NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington D.C. 20594

METEOROLOGICAL GROUP CHAIRMAN'S FACTUAL REPORT

DCA-94-MA-065

A. ACCIDENT

Location: Charlotte/Douglas International Airport (CLT), Charlotte, North Carolina.

Date: July 2, 1994.

Time: About 1843 EDT.

Aircraft: Douglas DC-9-31, N954VJ, Owned by USAir, Inc., and Operated as USAir Flight 1016.

B. METEOROLOGICAL GROUP

Chairman: Gregory D. Salottolo, National Transportation Safety Board, Washington D.C.

Member: Bill Kneas, National Weather Service (NWS), Silver Spring, Maryland.

Member: Howard E. Garbee Jr., USAir, Pittsburgh, Pennsylvania.

Member: Gary L. Zindars, National Air Traffic Controllers Association (NATCA), Hapeville, Georgia.

Member: Christopher Head, Air Line Pilots Association (ALPA), Charlotte, North Carolina.

C. SUMMARY

The Meteorological Group was convened on July 3, 1994. The Group was tasked with defining the environment USAir 1016 was operating in prior to and up to the time of the accident and documenting

the pertinent products, services, and actions of agencies and individuals involved in the accident. These included the Federal Aviation Administration(FAA), NWS, and USAir. During the investigation numerous persons were interviewed which included individuals from the NWS, USAir, pilots operating in the area and ground based witnesses. Data were also collected from several data sources including the NWS, FAA and the State of North Carolina. An optical disk containing Doppler Weather Radar data from the WSR-88D weather radar at Columbia, South Carolina was obtained. Numerous products were generated from these data and color prints of the products were made. Satellite imagery was generated on the Board's Man computer Interactive Data Access System (McIDAS) Workstation.

D. DETAILS OF INVESTIGATION

Note: In the report all times Eastern Daylight Time (EDT) based on the 24 hour clock unless noted. All heights above mean sea level unless noted. Heights in surface weather observations and terminal forecast above ground level (AGL). Z = Coordinated Universal Time (UTC). EDT = Z - 4 hours. All directions with reference to true north unless noted.

Surface Weather Observations

Surface weather observations for CLT are made by the National Weather Service (NWS). The NWS office is located about 1 mile southeast of the Air Traffic Control Tower. The weather station clock was checked subsequent to the accident and found to be within 5 seconds of the time standard. The MAPSO (Microcomputer Aided Paperless Surface Observations) time was found to be within 1/2 minute of the weather station clock. This time is the longline dissemination time noted in the report. It was determined by observation on July 4 that the AWIS clock was about 3 minutes slow. The times noted below have not been adjusted to reflect these differences.

The observations are, in part, as follows:

1751...Record..5,000 feet scattered; visibility 6 miles; haze; temperature 88 degrees F; dew point 67 degrees F; winds 150 degrees at 8 knots; altimeter setting 30.02 inches of Hg.

This observation was disseminated on the Automated Weather Information System (AWIS) at 1750. The CLT Tower receives weather information on AWIS. The observation was disseminated to outside aviation interests (longline) at 1752.

1836...Special...Measured ceiling 4,500 feet broken; visibility 6 miles; thunderstorm, light rain showers, haze; winds 170 degrees at 9 knots; altimeter setting 30.02 inches of Hg.; thunderstorm overhead; occasional lightning cloud to ground.

This observation was disseminated on AWIS at 1836. The observation was disseminated longline at 1837.

1840...Special...Measured ceiling 4,500 feet overcast; visibility 1 mile; thunderstorm, heavy rain showers, haze; winds 220 degrees at 11 knots; altimeter setting 30.03 inches of Hg.; runway 36L (visual range) greater than 6,000 feet; thunderstorm overhead; occasional lightning cloud to ground.

This observation was disseminated on AWIS at 1841.The observation was transmitted longline at 1842.

1850...Record...Measured ceiling 4,500 feet overcast; visibility 6 miles; thunderstorm, heavy rain showers, haze; temperature 77 degrees F; dew point 73 degrees F; winds 080 degrees at 5 knots; altimeter setting 30.02 inches of Hg.; runway 36L visual range greater than 6,000 feet; thunderstorm began 1833; thunderstorm north occasional lightning in cloud, cloud to ground; breaks in the overcast; rain began 1834.

This observation was disseminated on AWIS at 1851. The observation was transmitted longline at 1852.

The visibility in the 1850 observation was corrected to 1 mile. The corrected observation was transmitted longline at 1855.

The following was obtained from the surface weather observation form for CLT..

Thunderstorm began 1833 and ended 1900.
Light rain showers began 1834 and ended 1837.
Heavy rain showers began at 1837 and ended at 1901.

NWS Gust Recorder Record..CLT

The Gust Recorder record showed that between 1830 and 1900 the wind speed varied between 4 and 16 knots. Four knots occurred about 1854 and 16 knots occurred about 1840. The wind sensor is located about 100 feet northwest of the Weather Service Office. The wind sensor is at a height of about 15 feet. All times are estimated chart times. See Attachment 1.

NWS Rain Gauge Record..CLT

The Rain Gauge Record showed that between about 1845 and 1900 about .33 inches of rain was measured. The Rain Gauge is located on the roof of the NWS Office. All times are estimated chart times. See Attachment 2.

NWS Barograph Record..CLT

The Barograph Record showed a station pressure of about 29.20 inches of Hg. at 1800 and 29.21 inches of Hg. at 1900. The maximum pressure change during this period was about .02 inches of Hg. This occurred about 1835. All times are estimated chart times. See Attachment 3.

Runway Visual Range (RVR) Data...CLT

Tasker 500 transmissometers with a 250 feet baseline are installed at CLT.

Graphs of Transmittance for the runway 05 touchdown zone (TD) and runway 36L TD were obtained from the NWS at CLT.

Runway 05 TD

Time	Transmittance (%)	RVR (Feet)
1835	95	6000+
1840	87	5500
1845	86	5000
1849	95	6000+

During the period 1840 to 1845 there was a decrease in transmittance to a value of less than 0 % (RVR less than 500 feet). See Attachment 4.

Runway 36L TD

Time	Transmittance (%)	RVR (Feet)
1835	96	6000+
1840	95	6000+
1845	91	6000+
1849	94	6000+

During the period 1840 to 1845 there was a decrease in transmittance to 5 % (RVR less than 500 feet). See Attachment 5.

Runway 36L Rollout (RO)

This transmittance trace was obtained from the FAA.

Time	Transmittance (%)	RVR (Feet)
1835	95	6000+

1840	85	4500
1845	76	2800
1850	89	6000+

During the period 1840 to 1845 there was a decrease in the transmittance to 29 % (RVR 800 feet). See Attachment 6.

Attachment 7: Conversion Table used to convert transmittance to RVR...Light setting 4 was used...day conditions.

Note: Runway 05 TD Transmissometer = Runway 18R Midpoint Transmissometer.
Runway 36L TD Transmissometer = Runway 18R RO Transmissometer.
Runway 36L RO Transmissometer = Runway 18R TD Transmissometer.

Note: All times estimated chart times.

The Runway 36L RO Transmissometer (18R TD) is loacted about 112 degrees at 1,447 feet from the initial impact point.

The Runway 36L Midpoint Transmissometer (18R Midpoint) is located about 160 degrees at 4,573 feet from the initial impact point.

The Runway 36L TD Transmissometer (18R RO) is located about 166 degrees at 7,520 feet from the initial impact point.

NWS Laser Beam Ceilometer (LBC) Trace...CLT

Attachment 8 is a copy of the LBC Trace. The trace showed a return at an elevation angle of 0 degrees from about 1833 through 1850. The NWS reviewed the LBC trace on July 11. According to the NWS, the trace between 1833 through 1850 was indicative of heavy rain. The heaviest rain occurred about 1840. The LBC is located near the NWS wind equipment. All times estimated chart times.

Weather Radar Data

The Bristol, Tennessee weather radar is a WSR-57 network radar. It is located about 92 nautical miles northwest of the Charlotte-Douglas airport on Holston Mountain at an elevation of about 5,000 feet. Attachment 9 is an excerpt of the Radar Observations form taken from the Bristol radarscope. The excerpt covers the period from 1526Z July 2, to 0031Z July 3, 1994. Attachments 10 - 14 includes radar overlays taken from the Bristol radarscope at 2032Z, 2134Z, 2225Z, and 2325Z July 2, and 0031Z July 3, 1994. Superimposed on the radar overlays are range rings which are depicted at 25 nautical mile intervals. The overlays cover a 250

nautical mile range from the radar site. Also superimposed on each overlay is a manually digitized radar (MDR) grid. Weather radar echoes are indicated by hand drawn areas which outline the observed echoes.

Manually Digitized Radar (MDR) data from Bristol, Tennessee for 2225Z and 2325Z are noted in Attachments 15 and 16.

Code Number	Echo Intensity
0	None
1	Weak
2	Moderate
3	Strong
4	Very Strong
5	Intense
6	Extreme

Each grid box is about 22 nautical miles on a side. The maximum observed intensity is reported for each grid box containing echoes of moderate or greater intensity. If light intensity is the greatest intensity observed in a grid box, it is reported only if more than 20 percent of the grid box is covered.

The Columbia, South Carolina WSR-88D Doppler weather radar is located about 186 degrees at 77 nautical miles from the initial impact point of the airplane. Attachments 17 - 25 includes the base reflectivity products from the Columbia WSR-88D radar. Each product is a four-panel color image. The images were taken at 2217Z, 2223Z, 2229Z, 2235Z, 2241Z, 2247Z, 2252Z, 2258Z and 2304Z July 2, 1994. In panels 1 through 4 the radar antenna elevation is set at 0.5, 1.5, 2.4, and 3.4 degrees, respectively. A template on which the approximate location of the initial impact point (noted by an X) and a polar grid with range rings = 10 nautical miles is included as Attachment A. True north is to the top of the images. The City of Charlotte is depicted and labeled "CLT". According to the NWS the position of the cities may not be accurate. Along the right side of each panel is a color coded legend covering the range of radar reflectivity values from 5-75 dBZ. According to the NWS the time on the images is the time of the start of the first elevation scan (.5 degrees).

Elevation Angle (degrees)	Beam Center (approximate feet)
0.5	8,400
1.5	16,500
2.4	23,900
3.4	32,000

Beam Width = about 7,800 feet at 77 nautical miles from Columbia.

A WSR-74C weather radar is located at CLT. Attachment 26 is an overlay for 2330Z from the CLT weather radar. Attachment 27 is a copy of the weather radar observations form from CLT. Attachment 28 is a plot of MDR values for 2330Z from the CLT radar.

Attachments 29 - 30 are charts which relate dBZ values to Video Integrator and Processor (VIP) values.

Low Level Wind Shear Alert System (LLWAS)

A LLWAS was installed and was operational at CLT the day of the accident. The system consists of 6 wind sensors that measure wind direction and speed. One of the sensors is located near the center of the airport while the others are located around the periphery of the airport. The system incorporates the six station enhanced LLWAS windshear/microburst detection software.

The following data were from the CLT LLWAS output listing obtained from the FAA.

Sensor Number 6 is north of runway 18R and is located about 3,150 feet from the end of the runway. Sensor Number 6 is located about 19 degrees at 4,352 feet from the initial impact point. The height of the sensor is about 60 feet above ground level. Wind direction is in degrees magnetic. According to the FAA LLWAS data times are 10 seconds fast. Attachment 31 is a plot of LLWAS wind sensor locations.

Sensor Number 6

Time	Wind Direction	Wind Speed (knots)
18:41:17	177	17
18:41:27	176	20
18:41:37	178	20
18:41:47	174	23
18:41:57	176	21
18:42:07	181	23
18:42:17	183	20
18:42:27	187	25
18:42:37	184	25
18:42:47	174	28
18:42:57	177	34
18:43:07	173	34
18:43:17	170	33
18:43:27	167	25
18:43:37	164	26

18:43:47	173	19
18:43:57	182	16
18:44:07	185	15

Wind vector plots based on a wind sample every 10 seconds for each wind sensor were developed by the FAA. The plots are included as Attachments 32 to 49. The time of the plots is in UTC. The directions are magnetic. One meter per second = about 2 knots.

Attachments 50 and 51 are plots of the LLWAS six sensor data for every 10 seconds. s1 = sensor #1, s2 = sensor #2, s3 = sensor #3, s4 = sensor #4, s5 = sensor #5, s6 = sensor #6.

A plot of the Along Track Wind Component (ATC) and the Cross Track Wind Component (CTC) in knots is contained in Attachment 52. CTC negative: left to right crosswind. CTC positive: right to left crosswind. ATC positive: headwind. ATC negative: tailwind. Data from LLWAS sensor number 1 and 6 used.

A plot of ATC using data from LLWAS sensor 1 and LLWAS sensor 6 is contained in Attachment 53. Sensor number 6 is located about 7,876 feet at 348 degrees from sensor number 1. Sensor number 1 is located about 139 degrees at 7,404 feet from the initial imapct point.

Lower Atmospheric Profiler (LAP 3000)

A Test Doppler Profiler was located at the airport. Data from the Profiler will be obtained and analyzed at a later time. The Doppler is owned by the State of North Carolina. The instrument will provide horizontal and vertical wind information from about 300 to above 1,000 feet above the ground for the volume of atmosphere above the beam center. The LAP is located about 700 feet southeast of the approach end of runway 23.

Location Plot

The following locations are noted in Attachment 54:

(1)...Initial Impact Point
(2)...LLWAS Station #1
(3)...LLWAS Station #2
(4)...LLWAS Station #3
(5)...LLWAS Station #4
(6)...LLWAS Station #5

(7)...LLWAS Station #6
(8)...NWS Office
(9)...Runway 36L TD Transmissometer
(10)...Runway 36L Midpoint Transmissometer
(11)...Runway 36L RO Transmissometer

Note: True North to Top of Plot.

Upper Air Data

LEVEL...Height Millibars
TEMP...Temperature Degrees C
DEW PT...Dew Point Temperature Degrees C
DIR...Wind Direction Degrees True
SPEED...Wind Speed Meters per Second
HEIGHT...Height Meters Above Mean Sea Level

Greensboro, North Carolina (72317)
1200Z

Greensboro is located about 71 nautical miles northeast of CLT.

STATION:72317 DAY/TIME:94183 120000 LAT/LONG:360833 799500

LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
987.0	20.6	20.4	270.0	1.0	270.0
925.0	21.6	16.6	250.0	8.2	834.2
850.0	15.6	14.5	245.0	6.1	1562.6
700.0	5.0	0.3	230.0	5.6	3184.0
500.0	-9.9	-30.9	220.0	7.7	5858.0
400.0	-22.5	-43.5	245.0	6.6	7538.4
300.0	-35.5	-53.5	345.0	6.6	9596.6
250.0	-43.5	-59.5	355.0	18.5	10844.9
200.0	-53.7	-67.7	10.0	41.1	12313.1
198.0	-54.1	-68.1	10.0	41.1	12375.9
151.0	-65.9	-77.9	350.0	15.4	14070.0
150.0	-65.7	-77.7	350.0	14.4	14110.4
100.0	-64.7	-76.7	210.0	2.5	16581.0
96.5	-63.9	-75.9			16799.0
55.2	-60.5	-73.5			20251.6
46.6	-54.5	-68.5			21321.8
37.2	-54.5	-68.5			22765.2
30.0	-50.1	-65.1			24157.2
10.1	-42.3	-59.3			31397.0

PARCEL: DEW PT.= 290.7 POT. TEMP= 304.0 EQUIV.POT.TEMP= 344.2 MIX= 14.4
PRECIP.WATER= 37.9 CONV.TEMP= 27.9 FCST MAX= 29.7 LIFTED INDEX= -5.1
TOTALS= 49.9 EQUIL.PRES.= 227.8 K-INDEX= 35.3 SWEAT INDEX=230.7

Greensboro, North Carolina

0000Z

STATION:72317 DAY/TIME:94184 000000 LAT/LONG:360833 799500

LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
985.0	25.6	22.3	150.0	3.6	270.0
978.0	25.6	21.2	157.4	3.7	333.1
941.0	23.0	19.6	197.4	4.0	672.5
937.0	23.6	13.6	201.8	4.0	709.8
925.0	22.4	14.4	215.0	4.1	822.4
915.3	21.6	12.2	215.0	4.6	914.0
911.0	21.2	11.2	216.3	4.7	955.0
894.0	20.4	17.8	221.7	4.9	1118.4
883.7	19.4	16.7	225.0	5.1	1219.0
871.0	18.2	15.3	218.9	5.5	1343.6
866.0	17.8	10.8	216.4	5.7	1393.0
852.8	16.3	11.5	210.0	6.1	1524.0
850.0	16.0	11.7	220.0	4.6	1552.5
843.0	14.8	9.8	213.6	4.6	1622.8
822.8	15.7	9.4	195.0	4.6	1829.0
812.0	16.2	9.2	178.4	4.0	1941.4
793.6	14.1	7.4	150.0	3.0	2134.0
765.3	10.8	4.5	110.0	2.5	2439.0
749.0	8.8	2.8	107.0	2.8	2620.5
738.0	8.2	3.0	105.0	3.0	2743.0
700.0	6.0	3.9	140.0	1.5	3179.0
659.7	3.3	1.2	20.0	1.0	3658.0
611.8	-0.2	-2.3	40.0	2.5	4268.0
584.0	-2.3	-4.5	132.5	2.5	4644.3
567.0	-3.1	-9.9	190.0	2.5	4878.0
545.7	-4.3	-16.9	235.0	6.6	5182.0
541.0	-4.5	-18.5	236.5	6.8	5249.9
500.0	-9.7	-23.7	250.0	8.7	5864.8
493.0	-10.3	-16.3	252.3	8.5	5973.6
485.1	-11.5	-17.0	255.0	8.2	6097.0
473.0	-13.5	-18.1	267.7	7.4	6291.1
468.0	-13.3	-24.3	273.0	7.0	6372.0
460.0	-13.1	-26.1	281.7	6.5	6503.4
447.8	-14.4	-28.4	295.0	5.6	6707.0
426.0	-16.7	-32.7	301.7	6.5	7084.8
421.0	-17.3	-25.3	303.2	6.7	7173.4
414.0	-16.3	-31.3	305.4	7.1	7299.4
405.0	-15.5	-34.5	308.4	7.5	7465.2
400.0	-16.1	-35.1	310.0	7.7	7558.9
396.7	-16.4	-35.4	310.0	8.2	7621.0
380.9	-18.2	-37.2	325.0	8.7	7926.0
376.0	-18.7	-37.7	324.2	8.8	8022.7
322.0	-28.9	-45.1	315.0	9.7	9146.0
300.0	-33.5	-48.5	310.0	9.7	9657.5
295.7	-34.3	-49.1	310.0	9.2	9756.0
258.9	-42.1	-54.6	320.0	14.9	10670.0
250.0	-44.1	-56.1	325.0	13.3	10909.6
215.2	-51.5	-62.1	330.0	5.6	11890.0

200.0	-55.1	-65.1	335.0	7.2	12371.3
186.8	-58.4	-67.6	340.0	10.2	12804.0
184.0	-59.1	-68.1	340.0	9.9	12899.1
177.8	-60.3	-69.1	340.0	9.2	13109.0
169.3	-62.0	-70.6	315.0	6.6	13414.0
161.1	-63.8	-72.1	285.0	11.8	13719.0
150.0	-66.3	-74.3	295.0	19.5	14158.9
138.6	-67.8	-75.8	315.0	30.3	14634.0
126.0	-69.7	-77.7	330.0	27.2	15207.0
117.0	-63.7	-72.7	351.4	19.1	15655.3
102.5	-65.7	-73.9	30.0	4.6	16463.0
100.0	-66.1	-74.1	25.0	3.6	16613.3
94.9	-67.3	-75.3			16930.0
86.1	-67.5	-75.5			17516.7
58.9	-58.7	-68.7			19853.4
50.0	-60.3	-70.3			20879.0
38.4	-53.9	-64.9			22550.0
32.7	-55.1	-66.1			23579.5
20.0	-48.9	-60.9			26765.4
19.4	-48.1	-60.1			26965.9

PARCEL: DEW PT.= 290.4 POT. TEMP= 301.8 EQUIV.POT.TEMP= 340.9 MIX= 14.1
PRECIP.WATER= 38.0 CONV.TEMP= 32.6 FCST MAX= 0.0 LIFTED INDEX= -3.6
TOTALS= 47.1 EQUIL.PRES.= 245.9 K-INDEX= 35.3 SWEAT INDEX=175.2

Terminal Forecast (FT)

CLT...1300 to 2100 (CLT FT 021717)
5,000 feet scattered; visibility 5 miles, haze; occasional ceiling 5,000 feet broken; visibility 6+ miles; slight chance ceiling 2,000 feet broken; visibility 2 miles; thunderstorm, moderate rain showers after 1600.

The FT was issued about 1231 by the NWS Forecast Office in Raleigh Durham, North Carolina (RDU).

The forecast was amended at 1845.
The amended forecast valid 1845 to 2000 is as follows...

Ceiling 4,500 feet broken; visibility 6 miles; thunderstorm, light rain showers, haze; winds 200 degrees at 10 knots; occasional ceiling 1,000 feet overcast; visibility 1 mile; thunderstorm, heavy rain showers; wind gusts 25 knots.

Area Forecast (FA)

The following information pertinent to the accident is contained

in the NWS FA (MIA FA 021812 AMD) issued July 2/ 1412 and valid until July 3/ 0200 is as follows:

Thunderstorms imply severe or greater turbulence, severe icing, low level wind shear, and IFR conditions.

NC
Piedmont...Clouds 2,500 to 3,500 feet scattered; visibility 4 to 6 miles; haze. 1600...Clouds 3,000 to 3,500 feet scattered to broken; tops 8,000 feet; visibility 4 to 6 miles; haze / isolated thunderstorms, moderate rain showers; cumulonimbus tops to 40,000 feet.

The FA was issued by the National Aviation Weather Advisory Unit (NAWAU) in Kansas City, Missouri.

In Flight Weather Advisories

The following AIRMETs (WAs) issued at 1545 were pertinent to the accident:

AIRMET Sierra Update 3 for IFR valid until 2200...
No widespread IFR expected.

AIRMET Tango Update 3 for Turbulence valid until 2200...
No significant turbulence expected except in the vicinity of convective activity.

AIRMET Zulu Update 3 for Icing valid until 2200..
No significant icing expected outside convective activity.

There were no Convective SIGMETS, SIGMETS, or Atlanta Air Route Traffic Control Center (ZTL) Center Weather Advisories in effect for the time and area of the accident.

AIRMETs, SIGMETs, and Convective SIGMETS are issued by the NAWAU.

Aviation Weather Watch (AWW)

There were no AWWs (severe thunderstorm and tornado watches) in effect for the time and area of the accident.

AWWs are issued by the National Severe Storms Forecast Center in Kansas City, Missouri

Meteorological Impact Statement (MIS)

The following MIS (in part)issued by the ZTL Center Weather

Service Meteorologist is as follows..
ZTL MIS 01 valid 0935 to 2135...
Widely scattered level 3 to 5 thunderstorms developing after 1400. Movement from 250 degrees at 10 knots..Maximum tops 45,000 to 50,000 feet. The area encompassed by this MIS included CLT (See Attachment 55).

This information was transmitted to the CLT Terminal Radar Approach Control (TRACON).

Dispatch Document

The weather information contained in the Dispatch Document for USAir Flight 1016 included the 1651 Columbia, South Carolina (CAE) surface weather observation and the CAE forecast prepared by Kavouras Inc., Minneapolis, Minnesota; the 1651 CLT surface weather observation (in part) of 5,000 feet scattered, visibility 6 miles in haze; and a forecast for CLT prepared by Kavouras of 4,000 feet scattered, 25,000 feet broken; occasional 4,000 feet broken; visibility 4 miles; thunderstorm, light rain showers. The forecast was valid for the time of the accident. The forecast was issued at 0817.

Interviews

1) The Meteorological Technician at the CLT NWS office was interviewed in person on July 3, 1994. The following is a summary of that interview:

The Meteorological Technician was on duty from 1600 to midnight the day of the accident. He has been at CLT since 1983. His duties include taking and disseminating surface weather observations, monitoring the weather radar (WSR-74C), issuing severe thunderstorm and tornado warnings, and disseminating information on NOAA Weather Radio. He made and disseminated the following weather observations: the hourly observation at 1751, the special observation at 1836 and 1840 and the hourly observation at 1850. Between 1836 and 1840 he was notified by the CLT Tower that the visibility was down to 1 mile. The Meteorological Technician agreed with the 1 mile visibility report. Prior to the call the visibility reported was 6 miles in a thunderstorm with light rain showers and haze. At 1840 the visibility was reported as 1 mile. The Technician stated that the thunderstorm that developed at 1833 developed overhead the field and was moving to the north. He was surprised by the "clap" of thunder because the convective activity was decreasing in the area between 1600 and 1800. There was not much lightning associated with the thunderstorm.

He stated that the center of the thunderstorm appeared to be between the Air Traffic Control Tower and the Weather Office. The heavy rain shower was uniform in all directions. Between 1800 and 1850 he was not working the weather radar because he was making surface weather observations. He did not know the intensity (VIP level) of the thunderstorm over the field. He stated that the 1 mile visibility value was uniform in all directions

The Technician makes surface weather observations and disseminates the observations first longline on the Automation of Field Operations and Services (AFOS) and than on AWIS to local interests which includes the CLT Tower. The thunderstorm at the time of the accident was not unusual. It was a typical summertime thunderstorm.

There were no reports of severe weather associated with the thunderstorm. The Technician made a weather radar observation at 1930. He indicated a VIP level 3 (strong) echo north of CLT. He stated that the top was about 20,000 feet.

All equipment was operating satisfactorily. The station time clock was checked and found to be within 5 seconds of the National Bureau of Standards clock in Boulder, Colorado. There were no problems with communications. There were no severe weather warnings in effect. The office has no aviation forecast/ warning/ advisory responsibilities. There was no contact between the ZTL Center Weather Service Unit Meteorologist and the CLT weather office. He stated that the spike on the transmittance trace (converts to RVR) for runway 05 and 36L was not a common occurrence.

Interviewers:

Kneas
Head
Zindars
Garbee
Salottolo

2) The Center Weather Service Meteorologist at the ZTL Center Weather Service Unit (CWSU) was interviewed by phone on July 5, 1994. The following is a summary of that interview:

He is the Meteorologist in Charge (MIC) of the unit. He has been at the ZTL CWSU since 1978. He has been a MIC for 12 years. The day of the accident he worked the 1400 to 2200 shift. Except for the first 30 minutes of overlap he was the only one on shift. His duties and responsibilities include providing weather support to center personnel and other Federal Aviation Administration (FAA) facilities. This would include information on severe weather including thunderstorms/ icing/ turbulence. He verbally briefed

the FAA facility at CLT at 1508 and then the Atlanta TRACON facility a few minutes later. He than faxed a document to the CLT TRACON containing a chart depicting significant weather in the ZTL area and a forecast for CLT indicating an isolated ceiling 1,000 feet overcast, visibility 1 mile, in a thunderstorm, heavy rain showers with a gust to 45 knots in the vicinity. For the general ZTL area the document indicated isolated level 4 to 5 thunderstorms tops to 45,000 to 50,000 feet. See Attachment 56.

He had a stand up briefing for center personnel at 1610. The briefing indicated scattered thunderstorms eastern and southern ZTL boundaries with isolated thunderstorms elsewhere. After the briefing he went about his normal task of Met Watching the airspace.

At the time of the accident he was reviewing data from the Maxwell Air Force Base NEXRAD (Doppler Radar) to provide weather assistance to the Columbus, Georgia FAA facility. The more organized activity appeared to be in the Columbus area. There were some VIP level 4 (Very Strong) echoes in this activity. In the period after the stand up briefing he had several contacts with other FAA facilities in the ZTL area including, TCL, ATL, BHM, MGM, and CSG, to discuss thunderstorm activity.

TCL...Tuscaloosa, Alabama
ATL...Atlanta, Georgia
BHM...Birmingham, Alabama
MGM...Montgomery, Alabama
CSG...Columbus, Georgia

At 1843 he was contacted by an individual from the Traffic Management Unit at the Center regarding thunderstorm development in the CLT area. The Radar Remote Weather Display System (RRWDS) with the Athens, Georgia Weather Radar selected showed a small level 1 to 2 cell near CLT. Selecting the FAA Maiden, North Carolina site a level 2 cell was displayed near CLT. At 1853 he called the CLT TRACON to advise of a level 3 cell north of the airport. At this time the Maiden radar indicated a VIP level 3 cell while the Athens radar indicated a VIP level 2 cell. The diameter of the cell was about 2 miles. The reason he did not call the CLT FAA facility prior to 1853 was that up until that time he did not notice anything of significance in the CLT area. According to the MIC the more significant and organized thunderstorm activity was in the southern portion of the ZTL area.

At 1858 he was advised of the accident. There were no Center Weather Advisories in effect for the ZTL area. The thunderstorm activity did not meet issuance criteria. Criteria for issuing CWAs are specified in Weather Service Operations Manual Chapter D-25. He stated that a CWA can be issued for a lone severe thunderstorm but not usually issued for a lone level 3

thunderstorm even if it is over a major airport. However, he would normally give the Tower a call if he observed a VIP level 3 weather echo in the airport area. All equipment was operating satisfactorily except the weather radar mosaic product the operation of which was questionable.

Equipment at the CWSU includes:
RRWDS.
NEXRAD Principal User Processor (PUP).
Meteorological Weather Processor (MWP).
The MWP displays on a CRT terminal, satellite, weather radar data, graphics, alpha/ numeric, and lightning data.
Remote Terminal to AFOS (RTA).
RTA used to access alpha/ numeric data.

Interviewers:

Kneas
Salottolo

3) The Aircraft Dispatcher who was responsible for the dispatch of USAir Flight 1016 was interviewed by phone on July 5, 1994. The following is a summary of that interview:

He has been an aircraft dispatcher since 1987. A weather document was prepared by USAir Dispatch in Pittsburgh, Pennsylvania for Flight 1016. The Dispatcher has joint responsibility with the Captain in the flight planning and release of the aircraft. He is responsible for issuing information to the Flight Crew on significant weather which includes information on thunderstorms/ turbulence/ icing. He obtains weather information from the NWS and a private weather company - Kavouras, Inc. of Minneapolis, Minnesota. This information includes data from individual weather radar sites throughout the country as well as the National Composite Radar.

Prior to the dispatch of 1016 he reviewed all meteorological information available at the time. Prior to the departure of Flight 1016 from Columbia, South Carolina (CAE) he looked at the radar summary chart and the CAE and CLT weather radar sites. Most of the weather appeared to be in eastern North Carolina between CLT and Wilmington, North Carolina. After the accident at about 1851 he observed on the CAE weather radar site a very small VIP level 3 echo approximately the size of a "pencil head" just north of CLT. He had no contact with Flight 1016 after departure from CAE.

There were no amendments made to the flight release. After the departure of Flight 1016 from CAE at no time was he aware of thunderstorms developing in the CLT area. The workload was

moderate to high. He was responsible for 15 flights. In the past he has sent messages to crews regarding thunderstorm activity at destination airports.

Interviewers:

Kneas
Garbee
Zindars
Salottolo

4) The Meteorologist at the Bristol, Tennessee NWS Office was interviewed by phone on July 6, 1994. The following is a summary of that interview:

He worked the 1600 to midnight shift. There were 2 people on shift. One was responsible for the surface weather observation program and the other was responsible for operating the weather radar. He was responsible for operating the weather radar. He was at the weather radar console at 1842 and he observed a VIP level 3 weather echo approximately over CLT. The tops were less than 30,000 feet. There was no indication that the cell over CLT was producing or was going to produce severe weather. There were a lot of isolated cells about 20 miles apart observed during that period. The radar was operating up to performance standards. No cells that evening produced severe weather in the classical sense.

Interviewers:

Kneas
Salottolo

5) The Convective SIGMET Meteorologist at the NAWAU in Kansas City, Missouri was interviewed by phone on July 6, 1994. The following is a summary of that interview:

He worked the Convective SIGMET desk from 1600 to midnight. He was the only person working the desk; this is normal procedure. He issues hourly Convective SIGMETS for hazardous thunderstorms for the country. The criteria for issuance are contained in Weather Service Operations Manual Chapter D-22. There were no Convective SIGMETs in effect for the area of the accident. There was nothing there that would have met criteria for issuance. It was a very busy day with a lot of severe weather watches out. He has been at the Convective SIGMET unit for 10 years.

****Issuance Criteria for Convective SIGMETS******
a) Severe thunderstorms
b) Embedded thunderstorms

c) A line of thunderstorms
d) An area of active thunderstorms affecting at least 3,000 square miles. Active thunderstorms are defined as thunderstorms having a VIP level (i.e. a reflectivity intensity) of 4 or greater and/or having significant satellite signatures and affecting at least 40 percent of the area outlined.

Interviewers:

Kneas
Head
Salottolo

6) The National Resource Meteorologist at the Jacksonville Air Route Traffic Control Center (ZJX) Center Weather Service Unit (CWSU) was interviewed by phone on July 18, 1994. The following is a summary of that interview:

The Meteorologist has been at the ZJX CWSU for 2 1/2 years. He worked the 1400 to 2200 shift the day of the accident. He was the only one on shift except for a 30 minute overlap with the other meteorologist at the beginning of the shift. Subsequent to starting his shift he was routinely issuing radar and SIGMET updates between 10 to 15 minutes before the hour througout the ZJX. There were no Center Weather Advisories in effect for South Carolina at the time of the accident. He had no contact with the ZTL CWSU Meteorologist during his shift. If weather develops on the ZJX/ZTL boundary he coordinates with the ZTL CWSU Meteorologist. Weather in the CLT area late in the day and evening consisted of widely scattered level 2 (moderate) and level 3 (strong) weather echoes.

Interviewers:

Kneas
Salottolo

7) The Meteorologist (Journeyman Forecaster) at the NWS Forecast Office at Raleigh Durham, North Carolina was interviewed by phone on July 20, 1994. The following is a summary of that interview:

The Meteorologist worked the 1600 to midnight shift the day of the accident. He has been a Meteorologist for 6 1/2 years. He has been ar Raleigh Durham for 8 1/2 years and a Forecaster for about 2 years. He was working the aviation desk. His duties include maintaining an aviation weather watch of 11 terminal forecast sites including CLT. He was the only WSR-88D trained person on shift. Monitoring the WSR-88D for severe weather was his top priority. There is a WSR-88D at Raleigh Durham. However, it was

out of service the day of the accident due to a lightning strike sustained on June 29, 1994. The day of the accident he was obtaining data on the WSR-88D PUP from Moorehead City and Columbia, South Carolina (CAE). He was mainly using the Moorehead City site. Between 1600 and 1800 he did not observe any activity near CLT. At 1829 he called up the CAE WSR-88D on the PUP and noted isolated activity near CLT and Greensboro. He said there were three cells near CLT and Greensboro. From what the CAE WSR-88D radar showed at the time it was not that heavy at CLT - about a 40 DBZ core. He was aware of the 1836 special observation from CLT and felt the current Terminal Forecast for CLT was basically correct. Having received the 1840 special from CLT and after reviewing the radar and satellite data he decided to amend the CLT Terminal Forecast. The amendment was disseminated at 1845. At the time of the accident the WSR-88D PUP was set to Moorehead City and was indicating a 15 to 20 DBZ echo with a few pixels over CLT. At about 1911 the Meteorological Technician at the Weather Service Office at CLT called the forecast office about a possible aircraft accident.

The only aviation responsibility of the forecast office to CLT is the Terminal Forecast. However, one of the Transcribed Weather Broadcast (TWEB) routes has as one of its points CLT. A Local Aviation Weather Advisory is issued for the airport at Raleigh Durham. There is no requirement to issue the advisory for any other airport. If significant weather is indicated by the WSR-88D the forecaster would coordinate with the affected Weather Service Office at an airport. He would be more concerned about significant weather approaching the airport at Greensboro than CLT because Greensboro does not have a weather radar. A weather radar is at CLT. He never has called the Tower or TRACON at CLT. There is no requirement to do this. The day of the accident he did not talk to the ZTL CWSU Meteorologist. There were no Severe Weather Warnings or Special Weather Statements in effect for the CLT area that evening.

Interviewers:

Kneas
Salottolo

8) The Resource Meteorologist at the Air Traffic Control System Command Center in Herndon, Virginia was interviewed by phone on July 25, 1994. The following is a summary of that interview:

She has been a meteorologist for about 17 years. She has been at the Command Center for about 7 years. The day of the accident she worked the 1330 to 2130 shift. There were two meteorologists working at the time. She is responsible for keeping FAA personnel in the System Command Center apprised of weather that may have an impact on air traffic throughout the air traffic control system. She tries to provide a 2 to 4 hour lead time for any weather

expected to impact operations including operations at major airports. Weather of importance includes thunderstorms, low ceilings, and wind shifts. CLT is considered a major airport. One concern for CLT would be low ceilings and visibilities occurring during the early morning. However, she doesn't forecast specifically for each airport. She doesn't "detail each airport." She is concerned about lines and "big" clusters of thunderstorm cells that would impact air routes. She does not issue advisories for any of the major airports. She copies and outlines Severe Weather Watch Areas and passes the information to the appropriate areas within the System Command Center. She also calls the affected ARTCC. She was not sure if she contacted either the ZTL or ZJX CWSU the evening of the accident. She became aware of the accident within 5 to 10 minutes of the accident. She did not remember the weather conditions at CLT at the time of the accident. She had no contact with any of the FAA facilities at CLT.

Interviewers:

Kneas
Salottolo

9) Mr. Robert England called the NTSB and stated that his aunt and uncle had witnessed the crash of USAir Flight 1016 at Charlotte, North Carolina on July 2, 1994. Mr. England was called on August 10, 1994 and he gave the following information (summarized):

Mr. Jimmy England
[redacted]

-Mr. and Mrs. England were driving near the airport and the weather got "really bad" and they pulled over at the airport observation area. The observation area is located just west of the approach end of Runway 18R.

-When they pulled over they were able to see the tower and airplanes on the taxiway. The weather deteriorated to the point that they could not see the tower or the airplanes.

-Mr. English had rolled his window down and turned to his right. The accident airplane flew directly over their truck and crashed about 150 yards behind them.

-He described the weather as "really bad" and estimated that the winds were blowing 50-60 miles per hour and the trees to his left were bent over at about a 45 degree angle. He said it was like a "mini hurricane." He stated that the wind was from an easterly

direction. His truck was rocked by the wind. He stated that twigs were blown off trees.

-He said the rain and wind lasted about 5 minutes.

-They drove down to within 1/8th of a mile from the accident site but were prevented from getting closer because there were live wires down. From where they stopped, they could see survivors exiting the wreckage.

Interviewers:

Salottolo
Marshall NTSB AS-60

Interview Notes of Weather Group Member Gary Zindars

THERESA EDWARDS

[redacted]

THE WITNESS STATED SHE WAS DRIVING ON WALLACE NEEL ROAD WHEN SHE SAW A HUGE BALL OF LIGHTNING WHICH SHE BELIEVED TO BE VERY CLOSE. VERY SHORTLY AFTERWARD SHE HEARD THUNDER AND DESCRIBED IT AS ROLLING.

SHE DESCRIBED THE SKY CONDITIONS AS A VERY GRAY. VERY HEAVY RAIN STARTED LIMITING HER VISIBILITY. THE WITNESS SAID SHE DROVE ABOUT 1/4 MILE AND THE RAIN STOPPED. SHE STATED THE WIND WAS BLOWING RAIN INTO HER CAR AS SHE DROVE INTO THE WIND AND RAIN.

THE WITNESS STATED SHE WAS SITTING WITH HER HUSBAND WHO WAS DRIVING A 1976 4 WHEEL DRIVE PICK UP TRUCK AND THE WIND WAS CONTINUOUSLY AFFECTING THE TRUCK WHICH WAS LOADED WITH PLUMBING SUPPLIES.

THE WITNESS STATED THEY CAME UPON THE ACCIDENT SITE AND THE RAIN CEASED. THE WIND WAS BLOWING THE SMOKE FROM THE ACCIDENT TO HER LEFT. SHE STATED SHE NOTICED A DROP IN TEMPERATURE.

RALPH EDWARDS

[redacted]

THE WITNESS STATED THE WIND CAME FROM THE NORTHWEST AND BUFFETED HIS TRUCK LIKE YOU FEEL WHEN YOU PASS A SEMI TRAILER ON THE HIGHWAY. HE STATED THERE WAS A DEFINITE TEMPERATURE CHANGE. HE SAID STORM CLOUDS MOVED RIGHT TO LEFT. TO THE LEFT WAS LIGHT PUFFY CLOUDS. THE WITNESS SAID THERE WERE LOTS OF LEAVES BLOWING ACROSS THE ROAD. HE BELIEVED THE STORM MOVED FROM NORTH / NORTHEAST TO SOUTH /SOUTHWEST.

KEN RUSHING

[redacted]

WITNESS WAS LOCATED IN A PARKING LOT OF DUKE POWER. HE STATED HE NOTICED A STORM COMING BUT THEN IT HIT UNEXPECTEDLY. STATED HE JUMPED INTO CAB OF SERVICE TRUCK (BUCKET).

WHILE IN THE CAB OF THE TRUCK THE WITNESS STATED IT RAINED SO HARD HE COULD NOT SEE THE HOOD OF HIS TRUCK AND COULD FEEL THE TRUCK ROCKING FROM THE WIND.

THE WITNESS STATED THE STORM LASTED APPROXIMATELY 20 MINUTES WITH HEAVY RAIN AND WIND LASTING ABOUT 10 MINUTES. HE STATED HE DID NOT OBSERVE LIGHTNING BUT MAY HAVE HEARD THUNDER . HE STATED THE RAIN BEGAN IN A DOWNPOUR AND IT SEEMED TO GET VERY COOL.

THE WITNESS STATED THAT WHEN THE RAIN STOPPED IT WAS SUNNY BUT STILL VERY DARK AND RAINY TO THE WEST. HE STATED THE STORM SEEMED TO COME FROM THE SOUTHEAST AND MOVE NORTHWEST.

SHERRY HUDSON

[redacted]

THE WITNESS STATED SHE WAS LOCATED AT THE DEAD END OF NEWELL ROAD STANDING BESIDE CAR WHEN IT CLOUDED UP BIG DROPS OF RAIN STARTED FALLING AND THEN SUDDENLY THERE WAS A DOWNPOUR.

SHE GOT IN HER CAR AND THE HEAVY RAIN LASTED ONLY 2-3 MINUTES. SHE STATED SHE MAY HAVE HEARD THUNDER BUT DID NOT OBSERVE LIGHTNING.

SHE LEFT THIS LOCATION AND DROVE INTO THE ACCIDENT SITE WHERE IT WAS RAINING LIGHTLY AND MAY HAVE BEEN COOLER. SHE STATED SHE DID

NOT USE HER WINDSHIELD WIPERS.

NOTE: SHE DRIVES A BLUE ELDORADO CADILLAC AND STATED SHE DIALED 911 WHEN SHE ARRIVED UPON THE ACCIDENT SITE

BILL SEGRAM

[redacted]

WITNESS REPORTED HE WAS STANDING UNDER AN OVER HANGING ROOF WHICH EXTENDED APPROXIMATELY 35 YARDS TO THE WEST OF HIS POSITION . HE COULD CLEARLY SEE USAIR 1016 ON FINAL APPROACH. THE AIRCRAFT SEEMED TO APPLY POWER AND START A CLIMBING RIGHT TURN. SHORTLY AFTER THIS OBSERVATION THE AIRCRAFT AND THE NOISE FROM THE ENGINE DISAPPEARED INTO A WALL OF WATER.

THE POSITION OF THIS WITNESS, AS I OBSERVED AT THE JOB SITE WAS APPROXIMATELY 1/2 MILE EAST OF THE FINAL APPROACH TO RUNWAY 18R AND APPROXIMATELY ONE MILE FROM THE RUNWAY.

WITNESS STATED HEAVY RAIN CAME VERY SUDDENLY ACCOMPANIED BY 30-40 MPH WINDS. THIS LIMITED VISIBILITY TO THE VEHICLES IN THE COMPANY PARKING LOT AND BLEW TRASH CANS AND BOXES FROM THE LOADING DOCK WHERE HE WAS STANDING.

HE DESCRIBED THE SKY CONDITIONS AS GOOD AS HE LOOKED OUT AT THE AIRCRAFT ON FINAL APPROACH . THERE WERE A FEW LIGHT COLORED CLOUDS IN THIS DIRECTION BUT THE SUN WAS SHINING IN THE DIRECTION AND TO THE EAST.

HE STATED HE OBSERVED NO HAIL BUT DID EXPERIENCE A COOLING OF TEMPERATURE DURING THE STORM.

THE WITNESS STATED THE RAIN CAME SUDDENLY, LASTED APPROXIMATELY 15-20 MINUTES.

LATER DRIVING WILKERSON BOULEVARD , HE STATED THERE WERE LEAVES AND SMALL LIMBS COVERING THE ROAD. WLIKINSON BOULEVARD LIES UNDER THE FINAL APPROACH OF RUNWAY 18R...

Interview Notes of Weather Group Member Howard Garbee

RICK DEVAULT
AGENT USAIR RAMP TOWER
DOUGLAS INTLERNATIONAL AIRPORT
CHARLOTTE NORTH CAROLINA
[redacted]

LOCATION - RAMP TOWER

1. AT APPROXIMATELY 1830 NOTICED HEAVY RAIN /LIGHTNING OVER C CONCOURSE MOVING TOWARD B CONCOURSE AND THEN 18R
2. NOTICED HEAVY RAIN (WHICH HAD A DURATION OF 15-20 MINUTES)
3. DRIZZLE (5-10 MINUTES)
4. CLOUD TO CLOUD LIGHTNING
5. GUSTY WIND
6. CLOSED RAMP DUE TO LIGHTNING AT APPROXIMATELY 1830 FOR 20 MINUTES.
7. POOR VISIBILITY

ED EGAN- RAMP SUPVISOR (GATES B10-12-14-16)
USAIR
DOUGLAS INTERNATIONAL AIRPORT
CHARLOTTE NOTH CAROLINA
HOME PHONE [redacted]
LOCATION GATES B10-12-14-16

1. RAIN STARTED AT APPROXIMATELY 1830 (15-20 MINUTE DURATION)
2. HEAVY RAIN
3. THUNDER
4. LIGHTNING (CLOUD TO CLOUD)
5. LOTS OF STANDING WATER ON RAMP ONCE RAIN STOPPED
6. CLEARED UP QUICKLY
7. RAMP CLOSED 1830 (CLOSED FOR 15-20 MINUTES)
8. WIND ESTIMATE 30-35 MPH

DON DUNLOP
HERTZ RENT A CAR
DOUGLAS INTERNATIONAL AIRPORT
CHARLOTTE NORTH CAROLINA
[redacted]

LOCATION : HERTZ RENT A CAR DROP OFF AREA NEAR RUNWAY
1. RAIN HEAVY (HARD TO WALK THRU PARKING LOT)
2. WINDS 28 - 33 KNOTS (ESTIMATED USING BEAUFORD SCALE)

3. STRONG WINDS
4. 5-10 MINIUTE DURATION
5. SOME LIGHTNING
6. VERY LITTLE (IF ANY) THUNDER

CHERYL TORRENCE
"LADY IN WHITE CAR" THAT DROVE THRU CRASH
[redacted]

1. WHEN SHE LEFT HOME IT WAS NOT RAINING
2. WHEN SHE PASSED THE CONVENIENCE STORE ON WALLACE NEEL ROAD SHE RAN INTO HEAVY RAIN/POOR VISIBILITY
3. CONTINUED TO DRIVE (VERY HARD TO SEE)
4. HEAVY RAIN (15-20 MINUTES)
5. WINDS 22 - 33 KNOTS (ESTIMATE BASED ON BEAUFORD SCALE)
6. NO THUNDER
7. SOME LIGHTNING EARLY PART OF STORM
8. GUSTY WIND

TRIPP WOOD
[redacted] (APPROXIMATELY 1200 YARDS FROM CRASH SITE)
[redacted]
PILOT (ATP/COMMERCIAL)

1. APPROXIMATELY 1841 HEARD HEAVY WIND
2. OBSERVED TWO/THREE SHEETS OF HEAVY RAIN
3. 15-20 SECONDS DURATION
4. NO PUDDLES OF WATER (AFTERWARDS)
5. LEAVES/GRASS BLOWN WESTWARD AND THEN STRAIGHT UP (AS HIGH AS TREE TOPS)
6. GOOD VISIBILITY
7. SOME THUNDER (PRIOR TO CRASH)
8. NO LIGHTNING
9. MOMENTARY DARKNESS

Interview Notes of Weather Group Member Christopher Head

Captain Norman Allen CCAir Flight #5211 first aircraft behind 1016 on approach to 18R - Shorts 360
[redacted]

First Officer Rich Blevens was flying. The flight was 37 nautical miles from Hickory, North Carolina (HKY) to CLT. Good VFR (Visual Flight Rule) conditions with widely scattered (cumulonimbus') CB's and (thunderstorms and rain showers) TRW's.

ATIS (Automatic Terminal Information Service) had given the visibility as 1 mile with light rain showers. As they were flying in toward the airport, the radar showed a small cell slightly south, southeast of the airport center. The radar showed the heavest rain slightly east of the airport center, with a band of heavy rain showers extending west toward the airport boundry, northwest past the threshold of 18R to the airport boundry and south to the mid point of 18R. This radar information was confirmed visually by the flight crew that had good visibility prior to penetrating the precipitation, and could see the side boundries of the precipitation. The radar (on high gain) painted some red color in the cell to the east of 18R. The general impression of the Captain was that there was not a problem with this rain shower as they approached the runway. They had originally briefed the approach as a visual, what they were told to expect from approach control.

The Captain heard the LLWAS alert issued from the tower, but understood it to say that it was the northwest boundary sensor showing 90 degrees from the center field wind (the alert issued stated the northeast boundary). This alerted him to the possibility of wind shear during his approach.

At approximately 3 miles from the runway, he considered and briefed the First Officer (F/O) that if an escape were needed that the best way to exit the rain was a right turn. He based this on what the radar was showing him as well as his being able to see the boundry of the rain to the right.

They entered the precipitation that went from virtually none to moderate to heavy almost immediately. The ride had been smooth until they penetrated the precipitation, and went to moderate turbulence in the rain shower. The turbulence seemed to increase the lower they went. They could not classify it as severe, but it did increase as they descended.

They initiated a go around after the tower instructed them to. The Captain was already considering a go around when the tower instructed them to. By now the visibility in the shower was almost nil and the turbulence was increasing as they descended. They started the go around at approximately 600 feet above ground level. In commanding the go around, the Captain set Maximum Top power (standard in a missed approach procedure) while the First Officer rotated to approximately 8 1/2 degrees. Although the Captain sensed no unusual speed during the approach, and the aircraft was approximately 3,500 pounds less than maximum landing weight, the airspeed on the go around was observed to be 145 knots (normal for this situation should have been 130 knots). When the Captain noticed this, he instructed the F/O to increase pitch, hoping to increase performance of the go around. He believed that the excess speed was caused by the F/O not rotating to the correct pitch for the go around.

During their penetration of the precipitation, they briefed that the quickest way out of the rain was a slight right turn. When they initiated the go around, they followed that path and broke out of the heavy precipitation approximately 1/2 mile to the west and 1/3 of the way down the runway. Turbulence ended as they emerged from the precipitation, and the remainder of the

climb was unremarkable. As they turned to a 180 heading, they noticed that the southern end of 18R was in sunlight.

First Officer Richard Blevens
CCAir Flight 5211
Flying pilot of first airplane behind 1016.

Flight from Hickory, North Carolina to CLT (approximately 37 nautical miles) on the Shine arrival. The ATIS has mentioned a rain shower on the field, so the crew briefed for a visual approach backed up by the ILS to 18R. The tower gave them vectors to join the approach and gave the visibility of 1 mile with wind gusts to 18 knots. As they approached the airport, he observed the storm in the airport vicinity, and was painting the cell on the radar. The storm appeared as a small echo approximately 3 miles across that was showing as mostly red on the radar. The radar showed some additional small scattered cells further to the south of the airport.

They joined the localizer approximately 15 miles out on the approach. They noticed that the radar echo was showing the storm just to the north of the airport, with the entire echo showing red with a small fringe of yellow. They determined that a right turn would get out of the precipitation the quickest, because most of the storm was to the east of the runway. The visibility to the west was good, but very limited to the east and none at all to the south through the precipitation. He describes the rain as " a sheet or granite wall of water, solid and very white looking." He described the rain shaft on the right (west) side of the storm as "a cliff of water." He was unable to determine the extent of the shower to the east, because of the restricted visibility to that direction.

As they joined the Glide Slope (G/S), he was configured (except the props and final flaps) and slowing. They heard the LLWAS alert and he heard the radio exchange between the tower and 1016, with 1016 requesting a right turn on the go around. They entered the precipitation about 5 - 7 miles out. The ride had been smooth until entering the precipitation, and then they encountered light turbulence in the shower.

Because the rain was very intense,"never in precip that hard in an airplane" and the USAir had requested a go around, they were in the process of making the decision to go around when the tower instructed them to do so. The Tower's instructions included a straight out departure, but the F/O asked the Captain to request the right turn to get out of the precipitation.

They initiated the go around, with the props in high RPM and the pitch rotating to the command bars for a go around. The engines were producing Max Top power (higher than for takeoff and normal in a go around). They continued straight ahead through the precipitation "intense pelting rain with a conservative

estimation of moderate turbulence" 600 feet to 800 feet AGL. With the nose up in the command bars, the airplane did not climb. The airspeed was observed by the F/O to reach 160 knots (should normally be around 130 knots), and the Captain commanded to pull the nose up. The F/O replied that the nose was up into the command bars, but the airplane was not climbing.

A few seconds later (30 to 40) they popped out of the precipitation, which stopped suddenly along with the turbulence. The visibility improved dramatically as they emerged from the precipitation, and they were able to see the tower complex, and noticed that they were slightly west of the runway 18R.

First Officer Tom Carter
USAir Flight 806
Aircraft waiting on the hold line of 18R facing West.

Flight 806 pushed in sunshine from B-3 at 2232Z. During the pushback, the F/O noticed two strikes of cloud to ground lightning about 15 seconds apart, to the east southeast of the field. They made a remark about the lightning. They taxied to Spot 2 and noticed that to the west and north there were only scattered clouds. As they continued on E-12 he saw the "wall of water" approaching from the south, about 1/3 of the way up 36L. He described the wall of water as "like Moses parting the Red Sea in the movie." He did not notice the west boundary of the precipitation, but did see that it extended past the western boundary of the airport. There was no visibility through the precipitation. He made a radio call to the tower that there was a thunderstorm over the airport.

He didn't see USAir 983 until he passed by them, but watched as the F-100 dissappeared into the rain that was moving up the field. He was unable to see the F-100 make the turn on the reverse highspeed taxiway because the precipitation was so heavy. It was still not raining where they sat.

A few moments later the rain hit. He described the rain as not falling straight down, but blowing around. "The rain was blowing sideways." They shut the other engine down, because they believed that they were not going any place soon. He did not notice the airplane being buffeted by the wind, but he was sure that the rain was being blown around from all directions. The visibility was reduced to the point that they were unable to see across 18R. He described the rain as "as heavy as I've seen."

He heard the radio call of 1016 saying that he was "on the go." He believes that he heard the sound of engines increasing power, but the rain was coming down so hard and the sound of the rain hitting the airplane muted the sound. He noticed that the rain started to ease up a little shortly after 1016 went by, but he never did see the airplane. He had a conversation with the Captain questioning whether or not the sound had been made by an airplane going around, or by an airplane possibly taking off.

About 20 or 30 seconds after Carolina 5211 went around, they noticed the rain ease up, and they saw the Shorts on a southerly heading, paralleling the runway, but 1/4 mile to the west. The visibility toward the west was opening up in small areas, with one of them being the area over the parking area at the end of 18R. He describes seeing the wispy remnants of clouds that looked like "the tortured clouds that are left from violent vertical movement." The clouds dissapated rapidly, and as they did, they could see the smoke from the crash site. They could see it as it topped the trees, and appeared to be leaning to the right toward the North.

After about 90 seconds, as the B-727 went around, they could see the airplane break out north of their position, the sun came out. They could still see the bottoms of dark clouds over the crash site, that appeared to move away to the north, northeast.

They sat at the end of 18R for about 15 minutes, and then the tower asked them if they could taxi down the runay to sweep it for debris, because they didn't have any vehicles left to do it. They taxiied down and turned around at the end of 36L and turned the radar on to check their departure path to the north and saw that even straight out after departure would keep them out of the main part of the rain shower. The radar still painted the storm as mostly red with a yellow fringe.

First Officer Raymond Elsworth
CC Air Flight 5175 Jetstream
Third airplane behind 1016 on approach to 18R

Flight 5175 came in from the northwest on the Shine Arrival. On radar they saw the cell over the airport, and possibly one further to the east. Visually they saw the storm, with tops in the mid 20,000 feet (estimated), the top was well defined, with a scattered layer around it and appeared right over the airport. With their radar turned to maximum gain (Normal position for the setting), the storm was painting a very narrow fringe of green with the entire center as red. On the arrival they asked about movement, and were told that the storm was not moving much.

When they were established on final approach, they saw the "wall of water" between them and the runway. They had broken out of a stratus layer at about 4,000 feet, they never saw the 727 that they were following, but the visibility was good enough to see the "wall of water" distinctly.

As they changed to the tower frequency, the frequency was congested with the tower looking for 1016. At that time the radar was painting the majority of the storm east of the runway, with a "wedge of rain" coming out of the middle of the storm pointed west. He describes the wedge as a triangle that was painting mostly all red on the radar coming out of the side, pointing to the west, that did not appear to go much beyond the western

boundry of the airport, right over the end of 18R.

The tower was issuing LLWAS alerts, and the crew briefed about the possibility of a microburst, but believed that it would be over by the time that they reached the rain. The crew briefed about the possibility of going around, and from the information that was being displayed by the radar, they decided to go straight out if needed. The tower started to send other aircraft around. About 3,000 feet (2,300 feet AGL), they hit the rain. It started abruptly and he classifies it has "very heavy" with the rain coming down in sheets. There was not much turbulence associated with it, although the rain was so heavy. He thinks that they were in the rain for approximately 2-2 1/2 minutes, and it stopped as abruptly as it started.

When the tower sent them around, they flew runway heading and broke out of the shower just past the threshold of 18R. He looked to the right and saw the smoke from the accident. They flew to the south boundry of the airport when the tower gave them a right turn to 270. They stayed on that heading for about 5 miles before departure control gave them a turn to the north to return to Hickory, North Carolina. As they traveled north, he was trying to see what had happened on the ground, and did not notice the storm as he passed it going north. The scattered layer was still around, but they flew to Hickory at 4,000 feet and never got above it.

Captain John Engberg
USAir Flight #797
B-737 Number 2 to depart off 18R facing north on E taxiway.

Flight #797 pushed from C-2 at approximately 2230Z. While they taxied out coming around the C concourse, there was no rain, but the Captain saw the shower to the south of airport. He turned the radar on and saw the radar painting a small isolated cell to the south southeast of the threshold of 36L. The ground visibility was hazy, as they taxied north on the E taxiway. They noticed that the cloud that was producing the precipitation was not that dark, but the Captain saw the reflection of lightning that was behind them as he taxied to the end of E taxiway.

They saw the F-100 make the approach to 18R (USAir Flight #932). The rain came from behind them as they sat facing north, with the intensity increasing rapidly, that happened shortly after the F-100 was rolling out. The visibility decreased rapidly in the precipitation. The Captain described the rain as very heavy, with visibility reduced to almost nothing. They noticed no indication of wind as they sat facing north, and when the tower offered them take off clearence, they stated that they would like to stay put. This was because of the DC-9 in front of them (USAir #806) and that they had observed the storm to be moving rapidly, and the wait should not be long.

They heard 1016 state that he was on the go, but never saw or heard them as the precipitation was falling very hard and the sound of the rain was very loud inside the Cabin.

The Captain noticed that the rain stopped falling with the same abruptness that it had started, and as the visibility improved, saw the smoke rising out of the tree line. He did not notice any movement of the smoke, but saw that it was black and billowing up from the crash site.

They departed behind USAir 806 from runway 36L at approximately 2307Z. The radar was still painting the rain to the north of the airport, but the 330 heading after departure from 36L kept them to the edge of the rain and presented no problem. At this time the radar showed the storm to be approximately 10 miles wide about 10 north of the field. Ater climbing above a scattered layer, they noticed some towering CB's, but only widely scattered.

Captain Dave Greehan
USAir B-727 Captain sitting at spot 2 during accident.

The flight was delayed for about 40 minutes at the gate. While Dave was on the phone, it started to rain, with the sky going from sunshine to dark very quickly. The rain was heavy as they pushed back from the gate. The tug driver stated that this was going to be his last push because of the lightning and conditions.

The Captain turned on the radar as he came around the corner of the C and B concourse and checked the 5,10,20,40,80 mile ranges and did not see any returns from the radar. Although they didn't paint any precipitation on the radar, he was taxiing through the heaviest rain he had been through in a long time. He described the precipitation as a "wall of water." They arrived at spot 2 about 1 or 2 minutes after the tower started calling for 1016, and sat at spot 2 for 40 minutes and noticed that the visibility was reduced to less than 1,500 feet, with dark low clouds and precipitation all around them. He didn't notice any wind, but was able to detect variations in the intensities of the precipitation from different areas of the storm. One of the heaviest areas of precipitation was over the end of 18R. He described the bottom of the clouds as ragged.

Shortly after that, the rain started to decrease, and they could see the smoke from the crash site. He did not notice any movement of the smoke, which started out small and grew very quickly to black and billowy.

They departed on 36L about 2310Z, and during the departure, he deviated around some showers. He climbed above a thin layer with the tops about 9,000 - 10,000 feet and saw some widely scattered clouds, but no towering CB's. He felt that he should have been able to see the remnants of the storm that had caused the accident, but didn't see any evidence of it, other than

having to deviate around some showers on the climb out.

Captain James Hall
USAir Flight #983 F-100 Landed 2240Z Aircraft that landed just prior to 1016, circled from a visual approach to 23 to a visual Runway 18R.

Flight #983 arrived from the northeast down the Magic Arrival and was cleared for a visual approach to runway 23. As they approached, they observed the rain shower over the intersection of 18R/23, with lighter precipitation falling to the north. They observed the shower moving to the north, but the speed of the rain did not seem very fast.

Visibility was good as they approached the airport. Due to operational necessity, with 18R in sight, he chose to circle from 23 to 18R. The Captain viewed the rain shower over the airport not to be a problem, and because he could see 18R, he flew a visual around to the runway. The radar was painting a 2 - 3 mile wide cell over the south, southeast of the airport center.

The circling approach was kept close in, about 3/4 of a mile north of the field. The ride was smooth and the visibility remained good as they circled toward the runway. Looking at the rain shower that was moving over the field, the Captain considered that if he was unable to maintain visual contact with the runway that he "would be outta there."

As the airplane turned final, the rain began to fall. By the time they were touching down the intensity was increasing, and during roll out the intensity quickly became very heavy. By the time the airplane turned off at the reverse highspeed (E-5), the rain was very heavy with the taxiway and ramp covered with rain and puddles. When he parked at C-11, the rain was still falling heavily.

Due to the concentration of flying a close in circling approach to the runway, combined with the impression that the rain presented no problem, the Captain did not notice much of the particulars of the rain and the storm.

Captain Andrew Laczko
USAir Flight #332
B-727 that was two airplanes behind 1016 on the approach to 18R.

Captain Laczko departed AVL (Asheville, North Carolina) and joined the Shine Arrival northwest of the airport. As he was being vectored toweard the final approach course, the Captain noticed only widely scattered rain showers in the vicinity of the airport. The visibility was good, and the crew briefed for a visual approach to 18R.

About 10 miles out on the localizer, the Captain noticed the

rain shower that was between them and the runway. The Captain then briefed for the ILS approach. They received the LLWAS alert issued by the tower and briefed about the potential for windshear. The Captain kept the approach speed up to help compensate for the potential windshear.

As they continued, the Captain noticed that the precipitation was very heavy and could see the boundry of the rain to the west of the runway. The ride remained smooth and the visibility prior to reaching the precipitation was good (several miles). They observed the Shorts (CCAir Flight 5211) enter into the precipitation and lost sight of him. The Captain described the precipitation as very heavy, a "wall of water" with visibility through it as non existant.

They were established on the Glide Slope and Localizer at this time, still carrying extra speed, when they entered the precipitation. The Captain describes the intensity of the shower as increasing very rapidly to heavy rain. They had experienced similiar rain the previous day going into Sarasota, and they turned on the wipers and applied rain repellant to help clear the windshield.

With the power settings stable and the configuration of the airplane steady, the Captain noticed that although the ride was smooth in the precipitation, they drifted 1 1/2 dot low on the Glide Slope. The Captain recovered easily and regained that G/S. He believes that this deviation below the G/S was caused by external forces rather than by any actions that he made, as the configuration and power was steady and they were well established on the G/S.

The tower instructed them to go around, and as they initiated the go around at 800 feet AGL, the Captain had a thought that passed quickly, that the airpliane did not respond to the go around as quickly as he would have thought. They were light, and had the dash 17 engines, and he figured that the airplane would respond a little faster than it did. It passed quickly and the airplane did start to perform as he thought it should.

They broke out of the heavy precipitation as they reached the threshold of 18R. After breaking out, the Captain noticed the wispy remnants of clouds and scud down low among the trees. Visibility toward the south after emerging from the precipitation was very good. During the go around and vector by departure control, they were able to notice the cell that was over the field, and estimated it to be 1 to 3 miles wide, with tops around 20,000 feet plus.

Captain Tim Ludwig
DC-9 Captain USAir Flight #806
DC-9 sitting at the hold line of 18R at the time of the accident.
[redacted]

Pushed back from B-3/5 at 2232Z

Due to close proximity to other aircraft, the Captain was unable to notice the weather as he made the right turn from the gate toward Spot 2. While taxiing to spot 2, the Captain turned on the radar, checked the 10-20-40 mile ranges, there was nothing painting on the radar to the west and north (his departure path). Looking visually to the south, he could see the rain shower approaching from the south, but the rain had not reached the southern boundry of the airport. The threshold of 36L was easily visible, but visibility further to the south was obscured by the precipitation. He was able to see the western boundary of the rain shower, and from his perspective (parked at spot 2), it extended west to a point that was in a straight line from spot 2 to over the end of 36L, and looked to be at least a mile south of the airport. Looking further to the southeast, he was unable to see the boundary of the rain shower, as the rain was more extensive toward that direction. He was able to distinguish variations in the cloud base colors and shapes, with the darker clouds back toward the southeast. At this time, he noticed the reflection of a lightning strike that had come from behind them. The center of the storm appeared to be slightly east of the center of the field and to the south of the airport.

As they taxied down Echo taxiway northbound, he noticed the rain start. As he made the left turn to face west at the threshold of 18R, he pulled up to the hold line just short of the runway. At this time the intensity of the rain started to increase. He described the rain as not coming down vertically, but "swirling around a bit." Visibility was still OK to the west and north, but looking to the south, the heavy rain was covering the southern half of the runway. The rain shaft was easily distinguishable as it moved up from the south. The clouds were lighter to the west, but dark to the south-southeast, where the boundary of the rain shaft was undeterminable. Visually the heaviest of the rain seemed to be centered between the two north/south runways with a band of heavy rain extending toward the west.

The rain was starting to obscure visibility to the west and northwest as the F-100 (USAir Flight #983) was landing on 18R. As the Captain watched the F-100 land and dissapear into a "wall of water," he thought that the F-100 would probably be the last airplane to land for a while. He was unaware of any additional airplanes on approach to that runway.

The rain picked up in intensity quickly, and he was able to notice that the grass to the left of the airplane and the trees that were still visible were blowing around in different directions. The rain was coming down hard enough that visibility outside of the airplane was greatly reduced. He could feel the airplane being buffeted around from the wind, and the wind was blowing the rain around as it fell. When the tower offered him take off clearance, he decided to refuse, electing to "sit tight for a while." He was basing this on the intensity of rain

showers, the severly reduced visibility and the gusty winds that he could feel in the airplane.

When he heard the radio communication that 1016 was on the go, he heard the sound of engines at full power, and he originally believed that someone had taxied onto E10 and was departing. He never saw any airplane, because the visibility was so bad due to the heavy rain showers running down the windows and falling outside. He was unable to see either the far side of 18R or the taxi way next to him (E10). He commented to the F/O that "someone must be taking off?" At this point he remembers that the rain and the buffeting of the airplane was close to its peak. The buffeting of the airplane he described as jolts to the side of the aircraft, more than just the tail section, which lasted less than a couple of minutes. The rain increased in intensity for the next 20 seconds or so, and then started to abate somewhat. He remembers this because by now the tower was starting to look for 1016 and the rain was coming down so hard, that he was unable to hear the radio over the sound of the rain hitting the airplane and had to turn up the volume on the overhead speaker.

The rain started to ease up some, and they saw the Shorts (CCAir 5211) going around. He was coming out of the scud, and was southbound with wings level, about a 1/4 mile west of the runway. His nose was up in a climb attitude, and they first saw him just slightly to the north of their position. He appeared to go just about over the site that they would see the smoke about 90 seconds later. The scud and clouds that were to the west of the runway were wispy and shredded as they dissapated from around the scene of the crash. The rain and wind had calmed down, with the entire weather event lasting less than 10 minutes and less than 1 minute after 1016 called "on the go."

They then saw and heard USAir Flight #332 go around. The 727 was easily visible as it made it's go around, as the rain was ending quickly. The scud was clearing and they could see the smoke from the crash site. By the time that they saw the smoke, it was very black and billowing as it reached the tops of the trees, it started to lean to the right or in a northerly direction. The lean seemed to indicate that there was not a lot of wind, 10 or 15 degrees off vertical.

They stayed at the hold line to 18R for about 10 to 15 minutes, and were then asked to inspect the runway, as departures were going to start from 36L. They taxied down the runway and lined up with 36L. They actually departed at approximately 2305Z. The departure from 36L stipulates a right turn after departure to a heading of 330. As 806 departed, the Captain elected to turn further left to 320 to stay to the west side of the rain shower that was still visible and painting on the radar as a green and yellow storm with a large area of red inside.

McIDAS Data

The following data were obtained from the Man computer Interactive Data Access System (McIDAS) at the University of Wisconsin at Madison. Data were accessed by an IBM PS/2 Model 70 Computer connected to a SUPRA 144LC Modem.

Radiative temperatures in degrees Kelvin (deg K) from Geostationary Operational Environmental Satellite (GOES) infrared data are as follows for the following times and an approximate location of the initial impact point of the airplane:

Time (Z)	Radiative Temperature (deg K)	Height (feet)
2201	283.5	8,800
2231	280.0	10,800
2301	281.5	9,800

Note: Height based on data from Table 1. A listing of Height (feet) versus Temperature (deg K) based on a first order polynomial fit to Greensboro, North Carolina upper air data for 0000Z.

Note: In the Video Prints the cross box = the approximate location of the initial impact point of the airplane.

Parallax Error: Delta Latitude per Kilometer = -0.0077438
Delta Longitude per Kilometer = 0.0103271

Video Print
1,2,3...GOES visible images; 1 kilometer resolution; contrast stretched; 2201, 2231, and 2301Z.

4,5,6...GOES infrared images; 4 kilometer resolution; color enhanced; 2201, 2231, and 2301Z.

Color Enhancement Table

Segment #	Temperature (degrees C)	(degrees K)
1	-32.2 to -41.2	241.0 to 232.0
2	-42.2 to -52.2	231.0 to 221.0
3	-53.2 to -58.2	220.0 to 215.0
4	-59.2 to -62.2	214.0 to 211.0
5	-63.2 to -80.2	210.0 to 193.0
6	-81.2 to -109.2	192.0 to 164.0

7,8,9...GOES infrared images; .33 kilometer (blow up) resolution; radiative temperature contours plotted (interval = 2 degrees Kelvin); 2201, 2231, and 2301Z.

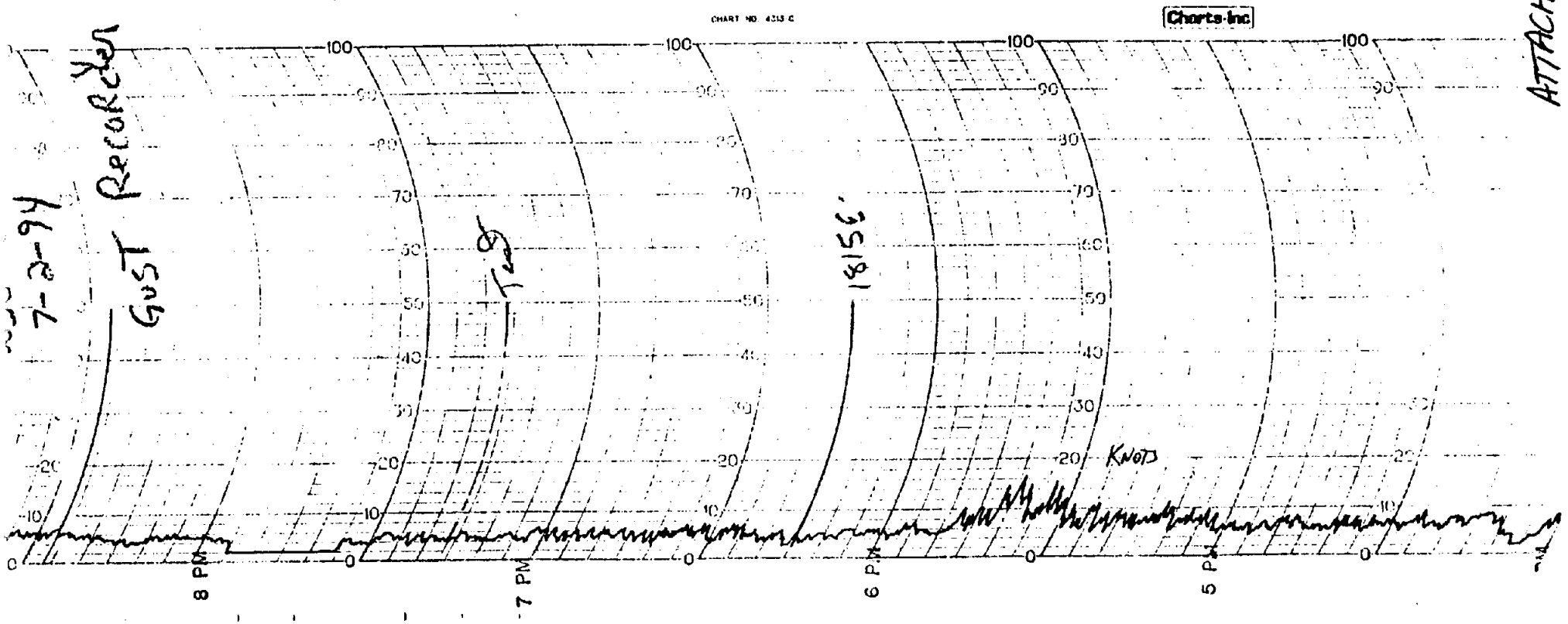
10,11...GOES water vapor images; 4 kilometer resolution; lighter colors indicate greater moisture; 2201 and 2301Z.

12...SKEW T LOG P Diagram; Greensboro, North Carolina; 1200Z and 0000Z 7/3/94.

[redacted]
Gregory D. Salottolo
National Resource Specialist
Meteorology
August 24, 1994

CLT WSO Gust Recorder

ATTACHMENT 1



Location = 100 feet northwest of the CLT WSO [redacted] EST

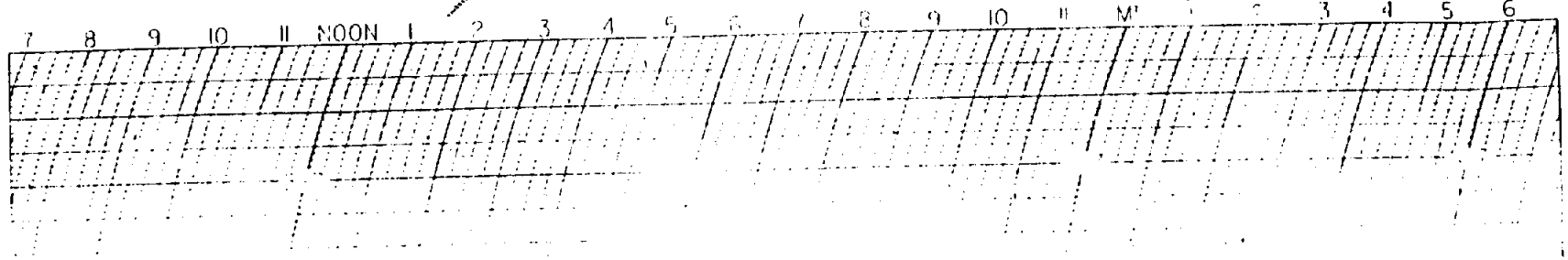
[redacted] feet (agl)

Height = 15 feet agl.

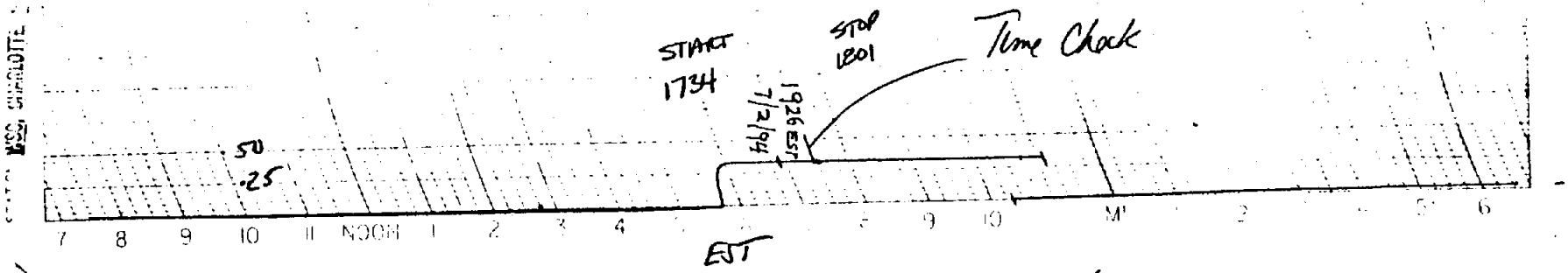
CLT WSO RAIN GAUGE

ATTACHMENT 2

0218 EST 2-1-94
2308 7/2/94



Total Precip This Chart 0.33 inches



INT = 15 minutes

Each = .05

Location on Roof CLT WSO

NWS FORM 4?? ?7
(02-89)

NATIONAL WEATHER SERVICE BAROGRAM

WSO, CHARLOTTE, N. C

STATION PRESSURE (IN INCHES) AT

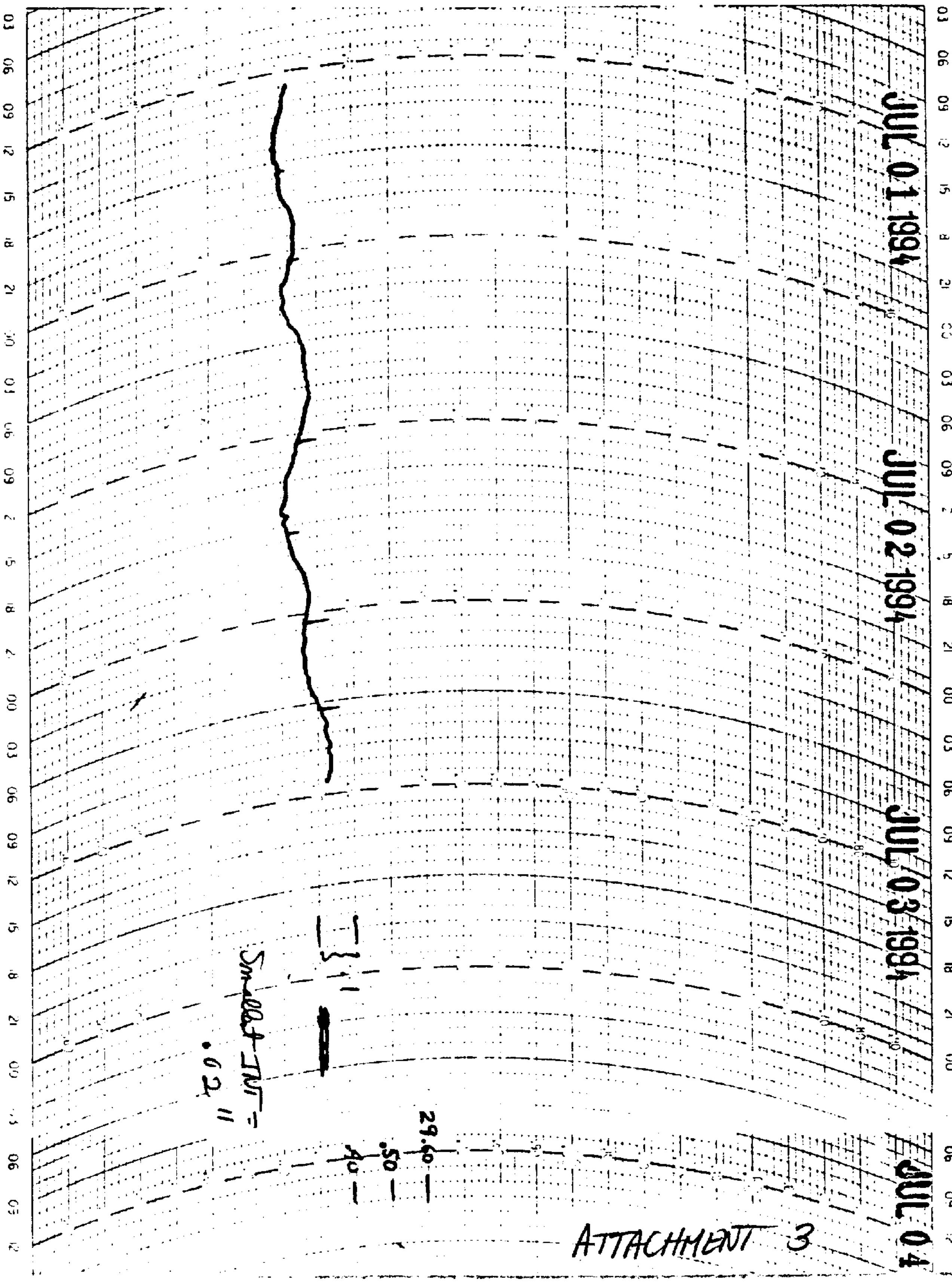
TIME OF RECORD 75 MERIDIAN ELEVATION 769

ON PRESSURE 29.220 DATE AND AM ( ) PM ( ) TIME 1300 EST 7/1/94

OFF PRESSURE DATE AND AM ( ) PM ( ) TIME JUL 05 1994

LOCATED CLT WSO

BT

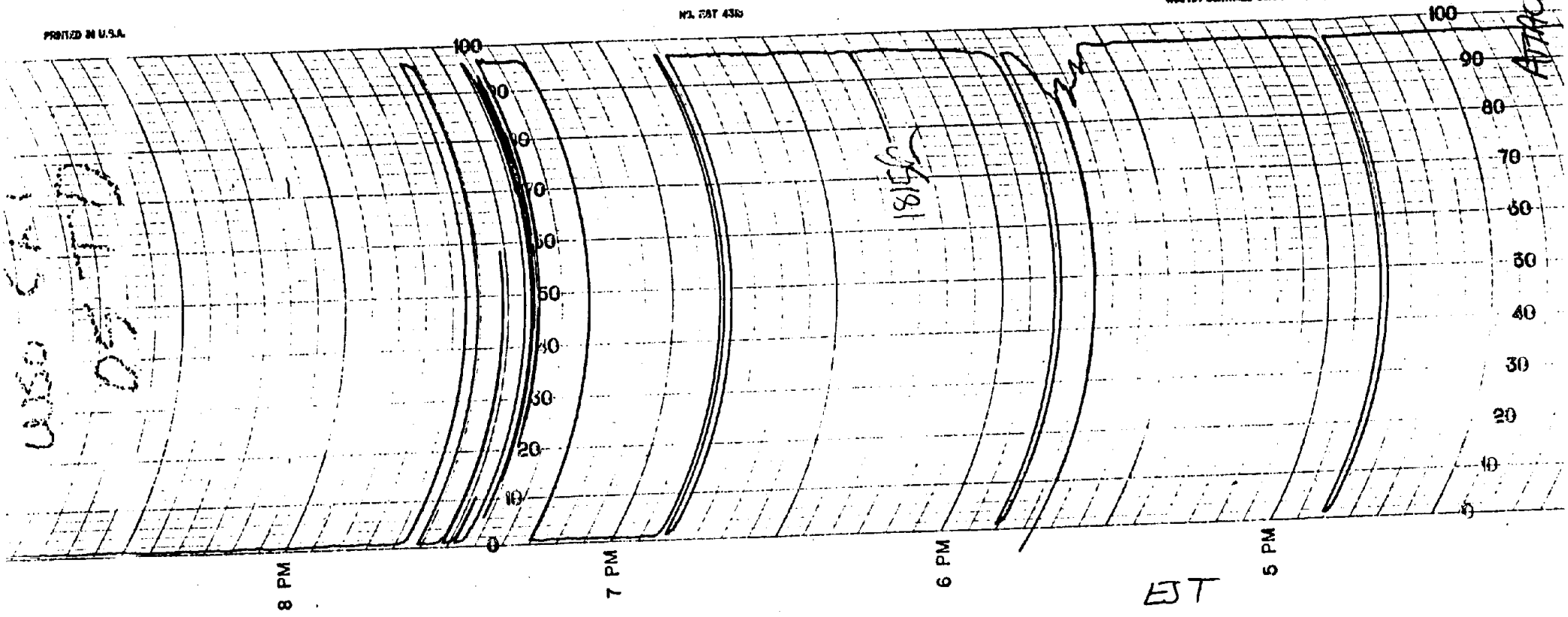


CLT WSO BAROGRAM

ATTACHMENT 3

ATTACHMENT 4

GRAPH TRANSMITTANCE



RNWY 05 TD

([redacted])

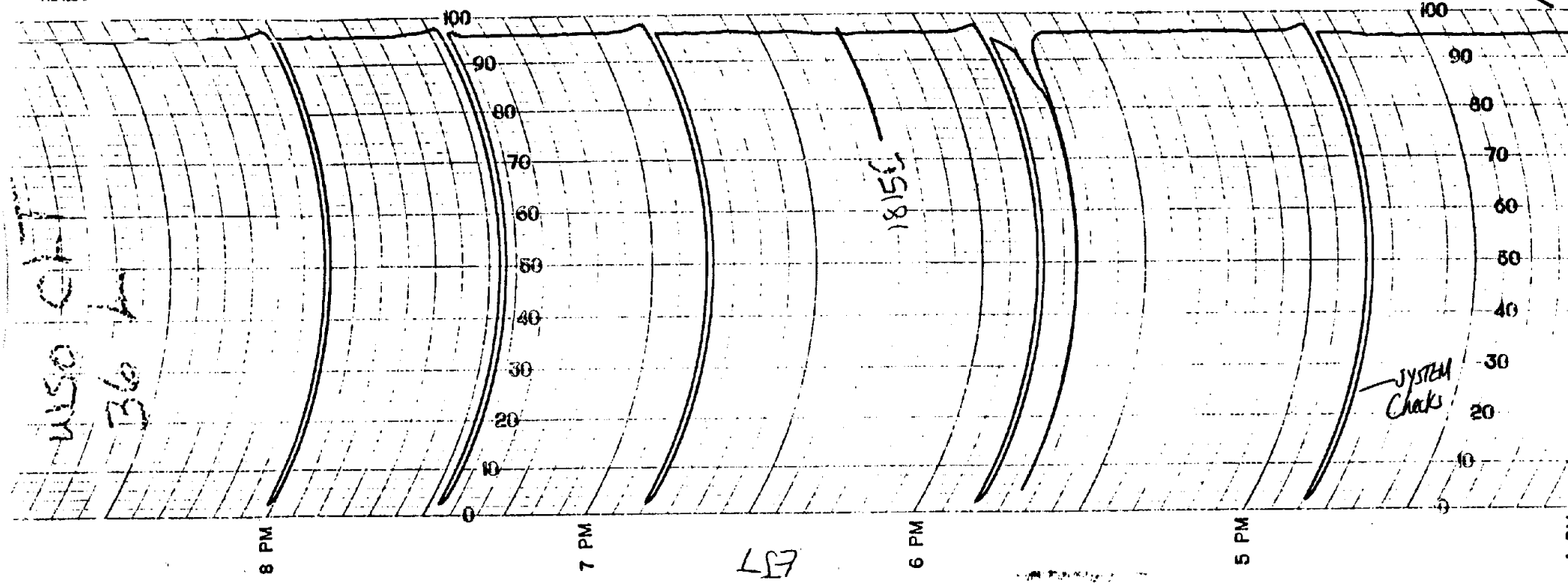
RNWY 36L MP

(981 LAX)

RL 36R RNWY

GRAPH TRANSMITTANCE

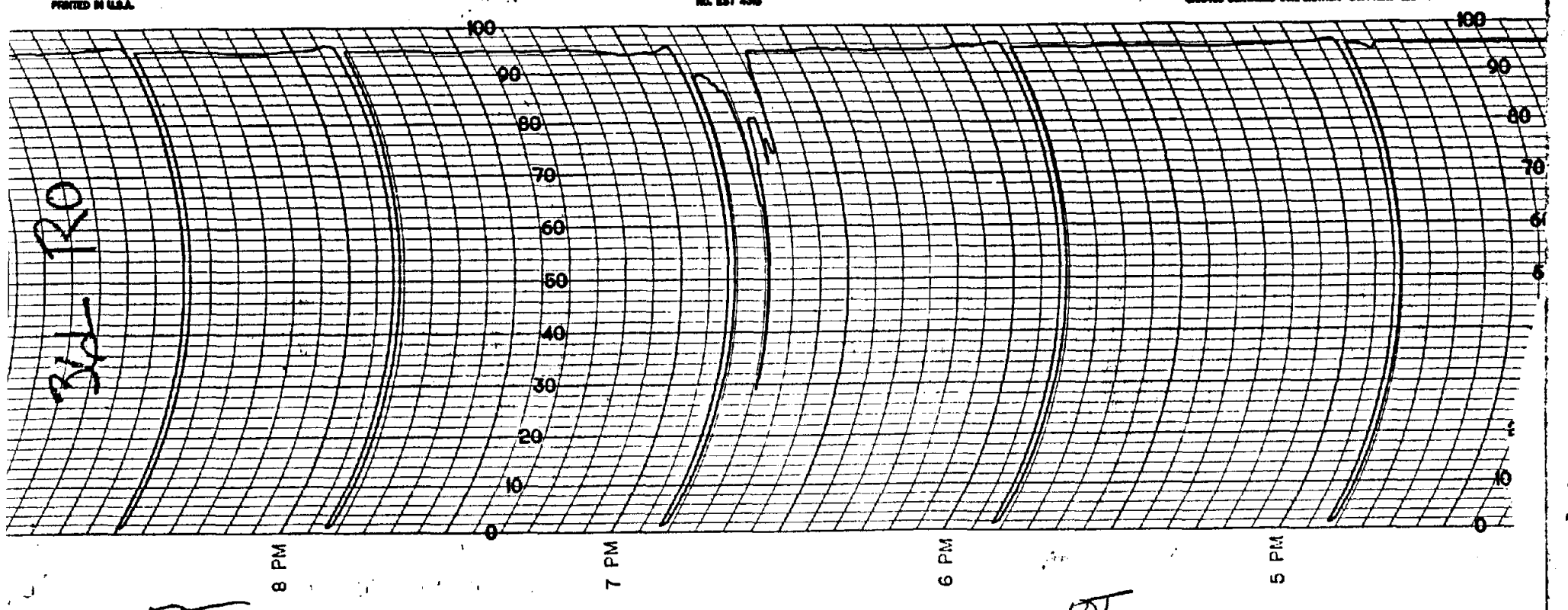
ATTACHMENT 5



RNWY 36L TD

ATTACHMENT 6

GRAPH TRANSMITTANCE



R10

R31

EDT

EDT

RNWY 36L RO

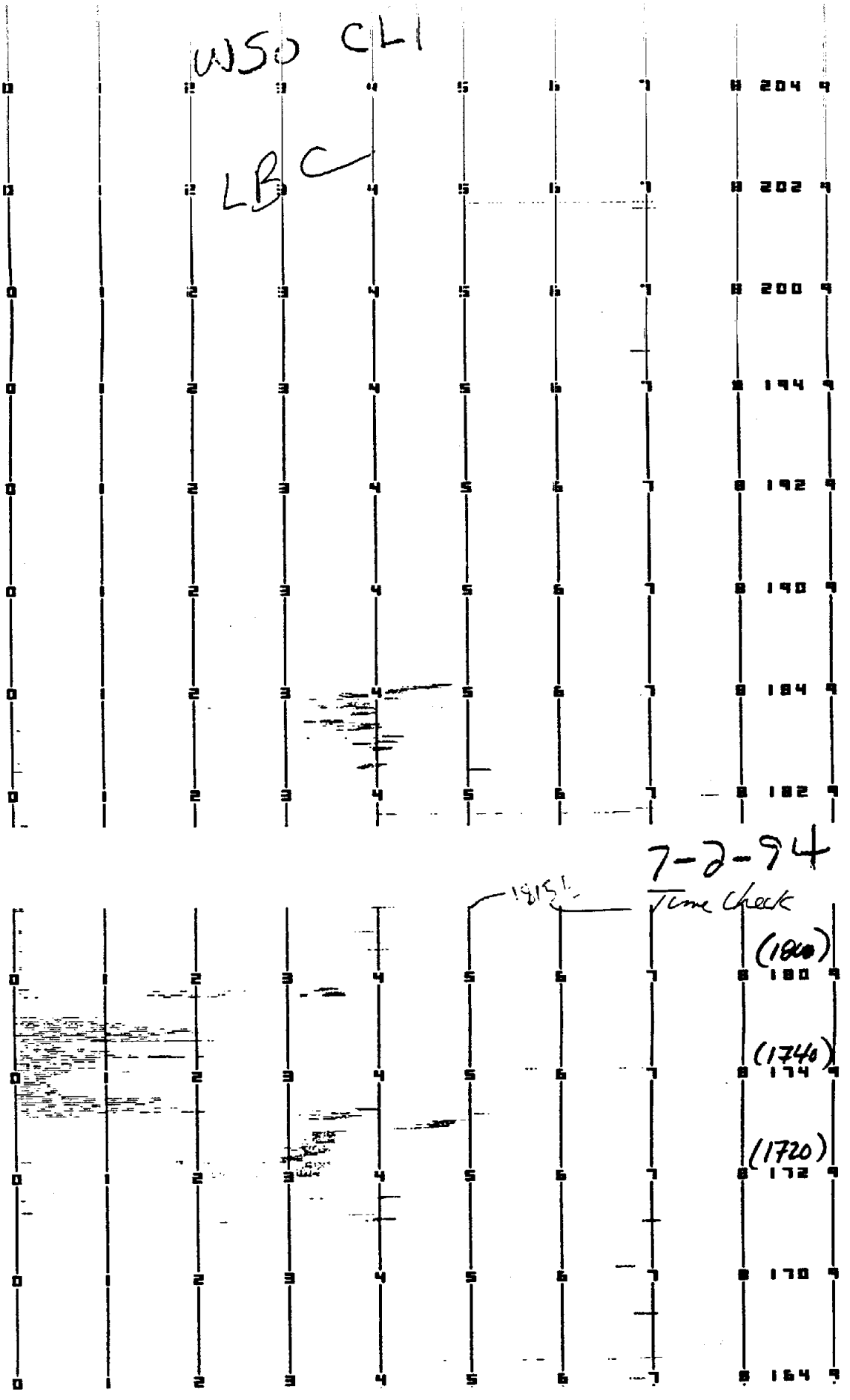
* TABLE A3-6C. TASKER 500 RVR Transmittance Conversion Table. 250-Foot Baseline, Contrast Threshold 5.0 Percent

	DAY			NIGHT		
RVR (Ft.)	LS 5	LS 4	LS 3	LS 5	LS 4	LS 3
500	.0449*	.0934*	.1940*	.0027*	.0055*	.0115*
600	.0823*	.1529*	.2840*	.0075*	.0140*	.0260*
700	.1264*	.2161*	.3684	.0159*	.0272*	.0466*
800	.1974*	.3087*	.4351	.0351*	.0549*	.0859*
1000	.2905	.4187	.5062	.0707	.1020	.1470
1200	.3746	.5105	.5621	.1134	.1545	.2106
1400	.4479	.5857	.6070	.1590	.2079	.2718
1600	.5107	.6437	.6437	.2048	.2595	.3287
1800	.5644	.6742	.6742	.2492	.3079	.3806
2000	.6104	.7000	.7000	.2913	.3528	.4273
2200	.6499	.7221	.7221	.3307	.3940	.4693
2400	.6840	.7411	.7411	.3674	.4316	.5069
2600	.7136	.7578	.7578	.4014	.4659	.5408
2800	.7395	.7724	.7724	.4328	.4972	.5712
3000	.7774	.7942	.7942	.4820	.5455	.6174
3500	.8190	.8190	.8190	.5415	.6028	.6711
4000	.8384	.8384	.8384	.5906	.6493	.7138
4500	.8541	.8541	.8541	.6317	.6875	.7483
5000	.8671	.8671	.8671	.6662	.7193	.7766
5500	.8779	.8779	.8779	.6957	.7461	.8002
6000	.8871	.8871	.8871	.7209	.7689	.8200

NOTE: When a given value of RVR is being reported, the transmittance should be between the two adjacent values listed in the table.

* - Refer to TABLE A3-6D for an interim CAT IIIb system.

NOTE: Nightime readings on the recorder cannot be determined for less than 700 ft. Report, if appropriate, 700-.



LOCATION NEAR WIND SENSOR

LBC

ATTACHMENT 8

Location Near wind

Day	Time	Type	Wx / Trend	Echo data			Movement	Tops	Remarks	
		^JI9 JJ3 =						AT		TI
02	1526	AREA	1 TRW+/NC	346/155 340/80 259/165			C3015	230 AT 331/78		TI
		^HE9 [illegible] JJ22 KK3 OH9 PH9 =						AT		TI
02	1626	AREA	2 TRW+/NC	280/105 250/185	30W		C2710	270 AT 274/120		TI
		AREA	2 TRW/NEW	57/120 73/120 89/90				290 AT 59/119		TI
		CELL	RW/NEW	104/50	D6			240 AT		TI
		CELL	TRWU/NEW	350/220	D8			AT		TI
		^DH9	HQ2 LR2 JQ2 LP2 NH32 OH3 PH9 =					AT		TI
02	1727	AREA	1 TRWX/+	61/125 153/210 273/235			C2710	350 AT 81/84	TOP 330 AT 26	TI
		CELL	TRWU/	351/210	D12		C3015	AT	TRWX 262/	TI
		^EH9 HQ3 IP4	JQ4 KP44 ~~IP4~~ LJ3 LP4 MJ2 MP3 NH22 OH96 OR2 PH8 =					AT		TI
02	1829	AREA	1 TRWX/NC	107/105 250/145	160W		C2608	370 AT 176/93	TOP 360 AT 133/137	TI
		CELL	TRWU/	353/190	D25		C3108	AT		TI
		^EI9	JO53 KP4539 LS9 NI33 NL9 OI2 OR349 PH92	QH9	QM2 =			AT		TI
02	1927	AREA	1 TRW+/-	303/150 130/185	300W		C0000	330 AT 225/106	APRNT TRWH	TI
		^FH99	MV9 IG99 IQ220009 JH9 JR2 KS99 LQ2 MP1 MU9 NH24	NS108	OP2	QS398 PM2 QM3 QS9				CIX
02	2032	AREA	1TRW++/NC	347/260 91/160 134/210 255/230			C3107	280 AT 309/112		CIX
		^EH99 FF9009 KH4	KQ2 LL3 LQ2 MI3 MP2 QM43 RM1 =					AT		CIX
02	2134	CELL	TRWX/+	311/102	D8		C3012	350 AT		CIX
		AREA	1TRW++/NC	344/260 88/170 138/140 249/260			C3008	~~300~~ 250 AT 9/98		CIX
		^EL9 GF909 HL9 JR3	KI5 KR3 MH441 OM2 DT3 OL3 =					AT		CIX
02	2225	AREA	1TRW++/NC	347/220 80/150 143/130 253/250			C3003	300 AT 311/102		CIX
	EXTEN	^JTP2 JU22 KI4 KR4	LI4 MR2 NQ2 OM200202 PO2 QN3 =					AT		CIX
02	2325	AREA	1TRW++/NC	345/220 141/90	190W		C3103	250 AT 100/106		CIX
		^HQ2 JJ2 KH2 KR4	LH423 LQ4 NO403 OM3 PN3 QM2 =					AT		CIX
03	0031	CELL	TRW++/NEW	240/123	D12			320 AT	(CXO TROP 480)	CIX
		AREA	3TRW++/NC	4/210 293/45 316/240			C3212	340 AT 319/76	APRNT TRWX 335/160	CIX
		^EJ9 FI99 GH999 HF9989	IF9994 KJ4 QJ4 =					AT		CIX
								AT		
								AT		
								AT		
								AT		

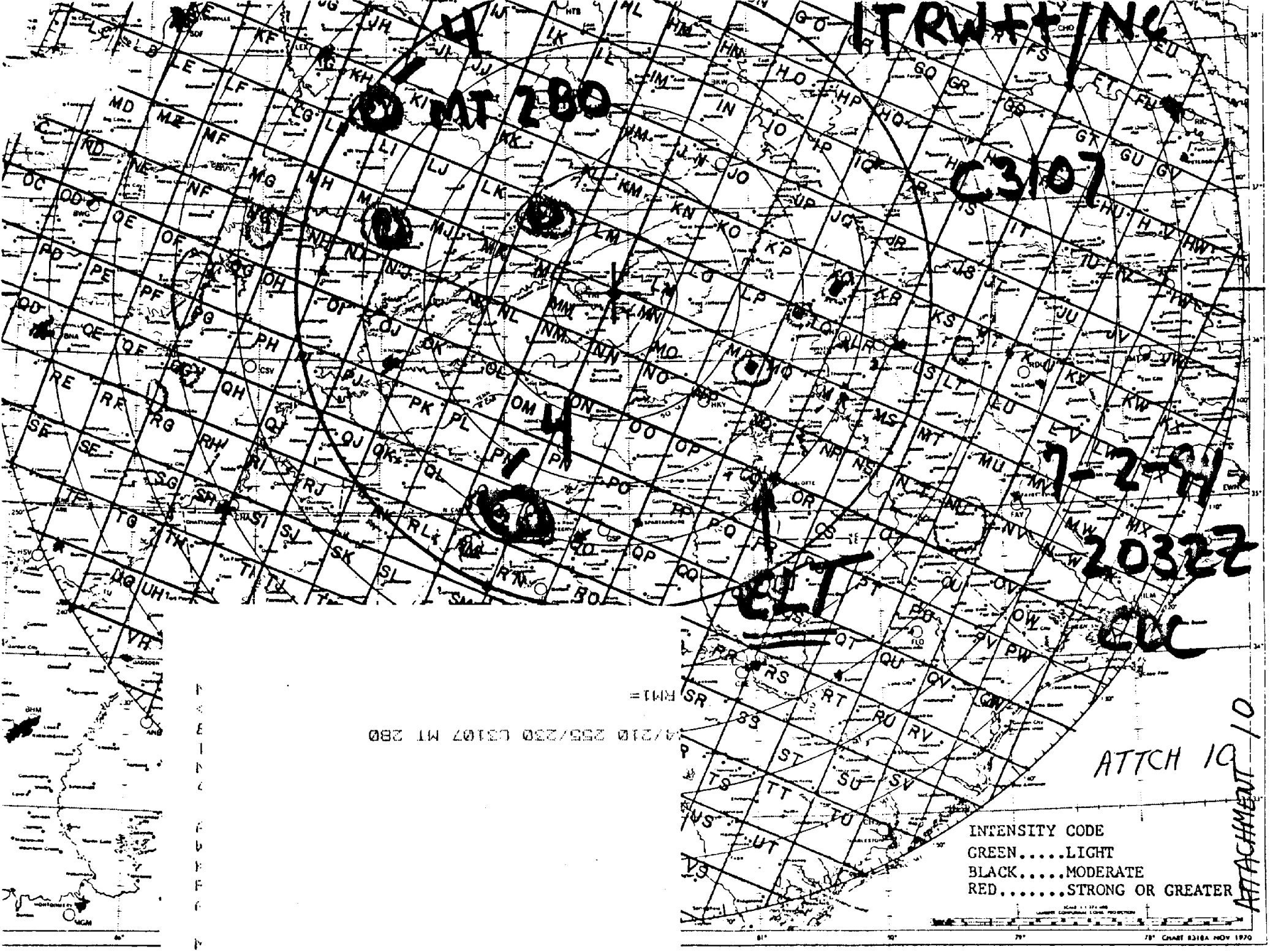
ATTACHMENT 9

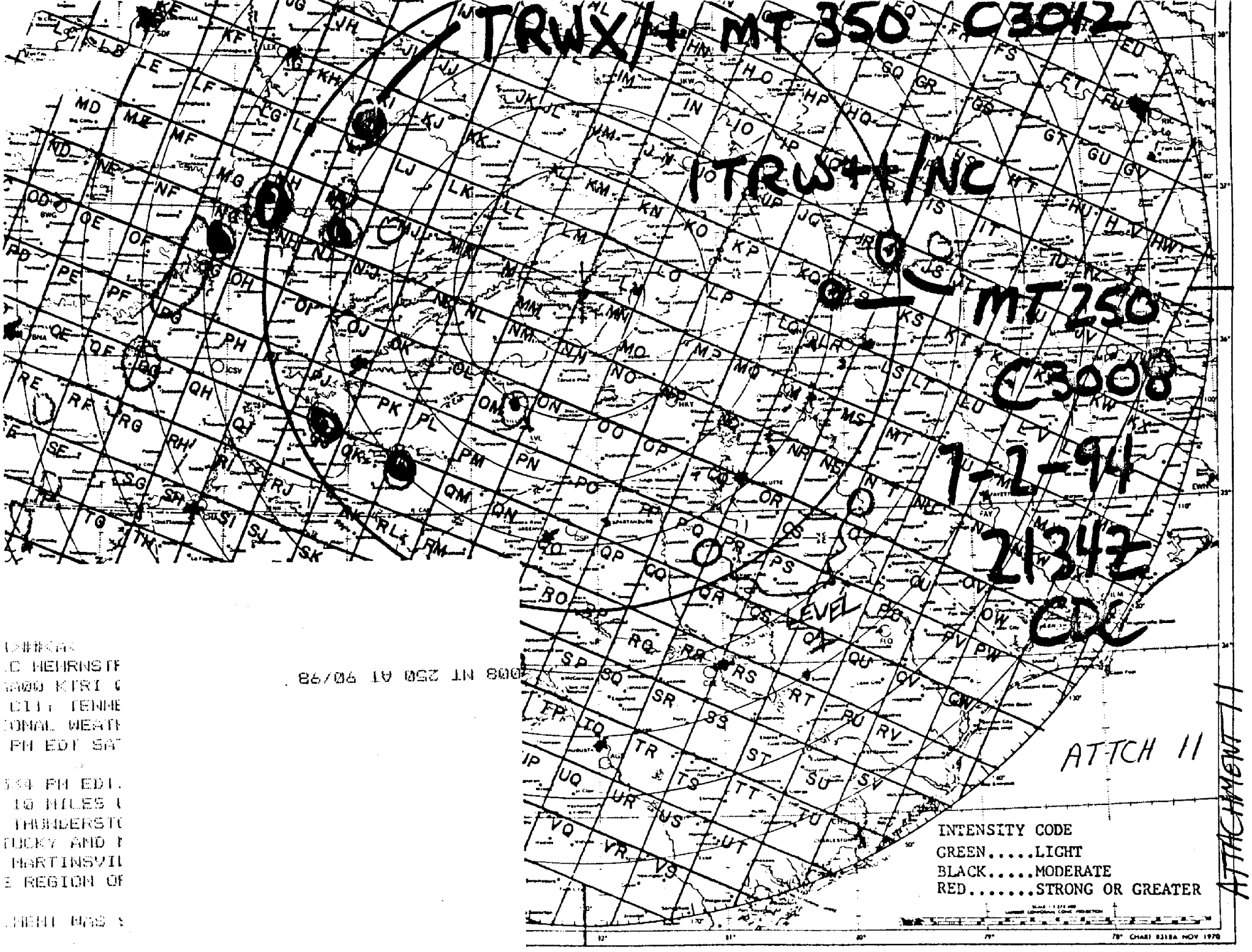
TIME = UTC

COPY OF MF 7-60 RADAR OBSERVATIONS FROM 2 JULY 1994 2032Z TO 3 JULY 1994 0031Z.

WSO TRI

ATTACHMENT 9


ITRWFT/INC
MT 280
C3107
7-27-94
20322
ZLT
ZDC
ATTCH 10
ATTACHMENT 10
INTENSITY CODE
GREEN.....LIGHT
BLACK.....MODERATE
RED.....STRONG OR GREATER



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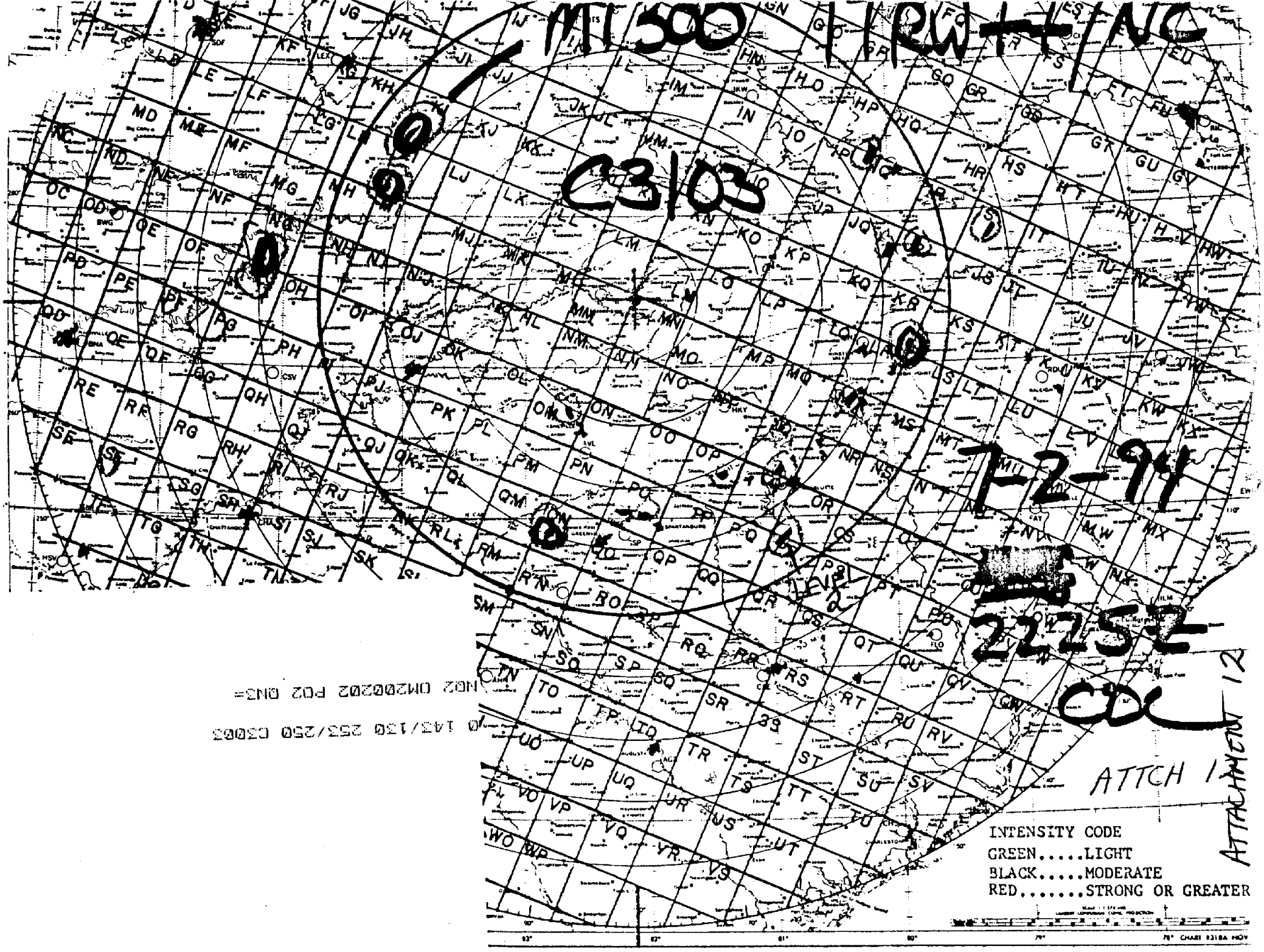
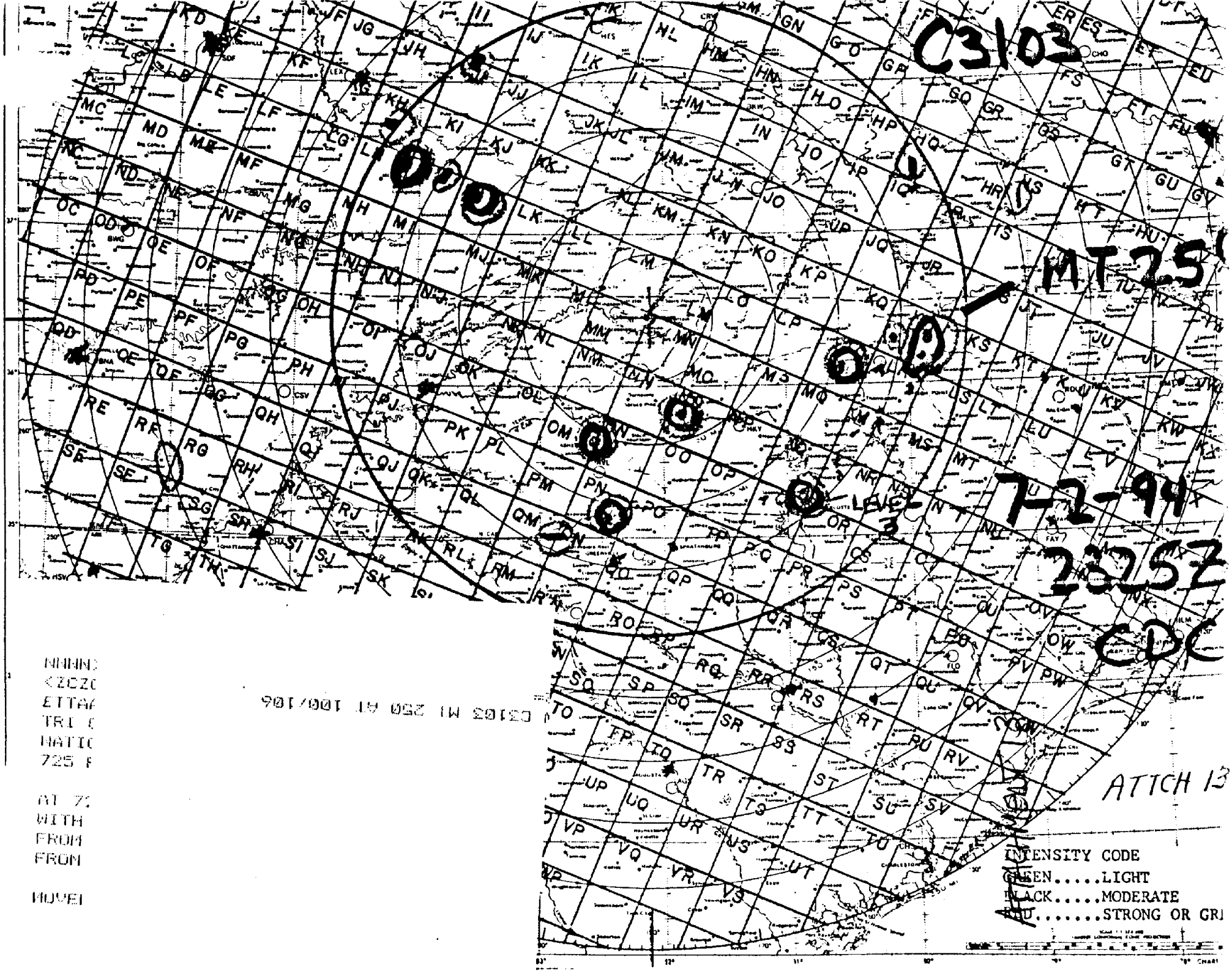
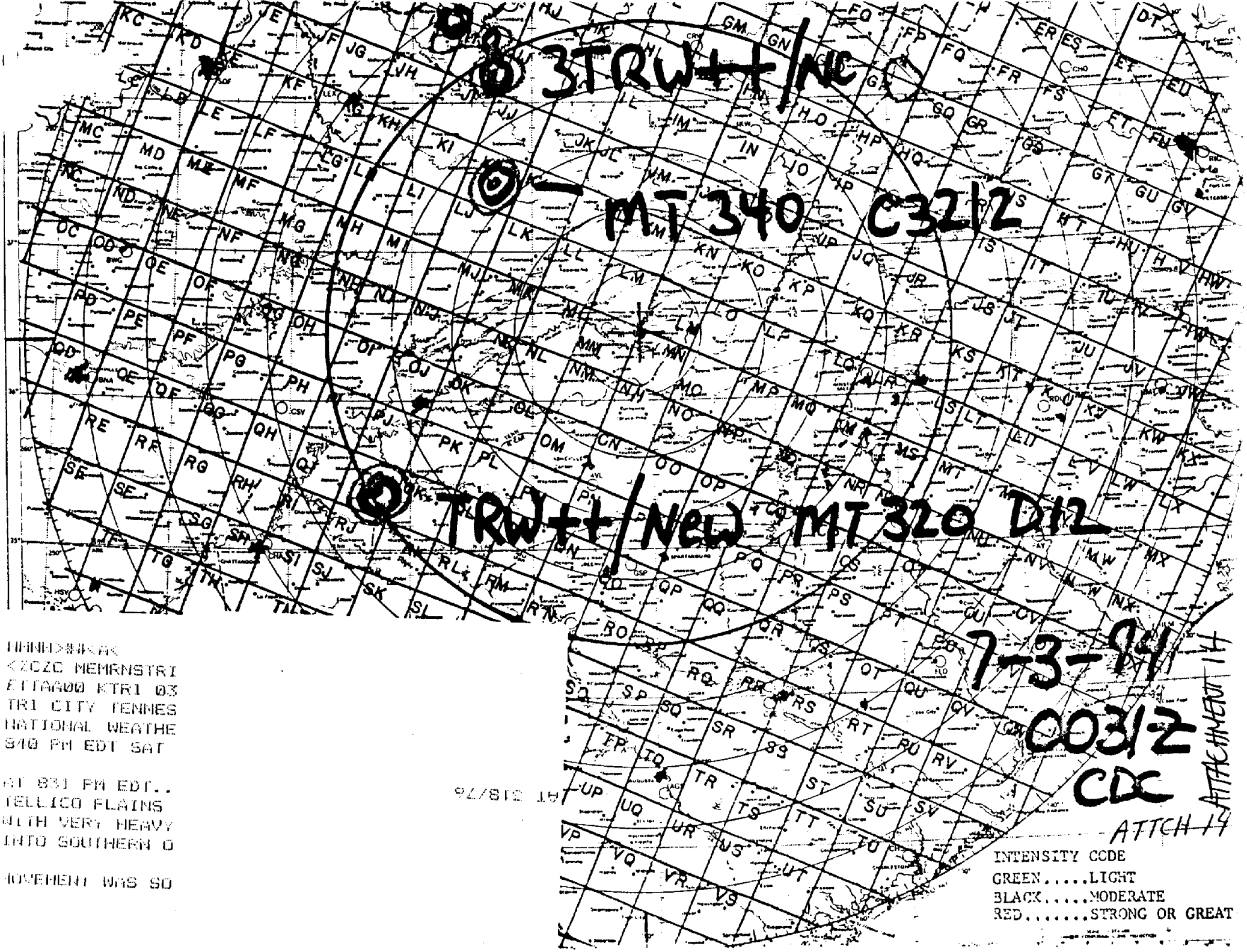


NO2 OM200202 F02 ONJ=

0 143/130 253/250 C3003


C3103
MT 25
T2-94
23252
CDC
ATTCH 13
INTENSITY CODE
GREEN.....LIGHT
BLACK.....MODERATE
RED.....STRONG OR GR
LEVEL 3



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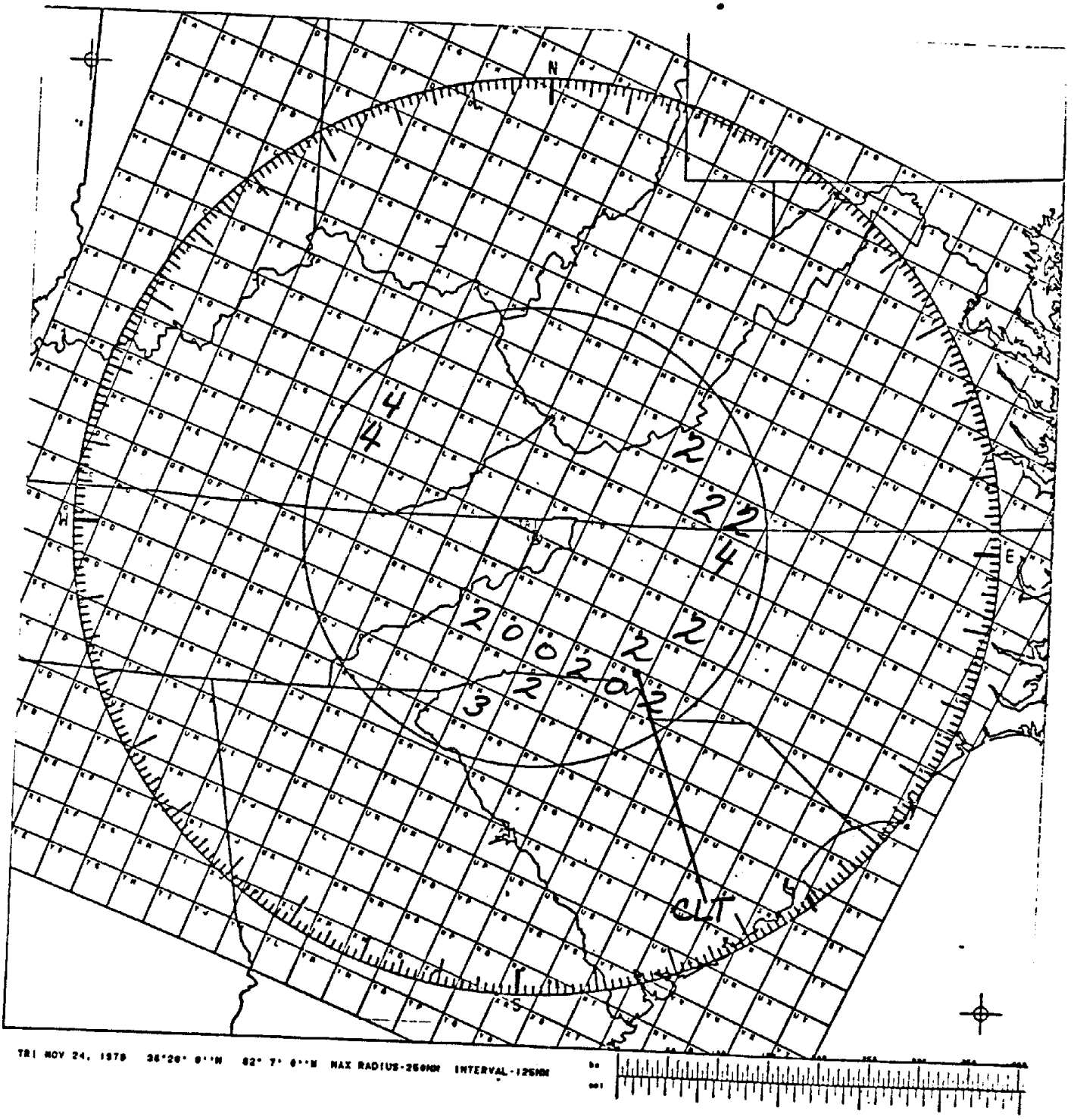


Figure 17.--250 nautical mile radar code grid for Bristol, Tenn.

ATTACHMENT 15

23252

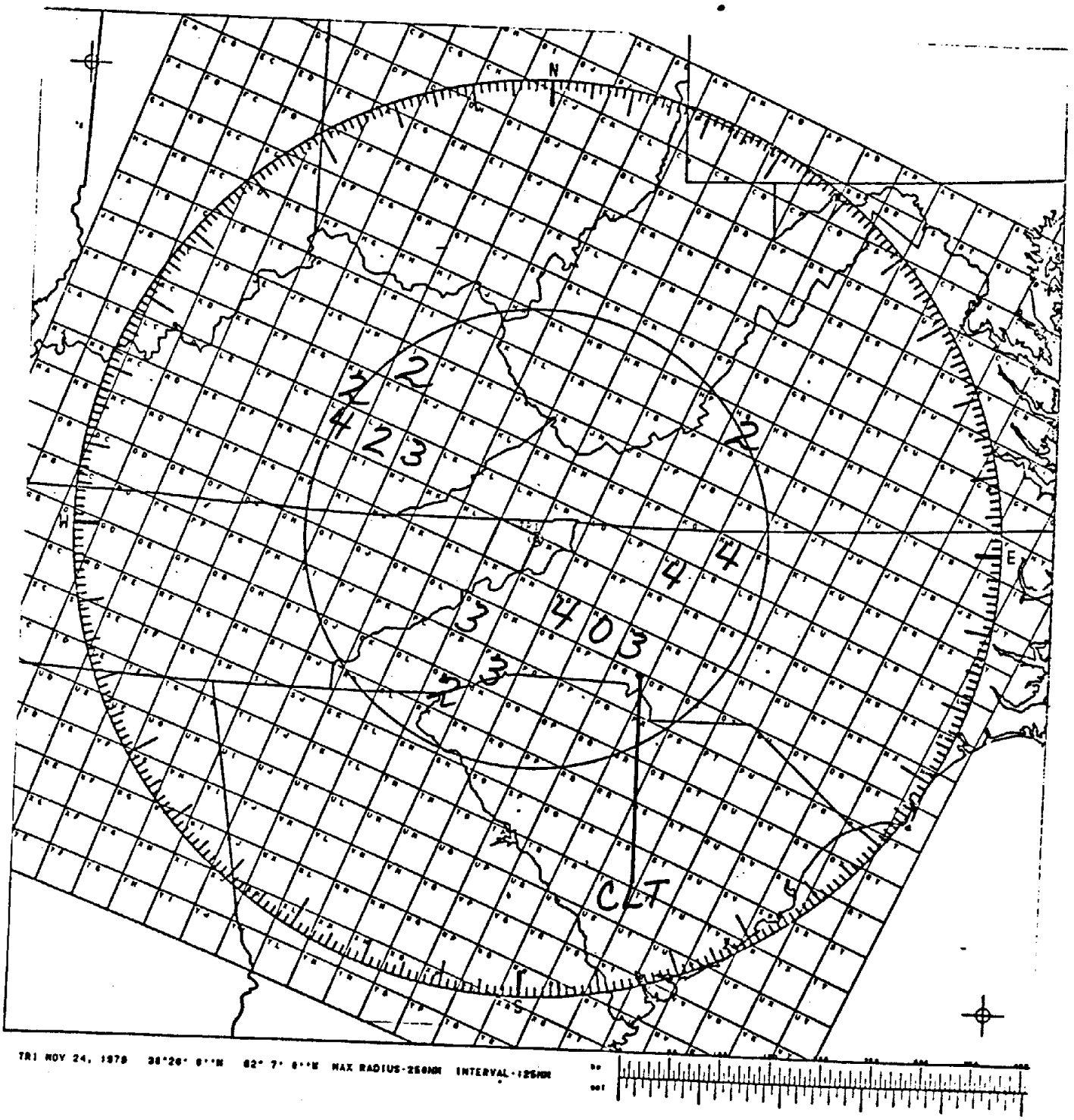
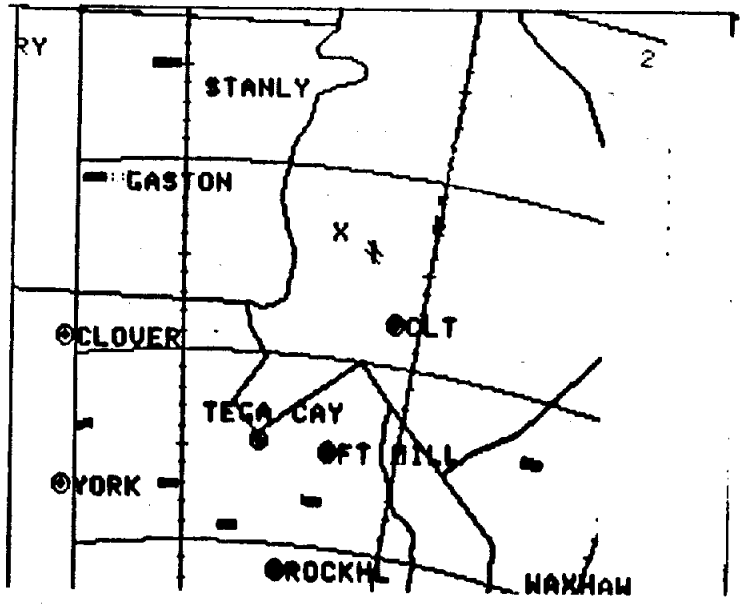
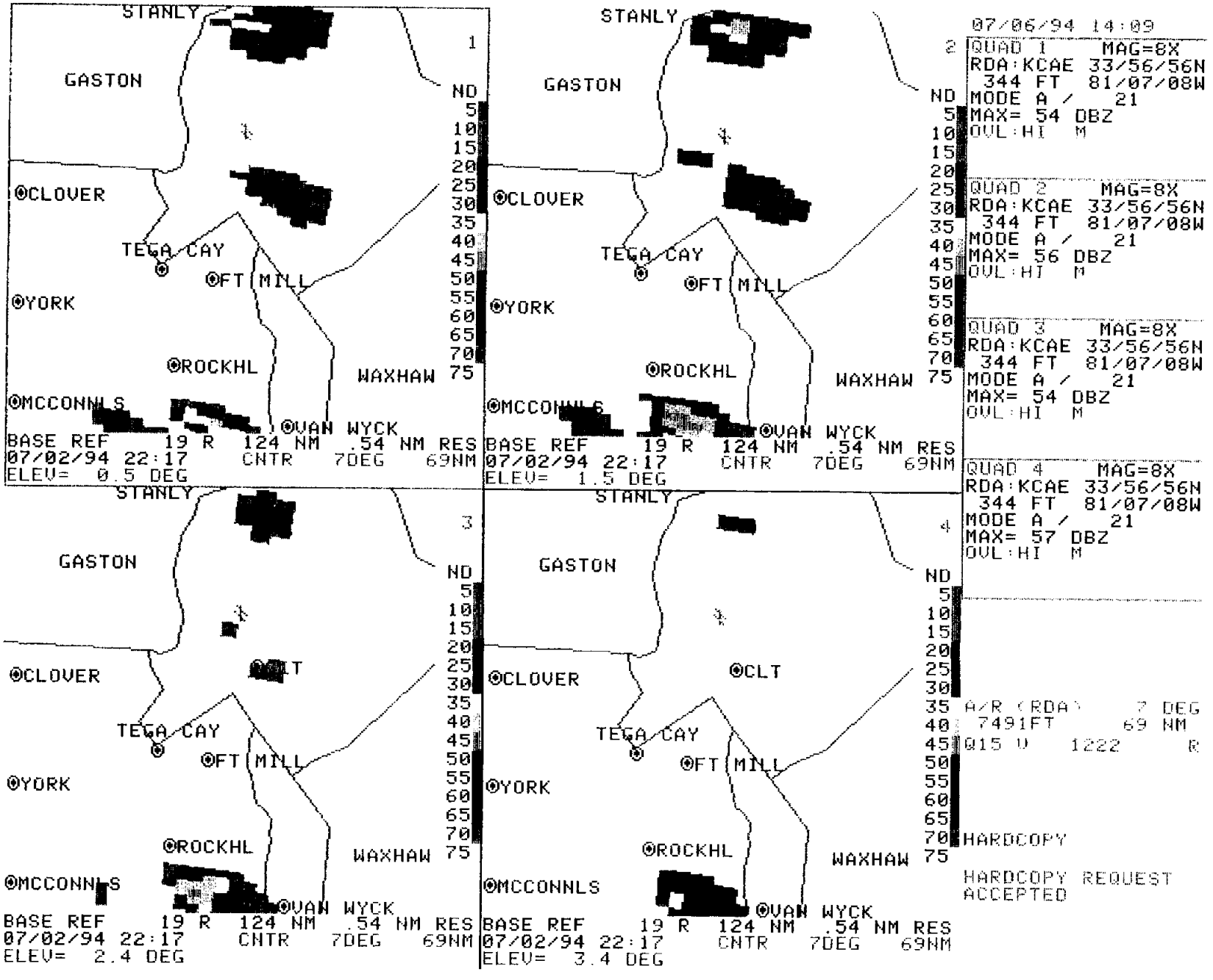


Figure 17.--250 nautical mile radar code grid for Bristol, Tenn.

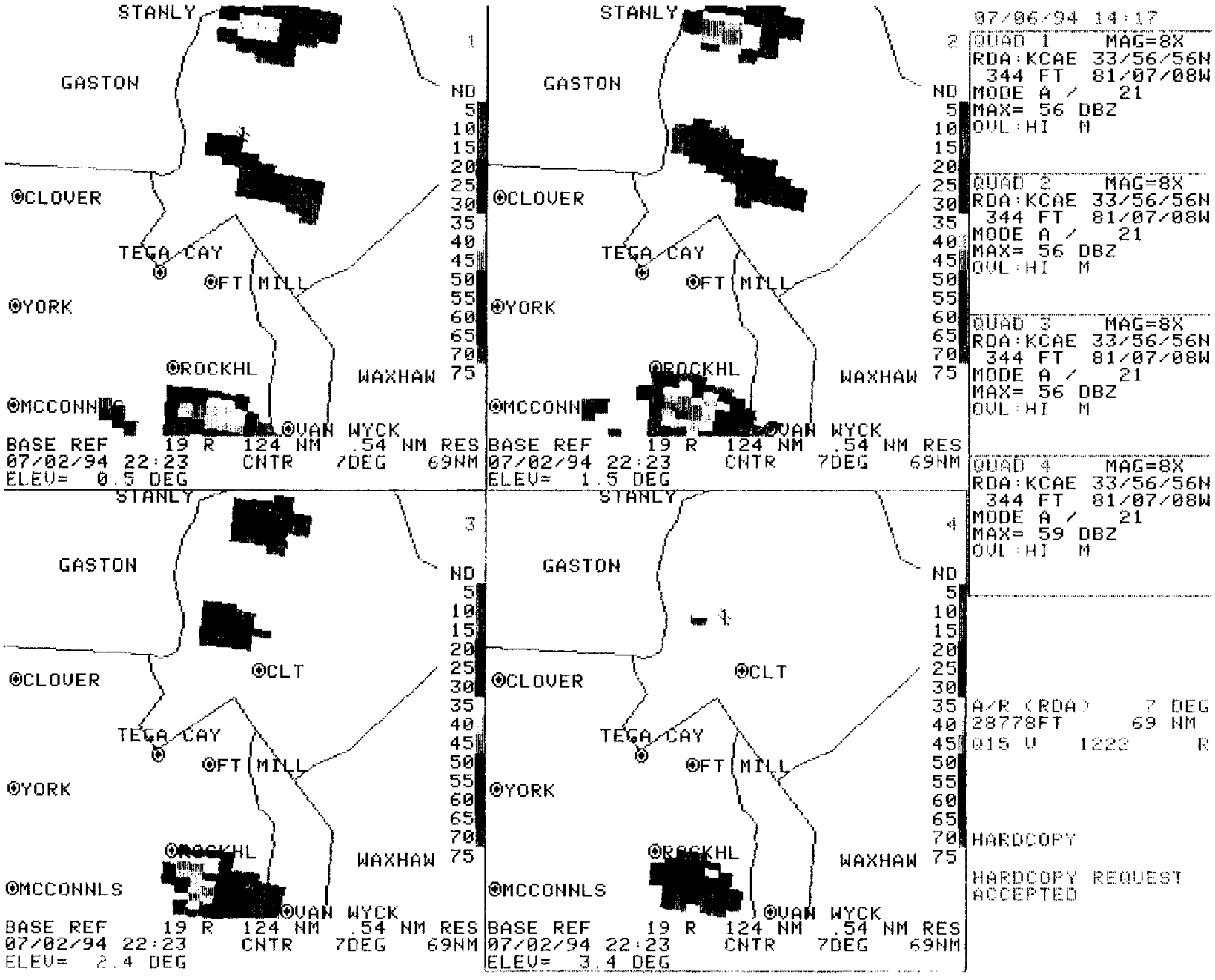
ATTACHMENT 16



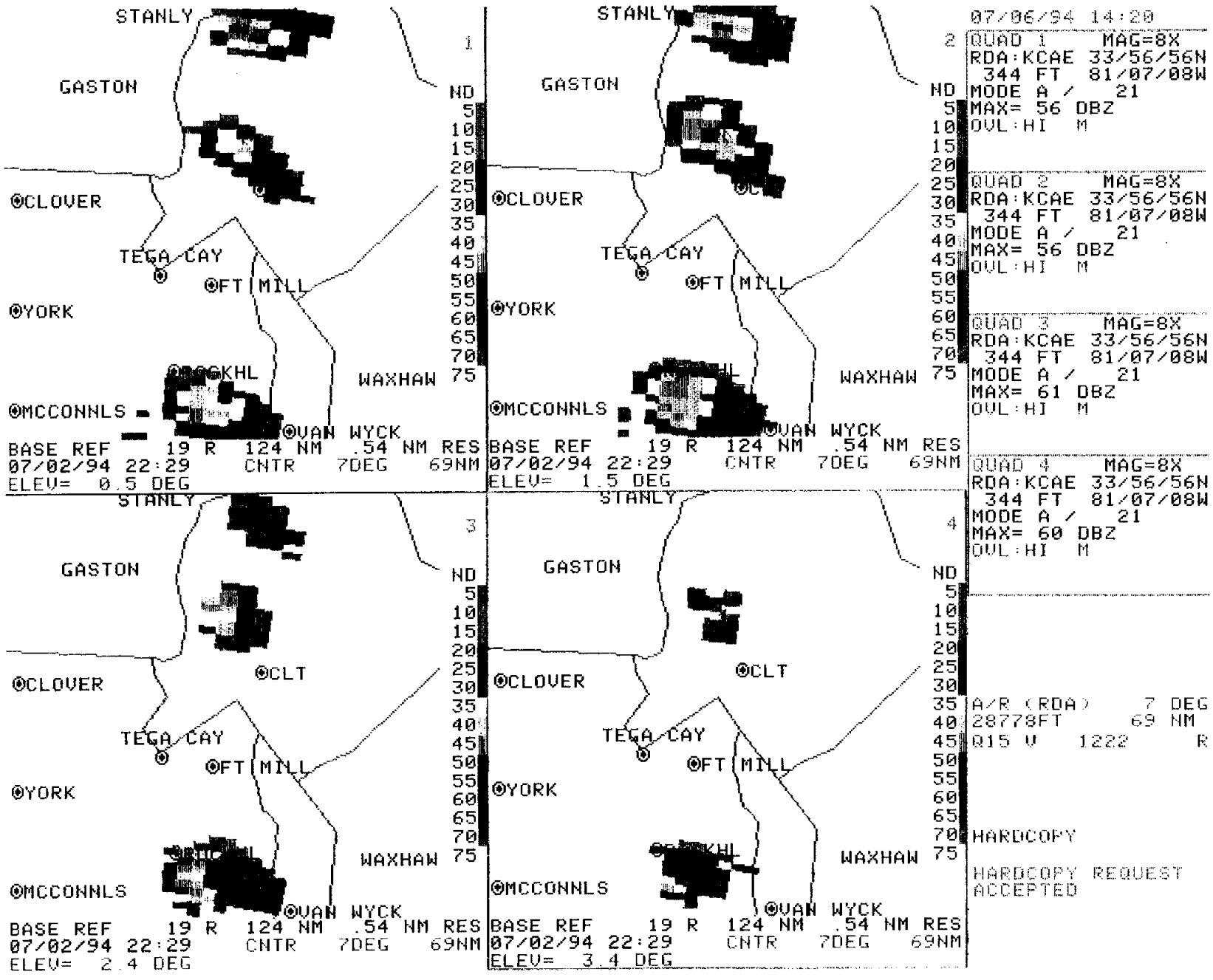
ATTACHMENT A



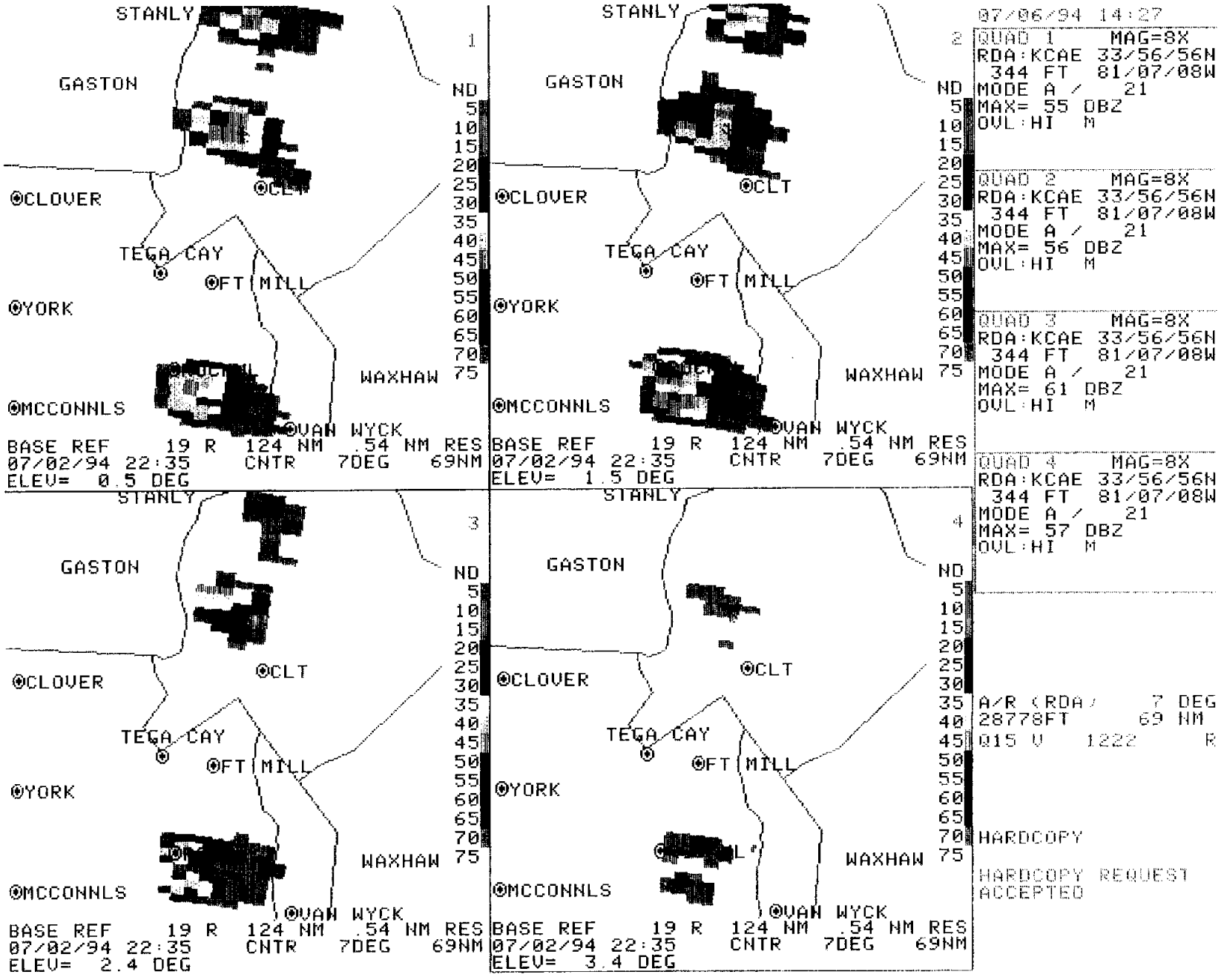
ATTACHMENT 17



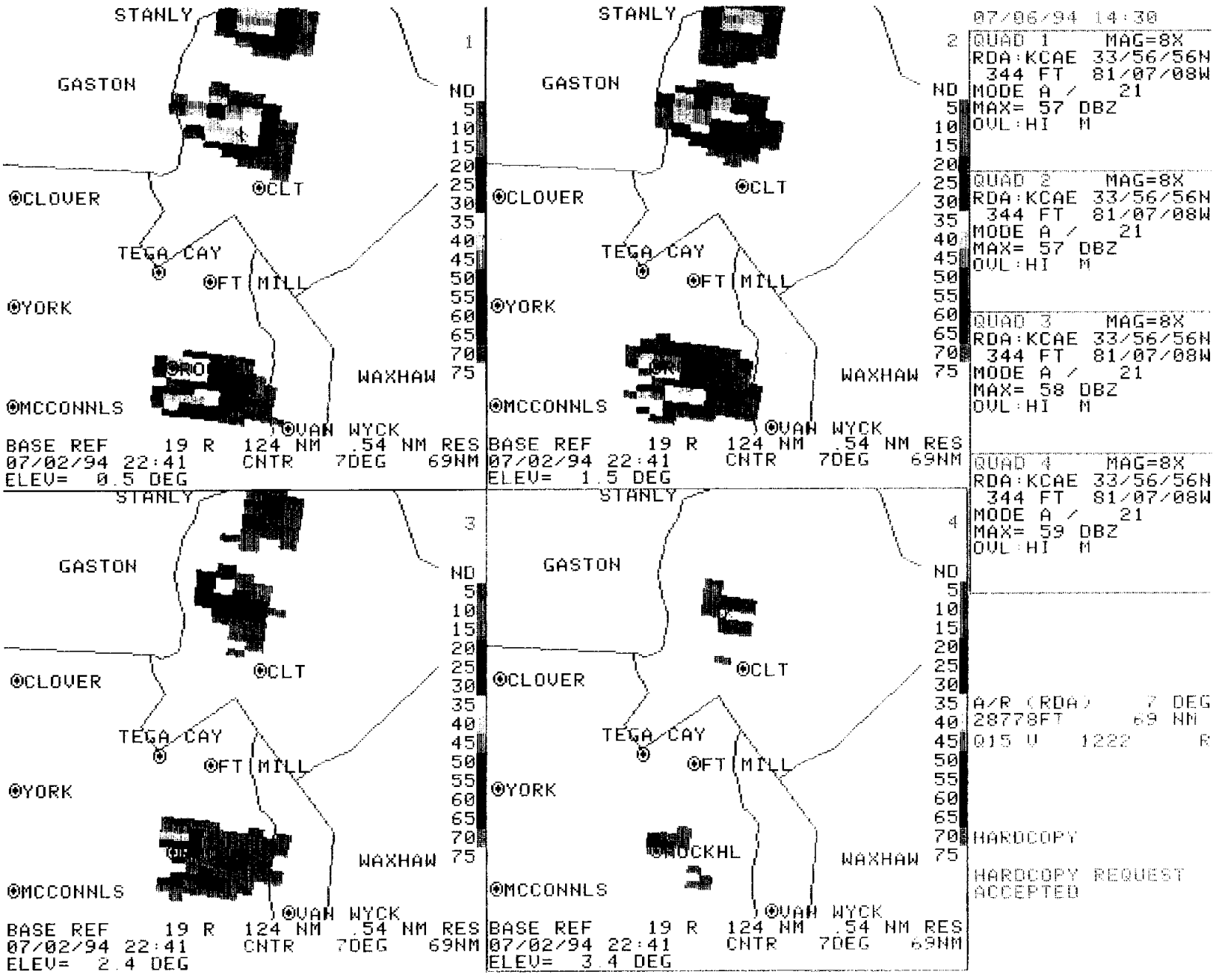
ATTACHMENT 18



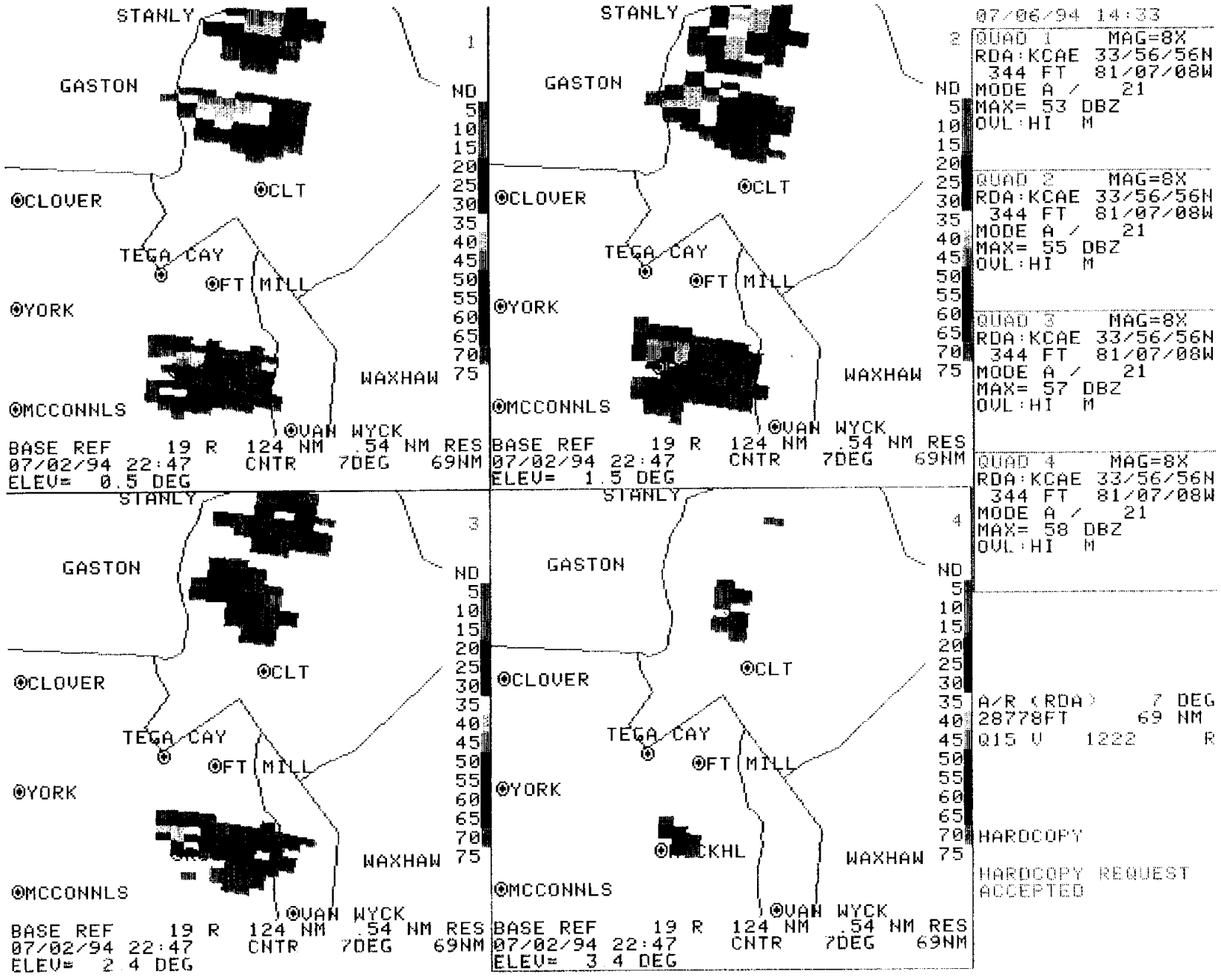
ATTACHMENT 19



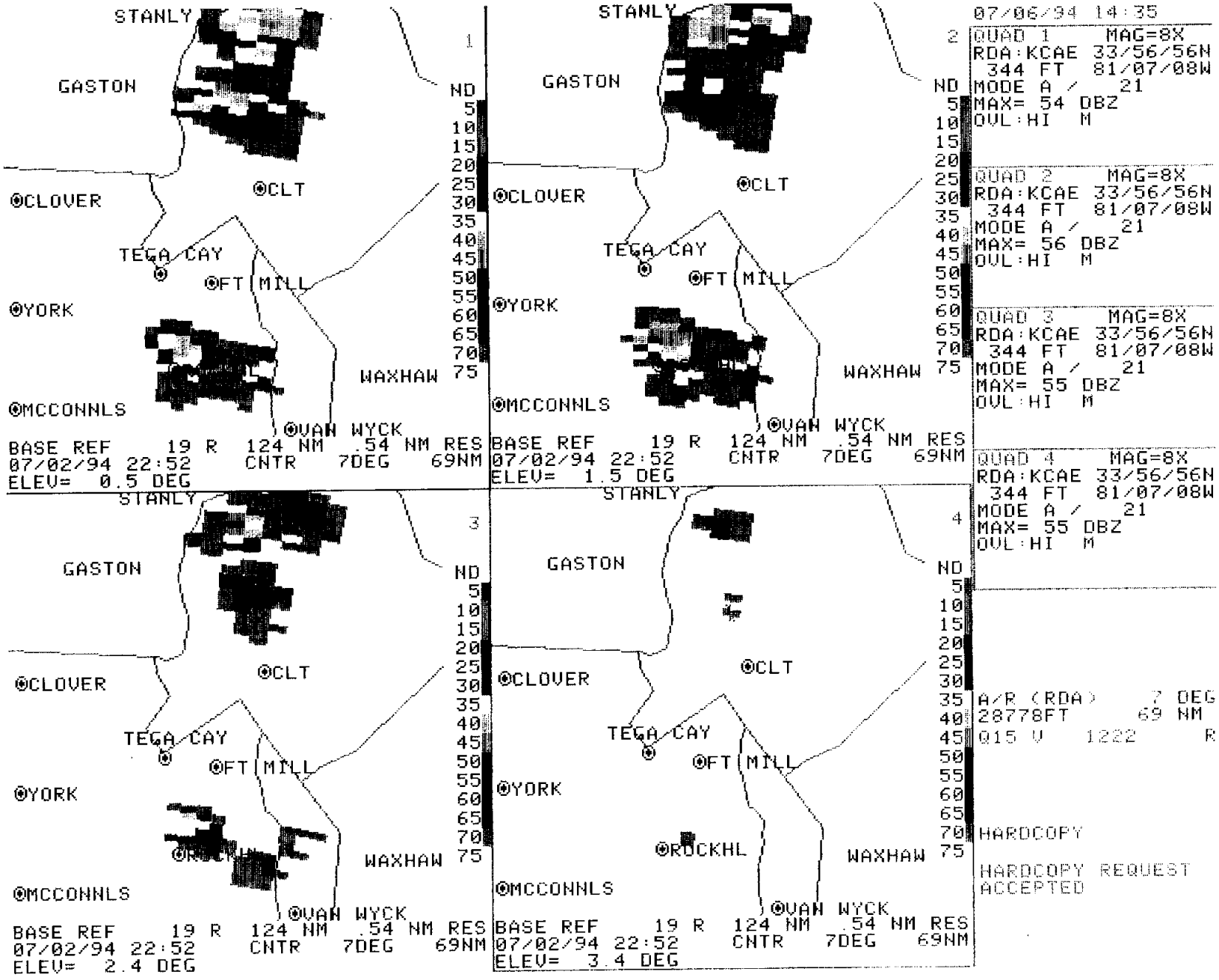
ATTACHMENT 2.0



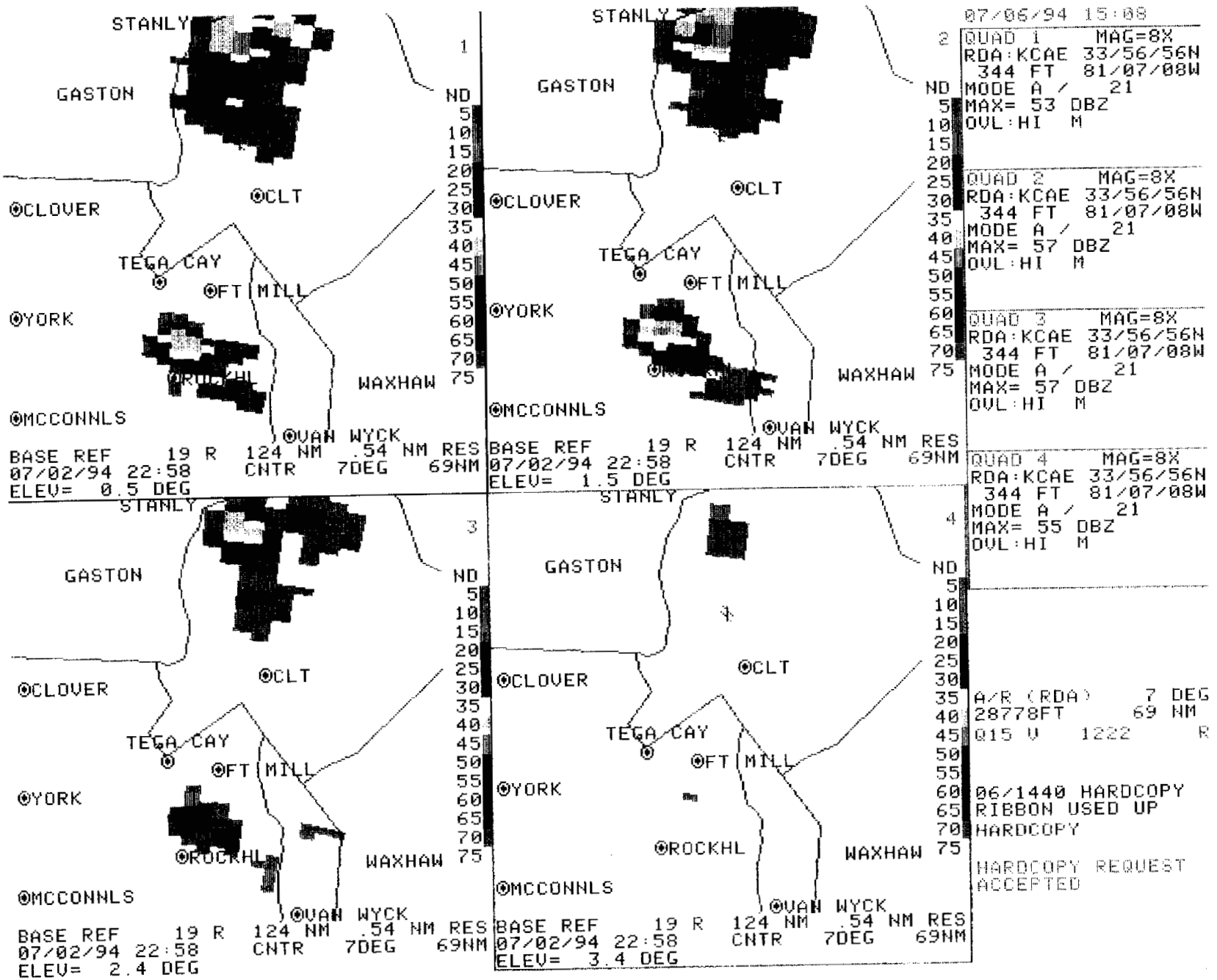
ATTACHMENT 21



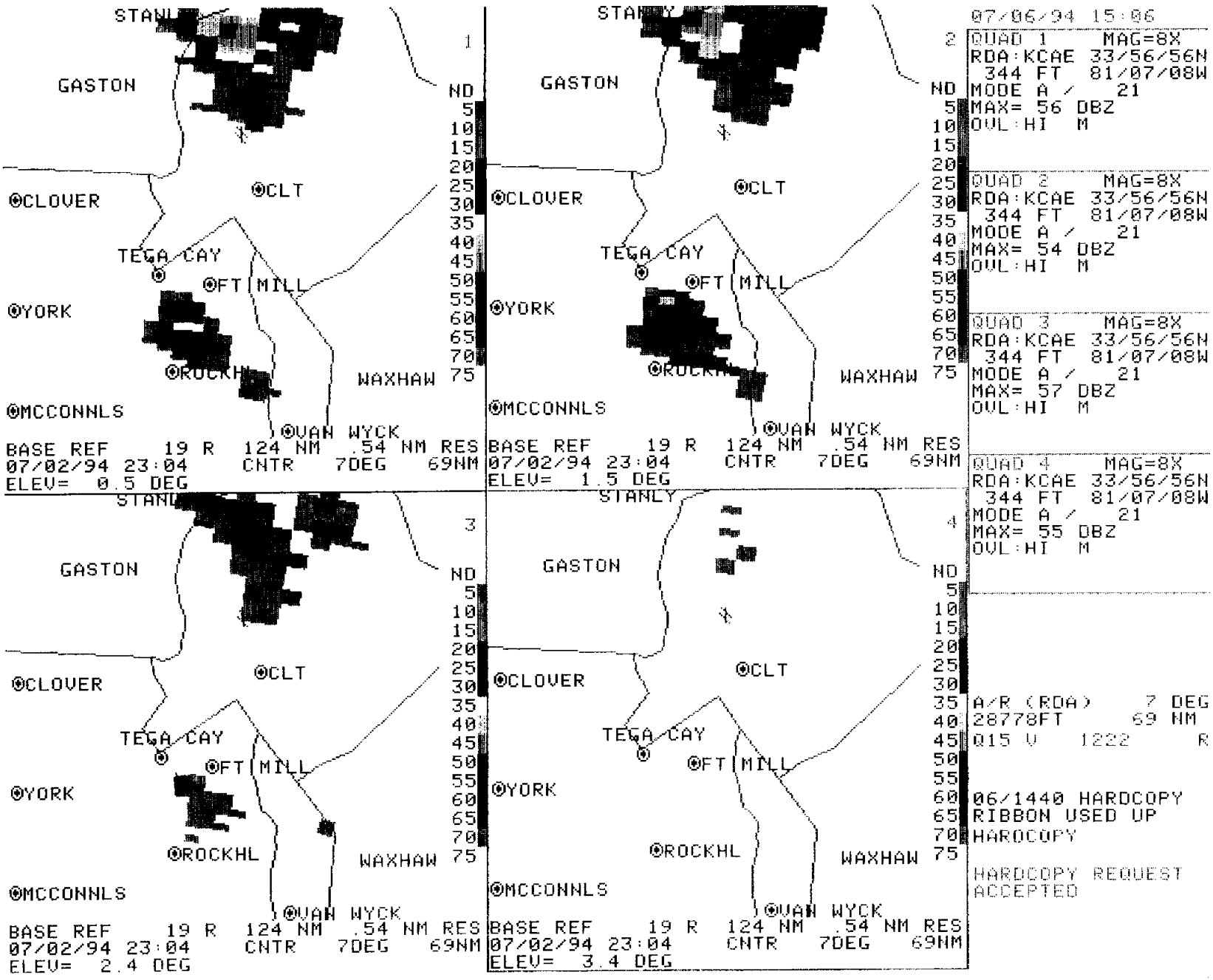
ATTACHMENT 22



ATTACHMENT 23



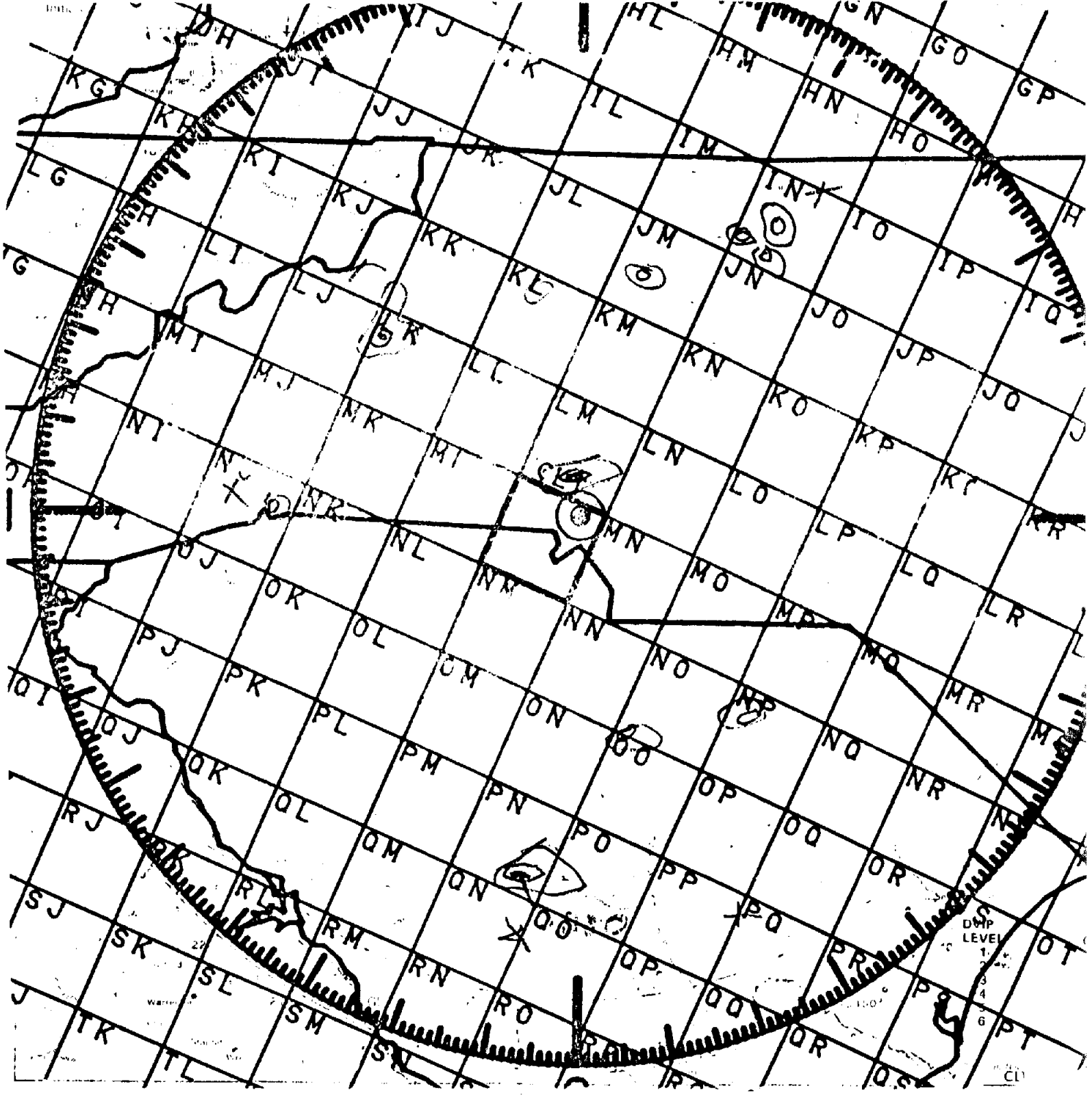
ATTACHMENT 24



ATTACHMENT 25

7/2/94
022330Z

CLT WSO



ATTACHMENT 26

WF 7-60 (6-78)
PRES. By FMH-7

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

PAGE 1

WEATHER RADAR OBSERVATIONS

STATION: WSO Charlotte NC	RADAR AND DVIP CALIBRATION	DATE-TIME: 071300	MDS: -109dBM	FILM ROLL ON	DATE-TIME	COUNTER	OFF DATE-TIME	COUNTER	MONTH: July / YEAR: 1994
TYPE OF RADAR: (Z) WSR-74C (5cm)	RADAR AND DVIP CALIBRATION	DATE-TIME	MDS: -109dBM	FILM ROLL ON	DATE-TIME	COUNTER	OFF DATE-TIME	COUNTER	DATE-TIME: 30/0024 TO DATE-TIME

1 DATE	2 TIME	3 CONFIGURATION	4 COVERAGE TYPE INTENSITY	5 TREND	6 LOCATION	7 WIDTH DIAMETER	8 MOVEMENT SYSTEM	8 MOVEMENT CELLS	9 TOPS	10 REMARKS	11 INT.
1	10			/					AT	(RHI OK) (AZRAN OK)	Gu
/				/					AT	(D/VIP CLBR 011500 -109 dbm)	/
2	0330	AREA	2TRW++	/	34/95 156/95 189/95 276/80 316/75		.		280 AT 191/85		JT
/		17N2	LK303	/	NT2 NO22 CO2 PN4=				AT		JT
				/					AT		
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ATTACHMENT 2

2330 Z

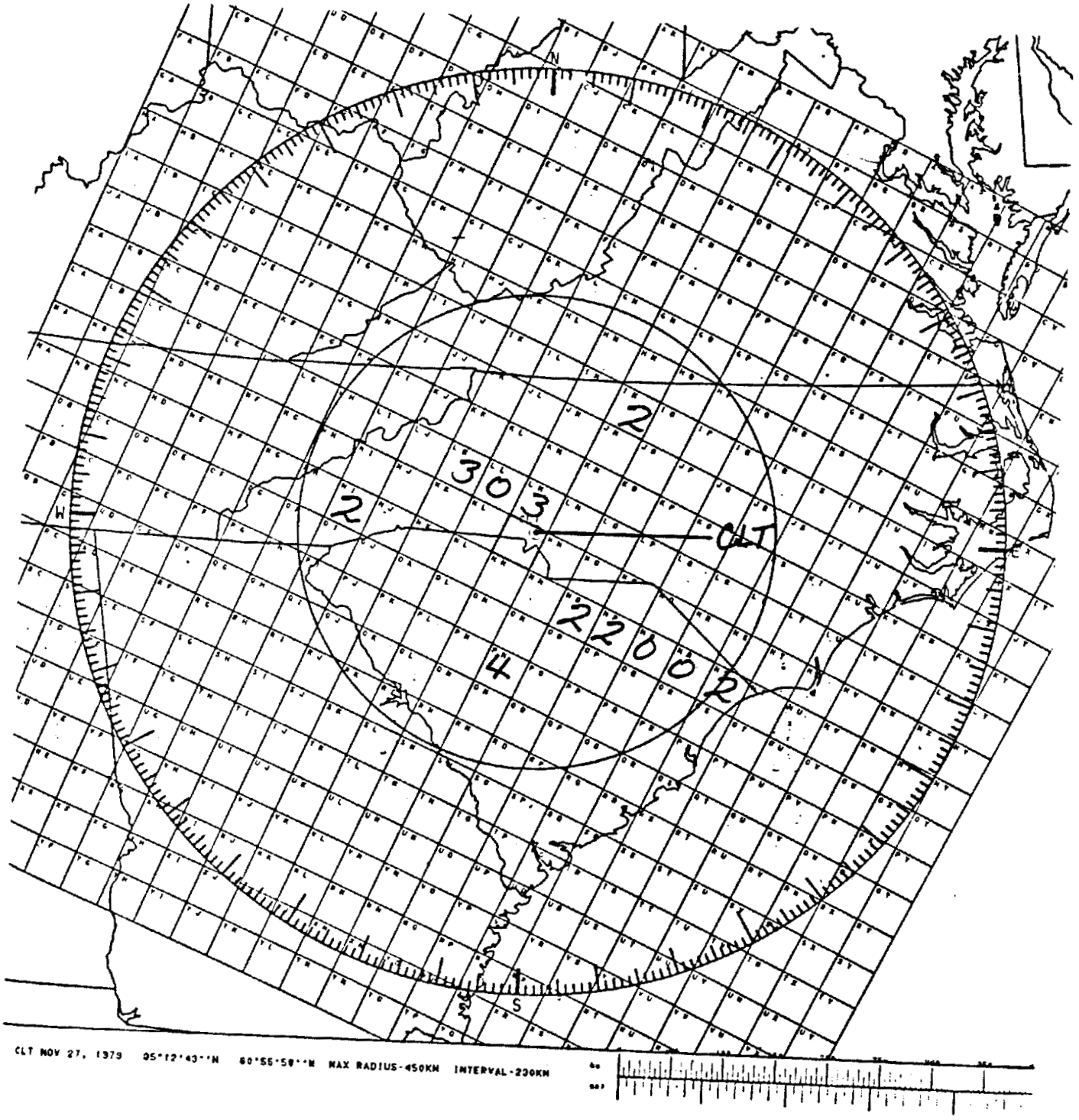


Figure 80.--450 kilometer radar code grid for Charlotte, N.C.

ATTACHMENT 28

ECHO INTENSITY CHART

(Combines Tables from FMH#7)

Symbol	VIP Level	Echo Intensity	Estimated Precipitation	Digital Code No.	PPI Display	Rainfall Rate (in/hr) Stratiform*	Convective**	dBZ#
				0				
-	1	Weak	Light	1	Gray	$\leq$0.1	$\leq$0.2	30
	2	Moderate	Moderate	2	White	0.1 - 0.5	0.2 - 1.1	41
+	3	Strong	Heavy	3	Black	0.5 - 1.0	1.1 - 2.2	46
++	4	Very Strong	Very Heavy	4	Gray		2.2 - 4.5	50
X	5	Intense	Intense	5	White		4.5 - 7.1	57
XX	6	Extreme	Extreme	6	Black		$\geq$7.1	
U		Unknown	Unknown	8 or 9		Unknown	Unknown	

* Based on $Z = 200R^{1.6}$. Z is reflectivity and R is rainfall rate. Very strong, Intense, and Extreme stratiform rain does not occur.

** VIP Level 1-5 are based on $Z = 55R^{1.6}$. Because hail is often observed with VIP Levels 5 and 6, this Z/R relationship becomes inaccurate at high VIP levels. An empirically derived rainfall rate of 7.1 in/hr is used as the threshold between VIP Levels 5 and 6.

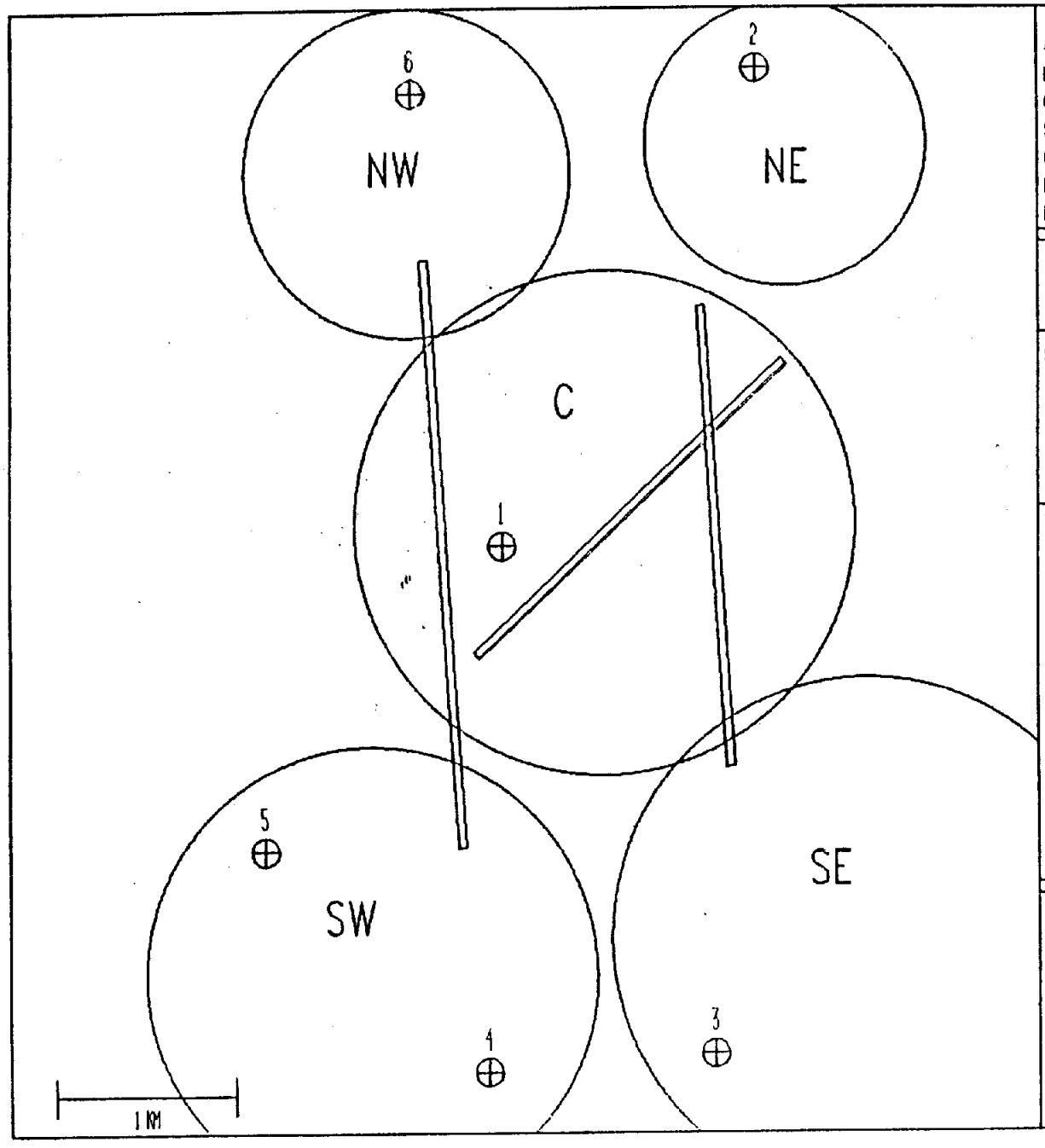
\# $dBZ = 10 \text{ Log}_{10} Z_e mm^6 m^{-3}$, where Z_e is the equivalent radar reflectivity.

ATTACHMENT 29

dBZ and DVIP Comparison (Precipitation Mode)

WSR-88D dBZ	WSR-57 dBZ	WSR-57 DVIP
75		6
70		6
65		6
60		6
55	57	6
50	50	5
45	46	4
40	41	3
35		2
30	30	2
25		1
20	18	1
15		
10		
5		
0		

ATTACHMENT 30



AIRPORT ID: CLT
NAME: Charlotte/Douglas Intl
CITY: Charlotte
STATE: NC
CONTRACTOR: Fairchild-Weston
REVISION #: 2
REVISION DATE: 2/23/93

STATIONS: 6
TRIANGLES: 7
EDGES: 15

STN #	LAT	LON	Z
1	35 12 50	80 56 55	20
2	35 14 10	80 55 59	56
3	35 11 25	80 56 8	68
4	35 11 22	80 56 58	55
5	35 11 59	80 57 47	58
6	35 14 6	80 57 15	60

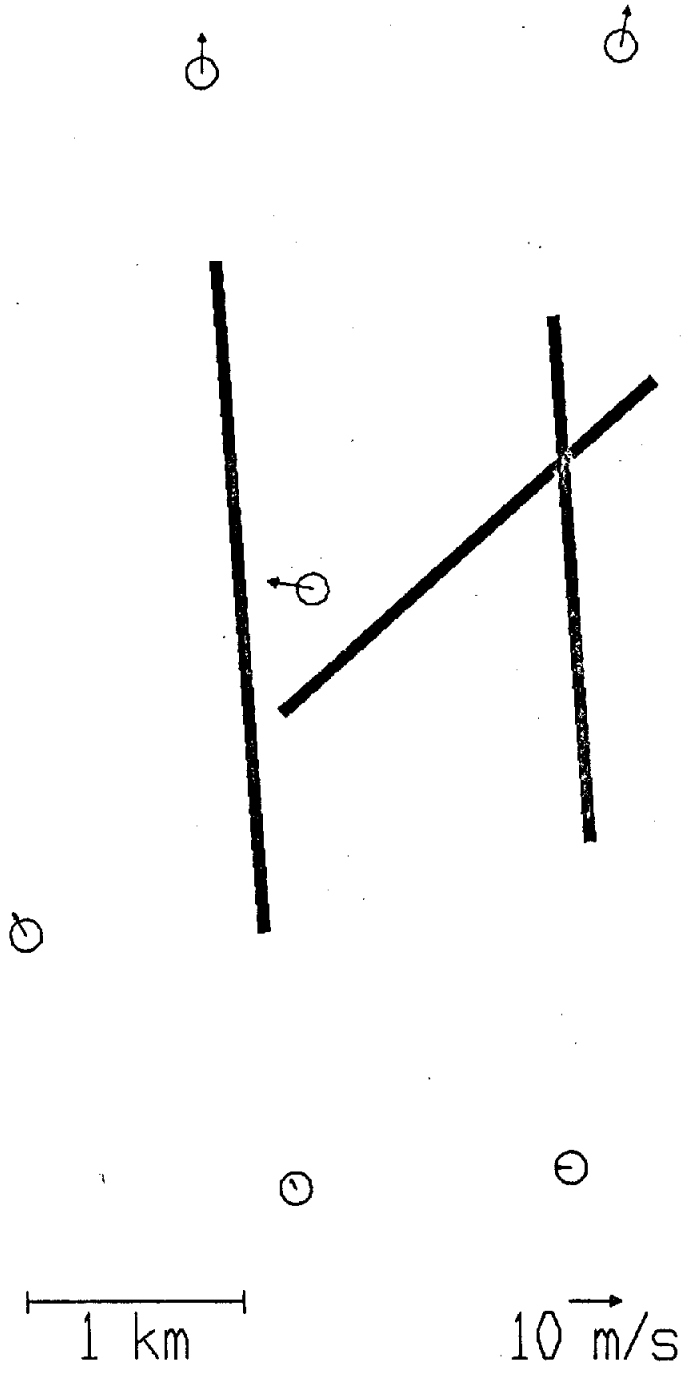
TRI #	VERTICES
1	1 2 3
2	1 3 4
3	1 3 5
4	1 4 5
5	1 6 2
6	2 3 5
7	3 5 6

EDGE #	END PTS.
1	1 2
2	1 3
3	1 4
4	1 5
5	1 6
6	2 3
7	2 4
8	2 5
9	2 6
10	3 4
11	3 5
12	3 6
13	4 5
14	4 6
15	5 6

SECTOR	STATIONS
C	1 1 1
NE	2 2 2
SE	3 3 3
SW	4 5 5
NW	6 6 6

FAA TECHNICAL CENTER

ATTACHMENT 31



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:41:17 UTC

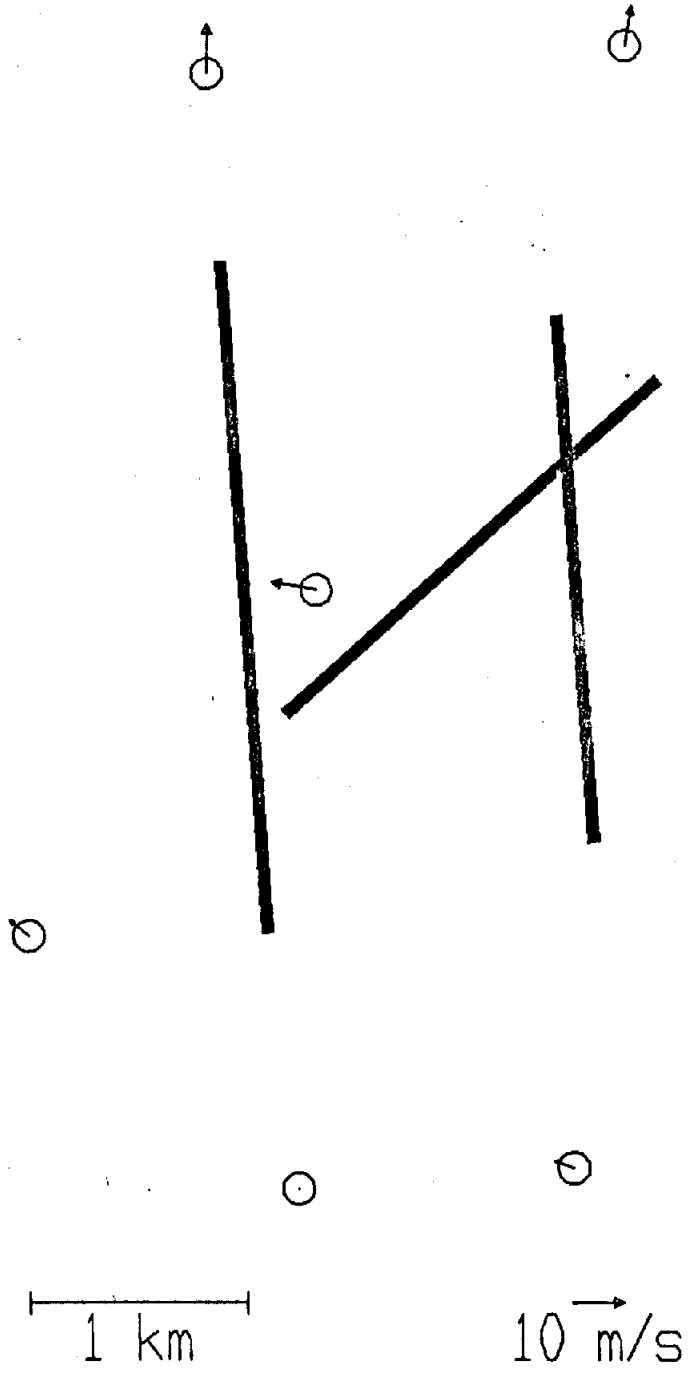
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 32



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:41:27

STATION

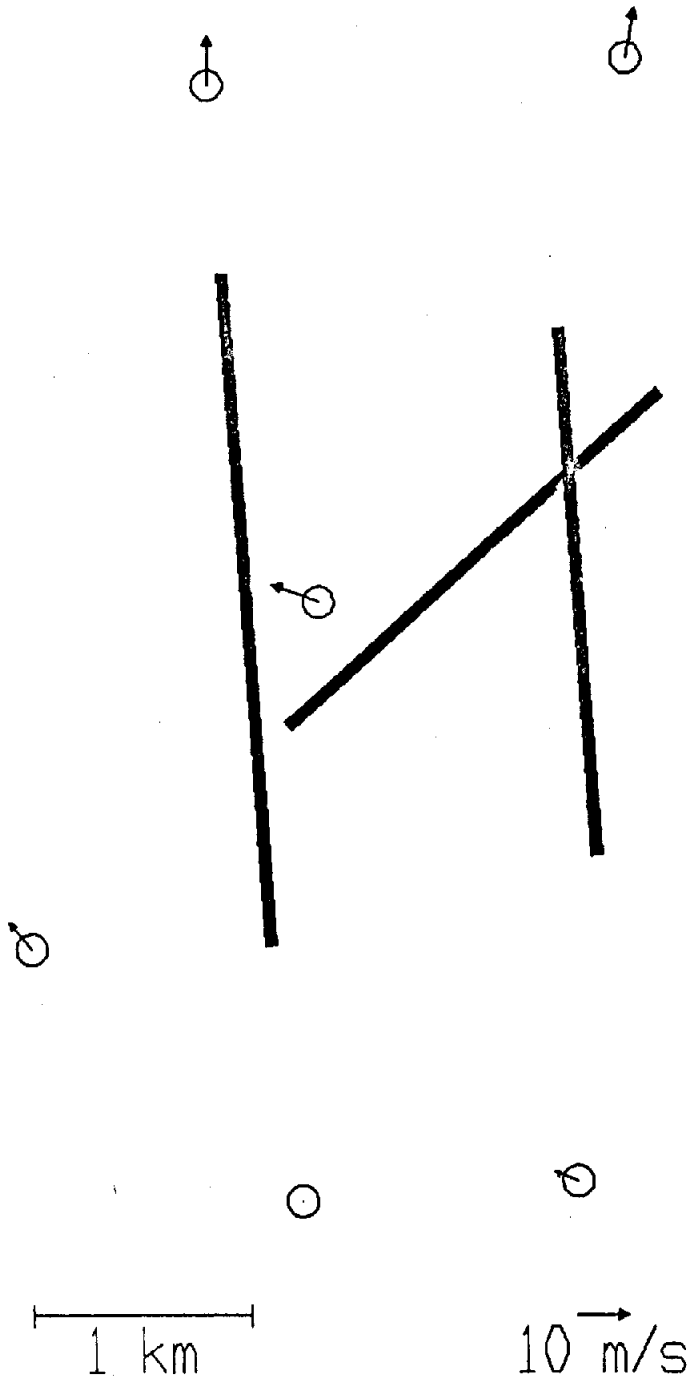
WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 33

ATTACHMENT 34



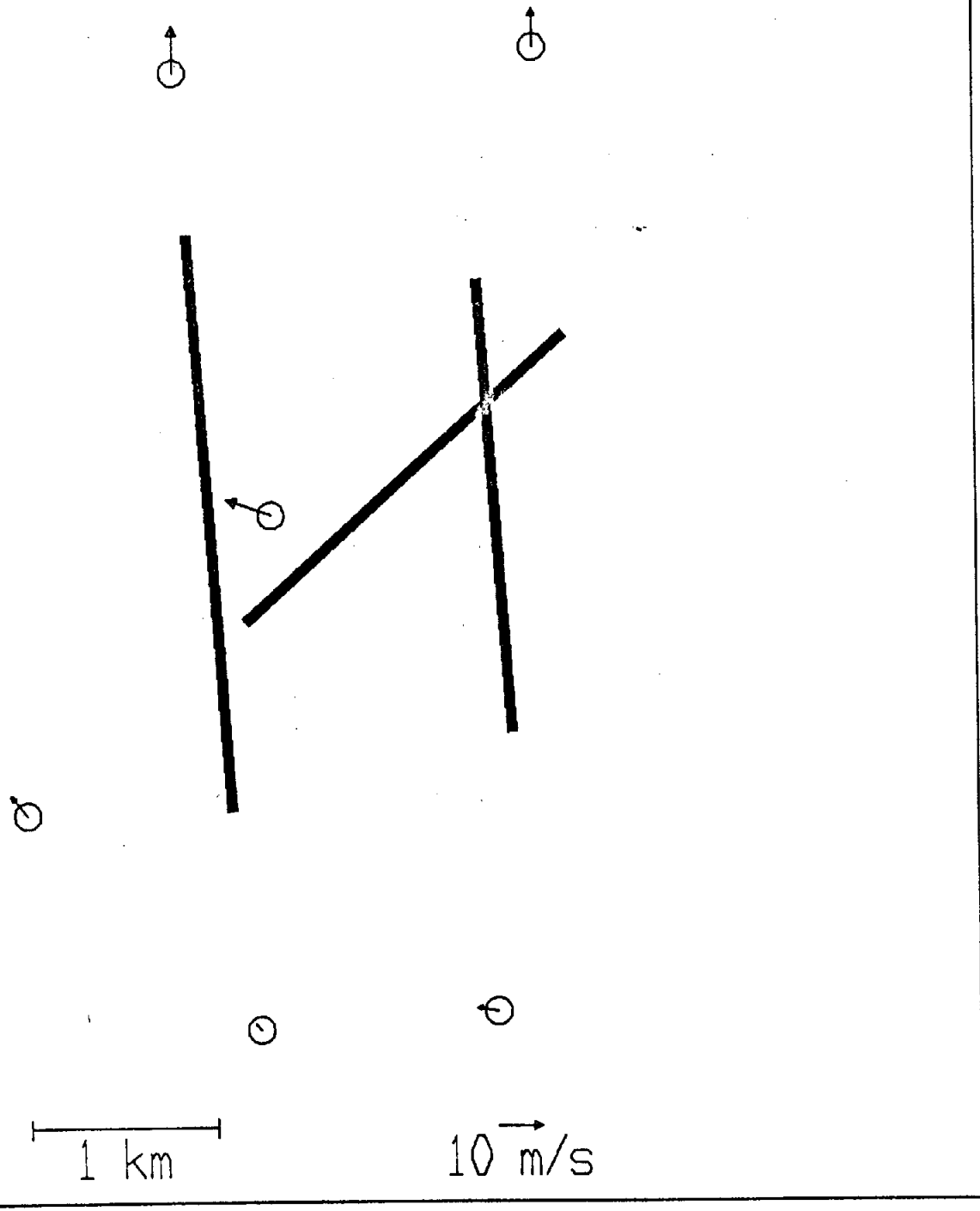
CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:41:37

STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:41:47

STATION

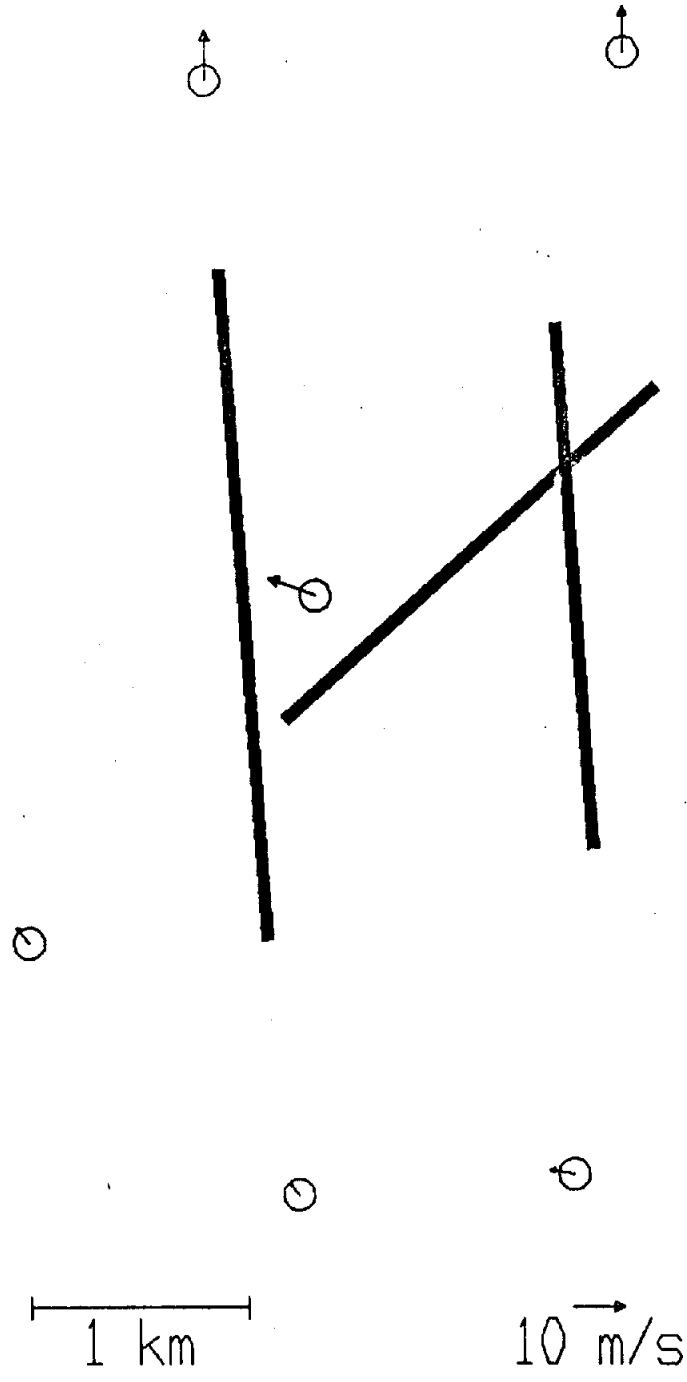
WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 35

CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:41:57



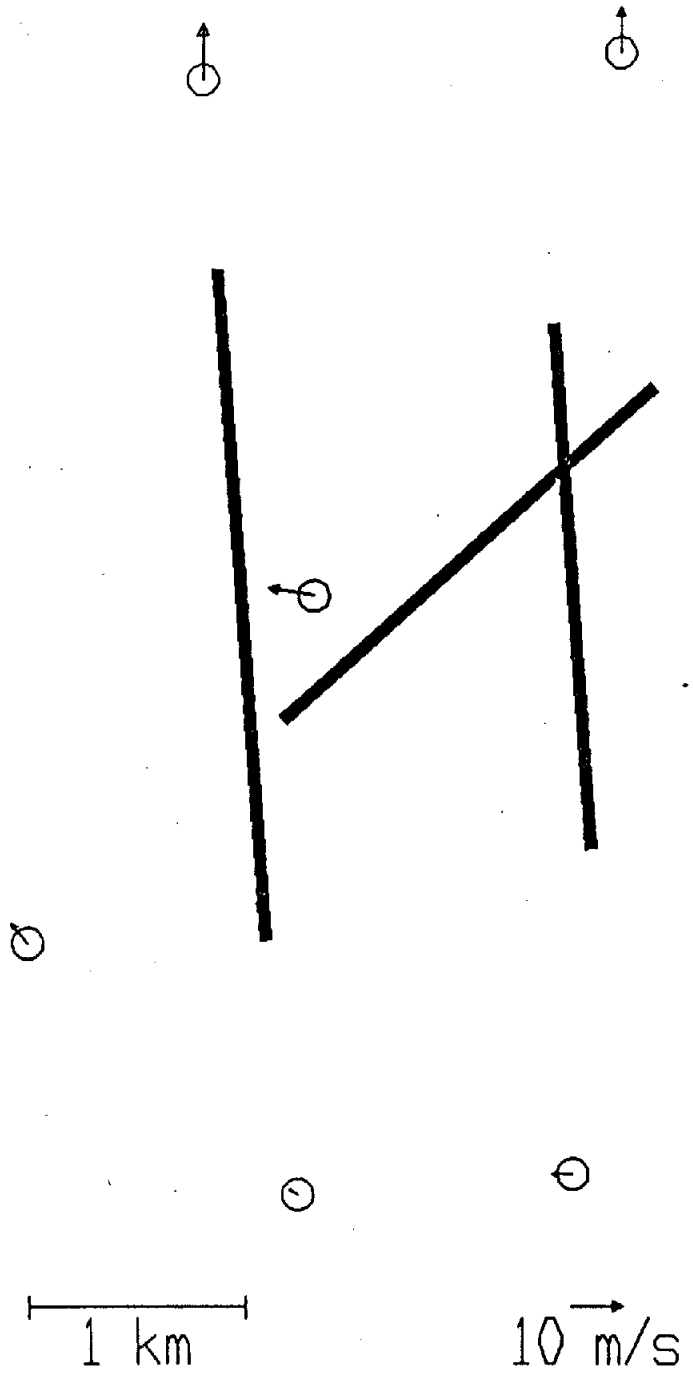
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 36



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42: 7

STATION

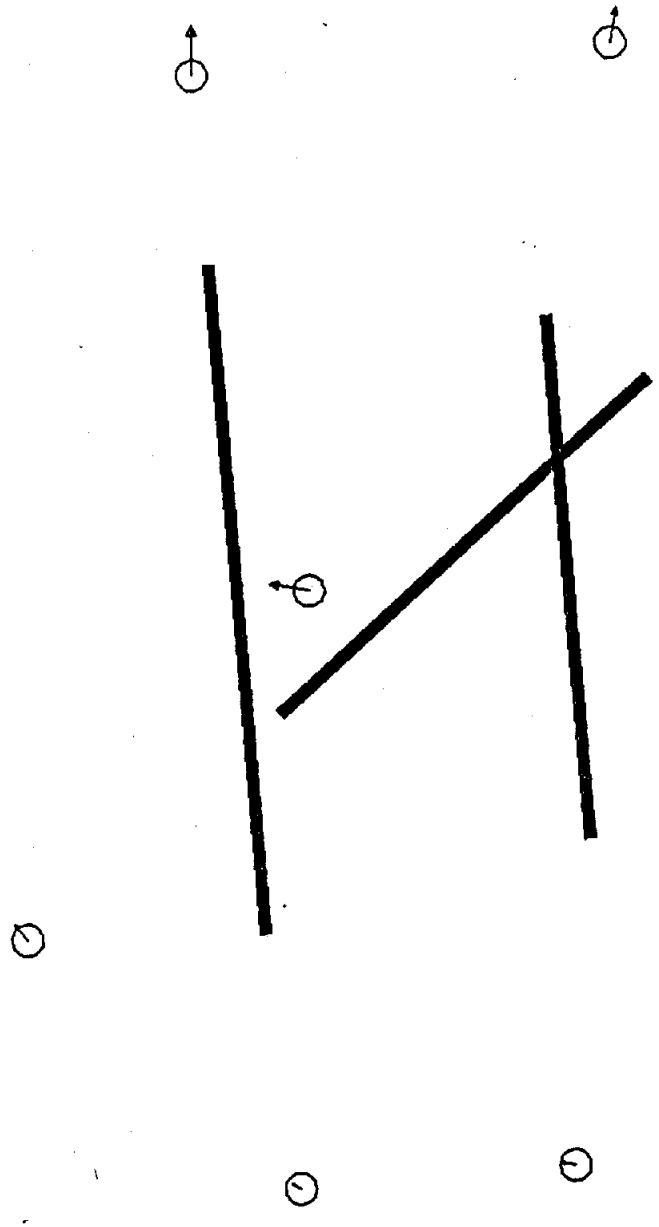
WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94.

ATTACHMENT 37

CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42:17



STATION

WIND VECTOR

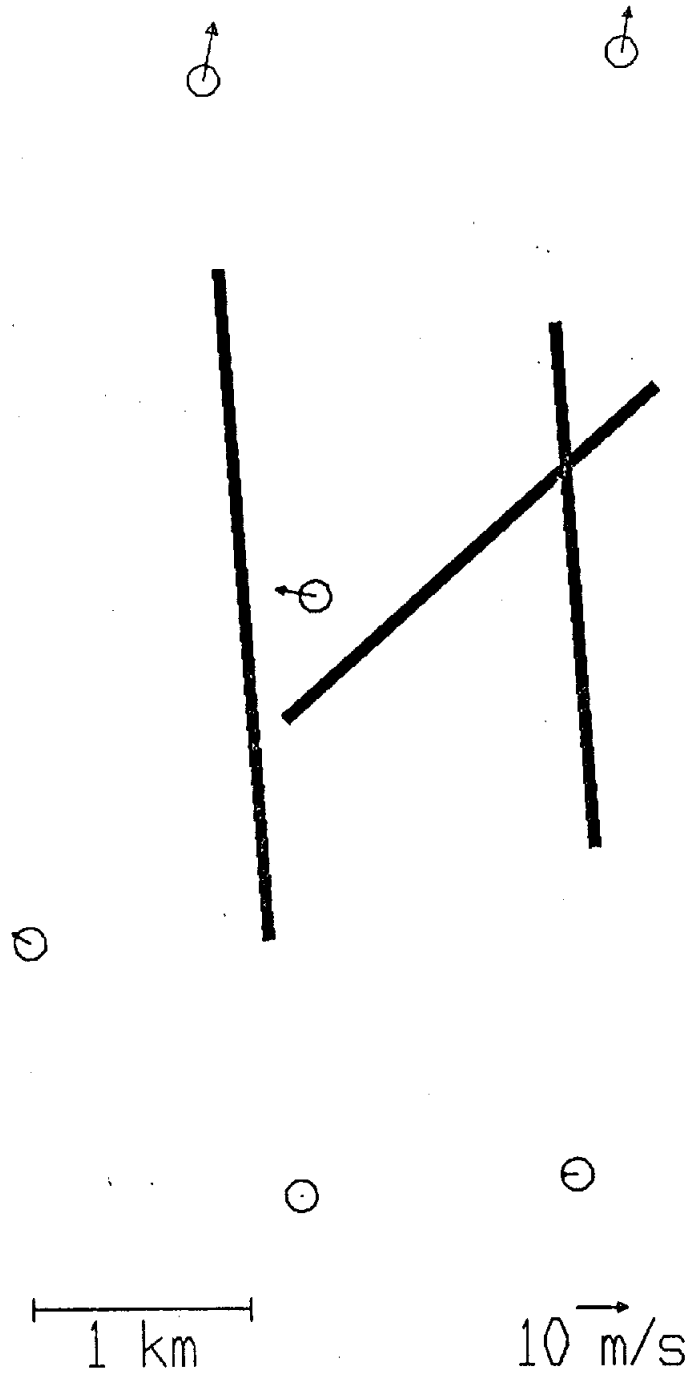
RUNWAY

1 km

10 m/s

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 38



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42:27

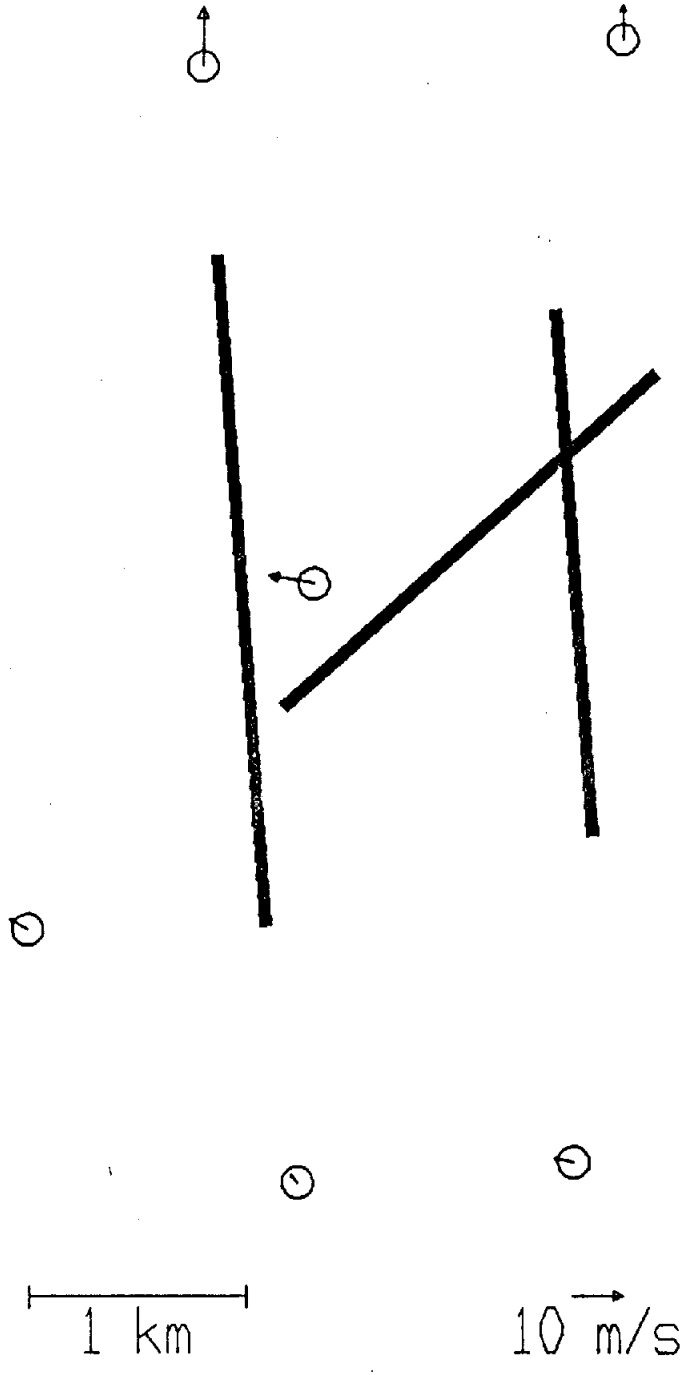
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 39



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42:37

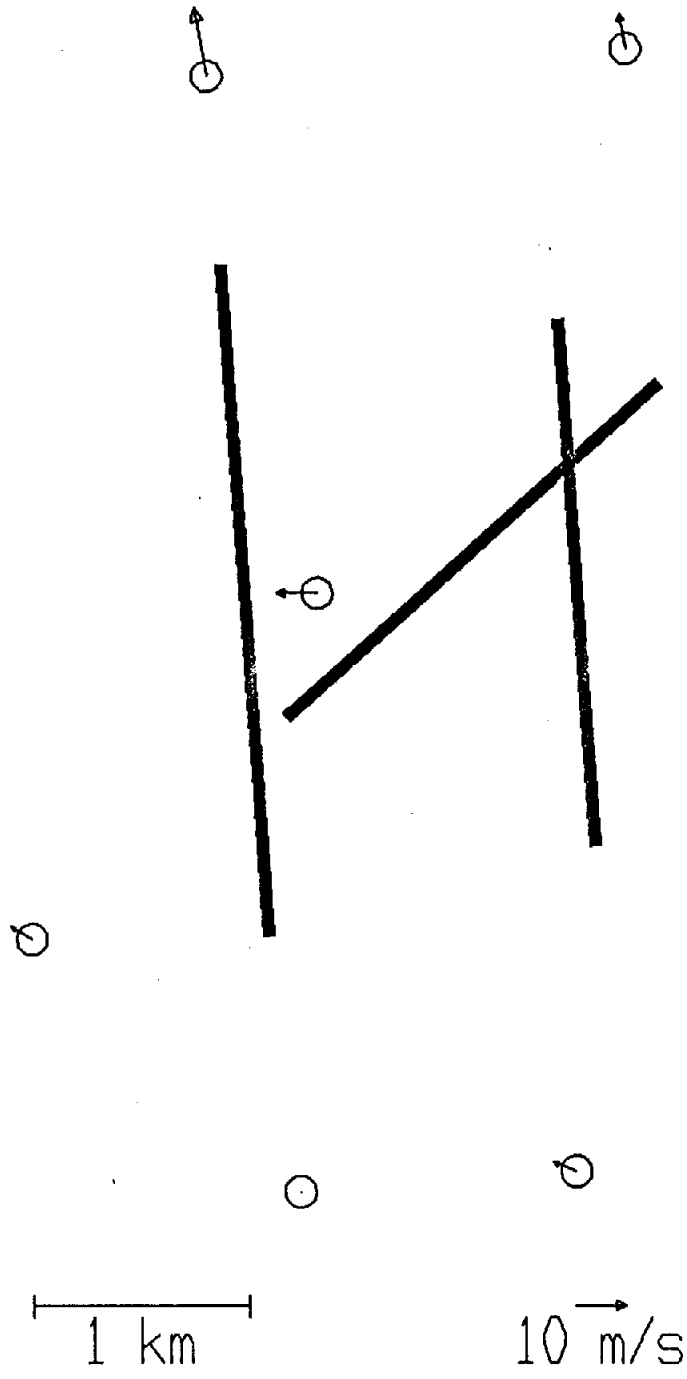
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 40



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42:47

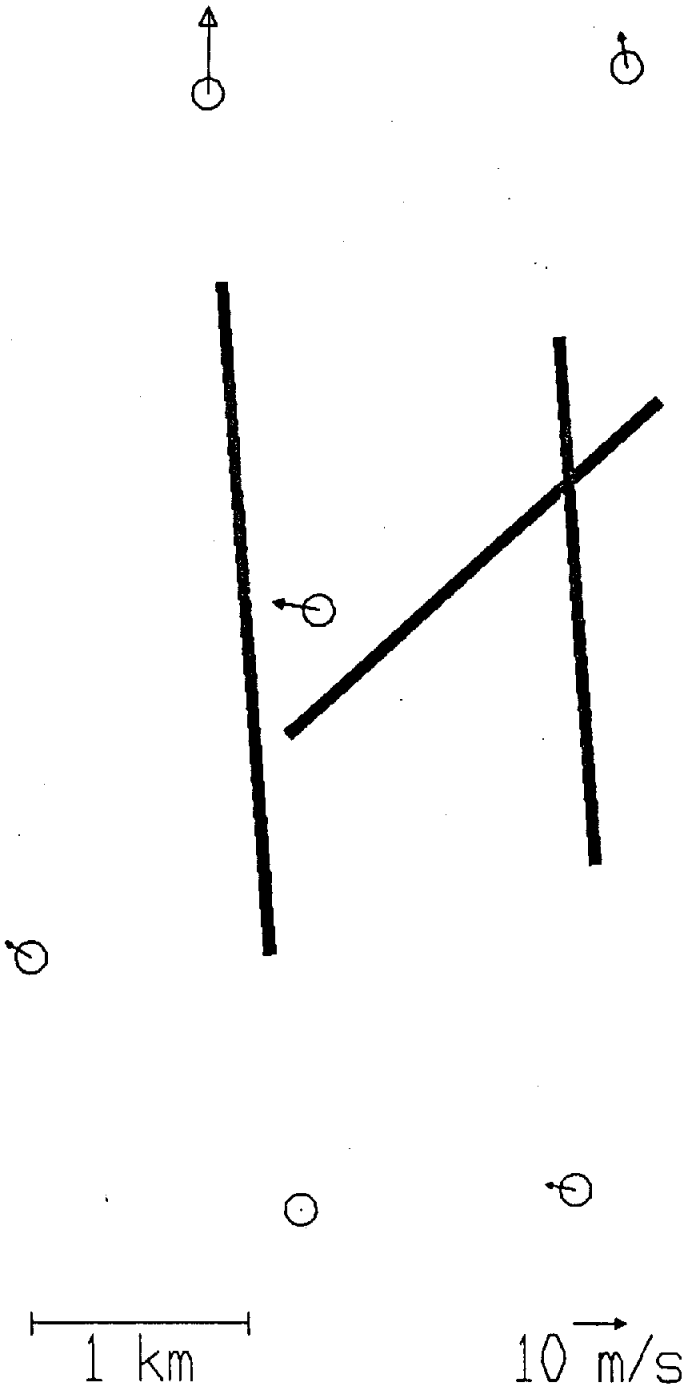
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94 .

ATTACHMENT 41



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:42:57

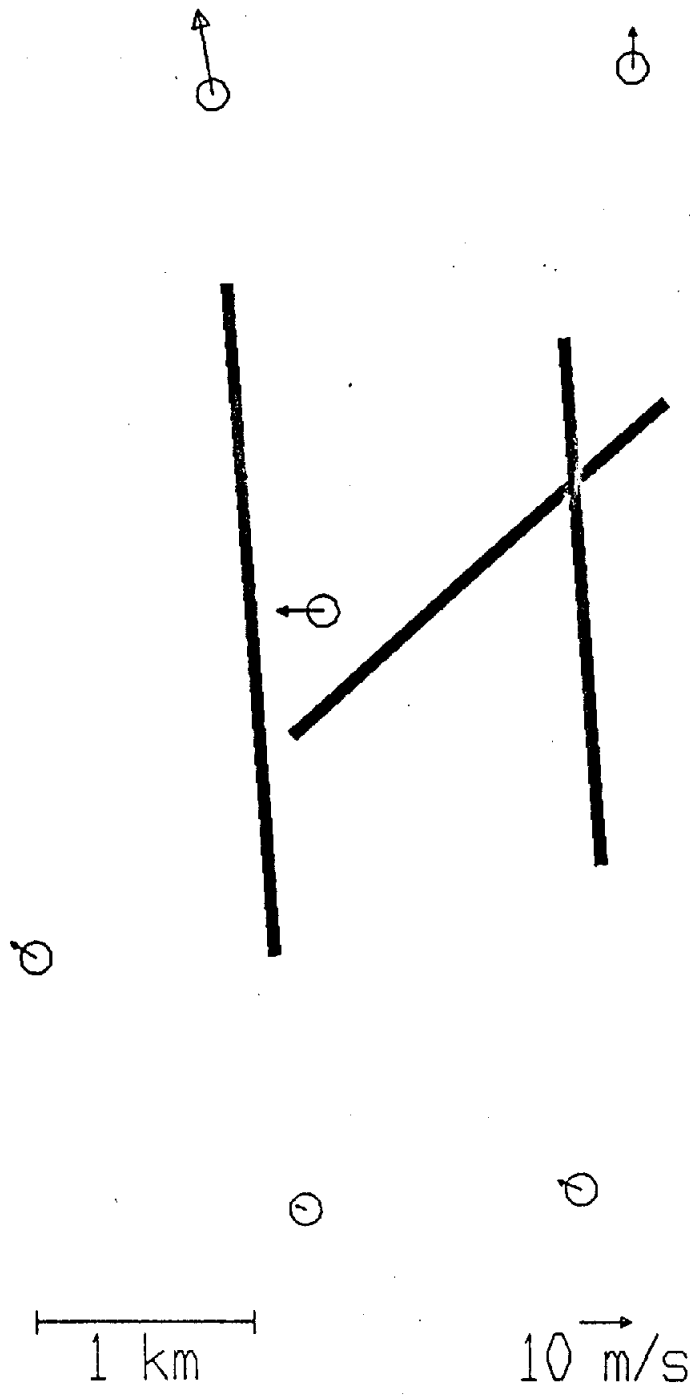
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 42



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43: 7

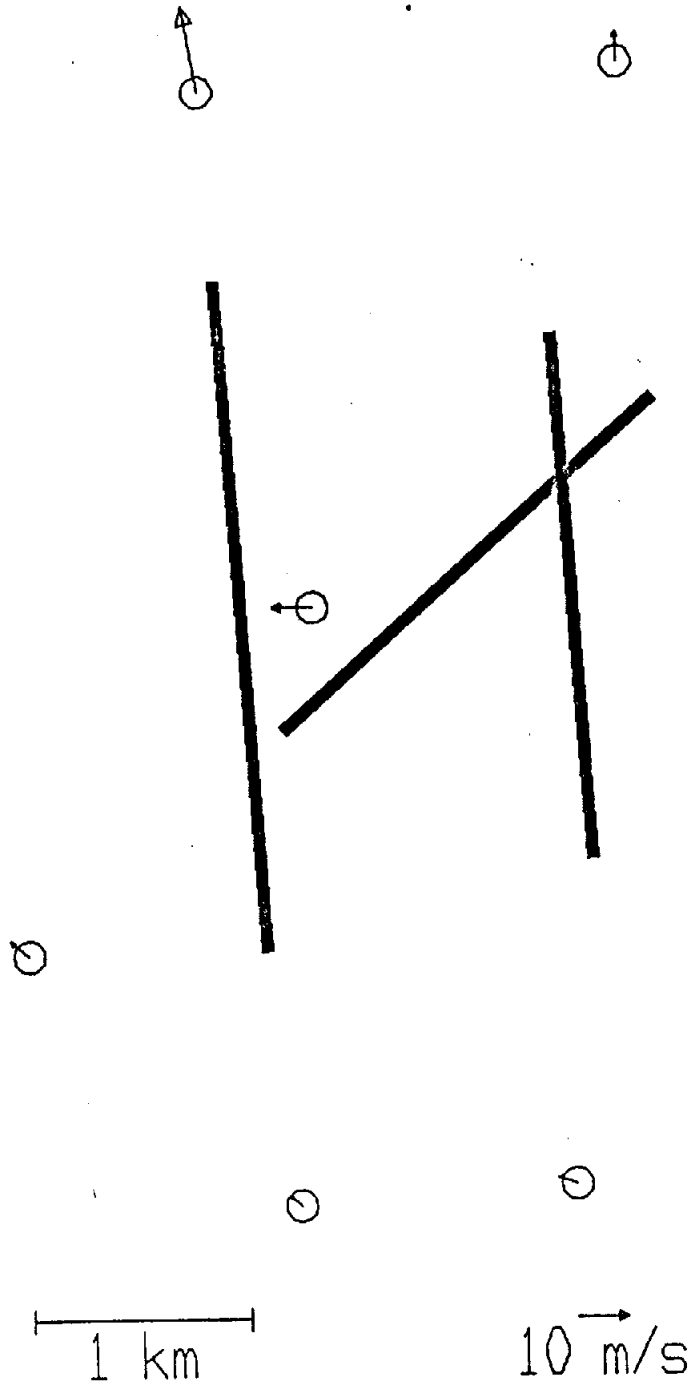
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 43



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43:17

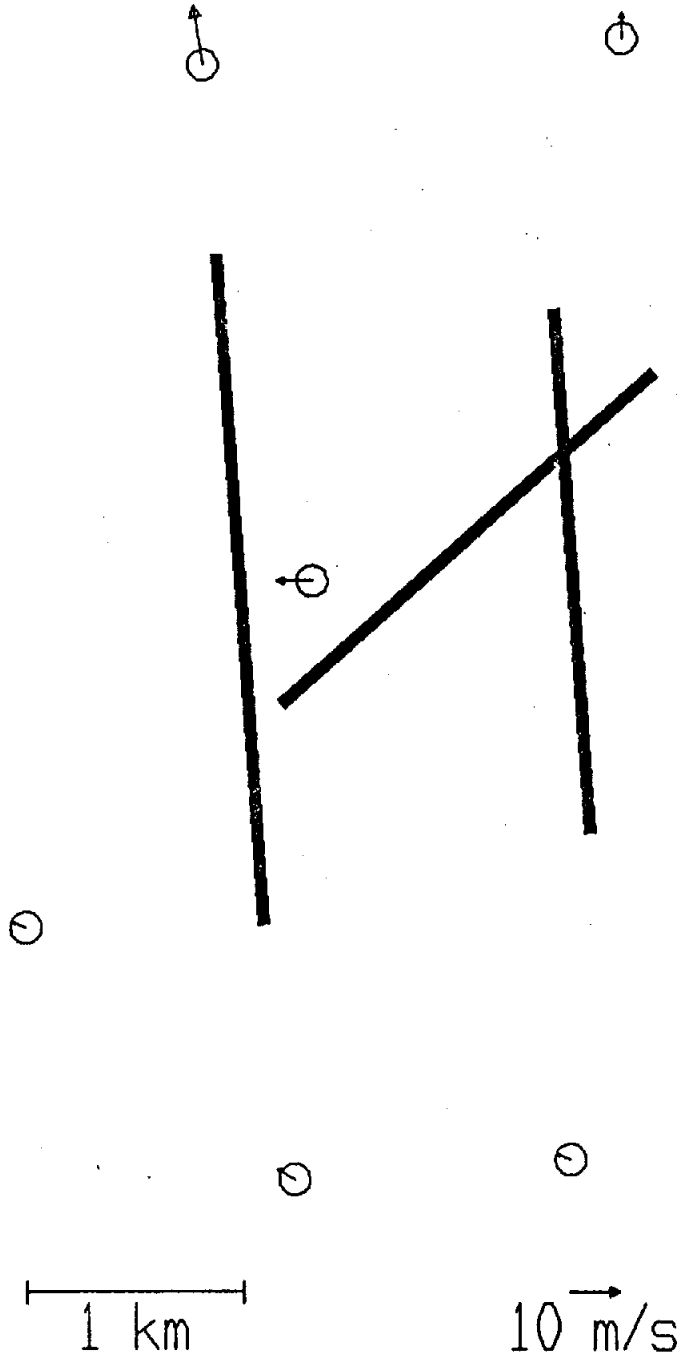
STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 44



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43:27

STATION

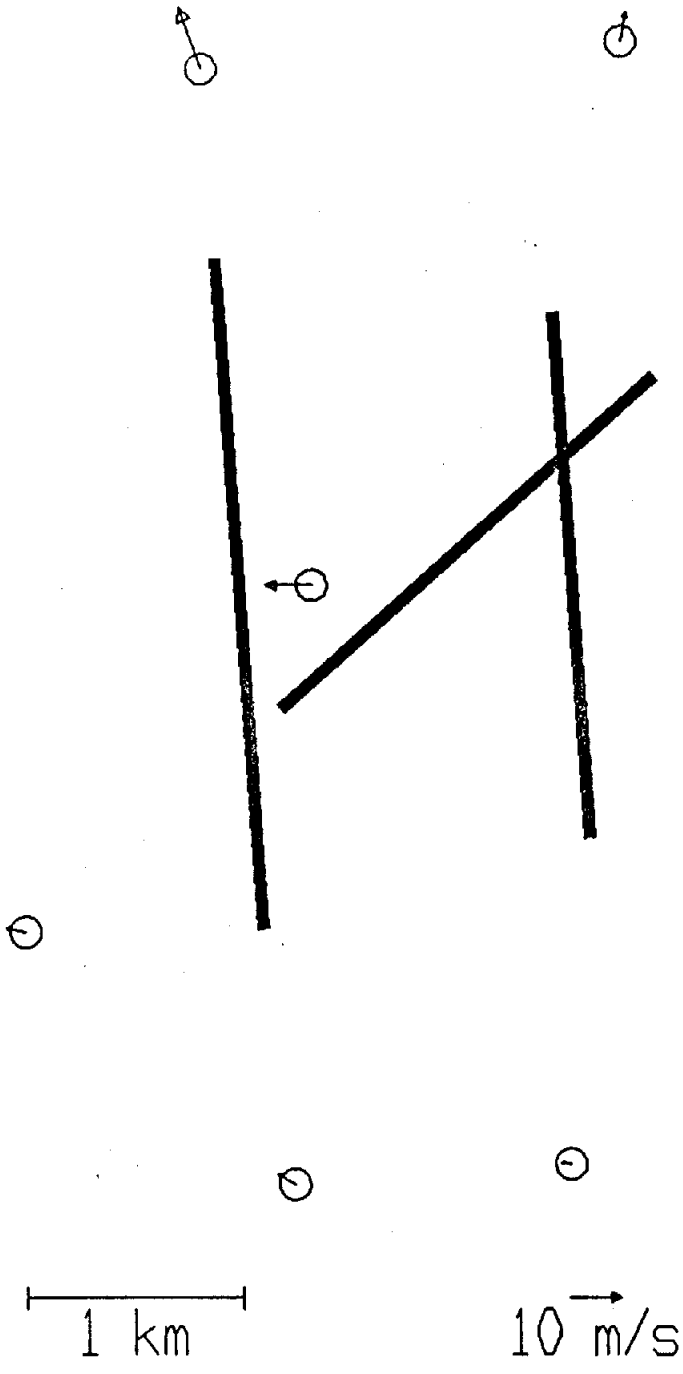
WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 45

ATTACHMENT 46



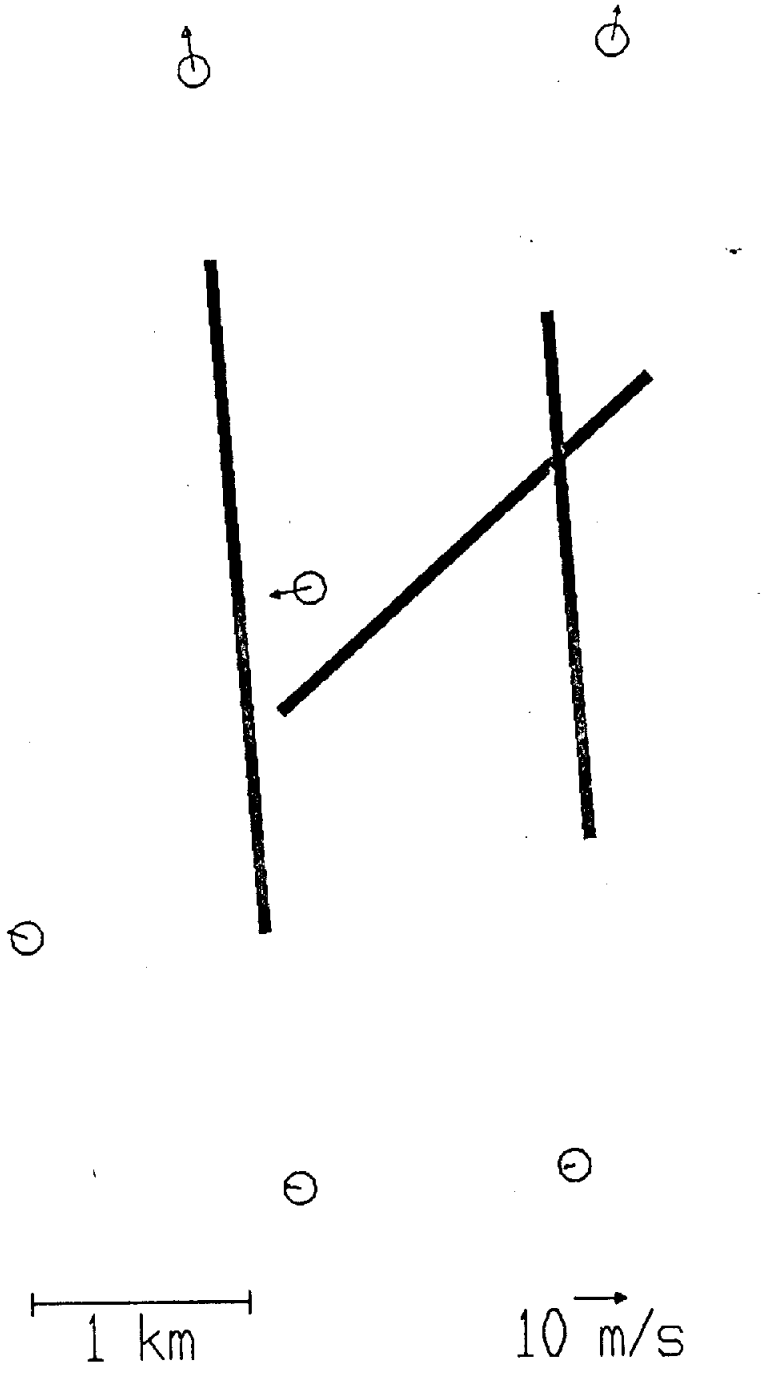
CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43:37

STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43:47

STATION

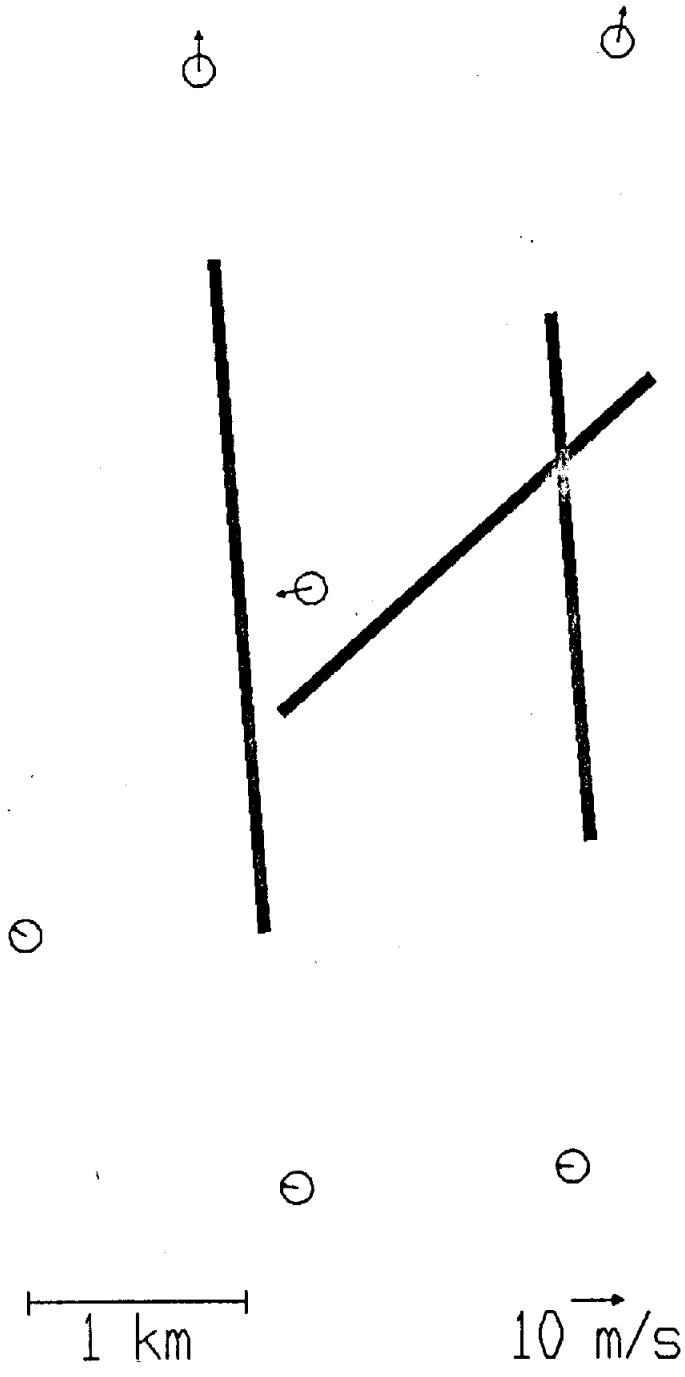
WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 47

ATTACHMENT 48



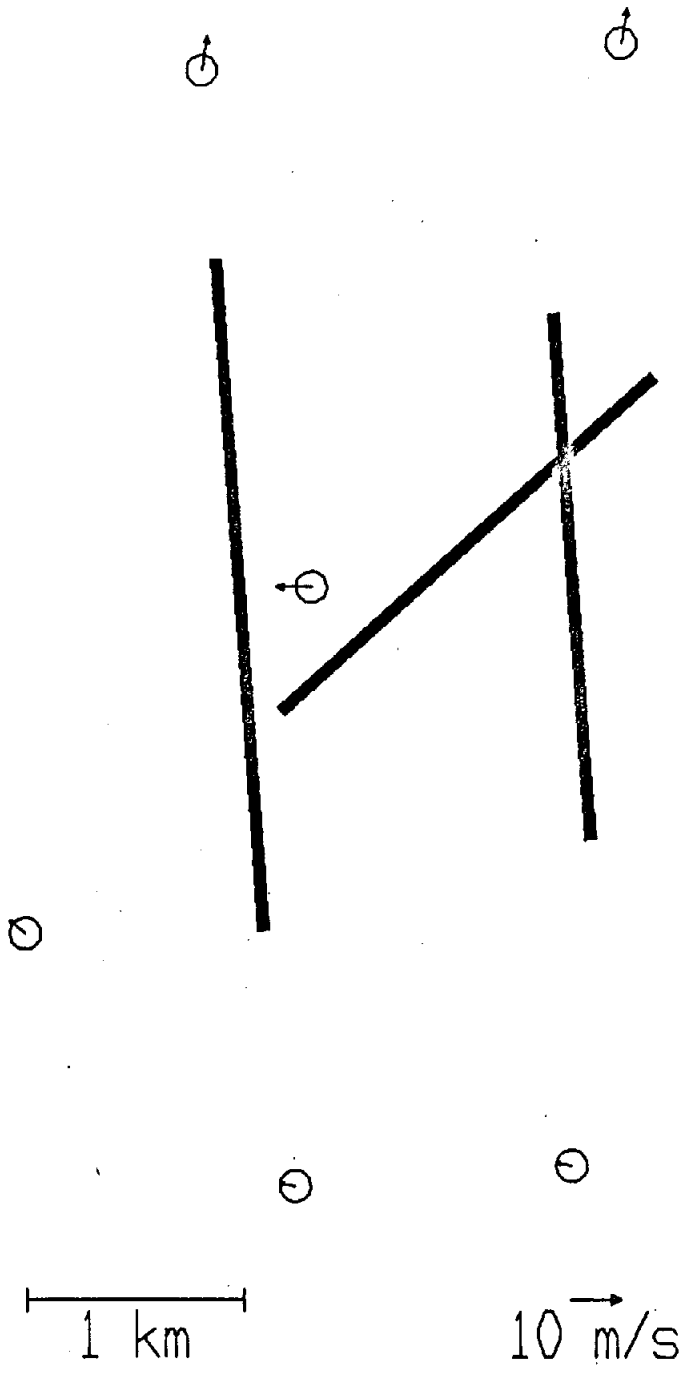
CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:43:57

STATION

WIND VECTOR

RUNWAY

FAA TECHNICAL CENTER
7/7/94



CHARLOTTE INTL AIRPORT
DATE: 7/ 2/94
TIME: 22:44: 7

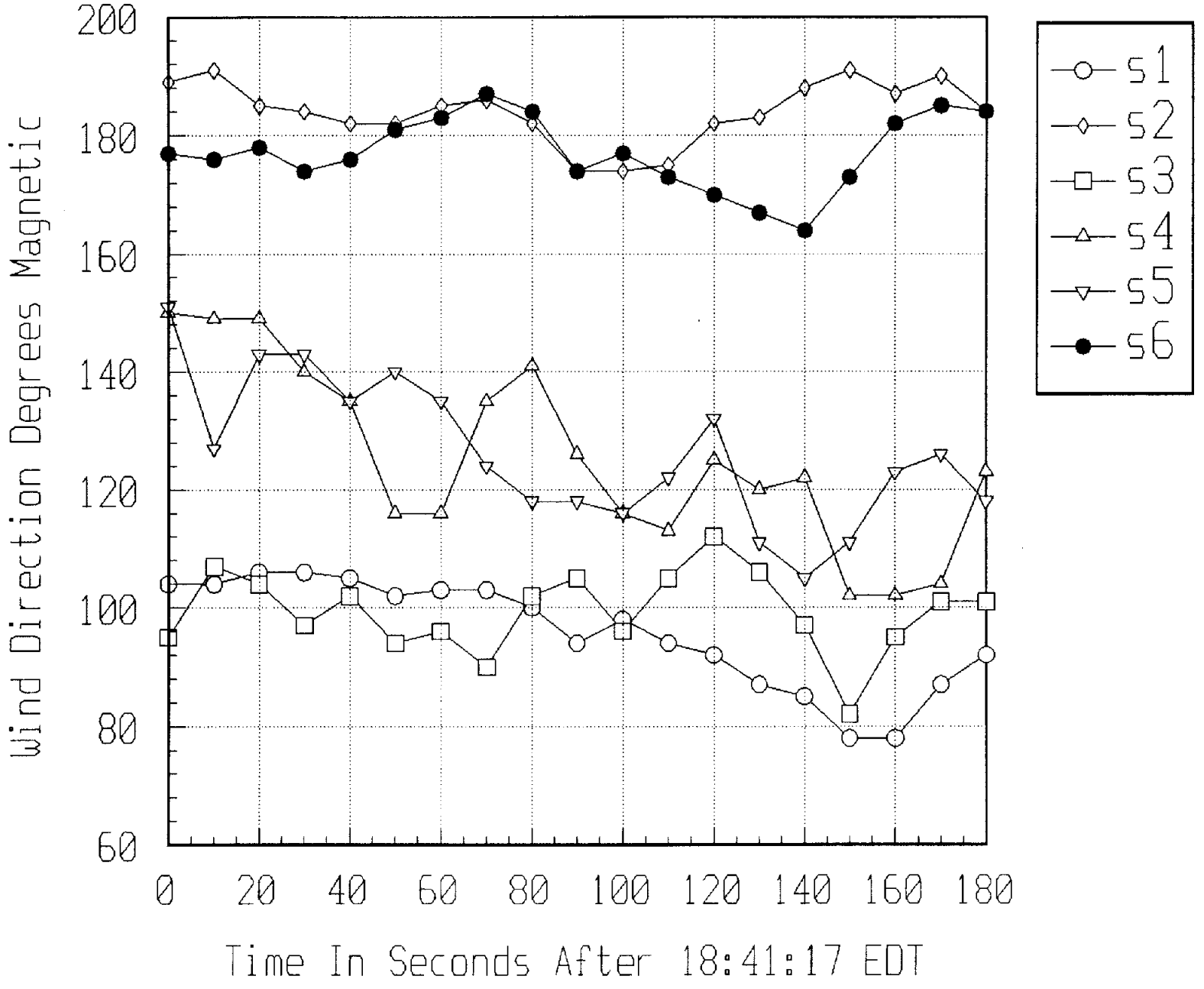
STATION

WIND VECTOR

RUNWAY

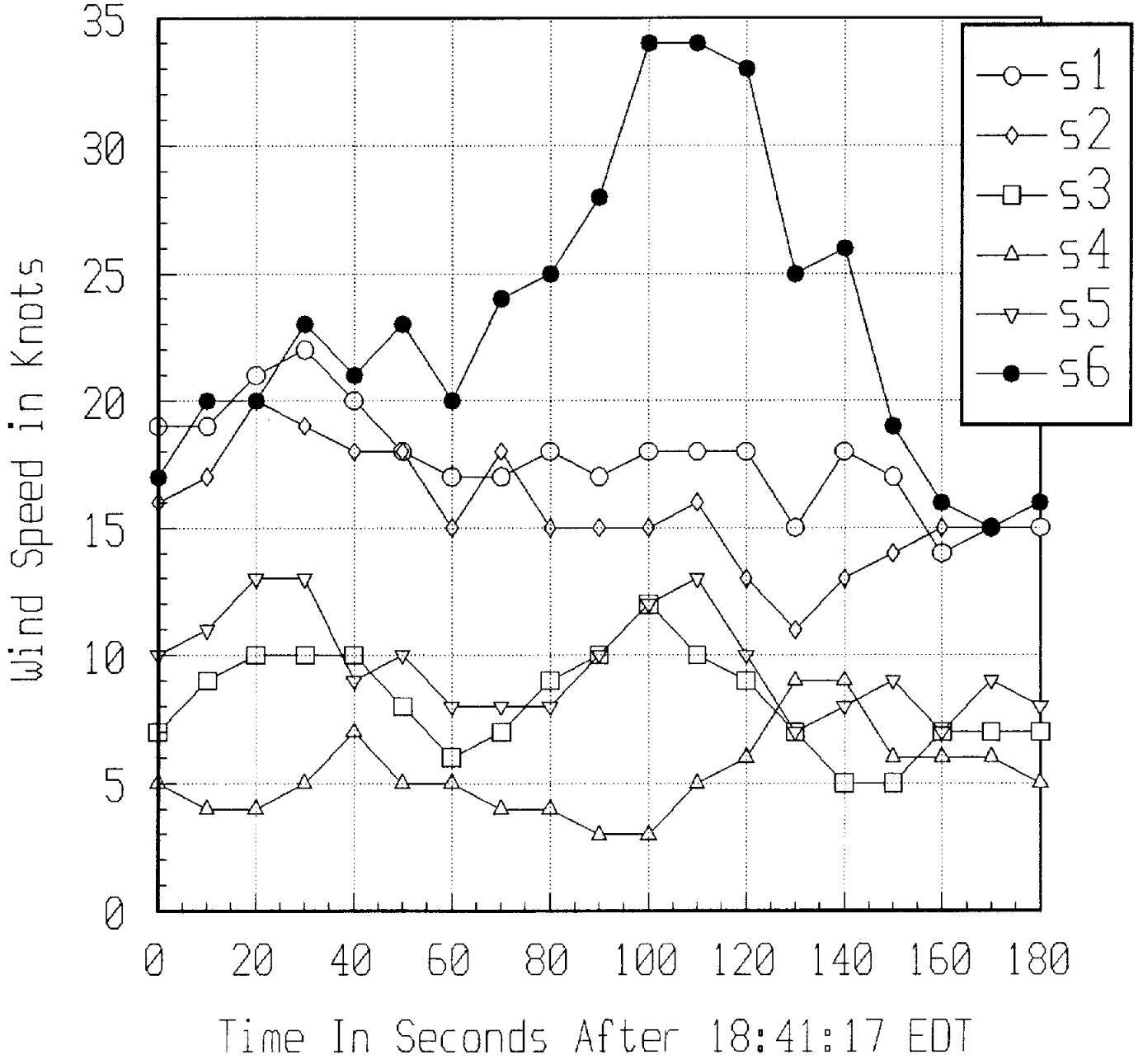
FAA TECHNICAL CENTER
7/7/94

ATTACHMENT 49

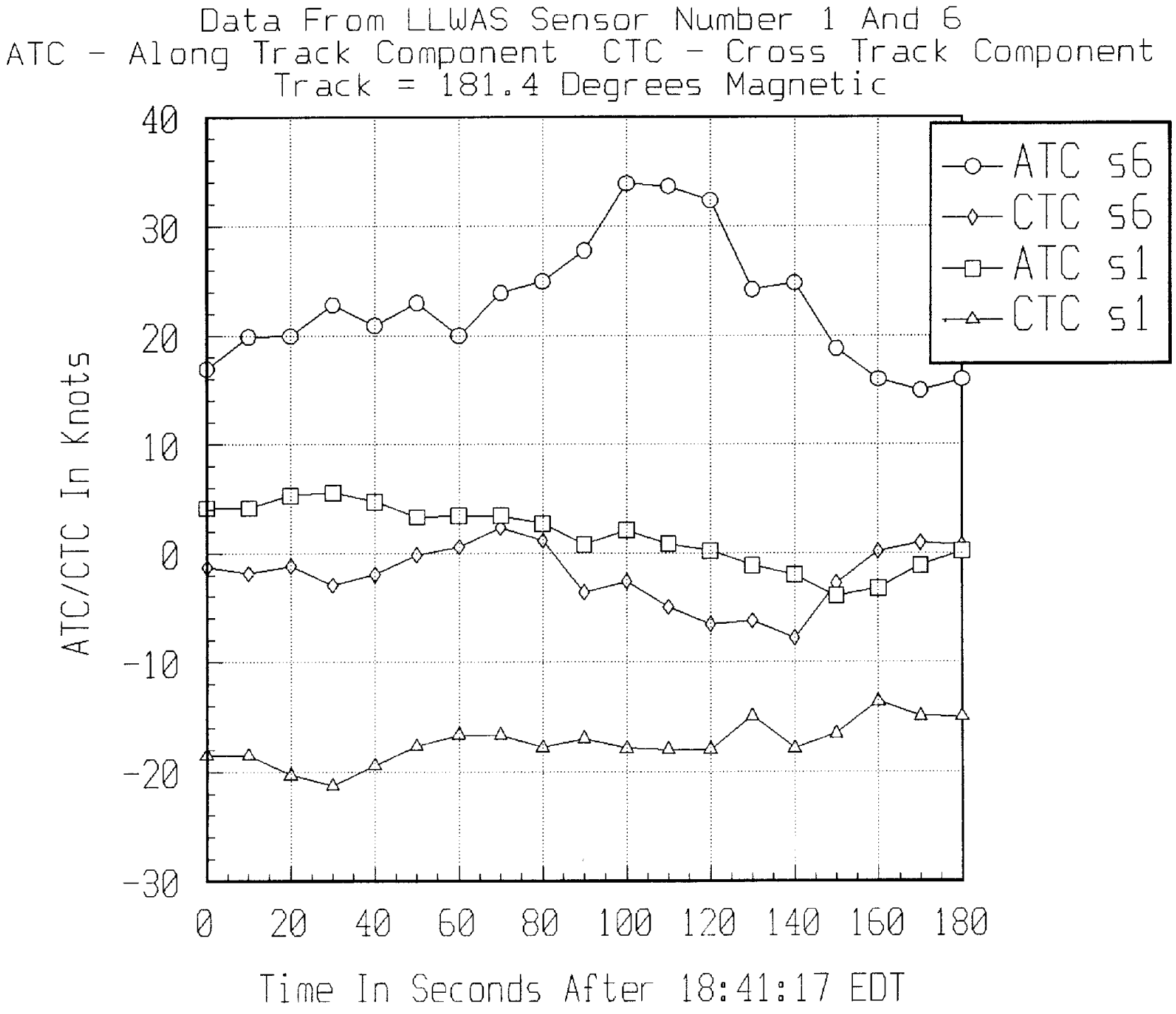


ATTACHMENT 50

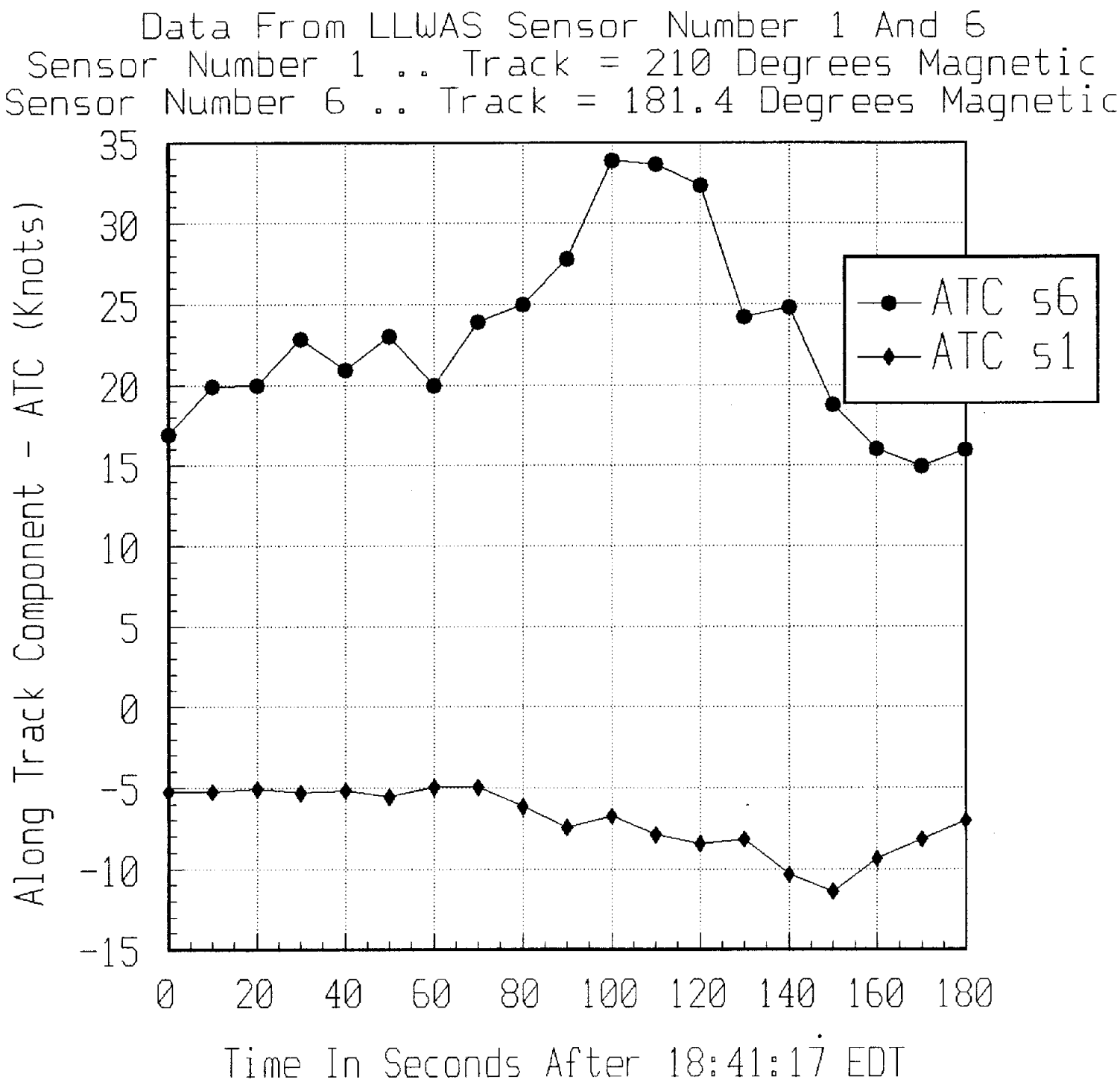
CLT LLWAS DATA 18:41:17 EDT to 18:44:17 EDT



ATTACHMENT S1

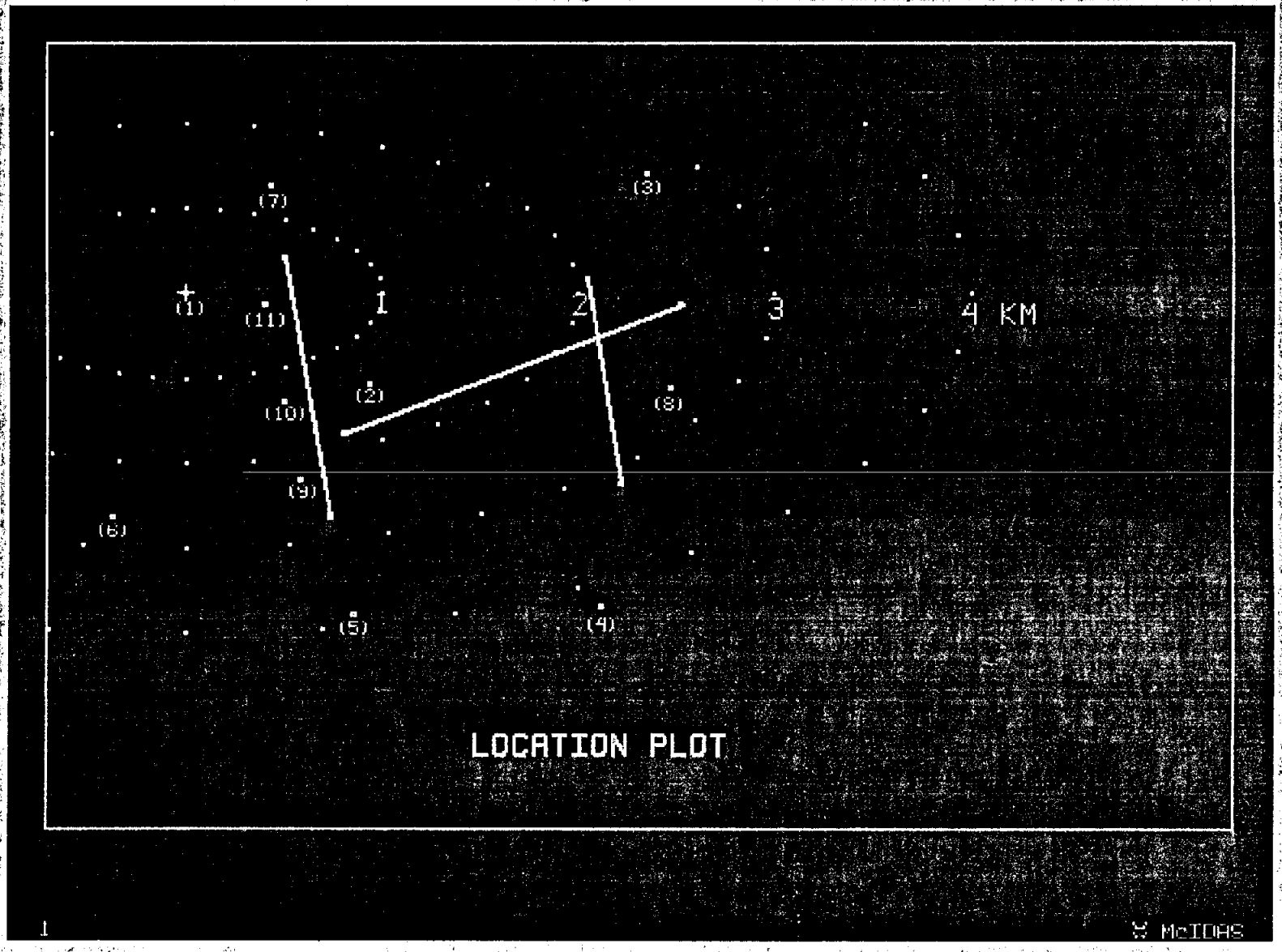


ATTACHMENT 52

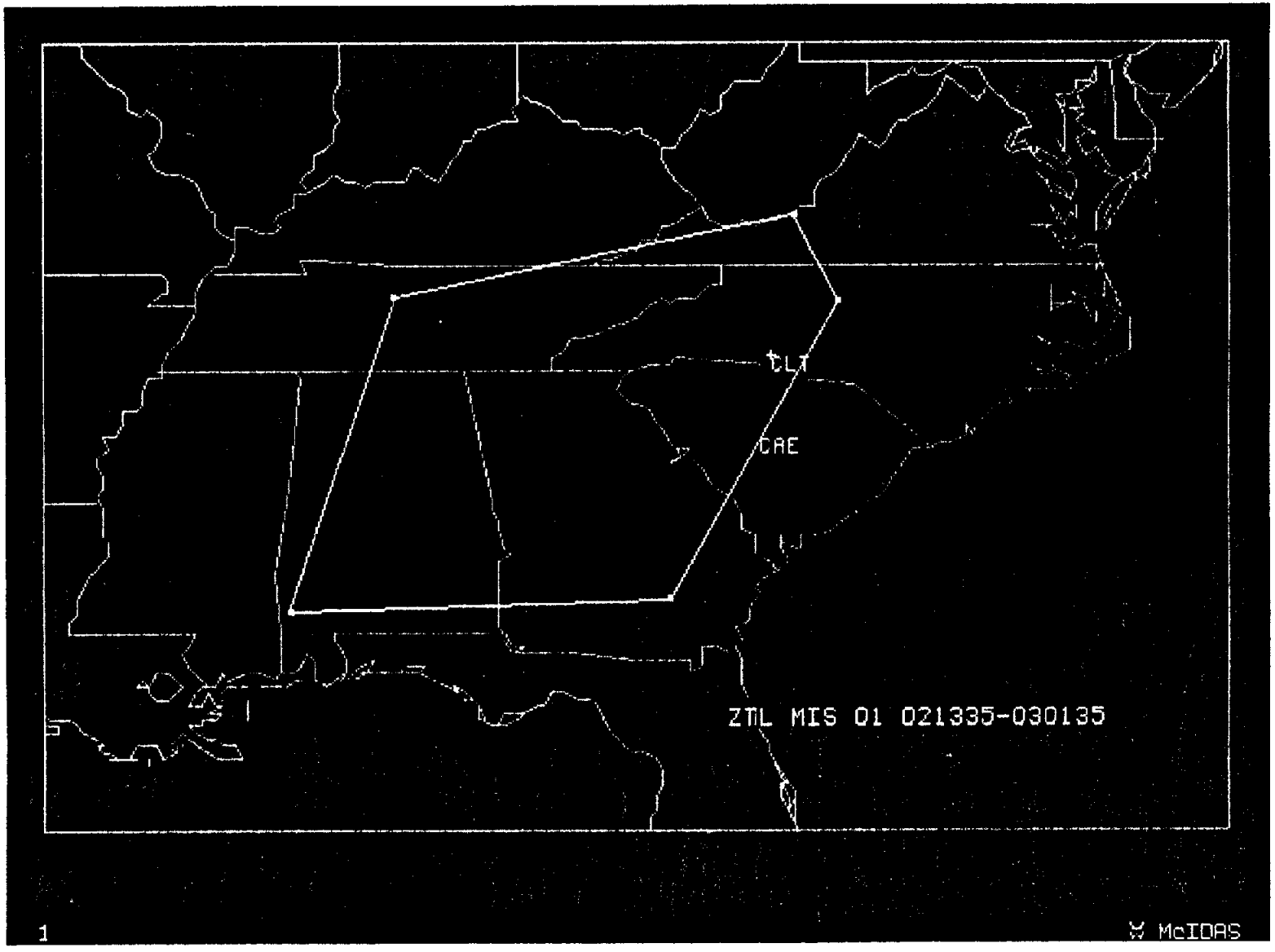


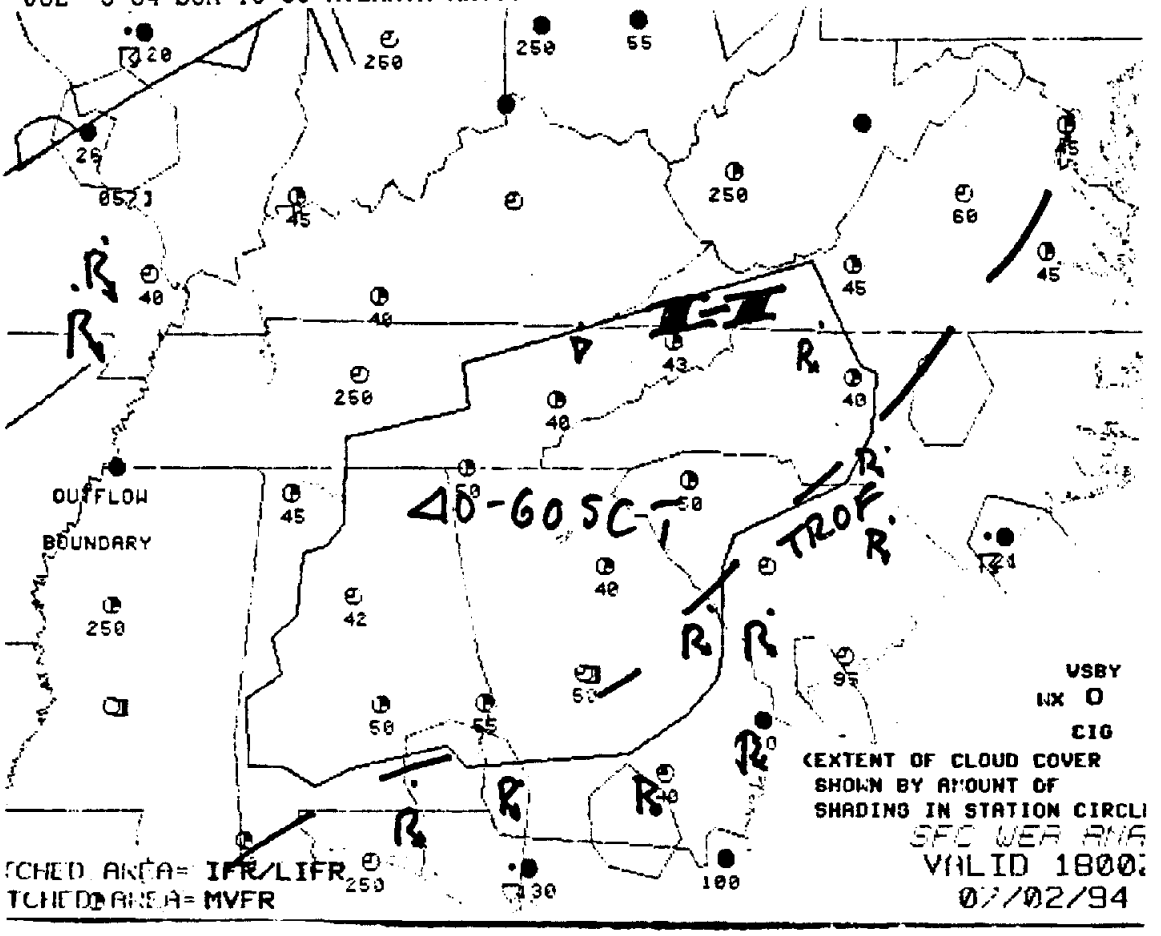
ATTACHMENT S3

ATTACHMENT 54



ATTACHMENT 55





DAY: Saturday
DATE:07/02/94
TIME:19:24 UTC

PIREPS to:
MET: 635
TMU: 224

SOME SYMBOLS:

RAIN ,,DRZL

SHWR **SNW

TSTM

ICE PELLETS

--- --- JTSTR

*REMEMBER: TSTMS imply SVR or greater TURBC, SVR ICG, low level WIND SHEAR, psbl HAIL, and LIFR conditions.

FORECAST AND IMPACT ON OPERATIONS VALID UNTIL 04Z

SYNOPSIS...AFTN/EVE HEAT FIRING WDLY SCT TSTMS MAINLY ALG SFC TROF NEAR E ZTL BNDRY. WEAK HIGH PRESSURE DIMINISHES TSTM THREAT ELSW.

CLDS (CIG)/VSBY...CLT 45 SCT 250 SCT 8 ISOLD C10 OVC 1TRW+ G45 VCNTY..AFT 02Z 50 SCT 7. ATL 50 SCT 8..AFT 22Z 50 SCT 8 ISOLD C10 OVC 1TRW+ VCNTY..AFT 01Z 250 SCT 7.

PCPN/SHWRS/TSTMS...ISOLD LVL 4-5 TSTMS WITH TOPS 450-500 DMSHG AFT 01Z.

FRZG LVL...NR 140.

ICG...NO SGFNT ICG FCST OUTSIDE TSTMS.

TURBC...NO SGFNT TURBC FCST OUTSIDE TSTMS.

ATTACHMENT 56

TABLE 1

Upper Air Data from Greensboro, North Carolina, 0000Z, 7/3/94

```
**********************************
\Polynomial regression of order 1
\Computed regression coefficients:
\a0 = 301.221
\a1 = -0.00198461
\Correlation statistics:
\mean of x = 20002.6
\mean of y = 261.523
\standard deviation of x = 14513.5
\standard deviation of y = 28.884
\variance of x = 2.10641E+008
\variance of y = 834.288
\correlation coefficent = -0.997212
**********************************
HGT...Height in Feet
TEMP...Temperature in Degrees Kelvin
HGT       TEMP
885.816 299.463
1214.71 298.81
1543.61 298.157
1872.5 297.504
2201.39 296.852
2530.29 296.199
2859.18 295.546
3188.08 294.893
3516.97 294.241
3845.87 293.588
4174.76 292.935
4503.66 292.283
4832.55 291.63
5161.44 290.977
5490.34 290.324
5819.23 289.672
6148.13 289.019
6477.02 288.366
6805.92 287.713
7134.81 287.061
7463.71 286.408
7792.6 285.755
8121.5 285.103
8450.39 284.45
8779.28 283.797
9108.18 283.144
9437.07 282.492
9765.97 281.839
10094.9 281.186
10423.8 280.533
```

10752.7 279.881
11081.5 279.228
11410.4 278.575
11739.3 277.923
12068.2 277.27
12397.1 276.617
12726 275.964
13054.9 275.312
13383.8 274.659
13712.7 274.006
14041.6 273.353
14370.5 272.701
14699.4 272.048
15028.3 271.395
15357.2 270.743
15686.1 270.09
16015 269.437
16343.9 268.784
16672.8 268.132
17001.6 267.479
17330.5 266.826
17659.4 266.173
17988.3 265.521
18317.2 264.868
18646.1 264.215
18975 263.563
19303.9 262.91
19632.8 262.257
19961.7 261.604
20290.6 260.952
20619.5 260.299
20948.4 259.646
21277.3 258.993
21606.2 258.341
21935.1 257.688
22264 257.035
22592.9 256.383
22921.7 255.73
23250.6 255.077
23579.5 254.424
23908.4 253.772
24237.3 253.119
24566.2 252.466
24895.1 251.813
25224 251.161
25552.9 250.508
25881.8 249.855
26210.7 249.203
26539.6 248.55
26868.5 247.897
27197.4 247.244
27526.3 246.592

27855.2 245.939
28184.1 245.286
28513 244.634
28841.9 243.981
29170.7 243.328
29499.6 242.675
29828.5 242.023
30157.4 241.37
30486.3 240.717
30815.2 240.064
31144.1 239.412
31473 238.759
31801.9 238.106
32130.8 237.454
32459.7 236.801
32788.6 236.148
33117.5 235.495
33446.4 234.843
33775.3 234.19
34104.2 233.537
34433.1 232.884
34762 232.232
35090.8 231.579
35419.7 230.926
35748.6 230.274
36077.5 229.621
36406.4 228.968
36735.3 228.315
37064.2 227.663
37393.1 227.01
37722 226.357
38050.9 225.704
38379.8 225.052
38708.7 224.399
39037.6 223.746
39366.5 223.094
39695.4 222.441
40024.3 221.788
40353.2 221.135
40682.1 220.483
41010.9 219.83
41339.8 219.177
41668.7 218.524
41997.6 217.872
42326.5 217.219
42655.4 216.566
42984.3 215.914
43313.2 215.261
43642.1 214.608
43971 213.955
44299.9 213.303
44628.8 212.65

44957.7 211.997
45286.6 211.344
45615.5 210.692
45944.4 210.039
46273.3 209.386
46602.2 208.734
46931 208.081
47259.9 207.428
47588.8 206.775
47917.7 206.123
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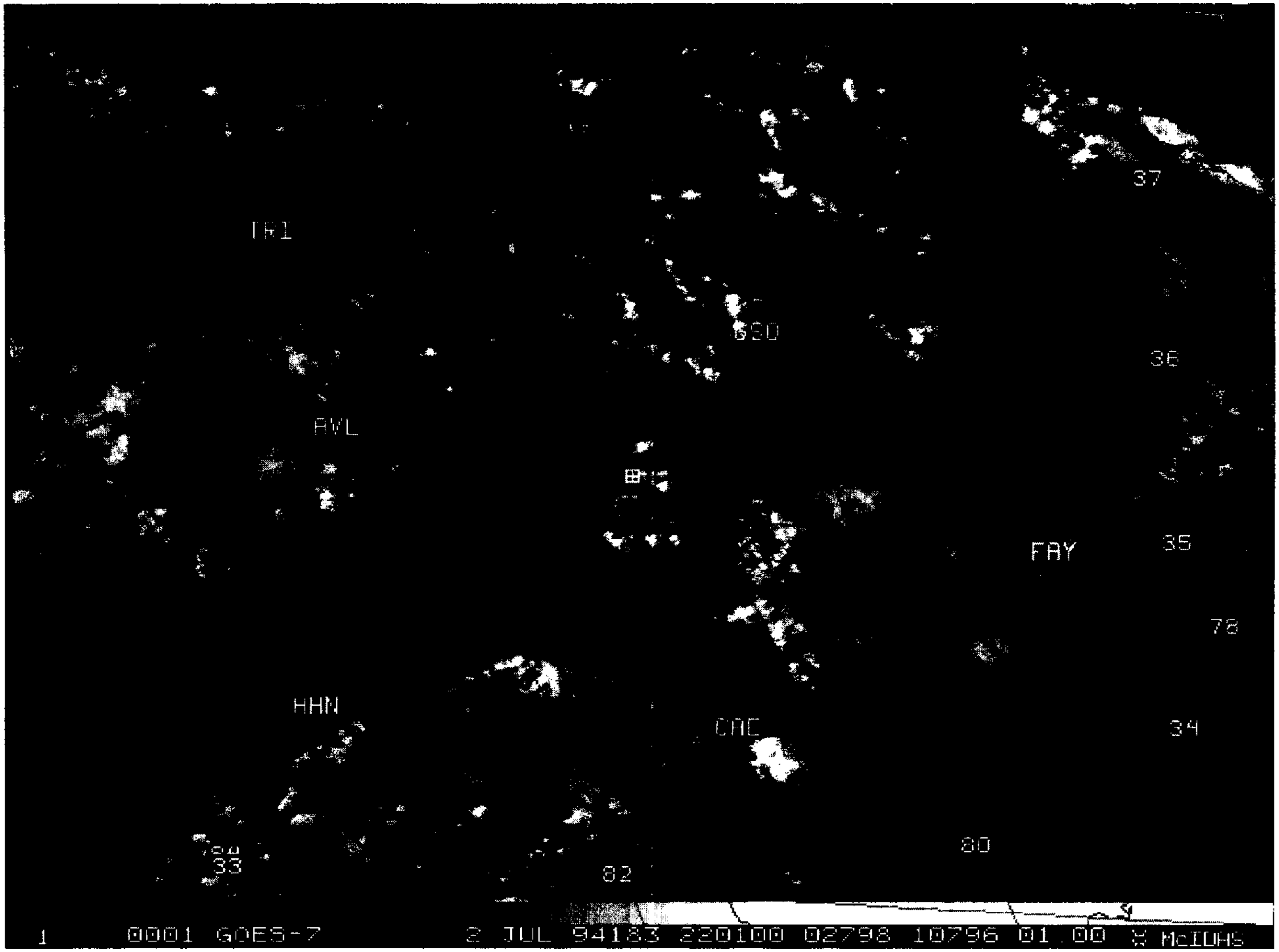
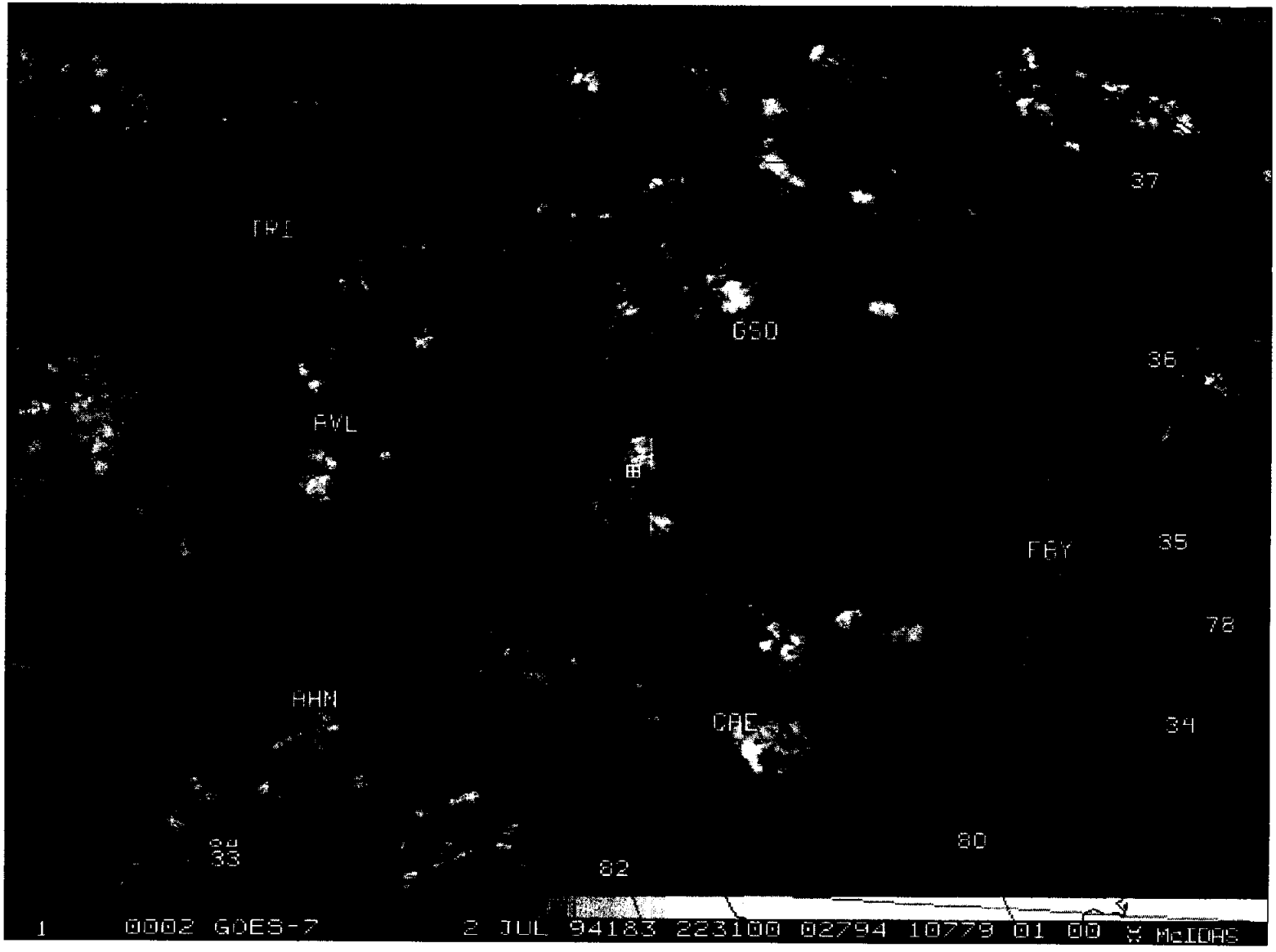
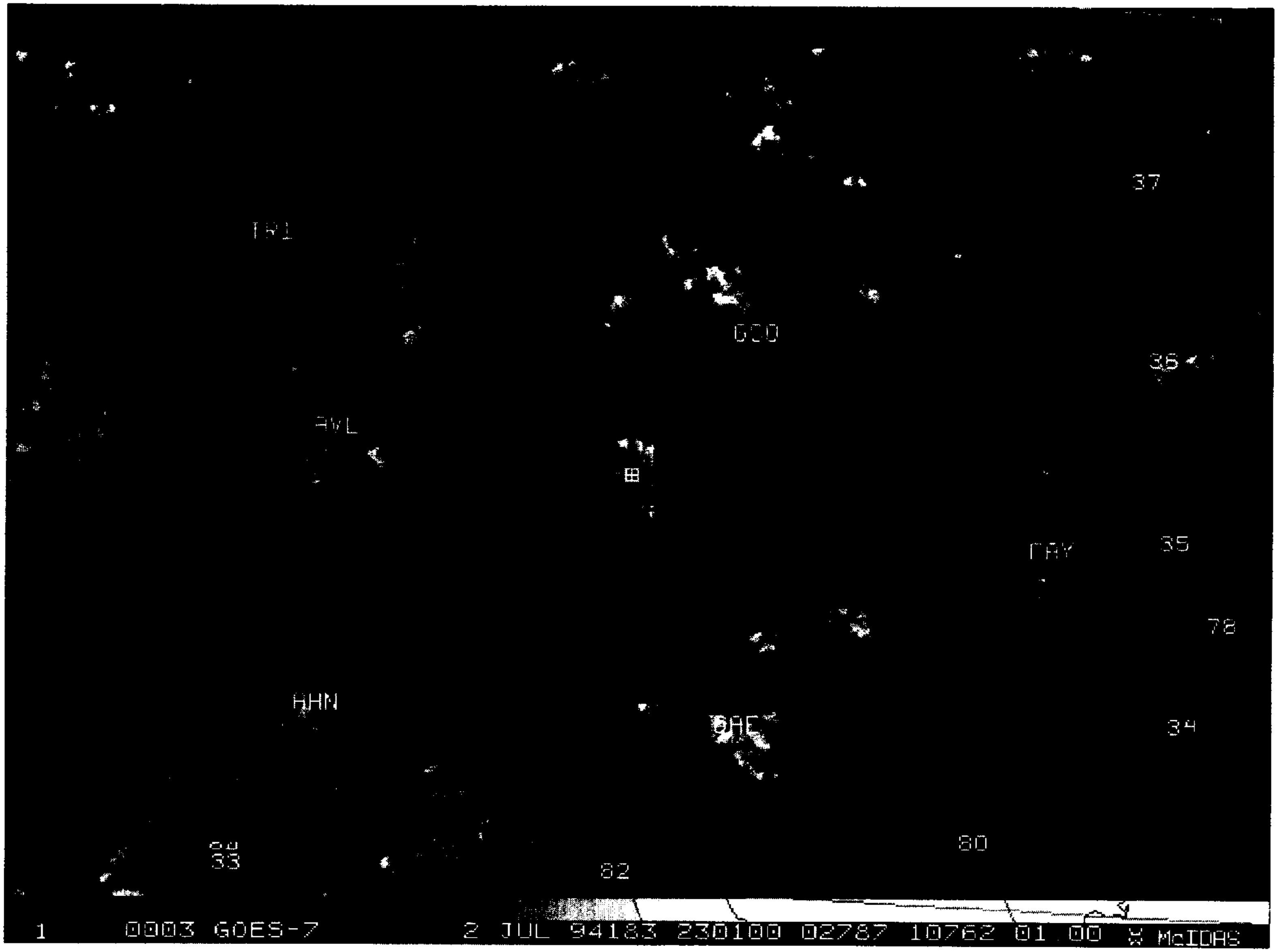
48575.5 204.817
48904.4 204.164
49233.3 203.512
49562.2 202.859
49891.1 202.206



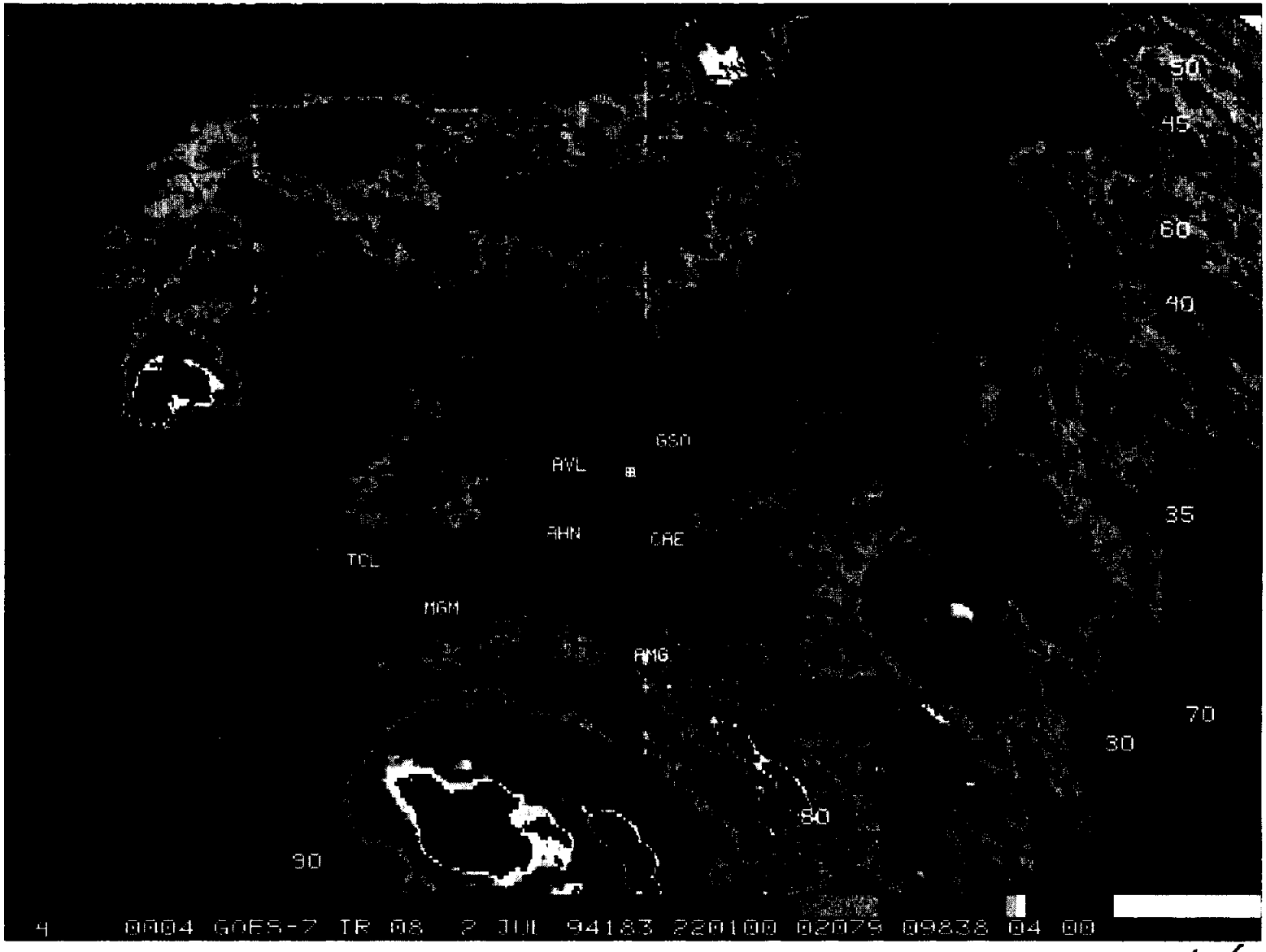
VIDEO PRINT #1



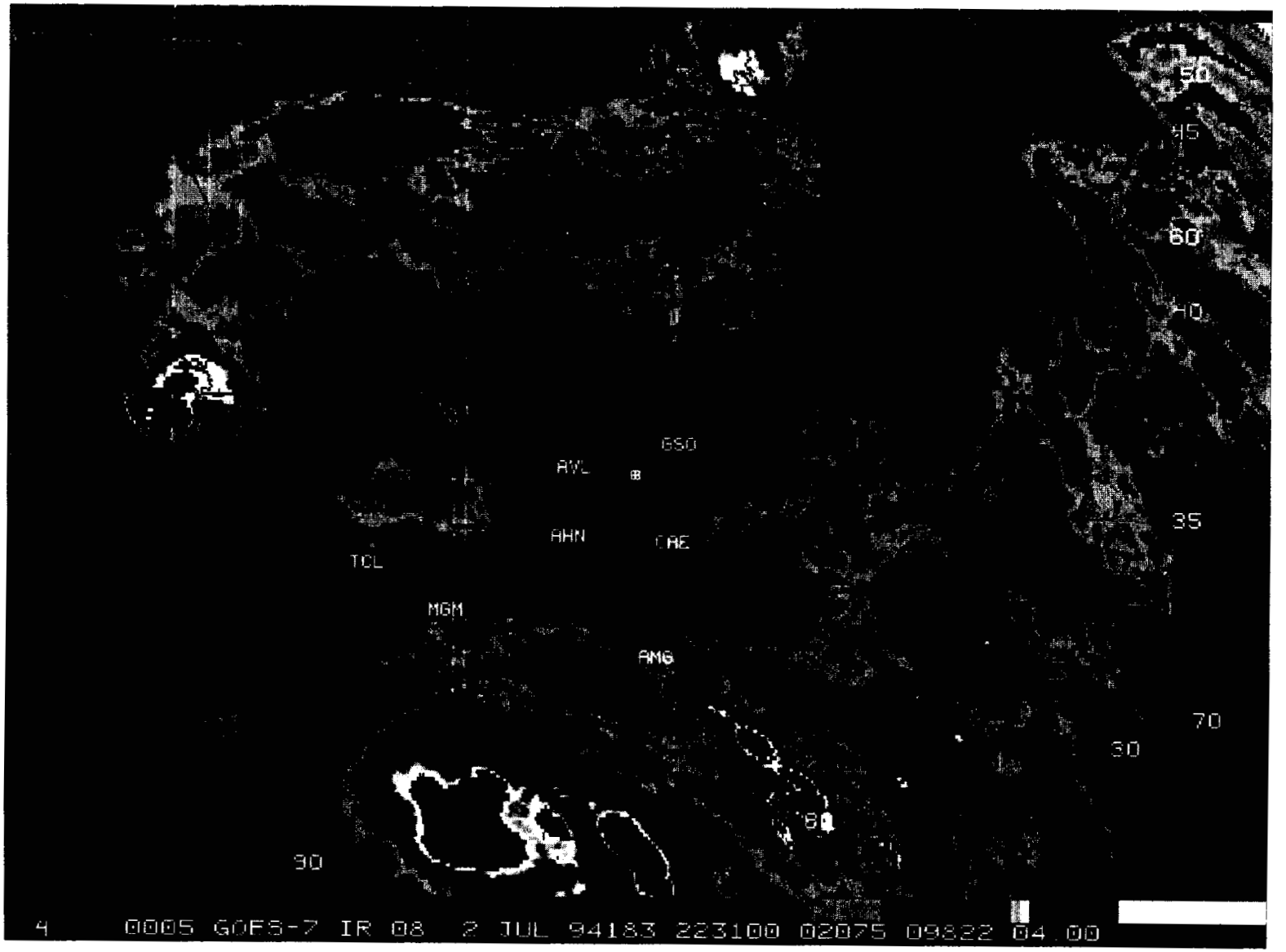
VIDEO PRINT #2



VIDEO PRINT #3



VIDEO PRINT #4



VIDEO PRINT #5

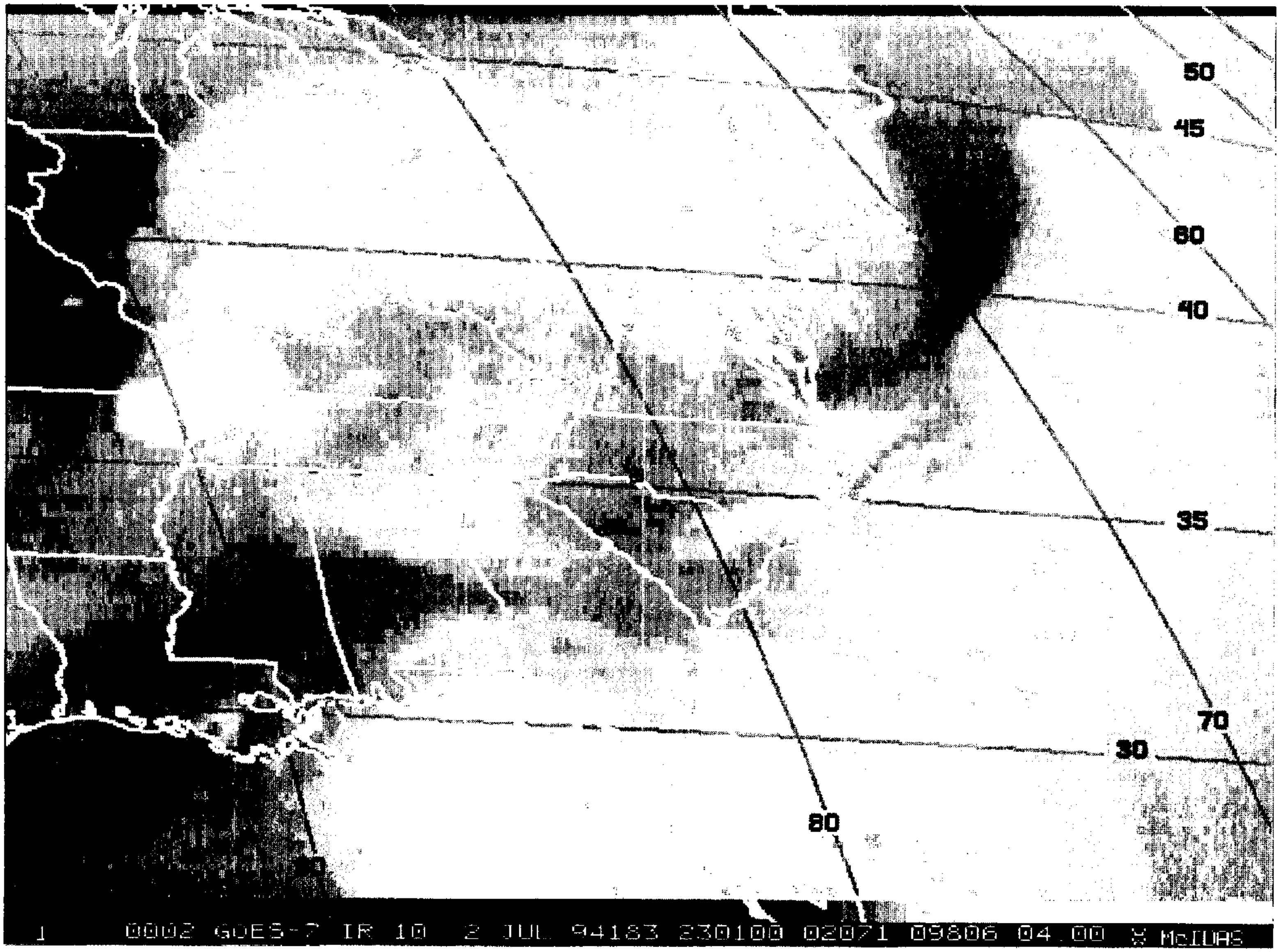
VIDEO PRINT #6

VIDEO PRINT #7

VIDEO PRINT #8

VIDEO PRINT #9

VIDEO PART #10



VIDEO PRINT # 11

VIDEO PRINT #12