Docket No. SA-509

Exhibit No. 5-J

NATIONAL TRANSPORTATION SAFETY BOARD

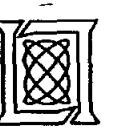
Washington D.C.

MIT Lincoln Laboratory CLT LLWAS Study

F. WESLEY WILSON

MIT LINCOLN LABORATORY

LLWAS DESIGN & PERFORMANCE



OUTLINE

- **EXPLANATION OF LLWAS**
  - WHAT IT IS
  - HOW IT WORKS
- **LLWAS PERFORMANCE ON 2 JULY, 1994**
  - SENSOR PERFORMANCE*
  - SYSTEM PERFORMANCE*

*WE APPRECIATE THE ASSISTANCE WITH THESE ANALYSES THAT WAS PROVIDED BY THE FAA TECHNICAL CENTER

EXPLANATION OF LLWAS

- SYSTEM DESCRIPTION
- DEPLOYMENT PHASES
- SYSTEM PERFORMANCE
- WIND SHEAR ALERT GENERATION
- SENSOR PERFORMANCE

LLWAS DESCRIPTION

- WIND SHEAR DETECTION SYSTEM BASED ON WIND MEASUREMENTS BY ANEMOMETERS
- SOURCE OF OPERATIONAL WIND INFORMATION
- THREE STAGES OF DEPLOYMENT
  - PHASE I: 1976 (55) AND 1987 (55)
  - PHASE II: 1989–1991 (110)
  - PHASE III: CURRENT INSTALLATION (9)

DEVELOPMENT PHASES I, II, & III

- PHASE I – SIX SENSORS, NOMINAL SPACING 2+ MILES
  COVERAGE: AIRPORT PLUS .5 MILES
  - NOT DESIGNED FOR MICROBURSTS DETECTION
  - HIGH FALSE ALERT RATE, CREDIBILITY PROBLEM
- PHASE III – 15+ SENSORS, NOMINAL SPACING 1.2 MILES
  DESIGN COVERAGE: AIRPORT PLUS 3 MILES
  - GOOD MICROBURST DETECTION
  - INSTALLATION AT OFF–AIRPORT SITES COSTLY AND SLOW
- PHASE II – UPGRADE USING PHASE I SENSORS (SIX)
  - SOFTWARE (ONLY) UPGRADE TO REDUCE FALSE ALERTS AND TO PROVIDE MODEST MICROBURST DETECTION
  - INTERIM IMPROVEMENT UNTIL PHASE III OR TDWR; LOW FALSE ALERT RATE IMPROVES CREDIBILITY

WESLEY WILSON
MIT/LINCOLN LABORATORY

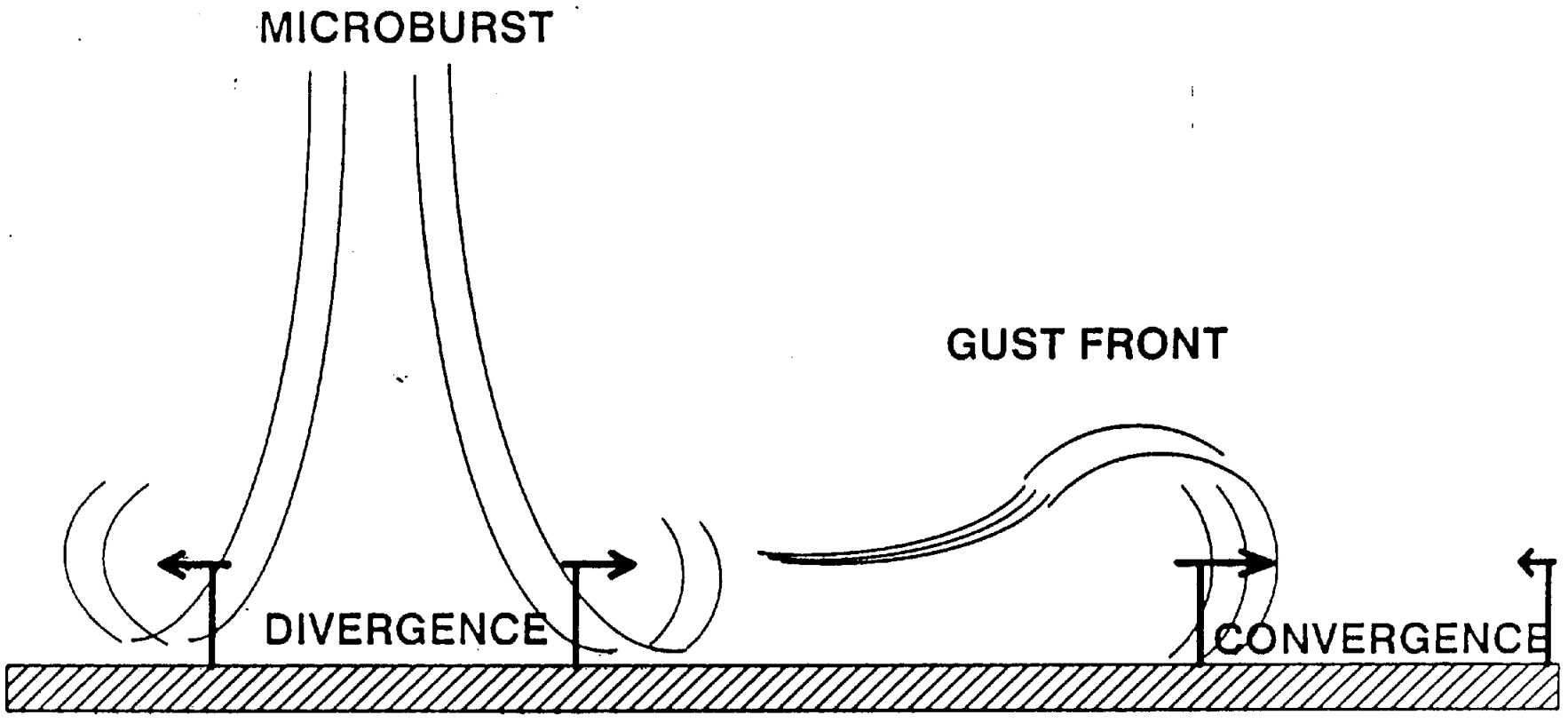
PHONE: (617) 981–7430
EMAIL: wesw@ll.mit.edu

SYSTEM PERFORMANCE STATISTICS

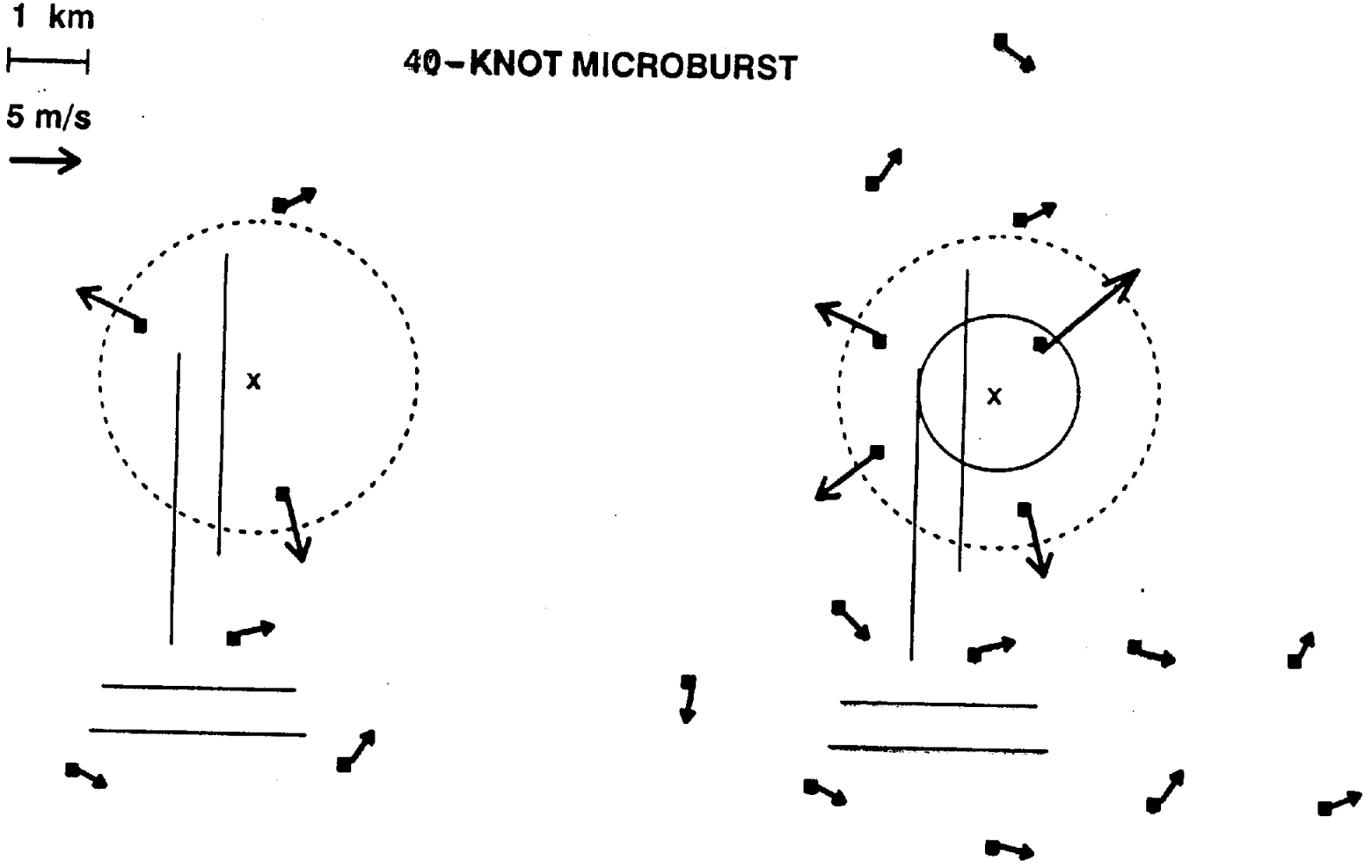
	PHASE II	PHASE III
POD|WS	.39	.76
POD|MB	.62	.97
PFA	.07	.04

POD: **PROBABILITY OF DETECTION** (POLL BY POLL)
PROBABILITY THAT A WIND SHEAR ALERT WILL BE ISSUED FOR EVENTS IN THE COVERAGE REGION

PFA: **PROBABILITY OF FALSE ALERT** (POLL BY POLL)
PROBABILITY THAT AN ISSUED WIND SHEAR ALERT IS FALSE



WIND SHEAR HAZARDS



LLWAS GEOMETRIES – PHASE II AND PHASE III

WIND SHEAR ALERT GENERATION

- **PHASE II**
  - ANOMALOUS WINDS AT A SENSOR
  - MEASURED SIGNIFICANT DIVERGENCE
  - ALERTS DELAYED BY SPARSE GEOMETRY AND ALERT PERSISTENCE REQUIREMENT
- **PHASE III**
  - MEASURED SIGNIFICANT DIVERGENCE
  - MEASURED SIGNIFICANT CONVERGENCE
  - ALERTS DELAYED BY ALERT PERSISTENCE REQUIREMENT

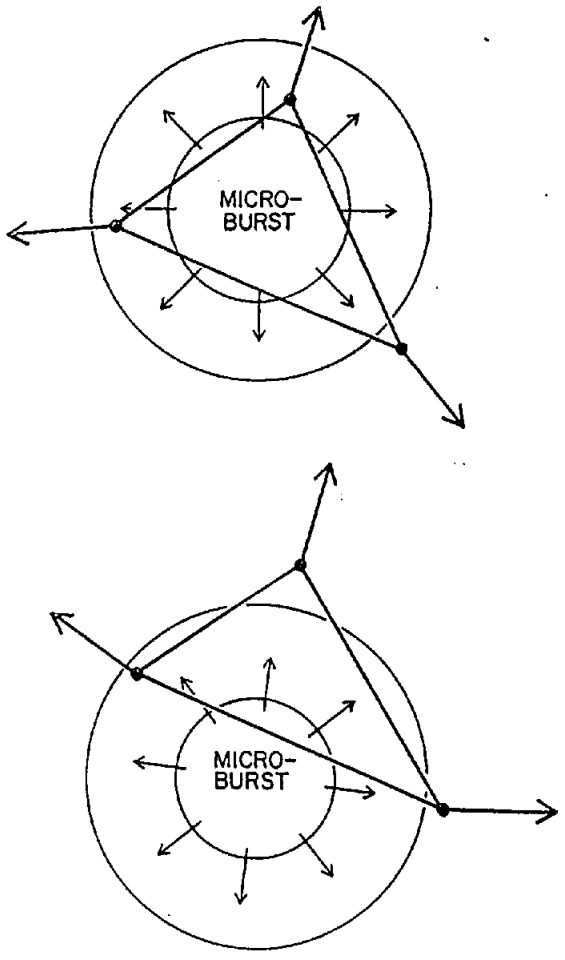


Figure III-4. Impact of event location on triangle divergence.

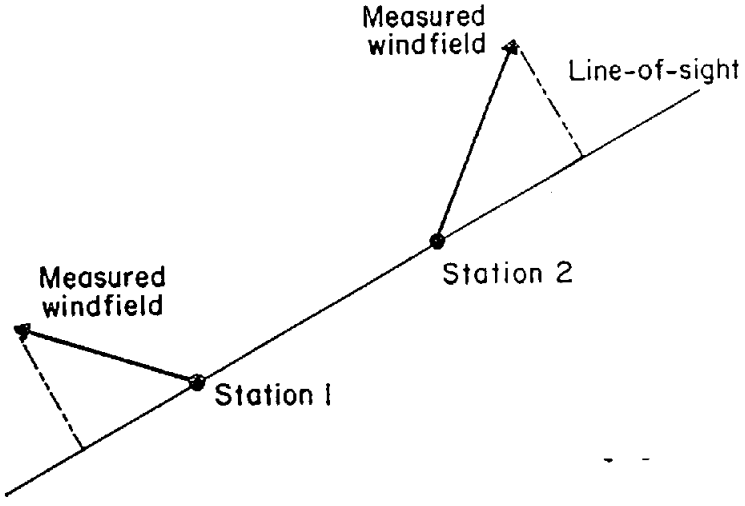
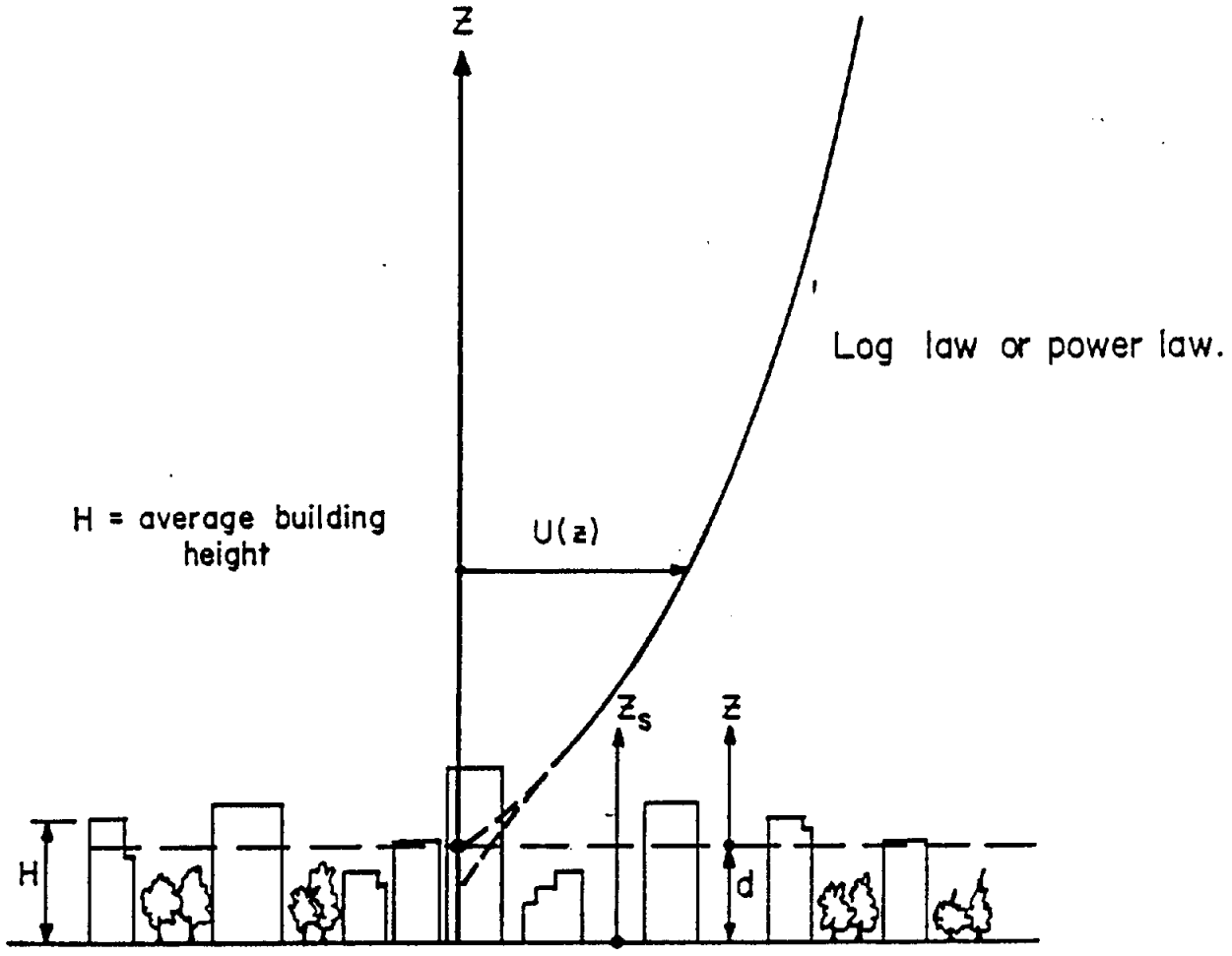


Figure III-2. Line divergence. The divergence is estimated by the vector difference of the projections onto the line-of-sight.

SENSOR PERFORMANCE

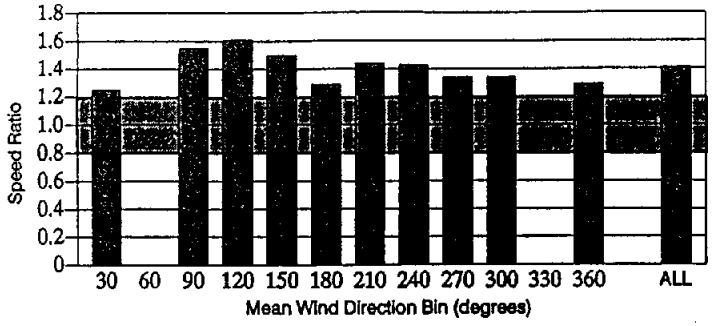
- CONSEQUENCES: FALSE ALERTS AND MISSED DETECTIONS
- BOUNDARY LAYER WIND PROFILE
  - ROUGHNESS EFFECTS
  - SHELTERING EFFECTS
  - CHANNELLING
- LLWAS SITING CRITERIA
- STATISTICAL PERFORMANCE ANALYSIS
  - MEASURE OF SHELTERING – REDUCED WIND SPEED
  - MEASURE OF CHANNELLING – DISTORTED WIND DIRECTION



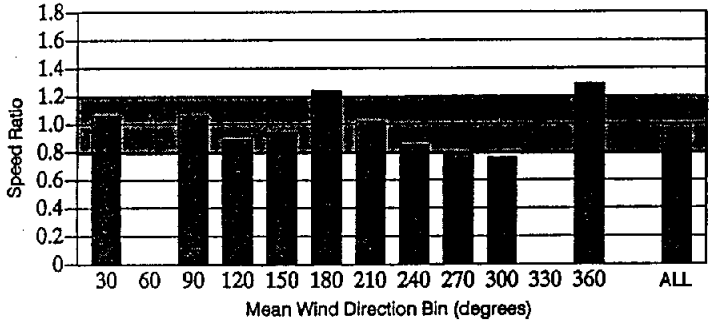
The Effective Displacement Height

CHARLOTTE (CLT) LLWAS, 15 JUNE – 1 JULY 1994

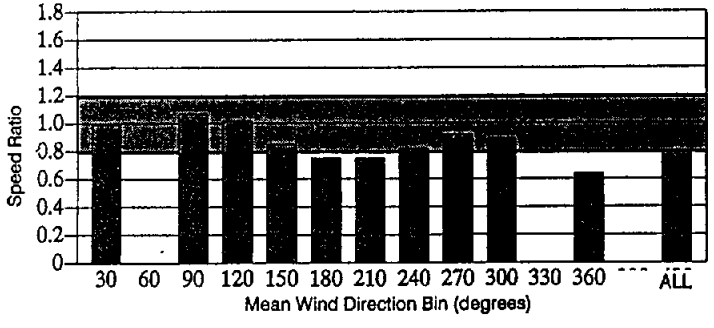
Station 1



Station 2

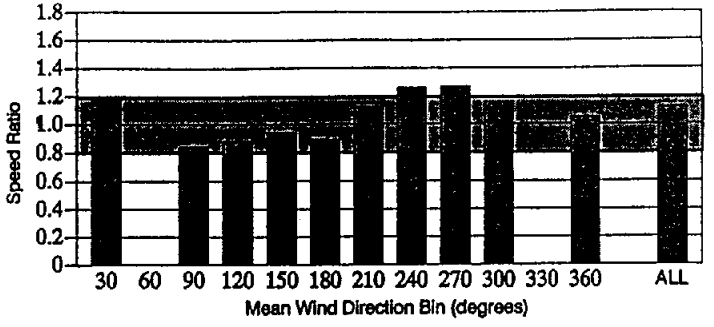


Station 3

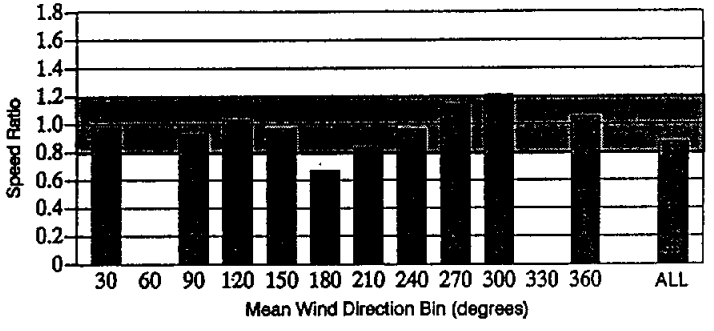


CHARLOTTE (CLT) LLWAS, 15 JUNE – 1 JULY 1994

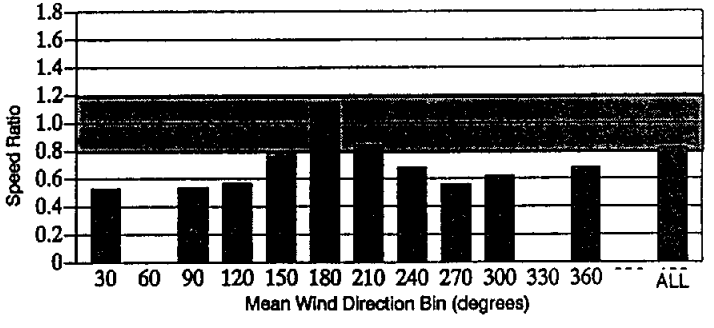
Station 4



Station 5

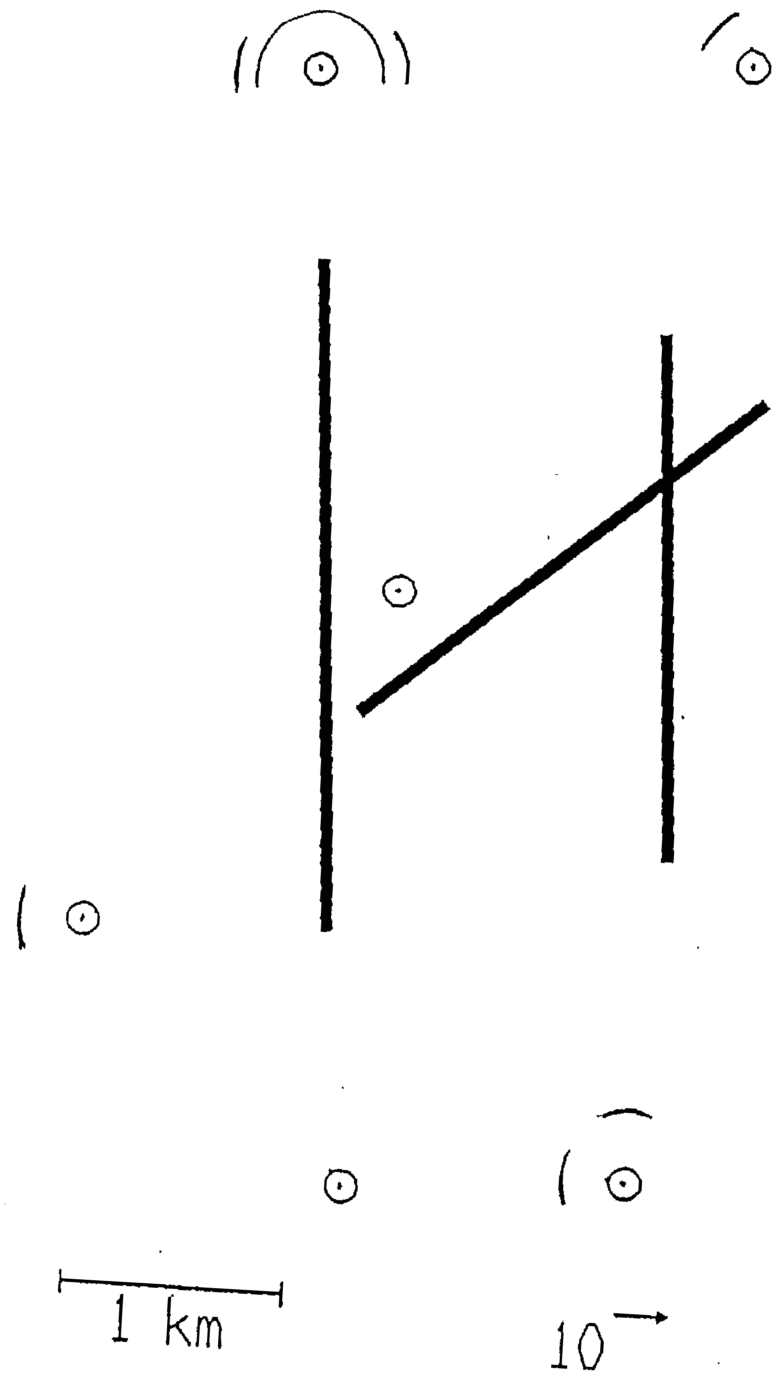


Station 6



Percentage Frequency (by station) of Dir -

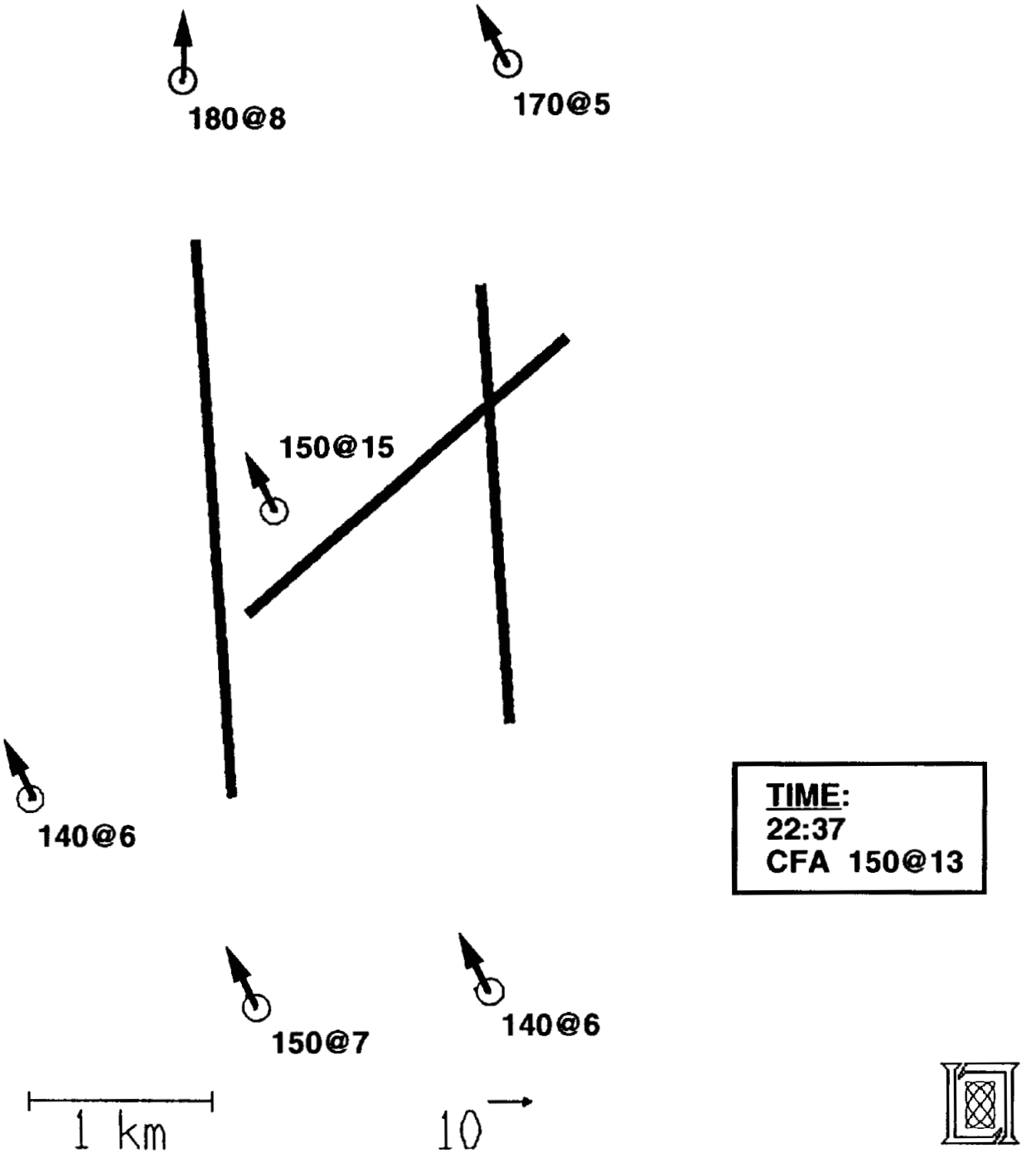
DIR_INC \ ST.	1	2	3	4	5	6
-90	0	0	0	0	0	0
-80	0	0	0	0	0	0
-70	0	0	0	0	0	0
-60	0	0	0	0	0	0
-50	0	0	0	0	0	1
-40	0	1	1	0	0	2
-30	1	2	2	1	1	7
-20	6	8	7	5	5	15
-10	27	19	21	18	17	26
0	43	33	32	35	31	27
10	19	26	23	27	28	15
20	4	8	9	10	12	4
30	1	2	3	2	4	2
40	0	1	1	1	1	0
50	0	0	0	0	0	0
60	0	0	0	0	0	0
70	0	0	0	0	0	0
80	0	0	0	0	0	0
90	0	0	0	0	0	0
HI	0	0	0	0	0	0
AVERAGE	-1.4	0.5	0.6	2.8	3.7	-6.0
COUNTS	27002	19204	13551	22710	15525	14728

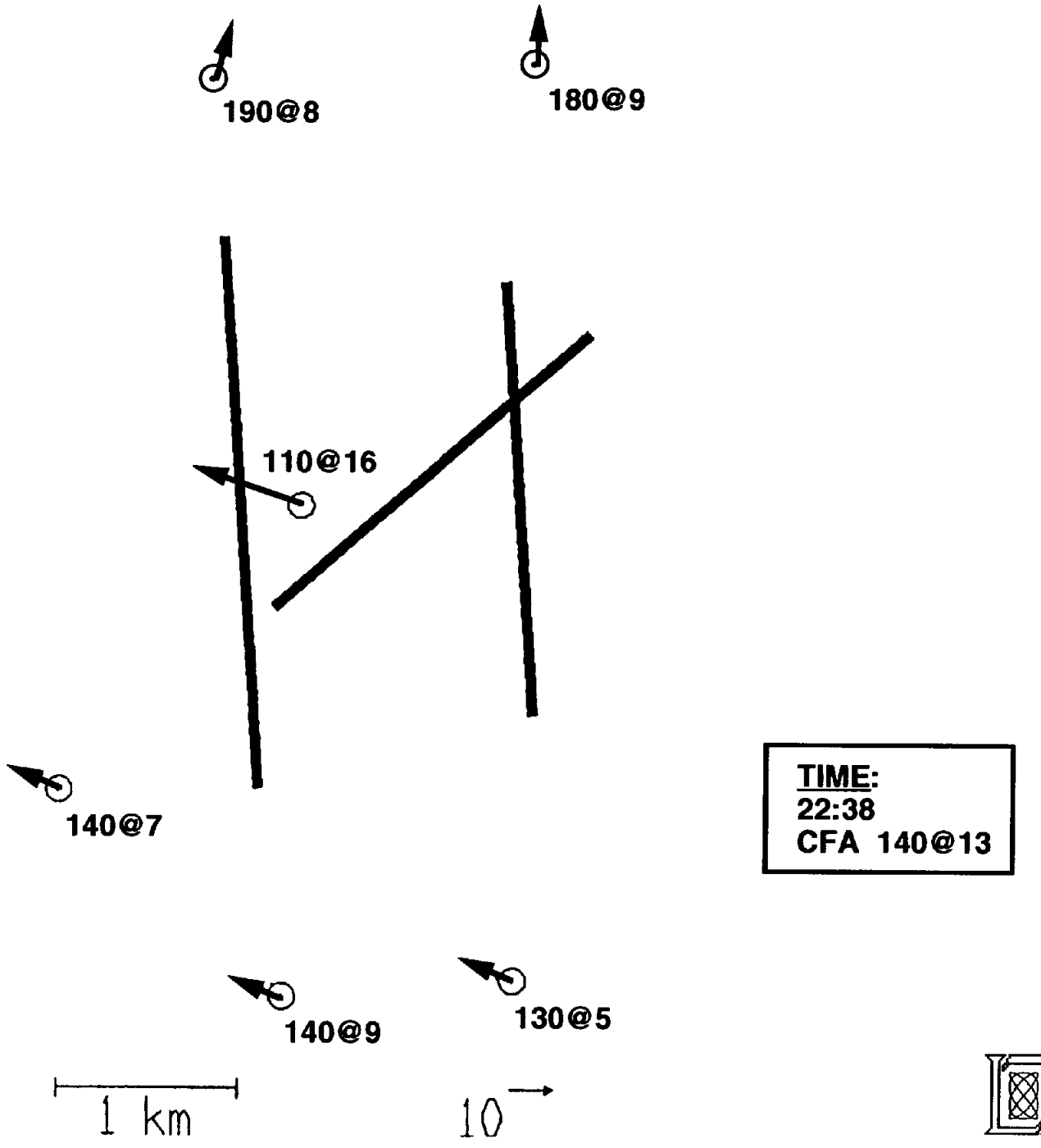

1 km
10

OUTLINE

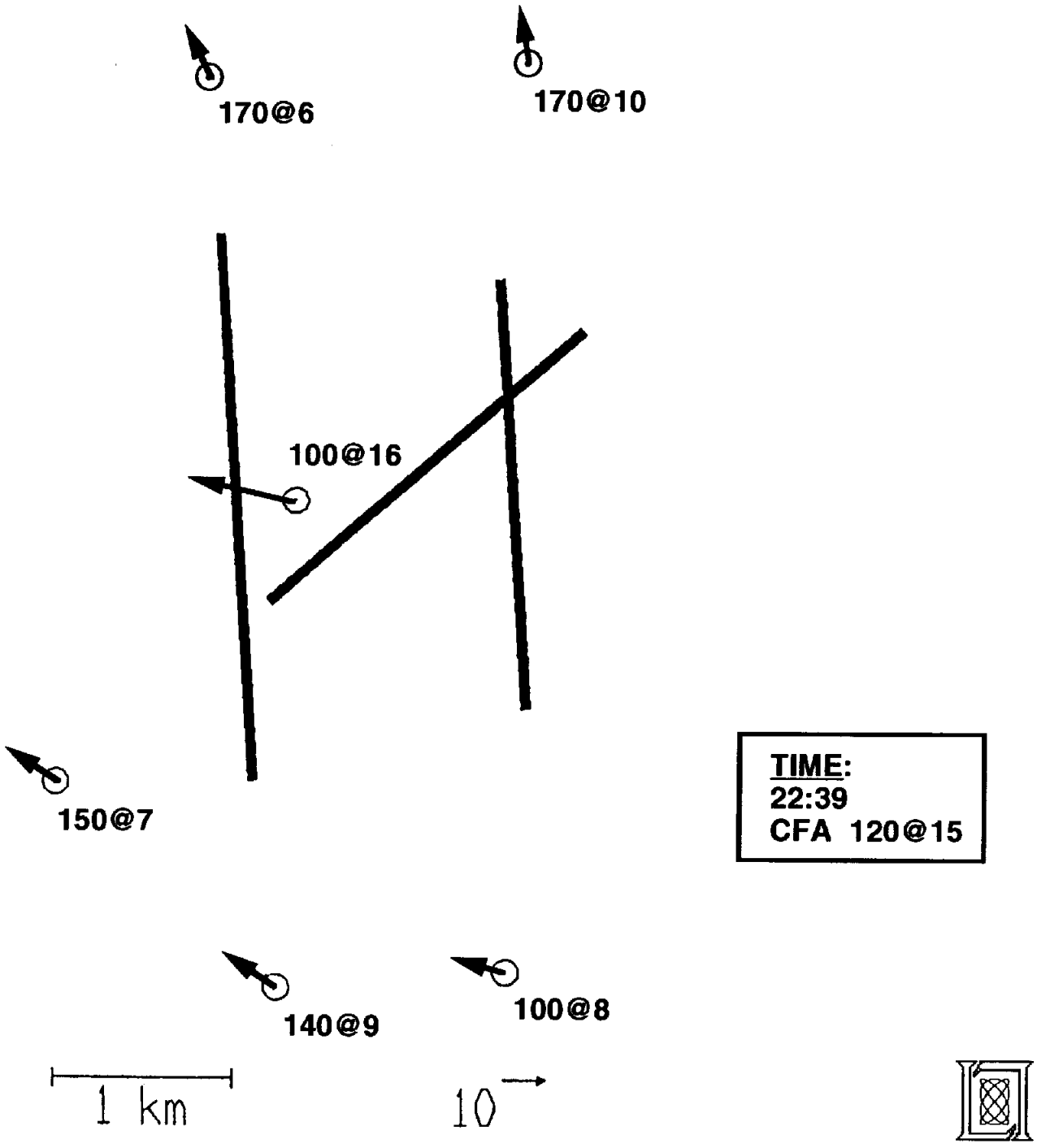
- EXPLANATION OF LLWAS
  - WHAT IT IS
  - HOW IT WORKS
- LLWAS PERFORMANCE ON 2 JULY, 1994
  - SENSOR PERFORMANCE*
  - SYSTEM PERFORMANCE*

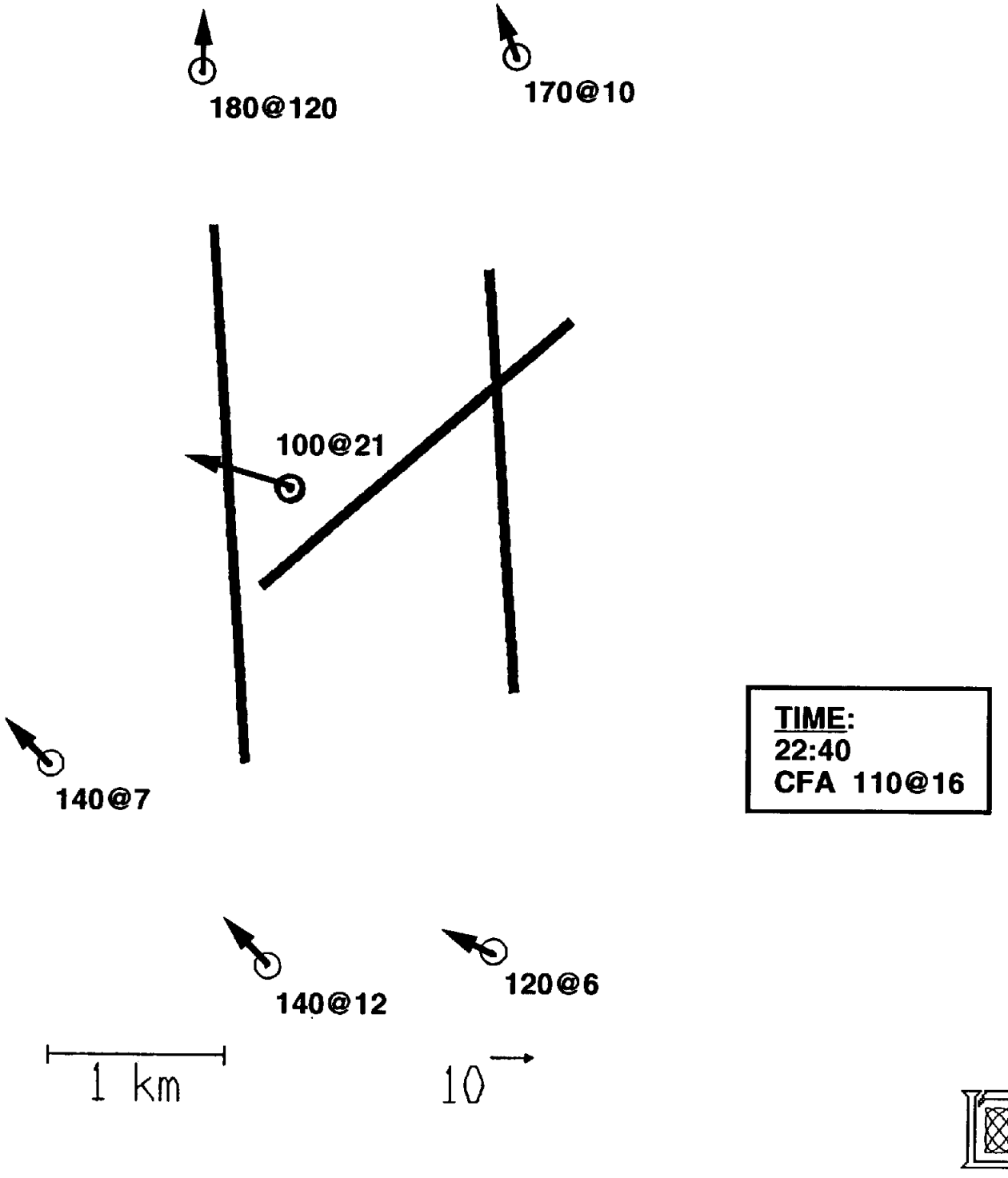
*WE APPRECIATE THE ASSISTANCE WITH THESE ANALYSES THAT WAS PROVIDED BY THE FAA TECHNICAL CENTER

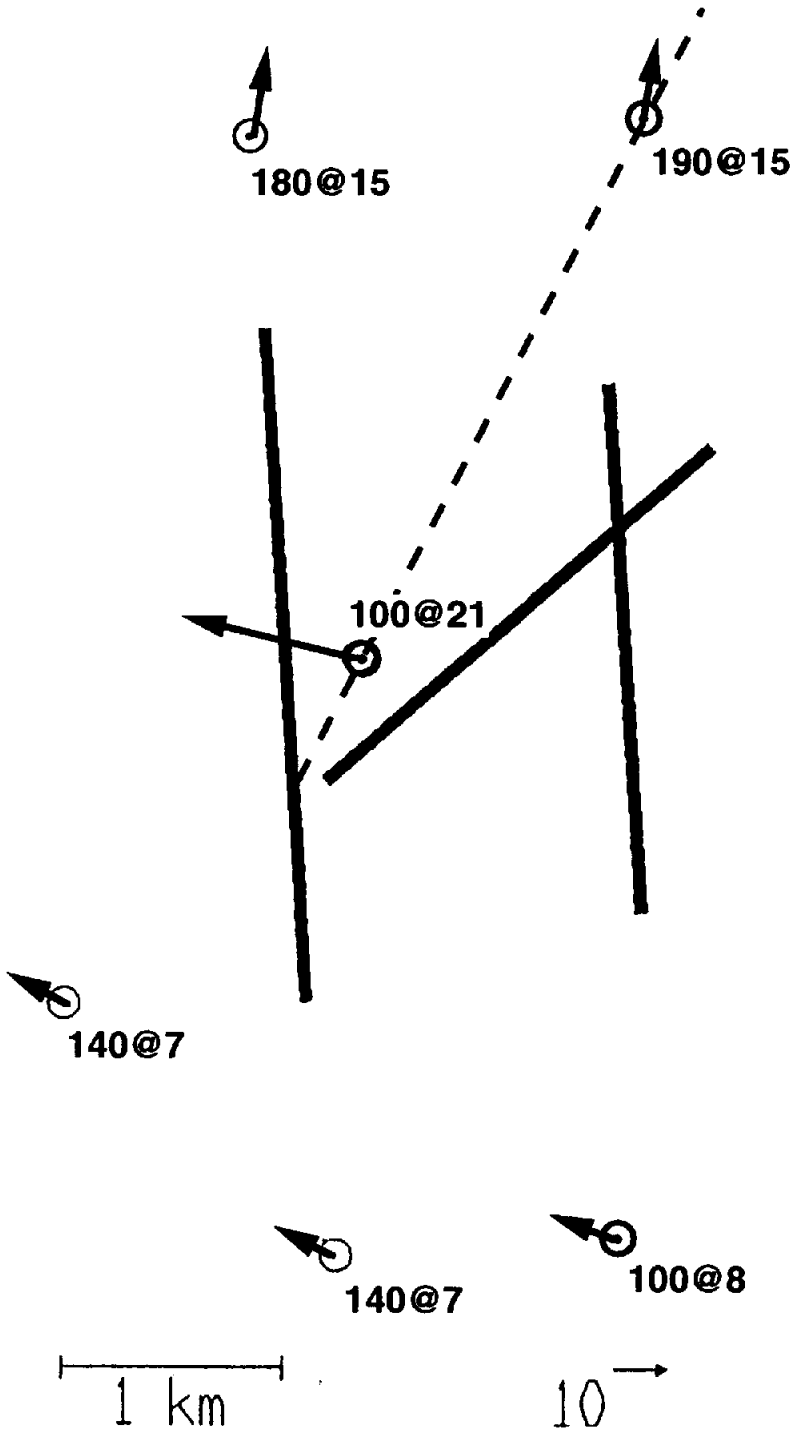

180@8
170@5
150@15
140@6
TIME:
22:37
CFA 150@13
150@7
140@6
1 km
10



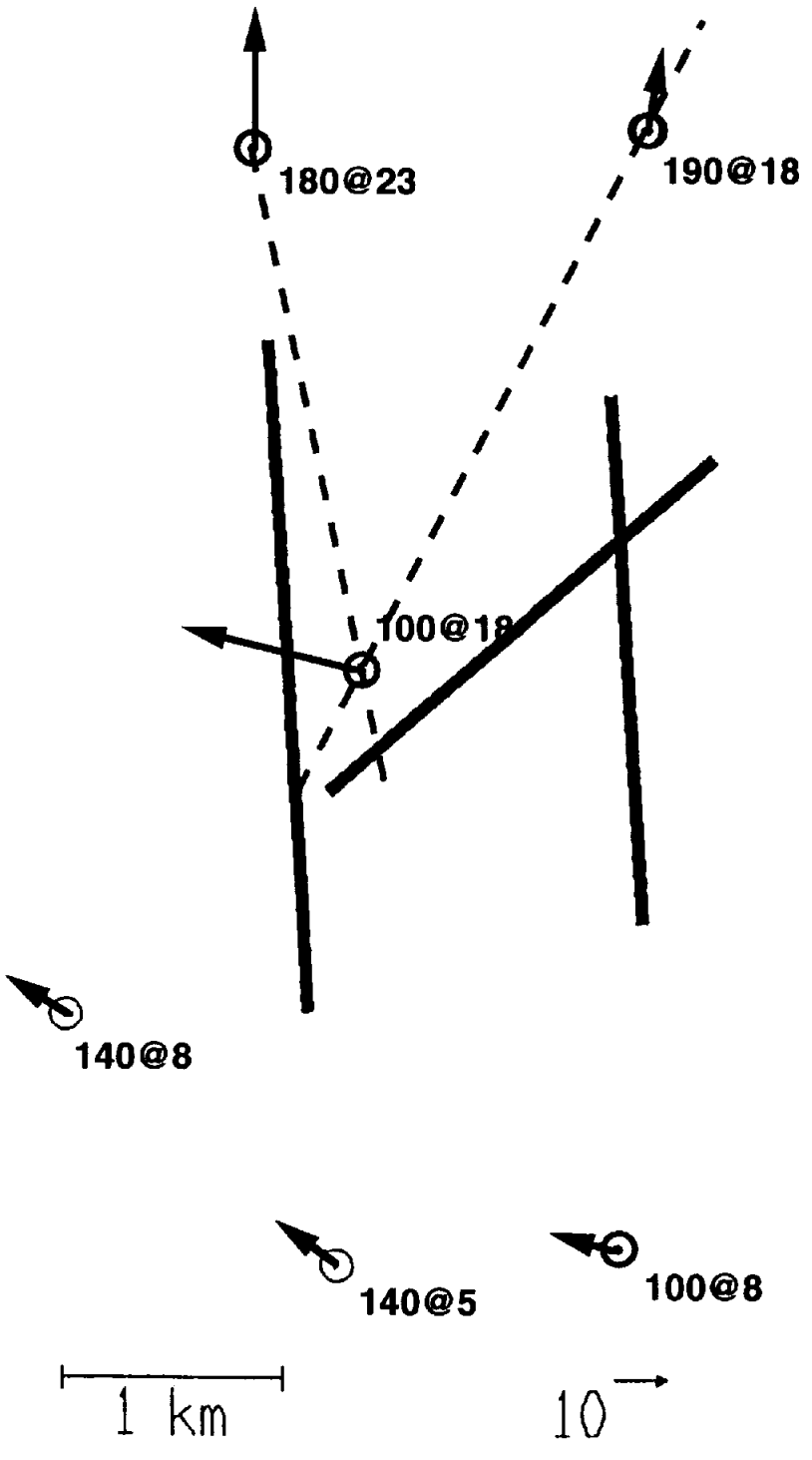
F.W. Wilson 16 September 1994


170@6
170@10
100@16
150@7
140@9
100@8
1 km
10
TIME:
22:39
CFA 120@15


180@120
170@10
100@21
140@7
140@12
120@6
1 km
10
TIME:
22:40
CFA 110@16



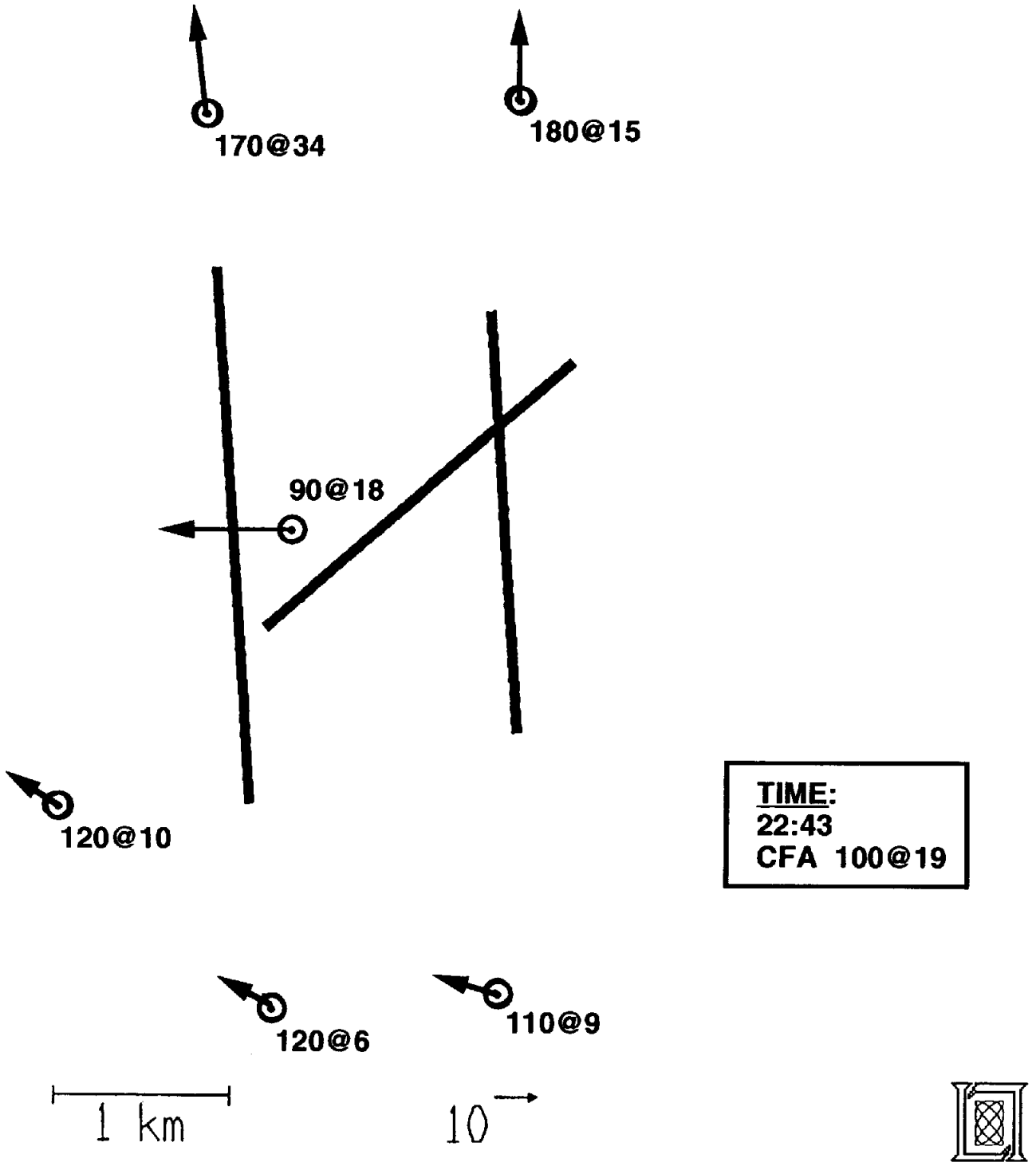
TIME:
22:41
CFA 100@20



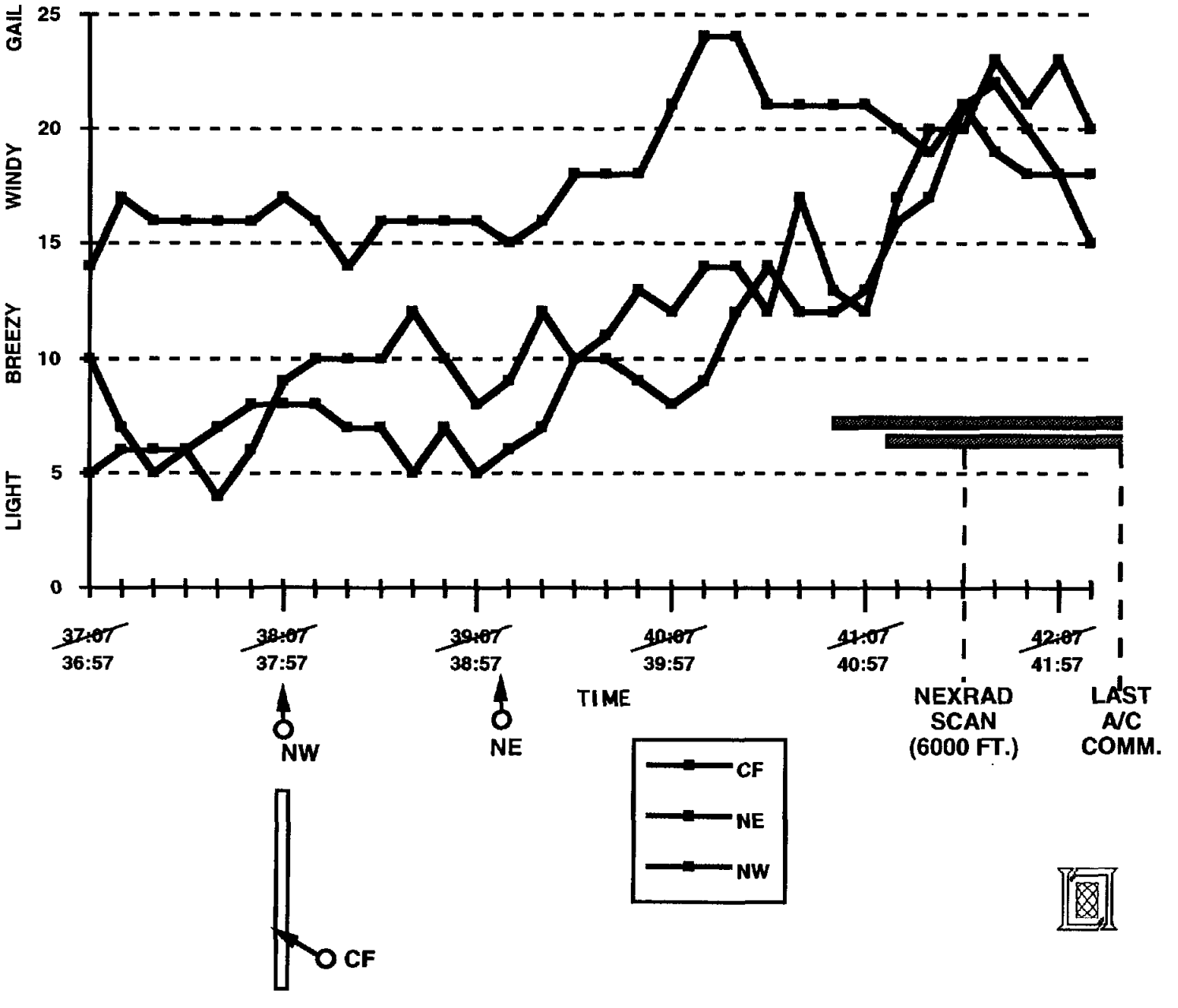
TIME:
22:42
CFA 110@21

F.W. Wilson 16 September 1994

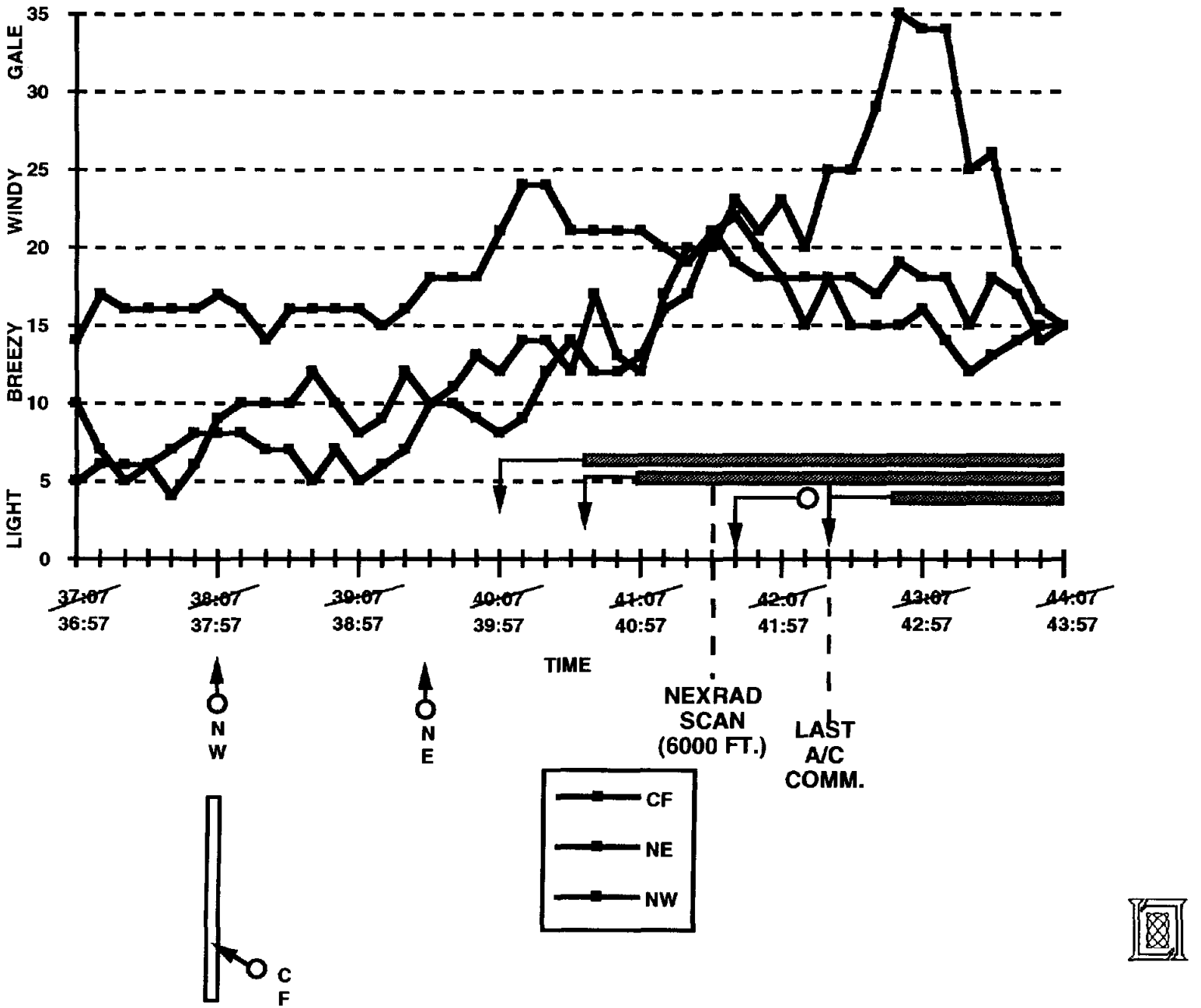
LRM: Filename: Airports


170@34
180@15
90@18
120@10
TIME:
22:43
CFA 100@19
120@6
110@9
1 km
10

WINDS EVOLUTION



WINDS EVOLUTION



TYPE OF MICROBURST EVENT

- **SINGLE EVOLVING EVENT**
  - PRO
    - SEQUENTIAL PULSES: CF, NE, NW
  - CON
    - WIND DIRECTIONS DO NOT EVOLVE
    - NE AND NW WINDS ARE PARALLEL
- **2 PHASE EVENT**
  - PRO
    - DIFFERENT PULSE TYPES CF/NE & NW
    - NEXRAD CELL POSITION
  - CON
    - INSUFFICIENT DATA FOR CONFIRMATION

SUMMARY

- LLWAS PHASE II HAS KNOWN LIMITATIONS AS A MB DETECTION SYSTEM; ITS WS ALERTS HAVE CREDIBILITY
- MANY OF THE INADEQUACIES OF THE SYSTEM ARE THE RESULT OF THE SPARSE SENSOR SPACING
- THE SYSTEM PERFORMED ACCORDING TO DESIGN
- THERE IS EVIDENCE OF A COMPLEX MICROBURST EVENT WITH A FIRST SURGE AT 22:39–41 (CF & NE) AND A SECOND SURGE AT 22:41–43 (NW)