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VR/SHEAR INTERPRETATION

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Introduction

This Technical Attachment discusses the use of a WSR-88D Operational Support Facility (OSF) nomogram, created for mesocyclone recognition, used in conjunction with WSR-88D storm relative velocity (SRV) products. In short, a nomogram is a trace of three coplanar curves which are usually straight parallel lines, each graduated for a different variable. In this case, radar-defined variables are used and include weak shear, minimal mesocyclone, moderate mesocyclone, and strong mesocyclone. The nomogramatic method is used as an operational tool to help decipher mesocyclone strength and predict which ones may be tornadic.

Four (three mini-supercell and one supercell) severe weather events from the California Central Valley are used to test the nomogram.

1. 13 May 1995, an F0 tornado event located 14nm west southwest of the Fresno Yosemite International Airport.
2. 12 March 1996, an F0 tornado event located 2nm northwest of the RDA in Hanford.
3. 22 November 1996, an F1 tornado event within Lemoore NAS located 16nm from the RDA in Hanford.
4. 20 January 1997, a severe thunderstorm, which produced multiple funnel clouds, located 25nm to 30nm southeast of the Hanford RDA site. One funnel cloud was observed near the town of Strathmore and another near Exeter.

Background

Several years ago, the OSF devised a nomogram which determines mesocyclone strength. As seen in Fig. 1, four categories of mesocyclone shear strength are depicted. They are defined as weak shear, minimal mesocyclone, moderate mesocyclone, and strong mesocyclone. To use the nomogram, the Vr/shear algorithm is run. From the algorithm results several variables are determined including the diameter of mesocyclone rotation (nm), mesocyclone distance from the RDA sight or range (nm), and mesocyclonic rotational velocity (kts). Using these variables, the mesocyclonic rotational velocities are plotted on the nomogram to determine potential mesocyclone strength.

From OSF results of **Midwest supercell** events, conclusions state:

1. A severe thunderstorm warning is <u>recommended</u> if a mesocyclone is recognized by the radar.
2. A tornado warning is <u>recommended</u> if a **strong** mesocyclone is recognized by the radar.
3. Only 30% of all radar defined mesocyclones produce tornadoes.
4. 90% of all radar-defined mesocyclones produce severe weather.

Recently, more and more mesocyclone studies have been submitted to the OSF for research, including studies from east and west coast mini-supercell events. From these events, new nomograms have been developed. The original **Midwest** nomograms were based on 3.5nm to 5.0nm mesocyclone core diameters, while the newer mini-supercell nomograms assume 1.0nm to 2.0nm core diameters.

Case-Analysis

Mesocyclone/circulation parameters for the four events are shown in Table 1.

TABLE 1

Date	Event	Maximum VR/shear	Range @ maximum VR/shear	Greatest depth of Circulation (AGL)	Apparent gate to-gate shear
05/13/95	F0 tornado	16 kts 2.4 degree scan	29nm	5,627f t -11,613ft 1.5 - 3.4 degree scan	21:05 - 21:23UTC
03/12/96	F0 tornado	16 kts 2.4 degree scan	06nm	700ft - 1973ft 0.5 - 2.4 degree scan	22:03 - 22:09UTC
11/22/96	F1 tornado	40 kts	14nm	No Data	No Data
01/20/97	Funnel cloud	16 k 1.5 degree scan	26nm	Only detected by 1.5 degree scan @ 4856ft	00:14UTC
	Funnel cloud	12 kt 1.5 degree scan	29nm	Only detected by 1.5 degree scan @ 5782ft	23:50UTC

Using the updated nomograms (Fig. 2), the 22 November 1996 event closely resembles **Midwest** guidance, where a tornado warning is <u>recommended</u> if a **strong** mesocyclone is recognized by radar. The data point (40kts at 14nm) is in the higher values of the moderate category, approaching strong mesocyclone values. The other events, which are more common to the California Central Valley, all fall within the weak shear range. Of most importance, two events, 13 May 1995 and 12 March 1996, were tornadic, but had rotational velocity values of only 16kts. These values, at their respective ranges, fall well below the **strong** mesocyclone category and OSF guidance for tornado warning issuance. The last event, 20 January 1997, produced multiple funnel clouds. No mesocyclones were defined by the mesocyclone algorithm, but rotational velocity values analyzed by hand were 12kts and 16kts.

Since three events, two tornadic and the other non-tornadic, had the same Vr/shear values at about the same range, a comparison was made of the storm relative velocity product. A subtle difference was observed between tornadic and non-tornadic events. In the tornadic events, (13 May 1995 and 12 March 1996), the maximum azimuthal shear resided within **multiple** radial pixels **adjacent** to each other, i.e., gate-to-gate (Figs. 3 and 4), while the shear of the non-tornadic events of (20 January 1997) did not (Figs. 5 and 6). These results follow the reasoning that, within sampling constraints, small tornadoes are more likely to be associated with well-structured and developed gate-to-gate shear.

Conclusions

California Central Valley mini-supercell tornadoes are usually associated with very weak rotational velocities. It was found that these mini-supercells, with approximately 1nm mesocyclone cores, can be tornadic with Vr/shear values of only 16kts. This value, at a given distance, falls well below OSF recommendations of tornado warning issuance. Also, the greatest Vr/shear values and organized storm structure were located by using either the 1.5 or 2.4 elevation slice, depending on distance. Results also indicate that gate-to-gate shear is important in discriminating between tornadic and non-tornadic circulations as seen on radar. In addition, these types of tornadoes are anticipated to be well-handled by the upcoming Build 10 Tornado Detection Algorithm. However, it is expected that optimal adaptable parameters will need to be determined (see Vasiloff 1996 for a TDA parameter study in Utah).

Acknowledgments

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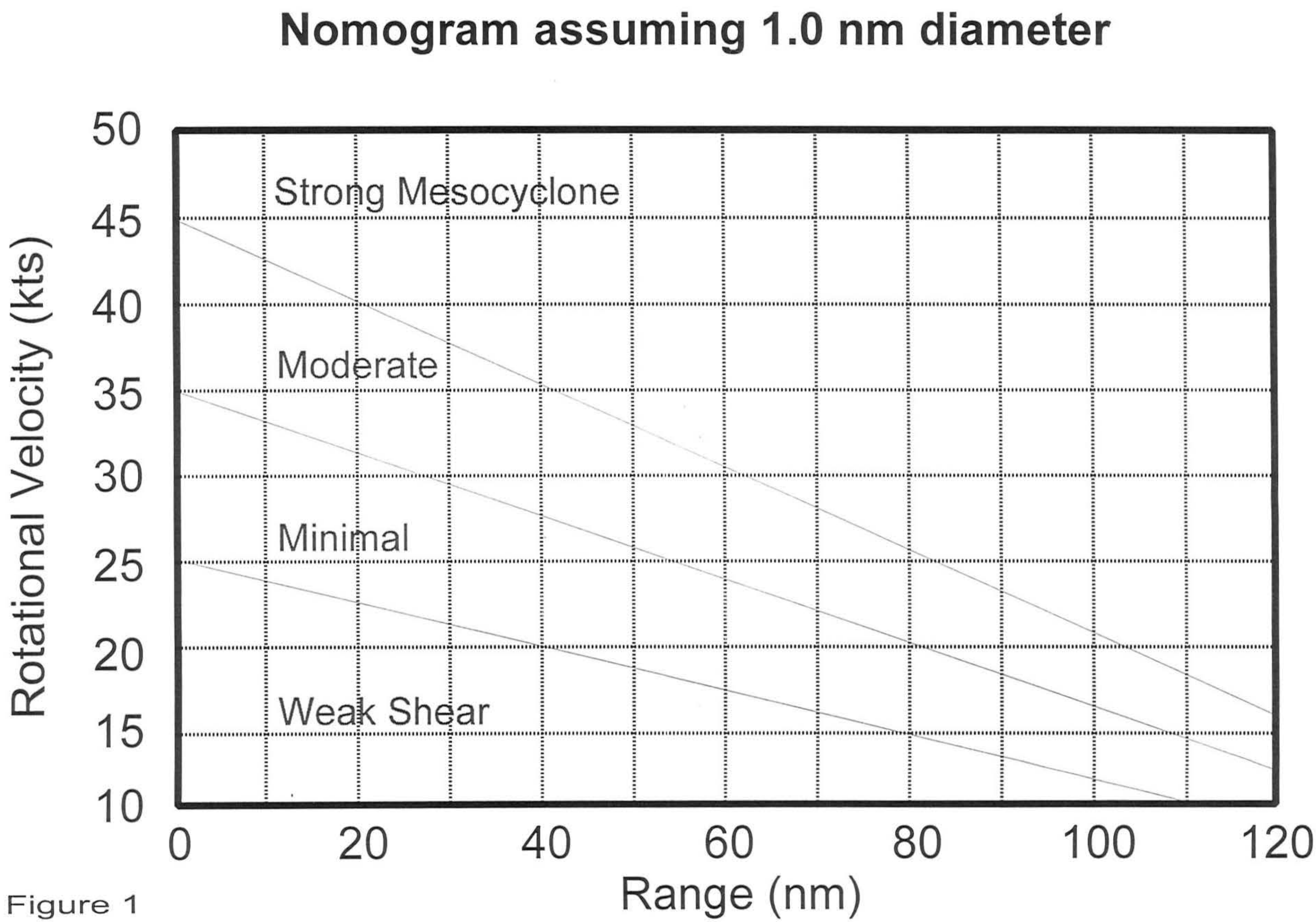
References

Vasiloff, S. V., 1996: WSR-88D TVS parameter study. WR TALITE96-11, NWS WR Homepage.



Nomogram assuming 1.0 nm diameter
Rotational Velocity (kts)
50
45
40
35
30
25
20
15
10
Strong Mesocyclone
Moderate
Minimal
Weak Shear
0
20
40
60
80
100
120
Range (nm)

Figure 1

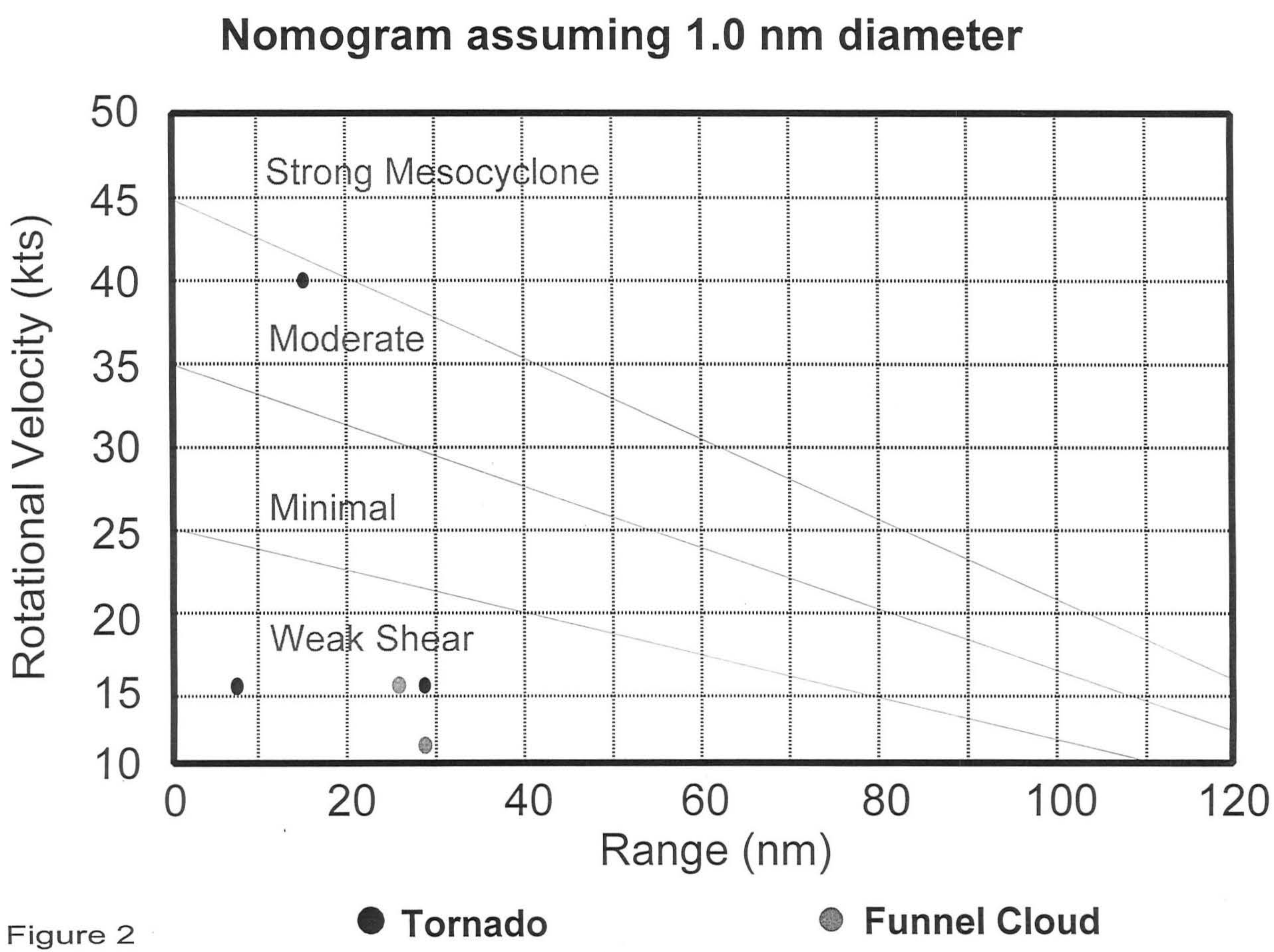
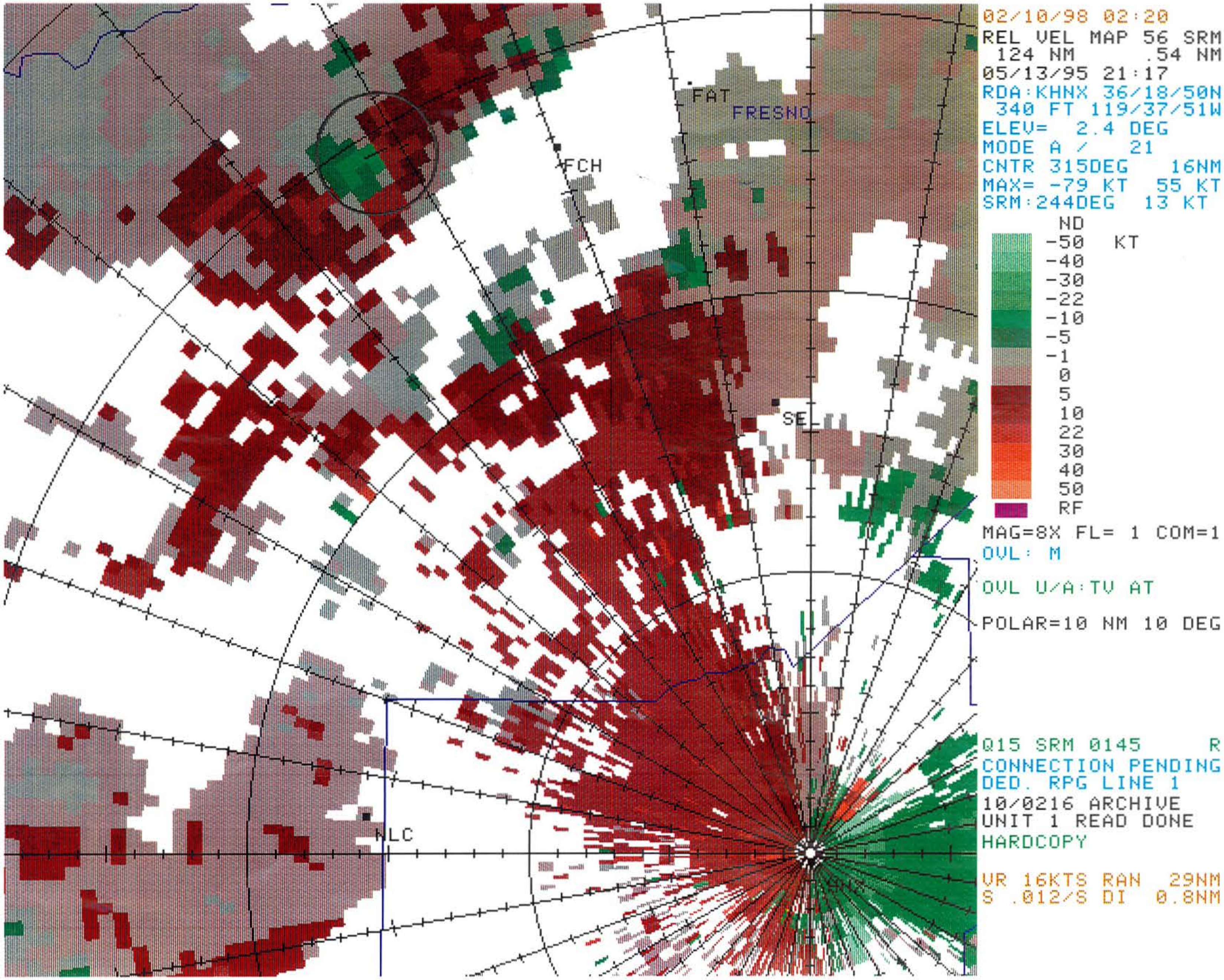

Nomogram assuming 1.0 nm diameter
Rotational Velocity (kts)
50
45
40
35
30
25
20
15
10
Strong Mesocyclone
Moderate
Minimal
Weak Shear
0
20
40
60
80
100
120
Range (nm)
Tornado
Funnel Cloud

Figure 2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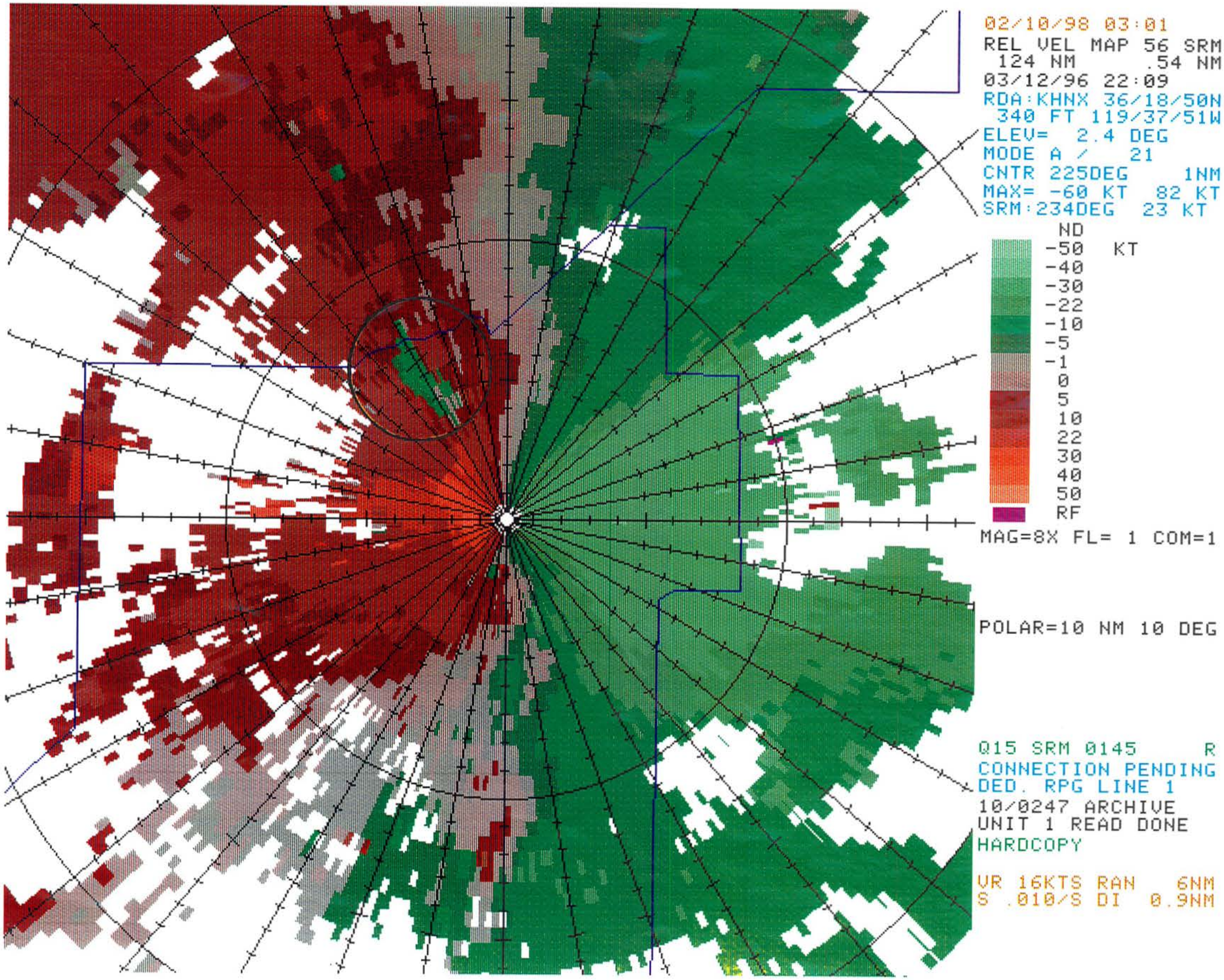
REL VEL MAP 56 SRM
124 NM .54 NM
05/13/95 21:17
RDA:KHNX 36/18/50N
340 FT 119/37/51W
ELEV= 2.4 DEG
MODE A / 21
CNTR 315DEG 16NM
MAX= -79 KT 55 KT
SRM:244DEG 13 KT
ND
-50 KT
-40
-30
-22
-10
-5
-1
0
5
10
22
30
40
50
RF
MAG=8X FL= 1 COM=1
OVL: M
OVL U/A:TV AT
POLAR=10 NM 10 DEG
Q15 SRM 0145 R
CONNECTION PENDING
DED. RPG LINE 1
10/0216 ARCHIVE
UNIT 1 READ DONE
HARDCOPY
VR 16KTS RAN 29NM
S .012/S DI 0.8NM
FAT
FRESNO
FCH
SE
NLC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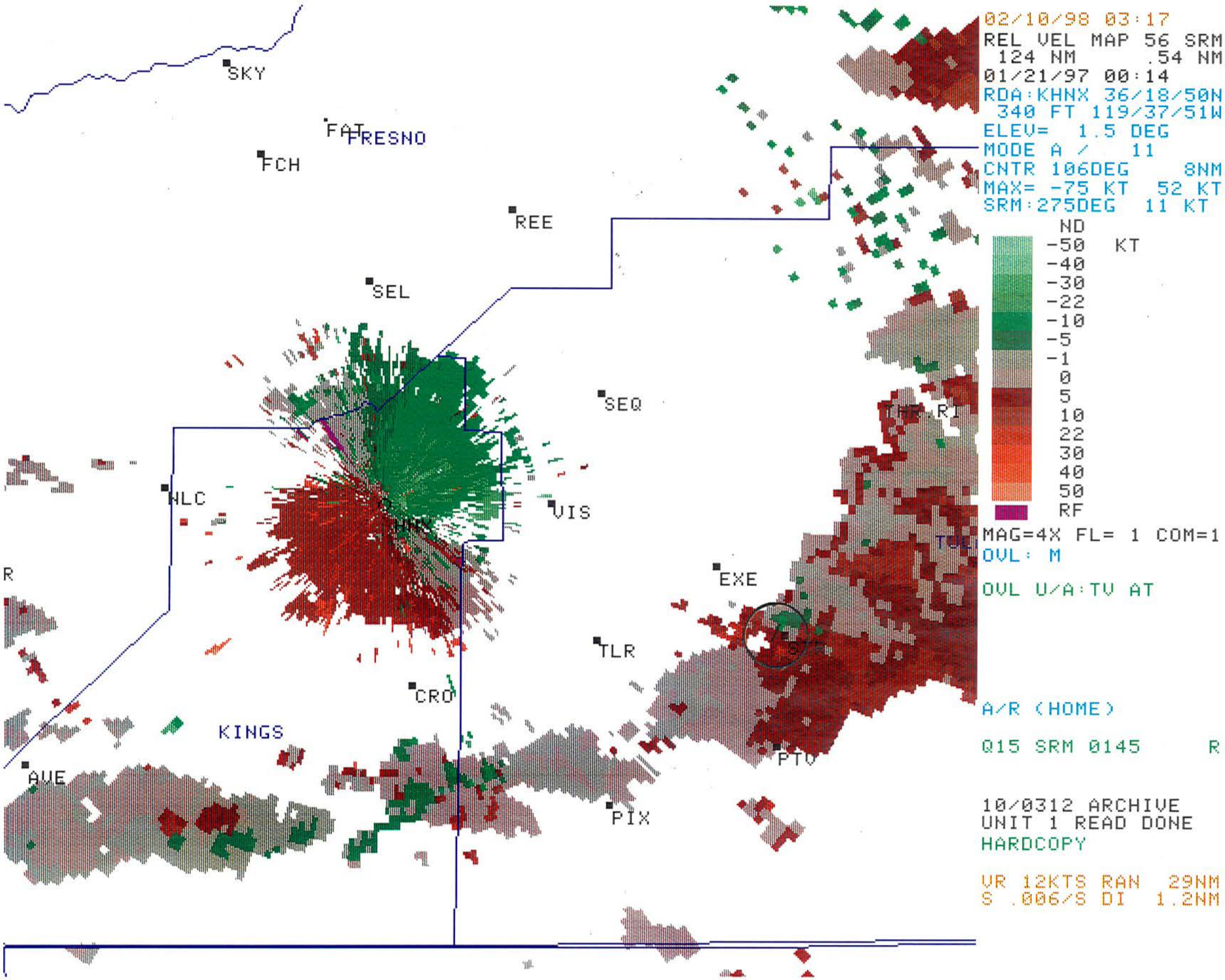
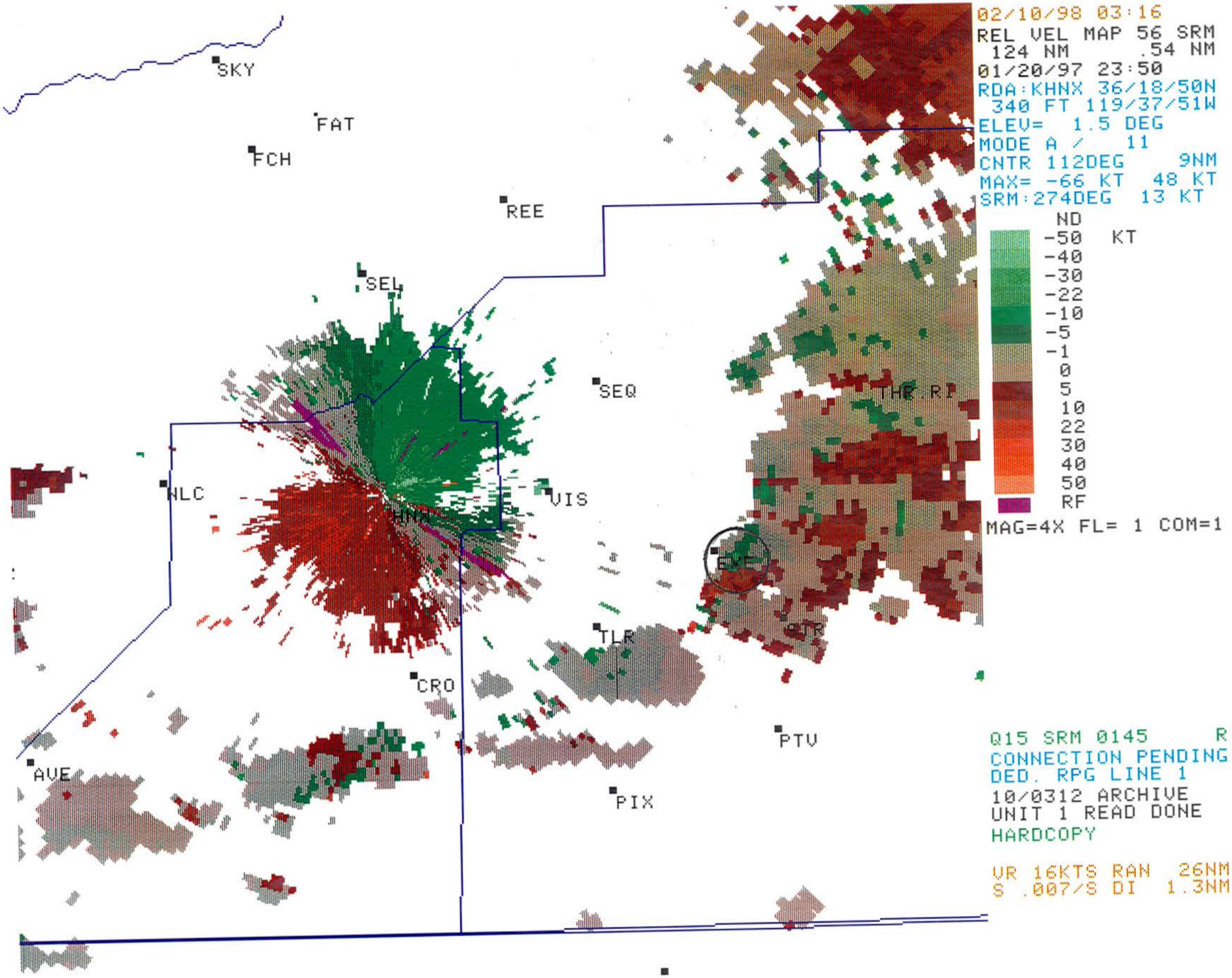
REL VEL MAP 56 SRM
124 NM .54 NM
03/12/96 22:09
RDA:KHNX 36/18/50N
340 FT 119/37/51W
ELEV= 2.4 DEG
MODE A / 21
CNTR 225DEG 1NM
MAX= -60 KT 82 KT
SRM:234DEG 23 KT
ND
-50 KT
-40
-30
-22
-10
-5
-1
0
5
10
22
30
40
50
RF
MAG=8X FL= 1 COM=1
POLAR=10 NM 10 DEG
015 SRM 0145 R
CONNECTION PENDING
DED. RPG LINE 1
10/0247 ARCHIVE
UNIT 1 READ DONE
HARDCOPY
VR 16KTS RAN 6NM
S .010/S DI 0.9NM



02/10/98 03:17
REL VEL MAP 56 SRM
124 NM .54 NM
01/21/97 00:14
RDA:KHNX 36/18/50N
340 FT 119/37/51W
ELEV= 1.5 DEG
MODE A / 11
CNTR 106DEG 8NM
MAX= -75 KT 52 KT
SRM:275DEG 11 KT
ND
-50 KT
-40
-30
-22
-10
-5
-1
0
5
10
22
30
40
50
RF
MAG=4X FL= 1 COM=1
OVL: M
OVL U/A:TV AT
A/R (HOME)
Q15 SRM 0145 R
10/0312 ARCHIVE
UNIT 1 READ DONE
HARDCOPY
VR 12KTS RAN 29NM
S .006/S DI 1.2NM
SKY
FAT
FRESNO
FCH
REE
SEL
SEQ
NLC
VIS
EXE
TLR
CRO
KINGS
AVE
PTV
PIX



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124 NM .54 NM
01/20/97 23:50
RDA:KHNX 36/18/50N
340 FT 119/37/51W
ELEV= 1.5 DEG
MODE A / 11
CNTR 112DEG 9NM
MAX= -66 KT 48 KT
SRM:274DEG 13 KT
ND
-50 KT
-40
-30
-22
-10
-5
-1
0
5
10
22
30
40
50
RF
MAG=4X FL= 1 COM=1
SKY
FAT
FCH
REE
SEL
SEQ
NLC
VIS
HNX
THR.RI
EVE
TLR
CRO
PTV
AVE
PIX
Q15 SRM 0145 R
CONNECTION PENDING
DED. RPG LINE 1
10/0312 ARCHIVE
UNIT 1 READ DONE
HARDCOPY
VR 16KTS RAN 26NM
S .007/S DI 1.3NM