N93-14852

TDWR 1991 Program Review

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TDWR 1991 PROGRAM REVIEW

HISTORY OF WIND SHEAR STUDIES
AT STAPLETON INTERNATIONAL AIRPORT

1982: JAWS

1984: CLAWS

1987: Network Expansion LLWAS Operational Demonstration
TDWR Off-Line Test

1988: TDWR Operational Demonstration

1989: TNEXRAD Operational Demonstration
LLWAS Runway Extension Evaluation
Rudimentary TDWR/LLWAS Integration

1990: Enhanced TDWR/LLWAS Algorithm Demonstration

1991: TDWR/LLWAS Integration
Advanced Algorithm Development (off-line)

TDWR DEMONSTRATIONS
NOTABLE RESULTS/EVENTS

1988

SUCCESSFUL OPERATIONAL DEMONSTRATION OF TDWR

JULY 11 ENCOUNTER

JULY 16 SHUTDOWN DUE TO OVERWARNING

AUGUST 12 VERIFIER INSERT

CHANGE IN MICROBURST ALERT FORMAT

MICROBURST "COAST" FEATURE IMPLEMENTED

1989

FIRST USE OF MILE HIGH RADAR

FIRST INTEGRATION OF TDWR/LLWAS ALARMS

JULY 8 ENCOUNTER

SEPTEMBER 2 ENCOUNTER

849

NOTABLE RESULTS/EVENTS CONT'D

1990

ENHANCED TDWR/LLWAS INTEGRATION TEST

TDWR/LLWAS INTEGRATION TEST

TDWR/LLWAS SYSTEM RUN BY FAA PERSONNEL

1991

CONTINUE TDWR/LLWAS INTEGRATION DEMO

INTEGRATION SPECIFICATION COMPLETED

TDWR DEMONSTRATION DENVER CHRONOLOGY

PRODUCTS	1988	1989	1990	1991
MICROBURST	X	X	X	X
GUST FRONT	X	X	X	X
WIND SHIFT	X	X	X	X
PRECIPITATION	X	X	X	X
LLWAS WINDS	X	X	X	X
NOWCAST		X	X	
STORM MOTION		X	X	X
WIND SHEAR POTENTIAL				X (OFF LINE)
TORNADO VORTEX SIGNATURE				X (OFF LINE)

11 JULY '88

EDDY FIELD(WITH VELOCITY DIFFERENCE BY SEARCH OVERLAY)

FL2 = (0.00, 0.00)   TIME = 88 7 11 22 9 0

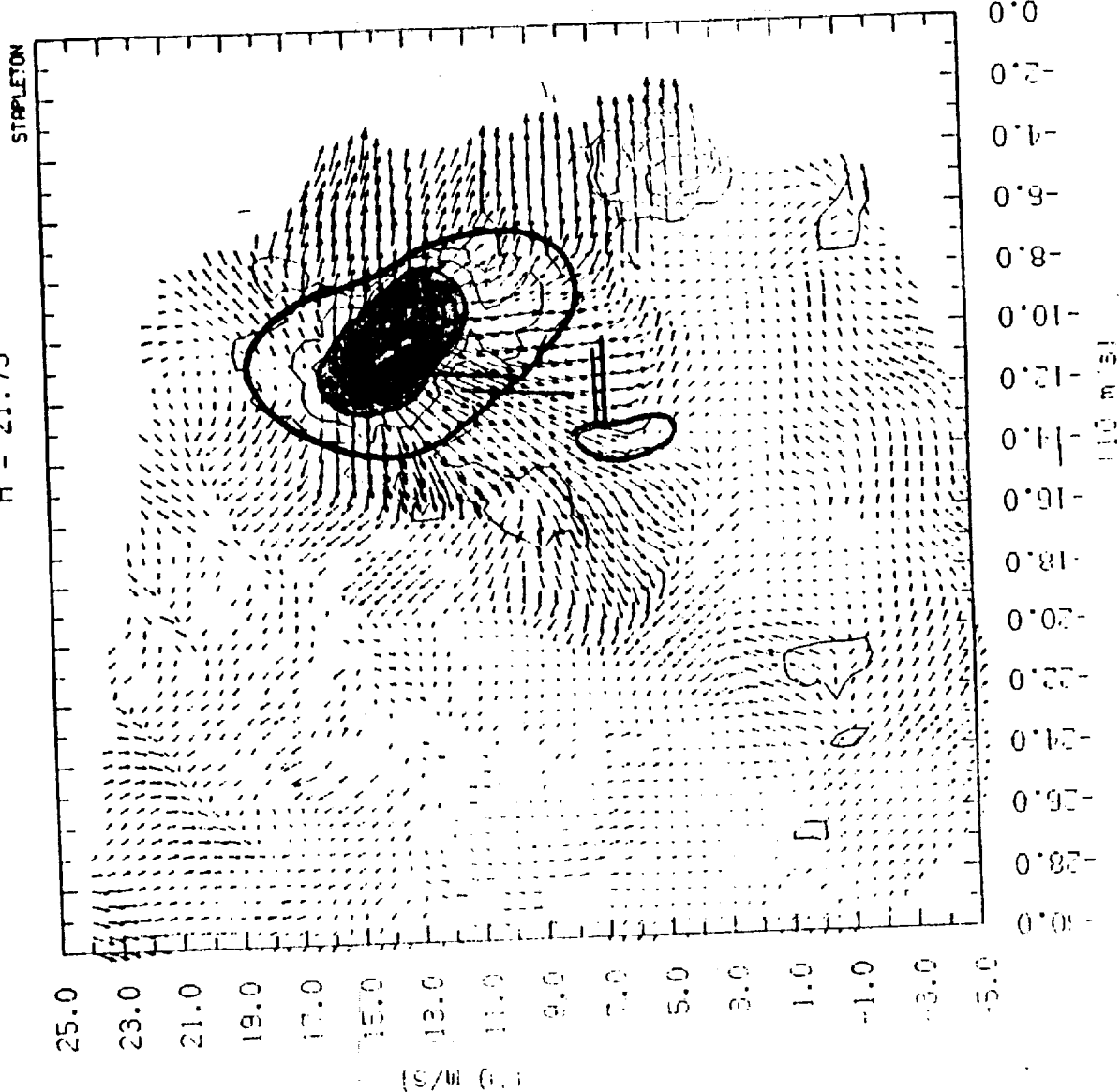UND = (-2.74, 20.55)   REMOVED VECT. = (5.53, -5.72)

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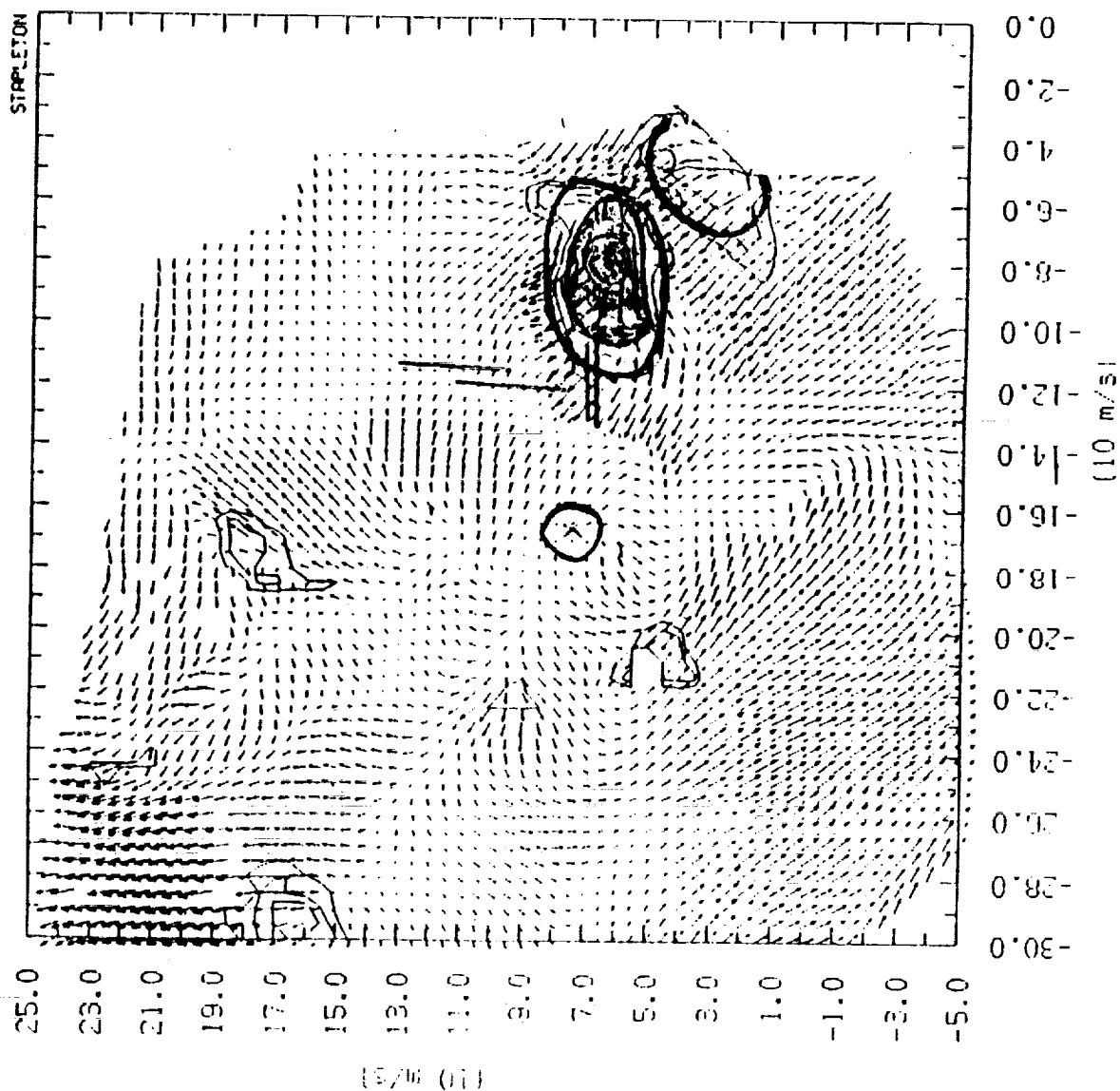
STAPLETON

(10 m/s)

(5/m (1))

EDDY FIELD(WITH VELOCITY DIFFERENCE BY SEARCH OVERLAY)

FL2 = (0.00, 0.00)   TIME = 88 7 16 22 23 34

UND = (-2.74, 20.55)   REMOVED VECT. = (2.80, -2.82)
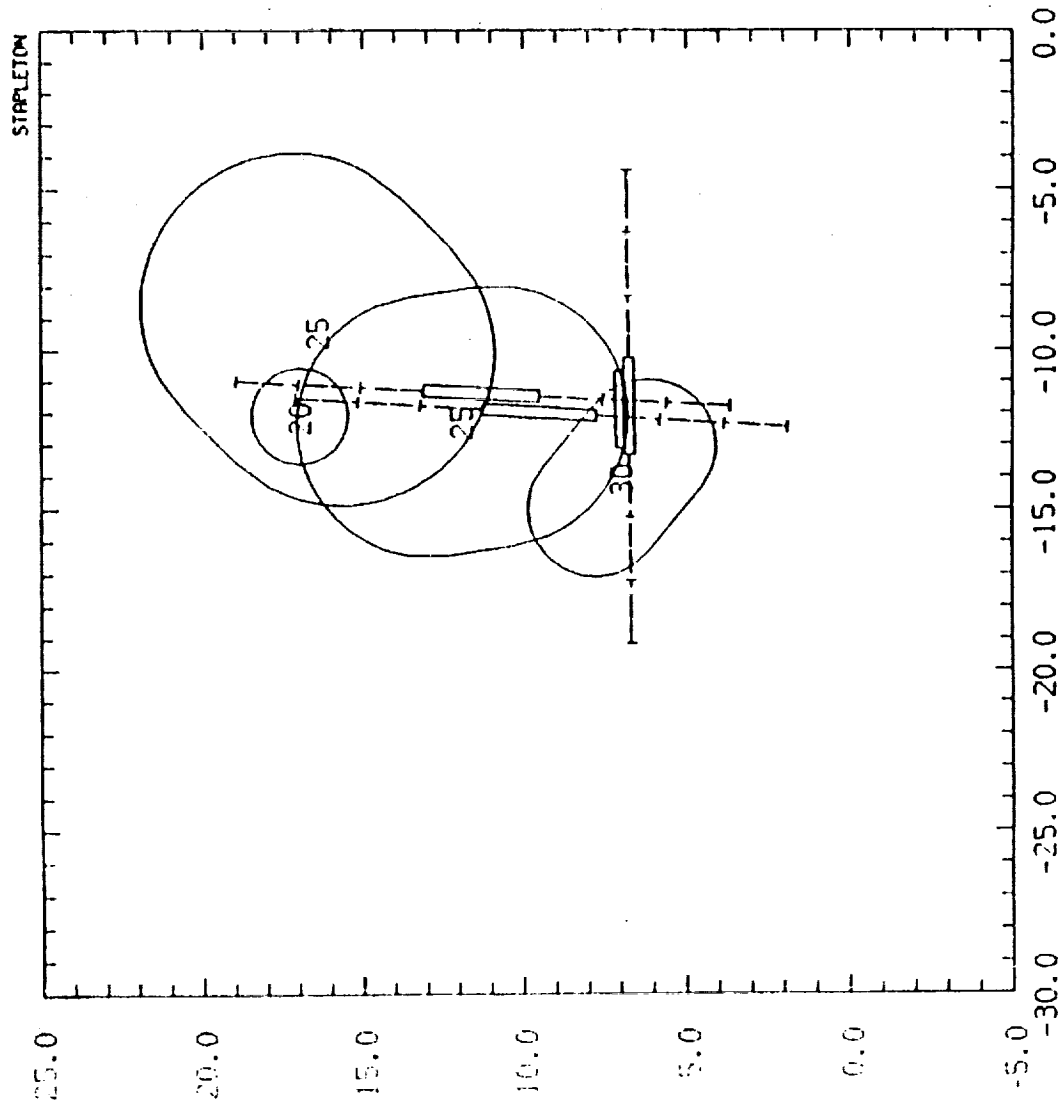
H = 21.73

STAPLETON

16 JULY '88
"TRUTH"

25.0
23.0
21.0
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
3.0
1.0
-1.0
-3.0
-5.0

(m/s)

0.0 -2.0 -4.0 -6.0 -8.0 -10.0 -12.0 -14.0 -16.0 -18.0 -20.0 -22.0 -24.0 -26.0 -28.0 -30.0

(m)

GEOGRAPHIC EVENT DISPLAY
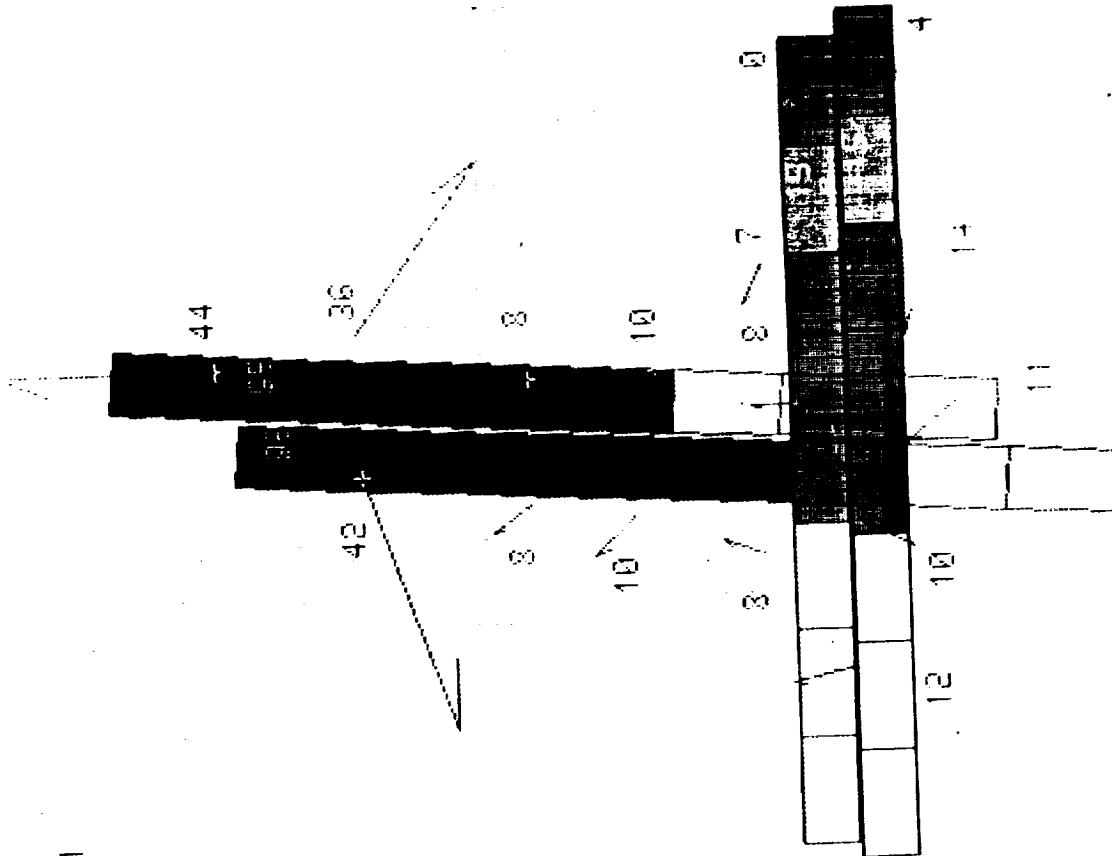
SHAPES

TIME = 88 7 16 22 23 34

STAPLETON

16 JULY '88

ALARMS

854

88 7 8 23:20:41

8 JULY '89

KNOTS

OVERVIEW OF GENERIC INTEGRATION CONCEPTS

- ● Exploit Strengths of Stand-Alone Systems

- ● Limit Impact of Weaknesses of Stand-Alone Systems

- ● User-End Products (Graphic and Alphanumeric) Should Be Transparent as to Source

OVERVIEW OF GENERIC INTEGRATION CONCEPTS
(continued)

Three Possible Techniques:

1. Alphanumeric-Level
   - Generate consensus of runway alerts by taking "worst case" alphanumeric alerts from stand-alones.

2. Data-Level, "Bottom-Up"
   - Synthesize raw data to then generate end-products.

3. Product-Level, "Top-Down"
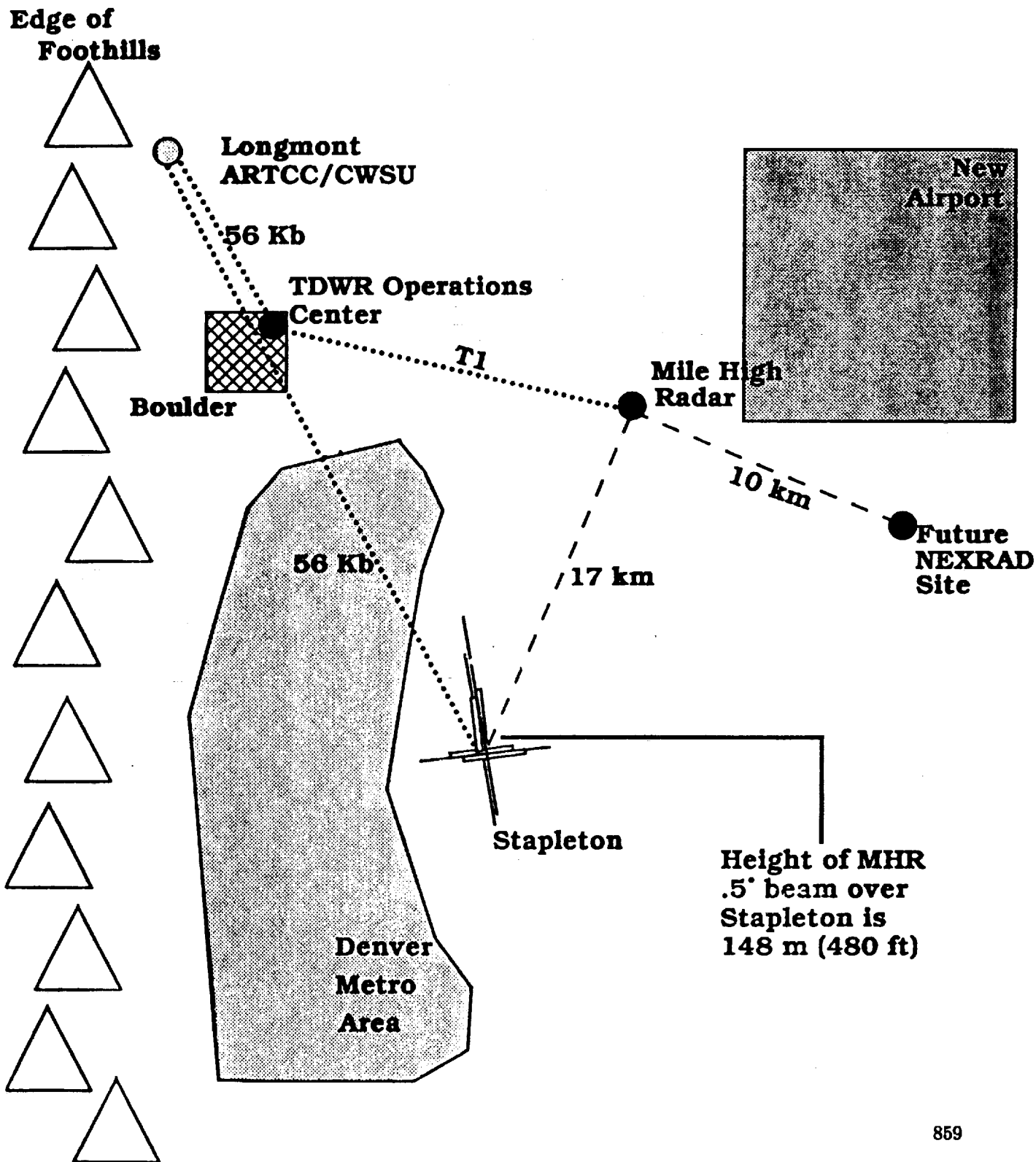   - Utilize intermediate products to generate end-products. "Expert-system".

Denver Operations 1991:

Operational 1 June - 31 August

Noon to 7 pm daily

Total Days - 92

Terminal Doppler Weather Radar (TDWR) Project Setting

Edge of Foothills

Longmont ARTCC/CWSU

56 Kb

TDWR Operations Center

Boulder

T1

Mile High Radar

New Airport

10 km

Future NEXRAD Site

56 Kb

17 km

Stapleton

Denver Metro Area

Height of MHR .5° beam over Stapleton is 148 m (480 ft)

TDWR 1991 PROGRAM REVIEW

1991 OBJECTIVES:

a) Protect Stapleton from wind shear

b) Evaluate TDWR & LLWAS stand-alone systems

c) Test & demonstrate the TDWR/LLWAS integration algorithm

d) Evaluate TDWR algorithm performance during winter conditions

e) Test & evaluate (off-line) "new" algorithms

f) Provide a reliable, stable system

Denver Operations 1991:

Algorithms:

Microburst Detection
Gust Front Detection
Windshift Prediction
Precipitation
Storm Motion
TDWR/LLWAS Integration
TVS (Tornado) (Offline)
Windshear Potential (offline)

Denver Operations 1991:

Facility Demonstration:

**ATCT
TRACON
CWSU(ARTCC)
United Airlines**

Denver Operations 1991:

Events: Microbursts - 69 (within 5nm of airport)

Strongest Microburst - 55kts (July 12th and 30th)

Gust Fronts - 57

Strongest Gust Front - 45 kts (1 June)

Total Alarm Time (Integrated LLWAS/TDWR) - 35.7 hours

Total Alarm Time - 6.6% of total operational time

863

LLWAS DEMONSTRATIONS
DENVER MICROBURST SCORING

	1988	1989	1990	1991
POD*	X	90%	95%	96%
FAR	X	14%	3%	1%

* For Events Within LLWAS Network Only!

TDWR DEMONSTRATIONS
DENVER MICROBURST SCORING

	1988	1989	1990	1991
POD*	98%	94%	92%	91%
FAR	2%	**12%	3%	2%

TDWR/LLWAS INTEGRATION

				1991
POD				93%
FAR				2%

* For Events With Losses ≥30 kts

** High FAR due to new radar (Mile High Radar)

-5.0

-10.0

-15.0

25

45

30

20

11

14

17

2

0

15

3

0

9

12

16

8

-15.0   -10.0   -5.0
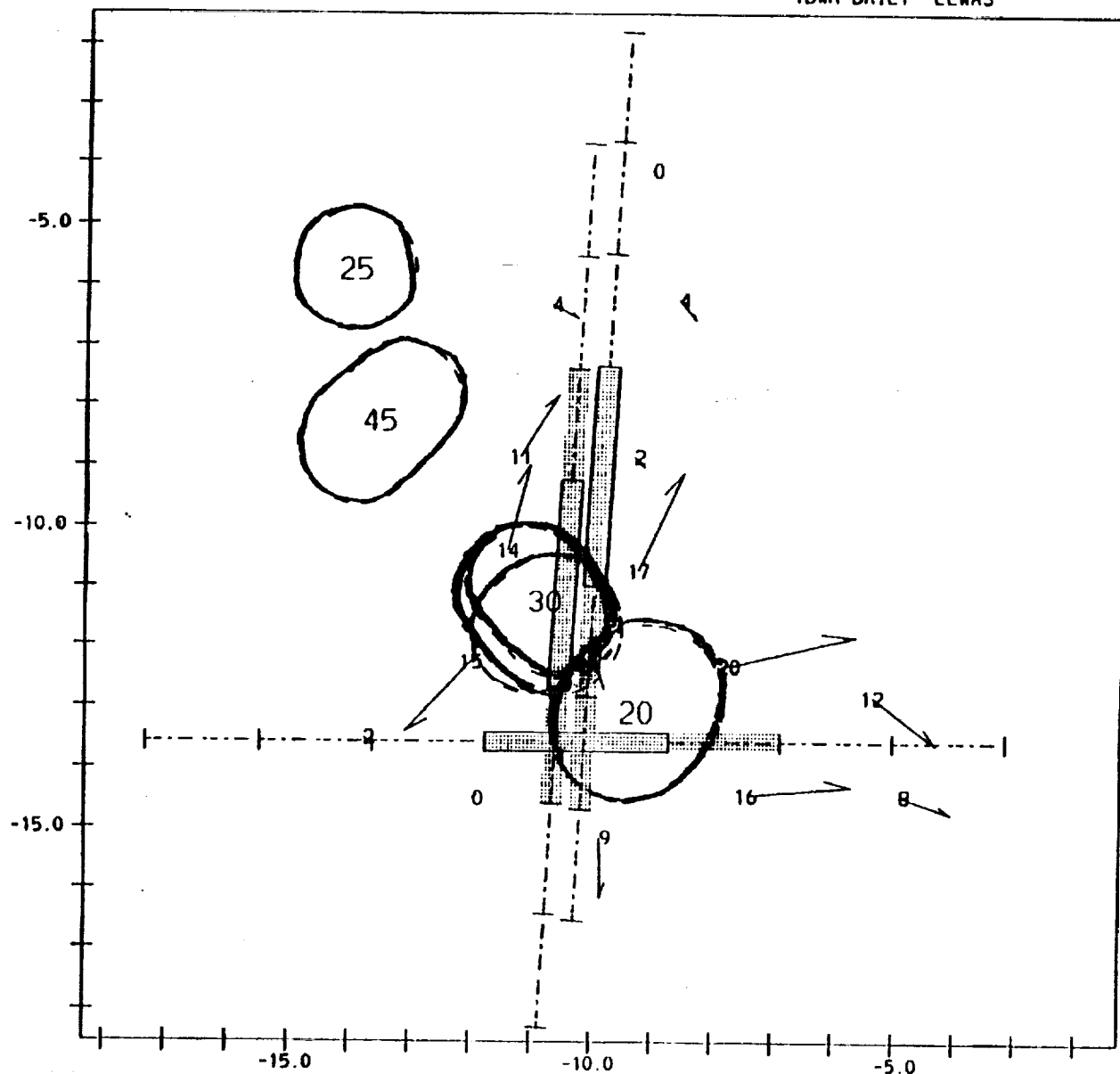
BLUE = TD

RED = LLW
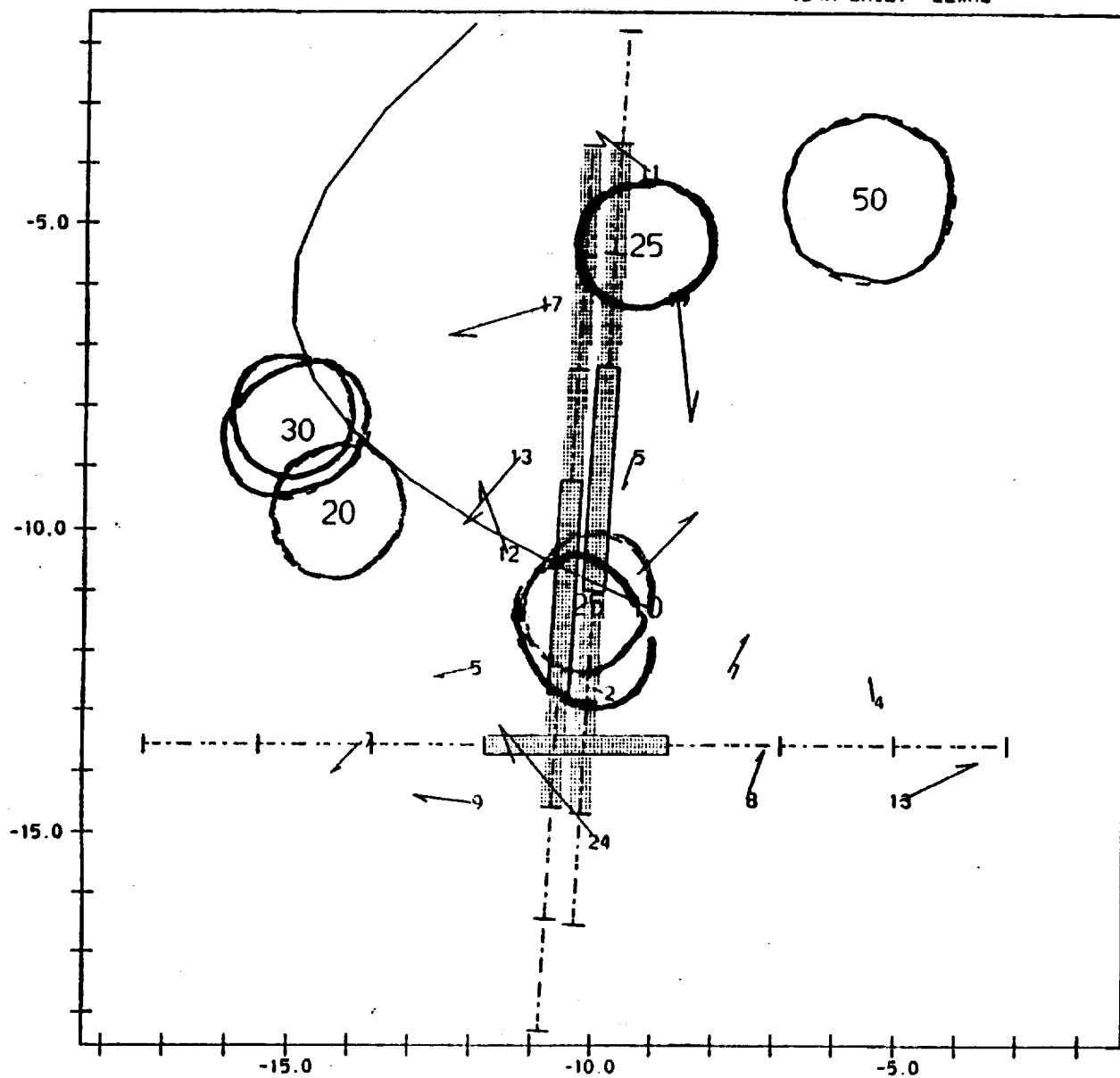
12 - JUL - 91   21.59. 0

TOWR DAILY--LLWAS

40

-5.0

20

20

31

14

10

8

10

10

17

10

23

4

I_3

4

16

45

21

16

16

-10.0

-15.0

-15.0   -10.0   -5.0
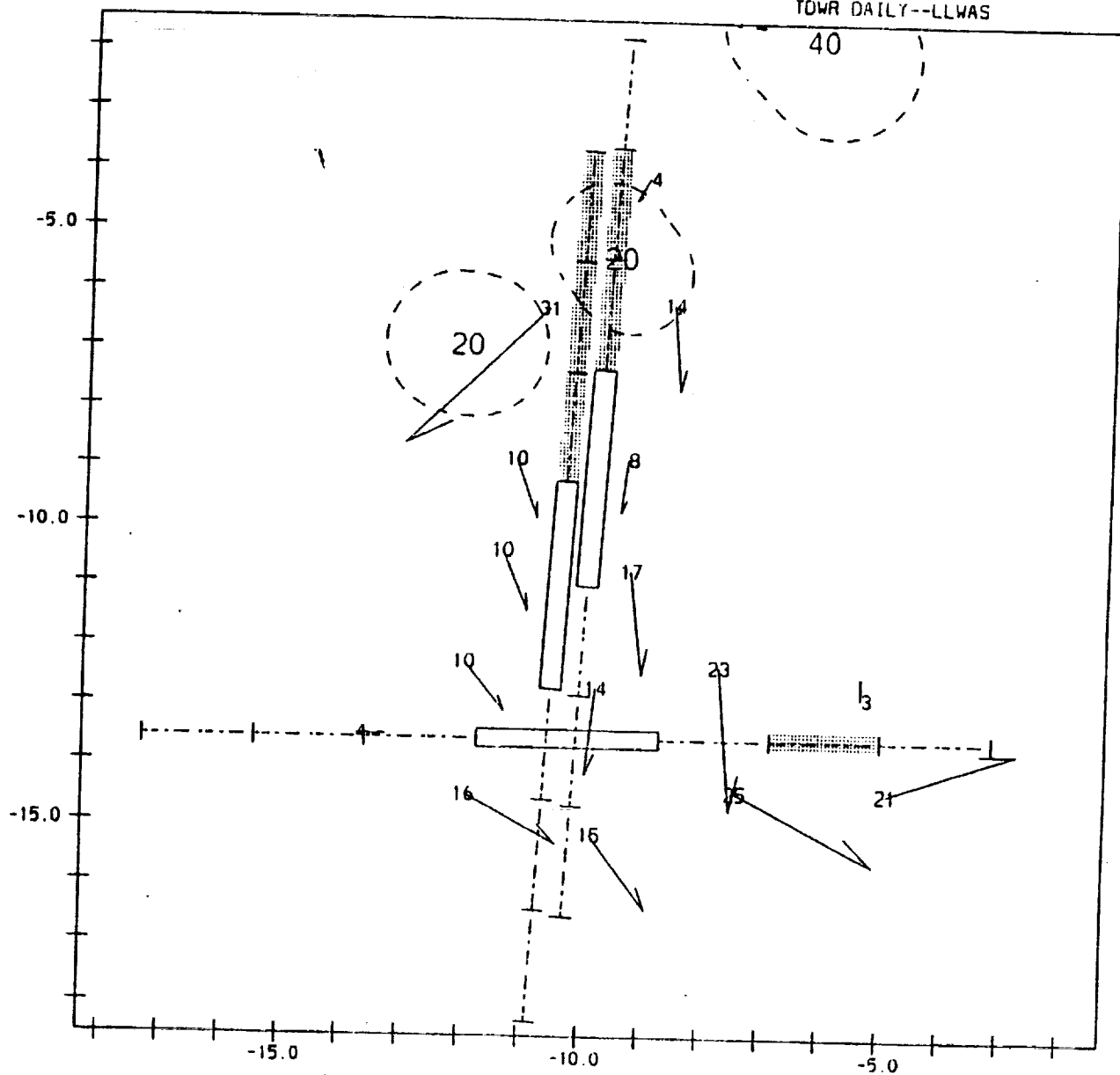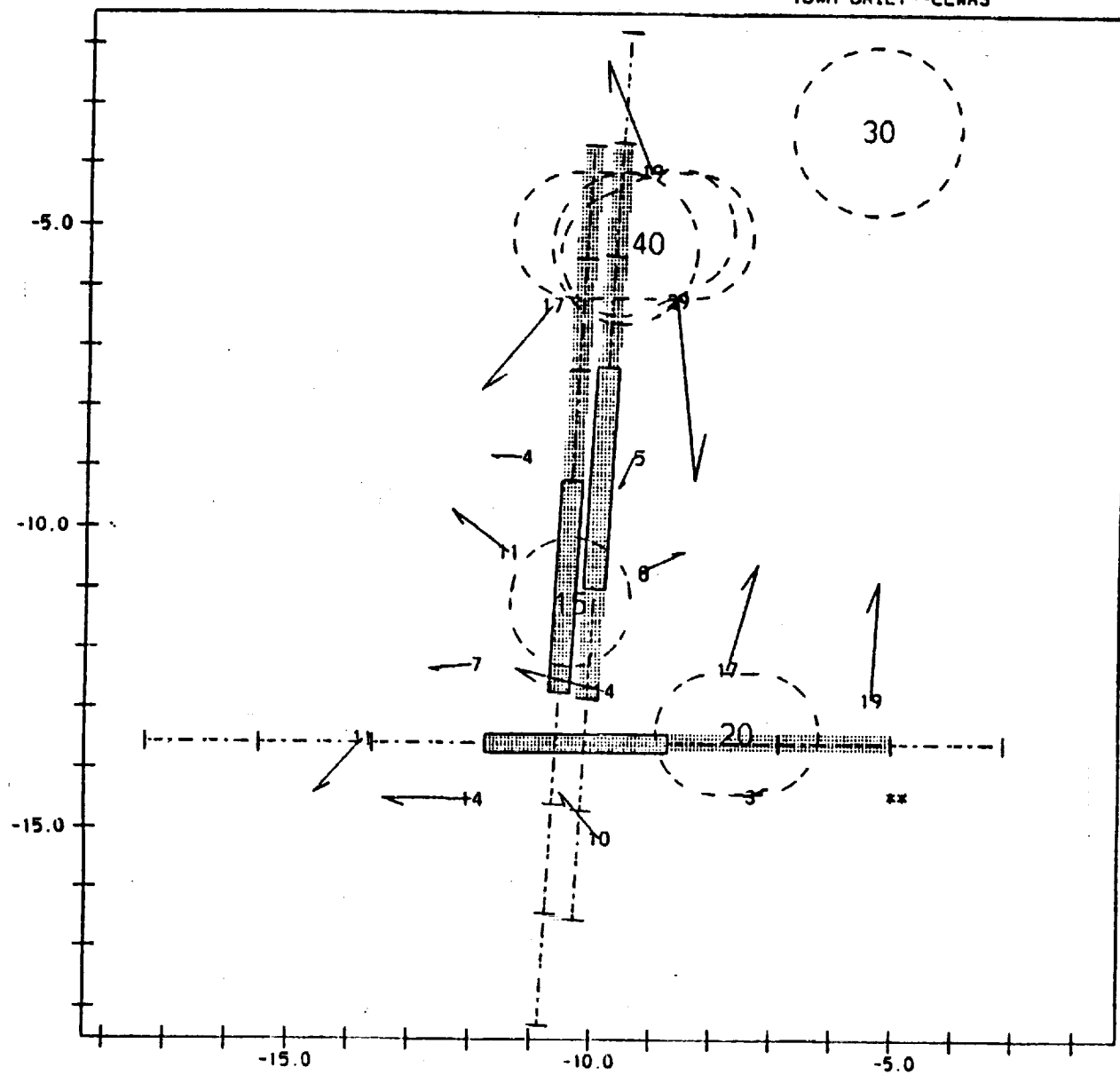
FY-92 Plans

Summer Operations (1 June - 31 August)

Operational Time - noon to 19:00 LT, daily

Products: Microburst Detection
Gust Front Detection
Windshift Prediction
Storm Motion
Precipitation
TDWR/LLWAS Integration (Spec Compliant)
TVS (Tornado)
Windshear Potential
Shear-Based MB - offline
Shear-Based GF - offline
Shear-based Tornado - offline
New Storm Track/Prediction - offline

FY-92 TDWR Plans - Denver

Winter Operations (20 January - 15 March)

Operational Times - 10:00 to 17:00 Daily

During Storms - extended hours

Products: Microburst Detection
Gust Front Detection
Windshift Prediction
TDWR/LLWAS Integration
Precipitation
Storm Motion
Snowfall Rate (new)
TVS (tornado) (offline)
Windshear Potential (offline)

NASA-NCAR '92

Dates: 6 July - 21 July

Changes for '92:

Way points with shear (2-D, 1 km)

Markers (up to 10)

Real-Time Reflectivity uplink
(4 levels)

Downlink A/C Position

Downlink A/C alarm status

"Quick look" data (48 hr turnaround)

Polarimetric radar data for
hail avoidance

NASA-NCAR '92

Dates: 6 July - 21 July

Changes for '92:

Way points with shear (2-D, 1 km)

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Polarimetric radar data for
hail avoidance

Q: Branimir Dulic (Transport Canada) - Could you elaborate on that polarometric radar. What kind of radar is it?

A: Kim Elmore (NCAR) - Well, it is a 10 centimeter radar, it is the NCAR CP2 radar. We can look at all kinds of things. We can look at KDP, PDP, linear depolarization ratios, ZDR, plus we actually have dual band radar capability, we have X band and S band. It is linear polarization. NOAA operates a circular polarization radar, but we operate linear polarization, horizontal, and vertical. We have a polarization switch so we can change from one to the other. Typically with polarometric radars, because you interlace pulses, you cut your Nyquist interval in half. We are going to install a processor where we can retain the Nyquist interval because we will use phase information from both polarizations instead of just horizontal.

Q: Joe Youssefi (Honeywell) - The false alert rates that you quoted, one or two percent, what are the units for that?

A: Jim Evans (MIT) - They are not false alert rates. They are probabilities that when you issue an alert that it is false. There is an important difference between this and the way people are talking about false alert rates with respect to the airborne systems. In the ground based systems, we have been convinced that from a pilot's belief view point you should have a high probability that when we present you alert that it actually is a valid alert. If you take false alert rates, it turns out most of the time there is no weather. If you actually had a false alert rate as low as one a week, it might mean that the probability when you hear an alert that it is false could be 90%.

Q: Joe Youssefi (Honeywell) - Let me see if I understand. If you give a hundred alerts the probability would be that there is one out of the hundred that is false?

A: Kim Elmore (NCAR) - That is correct.

Q: Joe Youssefi (Honeywell) - I had a second question relating to the issue of the dry microburst season in Denver.

A: Kim Elmore (NCAR) - I knew that was going to come up. Pete Sinclair and us seem to be somewhat at odds. NASA will be in Denver for basically the month of July, which was the month that Dr. Sinclair suggested they avoid. Our studies have found that while June is a great month for microbursts, they tend to also be associated with hail. So, if you just want to study microburst that is fine, but if want to fly airplanes through them that is not fine. So we counseled them to avoid June. Our experience has been that sometime in August we usually lose the Southwest monsoon over the Denver area which gives us the mid level moisture that we need for the dry low reflectivity microburst. Now it is absolutely true that we could have microbursts into October, certainly. But, our work has found that the highest frequency of them tends to be sometime in July. Those of you that did not know that Denver had a monsoon season it does.

Q: Pat Adamson (Turbulence Prediction Systems) - Are you doing a calculation of the F-factor? If so, are you using a similar formula or has work been done in that area?

A: Kim Elmore (NCAR) - From our shear base stuff we will be calculating F this season. We will be doing it essentially the same way that Steve and NASA do it.

Q: Pat Adamson (Turbulence Prediction Systems) - So the formula for a vertical computation is the same for wet or dry microburst?

A: Kim Elmore (NCAR) - Yes.

Session X. Flight Management Research