P0000 60000 T02440200 10244 20222 50003 (JGC)
M	0751	260	8			8		SCT080	25	19	A3010	SLP193 T02500194 (JGC)
M	0851	270	11			10		SCT070	26	18	A3010	SLP192 T02610178 (JGC)
M	0951	270	12			10		SCT110	29	18	A3011	SLP194 T02890183 53003 (JGC)
M	1051	250	8			10		FEW110	29	19	A3010	SLP192 T02890194 (JGC)
M	1151	230	12			10		FEW043	29	21	A3009	SLP188 T02890206 (JGC)
M	1251	230	14			10		SCT045	29	21	A3007	SLP183 T02940206 10300 20239 58010 (JGC)
M	1351	220	16			10		SCT050	30	21	A3006	SLP180 T03000211 (JGC)
M	1451	230	18			10		SCT055	30	21	A3005	SLP175 T03000211 (JGC)
	1501										A	
	1501										A	
M	1551	230	13			10		SCT060	30	21	A3005	SLP175 T03000206 56008 (JGC)
M	1651	240	10			10		FEW060	29	21	A3005	SLP176 T02940206 (JGC)
M	1751	230	11			10		BKN060 BKN100	28	21	A3006	SLP179 VCSH NW T02830211 (JGC)
S	1819										A	
S	1827	280	8			10	–RA	BKN060 BKN095	29	20	A3007	WSHFT 2306 RAB18 P0000 (RR)
M	1851	220	8			10		SCT060 BKN070 BKN090	28	21	A3007	WSHFT 2306 RAB18E29 SLP183 P0000 60000 T027 80211 1030 20278 53007 (RR)
M	1951	240	9			10		FEW100	27	21	A3008	SLP185 T02670206 (RR)
M	2051	240	7			10		CLR	26	21	A3009	SLP190 T02610211 (RR OBS LISTING COMPLETE, 314 OBS(S) LISTED.
M	2051	240	7			10		CLR	26	21	A3009	SLP190 T02610211 (RR)
M	2151	260	8			10		CLR	26	20	A3009	SLP190 T02610200 51006 (RR)
M	2251	290	7			10		CLR	26	19	A3010	SLP192 T02610189 (RR)
M	2351	290	5			10		CLR	26	19	A3011	SLP194 T02560189 403060222 (RR)
								*** End of File ***				

SURFACE WEATHER OBSERVATIONS (METAR/SPEC)

LATITUDE	LONGITUDE	STATION ELEVATION FT. (MSL)	TIME CONVERSION	DAY	MONTH	YEAR	SID	STATION (TYPE, NAME, STATE)
40° 39'N	73° 47'N	13	+5	17	07	1996	JFK	ASOS NEW YORK (JFK AP), NY

TIME LST 16	TOTAL SKY COVER (0-8) 17	TEMP. DRY-BULB 18	DEW POINT 19	TEMP. WET BULB 20	RELATIVE HUMIDITY (%) 21	STATION PRESSURE (INS) 22	PRESSURE TENDENCY 23	NET 3-HR CHANGE 24	HOURLY PRECIPITATION (INS) 25	HR
0051		22.8	20.6	21.4	87	30.06	6	003	0.00	00-01
0151		23.3	20.6	21.5	85	30.06			0.00	01-02
0251		23.9	20.0	21.4	79	30.06			0.00	02-03
0351		23.3	20.0	21.2	82	30.06	3	006	0.00	03-04
0451		22.8	20.0	21.0	84	30.06			0.00	04-05
0551		22.8	20.6	21.4	87	30.09			0.00	05-06
0651		24.4	20.0	21.5	77	30.06	0	003	T	06-07
0751		25.0	19.4	21.3	71	30.09			0.00	07-08
0851		26.1	17.8	20.8	60	30.09			0.00	08-09
0951		28.9	18.3	21.9	53	30.10	3	003	0.00	09-10
1051		28.9	19.4	22.6	57	30.09			0.00	10-11
1151		28.9	20.6	23.3	61	30.06			0.00	11-12
1251		29.4	20.6	23.4	59	30.06	8	010	0.00	12-13
1351		30.0	21.1	23.9	59	30.05			0.00	13-14
1451		30.0	21.1	23.9	59	30.04			0.00	14-15
1551		30.0	20.6	23.6	57	30.04	6	008	0.00	15-16
1651		29.4	20.6	23.4	59	30.04			0.00	16-17
1751		28.3	21.1	23.4	65	30.05			0.00	17-18
1851		27.8	21.1	23.3	67	30.06	3	007	T	18-19
1951		26.7	20.6	22.6	69	30.07			0.00	19-20
2051		26.1	21.1	22.7	74	30.06			0.00	20-21
2151		26.1	20.0	22.1	69	30.06	1	006	0.00	21-22
2251		26.1	18.9	21.4	65	30.09			0.00	22-23
2351		25.6	18.9	21.2	67	30.10			0.00	23-24

SYNOPTIC DATA

TIME 26	NO 27	LOW CLOUD TYPE 28	MID CLOUD TYPE 29	HIGH CLOUD TYPE 30	MAX TEMP (.1 C) 31	MIN TEMP (.1 C) 32	PRECIP (INS) 33	SNOW FALL (INS) 34	SNOW DEPTH (INS) 35	STATION PRESSURE (INS) 36	BAROGRAPH 37	BARR CORR 38	LOCAL USE 39

WEATHER AND OBSTRUCTION TO VISION

TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42
HZ	0015	0020									
BR	0020	0050									
HZ	0055	0110									
BR	0110	0120									
HZ	0120	0150									
HZ	0155	0205									
HZ	0310	0330									
HZ	0335	0345									
HZ	0355	0440									
BR	0440	0445									
HZ	0445	0500									
BR	0500	0525									
HZ	0525	0615									
-RA	0615	0630									
BR	0615	0635									
HZ	0635	0650									
-RA	1820	1830									

SUMMARY OF THE DAY (MIDNIGHT TO MIDNIGHT)

PEAK WINDS SPEED (KTS) 43	PEAK WINDS DIREC-TION 44	PEAK WINDS TIME (LST) 45	FASTEST 2-MIN WIND SPEED (KTS) 46	FASTEST 2-MIN WIND DIREC-TION 47	FASTEST 2-MIN WIND TIME (LST) 48	SUNRISE TIME (LST) 49	SUNSET TIME (LST) 50	TOTAL SUNSHINE (MIN) 51	PERCENT PSBL SUNSHINE 52	CHARACTER SUNRISE 53	CHARACTER SUNSET 54	SKY COVER SUNRISE TO SUNSET 55	SKY COVER MIDNIGHT TO MIDNIGHT 56	24-HR MAX TEMP. (0.1 C) 57	24-HR MIN TEMP. (0.1 C) 58	24-HR PRECIP. WATER EQUIV (INS) 59	24-HR SNOW-FALL UNMLTD 60	1200 UTC SNOW DEPTH (INS) 61	WATER EQUIV. (INS) 62	STATION PRESSURE 63	SEA LEVEL PRESSURE 64
24	230	1513	21	230	1505			M	M					30.6	22.2	T					

TIME CHECK-CLOCK CORRECT TO THE NEAREST MINUTE AT: / / /

REMARKS, NOTES AND MISCELLANOUS PHENOMENA 65 :

(SUPERSEDES MF1-10B - PREVIOUS VERSIONS OBSOLETE)

U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE

MF1M-10B (1-96) (PRESCRIBED BY FMH-1)

SURFACE WEATHER OBSERVATIONS (METAR/SPEC)

LATITUDE	LONGITUDE	STATION ELEVATION FT. (MSL)	TIME CONVERSION	DAY	MONTH	YEAR	SID	STATION (TYPE, NAME, STATE)
40°39'N	73°47'N	13	+5	18	07	1996	JFK	ASOS NEW YORK (JFK AP), NY

(3)

TYPE M/S	TIME (LST)	WIND DIR TRUE	WIND SPD KTS	WIND GUST KTS	VARIABILITY TRUE	VISIBILITY SURFACE STATUTE MILES	RUNWAY VISUAL RANGE (FEET)	PRESENT WEATHER	SKY CONDITION	TEMP °C	DEW POINT °C	ALTIMETER INS.	REMARKS AND SUPPLEMENTAL CODED DATA
1	2	3	4	5	6	7	8	9	10	11	12	13	14
M	0051	310	5			10			CLR	26	19	A3010	SLP193 T02560189 10278 20250 50003 (RR)
M	0151	000	0			10			CLR	24	20	A3010	SLP192 T02390200 (RR)
M	0251	000	0			10			CLR	24	19	A3009	SLP190 T02440194 (RR)
S	0320											A	
S	0320											A	
M	0351	280	4			10			CLR	23	20	A3009	SLP189 T02280200 55003 (RR)
M	0451	260	4			9			FEW100	22	21	A3010	SLP191 T02170206 (RR)
M	0551	000	0			9			SCT100	24	21	A3010	SLP192 T02390206 (RR)
S	0619											A	
M	0651	210	4			6		HZ	CLR	24	21	A3010	SLP191 T02440211 10250 20211 51001 (JGC)
M	0751	240	4			5		HZ	SCT075	26	21	A3010	SLP194 T02610211 (JGC)
M	0851	230	7			7			SCT100	27	21	A3010	SLP192 T02720206 (JGC)
M	0951	240	6			9			FEW043 SCT100	28	20	A3009	SLP189 T02830200 58002 (JGC) OBS LISTING COMPLETE, 47 OBS(S) LISTED.
M	1051	200	9			10			FEW045	29	19	A3006	SLP184 T02940194 (JGC)
M	1151	210	10			10			FEW045	30	19	A3005	SLP175 T03000189 (JGC)
M	1251	190	10			10			FEW050 SCT120	29	21	A3005	SLP175 T02940206 10306 20244 56015 (JGC)
M	1351	190	11			10			SCT050	29	22	A3003	SLP167 T02940217 (JGC)
M	1451	190	13			10			SCT055	29	22	A3000	SLP160 T02890222 (JGC)
S	1519											A	
S	1519											A	
M	1551	180	11			10			SCT060CB BKN100	27	22	A2999	SLP154 CB DSNT S T02670217 56020 (JGC)
M	1651	180	9			8			SCT055CB BKN100	26	22	A2997	SLP149 CB VC N T02610222 (JGC)
M	1751	240	13			10			SCT060 SCT100	29	21	A2996	SLP145 T02890206 (JGC)
S	1816											A	
M	1851	230	11			10			FEW060TCU SCT100	27	22	A2996	SLP146 TCU DSNT NE T02720222 10306 20261 55008 (RR)
M	1951	220	8			9			SCT100	26	22	A2996	SLP146 T02560222 (RR)
M	2051	220	9			8			SCT100	26	23	A2995	SLP143 T02560228 (RR)
M	2151	210	11			10			FEW100	25	20	A2994	SLP139 T02500200 58006 (RR)
M	2251	220	7			10			FEW070 OVC095	24	21	A2993	SLP133 T02390211 (RR OBS LISTING COMPLETE, 31 OBS(S) LISTED.
M	2351	180	11			8			OVC055	23	21	A2991	SLP127 T02330211 403060211 (RR)
									*** End of File ***				

[redacted]

SURFACE WEATHER OBSERVATIONS (METAR/SPEC)

LATITUDE	LONGITUDE	STATION ELEVATION FT. (MSL)	TIME CONVERSION	DAY	MONTH	YEAR	SID	STATION (TYPE, NAME, STATE)
40°39'N	73°47'N	13	+5	18	07	1996	JFK	ASOS NEW YORK (JFK AP), NY

TIME LST 16	TOTAL SKY COVER (0–8) 17	TEMP. DRY-BULB 18	DEW POINT 19	TEMP. WET BULB 20	RELATIVE HUMIDITY (%) 21	STATION PRESSURE (INS) 22	PRESSURE TENDENCY 23	NET 3-HR CHANGE 24	HOURLY PRECIPITATION (INS) 25	HR
0051		25.6	18.9	21.2	67	30.09	0	003	0.00	00–01
0151		23.9	20.0	21.4	79	30.09			0.00	01–02
0251		24.4	19.4	21.2	74	30.08			0.00	02–03
0351		22.8	20.0	21.0	84	30.08	5	003	0.00	03–04
0451		21.7	20.6	21.0	94	30.09			0.00	04–05
0551		23.9	20.6	21.7	82	30.09			0.00	05–06
0651		24.4	21.1	22.2	82	30.09	1	001	0.00	06–07
0751		26.1	21.1	22.7	74	30.09			0.00	07–08
0851		27.2	20.6	22.8	67	30.09			0.00	08–09
0951		28.3	20.0	22.7	61	30.08	8	002	0.00	09–10
1051		29.4	19.4	22.7	55	30.07			0.00	10–11
1151		30.0	18.9	22.6	51	30.04			0.00	11–12
1251		29.4	20.6	23.4	59	30.04	6	015	0.00	12–13
1351		29.4	21.7	24.1	63	30.02			0.00	13–14
1451		28.9	22.2	24.3	67	29.99			0.00	14–15
1551		26.7	21.7	23.3	74	29.98	8	020	0.00	15–16
1651		26.1	22.2	23.4	79	29.96			0.00	16–17
1751		28.9	20.6	23.3	61	29.95			0.00	17–18
1851		27.2	22.2	23.8	74	29.95	5	008	0.00	18–19
1951		25.6	22.2	23.3	82	29.95			0.00	19–20
2051		25.6	22.8	23.7	85	29.94			0.00	20–21
2151		25.0	20.0	21.7	74	29.93	8	008	0.00	21–22
2251		23.9	21.1	22.0	84	29.92			0.00	22–23
2351		23.3	21.1	21.8	88	29.90			0.00	23–24

SYNOPTIC DATA

TIME 26	NO 27	LOW CLOUD TYPE 28	MID CLOUD TYPE 29	HIGH CLOUD TYPE 30	MAX TEMP (.1 C) 31	MIN TEMP (.1 C) 32	PRECIP (INS) 33	SNOW FALL (INS) 34	SNOW DEPTH (INS) 35	STATION PRESSURE (INS) 36	BAROGRAPH 37	BARR CORR 38	LOCAL USE 39

WEATHER AND OBSTRUCTION TO VISION

TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42	TYPE 40	BEGIN 41	ENDED 42
BR	0305	0325									
BR	0330	0350									
BR	0435	0450									
BR	0455	0510									
HZ	0510	0525									
HZ	0530	0550									
HZ	0555	0615									
BR	0615	0630									
HZ	0630	0640									
BR	0640	0645									
HZ	0645	0650									
HZ	1630	1650									
HZ	1700	1715									
HZ	1855	1945									
HZ	2035	2045									
BR	2045	2050									
HZ	2055	2120									

SUMMARY OF THE DAY (MIDNIGHT TO MIDNIGHT)

PEAK WINDS SPEED (KTS) 43	PEAK WINDS DIRECTION 44	PEAK WINDS TIME (LST) 45	FASTEST 2-MIN WIND SPEED (KTS) 46	FASTEST 2-MIN WIND DIRECTION 47	FASTEST 2-MIN WIND TIME (LST) 48	SUNRISE TIME (LST) 49	SUNSET TIME (LST) 50	TOTAL SUNSHINE (MIN) 51	PERCENT PSBL SUNSHINE 52	CHARACTER SUNRISE 53	CHARACTER SUNSET 54	SKY COVER SUNRISE TO SUNSET 55	SKY COVER MIDNIGHT TO MIDNIGHT 56	24-HR MAX TEMP. (0.1 C) 57	24-HR MIN TEMP. (0.1 C) 58	24-HR PRECIP. WATER EQUIV (INS) 59	24-HR SNOW-FALL UNMLTD 60	1200 UTC SNOW DEPTH (INS) 61	WATER EQUIV. (INS) 62	STATION PRESSURE 63	SEA LEVEL PRESSURE 64
20	220	1807	16	230	1824			M	M					30.6	21.1	0.00					

TIME CHECK–CLOCK CORRECT TO THE NEAREST MINUTE AT: / / /

REMARKS, NOTES AND MISCELLANOUS PHENOMENA 65 :

[redacted]

MF1M-10B (1-88) (PRESCRIBED BY FMH-1)

U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE

(SUPERSEDES MF1-10B – PREVIOUS VERSIONS OBSOLETE)

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(5)

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)	LATITUDE	LONGITUDE	STATION ELEVATION Ft. (MSL)	TIME CONVERSION (LST to UTC)	DAY	MONTH	YEAR	WBAN	STATION (Type, Name, State)
					17	07	96		Farmingdale, NY ATCT

TYPE (1)	TIME (2)	WIND DIREC-TION (3)	WIND SPEED (4)	WIND GUST (5)	VARIABILITY (6)	VISIBILITY SUR-FACE (7a)	VISIBILITY TOWER (7b)	RUNWAY VISUAL RANGE (8)	PRESENT WEATHER (9)	SKY CONDITION (10)	TEMP (°C) (11)	DEW POINT (°C) (12)	ALTIMETER SETTING (Ins.) (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14)	TOTAL SKY COVER (17)	(18)	(19)	(20)	INITIALS (16)
M	1045	230	07			7				SCT070 OVC 150	24	20	3007		5				AW
M	1145	240	06			7				SCT100 BKN 150	24	20	3007		6				AW
M	1245	250	06			7				SCT 120	~~24~~	~~22~~	3006		4				Rm
M	1345	250	08			7				BKN 080 BKN 120	~~[illegible]~~	~~[illegible]~~	3007		7				Rm
M	1445	250	08			7				SCT 080 BKN 150.			3007		7				AW
M	1545	250	10			7				SCT 150			3007		3				AW
M	1645	250	05			7				FEW 065			3006		1				RW
M	1745	2[illegible]0	08			7				FEW 040			3005		1				Rm
M	1845	240	08			7				SCT 050			3004		3				RW
M	1945	220	15			7				SCT 040			3003		4				SD
M	2045	210	14			7				SCT 040			3002		4				SD
M	2145	230	08			7				SCT 050			3002		4				RW
M	2245	240	05			7				SCT 050			3003		3				RW
M	2345	240	05			7				SCT 050			3004		3				RT
M	0045	250	05			7				SCT 050			3005		3				RT
M	0145	250	05			10				~~SCT 050~~ SKC			3005		3				RT
M	0245	260	05			10				~~SCT 050~~ SKC			3006	LAST	3				SD

TIME (LST/UTC) MID TO	NO. (27)	PRECIP. (Ins.) (28)	SNOW FALL (Ins.) (29)	SNOW DEPTH (Ins.) (30)	MAX. TEMP. (0.1°C) (31)	MIN. TEMP. (0.1°C) (32)	STATION PRESSURE (36)	BAROGRAPH (37)	BARO. CORR. (38)
	1								
	2								
	3								
	4								
MID									

SUMMARY OF DAY (Midnight to Midnight)

24-HR. MAXIMUM TEMP. (0.1°C) (57)	24-HR. MINIMUM TEMP. (0.1°C) (58)	24-HR. PRECIP. WATER EQUIV. (Ins.) (59)	24-HR. SNOWFALL WATER EQ. (Ins.) (60)	1200 UTC SNOW DEPTH (Ins.) (61)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (66)

[redacted]

TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: / / /

MF1-10C (1-96) (PRESCRIBED BY FMH-1) U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE (SUPERSEDES MF1-10C – PREVIOUS VERSIONS OBSOLETE)

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

LATITUDE	LONGITUDE	STATION ELEVATION Ft. (MSL)	TIME CONVERSION (LST to UTC)	DAY	MONTH	YEAR	SID	STATION (Type, Name, State)
			+5 Hrs.	18	07	96		ATCT, FARMINGDALE, NY

TYPE (1)	TIME (2)	WIND DIRECTION (3)	WIND SPEED (4)	GUST (5)	VARIABILITY (6)	VISIBILITY SURFACE (7a)	TOWER (7b)	RUNWAY VISUAL RANGE (8)	PRESENT WEATHER (9)	SKY CONDITION (10)	TEMP (11)	DEW POINT (12)	ALTIMETER SETTING (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14)	TOTAL SKY COVER (17)	TOTAL SKY ... (18)	... (19)	STATION PRESSURE (20)	OBSERVER'S INITIALS (21)
M	1045	010	04			10				SCT250			3007		3				[illegible]
M	1145	260	05			10				SCT250			3007		3				[illegible]
M	1245	000	00			10				SCT050			3007		4				[illegible]
M	1345	200	07			10				SCT070			3007		3				[illegible]
M	1445	210	08			10				SCT070			3006		3				[illegible]
M	1545	220	06			10				SCT050			3005		4				[illegible]
M	1645	200	10			10				SCT050			3003		3				[illegible]
M	1745	[illegible]	12			10				SCT050			3002		3				RW
M	1845	230	10			7				SCT050			3001		3				[illegible]
M	1945	210	09			7				SCT050			2998		3				[illegible]
M	2045	200	15			7				SCT050			2997		3				RW
M	2145	210	10			7				BKN050 BKN100			2995	VIS 3 1/4SM N	6				[illegible]
M	2245	220	08			5			BR	SCT050 BKN080			2995		7				SD
M	2345	210	10			5			HZ	SCT050 BKN080			2994		7				SD
M	0045	210	08			3			HZ	SCT050 BKN080			2994		7				SD
M	0145	220	08			3			HZ	SCT050 BKN080			2994		7				DD
M	0245	220	08			3			HZ	SCT050 BKN080			2993	LAST	7				

TIME ☐ LST ☐ UTC (26)	HR. (27)	PRECIP. (In.) (28)	SNOW FALL (In.) (29)	SNOW DEPTH (In.) (30)	MAX. TEMP. (0.1°C) (31)	MIN. TEMP. (0.1°C) (32)	STATION PRESSURE (36)	BAROGRAPH (37)	BARO. CORR. (38)
AVG. TO									
	1								
	2								
	3								
	4								
MID									

SUMMARY OF DAY (Midnight to Midnight)

24-HR. MAXIMUM TEMP. (0.1°C) (57)	24-HR. MINIMUM TEMP. (0.1°C) (58)	24-HR. PRECIP. WATER EQUIV. (In.) (59)	24-HR. SNOWFALL UNMELTED (In.) (60)	1200 UTC SNOW DEPTH (In.) (61)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (65)

[redacted]

TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: / / /

(SUPERSEDES MF1-10C – PREVIOUS VERSIONS OBSOLETE)

U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE

MF1-10C (1-96) (PRESCRIBED BY FMH-1)

6

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

Latitude	Longitude	Station Elevation Ft. (MSL)	Time Conversion (LST to UTC)	Day	Month	Year	Station (Type, Name, State)
			05	19	07	96	ACT, FARMINGDALE, NY

Time	Wind Direction	Speed	Gust	Variability	Visibility Surface	Tower	Runway Visual Range	Present Weather	Sky Condition	Temp (°C)	Dew Point (°C)	Altimeter Setting	Remarks and Supplemental Coded Data	Total Sky Cover	Observer's Initials
1055	220	08			1			BR	BKN005 OVC010			2974		8	AW
1145	230	08			1½			BR	OVC004			2974		8	RW
1245	210	10			2			BR	OVC005			2972		8	EM
1345	230	10			1½			RASH	OVC006			2971		8	JA
1446	200	08	18		1½			RASH BR	OVC004			2962		8	EM
1545	200	15			3			BR	OVC006	24	22	2959		8	RW
1645	230	15			7				OVC012	25	22	2957	BINOVC	8	RV
1745	200	15G20			5			BR	OVC010	24	22	2953		8	JA
1845	200	15			9				BKN010	27	22	2951		6	JA
1945	190	10			7				BKN010 OVC015	27	22	2948		8	RW
2045	190	08			5			BR	SCT008 BKN110	28	22	2945		7	RW
2150	240	08			7			-TSRA	SCT008 BKN035 BKN110	27	23	2944	TB50	6	RW
2215	250	08			15				FEW026 SCT036 BKN060	27	22	2945	TS MVD SE	5	RW
2245	240	08			15				FEW035 SCT120	26	22	2944		4/5	RW
2345	[illegible]	08			15				BKN030	25	22	2946		7	[illegible]
0045	240	06			20				BKN035 BKN120	25	21	2948		5	[illegible]
0145	240	08			20				SCT040	25	20	2951		3	[illegible]
0245	300	14			20				SCT050	25	19	2951	LAST	2	20

Mid. To	No.	Precip. (Ins.)	Snow Fall (Ins.)	Snow Depth (Ins.)	Max. Temp. (0.1°C)	Min. Temp. (0.1°C)	Station Pressure	Barograph	Baro. Corr.
	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(37)	(38)
	1								
	2								
	3								
	4								

Summary of Day (Midnight to Midnight)

24-Hr. Maximum Temp. (0.1°C)	24-Hr. Minimum Temp. (0.1°C)	24-Hr. Precip. Water Equiv. (Ins.)	24-Hr. Snowfall Water Equiv. (Ins.)	1200 UTC Snow Depth (Ins.)
(67)	(68)	(69)	(70)	(71)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (69)

[redacted]

TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: / / /

7

LST

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

Latitude	Longitude	Station Elevation	Time Conversion (LST to UTC)	Day	Month	Year	ID	Station (Type, Name, State)
40° 48' N	73° 06 N	99	+5 Hrs.	17	07	96	KISP	AFSS Isp NY

Type (1)	Time LST (2)	Wind Dir (3)	Speed (4)	Gust (5)	Variability (6)	Visibility Surface (7a)	Tower (7b)	RVR (8)	Present Weather (9)	Sky Condition (10)	Temp (°C) (11)	Dew Point (°C) (12)	Altimeter Setting (13)	Remarks and Supplemental Coded Data (14)	Total Sky Cover (17)	(18)	(19)	Station Pressure (20)	Initials (21)
M	0050	210	06			7			~~SKC~~	SKC	23	21	3005	SLP181 10247 20225 56003	0			29.96	MS
M	0150	230	06			6			HZ	SCT120	22	20	3005	SLP181	4			29.96	MS
M	0250	220	06			5			HZ BR	SCT120	22	21	3005	SLP181	5			29.945	MS
M	0350	250	03			4			HZ BR	BKN120 OVC250	21	21	3005	SLP181 54000	8			29.945	FG
M	0450	000	00			4			BR HZ	BKN120	21	21	3006	SLP183	6			29.955	FG
M	0550	270	05			4			BR HZ	BKN090 OVC200	22	21	3005	SLP190	8			29.975	SE
M	0650	260	03			4			BR HZ	BKN130	23	21	3008	SLP190 ~~70011~~ 10230 20210 53003	6			29.975	FG
M	0750	250	04			5			HZ	SCT120	26	21	3008	SLP190	4			29.975	JM
M	0850	290	03			4			HZ	BKN080	27	21	3008	SLP190	7			29.975	JM
M	0950	300	04			4			HZ	BKN080	29	21	3008	SLP190 53000	6			29.975	[illegible]
M	1051	300	—			8				FEW030 SCT080 SCT150	30	18	3008	SLP190	4			29.975	[illegible]
—	—	260	09																
M	1150	330	03			8				FEW080	30	18	3008	SLP190	1			29.975	BV
M	1250	200	09			8				FEW080	30	20	3006	10295 20230 58007 ~~SLP183~~	1			29.955	BV
M	1345	230	11			8				SCT040	30	21	3004	SLP176	4			29.935	JT
M	1445	240	08			8				SCT040	30	22	3004	SLP176 TCU N	4			29.935	MA
M	1550	220	13			8				SCT040	30	22	3004	SLP176 56007	3			29.935	CA
M	1650	240	08			8				SCT085	29	21	3004	SLP176	3			29.935	CA
M	1750	240	05			8				FEW080	29	22	3004	SLP176 HAZY	1			29.935	JK
M	1850	220	04			8				SKC	27	23	3005	SLP181 10030 20027 53003	0			29.945	JK
M	1950	250	03			8				SKC	25	22	3005	SLP181	0			29.945	JD
M	2050	000	00			8				SKC	25	21	3008	SLP190	0			29.975	JD
M	2150	000	00			8				SKC	24	21	3008	SLP190 51010	0			29.975	[illegible]
M	2250	000	00			8				SKC	23	20	3008	SLP190	0			29.975	[illegible]
M	2350	000	00			8				SKC	22	20	3008	SLP190	0			29.975	FG

Time LST (UTC) Mid. to	(27)	Precip. (in.) (28)	Snow Fall (in.) (29)	Snow Depth (in.) (30)	Max. Temp. (0.1°C) (31)	Min. Temp. (0.1°C) (32)	Station Pressure (33)	Barograph (37)	Baro. Corr. (38)
		0	0		22.9	22.5			
0050	1	0	0	0	24.9	22.5			
0650	1	0	0	0	23.4	21.3			
1250	1	0	0	0	29.5	23.0			
1850	1	0	0	0	26.6	23.0	23.0		
Mid		0	0	0	26.6	22.0			

22.0

Summary of Day (Midnight to Midnight)

24-Hr. Maximum Temp. (0.1°C) (57)	24-Hr. Minimum Temp. (0.1°C) (58)	24-Hr. Precip. Water Equiv. (in.) (59)	24-Hr. Snowfall Unmelted (in.) (60)	1200 UTC Snow Depth (in.) (61)
29.5	22.0			
29.5	22.0	0	Ø	Ø

Remarks, Notes and Miscellaneous Phenomena (65)

HZ BR

[redacted]

TIMECHECK - CLOCK CORRECT TO NEAREST MINUTE AT: / / /

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

Latitude	Longitude	Station elevation (ft)	Time conversion (LST to UTC)	Day	Month	Year	ID	Station (Type, Name, State)
40°48'N	73°06'W	99	+ 5 hrs.	18	07	96	KISP	AFSS ISLIP, New York

9

Type (1)	Time LST (2)	Wind direction (3)	Wind speed (4)	Gust (5)	Wind variability (6)	Surface visibility (7a)	Tower visibility (7b)	Runway visual range (8)	Present weather (9)	Sky condition (10)	Temp (°C) (11)	Dew point (°C) (12)	Altimeter setting (13)	Remarks and supplemental coded data (14)	Total sky cover (17)	Temp dry bulb (18)	Temp wet bulb (20)	Station pressure (22)	Initials (16)
M	0050	000	00			8				BKN250	22	21	3008	SLP190 10212 20217 54000	5			29.975	FG
M	0150	000	00			8				BKN250	22	20	3008	SLP190	7			29.975	FG
M	0250	000	00			8				SCT250	21	20	3008	SLP190	4			29.975	FG
M	0350	000	00			8				SCT 250	21	20	3008	SLP190 54000	4			29.975	[illegible]
M	0450	000	00			8				SCT 250	19	19	3009	SLP193	3			29.985	[illegible]
M	0550	000	00			8				FEW200	21	21	3008	SLP190	2			29.975	ZG
M	0650	000	00			8				FEW200	26	21	3008	SLP190 10026 20019 50000	1			29.975	ST
M	0750	000	00			8				FEW200	27	20	3008	SLP190	1			29.975	HU
M	0850	000	00			8				SCT200	28	21	3008	SLP190	3			29.975	HU
M	0950	170	03			8				SCT200	29	22	3008	SLP190 54000	3			29.975	ST
M	1050	180	07			8				SCT040	30	20	3006	SLP183	3			29.955	ST
M	1150	190	08			8				SCT040	30	20	3005	SLP181	3			29.945	BO
M	1250	190	08			10				SCT040	30	22	3004	SLP176 10030 20027 52014	3			29.935	BO
M	1350	200	10			8				~~SCT040~~ FEW040	29	22	3003	SLP173	2			29.925	MR
M	1450	230	12			6			HZ	SCT040	30	22	3001	SLP166	3			29.905	MR
M	1548	230	10			8				SCT040 SCT100	28	22	2999	SLP159 57017	43			29.885	TL
M	1648	240	09			6			HZ	SCT040 BKN090	28	22	2998	SLP156	4			29.875	TL
M	1750	230	10			6			~~HZ~~	SCT040 BKN090	26	22	2997	SLP153	6			29.865	JD
M	1850	230	06			6			HZ	SCT055 BKN120 ~~OVC~~250	26	23	2996	SLP150 10298 20255 57010	~~4~~8			29.855	SB
M	1950	210	08			3			BR	SCT055 BKN120 OVC250	25	22	2996	SLP150	8			29.855	JH
M	2050	220	05			10			~~BR~~	FEW050	24	22	2996	~~HAZY~~ SLP150	2			29.855	[illegible]
M	2150	220	07			8				FEW050	23	22	2995	SLP146 HAZY 58003	2			29.845	JK
M	2240	220	07			8				BKN130	24	22	2993	SLP139	6			29.825	MH
M	2350	240	08			8				BKN110	24	22	2991	SLP132	7			29.805	[illegible]

Time LST (MID. TO)	No. (27)	Precip. (in.) (28)	Snow fall (in.) (29)	Snow depth (in.) (30)	Max. temp. (0.1°C) (31)	Min. temp. (0.1°C) (32)	Station pressure (36)	Barograph (37)	Baro. corr. (38)
		0	0		21.8	21.2			
0050	1	0	0	0	24.7	21.2			
0650	2	0	0	0	26.2	19.1			
1250	3	0	0	0	30.0	20.0			
1850	4	Ø	Ø	Ø	29.8	25.8			
MID		Ø	Ø	Ø	23.9	23.0			

Summary of day (midnight to midnight)

24-hr. maximum temp. (0.1°C) (57)	24-hr. minimum temp. (0.1°C) (58)	24-hr. precip. water equiv. (in.) (59)	24-hr. snowfall unmelted (in.) (60)	1200 UTC snow depth (in.) (61)
30.6	19.1	Ø	Ø	Ø

Remarks, notes and miscellaneous phenomena (56)

HZ BR

[redacted]

TIMECHECK - CLOCK CORRECT TO NEAREST MINUTE AT: / / /

MF1M-10C (1-96) (PRESCRIBED BY FMH-1)

U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE

(SUPERSEDES MF1-10C - PREVIOUS VERSIONS OBSOLETE)

*U.S.GPO:1996-410-680/40071

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

LATITUDE	LONGITUDE	STATION ELEVATION Ft. (MSL)	TIME CONVERSION (LST to UTC)	DAY	MONTH	YEAR	ID	STATION (Type, Name, State)
		67	+ 4 Hrs.	17	JULY	96	KOGC?	WESTHAMPTON BEACH Sawes The Francis S Gabreski Tower NY

TYPE (1)	TIME ☐ LST ☑ UTC (2)	WIND DIRECTION (3)	WIND SPEED (4)	GUST (5)	VARIABILITY (6)	VISIBILITY SURFACE (7a)	VISIBILITY TOWER (7b)	RUNWAY VISUAL RANGE (8)	PRESENT WEATHER (9)	SKY CONDITION (10)	TEMP (°C) (11)	DEW POINT (°C) (12)	ALTIMETER SETTING (Ins.) (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14)	TOTAL SKY COVER (17)	(18)	(19)	(20)	OBSERVER'S INITIALS (16)
M	1050	200	005			2			BR	BKN 100	21	18	A3010	FIRST	7				AG
M	1145	200	005			2			BR	BKN 090	21	18	A3012		7				AG
M	1245	200	005			3			BR	BKN 090	23	19	A3014		6				AS
S	1330	200	005			2			BR HZ	BKN 090	24	20	A3011		6				AC
M	1345	200	005			2			BR HZ	BKN 100	24	20	A3012		7				AC
S	1415	200	005			3			BR HZ	OVC ~~BKN~~ 090	24	20	A3012		8				AT
M	1445	210	04			3			BR HZ	BKN 090	22	19	A3011		7				AR
M	1545	230	04			4			BR HZ	BKN 080	26	20	A3012		7				AR
M	1645	260	05			5			BR HZ	SCT 070	27	19	A3011		4				AR
M	1745	200	06			5			HZ	SCT 060	27	19	A3009		3				AR
M	1845	240	06			5			HZ	SCT 060	27	19	A3008		3				AR
M	1945	220	06			6			HZ	SCT 040	27	19	A3006		3				AR
M	2045	220	06			6			HZ	SCT 040	27	19	A3006		3				Fm
M	2145	220	06			5			HZ	SCT 040	26	20	A3007		3				Fm
M	2245	230	04			4			HZ	SCT 060	25	20	A3007		3				Fm
M	2345	240	04			4			HZ	SCT 060	23	19	A3008		3				Fm
M	0045	000	00			6			HZ	SCT 060	22	19	A3009		3				Fm
M	0145	300	04			7			~~HZ~~	SCT 060	21	20	A3010		3				Fm
M	0245	240	04			8				SCT 080	21	20	A3011		3				Fm
M	0345	240	04			8				SCT 080	21	20	A3011		3				Fm
M	0445	000	00			8				SKC	19	18	A3011		0				Fm

TIME ☐ LST ☐ UTC (60)	NO. (27)	PRECIP. (Ins.) (33)	SNOW FALL (Ins.) (34)	SNOW DEPTH (Ins.) (35)	MAX. TEMP. (0.1°C) (31)	MIN. TEMP. (0.1°C) (32)	STATION PRESSURE (36)	BAROGRAPH (37)	BARO. CORR. (38)
AMD. TO									
	1								
	2								
	3								
	4								
MID									

SUMMARY OF DAY (Midnight to Midnight)

24-HR. MAXIMUM TEMP. (0.1°C) (57)	24-HR. MINIMUM TEMP. (0.1°C) (58)	24-HR. PRECIP. WATER EQUIV. (Ins.) (59)	24-HR. SNOWFALL UNMLTD. (Ins.) (60)	1200 UTC SNOW DEPTH (Ins.) (61)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (66)

[redacted]

TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: 1 0 1 5 1 3

MF1M-10C (1-96) (PRESCRIBED BY FMH-1) U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE (SUPERSEDES MF1-10C – PREVIOUS VERSIONS OBSOLETE)

*U.S.GPO:1996-410-880/40071

10

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

Latitude	Longitude	Station Elevation ft. (MSL)	Time Conversion (LST to UTC)	Day	Month	Year	SID	Station (Type, Name, State)
		67	+4	18	July	96	KFOK	SAWRS THE FRANCIS S GABRESKI TOWER WESTHAMPTON BEACH NY

Type (1)	Time ☒ UTC (2)	Wind Direction (3)	Wind Speed (4)	Gust (5)	Variability (6)	Visibility Surface (7a)	Visibility Tower (7b)	Runway Visual Range (8)	Present Weather (9)	Sky Condition (10)	Temp (°C) (11)	Dew Point (°C) (12)	Altimeter Setting (ins.) (13)	Remarks and Supplemental Coded Data (14)	Total Sky Cover (17)	(18)	(19)	(20)	Observer's Initials (21)
M	0445	000	00			8				SKC	19	18	3011		0				[illegible]
M	0545	000	00			8				SKC	19	18	3012		0				[illegible]
M	0645	000	00			8				SKC	19	17	3012		0				[illegible]
M	0745	000	00			8				SKC	18	17	3011		0				[illegible]
M	0845	000	00			8				SCT 150	17	17	3011		4				[illegible]
M	0945	000	00			8				SCT 150	17	16	3013		3				[illegible]
M	1045	000	00			8				SKC	20	17	3013		0				[illegible]
M	1145	000	00			7				FEW 150	22	17	3013		2				[illegible]
M	1245	000	00			8				FEW 120	26	18	3012		2				[illegible]
M	1345	000	00			10				FEW 150	26	18	3013		2				[illegible]
M	1445	000	00			10				FEW 120	26	18	3011		2				[illegible]
M	1545	000	00			10				FEW 60 SCT 100	27	18	3011		3				[illegible]
M	1645	240	06			10				FEW 80	28	19	3007		2				[illegible]
M	1745	240	06			8				FEW 40	28	19	3006		2				[illegible]
M	1845	240	06			8				FEW 30 SCT 120	27	19	3007		4				[illegible]
M	1945	230	04			8				SCT 040	26	19	3005		3				[illegible]
M	2045	230	06			8 10				SKC	26	19	3002		0				[illegible]
M	2145	220	04			7				SKC	24	19	2999		0				[illegible]
M	2245	220	04			7				SKC	24	19	2999		0				[illegible]
M	2345	240	04			7				SCT 100	23	19	2998		3				[illegible]
M	0045	240	04			4			BR	SCT 060	21	19	2998		4				[illegible]
M	0145	240	04			7				BKN 090	21	19	2998		5				[illegible]
M	0245	240	06			7				SCT 120	21	19	2997		3				[illegible]
M	0345	210	04			5			BR	SCT 120	21	19	2995		3	—			[illegible]

Time ☐ LST ☐ UTC (26)	No. (27)	Precip. (ins.) (28)	Snow Fall (ins.) (29)	Snow Depth (ins.) (30)	Max. Temp. (0.1°C) (31)	Min. Temp. (0.1°C) (32)	Station Pressure (36)	Barograph (37)	Baro. Corr. (38)
MID. TO									
	1								
	2								
	3								
	4								
MID									

SUMMARY OF DAY (Midnight to Midnight)

24-HR. Maximum Temp. (0.1°C) (57)	24-HR. Minimum Temp. (0.1°C) (58)	24-HR. Precip. Water Equiv. (ins.) (59)	24-HR. Snowfall Unmltd. (ins.) (60)	1200 UTC Snow Depth (ins.) (61)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (65)

[redacted]

TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: / / /

SURFACE WEATHER OBSERVATIONS (METAR/SPECI)

Station Elevation Ft. (MSL)	Time Conversion (LST to UTC)	Day	Month	Year	SID	Station (Type, Name, State)
67	+4 Hrs.	19	JULY	96	KFOK	SAWRS THE FRANCIS S. GABRESKI TOWER, NY WESTHAMPTON BEACH

Type (1)	Time (LST/UTC) (2)	Wind Dir. (3)	Speed (4)	Visibility Surface (7a)	Present Weather (9)	Sky Condition (10)	Temp (°C) (11)	Dew Point (°C) (12)	Altimeter (13)	Remarks (14)	Total Sky Cover (17)	Initials (19)
M	0445	240	04	5	BR	SCT 120	21	19	2992		3	AG
M	0545	250	06	7		BKN 110	21	19	2989		5	[illegible]
M	0645	240	06	7		BKN050 OVC080	21	19	2987		8	[illegible]
M	0745	240	06	7		BKN025 OVC034	21	19	2985		8	[illegible]
M	0845	240	05	2	~~BR~~ RA BR	BKN010 OVC020	21	19	2980	PRESFR	8	[illegible]
S	0925	240	04	3/4	~~BR~~ -RA BR	VV003	20	19	2980		8	[illegible]
M	0945	230	04	3/4	~~BR~~ DZ BR	VV002	20	19	2980		8	[illegible]
M	1045	230	06	1/2	~~BR~~ -RA FG	VV001	21	19	2977		8	[illegible]
M	1145	230	06	1/2	~~BR~~ FG	VV002	19	18	2977		8	[illegible]
M	1245	240	10	1/2	FG	VV002	20	18	2976		8	[illegible]
M	1345	240	10	1	BR	VV002	21	18	2975		8	[illegible]
M	1445	240	10	1 1/4	BR	VV003	20	18	2972		8	[illegible]
M	1545	230	03	1 1/2	BR	VV003	21	18	2967		8	AR
M	1645	210	10	1 1/2	BR	VV005	21	18	2963		8	AR
M	1745	210	08	1 1/4	BR	VV004	21	19	2959		8	AR
M	1845	210	03	3	BR	BKN ~~[illegible]~~ 008	22	19	2955		8	AG
M	1945	210	12	1 1/2	BR	OVC 006	21	19	2955		7	AR
M	2045	200	12	1 1/4	BR	OVC 006	21	14	2953		8	AR
M	2145	240	10	1 1/4	BR	VV 005	21	19	2949		8	AR
S	2220	240	08	1	TS RA BR	VV 003	21	19	2947		8	AR
M	2245	220	06	2	BR	SCT 007 BKN 25	21	19	2947	OCCL LTNG NW	8	AG
M	2345	230	06	2	BR	BKN 030	21	19	2947		7	AG
S	0005	240	06	3	BR	BKN 030	21	19	2947		6	AG
M	0045	230	04	7	BR	BKN 030	22	19	2947		6	AG
M	0145	300	10	7		SKC	22	19	2949		5	AG
M	0245	300	10	7		SKC	22	19	2950		0	AG
											0	AG

SUMMARY OF DAY (Midnight to Midnight)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA (66)

[redacted]

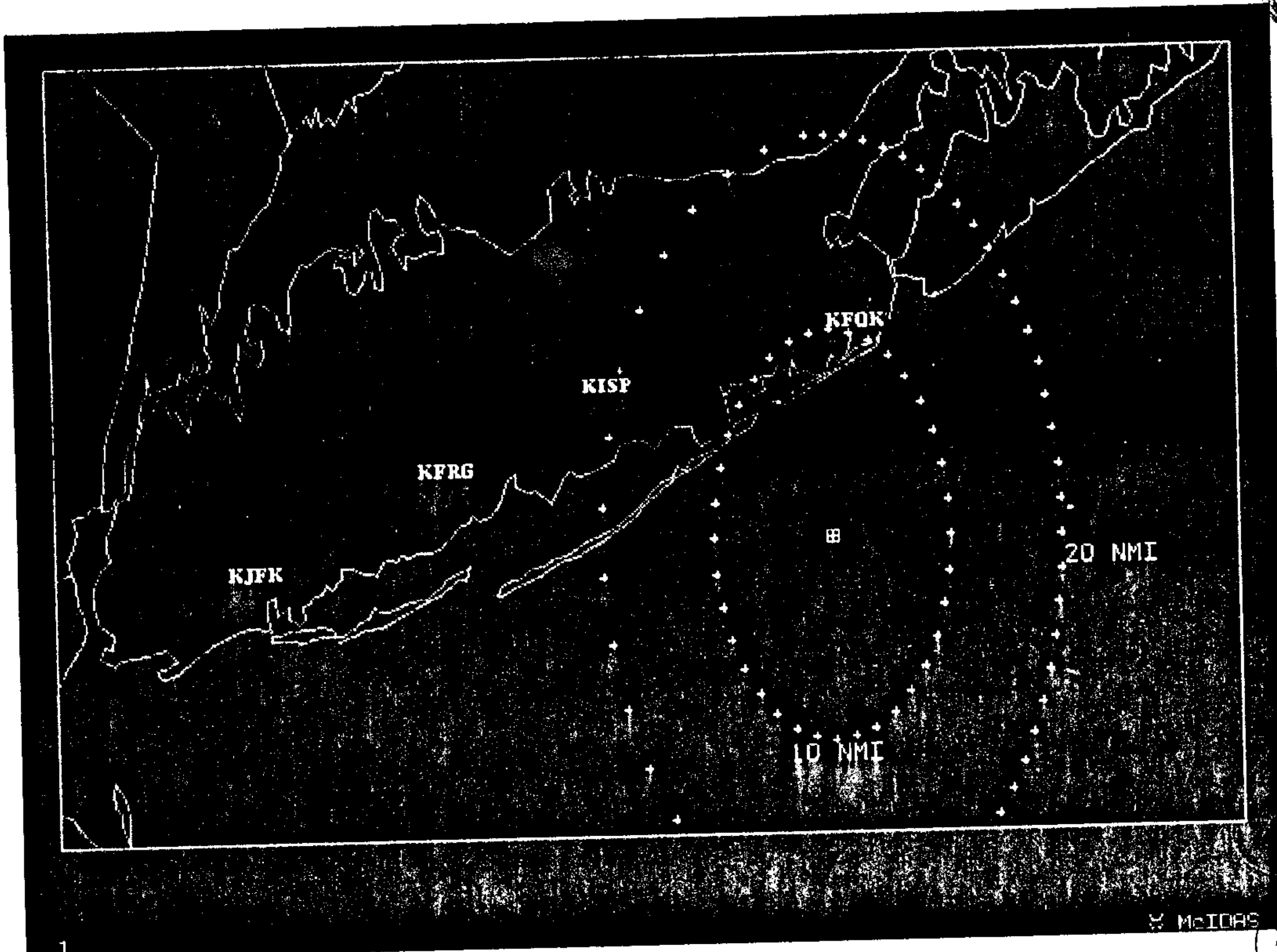
TIMECHECK – CLOCK CORRECT TO NEAREST MINUTE AT: / / /

MF1M-10C (1-96) (PRESCRIBED BY FMH-1)

U.S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL WEATHER SERVICE

(SUPERSEDES MF1-10C – PREVIOUS VERSIONS OBSOLETE)

*U.S.GPO:1996-410-880/40071


KJFK
KFRG
KISP
KFOK
10 NMI
20 NMI
1
McIDAS

UPTON, N.Y.

°C °C °True m/sec⁻¹ meters

STATION:72501 DAY/TIME:96200 000000 LAT/LONG:408500 728500

LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
1015.0	27.8	20.8	240.0	2.5	20.0
1000.0	27.2	18.2	255.0	4.6	152.3
982.9	26.1	16.9	270.0	6.6	304.0
949.4	23.9	14.2	280.0	7.7	609.0
925.0	22.2	12.2	285.0	8.7	837.5
916.8	21.5	11.9	285.0	9.2	914.0
884.9	18.6	10.7	290.0	9.7	1219.0
850.0	15.4	9.4	305.0	10.2	1564.9
823.8	13.5	8.0	310.0	10.8	1829.0
794.5	11.3	6.3	315.0	9.7	2134.0
793.0	11.2	6.2	315.3	9.6	2150.4
766.0	10.3	-1.4	320.0	8.2	2439.0
757.0	10.0	-4.0	323.3	7.7	2538.0
748.0	9.2	1.2	326.5	7.2	2637.3
738.5	8.4	1.7	330.0	6.6	2743.0
723.0	7.2	2.4	332.9	6.3	2918.6
711.7	6.3	0.9	335.0	6.1	3048.0
700.0	5.4	-0.6	325.0	6.1	3184.2
699.0	5.4	-0.6	324.7	6.1	3196.0
686.0	5.2	-12.8	320.1	6.1	3349.5
685.7	5.2	-12.9	320.0	6.1	3353.0
676.0	4.4	-16.6	310.5	6.9	3469.2
660.4	3.3	-17.0	295.0	8.2	3658.0
636.0	1.5	-17.6	290.0	8.7	3963.0
634.0	1.4	-17.6	290.8	8.8	3988.5
612.3	0.8	-20.4	300.0	9.7	4268.0
586.0	0.0	-24.0	302.9	10.9	4620.7
567.3	-1.9	-23.0	305.0	11.8	4878.0
545.9	-4.2	-21.8	315.0	15.9	5182.0
530.0	-5.9	-20.9	315.0	17.1	5416.5
500.0	-9.3	-28.3	315.0	19.5	5870.1
485.5	-10.4	-30.2	310.0	20.0	6097.0
466.6	-11.8	-32.7	305.0	20.5	6402.0
465.0	-11.9	-32.9	304.8	20.5	6428.6
400.0	-22.5	-35.5	295.0	20.5	7558.2
396.5	-23.0	-36.0	295.0	20.5	7621.0
363.9	-27.9	-40.6	295.0	20.5	8231.0
319.9	-35.2	-47.5	305.0	20.0	9146.0
306.5	-37.7	-49.8	315.0	19.0	9451.0
300.0	-38.9	-50.9	315.0	19.0	9602.3
286.0	-41.9	-51.9	300.8	18.6	9928.2
280.4	-42.7	-52.9	295.0	18.5	10060.0
256.0	-46.5	-57.3	280.0	21.0	10670.0
250.0	-47.5	-58.5	280.0	21.6	10828.8
200.0	-58.1	-67.1	310.0	24.6	12269.6
182.0	-56.5	-65.5	313.6	29.0	12866.1
175.1	-57.2	-66.2	315.0	30.8	13109.0
151.4	-59.9	-68.9	300.0	25.7	14024.0
150.0	-60.1	-69.1	300.0	25.7	14083.4
133.0	-61.9	-70.9	312.9	23.4	14831.2
124.5	-60.8	-69.8	320.0	22.1	15243.0
118.5	-59.9	-68.9	320.0	20.0	15548.0
117.0	-59.7	-68.7	318.7	19.3	15628.7
102.3	-61.8	-70.8	305.0	12.3	16463.0
100.0	-62.1	-71.1	305.0	11.3	16605.1
93.3	-62.5	-71.5			17033.6
25.9	-49.7	-62.7			25184.4

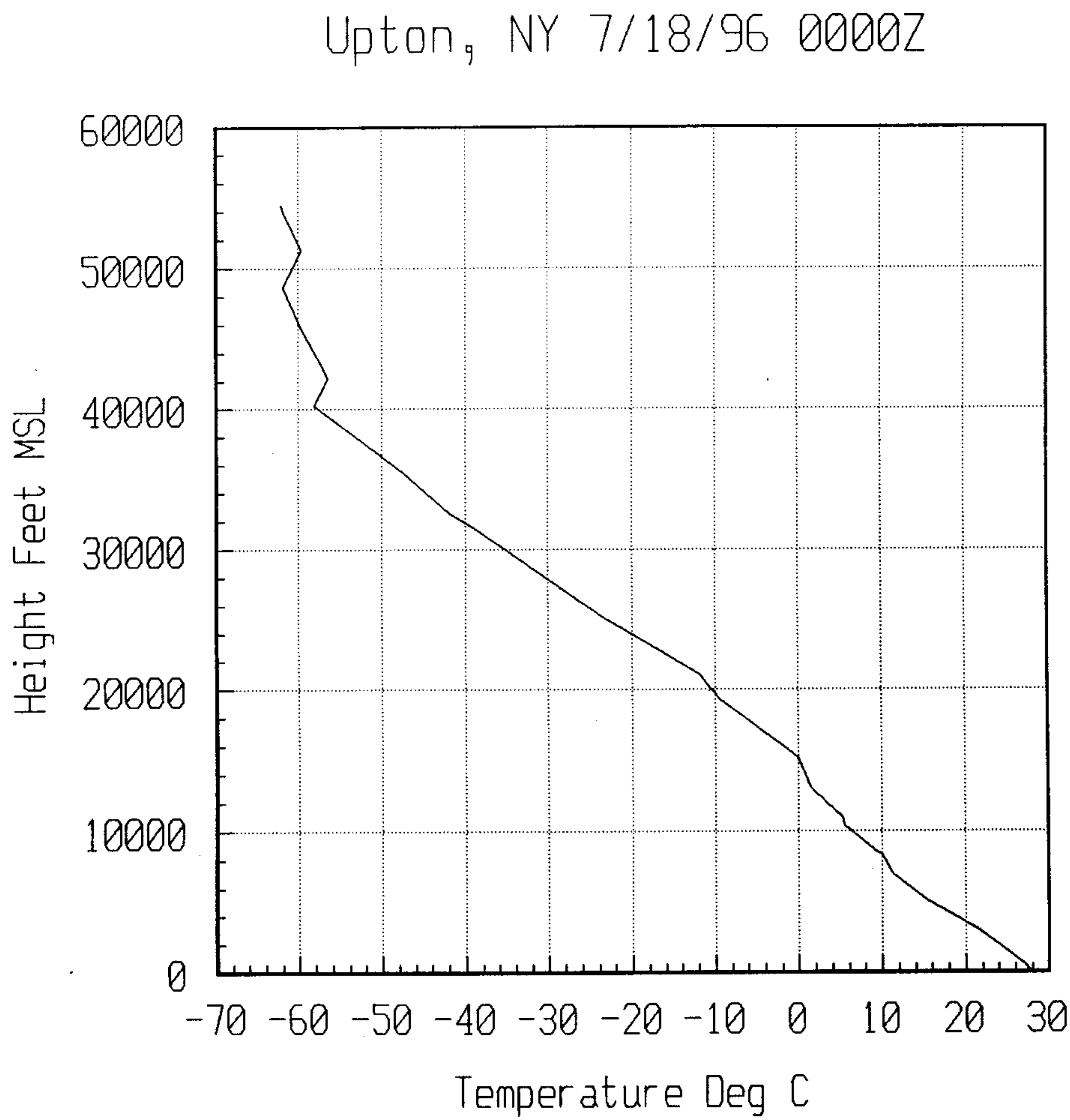
JFK 254 at 44 NMiles from upton

Acc. site ≈ 15 NMiles SE of Upton

14

24.7 -49.7 -62.7 25495.0

PARCEL: DEW PT.= 288.7 POT. TEMP= 301.1 EQUIV.POT.TEMP= 334.9 MIX= 12.3
PRECIP.WATER= 30.4 CONV.TEMP= 30.9 FCST MAX= 0.0 LIFTED INDEX= -0.6
TOTALS= 43.4 EQUIL.PRES.= 253.8 K-INDEX= 28.1 SWEAT INDEX=190.4



Upton, NY 7/18/96 0000Z
Height Feet MSL
60000
50000
40000
30000
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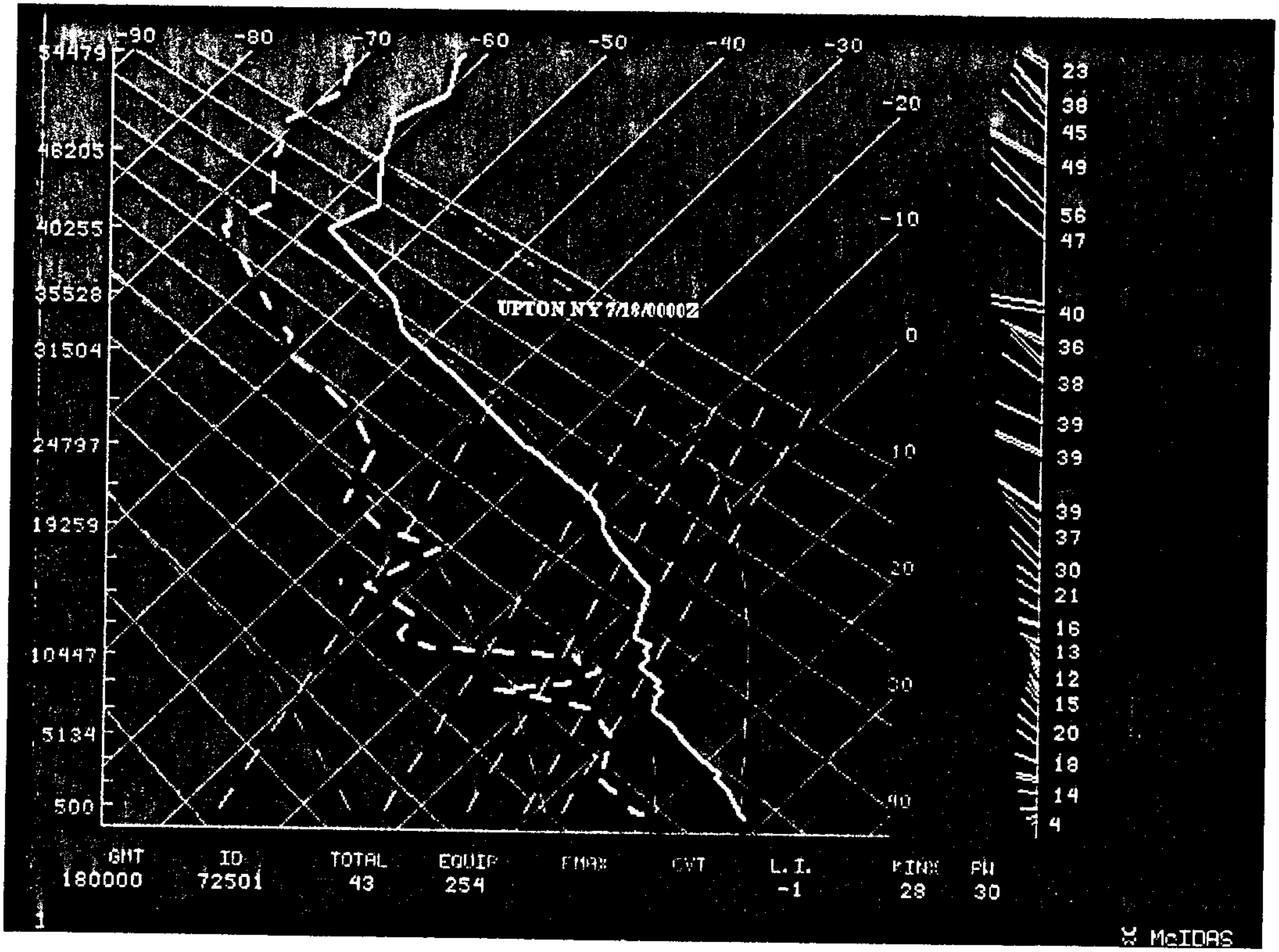
10000
0
-70 -60 -50 -40 -30 -20 -10 0 10 20 30
Temperature Deg C

16


UPTON NY 7/18/0000Z
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40255
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31504
24797
19259
10447
5134
500
-90 -80 -70 -60 -50 -40 -30
-20 -10 0 10 20 30 40
23 38 45 49 56 47 40 36 38 39 39 39 37 30 21 16 13 12 15 20 18 14 4
GMT 180000
ID 72501
TOTAL 43
EQUIP 254
FMAX
CVT
L.I. -1
KINX 28
PW 30
McIDAS

17

Robert D. Gallagher

1 Fairbanks Road, Chelmsford, MA, 01824, (508) 256-0794

23 October 1996

Mr. Robert Francis, Vice Chairman
U. S. National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, D.C. 20594

Dear Mr. Francis:

With regard to the TWA Flight 800 crash have you considered that a possible cause of the ignition of the explosion might have been a lightning discharge?

Professional pilots reported a "flash of light " in the sky just before the explosion. Is there some reason that lightning has been ruled out?

Mr. Mark Malone of The National Lightning Detection Network (NLDN) reports that no lightning was detected within 100 miles of the crash site on their network. However, the NLDN only records cloud-to-ground discharges and filters out cloud-to-cloud discharges from their database. If lightning did occur at 13,700 ft. it might have been a cloud-to-cloud discharge. Also, the NLDN detection efficiency for off-shore events is only 60%.

Normally a perfectly conducting enclosure acts as a "Faraday shield" and protects internal occupants and equipment from harm of high voltage discharges. This is demonstrated by the Van deGraff Generator operator who sits in a conducting screened enclosure surrounded by spectacular high voltage arcs. One might thus dismiss lightning as causing any problem to an aircraft enclosed with a perfectly conducting skin.

However, early newspaper accounts reported that Boeing 747's of the vintage of TWA/800 had developed fatigue cracks in the aircraft skin at the junction of the wings and the body of these aircraft. This same article indicated that residual jet fuel might be associated with these cracks. These cracks were described as being adjacent to the main fuel tank compartment that exploded.

If a lightning discharge occurred from wing-to-wing (or nose, or tail to wing) the flow of current in the aircraft skin might cause arcing/sparking at such a crack. If jet fuel was present at the crack "ignition" of the fuel might have occurred. If the fuel-air ratio in the enclosed area behind the crack was just right a minor explosion might have occurred. That minor explosion could have ruptured the main fuel tank causing the major explosion that ripped the plane apart.

18 [redacted]

Early newspaper articles reported a small initial explosion then a major explosion. More recent articles report a low energy explosion (more indicative of jet fuel) rather than "high explosives". The recent article also reported that the main fuel tank debris examined showed deformation indicating both an external and an internal explosion with respect to the fuel tank. These accounts would tend to support the above theory.

One might ask, why should the lightning current jump the crack and make a spark if there was conducting metal surrounding the crack? Just as the wings flexed during flight causing the crack by metal fatigue that same flexure during flight will open and close that crack alternately causing contact and non-contact. If lightning current was passing across the crack when it was closed the associated magnetic field (inductance) will tend to cause the current to continue flowing when the crack opens thus causing a spark. Much the same as opening the contacts of a high power switch under load results in arcing.

A second scenario to consider might be if lightning caused ignition of jet fuel at a crack but no explosion occurred immediately but that a 320 kt. wind whipped flame burned in the crack with fuel wicked up the inside surface of the aircraft skin in a blow torch effect. Such a hot flame might have burned through the nearby fuel tank thus causing the fatal explosion.

Proving that lightning was the cause of this tragedy may be very difficult but perhaps a case built on circumstantial evidence might be persuasive.

If TWA/800 was hit by lightning the "black-box" recorders may have picked up electromagnetic "noise" (static) on their recordings. Perhaps the mysterious "noise" at the end of the recording is not acoustic "noise" caused by aircraft breakup picked up by the cockpit microphone but instead an electromagnetic pulse picked up in the aircraft wiring caused by the lightning current flowing through the aircraft skin. A very high current flowing along an aircraft skin punctured with cracks, windows, radio and radar radomes might admit enough radiation to be recorded on the "black-box" tape.

Perhaps a time-spectrum analysis of the "noise" on the TWA/800 tape could be compared with "noise" pulses on tapes of other aircraft known to have been hit with lightning discharges to prove or disprove the lightning theory. There should be adequate data of this type available due to the large number of military and commercial aircraft reported damaged each year by lightning. Also, any "noise" pulses detected on the tape from takeoff to the end of the recording should be examined in case the second scenario described above was the way it happened.

The recovered aircraft skin could be examined for signs of "lightning strike damage". I would assume that the FAA has a large database of information describing this type of effect due to the reported large cost of damage to aircraft from lightning strikes each year.

If the crack area has been recovered it might be examined to see if any electrical arc or burn marks can be found. Pitting may also be observed on metal at an electrical arc due to electron erosion effects.

Also, if any structural metal near the crack shows signs of high temperature deformation the blow torch theory might be explored further.

Finally, Mr. Mark Malone, of Global Atmospherics, Inc., NLDN, has suggested that "PIREPS (Pilot REPortS)" for the evening of July 17, 1996 might be examined to see if any other pilots reported "lightning discharges" in the accident area. He also raises the issue of "bolt out of the blue" lightning phenomena which occur on clear days.

I have attached illustrative sketches, pertinent e-mail messages and the Global Atmospherics "FaultFinder" report for your information.

I am not an expert in any of the above areas and I offer these theories "**only as suggestions**" by a concerned citizen who has done a lot of flying as a passenger. If I can be of any help to your investigation please feel free to call on me, however, I feel that at this time I have told you all that I know.

Yours truly,

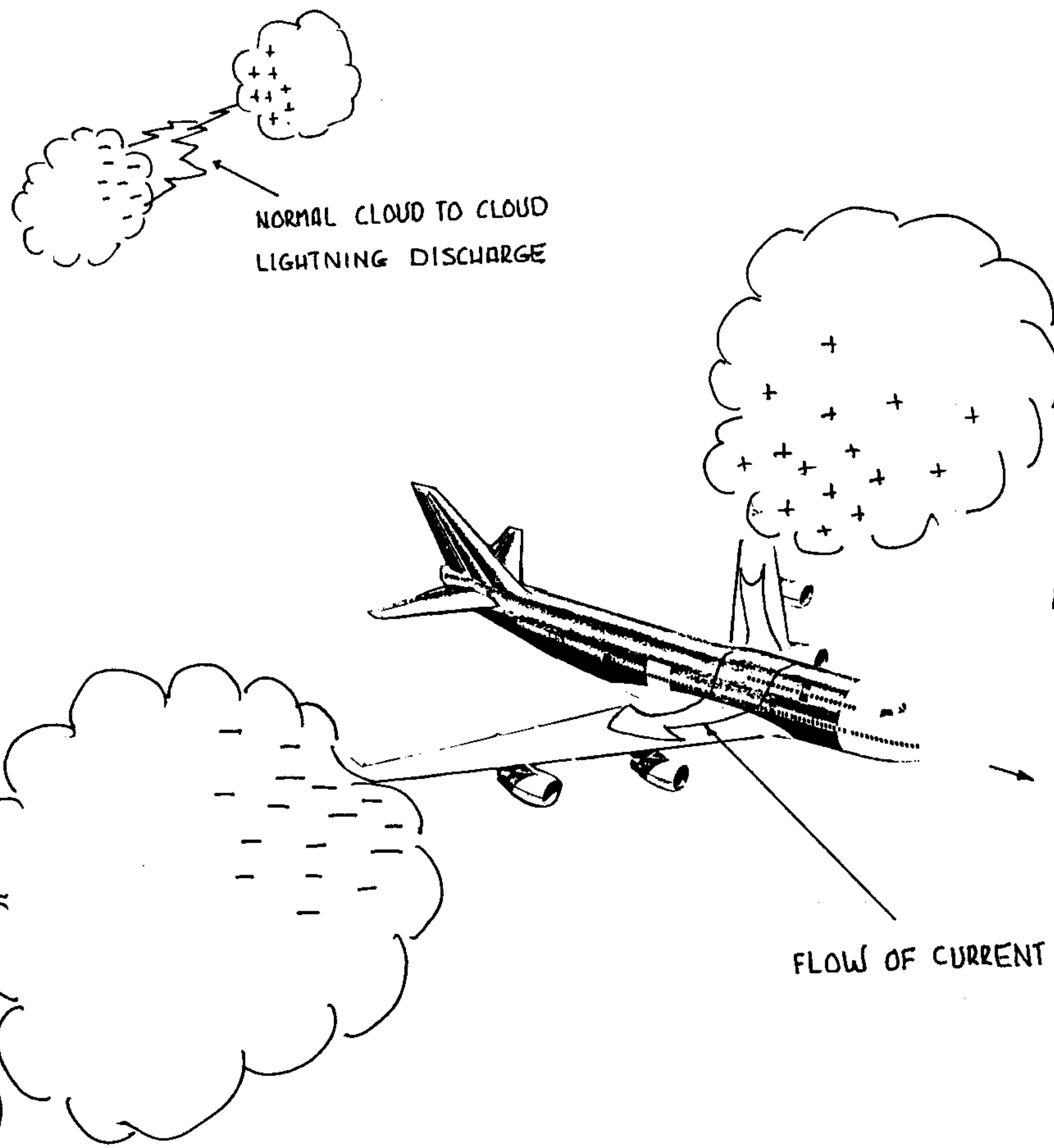
Robert D. Gallagher

RDG/CC:

Mark Malone, Global Atmospherics, Inc.

ATTACHMENTS:

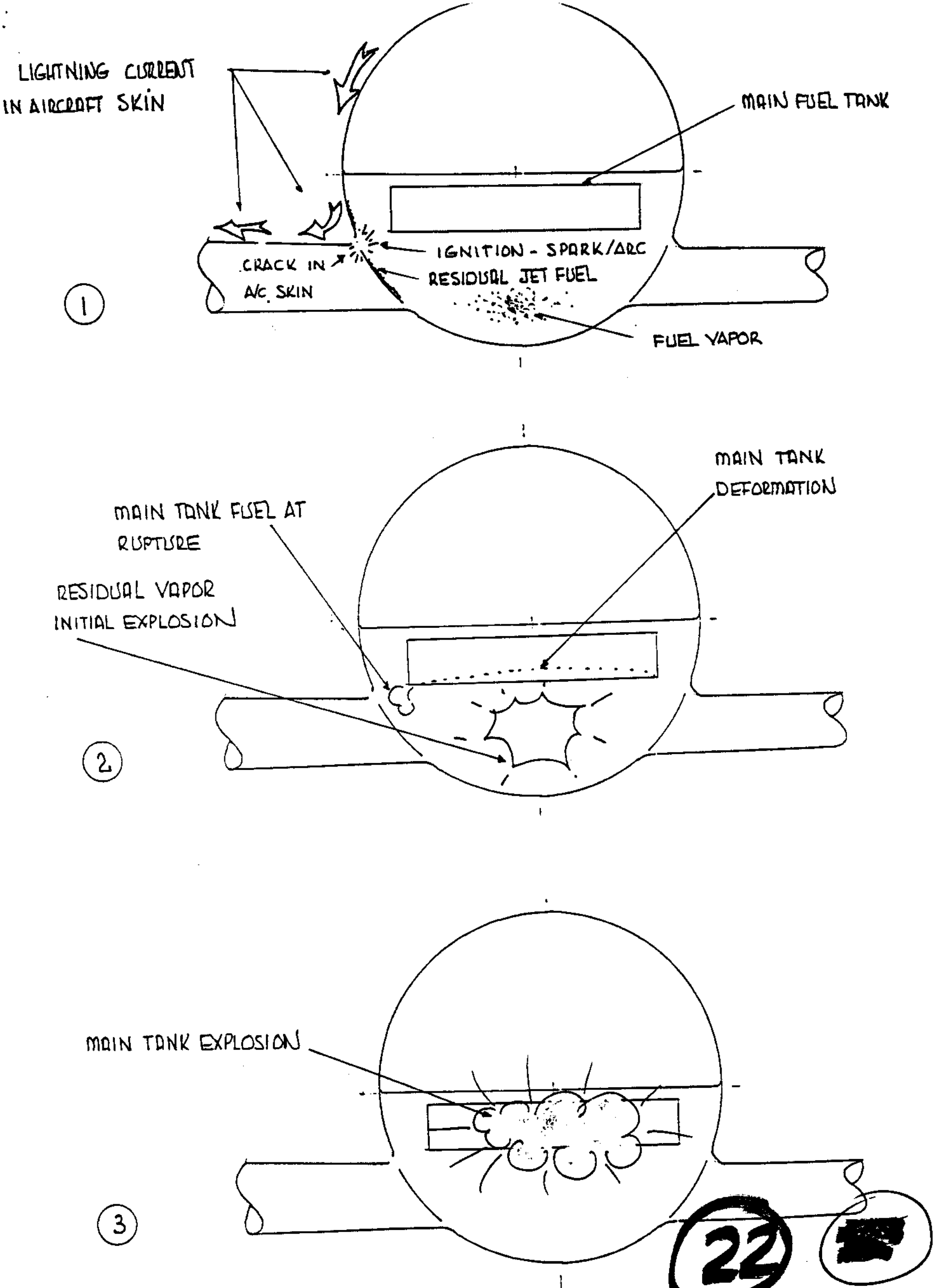
1. Cloud to Aircraft Discharge
2. Scenario 1
3. Scenario 2
4. E-mail Mark Malone 9/27/96
5. E-mail Mark Malone 10/16/96
6. FaultFinder Cover Letter
7. FaultFinder Report
8. FaultFinder Map/Plot



21

[redacted]

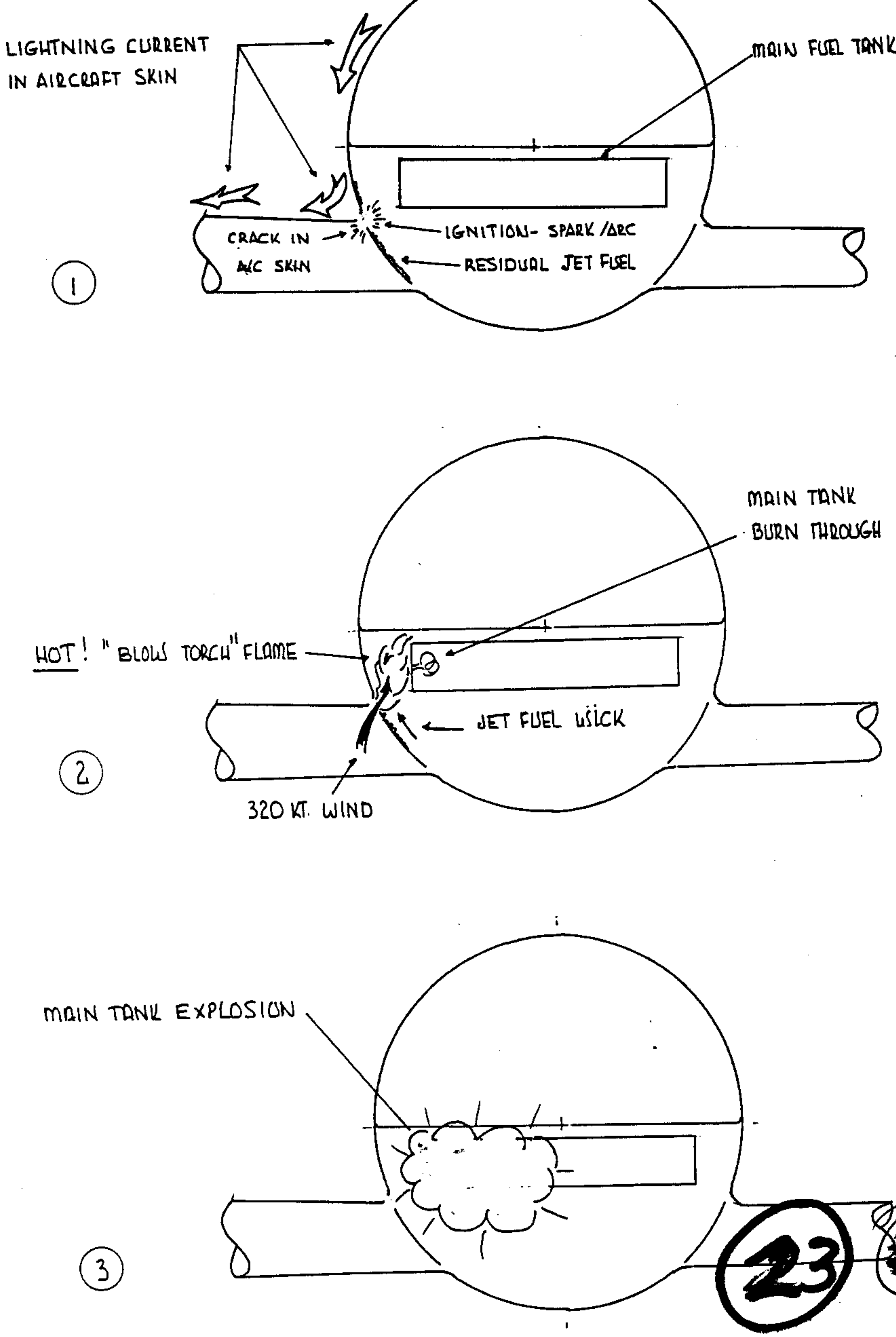
RDG 10/21/96



22 [redacted]

SCENARIO 1

RDG 10/21/96



23 [redacted]

SCENARIO 2

RDG 10/21/96

Date: Fri, 27 Sep 1996 15:51:58 GMT
From: mdm@gds.com (Mark Malone)
To: rdginc@tiac.net
Subject: Re: Lightning Data - response to your inquiry
X-Sun-Charset: US-ASCII

Mr. Gallagher:

Glad to help, we'll do a lightning data report (on a map printout) referencing that lat and lon. Be aware of some things:

1. The National Network provides cloud-to-ground information only (both pos/neg polarities). Intra-cloud lightning we filter out.

2. Detection efficiencies off the coast probably drop to 60% (sensors are land based., although we have very long range capability - 1000's of kilometers). NWS uses our long range stuff for over water severe storm detection. I'll see about checking both data bases (US and Long range).

3. If there is no lightning detected for that time period, we'll show where nearest lightning was occurring.

Also...who do I send this report to? I'll need an address.

Thanks

Mark Malone
Global Atmospherics, Inc.

mdm@gds.com

24 [redacted]

Date: Tue, 15 Oct 1996 19:54:31 GMT
From: mdm@gds.com (Mark Malone)
To: rdginc@tiac.net
Subject: Re: Lightning Data July 17, 1996
X-Sun-Charset: US-ASCII

> From rdginc@tiac.net Tue Oct 15 00:18 GMT 1996
> X-Sender: rdginc@pop.tiac.net
> Mime-Version: 1.0
> Date: Mon, 14 Oct 1996 20:20:13 +0500
> To: mdm@gds.com (Mark Malone)
> From: rdginc@tiac.net (Bob Gallagher)
> Subject: Re: Lightning Data July 17, 1996
>
> Mark,
>
> Thank you for your help! Can you estimate the probability that there was a
> lightning discharge in that area and your network did not record it? (i.e.
> one in a million???)
>
> I will forward your report to the NTSB with a note when I receive it.
>
> Thanks again!
>
> Bob Gallagher
>

Bob,

Without knowing a lot of other things, like was there convection in that area? Satellite imagery showed clouds? surface observation reports. etc. I can only state that our chances of missing an entire storm is pretty low, almost nil. However, if there was a "bolt out of the blue", yes there is a chance we missed it, especially if it were a cloud to cloud strike, which we do not measure. I would check NWS surface reports and archived satellite and radar data too. Also, other pilots may have filed "PIREPS (PIlot REPortS)" which are in-flight updates as observed by aircrews as they fly through areas. The NWS or FAA should have that data.

For more precise quantification, you may want to contact some of our academic affiliates like Dr. Phil Krider at the University of Arizona Atmospheric Science Dept. Or, Dr. Martin Uman at the Univeristy of Florida Electrical Eng. Dept. Or, Dr. Richard Orville, at Texas A&M College Station, TX. Phil and Martin founded our company, and Dr. Orville designed the National Lightning Detection Network (when he was at S.U.N.Y. - Albany, I worked under him there). Finally, another scientist I recommend is Dr. Vince Idone at S.U.N.Y. - Albany Atmospheric Science Dept.

here's some phone numbers:

Krider: (520) 621-6831
Uman: (904) 392-4038
Idone: (518) 442-3300 (I think this is SUNYA's main number...not sure)

Another excellent scientist that we work with is Mr. Ron Holle at the National Severe Storms Lab in Norman Oklahoma, he is real adept at quantifying this sort of thing. (He and I and others co-authored a short paper on a "bolt out of the blue" lightning phenomena that occurred in Connecticut during the Winter. Ron can be reached by e-mailing: holle@nssla.nssl.uoknor.edu

Oh, NASA also has OTD's in space (Optical Transient Detectors) that pick up lightning from space platforms. Check the NASA.GOV web site or contact them directly. there is a gentleman named Otha Vaughn that does some pretty incredible reserach in that area and supports the NASA mission. He is located at the Marshall Space Flight Center, I don't have his number.

Hope this helps.

25

Global Atmospherics, Inc.
2705 East Medina Road, Tucson, Arizona 85706-7155 *Telephone* (520) 741-2838 *Fax* (520) 741-2848

FaultFinder™ Report

October 18, 1996

Robert Gallagher
1 Fairbanks Road
Chelmsford, MA 01824

Dear Mr. Gallagher:

Thank you for using Global Atmospheric's *FaultFinder*™ Lightning Report to validate your event. Data from the National Lightning Detection Network™ was analyzed for your requested search time and region.

Reference Number: SO-819

Report Details:

```
Requested By:       Robert Gallagher

Search period:      July 17, 1996 20:20:00 EDT

                    To:

                    July 17, 1996 20:35:00 EDT

Location Region:    Latitude: 40.5833
                    Longitude: -72.7167
```

Results:

```
Strokes Detected:   0 (within 100 miles)

Suspect Strokes:    0 detected on centerpoint
                    (nearest stroke detected at 361.0 miles)
```

If you have any other questions about your report, please call me at (800) 283-4557.

Sincerely,

William Brooks

26

FaultFinder Report

Robert Gallagher - Consultant

ASCII Data

Dates and Times Below are in GMT (EDT + 4 hours)
To get local time subtract 4 hours from times below

No detected lightning within the 100 mile buffer radius. Nearest stroke detected at 361.0 miles.

27

[redacted]

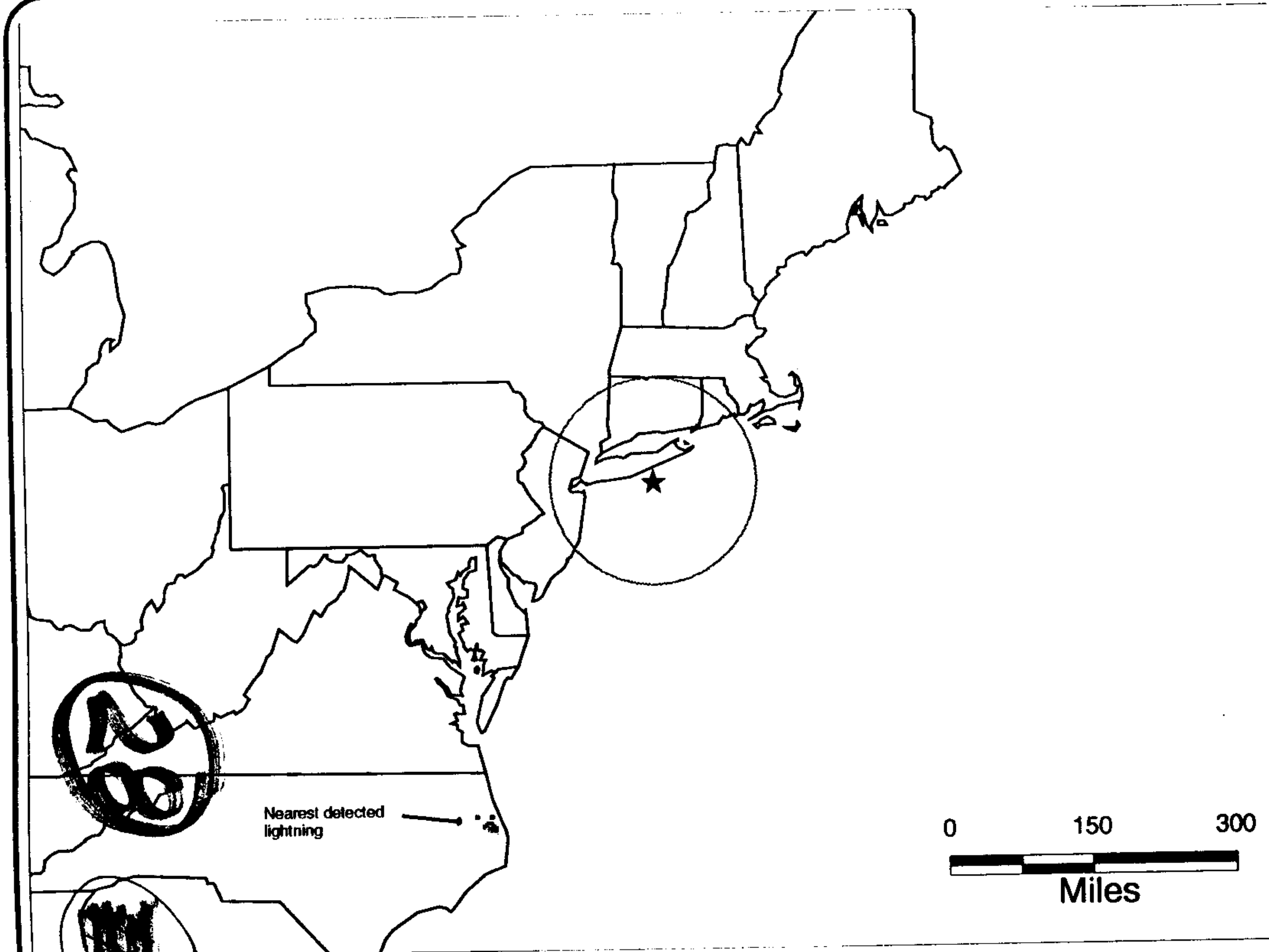
2705 East Medina Road
Tucson, Arizona 85706-7155
Telephone 602 573-0090 or 800 283-4557
Fax 602 741-2848

Global Atmospherics, Inc.

The National Lightning Detection Network™

FaultFinder™ Report

Map of Selected Region and Time Period



Robert Gallagher - Consultant

Search Parameters

Date/Times Searched:

07/17/1996 20:20 EDT
To:
07/17/1996 20:35 EDT

Search Point/Radius:

Latitude: 40.5833
Longitude: -72.7167

(Green Star at center of circle)
Circle is 100 mile radius

Reference: SO819

Lightning ground strike points are marked with a blue point.

2705 East Medina Road
Tucson, Arizona 85706-7155
Telephone (520) 573-0090 or 800 283-4557
Fax (520) 741-2848

Background

The Optical Transient Detector (OTD), the world's first space-based sensor capable of detecting and locating lightning events in the daytime as well as during the nighttime with high detection efficiency was designed and built at Marshall Space Flight Center (MSFC). The concept for this instrument was developed at NASA's Marshall Space Flight Center in the 1980's, and was selected for development as part of NASA's Earth Observing System (EOS). The purpose of the sensor is to detect the full spectrum of lightning flashes, including cloud to ground, cloud to cloud, and intra-cloud (within cloud) lightning events. Ground-based techniques detect only cloud-to-ground lightning events which are believed to comprise 25% of the total lightning activity. In addition, these techniques generally detect lightning activity near land masses; very little information is provided regarding lightning events over the Earth's oceans. OTD is designed to aid scientists in determining the global distribution of lightning activity and thunderstorms and the characteristics of the Earth's electric circuit.

The OTD was launched on 3 April 1995 into a near polar orbit at an inclination of 70 degrees with respect to the equator, at an altitude of 740 km. At any given instant, this views a 1300 by 1300 km region of the earth.

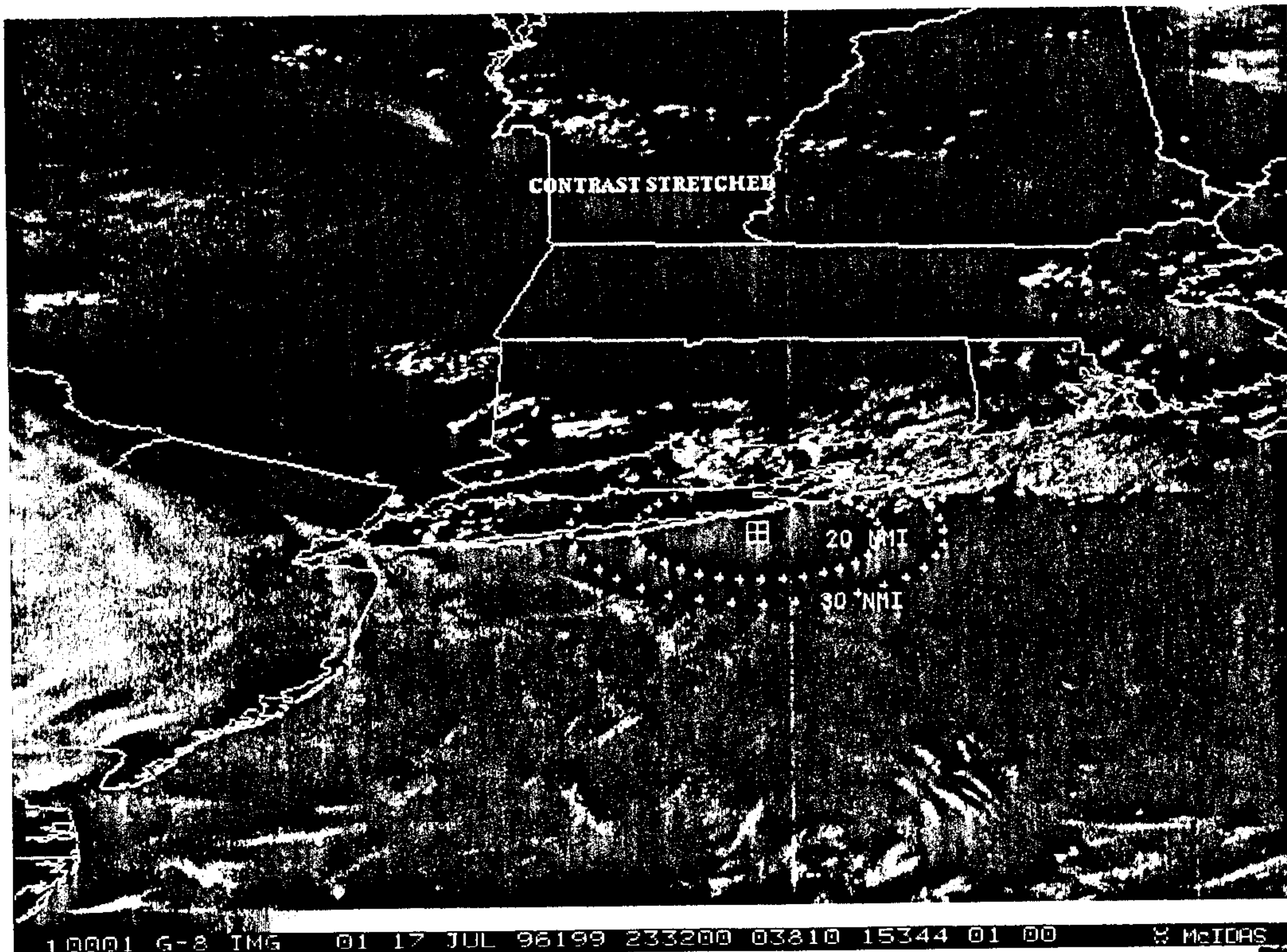
The OTD development team adopted a fast-track, low-cost approach, making maximum use of engineering model hardware configured for flight on a small satellite. Launch on the Orbital Sciences Corporation Pegasus rocket was provided free via a data buy arrangement providing low cost access to space with a shared government-industry risk factor. The instrument was designed, fabricated, space qualified, calibrated, and delivered within a period of nine months. It is designed to observe lightning for a period of two years or more.

The Microlab satellite carrying the OTD (silver canister) shared the launch with two commercial communications satellites called Orbcoms.

Scientific Objectives

OTD is designed to detect, locate and measure the intensity of lightning for scientific investigation of the distribution and variability of total lightning over the Earth and to increase our understanding of the Earth's atmosphere system. Lightning is closely coupled to storm convection dynamics, and can be correlated to the global rates, amounts and distribution of convective precipitation. The Optical Transient Detector contributes to studies of Earth's water cycle, sea-surface temperature variations, electrical coupling of thunderstorms with the ionosphere and magnetosphere, and modeling of the global distribution of electrical fields and currents in the Earth's atmosphere. In addition, it begins the development of a global lightning climatological database for use in NASA's Mission to Planet Earth

30



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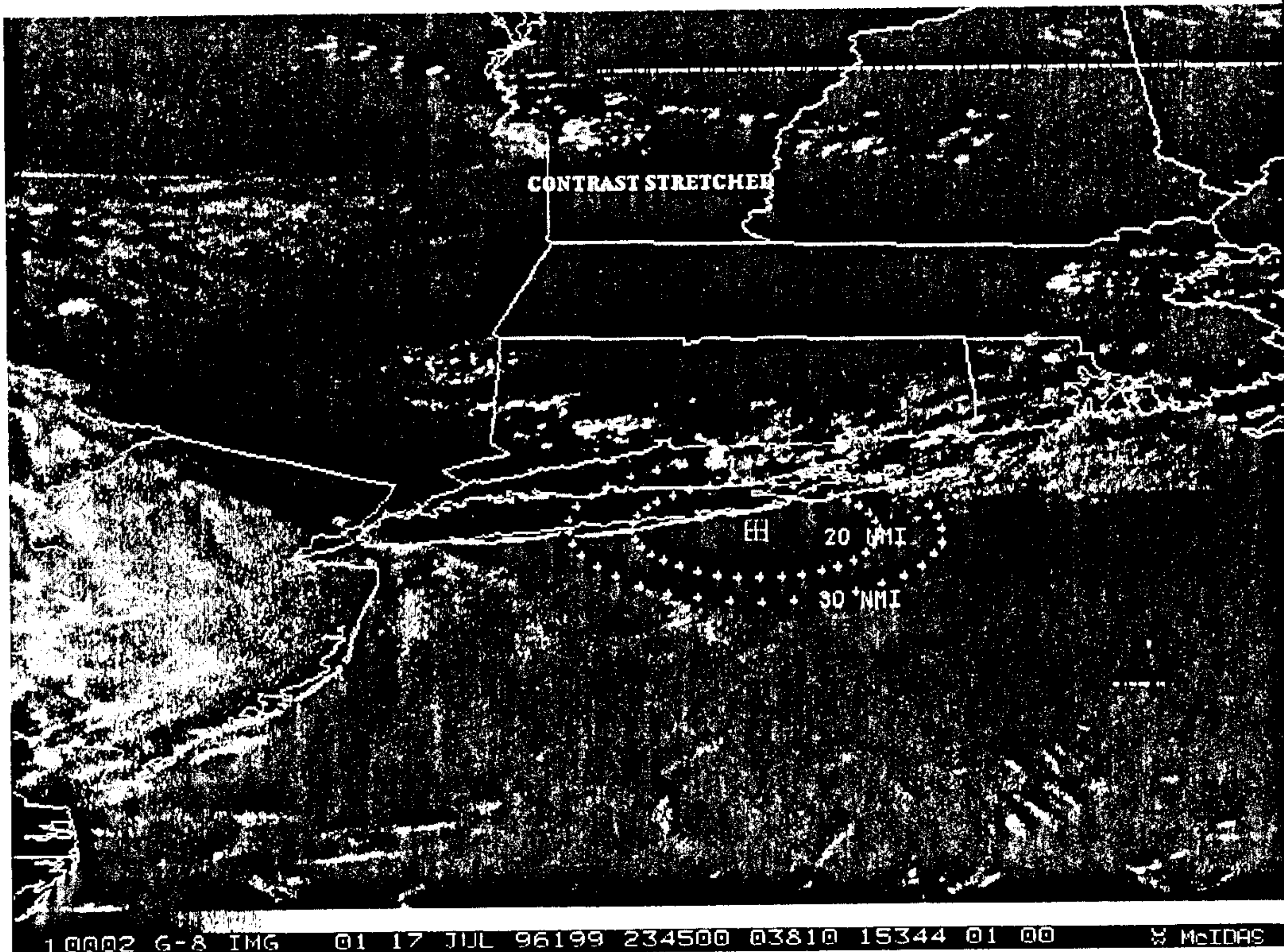
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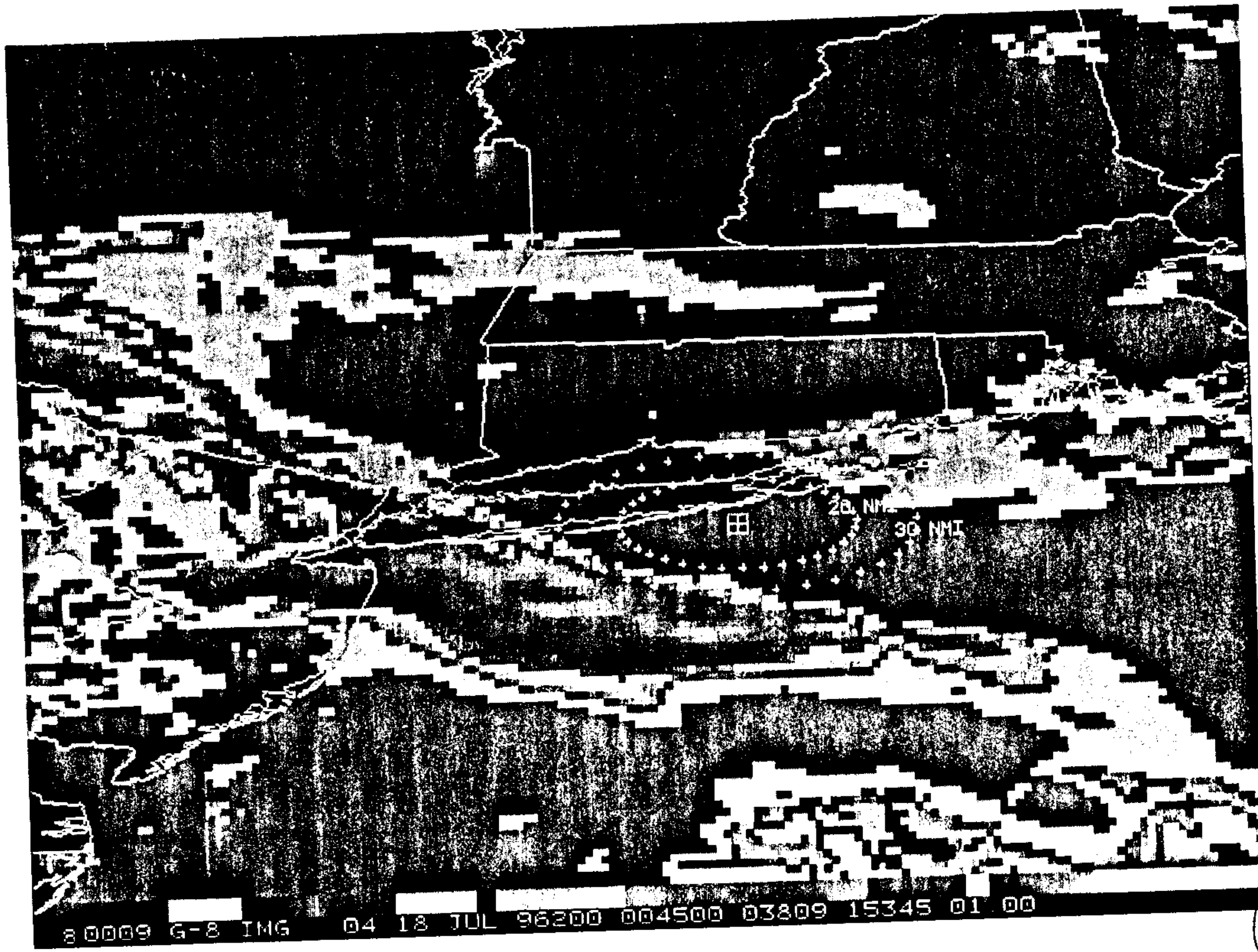
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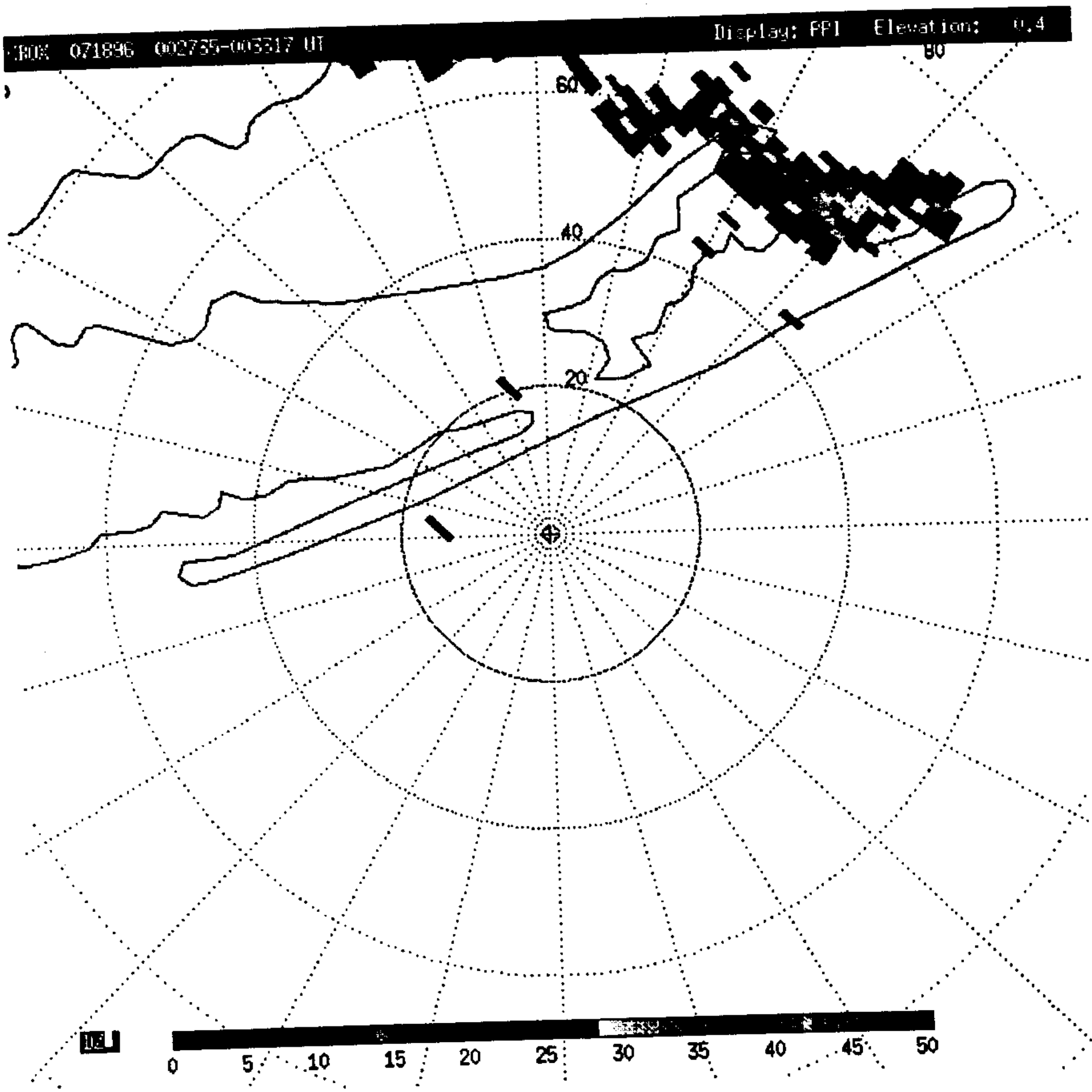
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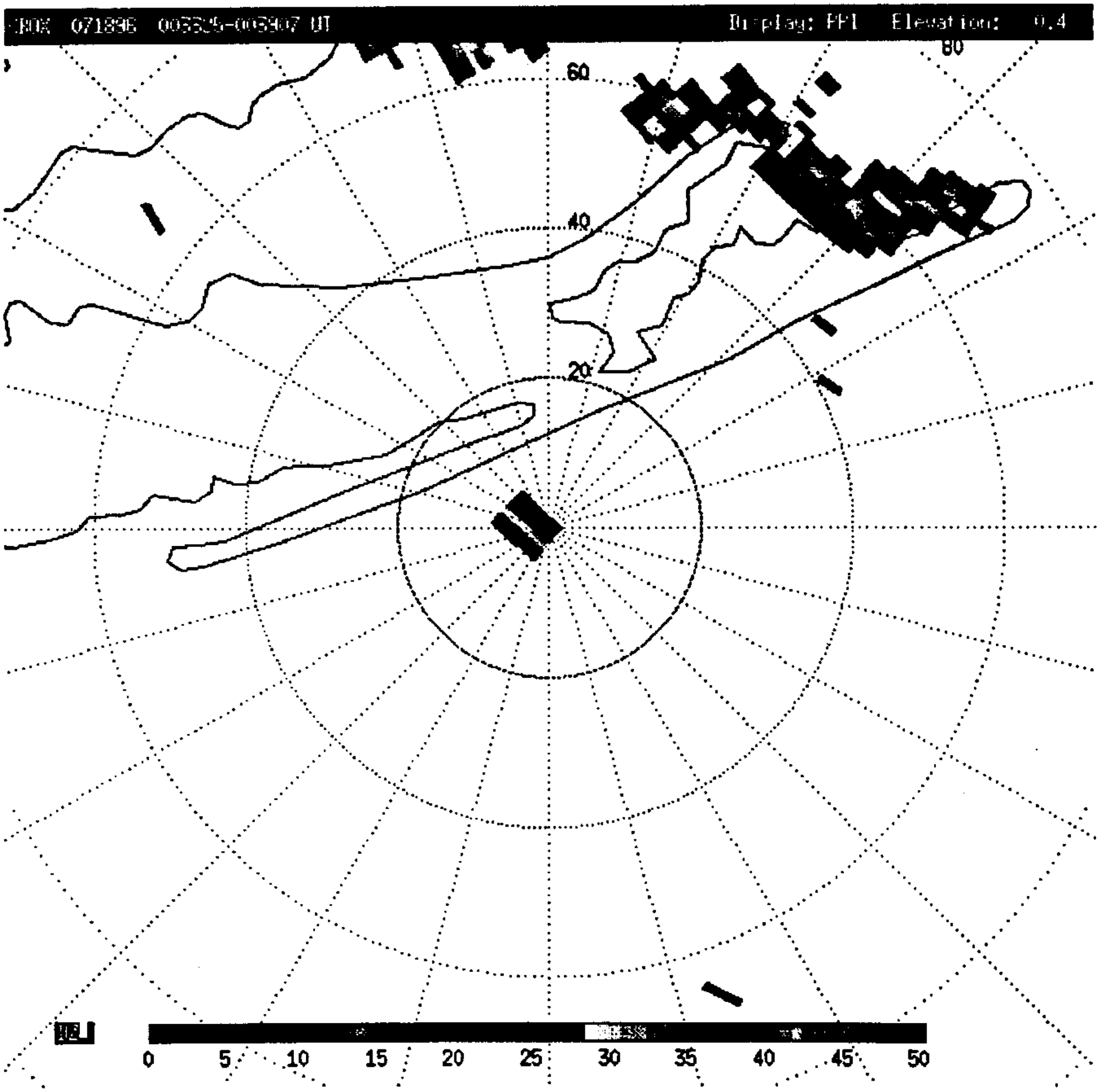
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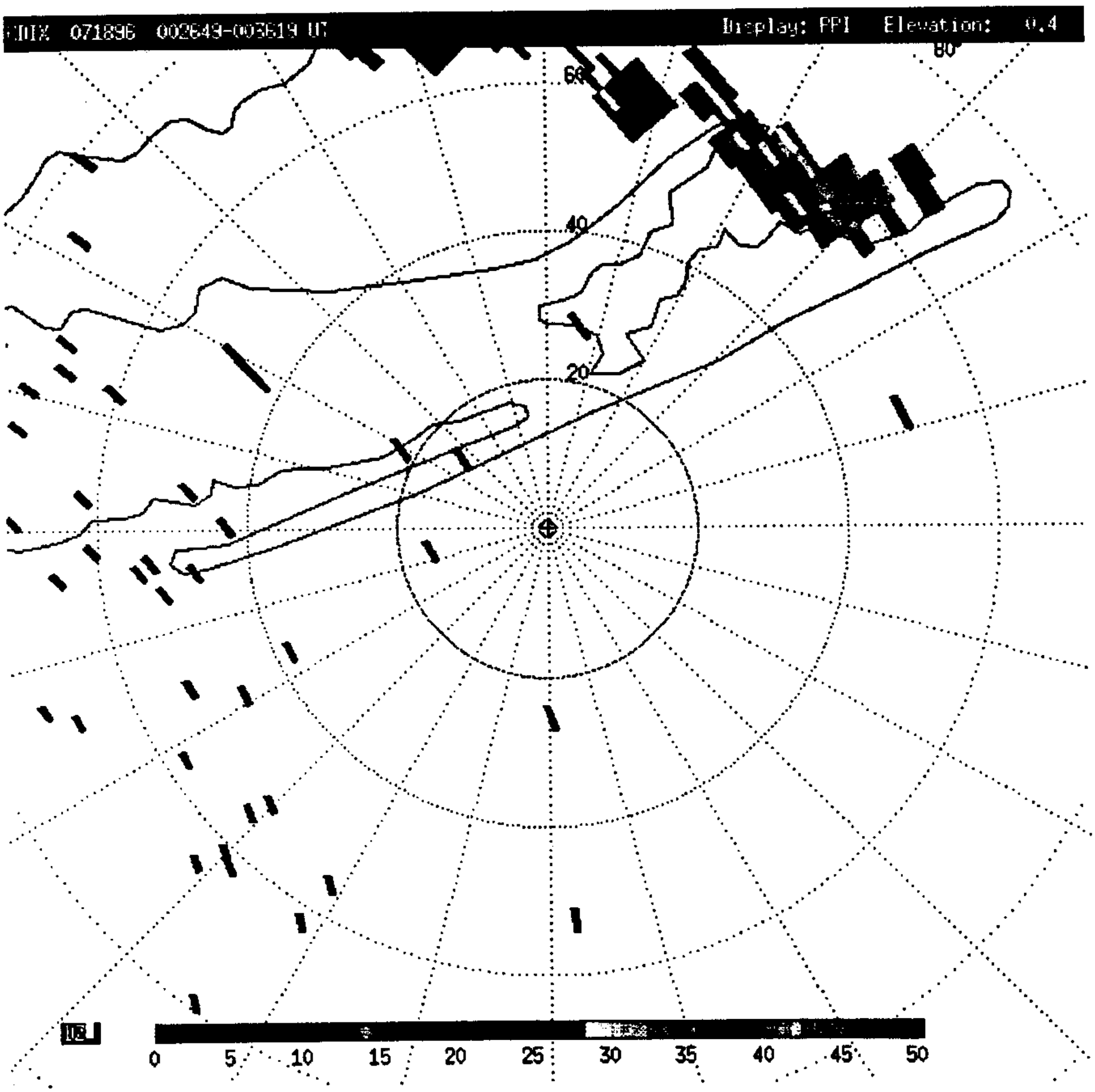
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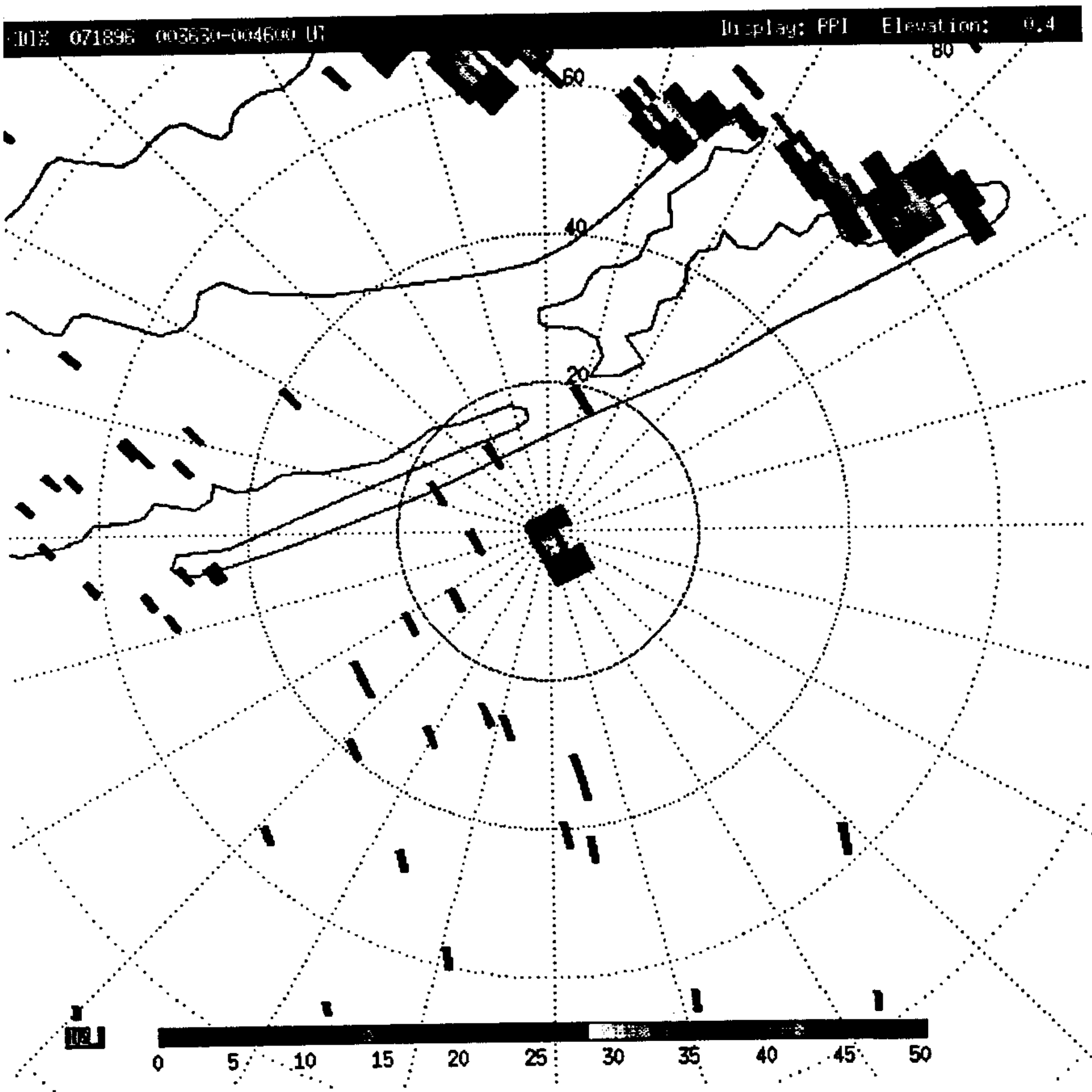
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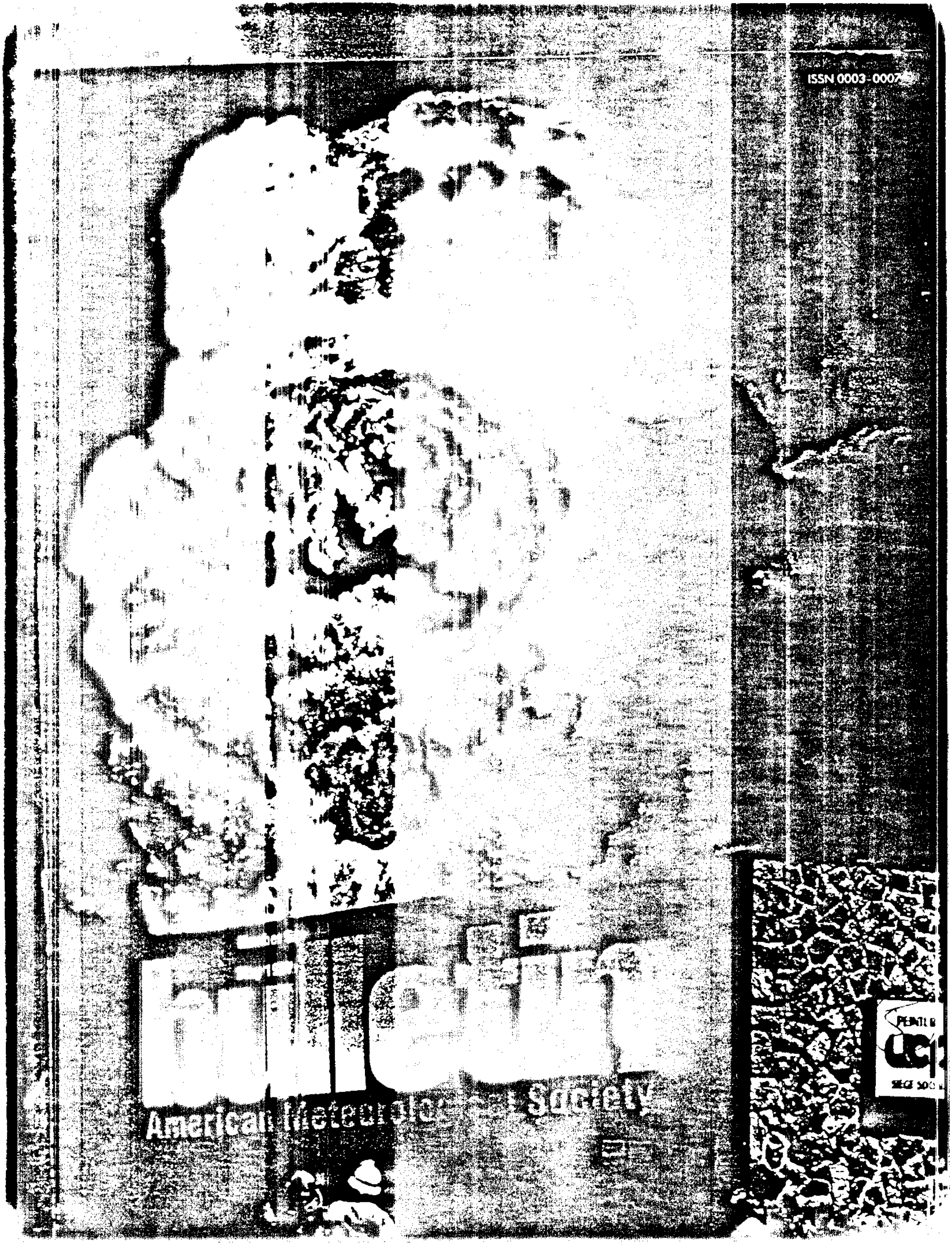
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Radar Observations of a Major Industrial Fire

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ABSTRACT

On 23 May 1996, a Montreal suburban paint factory containing several hundred thousand gallons of paints, solvents, and other chemicals burned to the ground in a spectacular fire. The smoke plume from the fire was readily detected by three radars operated by McGill University for routine observations of the atmosphere. An S-band (10-cm wavelength) scanning radar provided a plan view of the plume from the time of its initial appearance over the plant until the fire was finally extinguished. These data reveal the history of the plume, showing how it meandered and spread as it was advected downwind. The plume passed directly over the site of two vertically pointing radars, one a high-resolution X-band radar (3-cm wavelength) and the other a UHF (33-cm wavelength) wind profiler. Doppler spectra of the smoke echoes in the vertical beam of the profiler indicated predominantly downward velocities, but it was not possible to distinguish in the spectra between scattering by settling particles and scattering by the refractively perturbed air. The reflectivity of the plume in the vertical beam of the wind profiler, expressed in terms of the rain-equivalent reflectivity factor, had values up to 40 dBZ. At the shorter wavelength of the X-band radar, the reflectivity factors were less by amounts ranging from 20 to more than 30 dBZ. The difference in reflectivity can probably be accounted for by a combination of 1) the presence in the plume of particles on the order of 10 mm in diameter, which are too large to satisfy the Rayleigh scattering approximation at the shorter wavelength, and 2) a strongly perturbed structure of atmospheric refractivity, caused by the heating and turbulent mixing generated by the fire and creating a strong echo at the longer wavelength.

1. Introduction

On 23 May 1996, a spectacular fire destroyed a paint factory in the Montreal, Canada, suburb of Laval, located approximately 10 km northwest of the McGill University campus in the center of the city. The blaze leveled three buildings filled with paint, wood stain, and preservatives; solvents; and other chemicals used in the manufacturing of paint. A column of black smoke rising from the fire was clearly visible from the McGill campus. It appeared to reach a height of at least a kilometer and then to spread southeastward, toward the campus and downtown Montreal. By the time the smoke trail was overhead at the campus, it was no longer black and was only barely perceptible as a kind of haze that caused an increase in the amount of diffuse light from directions near the sun.

The smoke trail was readily detected by three radars operated by McGill that are used for continuous atmospheric observations. Data from an S-band surveillance radar located 30 km west of the downtown site show the plume as it first appeared over the paint factory and as it grew and was advected toward the southeast. A vertically pointing X-band radar on the downtown campus provided high-resolution measurements of the reflectivity of the plume as it passed overhead. At the same site, a UHF wind profiling radar measured the reflectivity and the Doppler spectra of the plume overhead. Curiously, in spite of the strong radar echoes from the plume, it was optically too thin to give more than a brief detectable signal on our laser ceilometer, and that signal might actually have been caused by a patch of thin cloud at the top of the boundary layer.

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E-mail: rogers@zephyr.meteo.mcgill.ca
In final form 12 November 1996.

This paper describes [illegible] smoke plume. The data [illegible] tion of the way in which such [illegible] helpful in monitoring plume be[illegible] of the reflectivities at wavelength[illegible] indicates a strong deviation from [illegible] The wavelength dependence is pr[illegible] a combination of Bragg scatter[illegible] fluctuations and the existence of [illegible] plume that are too large for the Ra[illegible] tion at the shorter wavelength, b[illegible] favor the longer wavelength.

2. The fire

The fire started soon after [illegible] time). Workers returning from lun[illegible] shooting from a large mixing mach[illegible] is speculated that the fire may hav[illegible] an overheated bearing in the mixer [illegible] tion of the plant was so complete th[illegible] may never be known for sure. The [illegible] arrive tried to contain the blaze but we[illegible] of the building by the extreme heat and [illegible] explosions. The fire spread quickly th[illegible] factory complex, causing roofs and ex[illegible] collapse. The buildings were shaken [illegible] small explosions, which shot fireballs, chemicals and debris high into the air. Three cars parked [illegible] beside the plant were destroyed. Although [illegible] firefighters and a half dozen pumper trucks were on the scene, the fire did not come under control until the

[illegible] and [illegible] [illegible] are [illegible] [illegible] 000 gal [illegible] 300 gal [illegible] smaller and [illegible] and other [illegible] former Cana[illegible] position of the [illegible] concentration [illegible] were no [illegible] the smoke [illegible] the wood, in [illegible] ture of the pl[illegible] cloud of ae[illegible] chemical comp[illegible]

[illegible] operates equipment [illegible] the downtown [illegible] at the Marsh[illegible] College campus, located 26 km [illegible] campus are a UHF bound[illegible] high-resolution [illegible] radar nicknamed the VPR and a la[illegible] wind profiler is equipped with a Ra[illegible] Sounding System (RASS) that pro[illegible] temperature soundings, which typically reach [illegible] These instruments work all the time [illegible] On the Macdonald campus is a large [illegible] scanning Doppler radar used for weather surveillance, similar to Next Generation Radar in its operating characteristics. It runs continuous[illegible] data are only archived for weather situations of interest [illegible] precipitation events. The main characteristics of the radars are listed in Table 1.

TABLE 1. Characteristics of the three radars

	Scanning radar	VPR	Wind profiler
Frequency band	S band	X band	UHF
Wavelength, cm	10.4	3.2	32.8
Peak power, kW	800	40	0.5
Pulse duration, μs	0.8	0.1	0.7
Beamwidth, °	0.86	2	9
Sampling period, s	150	[illegible]	30

4. Smoke plume observed by the scanning radar

Figure [illegible] shows the plume as it was observed by the scanning S-band radar at the time when it had spread to the McGill campus. This is a 1.5-km constant altitude plan position indicator (CAPPI) display with a spatial resolution of 1 km, which is a composite plot assembled from more fundamental slant–Plan Position Indicator data and the form of the archival records of the S-band radar. The plume is plotted on a map indi-

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cating the large islands of Montreal and Laval, and several smaller islands lying in the St. Lawrence River. The letter *F* is centered on the location of the fire on the island of Laval, *P* on the profiler and VPR, and *R* on the scanning radar.

The radar reflectivity of the plume is plotted in terms of its rain-equivalent reflectivity factor. These quantities are related by

$$Z = \frac{\lambda^4}{\pi^5 |K|^2} \eta, \qquad (1)$$

where Z is the reflectivity factor (dimensions L^3), η is the reflectivity (dimensions L^{-1}), λ is the wavelength, and $K = (m^2 - 1)/(m^2 + 2)$, where m is the complex index of refraction of the scattering material (Battan 1973). For water, the dielectric factor $|K|^2$ for wavelengths in the centimeter range and temperatures around 0°C equals approximately 0.93, and that is the value used in (1) for converting η to Z. [The reflectivity factor defined by (1) is usually denoted by Z_e to emphasize that it is the rain-equivalent reflectivity factor, but for notational simplicity we have omitted the subscript.] Basically, the property of a target that a radar is able to sense and measure is η; Z is a computed quantity proportional to η, with a constant of proportionality that depends on the wavelength. For rain, Z is related to the the drop size distribution by

$$Z = \int_0^\infty D^6 N(D) dD, \qquad (2)$$

where $N(D)dD$ is the number of drops per unit volume of space whose diameters are between D and $D + dD$. Although Z has a physical significance only for radar targets consisting of precipitation, it can be useful for rescaling the reflectivity of radar targets in general. For any targets consisting of a cloud of scattering elements such as raindrops that are small compared with the wavelength, it follows from the Rayleigh scattering approximation that $\eta \propto \lambda^{-4}$, and hence Z is independent of wavelength.

By convention, the reflectivity factor is often measured on a logarithmic scale in units of decibels of reflectivity (dBZ), defined by

$$\zeta = 10 \log_{10}\left(\frac{Z}{Z_0}\right), \qquad (3)$$

where $Z_0 = 1\ mm^6\ m^{-3}$. The outer contour of the smoke plume in Fig. 1 has a reflectivity factor of 25 dBZ, and the maximum reflectivities within the plume are about 45 dBZ. These are substantial reflectivities, which, for precipitation, would correspond to moderate rain.

Figure 2 shows a sequence of CAPPI displays at 10-min intervals from the time the smoke echo first appeared until the worst of the fire was over and the plume was dissipating. Here, the base map is simplified to show principally the main islands of Laval and Montreal, separated by Rivière des Prairies. The first three frames suggest that there may have been an initial explosion, followed after a short delay by the major fire. The map at 1315 EST is the same as th[...] shown in Fig. 1, when the plu[...] just reached th[...]

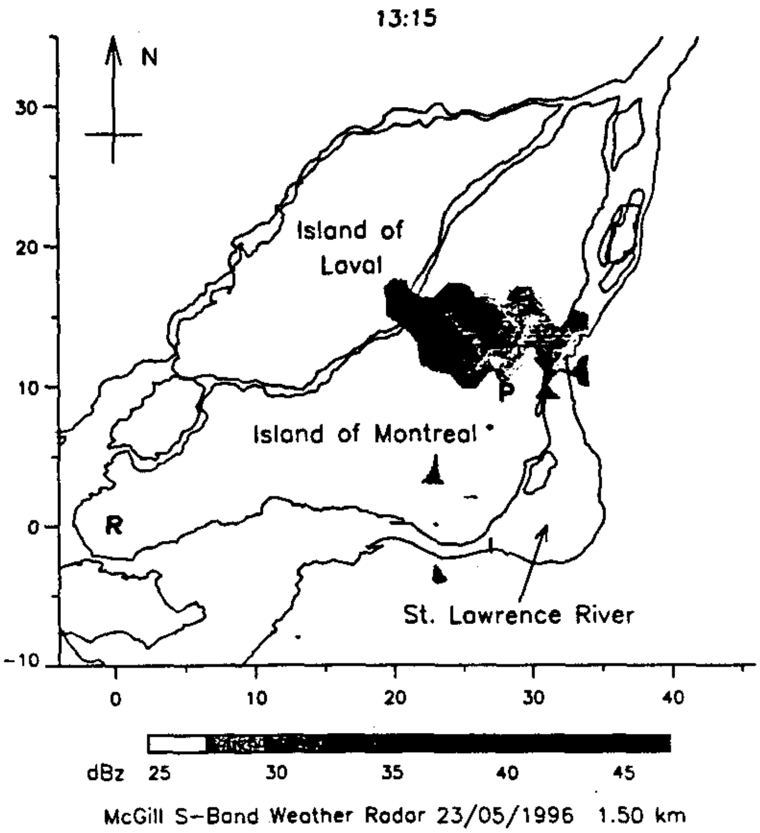

FIG. 1. Reflectivity pattern of the smoke plume observed by S-band scanning radar at 1315 EST 23 May 1996. This is a 1.5-km CAPPI map, with scales indicating the distance from the scanning radar in kilometers. The letters *F, P,* and *R* indicate, respectively, locations of the fire, the profiler and VPR, and the scanning radar.

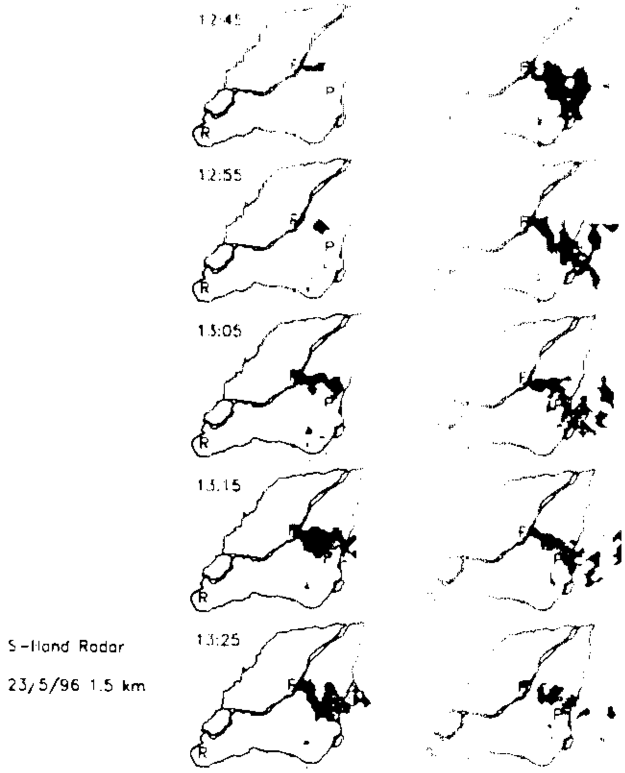

FIG. 2. Sequence of CAPPI maps at 10-min intervals showing the evolution of the smoke plume. The base map is simplified, indicating only the islands of Montreal and Laval. Some of the small, faint echoes south of the profiler site (letter *P*) are ground clutter, not echoes from the plume.

site of the profiler and the VPR. Hourly winds measured by the profiler indicated a northwesterly flow of approximately 8 m s^{-1} at 1.5 km. Although the plume meanders, its overall displacement is consistent with the profiler winds.

5. The plume overhead

Figure 3 is an 8-h time–height record of reflectivity measured by the VPR. The reflectivity is expressed in terms of the rain-equivalent reflectivity factor using (1). The minimum value plotted is −15 dBZ. The weak and spotty echoes up to about 2 km are believed to be primarily due to insects. Unmistakable are the stronger echoes starting just after 1300 EST and sometimes extending from nearly 3 km down to the ground. The core reflectivities in these columns exceed 10 dBZ. The stronger echoes are clearly associated with the smoke plume as it passed over the McGill campus.

Figure 4 focuses on the period 1300–1500 EST which includes the strongest echoes from the smoke plume, and compares the VPR data with the reflectivities measured in the vertical beam of the wind profiler. The high-resolution VPR data indicate an extremely grainy pattern of reflectivity, much rougher than the patterns observed in precipitation, showing that the smoke plume is a highly irregular scattering medium. Although the resolution of the profiler in height and time is coarser than the VPR, there is nevertheless an obvious similarity between the two patterns. However, the profiler-measured reflectivity factors in the echo cores are stronger than those measured by the VPR by as much as 20 dBZ or more. Collocated with the profiler and VPR is a laser ceilometer (Vaisala model CT-12K). The only detectable echo on the ceilometer during this time period was one at 2.1 km of about a 2-min duration at 1332 EST. This falls within the time and height interval of the strong radar echoes and might be an indication of the smoke plume. On the other hand, there were a few wisps of cloud in the sky, and the ceilometer echo may only indicate a passing cloud. Right away it should be noted as curious that a smoke trail, ordinarily thought of as consisting of particles with sizes on the order of micrometers, would be detectable by radars with wavelengths of 3, 10, and 33 cm, but not by the ceilometer with a wavelength of 0.9 μm. A possible explanation of the observations is that the radar plume was composed of rather large particles, presumably ash, debris, and other products of incomplete combustion, all

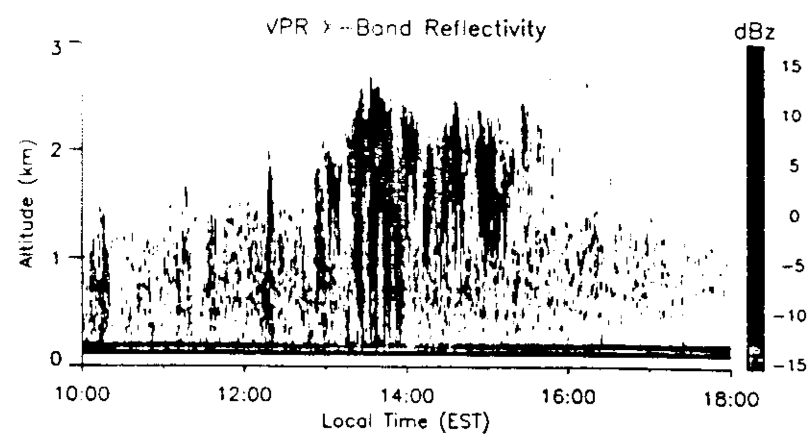

FIG. 3. Time–height pattern of reflectivity measured by the VPR. The resolution of the data in this plot is 30 m in altitude and 30 s in time. The strong echoes from about 1315 to 1530 EST are associated with the plume.

STATION:72501 DAY/TIME:96200 000000 LAT/LONG:408500 728500

LEVEL	TEMP (°C)	DEW PT (°C)	DIR (°True)	SPEED (m/sec⁻¹)	HEIGHT (meters)	RH
1015.0	27.8	20.8	240.0	2.5	20.0	
1000.0	27.2	18.2	255.0	4.6	152.3	
982.9	26.1	16.9	270.0	6.6	304.0	
949.4	23.9	14.2	280.0	7.7	609.0	
925.0	22.2	12.2	285.0	8.7	837.5	
916.8	21.5	11.9	285.0	9.2	914.0	
884.9	18.6	10.7	290.0	9.7	1219.0'	
850.0	15.4	9.4	305.0	10.2	1564.9	
823.8	13.5	8.0	310.0	10.8	1829.0	
794.5	11.3	6.3	315.0	9.7	2134.0	
793.0	11.2	6.2	315.3	9.6	2150.4	
766.0	10.3	-1.4	320.0	8.2	2439.0	
757.0	10.0	-4.0	323.3	7.7	2538.0	
748.0	9.2	1.2	326.5	7.2	2637.3	
738.5	8.4	1.7	330.0	6.6	2743.0	
723.0	7.2	2.4	332.9	6.3	2918.6	
711.7	6.3	0.9	335.0	6.1	3048.0	
700.0	5.4	-0.6	325.0	6.1	3184.2	
699.0	5.4	-0.6	324.7	6.1	3196.0	
686.0	5.2	-12.8	320.1	6.1	3349.5	
685.7	5.2	-12.9	320.0	6.1	3353.0	
676.0	4.4	-16.6	310.5	6.9	3469.2	
660.4	3.3	-17.0	295.0	8.2	3658.0	
636.0	1.5	-17.6	290.0	8.7	3963.0	
634.0	1.4	-17.6	290.8	8.8	3988.5	
612.3	0.8	-20.4	300.0	9.7	4268.0	
586.0	0.0	-24.0	302.9	10.9	4620.7	
567.3	-1.9	-23.0	305.0	11.8	4878.0	
545.9	-4.2	-21.8	315.0	15.9	5182.0	24
530.0	-5.9	-20.9	315.0	17.1	5416.5	
500.0	-9.3	-28.3	315.0	19.5	5870.1	20
485.5	-10.4	-30.2	310.0	20.0	6097.0	
466.6	-11.8	-32.7	305.0	20.5	6402.0	17
465.0	-11.9	-32.9	304.8	20.5	6428.6	
400.0	-22.5	-35.5	295.0	20.5	7558.2	31
396.5	-23.0	-36.0	295.0	20.5	7621.0	
363.9	-27.9	-40.6	295.0	20.5	8231.0	30
319.9	-35.2	-47.5	305.0	20.0	9146.0	
306.5	-37.7	-49.8	315.0	19.0	9451.0	
300.0	-38.9	-50.9	315.0	19.0	9602.3	29
286.0	-41.9	-51.9	300.8	18.6	9928.2	
280.4	-42.7	-52.9	295.0	18.5	10060.0	
256.0	-46.5	-57.3	280.0	21.0	10670.0	30
250.0	-47.5	-58.5	280.0	21.6	10828.8	
200.0	-58.1	-67.1	310.0	24.6	12269.6	33
182.0	-56.5	-65.5	313.6	29.0	12866.1	
175.1	-57.2	-66.2	315.0	30.8	13109.0	34
151.4	-59.9	-68.9	300.0	25.7	14024.0	
150.0	-60.1	-69.1	300.0	25.7	14083.4	33
133.0	-61.9	-70.9	312.9	23.4	14831.2	
124.5	-60.8	-69.8	320.0	22.1	15243.0	
118.5	-59.9	-68.9	320.0	20.0	15548.0	
117.0	-59.7	-68.7	318.7	19.3	15628.7	
102.3	-61.8	-70.8	305.0	12.3	16463.0	
100.0	-62.1	-71.1	305.0	11.3	16605.1	32
93.3	-62.5	-71.5			17033.6	
25.9	-49.7	-62.7			25184.4	

JFK 254 at 44 NMiles from upton

Acc. site ~ 15 NMiles SE of Upton

43 [redacted]

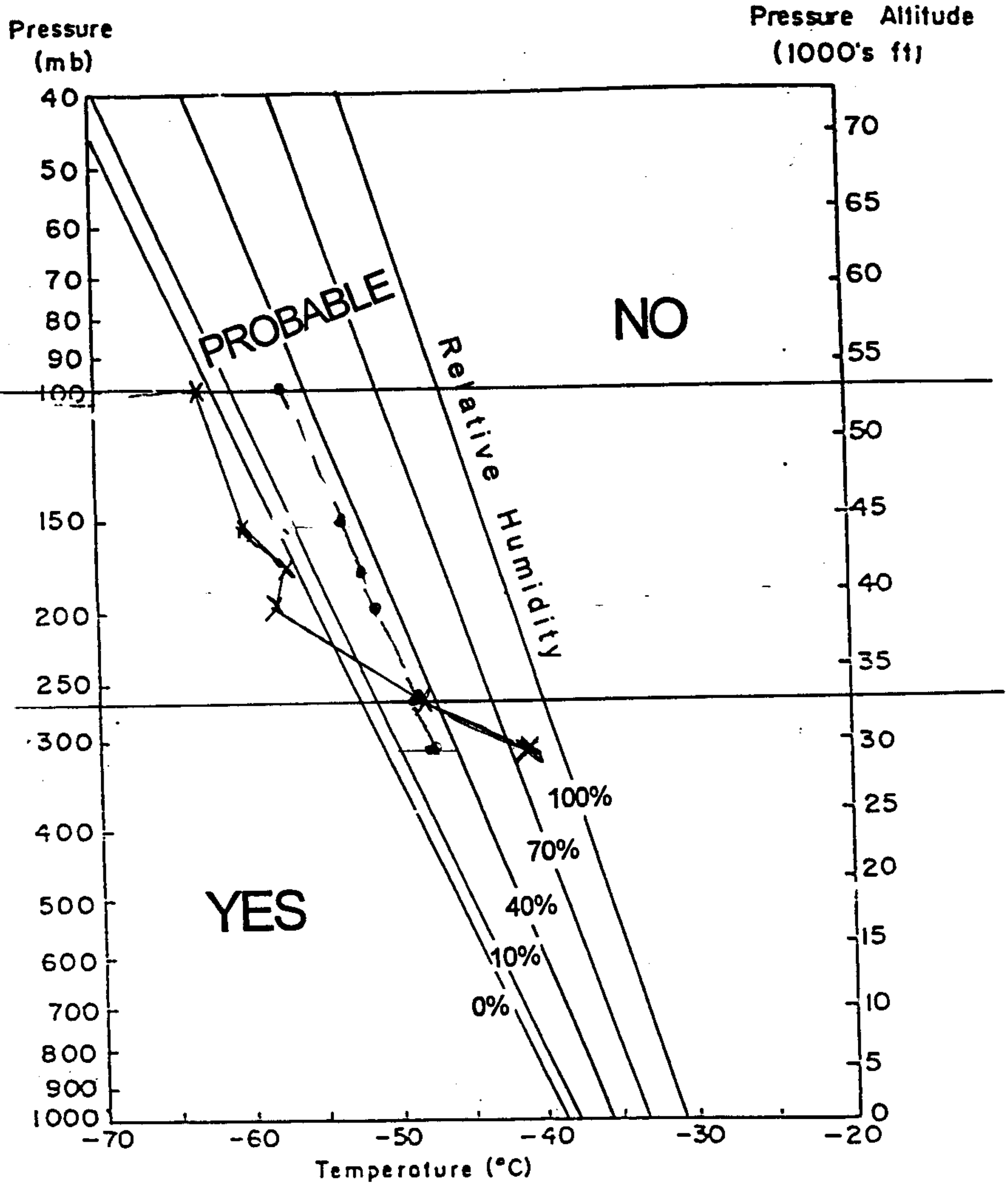

Figure 9. Low-Bypass Engine Contrail Algorithm.

44 [redacted]

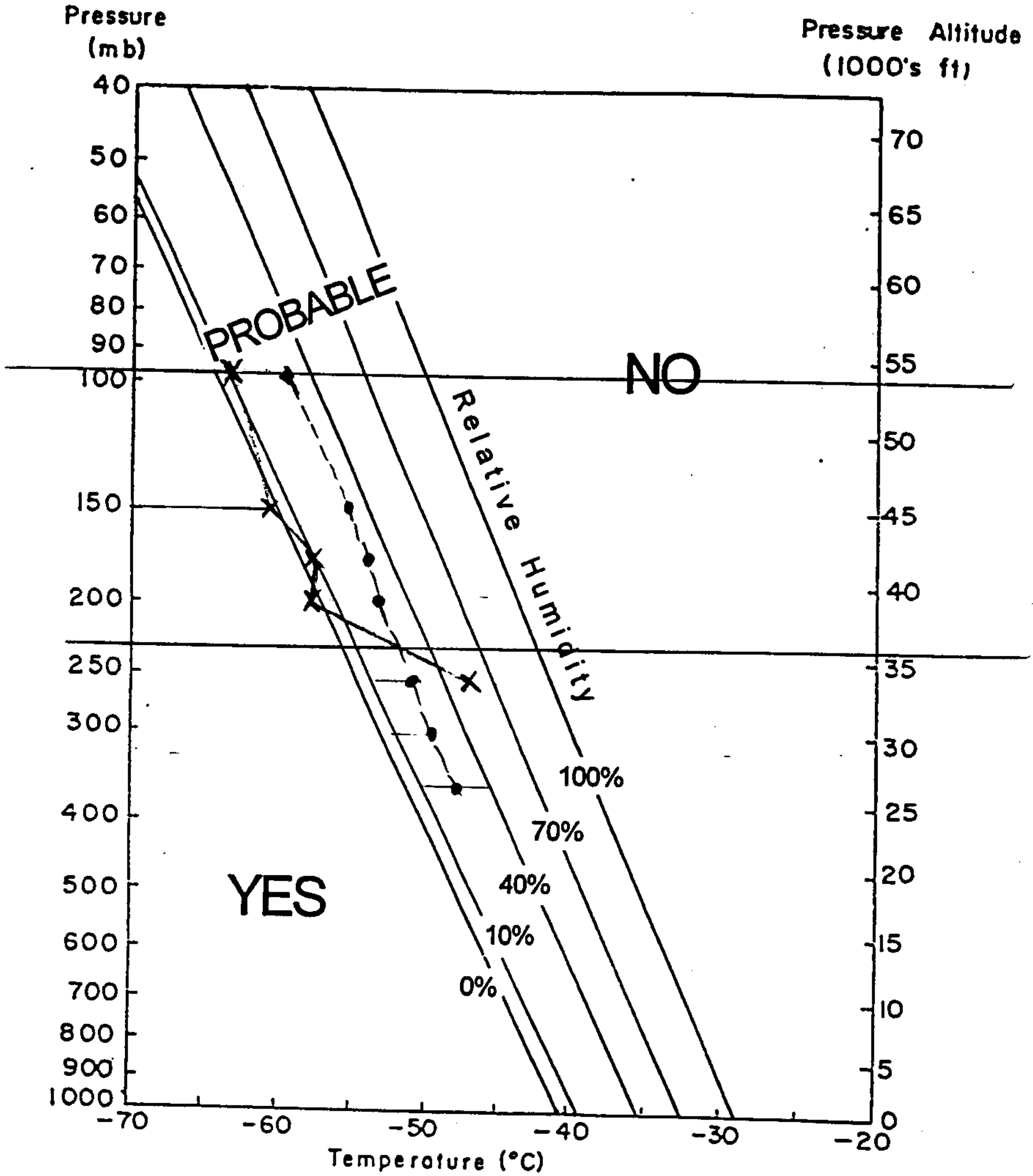

Figure 8. Non-Bypass Engine Contrail Algorithm

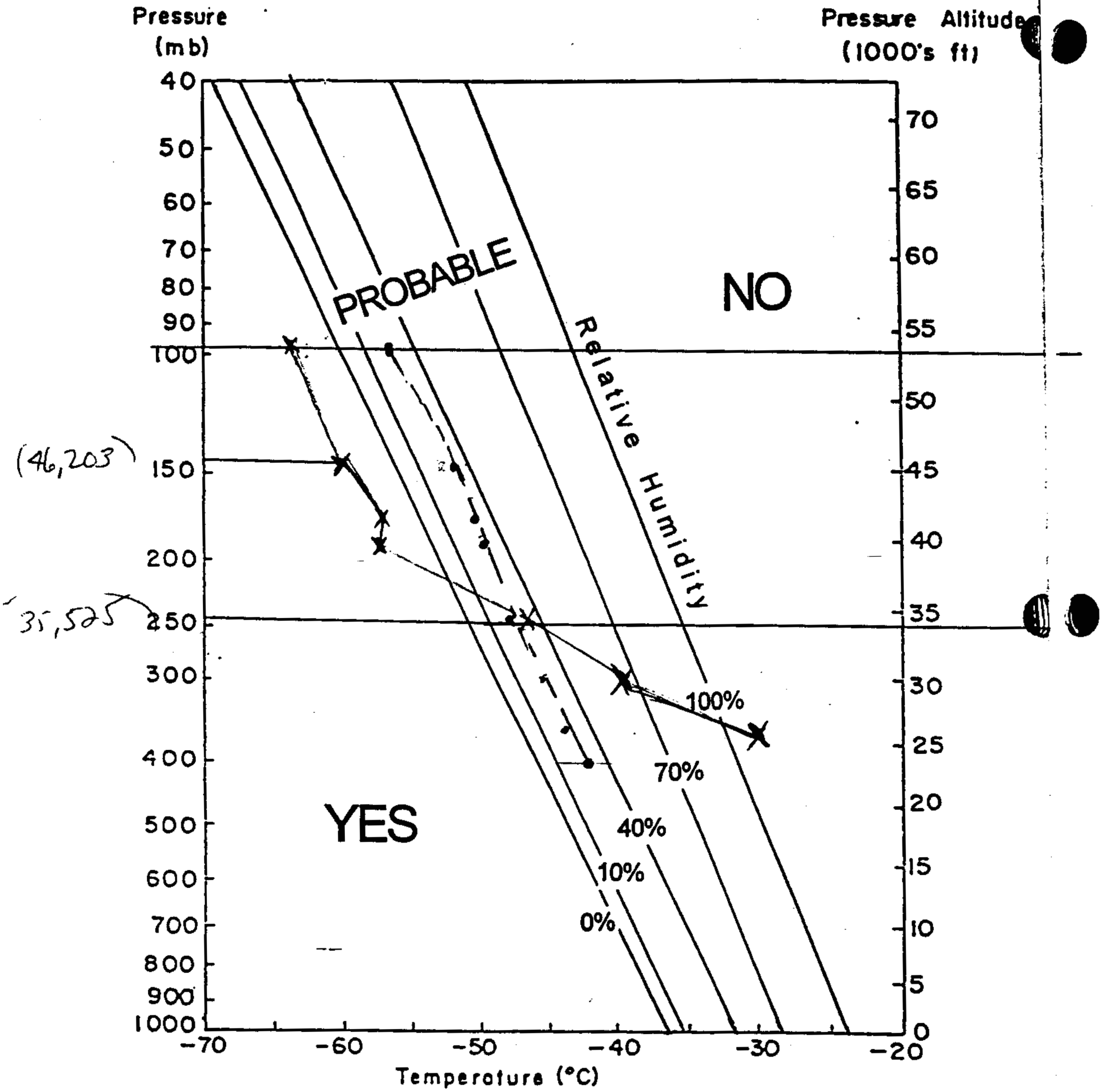

Figure 10. High-Bypass Engine Contrail Algorithm.