Natural Disaster Survey Report

Ft. Smith and Van Buren, Arkansas, Tornado of April 21, 1996

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland

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U.S. Department of Commerce
Mickey Kantor, Secretary

National Oceanic and Atmospheric Administration
Dr. D. James Baker, Administrator

National Weather Service
Dr. Elbert W. Friday, Jr., Assistant Administrator

PREFACE

As the National Weather Service moves forward in our modernization efforts we have made tremendous strides in improving our warning process to provide longer lead times and more precise delineation of warning areas. It would be easy to assume that the enhancements offered by new technologieshave led effortlessly to these forecast improvements. As this tragic event has shown us, however, technology is not the only key to success. Our success results from the dedicated efforts of motivated personnel using improved technological tools and a clear understanding of the scientific basis of each meteorological event to provide the best possible service to the American public. Only if advances in observing and display technology are matched by ongoing training in and understanding of the underlying causal science will we provide the full benefits of modernization to the public.

Elbert W. Friday, Jr.
Assistant Administrator
For Weather Services

December 1996

FOREWORD

This report on the Ft. Smith and Van Buren, Arkansas, tornado of April 21, 1996 was prepared by a NWS Disaster Survey Team (DST). The DST conducted the field survey over a period of four days. The initial work was conducted through investigations and interviews in Tulsa, Oklahoma, Ft. Smith, Van Buren and Little Rock, Arkansas, from April 24 through April 26, 1996. Additional interviews were conducted in Ft. Smith on April 30, 1996.

To create this report, the DST collected information from the components of the Storm Prediction Center located in Kansas City; the Weather Service Office in Ft. Smith; the NEXRAD Weather Service Forecast Offices in Tulsa and Little Rock; the National Climatic Data Center in Asheville, North Carolina; and the WSR-88D Operational Support Facility in Norman, Oklahoma. The DST also gained valuable insight and information through interviews and conversations with volunteer amateur radio operators, members of the print and broadcast media in Ft. Smith, the Ft. Smith City Administrator, and survivors in the areas devastated by the tornado. Officials of the Ft. Smith and Van Buren Police Departments were particularly helpful in ensuring the DST had complete access to the damaged areas. This information was used to develop an assessment of the performance and effectiveness of the NWS offices involved in this event. It was used to examine their relationships to local governments and to the media, and the paths that warnings took from the forecast office to the public. This report summarizes the available information, presents findings on the performance of the participating NWS offices, and makes recommendations to enhance or improve the performance of these and other NWS offices.

In response to widespread interest in the findings of the DST, the production of this report departed from the standard practice. The DST reconvened in Kansas City, Missouri, the week of May 6, 1996, to conduct additional interviews, to assemble the collected information, and to develop the basis for a preliminary report consisting of an Executive Summary, a set of Facts, Findings, and Recommendations, and a collection of substantiating documentation. A Preliminary Report was released to the Arkansas delegation to the U.S. Congress, to local government officials in Ft. Smith and Van Buren, and to the media on May 21, 1996. By releasing this report in preliminary form in May, the NWS chose to provide these findings as early as possible to allow the improvements in operations and services found in the recommendations to begin. Having achieved this critical goal of the Disaster Survey Report, this final version of the report will not spend significant resources on drafting and finalizing a detailed description of the facts provided. Continuing investigation did result in additional clarification to Finding 4.1 and the addition of Recommendation 4.2.

The DST wishes to thank the NWS employees, volunteer amateur radio operators, and local government officials interviewed for their frank discussions. We also extend our heartfelt appreciation and sympathy to the survivors of this event who shared their stories, their pain, and their hopes with us.

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EXECUTIVE SUMMARY

On Sunday, April 21, 1996, a severe weather outbreak across the Southern Plains produced a number of supercell thunderstorms and tornadoes which developed in northwest Texas and southwest Oklahoma. This severe weather then tracked east northeast across much of south central and northeast Oklahoma and northwest Arkansas during the late afternoon and evening hours.

This report, while providing a general overview of the severe weather event, focuses on the Fort Smith metropolitan area of northwest Arkansas, where a strong tornado caused extensive property damage, two fatalities, and more than forty injuries.

The tornado touched down on the west side of downtown Fort Smith at 11:12 p.m. CDT on the evening of April 21, 1996. After causing extensive damage to a number of historic buildings in the downtown area, the tornado moved northeast through an industrial area and then into a residential area on the north side of Fort Smith. The tornado then crossed the Arkansas River and moved into a residential area on the west side of Van Buren, Arkansas, and continued moving northeast through a more sparsely populated area.

Two fatalities occurred in the residential area on the north side of Fort Smith. Two children died in frame houses heavily damaged by the tornado. Numerous injuries occurred in the residential areas of both Fort Smith and Van Buren, where the tornado substantially damaged approximately 1,800 homes. Two additional fatalities occurred in St. Paul, Madison County, Arkansas, approximately 50 miles northeast of Ft. Smith as the parent thunderstorm produced another tornado in that area almost one hour after the storm moved through Ft. Smith.

The tornado was estimated to be approximately one-half-mile wide with a path length of approximately seven miles. The F3 tornado, as defined by the Fujita Tornado Intensity Scale, was estimated to have wind speeds of nearly 200 mph. At this intensity, roofs and walls were torn off well-constructed houses, train cars were overturned, and automobiles were lifted off the ground.

The severe weather outbreak was forecast in advance. The National Weather Service (NWS) Storm Prediction Center (SPC) in Kansas City, Missouri, identified the potential for severe weather in the Oklahoma/Arkansas area nearly two days prior to the onset of the outbreak. Severe weather outlooks were issued by the NEXRAD Weather Service Forecast Office (NWSFO) in Tulsa earlier on the 21st based on information from the SPC. The SPC issued a Tornado Watch which included the Ft. Smith and St. Paul areas three hours prior to the tornado striking Ft. Smith and Van Buren.

A Severe Thunderstorm Warning, issued 16 minutes prior to the onset of the tornado, identified the potential for tornadoes. The warning specified *"Hail to the size of quarters and gusts to 70 mph can be expected in the warned area. A Tornado Watch is also in effect for the warned area. Remember, severe thunderstorms can and occasionally do produce tornadoes with little or no advance warning."* When a Tornado Warning was issued four minutes prior to the onset of the tornado, a power loss at the Ft. Smith Police Department caused a failure of the primary communications method with Ft. Smith officials, depriving them of critical input to their decision to sound the Civil Defense sirens. As a result, the sirens were not sounded. The same storm system then moved northeast and the Tulsa NWSFO issued a Tornado Warning for the St. Paul area 25 minutes before the tornado struck that community.

The Tulsa NWSFO detected and tracked the supercell thunderstorm which produced the Ft. Smith/Van Buren tornado using the Weather Surveillance Radar 1988 Doppler (WSR-88D) radar. In addition, the severe weather spotter network servicing the Ft. Smith area and immediately adjacent counties in Oklahoma provided timely reports to NWSFO Tulsa via amateur radio.

At issue is why a Severe Thunderstorm Warning was issued for a storm that had a known tornadic history. The NWS Disaster Survey Team found that the Tulsa warning team perceived that the storm, while still dangerous, was decreasing in tornadic potential and, therefore, issued a Severe Thunderstorm Warning. This perception was influenced by several factors:

1) The warning team relied most heavily on a velocity product which had provided clear definition of tornadic potential of the storm in its passage from McAlester through Stigler, Oklahoma, resulting in tornado warnings with 30 minute lead time. However, in the three six-minute radar observation cycles just prior to the tornado warning decision, this product provided ambiguous information which was most easily interpreted as a decrease in the intensity of the mesocyclone.
2) The warning team did not clarify tornado location inconsistencies between spotter reports and radar signatures.
3) The warning team put too much importance on the lack of damage reports from areas over which the storm passed in making their decision.

While the National Weather Service and the Ft. Smith community cannot alter the amount of destruction caused by a storm of this magnitude, working together as partners will minimize human casualties. The low loss of life in this storm may be attributed to a combination of factors. Preparedness activities conducted by the Ft. Smith and Tulsa NWS offices and their partners in the local government and private sector contributed to the public's knowledge of life-saving actions. Early, widespread media coverage of the weather outlook and the storm's potential threat to the Ft. Smith metropolitan area prompted individuals to seek safe shelter. The response of the local hospital and several senior citizen homes to the pending severe weather threat was commendable. These facilities implemented their disaster action plans well in advance

of the tornado's arrival in Ft. Smith.

There were numerous watches, forecasts and warnings issued throughout the afternoon and evening of the event. These products alerted citizens throughout eastern Oklahoma and western Arkansas to the potential of severe weather including the threat of tornadoes prior to the actual tornado warning for the Ft. Smith and Van Buren areas. This, coupled with the responsiveness of the media and a generally aware public, without doubt, saved lives. However, there were some important lessons learned from the Ft. Smith event which are applicable to the entire NWS. Greater emphasis on interpretation of a representative suite of available Doppler products, vigorous questioning and clarification of spotter information, and a reduced dependence on damage reports should enhance the warning decision making process.

DISASTER SURVEY TEAM MEMBERS

Team Leader	James D. Belville, Director, WSR-88D Operational Support Facility, NWS
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ACRONYMS AND ABBREVIATIONS

AP	Associated Press
ASOS	Automated Surface Observing System
AWIPS	Advanced Weather Interactive Processing System
CAPE	Convective Available Potential Energy
CDT	Central Daylight Savings Time
CST	Central Standard Time
CWA	county warning areas
DST	Disaster Survey Team
EBS	Emergency Broadcast System
EHI	Energy Helicity Index
EMWIN	Emergency Manager Weather Information Network
EOC	Emergency Operations Center
FAR	False Alarm Ratio
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
kg	kilogram
kt	knots (nautical miles per hour)
J	Joules
LETS	Law Enforcement Telecommunications System
LI	Lifted Index
m	meters
MAR	Modernization and Associated Restructuring
mb	millibars
MIC	Meteorologist-in-Charge
mi	miles (statute)
mph	miles (statute) per hour
NAWAS	National Warning System
NEXRAD	Next Generation Radar
NGM	Nested Grid Model
nm	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NOW	Short Term Forecast (Nowcast)
NWR	NOAA Weather Radio
NWS	National Weather Service
NWSFO	NEXRAD Weather Service Forecast Office
NWSO	NEXRAD Weather Service Office
NWWS	NOAA Weather Wire Service
OUN	Norman, OK, NWSFO
POD	Probability of Detection
PUP	Principal User Processor
s	second
SFD	State Forecast Discussion
SGF	Springfield, MO, NWSO

SPC	Storm Prediction Center
SPS	Special Weather Statement
SRH	Storm Relative Helicity
SRM	Storm Relative Velocity Map
SVR	Severe Thunderstorm Warning
SVS	Severe Weather Statement
SWEAT	Severe Weather Threat
TOR	Tornado Warning
UTC	Universal Coordinated Time (Greenwich Mean Time)
Vr	Rotational Velocity
WCM	Warning Coordination Meteorologist
WSO	Weather Service Office (without NEXRAD)
WSR-74C	Weather Surveillance Radar-1974 (C-Band)
WSR-88D	Weather Surveillance Radar-1988 Doppler

FACTS, FINDINGS, AND RECOMMENDATIONS

A. Description and Impact of the Event

A1. Fact
The tornado that struck Ft. Smith and Van Buren, Arkansas, the night of April 21, 1996, was one of several produced by a long-lived supercell. This supercell was one of many that occurred from southwest Oklahoma and northwest Texas northeast into northwest Arkansas and southwest Missouri during this event.

A2. Fact
The destructive tornado which struck Ft. Smith and Van Buren, Arkansas, resulted in the death of two young children and between 40 and 50 injuries.

A3. Fact
The Ft. Smith/Van Buren tornado damaged several historical buildings in Ft. Smith and damaged or destroyed approximately 1800 homes located in a half-mile-wide, seven-mile-long swath extending from the downtown section of Ft. Smith northeast into residential areas of Van Buren. The destructive path also caused widespread damage to warehouses, industrial buildings, and a new waste water treatment plant in Ft. Smith.

A4. Fact
The same supercell which spawned the Ft. Smith/Van Buren tornado subsequently generated another tornado, killing a father and son who took shelter in a car in St. Paul, Arkansas, nearly 50 miles northeast of the Ft. Smith area.

B. Meteorological Analysis

B1. Fact
Many of the meteorological parameters typically required for development of severe thunderstorms were present over Oklahoma and northwest Arkansas on the afternoon and evening of April 21, 1996.

B2. Fact
Thunderstorms began mid-afternoon on Sunday, April 21, over west Oklahoma and northwestern Texas. The severe thunderstorm that eventually produced the Ft. Smith/Van Buren tornado formed in south central Oklahoma around 6 p.m. Its movement to the east northeast, to the right of the mean steering flow, carried it across the Ft. Smith area shortly after 11 p.m. The storm continued moving across northwest Arkansas for two more hours before weakening.

C. Observational Evaluation

C1. Fact
The Tulsa WSR-88D detected this supercell thunderstorm throughout its lifecycle, most of which was in the Tulsa County Warning Area (CWA). The base velocity and storm relative velocity products indicated a strong mesocyclone almost continuously from McAlester, Oklahoma, through Ft. Smith/Van Buren, Arkansas, and northeast into the St. Paul area.[1] Both the Tulsa WSR-88D radar, located 89 miles northwest of Ft. Smith, and the Little Rock WSR-88D radar, located 126 miles east, showed a well defined velocity couplet identifying the area of mesocyclone rotation as the storm moved across the Ft. Smith area.

Finding 1.1
The one-minute and five-minute Ft. Smith Automated Surface Observing System (ASOS) data, which were not available in real-time, would have provided detailed surface observation data for the Ft. Smith area. When integrated with the WSR-88D data, additional information concerning the increased inflow into the mesocyclone, as well as strong pressure falls as the storm approached, would have been available to the forecasters in Tulsa.

Recommendation 1.1
The ability to access and display detailed ASOS data integrated with radar and other data sources needs to be incorporated in the Advanced Weather Information Processing System (AWIPS).

C2. Fact
The Tulsa and Ft. Smith NWS offices both received a continuous flow of reports from severe storm spotters via amateur radio. All reports received by the Ft. Smith office were called to the Tulsa office in a timely manner.

D. Warnings, Forecasts, and Guidance

D1. Fact
The Severe Weather Outlooks issued by the Storm Prediction Center identified the potential for severe weather in the northwest Arkansas area nearly two days prior to the development of this outbreak. Subsequent outlooks continued to emphasize the potential for development of tornadoes.

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[1] The path of the storm which spawned the Ft. Smith/Van Buren tornado remained outside of the area of degraded radar coverage to the south of Ft. Smith as identified in the *Secretary's Report to Congress on the Adequacy of Weather Services Under National Weather Service Modernization for 32 Areas of Concern* .

Finding 2.1
The Tulsa NEXRAD Weather Service Forecast Office (NWSFO) issued Public Information Statements at 6 a.m. and 1 p.m. on April 21, 1996, regarding the potential severe weather threat for the day, including the possibility of tornadoes. These statements, while containing valuable information, were quite lengthy, limiting their utility to the media.

Recommendation 2.1
Public Information Statements are designed to be used by the media to alert the populace to a predicted weather event. Information contained in such statements should be concise and easy to use.

D2. Fact
The Storm Prediction Center issued Tornado Watch Number 219 which included the Ft. Smith area three hours prior to the occurrence of the tornado.

D3. Fact
Tulsa issued a Severe Thunderstorm Warning for Pittsburg County, Oklahoma, at 8:20 p.m. This was upgraded to a Tornado Warning at 8:57 p.m with a 30 minute lead time. A tornado was reported in northeast Pittsburg County at 9:27 p.m. by McAlester, Oklahoma, Emergency Management. Tornado Warnings were subsequently issued for Haskell, north LaFlore, and south Sequoyah Counties in Oklahoma as the storm continued moving east northeast.

D4. Fact
The short term forecast is regularly available through commercial vendors, NOAA Weather Radio (NWR) and the NOAA Weather Wire. These are routinely displayed by the *Weather Channel*. A short term forecast issued by the Tulsa NWSFO at 10:33 p.m. advised, *"If this storm holds together, it will affect the Ft. Smith, Arkansas, area after 11 pm. In addition to tornadoes, this storm is capable of producing hail up to golf ball size and winds up to 70 mph."*

D5. Fact
At 10:54 p.m. the Tulsa NWSFO issued a Severe Thunderstorm Warning for Sebastian and Crawford Counties in Arkansas, including Ft. Smith and Van Buren. This warning included a statement concerning the potential for tornadoes. A Tornado Warning was issued for Sebastian and Crawford Counties at 11:08 p.m.

Finding 2.2
A significant factor which led to the initial issuance of a Severe Thunderstorm Warning rather than a Tornado Warning was the perception that the tornadic potential of the storm had begun to diminish. The Survey Team believes that the warning team relied heavily throughout the evening on an assessment of the strength of the mesocyclone using the radar's Storm Relative Velocity Map (SRM) product along with the Rotational Velocity (Vr) Shear function of the Principal User Processor (PUP). This technique provided an assessment of the storm's tornadic potential as the storm moved from near McAlester, Oklahoma, to Stigler, Oklahoma, allowing the tornado warnings issued by the Tulsa NWSFO for those areas to provide 30 minutes lead time. However, slight changes in the storm structure in the time just prior to the warning decision caused this technique to provide ambiguous information which could be interpreted as a decrease in the intensity of the mesocyclone. This interpretation contributed to the perception that the tornadic potential of the storm had decreased.

Recommendation 2.2a
The NWS should continue to provide training to increase the level of understanding and appropriate use of new WSR-88D products and capabilities. Each successive software build for years to come will have new products and additional functions. Continuous training using various distance learning technologies appears to be an effective method for ensuring NWS field offices have adequate knowledge of updated products and system functions.

Recommendation 2.2b
The WSR-88D provides forecasters with a wide variety of products that assess the potential severity of storms. Forecasters diagnosing severe storms should use the system to its fullest capability by examining a representative suite of products in their evaluation.

Finding 2.3
A lack of damage reports immediately upstream of the Ft. Smith area may have contributed to the warning decision to issue a Severe Thunderstorm Warning in lieu of a Tornado Warning.

Recommendation 2.3
A lack of damage reports, especially at night or in sparsely populated areas, should not play a significant role in the decision process regarding the issuance of severe weather warnings, especially those involving tornadoes. Forecasters should issue warnings based on the best available information derived from various technologies and reports from trained spotters.

Finding 2.4
Another factor in the warning decision process was the appearance of inconsistencies between locations of funnel clouds reported by spotters and the mesocyclone location as depicted by the WSR-88D. This adversely affected the use of spotter reports in the decision process.

Recommendation 2.4
Accurate, descriptive reports from trained spotters provide a valuable source of ground truth which can enhance the interpretation of storm structure available from radar or other remotely observed data. These reports can appear geographically inconsistent with radar severe weather signatures for a number of reasons, including the relative location of the weather observed to the spotter's position. When discrepancies exist, attempts should be made by office personnel to resolve the discrepancies or obtain additional reports, if time allows. No spotter report should be dismissed solely on the grounds of not coinciding with the location of a radar signature.

Finding 2.5
The severe weather statement issued at 11:02 p.m. concludes with *"This is a dangerous storm. If you live in the Ft. Smith or Van Buren areas, you should move to a place of safety."*

Recommendation 2.5
Forecasters should tailor "Call to Action" statements in dangerous situations to the specific conditions inherent in the storm, as this statement did.

D6. Fact
At 11:08 p.m. the Tulsa NWSFO issued a Tornado Warning for Sebastian and Crawford Counties. This warning was based on the latest 0.5 degree Storm Relative Velocity Map product from the Tulsa WSR-88D. Based on information provided by the Oklahoma Gas & Electric Company on the time major power lines at the 3rd Street substation broke, the Survey Team concluded that a tornado entered the Ft. Smith/Van Buren area at the Garrison Street Bridge at 11:12 p.m.

Finding 2.6
During this event, personnel in the Ft. Smith Weather Service Office (WSO) interacted routinely with local emergency management and law enforcement officials in their former county warning area. They relayed critical warning information generated by the Tulsa NWSFO, and collected and relayed spotter information to the Tulsa office. Nevertheless, Ft. Smith personnel expressed some confusion over the extent to which they are expected to be involved in the warning process during severe weather events.

Recommendation 2.6a
NWS should provide further clarification of the roles of personnel in spin-down WSOs which maintain use of commissioned local warning radars.

Recommendation 2.6b
NWSFO Tulsa should enhance their working relationship with the Ft. Smith WSO so that the WSO's expertise on the local area, including the spotter network and community contacts, can be integrated more fully into the warning process.

D7. Fact
The Tulsa NWSFO issued a Tornado Warning for the St. Paul area of Madison County at 11:50 p.m., April 21, 1996 with a 25-minute lead time. A tornado subsequently struck the community at approximately 12:15 a.m. on April 22, 1996.

E. Preparedness

Finding 3.1
Activities related to the transfer of county warning areas (CWA) from the Ft. Smith WSO to the Tulsa NWSFO and Little Rock NWSFO began in 1990. The Meteorologists-in-Charge (MICs) of Little Rock, Tulsa, and Ft. Smith participated in many joint preparedness and awareness activities throughout the affected area. In addition, the MIC and Warning Coordination Meteorologist (WCM) of Tulsa have conducted numerous preparedness activities in the Ft. Smith area. The remaining staff of the Ft. Smith office also continue to remain involved in hazard awareness activities. These activities have not always been well coordinated between the Tulsa and Ft. Smith offices.

Recommendation 3.1
The NWS should accelerate the planned transfer of administrative responsibility for the Ft. Smith WSO from NWSFO Little Rock to NWSFO Tulsa. This transfer will facilitate the planning and coordination of joint preparedness and hazard awareness activities.

E1. Fact
The Warning Coordination Meteorologist in Tulsa has been very effective in cultivating positive media relationships in the Ft. Smith area.

F. Communications and Dissemination

F1. Fact
The decision by several Ft. Smith radio and television stations to bring in extra personnel to work throughout the storm was based on NWS reports and other information available earlier in the evening. As a result, storm coverage was

expanded. Many area residents interviewed found this additional coverage to be valuable.

F2. Fact
At least one television station uses an automated alert/warning display system that is activated by the NWS' universal generic code on warning products. This television station reports this system is consistently faster in transmitting NWS warnings than is the present NWR system.

Finding 4.1
Telephone calls and the National Warning System (NAWAS) were the primary means the Tulsa NWSFO used to communicate warning information to local officials in the Van Buren and Ft. Smith areas. Local officials did not have access to severe weather information, including warnings, from any other mass dissemination sources. As the Tulsa office initiated contact with Ft. Smith on the NAWAS at 11:08 p.m. to convey the Tornado Warning, communication on the NAWAS line was interrupted due to a power failure at the Ft. Smith police station. Attempts to phone both the Ft. Smith Police Department and Crawford County officials on commercial lines were not successful. The sole remaining means of providing warnings to Ft. Smith officials was through the Arkansas Law Enforcement Telecommunications System (LETS). Warnings received on a NOAA Weather Wire downlink in Little Rock were manually reentered onto this statewide teletype system. Service from this system was also interrupted until emergency power was restored.

An additional factor affecting communications between Tulsa NWSFO and the Ft. Smith Police Department was the change in operations of the NAWAS circuit due to an operations upgrade which allowed a single phone to be used to contact public officials across state lines. A review of the NAWAS archive tape suggests an inconsistent level of understanding on NAWAS procedures by the Tulsa NWSFO staff. In one instance, Tulsa NWSFO did not follow correct procedures and, as a result, was unsuccessful in communicating information on a funnel cloud report to the Ft. Smith Police.

Recommendation 4.1
The NWS should work with officials in Ft. Smith and surrounding areas to explore methods to improve the communication of critical warning information in a timely manner. Use of NWR, two-way radio, and Emergency Manager Weather Information Network (EMWIN) should be a priority consideration. Cooperative efforts between the NWS and Federal, State, and Local emergency management agencies are essential for improving the flow of critical weather information into the Ft. Smith and Van Buren areas.

Recommendation 4.2

The NWS shall provide additional guidelines clarifying the operations of the NAWAS regional circuits, and identifying protocols for calls within states and across state lines. Local offices shall conduct training and perform drills to ensure that these guidelines are followed during warning operations.

F3. Fact
All warning products for the Ft. Smith area were broadcast by the Tulsa NWSFO using the tone alert on the NWR transmitter serving Ft. Smith. These warnings were broadcast live via NWR and taped during the initial live broadcast for subsequent rebroadcast.

F4. Fact
Several media representatives monitor amateur radio reports during severe weather events and value this input.

G. User Response

G1. Fact
The low number of deaths and injuries, when compared to the area and intensity of storm damage, suggests that most Ft. Smith and Van Buren residents knew what to do and took appropriate protective action as the tornado approached.

G2. Fact
Most health care facilities queried recognized the severe weather threat and implemented their disaster action plans well in advance of the tornado's arrival in Ft. Smith. Specific actions taken included moving patients into hallways, and some non-critical personnel into emergency shelters. Four of the five facilities surveyed relied on tone-alert NWR and monitored weather developments on television and radio as well.

Finding 5.1
A limited number of interviews conducted by the Disaster Survey Team revealed no evidence of widespread NWR usage by residents of the disaster area.

Recommendation 5.1
The NWS should develop additional partnership initiatives with the public and private sector to encourage the distribution and usage of NWR.

CHAPTER 1
DESCRIPTION AND IMPACT OF EVENT

During the afternoon and evening of April 21, 1996, and the early morning hours of April 22, 1996, a major outbreak of tornadoes, severe thunderstorms, and flash flood producing rainstorms occurred over much of southern and eastern Oklahoma and northwest Arkansas. This severe weather episode resulted in four fatalities, dozens of injuries and property damage estimated to be in excess of $500 million. The loss of life, and much of the property damage which occurred was the result of nine tornadoes which took place during course of the event, the most notable of which was the Fort Smith/Van Buren, Arkansas, tornado.

The parent thunderstorm which produced the Fort Smith/Van Buren tornado had a long history. The storm developed during the late afternoon hours in south central Oklahoma in the vicinity of Ardmore. The storm moved east northeast, producing three significant tornadoes during its life history. The first struck McAlester, Oklahoma, around 8 P.M., causing considerable property damage. The second significant tornado was the Fort Smith/Van Buren tornado which occurred around 11:12 P.M. The third tornado occurred shortly after midnight in the vicinity of St. Paul, Arkansas. This report focuses on the Fort Smith/Van Buren tornado.

The Fort Smith/Van Buren tornado first touched down at 11:12 p.m. on the Oklahoma side of the Oklahoma/Arkansas state line near the confluence of the Arkansas and Poteau Rivers in extreme southeast Sequoyah County. The tornado then moved into the downtown Fort Smith business district near the Garrison Street bridge, doing extensive damage to a number of historic buildings in the downtown area of the city. The tornado exited the business district, moved northeast into an industrial area, and then into a residential section on the north side of Fort Smith. From there, it crossed the Arkansas River once again and, at approximately 11:18 p.m., moved into a residential area on the west side of Van Buren, Arkansas, destroying or heavily damaging a number of homes. The tornado continued moving to the northeast for approximately seven miles before dissipating in a rural area east of U.S. Highway 59[2]. The total path length of the tornado was nearly 10 miles. As it moved through Fort Smith proper, and the western section of Van Buren, the path width averaged approximately one half mile. After crossing Highway 59 on the northwest side of Van Buren, the path width gradually tapered to zero as the tornado dissipated.

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[1] The parent tornadic storm continued moving northeast and produced another tornado shortly after midnight near the community of St. Paul, Arkansas, approximately 40 miles northeast of Van Buren. This tornado resulted in two fatalities. A father and his 10 year old son were killed when the tornado struck and destroyed their mobile home.

After the tornado first developed just to the west of the Arkansas River near the Garrison Street Bridge, it rapidly spun-up to F2 intensity on the Fujita Scale (Appendix A) and moved through the historic district in downtown Fort Smith. It continued intensifying to F3 intensity as it entered the industrial and residential areas in northwest and north Fort Smith. The tornado maintained F3 intensity as it moved through the residential areas on the west side of Van Buren before beginning to weaken after crossing Highway 59 (Fig. 1).
Two fatalities occurred as the tornado moved through the residential area on the north side of Fort Smith. A two year old girl was killed at 1917 High St., when a home collapsed. Several blocks away, a five year old boy was killed at 3419 N. 23rd. St.

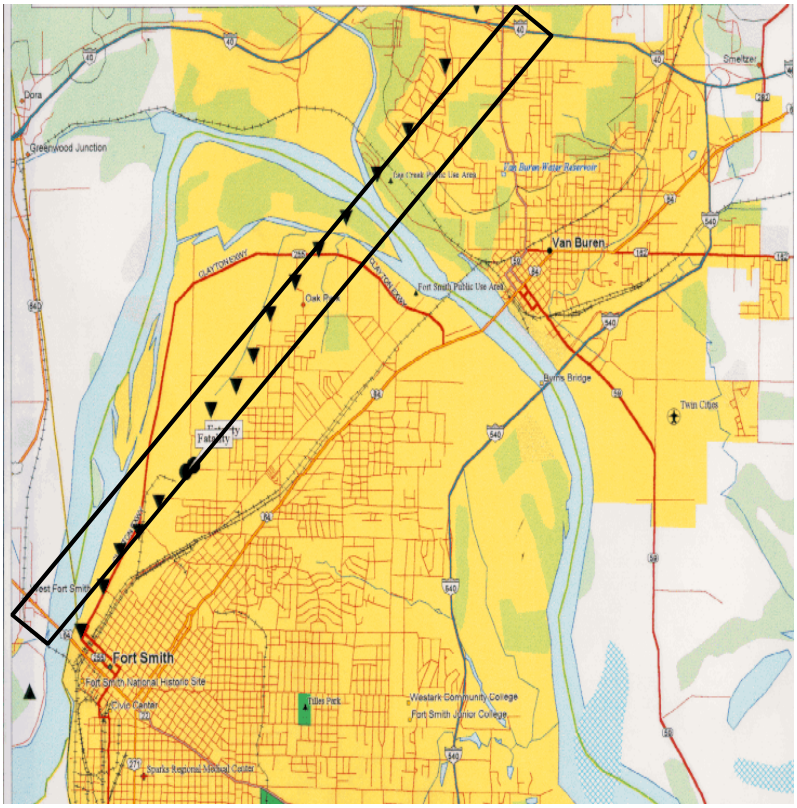


Figure 1. General track of Ft. Smith/Van Buren Tornado showing location of two fatalities (solid circles)

According to news reports, the boy was caught beneath the debris of the house as it shifted from its foundation and subsequently collapsed. It is believed these deaths occurred around 11:15 p.m.

Shortly after the tornado formed, it destroyed a high voltage transmission line which crossed the Arkansas River and supplied a power substation on the west side of the downtown area of Fort Smith. This resulted in an immediate, and widespread power outage in much of west and north Fort Smith. Also heavily damaged were a number of industrial buildings and warehouses on the east side of the river just to the north of the downtown area. A number of railroad cars on tracks serving the industrial area were

Historic Downtown Ft. Smith

Rogers Avenue, Downtown Ft.Smith

Damage to Industrial Buildings, Clayton Parkway, Ft. Smith

Damaged home, Vista Ridge subdivision, Van Buren

F3 Damage, Vista Ridge subdivision, Van Buren

Vista Ridge subdivision, looking northeast along track, Van Buren

blown completely off the tracks. A newly completed wastewater treatment plant in this same area sustained severe damage and was put out of commission. This resulted in an undetermined amount of raw sewage being released into the Arkansas River.

In addition to damaging or destroying a number of residences on the north side of Fort Smith, the tornado caused extensive damage to the Morrison Elementary School. Fortunately, since the storm occurred at night, the school was unoccupied. A number of other schools in Fort Smith, including the Howard, Parker, and Trusty Elementary Schools, the Kimmons Junior High School and the Northside High School also suffered damage, but to a lesser extent.

In both Fort Smith and Van Buren, the electrical system and the phone system infrastructure along and near the path of the tornado were extensively damaged.

In Van Buren, in addition to damaging or destroying a number of homes in the Vista Ridge subdivision, the tornado damaged the Coleman Junior High School and severely damaged a newly completed fire station including the fire engines inside. As the storm crossed Interstate Highway 40, just a short distance south of the fire station, a number of 18 wheel tractor trailer trucks were overturned. The drivers of the trucks had pulled over and stopped because of reduced visibility in heavy rain which preceded the tornado.

On Tuesday, April 23, 1996, President Clinton declared both Sebastian and Crawford counties to be natural disaster areas. The Federal Emergency Management Agency (FEMA) estimated that approximately 1800 homes in the two counties were either severely damaged or destroyed along with 88 uninsured businesses in Sebastian County and 10 uninsured businesses in Crawford County. Immediately after the tornado struck, approximately 100 firefighters and 40 volunteers responded to help search for victims. As late as Wednesday, April 24, about 130 electric company workers were still working to restore power to almost 1500 homes and businesses. Because of the extensive damage, officials with the Oklahoma Gas and Electric Company estimated that workers would be making repairs to the electrical system infrastructure for weeks.

CHAPTER 2
METEOROLOGICAL ANALYSIS

Many of the meteorological parameters typically required for development of severe thunderstorms were present over Oklahoma and northwest Arkansas the afternoon and evening of April 21, 1996.

1200 UTC (6 a.m. CST) April 21, 1996 Features

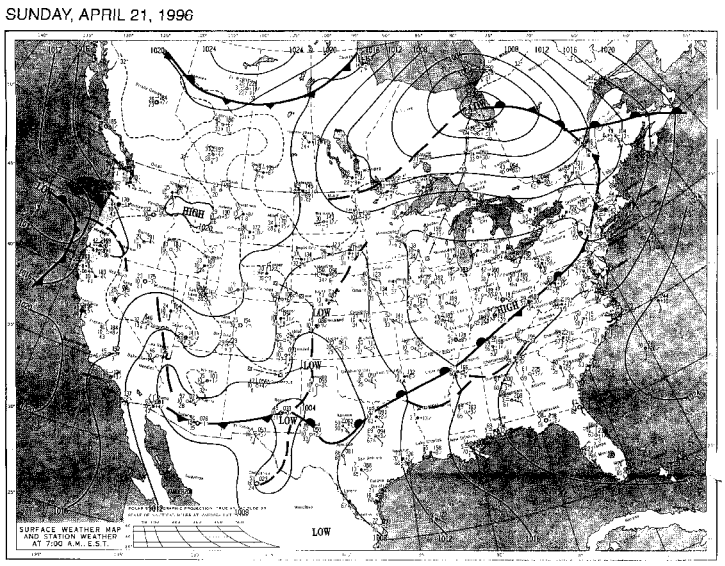


Figure 2 4/21/96 12Z Surface Weather Map

The stage appeared set early in the morning for a round of severe thunderstorms from Texas across Oklahoma into eastern Kansas and western Missouri that afternoon and evening. The surface chart (Fig. 2) featured a warm front from New England across Kentucky, Arkansas, and north Texas to a developing low pressure center in southeast New Mexico. An area of low pressure also reached from the New Mexico Low northeast to Minnesota. A warm, moist air mass originating over the Gulf of Mexico was poised to surge northward.

A progressive upper atmospheric pattern was in place at 1200 UTC. A 300 millibar (mb) southwesterly jet stream maximum (Fig. 3) of 100 knots (kts) reached from northern Baja California across New Mexico. A broad 500 mb trough (Figure 4) was drifting east, and embedded short waves were riding strong southwest flow toward north Texas and Oklahoma. A more pronounced short wave was crossing Arizona. A low was taking shape at the 850 mb level (Fig. 5) over west Texas with a low level jet of 35 kts from east Texas into eastern Oklahoma.

The progressive nature of the pattern suggested the upper jet stream and 500 mb short wave would shift east, increasing vertical wind shear in diffluent flow on the south side of the upper jet. Increasing low level flow and accompanying moisture were also expected. Studies have shown severe thunderstorms and tornadoes frequently form in an area where strong upper level flow exists above strong low level flow with a sharp

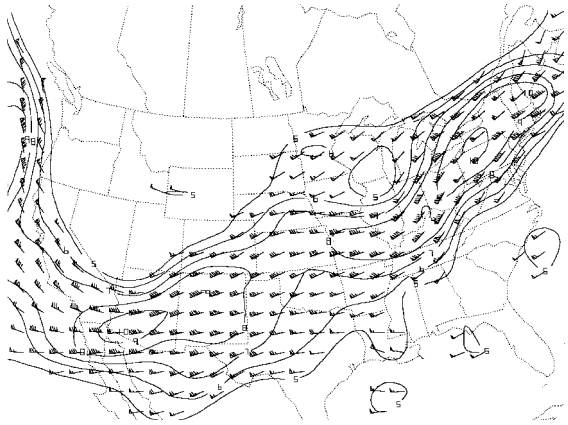


Figure 3. 4/21/96 12Z 300mb Heights/Winds (NGM)

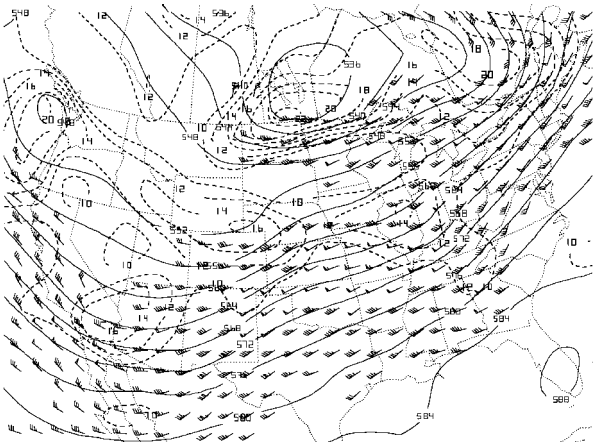


Figure 4. 4/21/96 12Z 500mb Heights/ Vorticity (NGM)

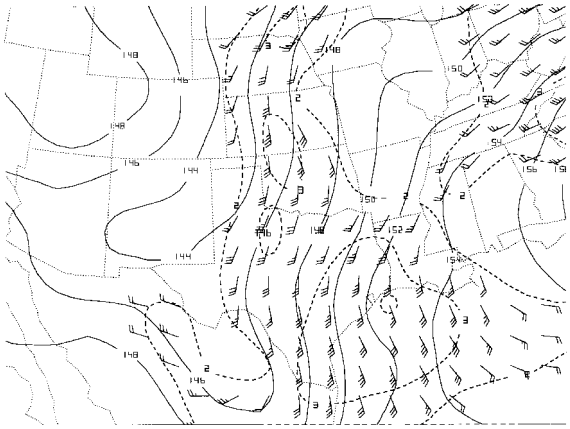


Figure 5. 4/21/96 12Z 850mb Heights/ Winds (NGM)

difference (shear) in both direction and speed between the two. The SPC identified an area, including eastern Oklahoma and far western Arkansas, as having a moderate risk of severe thunderstorms that afternoon and night.

The 1200 UTC radiosonde launched from the Norman, OK, NWSFO showed a nearly isothermal layer from the surface to about 800 mb that would likely inhibit convection for a time. Above 800 mb, though, the atmosphere was quite unstable and a surface temperature of about 75 degrees Fahrenheit would be enough to overcome the stable low layer.

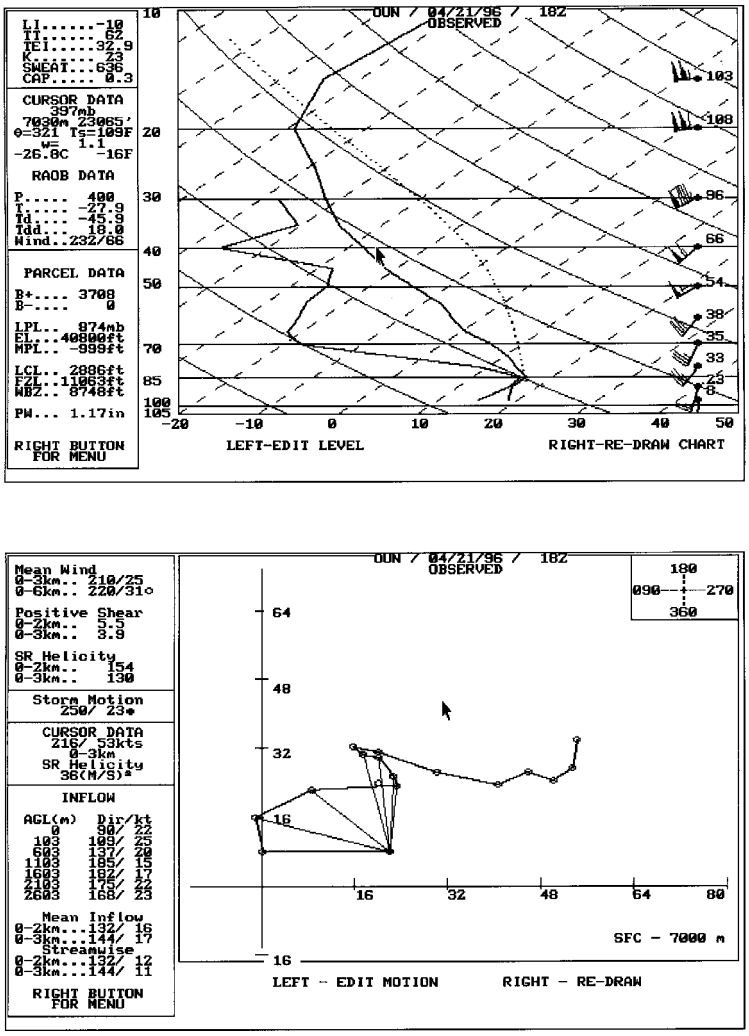


Figure 6. 4/21/96 18Z Sounding and Hodograph for Norman, OK, NWSFO

1800 UTC Radiosonde Features

A special upper air sounding was taken at noon CST at the Norman, OK NWSFO (Figure 6) to identify and quantify expected changes in the vertical atmospheric structure. Data from that sounding confirmed rapid destabilization to a point that severe weather was a near certainty, and tornadoes were likely. Indices traditionally used to measure instability (and generally accepted thresholds for severe storms and tornadoes) included: Lifted Index (LI) of minus 10 (less than minus 5), Total Total Index of 62 (greater than 56), Severe Weather Threat (SWEAT) Index of 636 (greater than 600), Energy Helicity Index (EHI) of 3.87 (greater than 2.0). Convective Available Potential Energy (CAPE) was measured at 3708 J/kg with 3000 the threshold for strong motion of 250 degrees at 23 kts was 154 m^2/s^2, which was slightly above the threshold

of 150 for weak tornadoes. The data also showed an intrusion of extremely dry air between 850 mb and 500 mb, which has also been shown to increase severe weather potential.

0000 UTC, April 22, 1996 Features

Synoptic scale features at 0000 UTC, as expected, continued to support long-lived supercell thunderstorms and a strong potential for tornadoes. Shear and instability both continued quite strong. Severe thunderstorms were in progress across parts of Oklahoma. The supercell that ultimately spawned the tornado that hit Fort Smith had already developed over south central Oklahoma.

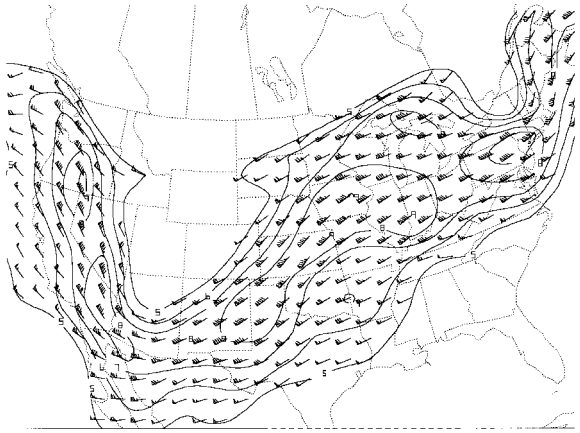


Figure 7. 4/22/96 00Z 300mb Heights/ Winds (NGM)

The 300 mb jet of 90 kts (Fig. 7) had advanced northeast to a location from eastern New Mexico to Iowa with eastern Oklahoma and western Arkansas in a favored area for severe storms, in diffluent flow near the right rear section of the jet. The 500 mb (Fig. 8) southwest flow continued strong with a 70 kt maximum across Oklahoma and eastern Kansas, and a series of embedded impulses were in the flow headed toward Oklahoma. An 850 mb (Fig. 9) jet of 40 kts had an axis from east Texas into eastern Oklahoma.

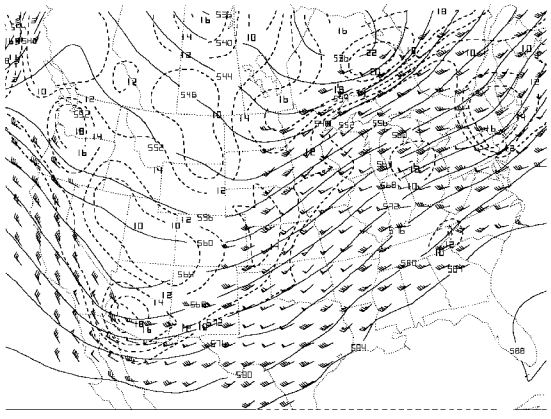


Figure 8. 4/22/96 00Z 500 mb Heights/ Vorticity (NGM)

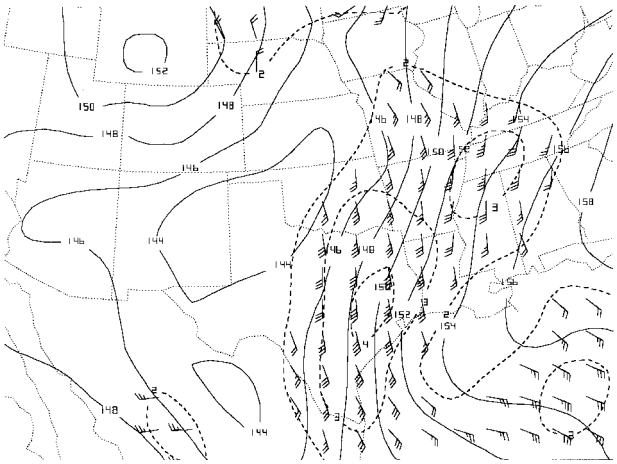
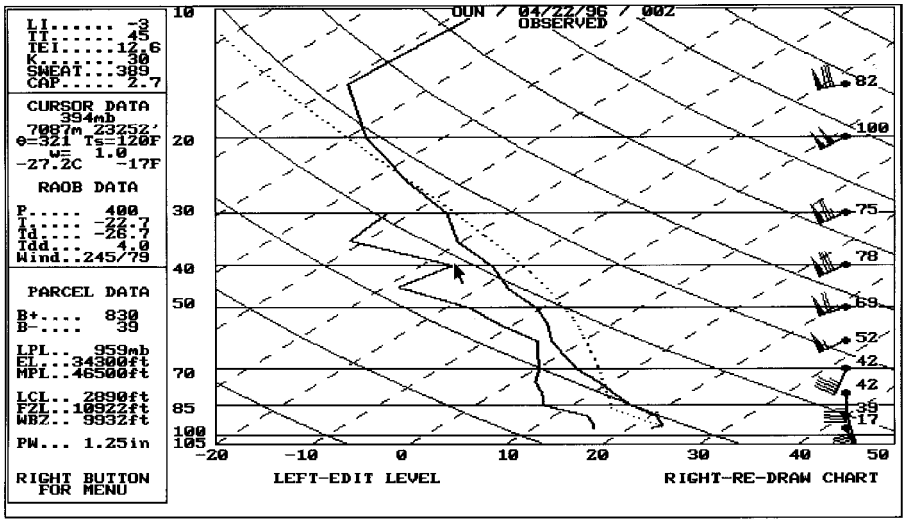


Figure 9. 4/22/96 00Z 850 mb Heights/ Winds (NGM)

The 0000 UTC upper air sounding taken at the Norman NWSFO (Fig.10) was unfortunately launched with thunderstorms nearby. Temperature and moisture data were not representative, but wind data and the hodograph appeared appropriate. Storm Relative Helicity (SRH) of 494 m^2/s^2 was extremely high, indicating a strong potential for low level shear induced rotation that could result in strong tornadoes. The Springfield, MO 0000 UTC sounding (Fig. 11) showed an LI of minus 7, Total Total Index of 59, SWEAT of 577, and CAPE of 1988. CAPE values, as initialized by the ETA model, (Fig. 12) were maximized at 2000 J/kg across east Texas and LI (Fig. 13) showed a minimum of minus 7 over the Fort Smith area.



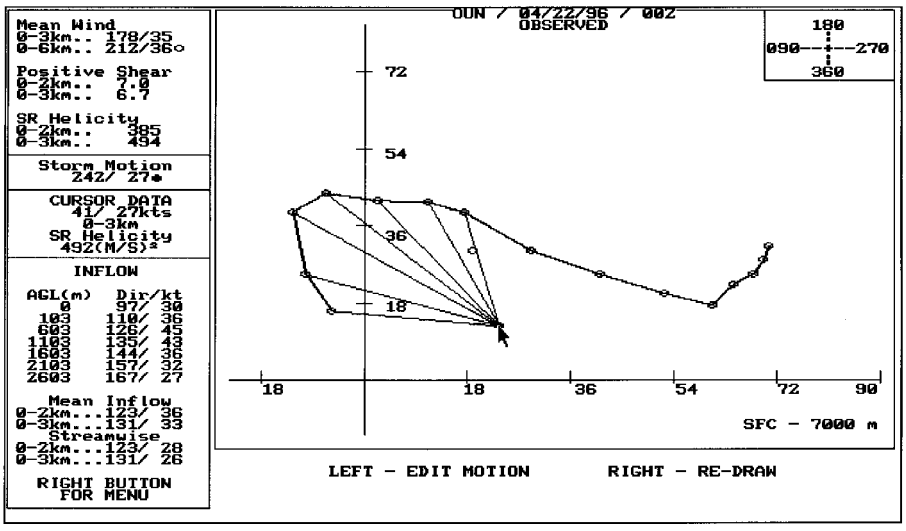
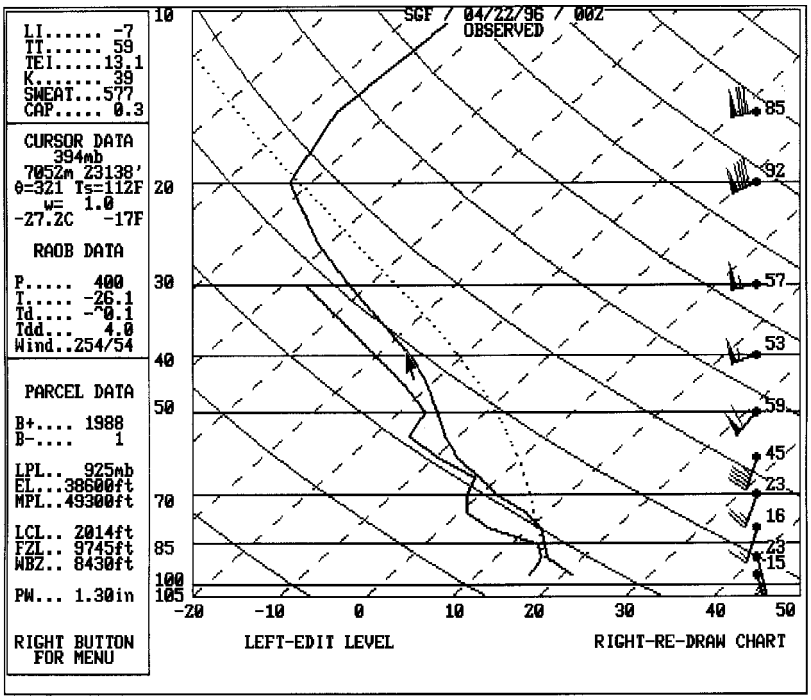


Figure 10. 4/22/96 00Z Sounding and Hodograph for Norman, OK, NWSFO



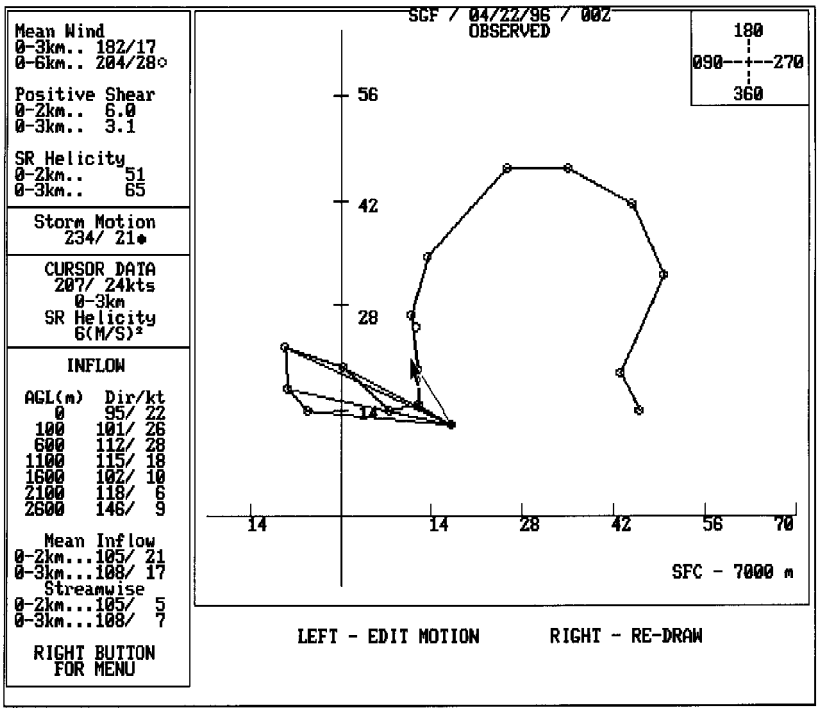


Figure 11. 4/22/96 00Z Sounding and Hodograph for Springfield, MO, NWSO

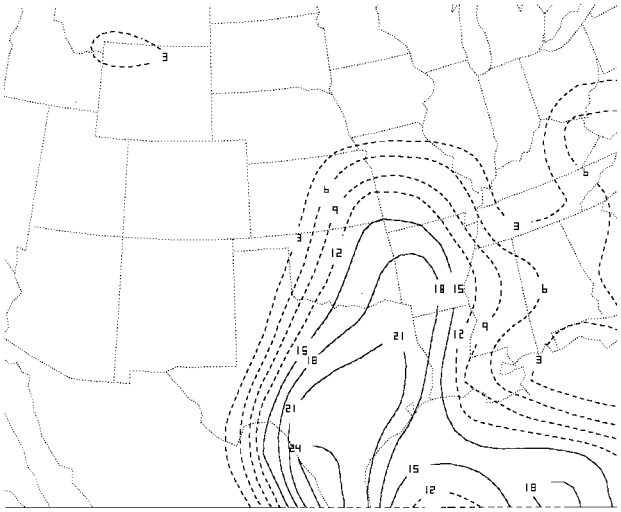


Figure 12. 4/22/96 00Z CAPE values (ETA)

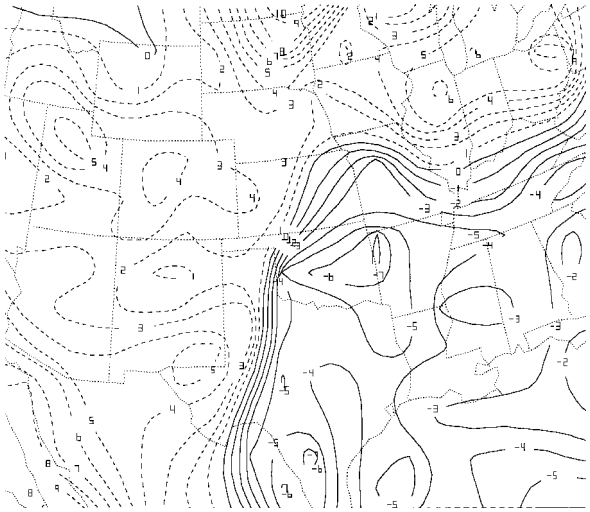


Figure 13. 4/22/96 00Z Lifted Index (ETA)

Mesoscale Analysis at 0000 and 0300 UTC

The subjectively analyzed 0000 UTC surface chart (Fig. 14) featured low pressure over the Texas panhandle. The remains of the early morning warm front stretched from the low across central Oklahoma into south central Kansas then east through Missouri into the Ohio Valley. A fast moving cold front was advancing across central Kansas which served to prolong the severe weather episode. Eastern Oklahoma and western Arkansas remained in a strong southerly gradient with dew points around 60 and temperatures between 75 and 80.

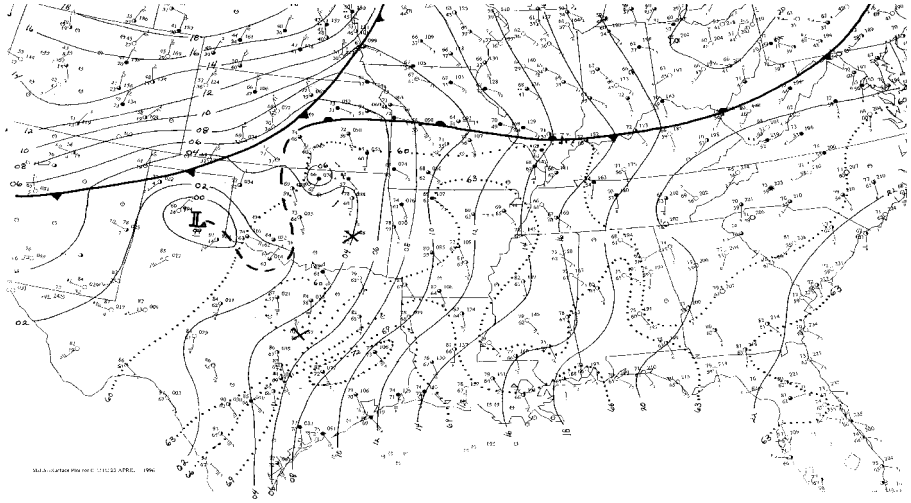


Figure 14. 4/22/96 00Z Surface Analysis (SPC)

At 0300 UTC the subjectively analyzed surface chart (Fig. 15) showed the cold front had overtaken the west end of the warm front and had advanced into eastern Kansas, central Oklahoma and west Texas. The southerly gradient had become even stronger east of the front and a low pressure trough had developed from southeast Oklahoma across central Arkansas. The trough had turned surface winds more easterly across Arkansas increasing low level shear and helicity.

The advancing front and shift of low level winds toward the east teamed with strong synoptic features to continue the threat of tornadoes well into the night.

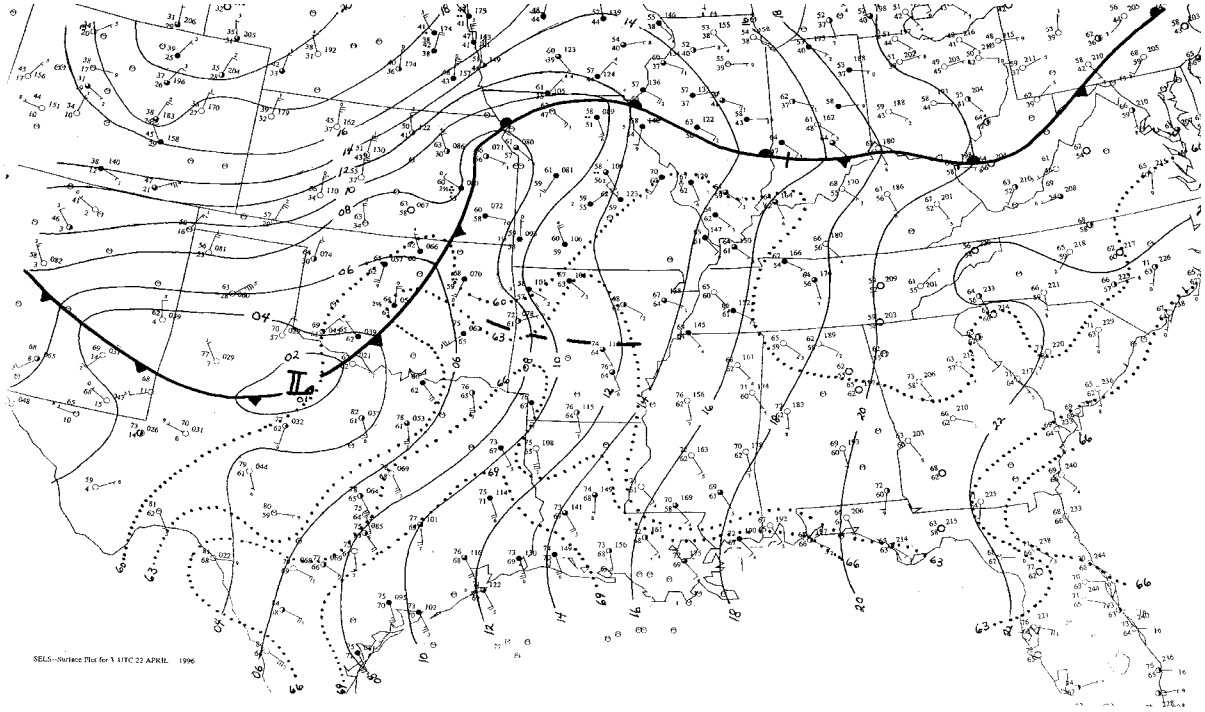


Figure 15. 4/22/96 03Z Surface Analysis (SPC)

Summary

Nearly all synoptic and mesoscale indicators supported the initial development and persistence of severe thunderstorms across Oklahoma and western Arkansas. Measures of instability and vertical wind shear both supported the potential for tornadoes. The cold front advancing from the northwest served to enhance and prolong the severe weather episode.

CHAPTER 3
OBSERVATIONAL EVALUATION

The Tulsa WSR-88D detected this supercell thunderstorm throughout its life cycle, most of which was in the Tulsa County Warning Area (CWA). The base velocity and storm relative velocity products indicated a strong mesocyclone almost continuously from McAlester, Oklahoma, through Ft. Smith/Van Buren, Arkansas, and northeast into the St. Paul area. Both the Tulsa WSR-88D radar, located 89 miles northwest of Ft. Smith, and the Little Rock WSR-88D radar, located 126 miles east, showed a well defined velocity couplet identifying the area of mesocyclone rotation as the storm moved across the Ft. Smith area.

Figure 16 shows the base velocity from 10:49 pm to 11:06 pm, focusing on the area identified within the blue box. At 10:49, the velocity couplet located northwest of Spiro, OK, had a gate-to-gate velocity shear of at least 80 kts. By 10:54 pm the couplet was northeast of Spiro. The couplet progressed half way between Spiro and Ft. Smith by 11:00 pm, and was just west of Ft. Smith at 11:06 pm, maintaining an 80 kt gate-to-gate shear.

The radial shear was less striking on the Storm Relative Velocity Products (Fig. 17) during this period. This is due in part to the 50 kt maximum velocity displayed with this product, compared to 64 kt maximum on the base velocity. At 10:49 pm, the gate-to-gate shear of the couplet was at least 60 kts. This went to 55 kts at 10:54 pm and 60 kts at 11:00 pm. At 11:06 pm, the storm relative velocity product showed the same 80 kt gate-to-gate shear as the base velocity.

Base reflectivity products provided basic storm structure information. Figure 18 shows a sequence of these products corresponding to the velocity products examined. The gold circles on the series of figures are the mesocyclones identified by the WSR-88D algorithms using base velocity data at all elevations. The thunderstorm which would spawn the Ft. Smith/Van Buren tornado had a maximum reflectivity of between 55 and 62 dbz, had a mesocyclone 15,000 ft deep, and showed a strong inflow notch from 10:49 pm to 11:06 pm. At 11:18 pm, the WSR-88D Tornadic Vortex Signature (TVS) algorithm detected a TVS near Van Buren. This is shown on the last reflectivity product in Figure 18.

Finding 1.1

The one-minute and five-minute Ft. Smith Automated Surface Observing System (ASOS) data, which were not available in real-time, would have provided detailed surface observation data for the Ft. Smith area. When integrated with the WSR-88D data, additional information concerning the increased inflow into the mesocyclone, as well as strong pressure falls as the storm approached, would have been available to the forecasters in Tulsa.

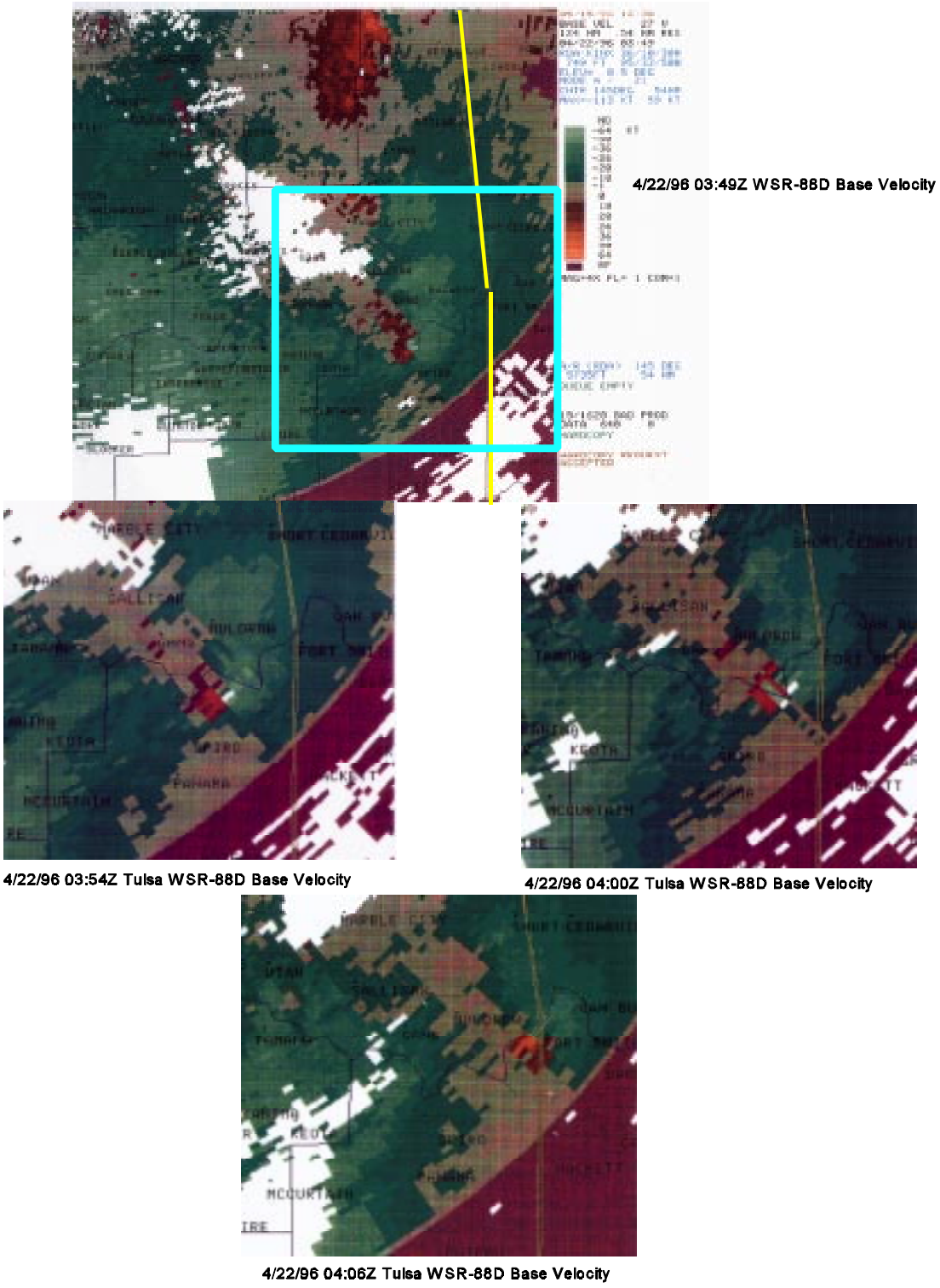
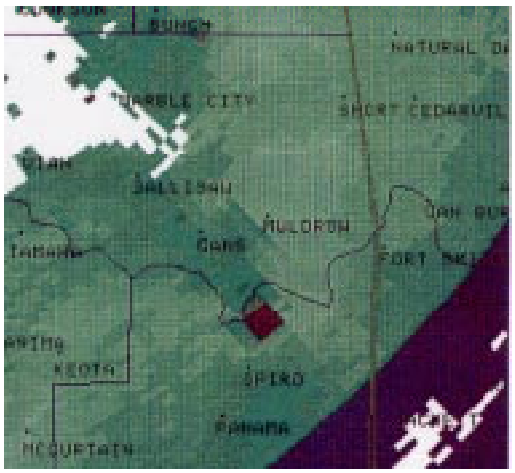
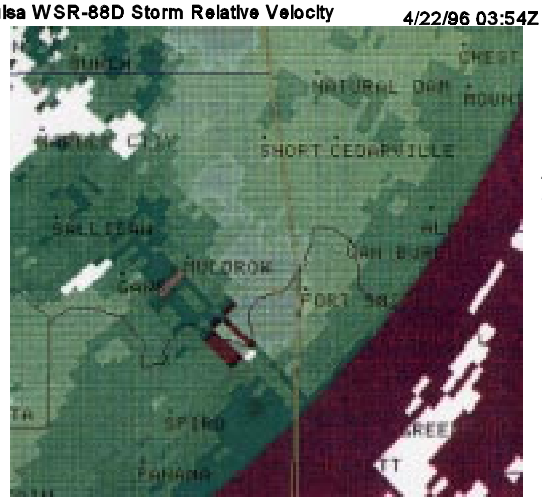


Figure 16. Tulsa WSR-88D Base Velocity Products

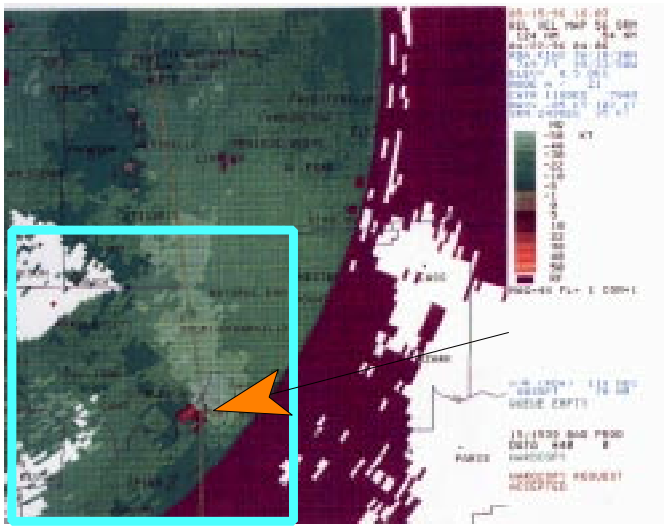
4/22/96 03:49Z Tulsa WSR-88D Storm Relative Velocity



4/22/96 03:54Z Tulsa WSR-88D Storm Relative Velocity

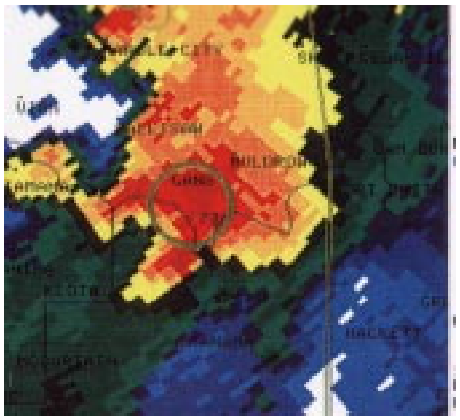


4/22/96 04:00Z Tulsa WSR-88D
Storm Relative Velocity

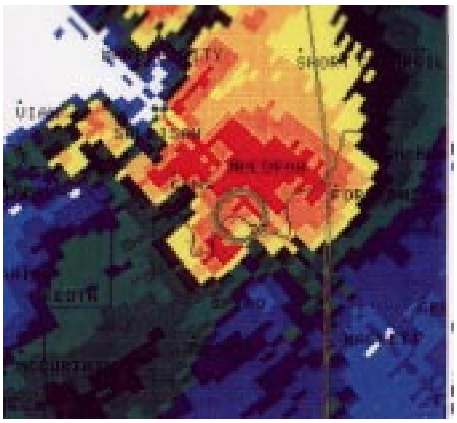


4/22/96 04:06Z Tulsa WSR-88D
Storm Relative Velocity
Note increased velocity shear

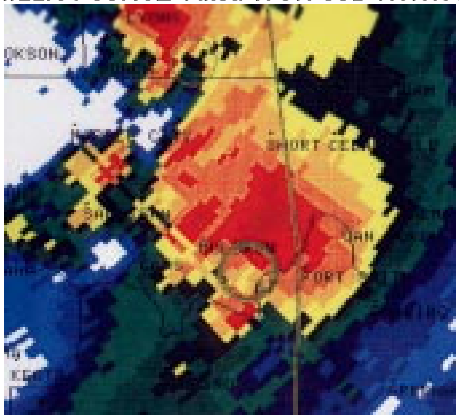
Figure 17. Tulsa WSR-88D Storm Relative Velocity Products



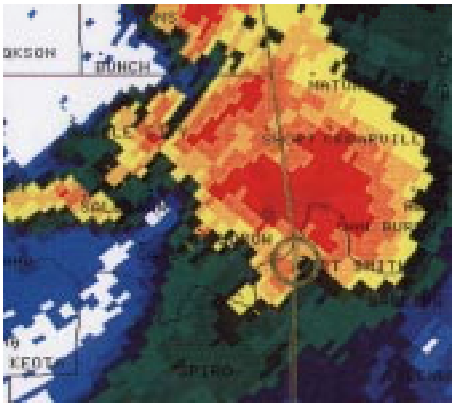
4/22/96 03:49Z Tulsa WSR-88D Refelectivity



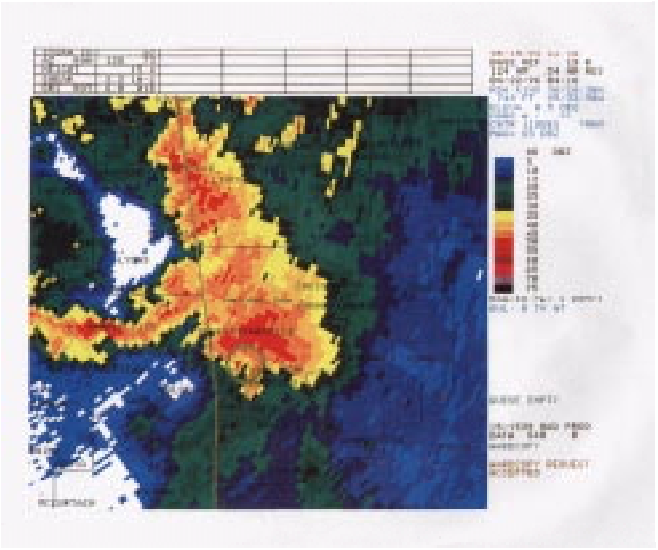
4/22/96 03:54Z Tulsa WSR-88D Reflectivity



4/22/96 04:00Z Tulsa WSR-88D Reflectivity



4/22/96 04:06Z Tulsa WSR-88D Reflectivity



4/22/96 04:18Z Tulsa WSR-88D Reflectivity.
Note Tornadic Vortex Signature (TVS) in Van Buren area

Figure 18. Tulsa WSR-88D Reflectivity Products

Recommendation 1.1
The ability to access and display detailed ASOS data (Fig. 19) integrated with radar and other data sources needs to be incorporated in the Advanced Weather Information Processing System (AWIPS).

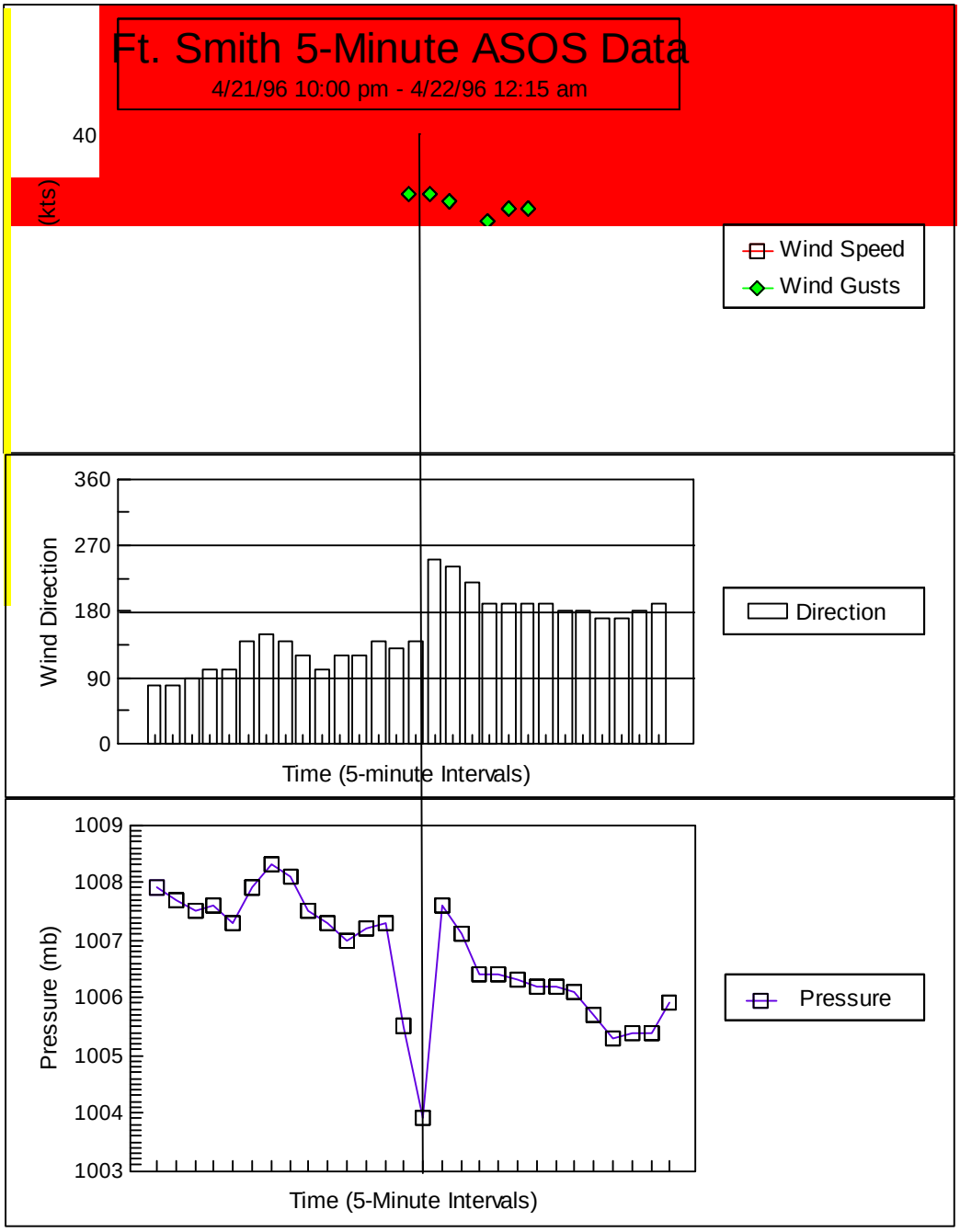


Figure 19. 5-minute ASOS data showing fall in pressure and changes in wind speed and direction at Ft. Smith airport (south and east of tornado track)

In addition to the data from the WSR-88D radar, forecasters had access to infrared (IR) and water vapor (WV) images from GOES 8 (Fig. 20). The Tulsa NWSFO also received a continuous flow of reports from severe storm spotters via amateur radio. All amateur radio and telephone reports received by the Ft. Smith office were called to the Tulsa office in a timely manner.

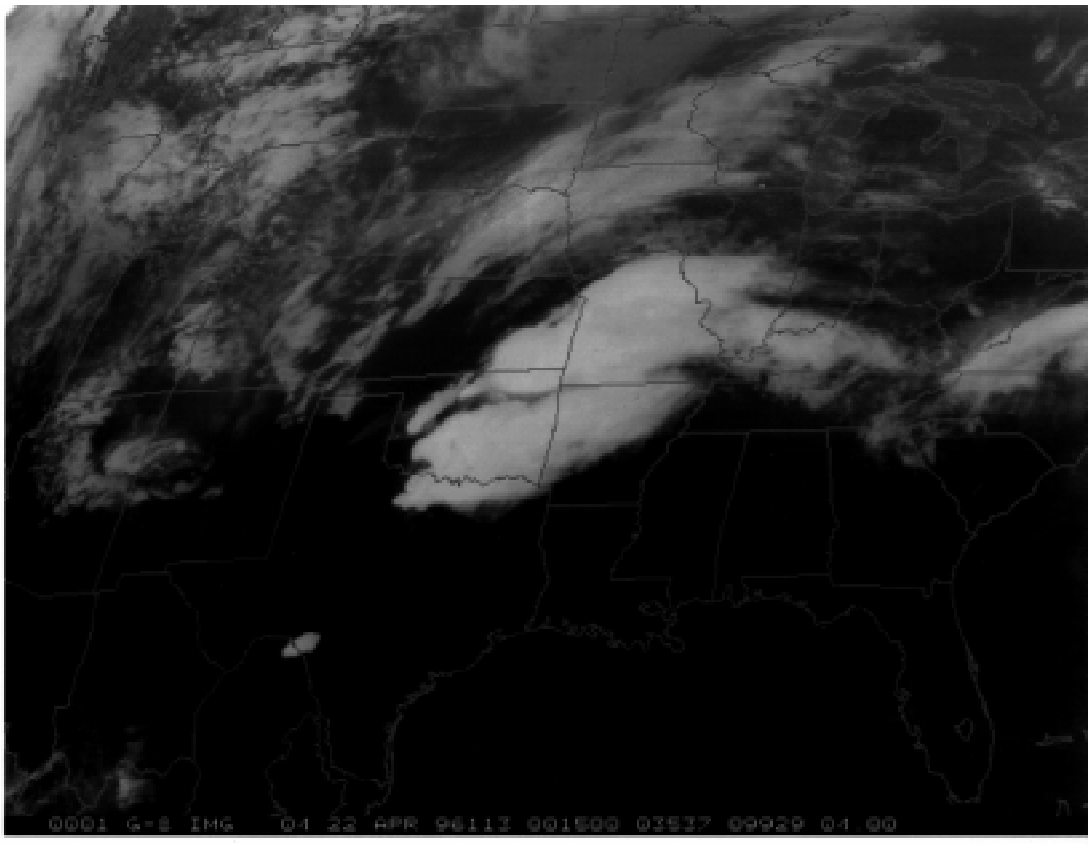


Figure 20. GOES 8 IR Image 4/22/96 04Z

CHAPTER 4
WARNINGS, FORECASTS, AND GUIDANCE

The storms which developed in southern Oklahoma and spawned the Ft. Smith/Van Buren tornado on April 21, 1996, were not unexpected. The SPC in Kansas City, Missouri, identified the potential for severe weather in the Oklahoma/Arkansas area nearly two days prior to the onset of the outbreak. The SPC issued a Tornado Watch which included the Ft. Smith and St. Paul areas three hours prior to the tornado striking Ft. Smith and Van Buren. Effective from just after 8:00 pm CDT until 3:00 am on April 22, 1996, Tornado Watch Number 219 (Appendix C) said that "*Tornados, large hail, dangerous lightning and damaging thunderstorm winds are possible in these areas.*"

Finding 2.1
The Tulsa NEXRAD Weather Service Forecast Office (NWSFO) issued Public Information Statements at 6 a.m. and 1 p.m. on April 21, 1996, regarding the potential severe weather threat for the day, including the possibility of tornadoes. These statements, while containing valuable information, were quite lengthy, limiting their utility to the media.

Recommendation 2.1
Public Information Statements are designed to be used by the media to alert the populace to a predicted weather event. Information contained in such statements should be concise and easy to use.

Tulsa NWSFO issued Public Information Statements at 6:00 am and 1:10 pm CDT April 21, 1996, which identified the threat of severe thunderstorms to eastern Oklahoma and northwestern Arkansas. The 1:10 pm statement was just over 12 paragraphs long, although only the first paragraph mentioned the expected weather by saying "*An outbreak of severe thunderstorms and tornadoes is expected across portions of eastern Oklahoma and northwest Arkansas late this afternoon and tonight.*" The balance of the statement provided detailed information on the recommended actions to be taken for the different severe weather threats.

The parent thunderstorm which spawned the Ft. Smith/Van Buren tornado produced its first significant tornado earlier in the evening to the northeast of McAlester, OK. Tulsa NWSFO issued a Severe Thunderstorm Warning (SVR) for McIntosh and Pittsburgh Counties at 8:20 pm. This was upgraded to a Tornado Warning (TOR) at 8:57 pm based on radar signatures associated with increasing tornadic potential and spotter reports. A tornado was reported near McAlester, Oklahoma, in Pittsburgh County at 9:27 pm by McAlester, Oklahoma, Emergency Management. Tornado warnings were extended at 9:30 pm to adjacent Haskell County and at 10:22 pm to north LaFlore and south Sequoyah Counties in Oklahoma as the storm continued moving east northeast.

During the period in which this dangerous storm system formed and moved, spawning a series of tornadoes, Tulsa NWSFO was issuing frequent short term forecasts (NOW). The short term forecast is regularly available through commercial vendors, NWR, and the NWWS. These are routinely displayed by the *Weather Channel*. A short term forecast issued by the Tulsa NWSFO at 9:57 pm included Crawford and Sebastian Counties in Arkansas, saying "*A dangerous severe thunderstorm, capable of producing a tornado, will move east northeast from the Quinton area of northeast Pittsburgh County across the Kinta and Keota areas of Haskell County through 10:30 pm... These storms will track across Sequoyah and far northern LeFlore County between 10:30 and 11 pm. If the storms hold together, they could threaten Ft. Smith, Arkansas, after 11 pm."* An additional NOW at 10:33 p.m. advised, *"Dangerous severe thunderstorm approaching the Ft. Smith area... If this storm holds together, it will affect the Ft. Smith, Arkansas, area after 11 pm. In addition to tornadoes, this storm is capable of producing hail up to golf ball size and winds up to 70 mph."*

At 10:54 pm, the Tulsa NWSFO issued a Severe Thunderstorm Warning for southern Crawford County and northern Sebastian County which identified the potential for tornadoes. The warning specified *"Hail to the size of quarters and gusts to 70 mph can be expected in the warned area. A Tornado Watch is also in effect for the warned area. Remember, severe thunderstorms can and occasionally do produce tornadoes with little or no advance warning."* At issue is why a Severe Thunderstorm Warning was issued for a storm that had a known tornadic history. The NWS Disaster Survey Team found that the Tulsa warning team perceived that the storm, while still dangerous, was decreasing in tornadic potential and, therefore, issued a Severe Thunderstorm Warning.

Finding 2.2

A significant factor which led to the initial issuance of a Severe Thunderstorm Warning rather than a Tornado Warning was the perception that the tornadic potential of the storm had begun to diminish. The Survey Team believes that the warning team relied heavily throughout the evening on an assessment of the strength of the mesocyclone using the radar's Storm Relative Velocity Map (SRM) product along with the Rotational Velocity (Vr) Shear function of the Principal User Processor (PUP). This technique provided an assessment of the storm's tornadic potential as the storm moved from near McAlester, Oklahoma, to Stigler, Oklahoma, allowing the tornado warnings issued by the Tulsa NWSFO for those areas to provide 30 minutes lead time. However, slight changes in the storm structure in the time just prior to the warning decision caused this technique to provide ambiguous information which could be interpreted as a decrease in the intensity of the mesocyclone. This interpretation contributed to the perception that the tornadic potential of the storm had decreased.

Recommendation 2.2a
The NWS should continue to provide training to increase the level of understanding and appropriate use of new WSR-88D products and capabilities. Each successive software build for years to come will have new products and additional functions. Continuous training using various distance learning technologies appears to be an effective method for ensuring NWS field offices have adequate knowledge of updated products and system functions.

Recommendation 2.2b
The WSR-88D provides forecasters with a wide variety of products that assess the potential severity of storms. Forecasters diagnosing severe storms should use the system to its fullest capability by examining a representative suite of products in their evaluation.

Finding 2.3
A lack of damage reports immediately upstream of the Ft. Smith area may have contributed to the warning decision to issue a Severe Thunderstorm Warning in lieu of a Tornado Warning.

Recommendation 2.3
A lack of damage reports, especially at night or in sparsely populated areas, should not play a significant role in the decision process regarding the issuance of severe weather warnings, especially those involving tornadoes. Forecasters should issue warnings based on the best available information derived from various technologies and reports from trained spotters.

Finding 2.4
Another factor in the warning decision process was the appearance of inconsistencies between locations of funnel clouds reported by spotters and the mesocyclone location as depicted by the WSR-88D. This adversely affected the use of spotter reports in the decision process.

Recommendation 2.4
Accurate, descriptive reports from trained spotters provide a valuable source of ground truth which can enhance the interpretation of storm structure available from radar or other remotely observed data. These reports can appear geographically inconsistent with radar severe weather signatures for a number of reasons, including the relative location of the weather observed to the spotter's position. When discrepancies exist, attempts should be made by office personnel to resolve the discrepancies or obtain additional reports, if time allows. No spotter report should be dismissed solely on the grounds of not coinciding with the location of a radar signature.

Although the forecasters believed that the tornadic potential of the storm system was decreasing, they did continue to monitor the storm closely. An SVS issued for Sequoyah, LeFlore, Sebastian, and Crawford counties at 11:01 pm was strongly worded and very concise.

Finding 2.5
The severe weather statement issued at 11:01 p.m. concludes with *"This is a dangerous storm. If you live in the Ft. Smith or Van Buren areas, you should move to a place of safety."*

Recommendation 2.5
Forecasters should tailor "Call to Action" statements in dangerous situations to the specific conditions inherent in the storm, as this statement did.

At 11:08 pm the Tulsa NWSFO issued a Tornado Warning for Sebastian and Crawford Counties. This warning was based on the latest 0.5 degree Storm Relative Velocity Map product from the Tulsa WSR-88D. This indicated a marked increase in the tornadic potential of the storm system. The warning indicated "*At 11:08 pm radar indicated a developing tornado near Ft. Smith. The tornado is moving northeast at 25 mph toward Van Buren. This is a dangerous situation. Act quickly..."* This warning was immediately relayed by the amateur radio operators to the spotter network and media outlets which monitor the spotter reports. It was placed on NWR and NWWS. In addition, the Tulsa Warning Coordination Meteorologist (WCM) phoned the Ft. Smith Police Department using the NAWAS connection to advise them of the warning. While this call was underway, a power loss at the Ft. Smith Police Department caused a failure of this primary communications method with Ft. Smith officials as well as the failure of the Arkansas LETS, their secondary source for NWS warnings. This deprived Ft. Smith officials of critical input to their decision to sound the Civil Defense sirens. As a result, the sirens were not sounded.

An additional short term forecast issued at 11:10 pm reinforced the tornado warning, saying, "*Severe thunderstorm with a possible tornado moving into the Ft. Smith and Van Buren areas. A severe thunderstorm with hail up to golfball size and a possible tornado will move across the Ft. Smith and Van Buren areas through 11:20 pm. Persons in the path of this dangerous storm should take cover immediately. The storm will continue east northeastward over southern Crawford county through 11:45 pm.*"

Based on information provided by the Oklahoma Gas & Electric Company on the time major power lines at the 3rd Street substation broke, the Survey Team concluded that a tornado entered the Ft. Smith/Van Buren area at the Garrison Street Bridge at 11:12 p.m. Interviews with the Ft. Smith Police Department revealed that reports were being received about the tornado before the tornado warning finally came across the LETS

printer. Spotter reports began almost as soon as the tornado formed. At 11:13 pm, a severe weather statement was issued that said, "*At 11:12 pm a funnel cloud was reported almost to the ground in Ft. Smith. Radar indicated that a tornado was developing in Ft. Smith. The tornado was moving northeast at 25 mph and will move toward Van Buren. If you are in or around Ft. Smith and Van Buren seek shelter now!*"

The parent cell of the Ft. Smith/ Van Buren tornado continued to the northeast. At 11:50 pm Tulsa NWSFO issued a Tornado Warning for southern Madison County, warning the St. Paul area nearly 25 minutes before the tornado struck that community. The warning pointed to the effects of the earlier tornado spawned by this storm in Ft. Smith, saying, "*This storm has done significant damage in the Ft. Smith and Van Buren areas.*"

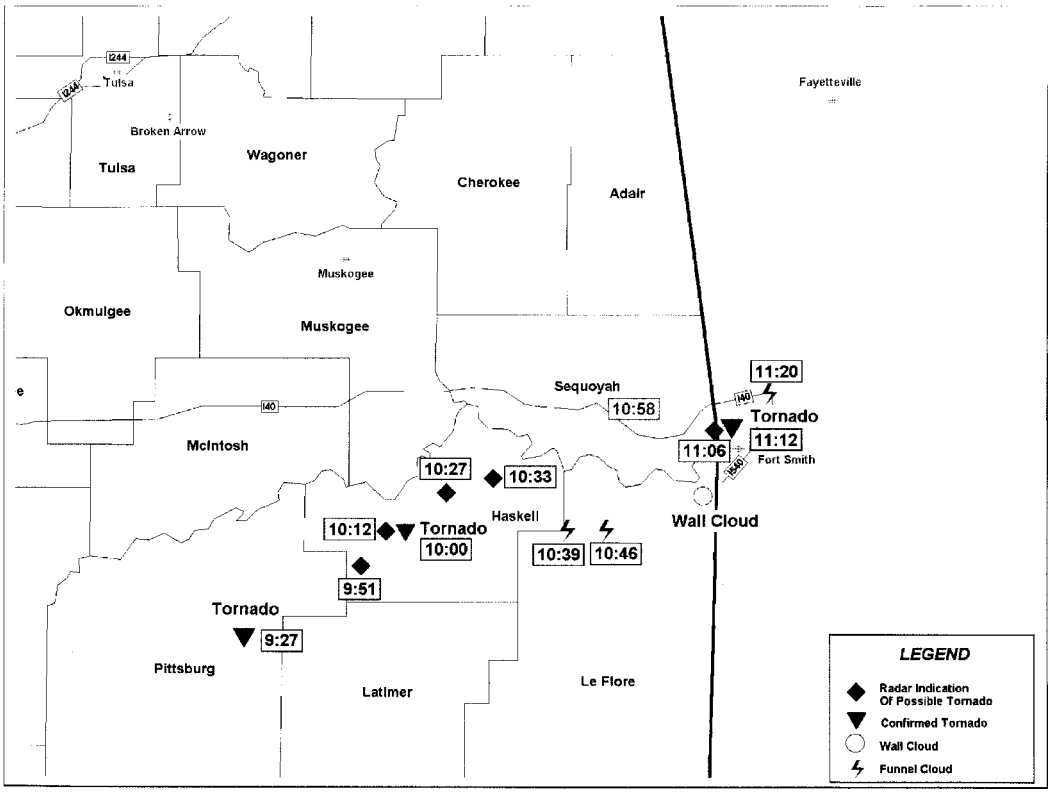


Figure 21. Location of tornadoes and spotter reports

The Tulsa NWSFO detected and tracked the supercell thunderstorm which produced the Ft. Smith/Van Buren tornado using the WSR-88D radar. In addition, the severe

weather spotter network servicing the Ft. Smith area and immediately adjacent counties in Oklahoma provided timely reports to NWSFO Tulsa via amateur radio (Fig. 21). Some confusion was engendered between the Ft. Smith-based and Tulsa-based spotter networks when an inexperienced volunteer amateur radio operator assisting in severe weather operations in the Tulsa office needed clarification on locations in the Ft. Smith area, although this was not a factor in use of the spotter reports by the forecasters on duty.

The NWS employee on duty in the Ft. Smith WSO maintained regular contact with local authorities in Sequoyah and LeFlore Counties in Oklahoma and in Sebastian and Crawford Counties in Arkansas. He received spotter reports which were relayed to Tulsa, and phoned emergency managers and law enforcement officials to advise them of warnings which had been issued by the Tulsa NWSFO or which were imminent. While this local liaison role provided a valuable resource to the Tulsa NWSFO, the Ft. Smith WSO was uncertain of the amount of interpretive information or opinions which should be provided to the forecasters at Tulsa. This confusion prevented the Ft. Smith WSO from providing additional subjective input into the forecast decision process. Because the operating relationship between Ft. Smith WSO and Little Rock NWSFO was long-standing and more clearly defined, subjective information was passed to Little Rock NWSFO which might have benefitted Tulsa NWSFO.

Finding 2.6
During this event, personnel in the Ft. Smith Weather Service Office (WSO) interacted routinely with local emergency management and law enforcement officials in their former county warning area. They relayed critical warning information generated by the Tulsa NWSFO, and collected and relayed spotter information to the Tulsa office. Nevertheless, Ft. Smith personnel expressed some confusion over the extent to which they are expected to be involved in the warning process during severe weather events.

Recommendation 2.6a
NWS should provide further clarification of the roles of personnel in spin-down WSOs which maintain use of commissioned local warning radars.

Recommendation 2.6b
NWSFO Tulsa should enhance their working relationship with the Ft. Smith WSO so that the WSO's expertise on the local area, including the spotter network and community contacts, can be integrated more fully into the warning process.

CHAPTER 5
PREPAREDNESS

Finding 3.1
Activities related to the transfer of county warning areas (CWA) from the Ft. Smith WSO to the Tulsa NWSFO and Little Rock NWSFO began in 1990. The Meteorologists-in-Charge (MICs) of Little Rock, Tulsa, and Ft. Smith participated in many joint preparedness and awareness activities throughout the affected area. In addition, the MIC and Warning Coordination Meteorologist (WCM) of Tulsa have conducted numerous preparedness activities in the Ft. Smith area. The remaining staff of the Ft. Smith office also continue to remain involved in hazard awareness activities. These activities have not always been well coordinated between the Tulsa and Ft. Smith offices.

Recommendation 3.1
The NWS should accelerate the planned transfer of administrative responsibility for the Ft. Smith WSO from NWSFO Little Rock to NWSFO Tulsa. This transfer will facilitate the planning and coordination of joint preparedness and hazard awareness activities.

During the period April 1993 through April 1996, the NWSFO at Tulsa was active in the Fort Smith area conducting MAR briefings and weather related preparedness presentations and coordination. The MAR briefings provided information on the new technology being implemented in the NWS, and in the plans for transitioning service responsibility for the Fort Smith area from the WSO at Fort Smith to the NWSFO at Tulsa. During the three year period, staff from NWSFO Tulsa met five times with either representatives from the local Congressman and or representatives from the two U.S. Senators from Arkansas, and twice with county and local officials. In addition, they met with reporters from the Fort Smith newspaper twice; local HAM radio club three times; and various general public groups five times. They provided interviews on Fort Smith television stations eight times, and gave interviews on local Fort Smith radio stations three times.

Tulsa NWSFO also conducted a number of weather preparedness related meetings and briefings in the Fort Smith area during the same three year time period. They met with county and local officials in Fort Smith on sixteen occasions; provided spotter training to the local HAM radio club on seven occasions; provided preparedness interviews to the Fort Smith newspaper on two occasions; conducted preparedness presentations on local television stations seven times, and delivered awareness presentations on Fort Smith radio stations two times. Severe weather information and safety rules were provided to the general public during four presentations.

The efficacy of these preparedness presentations became readily apparent as the Disaster Survey Team interviewed a number of people who were in the area of tornadic destruction. Time and again, residents reported taking precisely those actions recommended in severe weather preparedness materials and presentations, e.g., going to an interior closet or hallway, or crouching in a bathtub and pulling padded material (such as a mattress) on top for added protection from falling or flying debris. Although any loss of life in such events is tragic, the extraordinarily low loss of life which accompanied this strong tornado, which moved directly through a densely populated area gives testament to the effectiveness of the preparedness activities which had been undertaken in the Fort Smith area.

CHAPTER 6
COMMUNICATIONS AND DISSEMINATION

Interviews were conducted with the lead weather anchor and the weather director of the two local television stations, as well as one of the leading radio hosts, and the owner of a local consulting firm. Both television stations, KPOM and KHBS, have access to standard NWS products through NWWS or NWR. Both also supplement their information with data from commercial services such as the First Warn System from Acuweather. At least one television station uses an automated alert/warning display system that is activated by the NWS' universal generic code on warning products. This television station reports this system is consistently faster in transmitting NWS warnings than is the present NWR system. Both had key staff on duty because of the severe weather, and both issued frequent updates during the evening news.

The President and General Manager of a local radio station, KISR, monitors NWR, receives rebroadcast NWWS products, watches broadcast and cable television weather coverage, and monitors the local amateur radio network. Of these sources, he feels the amateur spotter network provides the most timely reports.

The owner of Video Base, a private consulting and video production firm, monitored the evolving weather situation using television coverage, NWR, personal contacts in Oklahoma, and the amateur spotter network. He felt that the NOWCASTS, if read on NWR, would be disregarded because they were not identified as forecasts.

Finding 4.1
Telephone calls and the National Warning System (NAWAS) were the primary means the Tulsa NWSFO used to communicate warning information to local officials in the Van Buren and Ft. Smith areas. Local officials did not have access to severe weather information, including warnings, from any other mass dissemination sources. As the Tulsa office initiated contact with Ft. Smith on the NAWAS at 11:08 p.m. to convey the Tornado Warning, communication on the NAWAS line was interrupted due to a power failure at the Ft. Smith police station. Attempts to phone both the Ft. Smith Police Department and Crawford County officials on commercial lines were not successful. The sole remaining means of providing warnings to Ft. Smith officials was through the Arkansas Law Enforcement Telecommunications System (LETS). Warnings received on a NOAA Weather Wire downlink in Little Rock were manually reentered onto this statewide teletype system. Service from this system was also interrupted until emergency power was restored.

An additional factor affecting communications between Tulsa NWSFO and the Ft. Smith Police Department was the change in operations of the NAWAS circuit due to an operations upgrade which allowed a single phone to be used to contact

public officials across state lines. A review of the NAWAS archive tape suggests an inconsistent level of understanding of NAWAS procedures by the Tulsa NWSFO staff. In one instance, Tulsa NWSFO did not follow proper procedures and, as a result, was unsuccessful in communicating information on a funnel cloud report to the Ft. Smith Police.

Recommendation 4.1
The NWS should work with officials in Ft. Smith and surrounding areas to explore methods to improve the communication of critical warning information in a timely manner. Use of NOAA Weather Radio (NWR), two-way radio, and Emergency Manager Weather Information Network (EMWIN) should be a priority consideration. Cooperative efforts between the NWS and Federal, State, and Local emergency management agencies are essential for improving the flow of critical weather information into the Ft. Smith and Van Buren areas.

Recommendation 4.2
The NWS shall provide additional guidelines clarifying the operations of the NAWAS regional circuits, and identifying protocols for calls within states and across state lines. Local offices shall conduct training and perform drills to ensure that these guidelines are followed during warning operations.

All warning products for the Ft. Smith area were broadcast by the Tulsa NWSFO using the tone alert on the NWR transmitter serving Ft. Smith. These warnings were broadcast live via NWR and taped during the initial live broadcast for subsequent rebroadcast.

CHAPTER 7
USER RESPONSE

Interviews conducted by the Team with survivors in some of the severely damaged areas of Ft. Smith and Van Buren identified no one who owned a NOAA Weather Radio (NWR). Most were not monitoring their televisions or radios, although they were usually aware of expected thunderstorm activity from reports earlier in the day. Many of the residents interviewed were awakened by the hail and high winds which preceded the tornado and responded by moving to interior hallways or bathrooms. The low number of deaths and injuries, when compared to the area and intensity of storm damage, suggests that most Ft. Smith and Van Buren residents knew what to do and took appropriate protective action as the tornado approached.

Finding 5.1
A limited number of interviews conducted by the Disaster Survey Team revealed no evidence of widespread NWR usage by residents of the disaster area.

Recommendation 5.1
The NWS should develop additional partnership initiatives with the public and private sector to encourage the distribution and usage of NWR.

To determine the impact of the NWS warning process on local area hospitals and nursing homes, interviews were conducted with a nursing supervisor at one area hospital and the directors of four area nursing homes. At St. Edwards Hospital, a "Code Green" was declared when the Tornado Watch was issued. This increases the staff's readiness stance and requires increased monitoring of the television and NWR. A "Code Black" was declared at 11:04 pm as a result of the severe thunderstorm warning and mention of tornadoes in the area. At this stage, ambulatory patients are moved into the corridors and bed-ridden patients are covered. Non-essential personnel are evacuated to the basement. After the tornado struck, the hospital moved into "Code Delta" status, calling doctors to report to the hospital.

Directors at three of the four nursing homes had plans which relied on NWR and television reports to monitor severe weather situations. Brownwood Manor had taken their steps to protect patients at about 10:30. The Methodist Home was aware of the storm history and earlier tornadoes. They monitored a NWR at each nursing station and had moved patients into hallways well in advance of the tornado. The Rose Care Center depends almost entirely on the NWR for weather information. They initiated their disaster plan about 10:50, and had their patients in the hallways before the storm hit. The final nursing center, Oaks Lodge, did not have a NWR, had no warning, and had taken no action to prepare for the storm. They had, however, already purchased a NWR prior to the interview.

APPENDIX A
FUJITA TORNADO INTENSITY SCALE

Category	Definition and Effect
(F0)	Gale tornado (40-72 mph): Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage sign boards.
(F1)	Moderate tornado (73-112 mph): Moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed of the roads.
(F2)	Significant tornado (113-157 mph): Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
(F3)	Severe tornado (158-206 mph): Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
(F4)	Devastating tornado (207-260 mph): Devastating damage. Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
(F5)	Incredible tornado (261-318 mph): Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

APPENDIX B
VERIFICATION STATISTICS FOR COMMON COUNTY WARNING AREAS TULSA, OK, VERSUS FORT SMITH, AR

Periods of comparison and responsible offices

Baseline:	Fort Smith WSO (FSM), AR 1986 - 1990
Transition:	Fort Smith WSO, AR 1991 - July 6, 1994
Post-Transfer:	Tulsa NWSFO (TUL), OK July 7, 1994 - 1995

Area of Concern:

Seven counties in FSM County Warning Area (CWA) transferred to TUL

Sebastian County, AR
Crawford County, AR
Benton County, AR
Washington County, AR
Madison County, AR
Sequoyah County, OK
LeFlore County, OK

All Severe Local Storms

	POD[1]	FAR[2]	Ave. Lead Time (min)[3]
Baseline	175/238 = .74	207/349 = .59	19.2
Transition	240/284 = .85	252/616 = .41	18.1
Post-Transfer	186/218 = .85	51/216 = .24	16.5

Tornado Only

	POD	FAR	Ave. Lead Time (min)
Baseline	1/6 = .17	14/15 = .93	1.2
Transition	9/12 = .75	36/44 = .82	15.8
Post-Transfer	5/5 = 1.00	12/16 = .75	18.6

[1] Probability of Detection (POD) is the percentage of actual events in any affected county for which a warning was in effect so that POD equals warned events/total events. 1.0 is perfect.

[2] False Alarm Ratio (FAR) is the percentage of warnings issued or extended for any county for which no verifying event has been reported so that FAR equals missed county warnings/total county warnings. 0.0 is perfect.

[3] Lead Time is the elapsed time between the issuance of a county warning and the onset of the event for which the warning was in effect. Average Lead Time (Ave Lead Time) equals the sum of the lead time for each warning/number of verified warnings.

APPENDIX C
Watches, Warnings, and Statements

Summary (Watches and Warnings):

Tornado Watch 219	SPC	4/21/96	8:16pm
OKCSVRTUL- McIntosh, Pittsburg Co., OK	TUL	4/21/96	8:20pm
OKCTORTUL- McIntosh, Pittsburg Co., OK	TUL	4/21/96	8:57pm
OKCTORTUL- Haskell Co., OK	TUL	4/21/96	9:30pm
OKCTORTUL- Pittsburg Co., OK	TUL	4/21/96	9:39pm
OKCTORTUL- Haskell Co., OK	TUL	4/21/96	10:05pm
OKCTOTTUL- Sequoyah, LeFlore Co., OK	TUL	4/21/96	10:22pm
OKCSVRTUL- Crawford, Sebastian Co., AR	TUL	4/21/96	10:54pm
OKCTORTUL- Crawford, Sebastian Co., AR	TUL	4/21/96	11:08pm
OKCTORTUL- Crawford Co., AR	TUL	4/21/96	11:26pm
OKCTORTUL- Madison Co., AR	TUL	4/21/96	11:50pm

Summary (Advisories and Statements):

OKCSPSTUL- East OK and NW AR	TUL	4/21/96	6:00am
Public Information Statement	TUL	4/21/96	1:10pm
OKCSVSTUL- Haskell Co., OK	TUL	4/21/96	9:53pm
OKCNOWTUL- East OK, NW AR	TUL	4/21/96	9:57pm
OKCSVSTUL- Stigler, Keoto, OK	TUL	4/21/96	10:14pm
OKCSVSTUL- Sequoyah, LeFlore, Haskell Co	TUL	4/21/96	10:28pm
OKCNOWTUL- East OK, NW AR	TUL	4/21/96	10:33pm
OKCSVSTUL- LeFlore, Haskell Co,., OK	TUL	4/21/96	10:36pm
OKCSVSTUL- LeFlore Co., OK	TUL	4/21/96	10:40pm
OKCSVSTUL- Sequoyah, LeFlore Co., OK	TUL	4/21/96	10:49pm
OKCSVSTUL- East OK, NW AR	TUL	4/21/96	11:01pm
OKCNOWTUL- Crawford, Sebastian Co., AR	TUL	4/21/96	11:10pm
OKCSVSTUL- Ft. Smith, AR	TUL	4/21/96	11:13pm
OKCSVSTUL- Crawford, Sebastian Co., AR	TUL	4/21/96	11:22pm
OKCNOWTUL- Madison Co., AR	TUL	4/22/96	12:08am

ZCZC MKCSAW9 ALL 220800;334,0971 374,0935 374,0912 334,0944;
WWUS40 KMKC 220111
^^MKC AWW 220111
WW 219 TORNADO OK AR MO 220200Z - 220800Z
AXIS..70 STATUTE MILES EAST AND WEST OF LINE..
30ESE DUA/DURANT OK/ - 50NE SGF/SPRINGFIELD MO/
..AVIATION COORDS.. 60NM E/E /64S MLC - 37NE SGF/
HAIL SURFACE AND ALOFT..3 INCHES. WIND GUSTS - 70 KNOTS.
MAX TOPS TO 600. MEAN WIND VECTOR 23035.
REPLACES WW 215.. OK AR MO
REPLACES WW 217.. OK
NNNN
ZCZC MKCSEL9 ALL 220800;334,0971 374,0935 374,0912 334,0944;
WWUS9 KMKC 220116
^^MKC WW 220116
OKZ000-ARZ000-MOZ000-220800-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
TORNADO WATCH NUMBER 219
NATIONAL WEATHER SERVICE KANSAS CITY MO
816 PM CDT SUN APR 21 1996

.A..THE STORM PREDICTION CENTER HAS ISSUED A
TORNADO WATCH FOR

PARTS OF EASTERN OKLAHOMA
PARTS OF WESTERN ARKANSAS
PARTS OF SOUTHWEST MISSOURI

EFFECTIVE THIS SUNDAY NIGHT AND MONDAY MORNING UNTIL 300 AM CDT.

TORNADOES...LARGE HAIL...DANGEROUS LIGHTNING AND DAMAGING
THUNDERSTORM WINDS ARE POSSIBLE IN THESE AREAS.

THE TORNADO WATCH AREA IS ALONG AND 70 STATUTE MILES EAST AND
WEST OF A LINE FROM 30 MILES EAST SOUTHEAST OF DURANT OKLAHOMA TO
50 MILES NORTHEAST OF SPRINGFIELD MISSOURI.

REMEMBER... A TORNADO WATCH MEANS CONDITIONS ARE FAVORABLE FOR
TORNADOES AND SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH
AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR
THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS
AND POSSIBLE WARNINGS.

B..OTHER WATCH INFORMATION.. THIS TORNADO WATCH REPLACES TORNADO WATCH NUMBER 215. WATCH NUMBER 215 WILL NOT BE IN EFFECT AFTER 900 PM CDT.

IN ADDITION.. THIS TORNADO WATCH REPLACES TORNADO WATCH NUMBER 217. WATCH NUMBER 217 WILL NOT BE IN EFFECT AFTER 900 PM CDT
$$

C...TORNADOES AND A FEW SVR TSTMS WITH HAIL SFC AND ALF TO 3 IN. EXTRM TURBC AND SFC WND GUSTS TO 70 KNOTS. A FEW CBS WITH MAX TOPS TO 600. MEAN WIND VECTOR 23035.

D...WITH LOW LVL JET INCRG AND STILL VERY MOIST/UNSTBL WARM SECTOR SUPERCELLS/TORNADO THREAT WILL CONT.

E...OTR TSTMS... THIS WATCH REPLACES..WW215..WW217.. CONT...WW 213..WW 214..WW 216..WW 218..

...HALES

NNNN

ZCZC OKCSVRTUL
TTAA00 KTUL 220121
OKC091-121-220215-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE TULSA OK
820 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A SEVERE THUNDERSTORM WARNING EFFECTIVE UNTIL 915 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN EAST CENTRAL OKLAHOMA

...MCINTOSH COUNTY

IN SOUTHEAST OKLAHOMA

...PITTSBURG COUNTY

AT 816PM...RADAR SHOWED A SEVERE THUNDERSTORM CENTERED 15 MILES SOUTHWEST OF HANNAH. IT WAS MOVING NORTHEAST AT 25 MPH AND WILL TRACK ALONG THE MCINTOSH...PITTSBURG COUNTY LINE AND OVER THE EUFAULA LAKE AREA. ANOTHER STRONG THUNDERSTORM MAY MOVE INTO SOUTHERN PITTSBURG COUNTY...MOVING EAST OUT OF NORTHERN COAL COUNTY.

HAIL TO THE SIZE OF QUARTERS AND WIND GUSTS TO 70 MPH CAN BE EXPECTED IN THE WARNED AREA.

A TORNADO WATCH IS ALSO IN EFFECT FOR THE WARNED AREA.
REMEMBER... SEVERE THUNDERSTORMS CAN AND OCCASIONALLY DO PRODUCE TORNADOES WITH LITTLE OR NO ADVANCE WARNING. REMAIN CALM BUT BE ALERT TO RAPIDLY CHANGING WEATHER CONDITIONS.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220158
OKC091-121-220245-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
857 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 945 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN EAST CENTRAL OKLAHOMA

...SOUTHERN MCINTOSH COUNTY

IN SOUTHEAST OKLAHOMA
...NORTHERN PITTSBURG COUNTY

AT 856 PM SPOTTERS AND RADAR INDICATED A TORNADO ON THE INDIAN NATION TURNPIKE...7 MILES WEST OF INDIANOLA. THE STORM IS MOVING NORTHEAST AT 30 MPH...HANNA...INDIANOLA AND EUFAULA ARE IN THE PATH OF THIS STORM.

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220231
OKC061-220315-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
930 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1015 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN SOUTHEAST OKLAHOMA
...HASKELL COUNTY

AT 929 PM RADAR INDICATED A TORNADO 13 MILES SOUTHWEST OF ENTERPRISE OR NEAR BLOCKER IN PITTSBURG COUNTY. THIS STORM PRODUCED A TORNADO IN MCALESTER. THE TORNADO IS MOVING EAST NORTHEAST AT 25 MPH. IF YOUR IN BLOCKER...ENTERPRISE AND QUINTON YOU SHOULD BE IN A PLACE OF SAFETY.

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

WATCH FOR SIGNS OF DEVELOPING STORMS. LARGE HAILSTONES AND UNUSUALLY LOW SWIRLING CLOUDS ARE MANY TIMES SEEN NEAR DEVELOPING TORNADOES. STRONG DAMAGING WINDS AND TORNADOES OFTEN PRODUCE A LOUD ROARING SOUND THAT CAN BE HEARD IN THE VICINITY OF STORMS. FREQUENT AND DANGEROUS LIGHTNING OCCURS WITH MOST SEVERE THUNDERSTORMS.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220240
OKC121-220300-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
939 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1000 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN SOUTHEAST OKLAHOMA
...NORTHERN PITTSBURG COUNTY

AT 939 PM RADAR INDICATED A POSSIBLE TORNADO JUST NORTHEAST OF BLOCKER. QUINTON IS IN THE PATH OF THIS STORM.

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220306
OKC061-220345-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
1005 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1000 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN SOUTHEAST OKLAHOMA
...HASKELLCOUNTY

AT1003 PM RADAR INDICATED A TORNADO 5 MILES SOUTHWEST OF STIGLER. THE TORNADO WAS MOVING EAST NORTHEAST AT 25 MPH. STIGLER AND KEOTA ARE IN THE PATH OF THE TORNADO. IF YOU ARE IN THESE AREAS TAKE SHELTER NOW!

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220323
OKC135-079-220415-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
1022 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1115 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN EAST CENTRAL OKLAHOMA

...SOUTHERN SEQUOYAH COUNTY

IN SOUTHEAST OKLAHOMA
...NORTHERN LE FLORE COUNTY

AT1020 PM SPOTTERS REPORTED A TORNADO NEAR STIGLER. RADAR SHOWED THIS STORM MOVING EAST NORTHEAST AT 25 MPH. KINTA...BOKOSHE...COWLINGTON...GANS...AND MULDROW ARE IN THE PATH OF THIS TORNADO.

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

&
NNNN

ZCZC OKCSVRTUL
TTAA00 KTUL 220356
ARC131-220445-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE TULSA OK
1054 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A SEVERE THUNDERSTORM WARNING EFFECTIVE UNTIL 1145 PM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN NORTHWEST ARKANSAS

...SOUTHERN CRAWFORD COUNTY

IN WEST CENTRAL ARKANSAS

...NORTHERN SEBASTIAN COUNTY

AT 1053 PM A DANGEROUS SEVERE THUNDERSTORM EXTENDED FROM MULDROW TO SPIROW. THIS STORM WAS MOVING EAST NORTHEAST AT 35 MPH ASND WILL MOVE INTO FORT SMITH AND VAN BUREN.

HAIL TO THE SIZE OF QUARTERS AND WIND GUSTS TO 70 MPH CAN BE EXPECTED IN THE WARNED AREA.

A TORNADO WATCH IS ALSO IN EFFECT FOR THE WARNED AREA.
REMEMBER... SEVERE THUNDERSTORMS CAN AND OCCASIONALLY DO PRODUCE TORNADOES WITH LITTLE OR NO ADVANCE WARNING. REMAIN CALM BUT BE ALERT TO RAPIDLY CHANGING WEATHER CONDITIONS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220410
ARC033-131-220500-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
1108 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL MIDNIGHT CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN NORTHWEST ARKANSAS

...SOUTHERN CRAWFORD COUNTY

IN WEST CENTRAL ARKANSAS

...NORTHERN SEBASTIAN COUNTY

AT 1108 PM RADAR INDICATED A DEVELOPING TORNADO NEAR FORT SMITH.
THE TORNADO IS MOVING NORTHEAST AT 25 MPH TOWARD VAN BUREN.

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220427
ARC033-220515-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
1126 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1215 AM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN NORTHWEST ARKANSAS

...CRAWFORD COUNTY

AT 1125 PM A TORNADO WAS REPORTED AND INDICATED BY DOPPLER RADAR 4 MILES NORTHEAST OF VAN BUREN. THE TORNADO WAS MOVING NORTHEAST AT 30 MPH. DAMAGE WAS DONE IN VAN BUREN AND FORT SMITH.

IF YOU ARE NEAR MOUNTAINSBURG...ALMA...AND CHESTER SEEK SHELTER NOW!

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

KEEP TUNED TO THIS STATION FOR THE LATEST WEATHER BULLETINS.

&
NNNN

ZCZC OKCTORTUL
TTAA00 KTUL 220452
ARC033-220515-

BULLETIN - EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE TULSA OK
1150 PM CDT SUN APR 21 1996

THE NATIONAL WEATHER SERVICE IN TULSA HAS ISSUED A
TORNADO WARNING EFFECTIVE UNTIL 1230 AM CDT
FOR THE PEOPLE IN THE FOLLOWING LOCATIONS...

IN NORTHWEST ARKANSAS

...SOUTHERN MADISON COUNTY

AT 1149 PM RADAR INDICATED A POSSIBLE TORNADO 15 MILES SOUTHWEST OF ST. PAUL. THE TORNADO WAS MOVING NORTHEAST AT 35 MPH AND WILL MOVE INTO THE COMBS AND ST. PAUL AREA. IF YOU ARE IN THESE AREAS SEEK SHELTER IMMEDIATELY.

THIS STORM HAS DONE SIGNIFICANT DAMAGE IN THE FORT SMITH AND VAN BUREN AREAS..

THIS IS A DANGEROUS STORM SITUATION. ACT QUICKLY. IF YOU ARE IN THE PATH OF THIS TORNADO MOVE TO A SHELTER BELOW GROUND IF AVAILABLE. OTHERWISE...GO TO A SMALL INTERIOR ROOM ON THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND AVOID WINDOWS. ABANDON CARS AND MOBILE HOMES FOR A REINFORCED BUILDING OR GET IN A GROUND DEPRESSION.

WATCH FOR SIGNS OF DEVELOPING STORMS. LARGE HAILSTONES AND UNUSUALLY LOW SWIRLING CLOUDS ARE MANY TIMES SEEN NEAR DEVELOPING TORNADOES. STRONG DAMAGING WINDS AND TORNADOES OFTEN PRODUCE A LOUD ROARING SOUND THAT CAN BE HEARD IN THE VICINITY OF STORMS. FREQUENT AND DANGEROUS LIGHTNING OCCURS WITH MOST SEVERE THUNDERSTORMS.

NNNN

WSU TULSA WARNING LOG

4/96
MONTH/YEAR

PAGE 2

Warning Type	Basis for Warning (List in order of importance)
T - Tornado	1-Public Report 2-CD/Amateur Report 3-Chase Report
S - Severe Tstm	4-VIL 5-Other RADAR 6-RADIO 7-WSR-57 8-NSSL Doppler
F - Flash Flood	9-SW 10-MESO 11-TVS 12-GustFnt 13-Hail 14-Tracking

Enter initials of person making the warning decision in the last column.

All times local (CST or CDT)

Day	Valid Time Issued	Valid Time Expired	Type	Basis	Counties or portions of counties warned	Hit?/	Init
21	722	815	T S F	10	NW Nowata	1/1	SF/SF
21	732	815	T S F	10	E Craig, Ottawa	2/2	SF/SF
21	743	815	T S F	10	Nowata	1/1	SF/SF
21	754	815	T S F	4	W Craig	/1	SF/SF
21	809	845	T S F	10	Ottawa	1/1	SF/SF
21	820	915	T S F	4	McIntosh - Pittsburg	2/2	SF/SF
21	857p	945p	T S F	10-2	S McIntosh N Pittsburg	1/2	SF/SF
21	930p	1015	T S F	2-10	Haskell	1/1	SF/SF
21	934p	1015p	T S F	4	Okfuskee	1/1	SF/SF
21	939p	1000	T S F	10	NE Pittsburg	1/1	SF/SF
21	1005	1045	T S F	880	Haskell	1/1	SF/SF
21	1015	1100p	T S F	4	S Okmulgee	1/1	SF/SF
21	1022	1115p	T S F	10	S Sequoyah N Leflore	2/2	SF/SF
21	1037p	145A	T S F	2 8[illegible]	Cherokee	1/1	SF/SF
21	1025p	1115p	T S F		N McIntosh	/1	SF/DH
21	1056p	1145p	T S F	4	S Crawford N Sebastian	2/2	SF/DH
21	1108p	Midnight	T S F	10	~~[illegible]~~ S Crawford N Sebastian	2/2	SF/DH
21	1117p	Midnight	T S F	12	Okfuskee	/1	SF/CM
21	1126p	1215A	T S F	10	Crawford	/1	SF/CM
21	1128	1215A	T S F	4	Tulsa S Rogers N Wagoner	/3	SF/CM
21	1140	1230A	T S F	12	McIntosh S Okmulgee	2/2	SF/CM
21	1144	1230A	T S F	12	Okfuskee	1/1	SF/CM
			T S F				

24/21

WSO TULSA WARNING LOG

4/96
MONTH/YEAR

PAGE 3

Warning Type	Basis for Warning (List in order of importance)
T - Tornado	1-Public Report 2-CD/Amateur Report 3-Chase Report
S - Severe Tstm	4-VIL 5-Other RADAP 6-RADID 7-WSR-57 8-NSSL Doppler
F - Flash Flood	9-SW 10-MESO 11-TVS 12-GustFnt 13-Hail 14-Tracking

Enter initials of person making the warning decision in the last column.

All times local (CST or CDT)

Day	Valid Time Issued	Valid Time Expired	Type	Basis	Counties or portions of counties warned	Hit?/ Init	
21	1150p	1230A	(T) S F	10	MADISON	1/1	SP/CH
22	1208A	100A	T (S) F	4/12	S WASHINGTON AR ADAIR		
—	—		T S F		CHEROKEE W MUSKOGEE	1/4	SP/CH
22	1225A	115A	T (S) F		MCINTOSH MUSKOGEE		
—			T S F		E OKMULGEE	2/2	SP/CH
22	1228A	100A	T (S) F	4	SE MADISON	1/1	SP/CH
22	1236A	115A	(T) S F	10	N MCINTOSH	1/1	SP/CH
22	1246	130	T (S) F	4	PITTSBURG	1/1	CH/SP
22	1249	130	T (S) F	4	MADISON	1/1	CH/SP
22	1255	130	(T) S F	10	ERN MUSKOGEE	1/1	CH/SP
22	1257	145	(T) S F	10	WASHINGTON AR	1/1	CH/SP
22	1259	145	T (S) F	4	SEQUOYAH	1/1	CH/SP
22	1241	130	T (S) F	4	CHEROKEE WAGONER	1/2	CH/SP
22	119	200	(T) S F	10	SEQUOYAH	1/1	CH/SP
22	124	215	T (S) F	4	MADISON SRN ADAIR SRN CHEROKEE	1/3	CH/SP
22	120	200	T (S) F	4	PITTSBURG	1/1	CH/SP
22	132	215	T (S) F	4	CARROLL	1/1	CH/SP
22	136	230	T (S) F	4	LATIMER HASKELL	1/2	CH/SP
22	142	445	T S (F)	1	WASHINGTON AR	1/1	CH/SP
22	145	230	(T) S F	10	ERN PITTSBURG NW LATIMER	1/2	CH/SP
22	150	230	(T) S F	10	SE ADAIR NW CRAWFORD SRN WASHINGTON	1/3	CH/SP
22	204	245	T (S) F	4	CRAWFORD, NRN SEBASTIAN	1/2	CH/SP
22	210	245	T (S) F	4	GRN CARROLL	1/1	CH/SP

14/

ZCZC OKCSPSTUL
TTAA KTUL 211100
ARZ001-002-010-011-019-029-OKZ054>077-221100-

EASTERN OKLAHOMA/NORTHWEST ARKANSAS THUNDERSTORM OUTLOOK
NATIONAL WEATHER SERVICE TULSA OK
600 AM CDT SUN APR 21 1996

NUMEROUS SEVERE THUNDERSTORMS ARE EXPECTED OVER EASTERN OKLAHOMA AND NORTHWEST ARKANSAS LATER TODAY THROUGH TONIGHT.

EARLY THIS MORNING A STATIONARY FRONTAL BOUNDARY WAS LOCATED ACROSS TEXAS WITH A VERY MOIST AND UNSTABLE AIRMASS TO THE SOUTH OF THE BOUNDARY. THE FRONT IS EXPECTED TO MOVE NORTHWARD AS A WARM FRONT TODAY AS STRONG SOUTHERLY JET STREAM WINDS CONTINUE TO STRENGTHEN. THIS WILL SPREAD THE MOIST AND UNSTABLE AIR BACK INTO EASTERN OKLAHOMA AND NORTHWEST ARKANSAS.

SCATTERED THUNDERSTORMS MAY DEVELOP NEAR THE RED RIVER DURING THE MORNING WHICH WOULD THEN SPREAD NORTHWARD... HOWEVER THE MAIN THREAT OF SEVERE THUNDERSTORMS WILL BE LATE THIS AFTERNOON INTO TONIGHT.

BY LATE THIS AFTERNOON A DEVELOPING LOW PRESSURE SYSTEM WILL BE LOCATED JUST SOUTH OF THE RED RIVER IN NORTHWEST TEXAS. A DRYLINE WILL EXTEND SOUTHWARD...AND THE WARM FRONT WILL STRETCH EASTWARD ACROSS EASTERN OKLAHOMA AND NORTHWEST ARKANSAS. ANOTHER IN A SERIES O UPPER LEVEL DISTURBANCES MOVING OUT OF THE ROCKIES AND INTO THE PLAINS WILL ALSO BE APPROACHING. THE DRYLINE AND WARM FRONT ARE EXPECTED TO BE THE FOCUS FOR INITIAL THUNDERSTORM DEVELOPMENT THIS AFTERNOON...WITH THE STORMS HAVING THE POTENTIAL TO QUICKLY BECOME SEVERE AS THEY RACE NORTHEASTWARD.

LARGE HAIL AND DAMAGING WINDS WILL BE THE PRIMARY THREAT... BUT THE VERTICAL WIND PROFILE EXPECTED OVER EASTERN OKLAHOMA AND NORTHWEST ARKANSAS BY THIS AFTERNOON AND THIS EVENING ALSO SUGGEST THAT A FEW LONG-LIVED SUPERCELL THUNDERSTORMS COULD DEVELOP... PRODUCING A THREAT OF TORNADOES.

THE MAIN TIME FRAME FOR SEVERE THUNDERSTORMS WILL BEGIN OVER EASTERN OKLAHOMA BY LATE THIS AFTERNOON SPREADING INTO NORTHWEST ARKANSAS BY THIS EVENING. THE THREAT WILL REMAIN ONGOING INTO THE NIGHT... ESPECIALLY OVER NORTHWEST ARKANSAS AND SOUTHEAST OKLAHOMA.

EMERGENCY MANAGEMENT AGENCIES AND SPOTTER GROUPS SHOULD MONITOR THIS WEATHER SITUATION CLOSELY THROUGH THE DAY... AND MAINTAIN A HIGH STATE OF READINESS FOR ACTIVATION THROUGH TONIGHT.

PUBLIC INFORMATION STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
110 PM CDT SUN APR 21 1996

AN OUTBREAK OF SEVERE THUNDERSTORMS AND TORNADOES IS EXPECTED ACROSS PORTIONS OF EASTERN OKLAHOMA AND NORTHWEST ARKANSAS LATE THIS AFTERNOON AND TONIGHT.

WATCHES...WARNINGS...SHORT TERM FORECASTS...AND STATEMENTS WILL DETAIL THE PROGRESS OF THIS SEVERE WEATHER EPISODE. NOW...BEFORE THE STORMS ARRIVE... IS THE TIME TO ENSURE THAT YOU ARE PREPARED FOR THE STORMY WEATHER.

THE FIRST KEY TO BEING PREPARED IS KNOWING THE TERMINOLOGY.

A WATCH IS A FORECAST INDICATING THE POSSIBILITY OF THREATENING WEATHER. IF A WATCH IS ISSUED FOR YOUR LOCATION REMAIN ALERT TO CONDITIONS IN YOUR AREA... KEEP A RADIO OR TELEVISION TURNED ON AND ENSURE YOUR NOAA WEATHER RADIO IS SET IN THE ALERT MODE.

A WARNING IS ISSUED WHEN SEVERE WEATHER IS ACTUALLY OCCURRING OR RADAR DATA INDICATES THAT IT IS ABOUT TO OCCUR. WARNING ARE ISSUED BY COUNTIES OR PARTS OF COUNTIES. IF A WARNING FOR SEVERE WEATHER IS ISSUED FOR YOUR LOCATION REMEMBER THAT THREATENING CONDITIONS WILL LIKELY PASS OVER OR NEAR WHERE YOU ARE.

WATCHES AND WARNINGS ARE ISSUED FOR TORNADOES...SEVERE THUNDERSTORMS...AND FLASH FLOODS. TORNADO AND SEVERE THUNDERSTORM WATCHES FOR ALL THE LOWER 48 UNITED STATES ARE ISSUED BY THE NATIONAL WEATHER SERVICE STORM PREDICTION CENTER IN KANSAS CITY MO. TORNADO AND SEVERE THUNDERSTORM WARNING...AS WELL AS FLASH FLOOD WATCHES AND WARNINGS FOR EASTERN OKLAHOMA AND NORTHWEST ARKANSAS ARE ISSUED BY THE NATIONAL WEATHER SERVICE IN TULSA.

IF A TORNADO WARNING IS ISSUED FOR YOUR AREA MOVE QUICKLY TO THE LOWEST FLOOR POSSIBLE. STAY AWAY FROM OUTSIDE WALLS AND WINDOWS. BASEMENTS AND STORM CELLARS OFFER THE BEST PROTECTION. IN PUBLIC BUILDINGS AVOID LARGE ROOMS SUCH AS AUDITORIUMS... THEATERS... CAFETERIAS.. .AND GYMNASIUMS. MOBILE HOMES SHOULD BE ABANDONED FOR NEARBY MORE SUBSTANTIAL STRUCTURES. IF YOU LIVE IN A MOBILE HOME NOW IS THE TIME TO SELECT WHERE YOU WOULD GO IF A TORNADO THREATENS. VEHICLES OFFER NO PROTECTION IN A TORNADO. IF A TORNADO APPROACHES WHILE YOU ARE DRIVING AND YOU CANNOT ESCAPE... SEEK SHELTER IN A NEARBY BUILDING. IF NO SHELTER IS AVAILABLE LIE FLAT IN THE NEAREST DITCH OR LOW SPOT AND HOLD ON TO SOMETHING.

IF A SEVERE THUNDERSTORM WARNING IS ISSUED FOR YOUR AREA MOVE INDOORS AND BE READY TO SEEK SHELTER. A SEVERE THUNDERSTORM IS DEFINED AS HAVING HAIL DIME SIZE OR GREATER AND WIND GUSTS OF 58 MPH OR MORE. IN EXTREME CASES... SEVERE THUNDERSTORMS CAN PRODUCE WINDS TO NEAR 150 MPH AND HAIL LARGER THAN GRAPEFRUITS.

SEVERE THUNDERSTORM WARNINGS ISSUED BY THE TULSA OFFICE WILL CONTAIN INFORMATION CONCERNING THE WIND AND HAIL POTENTIAL. WHILE THESE CONDITIONS MAY NOT OCCUR IN ALL OF THE WARNED AREA... THEY ARE LIKELY IN THE CORE OF THE STORM. IF WINDS OVER 70 MPH OR HAIL BIGGER THAN QUARTER SIZE IS EXPECTED... YOU SHOULD SEEK SHELTER AS YOU WOULD FOR AN APPROACHING TORNADO.

ALSO REMEMBER THAT TORNADOES OFTEN FORM VERY RAPIDLY FROM A SEVERE THUNDERSTORM. IF YOU ARE IN A TORNADO WATCH... AND A SEVERE THUNDERSTORM WARNING IS ISSUED FOR YOUR AREA YOU SHOULD KEEP A VERY CLOSE EYE ON YOUR LOCAL CONDITIONS AND BE READY TO TAKE QUICK ACTION TO SAVE YOUR LIFE.

WHILE HAIL AND STRONG WINDS ARE MOST OFTEN MENTIONED WHEN DESCRIBING SEVERE STORMS... REMEMBER THAT LIGHTNING IS A THUNDERSTORMS MOST UNDERRATED KILLER. PEOPLE OUTDOORS IN OPEN AREAS OR IN BOATS ARE AT THE GREATEST RISK FROM LIGHTNING. LIGHTNING TENDS TO STRIKE THE TALLER OBJECTS IN THE AREA... SO SEEKING SHELTER UNDER A TREE IS DANGEROUS. AUTOMOBILES OFFER GOOD PROTECTION FROM LIGHTNING... ALTHOUGH MOVING INDOORS IS BEST. EVEN INSIDE... LIGHTNING CAN KILL BY COMING INTO THE HOME ON PHONE LINES... PLUMBING AND ELECTRIC LINES. THEREFORE DO NOT USE THE TELEPHONE OR OTHER HAND HELD APPLIANCES WHILE THE STORM IS OVERHEAD. BE CAUTIOUS OF LIGHTNING BOTH BEFORE AND AFTER THE RAIN. LIGHTNING CAN STRIKE UP TO 15 MILES FROM THE PARENT STORM. MANY PEOPLE ARE STRUCK BECAUSE THEY STAYED OUT UNTIL THE LAST MINUTE... OR WENT OUTSIDE IMMEDIATELY AFTER THE RAIN ENDED.

FLASH FLOODING IS A THREAT TO BOTH THOSE WHO LIVE NEAR CREEKS OR STREAMS AND THOSE IN VEHICLES. IF YOU LIVE IN A FLOOD PRONE AREA BE READY TO MOVE TO HIGHER GROUND WHEN A FLASH FLOOD WATCH IS POSTED... AND TAKE ACTIONS TO PROTECT LIFE AND PROPERTY IF A FLASH FLOOD WARNING IS ISSUED. MOTORISTS ARE URGED TO NEVER DRIVE INTO FLOWING WATER... NO MATTER HOW SHALLOW AND NEVER DRIVE ONTO A FLOODED ROADWAY WHEN THE DEPTH OF THE WATER IS UNKNOWN. WHILE THE WATER MAY APPEAR SHALLOW... THE ROAD BELOW MAY HAVE BEEN WASHED AWAY... LEAVING A MUCH DEEPER AREA OF WATER THAN EXPECTED.

THIS SUMMARY OF SAFETY INFORMATION HAS BEEN COMPILED FOR QUICK REFERENCE BY THE MEDIA FOR USE DURING THE UPCOMING WEATHER EVENT. RADIO AND TELEVISION STATIONS ARE ASKED TO BREAK THIS INFORMATION INTO SHORT PUBLIC SERVICE ANNOUNCEMENTS AND OCCASIONALLY BROADCAST THEM DURING WATCHES... AND FREQUENTLY BROADCAST THEM DURING WARNINGS.

ZCZC OKCSVSTUL
TTAA00 KTUL 220254
OKZ074-220330

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
953 PM CDT SUN APR 21 1996

A TORNADO WARNING REMAINS IN EFFECT FOR HASKELL COUNTY UNTIL 1015 PM.

AT 951 PM RADAR INDICATED A POSSIBLE TORNADO BETWEEN QUINTON AND KINTA. THE STORM IS MOVING EAST NORTHEAST AT 25 MPH. IF YOU ARE IN OR NEAR KINTA
YOU SHOULD TAKE SHELTER NOW!

ZCZC OKCNOWTUL
TTAA00 KTUL 220258

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE TULSA OK
957 PM CDT SUN APR 21 1996

ARZ019-029-OKZ070>076-220400-
CRAWFORD AR-SEBASTIAN AR-MUSKOGEE OK-MCINTOSH OK-SEQUOYAH OK-
PITTSBURG OK-HASKELL OK-LATIMER OK-LE FLORE OK-

.NOW...
A DANGEROUS SEVERE THUNDERSTORM... CAPABLE OF PRODUCING A TORNADO... WILL MOVE EAST NORTHEAST FROM THE QUINTON AREA OF NORTHEAST PITTSBURG COUNTY ACROSS THE KINTA AND KEOTA AREAS OF HASKELL COUNTY THROUGH 1030 PM. ANOTHER INTENSE THUNDERSTORM WILL TRACK ACROSS THE PORUM AND WEBBERS FALLS AREAS OF SOUTHERN MUSKOGEE COUNTY THROUGH 1033 PM. THESE STORMS WILL TRACK ACROSS SEQUOYAH AND FAR NORTHERN LE FLORE COUNTY BETWEEN 1030 AND 1100 PM. IF THE STORMS HOLD TOGETHER... THEY COULD THREATEN FORT SMITH ARKANSAS AFTER 11PM.
&&
...TORNADO WARNING UNTIL 1015 PM FOR HASKELL COUNTY...

$$

ZCZC OKCSVSTUL
TTAA00 KTUL 220315
OKZ074-220330

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1014 PM CDT SUN APR 21 1996

A TORNADO WARNING IS IN EFFECT UNTIL 1045 PM.

AT 1012 PM RADAR INDICATED A TORNADO 4 MILES SOUTHWEST OF STIGLER. THIS TORNADO IS WRAPPED IN RAIN AND WOULD NOT BE VISIBLE. THE TORNADO IS TRACKING TO NEAR OR JUST SOUTH OF STIGLER AND TOWARD KEOTA.

IF YOU ARE IN THE STIGLER AND KEOTA AREAS TAKE SHELTER NOW!

ZCZC OKCNOWTUL
TTAA00 KTUL 220334

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE TULSA OK
1033 PM CDT SUN APR 21 1996

ARZ019-029-OKZ072-074-076-220400-
CRAWFORD AR-SEBASTIAN AR-SEQUOYAH OK-HASKELL OK-LE FLORE OK-

.NOW...
...DANGEROUS SEVERE THUNDERSTORM APPROACHING THE FORT SMITH AREA...
A VERY SEVERE THUNDERSTORM WITH A POSSIBLE TORNADO JUST NORTH OF KEOTA IN EASTERN HASKELL COUNTY WILL TRACK EAST NORTHEAST OVER SOUTHERN SOUTHERN SEQUOYAH AND NORTHERN LE FLORE COUNTIES...BETWEEN MULDROW AND SPIRO THROUGH 11 PM. IF THIS STORM HOLDS TOGETHER..IT WILL AFFECT THE FORT SMITH ARKANSAS AREA AFTER 11 PM. IN ADDITION TO TORNADOES... THIS STORM IS CAPABLE OF PRODUCING HAIL UP TO GOLF BALL SIZE AND WINDS UP TO 70 MPH.
&&
...TORNADO WARNING UNTIL 1115 PM FOR SOUTHERN SEQUOYAH AND NORTHERN LE FLORE COUNTIES...
$$

ZCZC OKCSVSTUL
TTAA00 KTUL 220337
OKZ072-074-076-220415-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1036 PM CDT SUN APR 21 1996

THIS STATEMENT IS FOR NORTHERN LE FLORE COUNTY AND HASKELL COUNTY.

AT 1033 PM RADAR INDICATED A POSSIBLE TORNADO JUST NORTH OF KEOTA... IN ADDITION... A SECOND CIRCULATION WAS DEVELOPING FURTHER SOUTH NEAR BOKOSHE. THIS LARGE AND DANGEROUS THUNDERSTORM WAS MOVING EAST NORTHEAST AT 25 MPH.

IF YOU ARE NEAR KEOTA...BOKOSHE...AND COWLINGTON YOU SHOULD BE IN A PLACE OF SAFETY!

ZCZC OKCSVSTUL
TTAA00 KTUL 220341
OKZ076-220415-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1040 PM CDT SUN APR 21 1996

THIS STATEMENT IS FOR LE FLORE COUNTY...

AT 1033 PM SPOTTERS REPORTED A FUNNEL CLOUD OVER BOKOSHE. RADAR INDICATED THAT A TORNADO IS DEVELOPING THERE. IF YOU ARE IN OR AROUND BOKOSHE SEEK SHELTER NOW!

ZCZC OKCSVSTUL
TTAA00 KTUL 220350
OKZ072-076-ARZ019-029-220415-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1049 PM CDT SUN APR 21 1996

A TORNADO WARNING REMAINS IN EFFECT FOR SOUTHERN SEQUOYAH AND NORTHERN LE FLORE COUNTY.

AT 1046 PM SPOTTERS REPORTED A FUNNEL CLOUD APPROACHING PANAMA AND RADAR INDICATES THAT A TORNADO IS FORMING THERE. THE STORM IS MOVING EAST NOTHEAST AT 25 MPH AND IS MOVING TOWARD POCOLA.

SPOTTERS IN MULDROW REPORTED QUARTER SIZE HAIL AT 1047 PM.

WARNINGS FOR THE FORT SMITH AND VAN BUREN AREAS MAY BE REQUIRED SOON.

ZCZC OKCSVSTUL
TTAA00 KTUL 220402
OKZ072-076-ARZ019-029-220430-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1101 PM CDT SUN APR 21 1996

THIS STATEMENT IS FOR SEQUOYAH... LE FLORE... SEBASTIAN AND CRAWFORD COUNTIES.

A LARGE SEVERE THUNDERSTORM WAS MOVING INTO THE FORT SMITH AND VAN BUREN AREAS. THIS STORM PRODUCED GOLFBALL SIZE HAIL IN MULDROW AT 1058 PM.

THIS IS A DANGEROUS STORM. IF YOU LIVE IN THE FORT SMITH AND VAN BUREN AREAS YOU SHOULD MOVE TO A PLACE OF SAFETY.

ZCZC OKCNOWTUL
TTAA00 KTUL 220412

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE TULSA OK
1110 PM CDT SUN APR 21 1996

ARZ019-029-OKZ072-076-220430-
CRAWFORD AR-SEBASTIAN AR-SEQUOYAH OK-LE FLORE OK-

.NOW...
...SEVERE THUNDERSTORM WITH A POSSIBLE TORNADO MOVING INTO THE FORT SMITH AND VAN BUREN AREAS...

A SEVERE THUNDERSTORM WITH HAIL UP TO GOLF BALL SIZE AND A POSSIBLE TORNADO WILL MOVE ACROSS THE FORT SMITH AND VAN BUREN AREAS THROUGH 1120 PM. PERSONS IN THE PATH OF THIS DANGEROUS STORM SHOULD TAKE COVER IMMEDIATELY!! THE STORM WILL CONTINUE EAST NORTHEASTWARD OVER SOUTHERN CRAWFORD COUNTY THROUGH 1145 PM.
&&
...TORNADO WARNING UNTIL MIDNIHT FOR SOUTHERN CRAWFORD AND NORTHERN SEBASTIAN COUNTIES...
$$

ZCZC OKCSVSTUL
TTAA00 KTUL 220415
OKZ072-ARZ019-029-220445-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1113 PM CDT SUN APR 21 1996

AT 1112 PM A FUNNEL CLOUD WAS REPORTED ALMOST TO THE GROUND IN FORT SMITH. RADAR INDICATED THAT A TORNADO WAS DEVELOPING IN FORT SMITH. THE TORNADO WAS MOVING NORTHEAST AT 25 MPH AND WILL MOVE TOWARD VAN BUREN. IF YOU ARE IN OR AROUND FORT SMITH AND VAN BUREN SEEK SHELTER NOW!

ZCZC OKCSVSTUL
TTAA00 KTUL 220423
ARZ019-029-220500-

SEVERE WEATHER STATEMENT
NATIONAL WEATHER SERVICE TULSA OK
1122 PM CDT SUN APR 21 1996

A TORNADO WARNING IS IN EFFECT FOR SOUTHERN CRAWFORD AND NORTHERN SEBASTIAN COUNTY.

AT 1120 PM RADAR INDICATED A POSSIBLE TORNADO JUST NORTH OF VAN BUREN. SPOTTERS REPORTED A FUNNEL CLOUD NEAR VAN BUREN AT 1119 PM

SOME DAMAGE HAS BEEN REPORTED IN FORT SMITH. IF YOU LIVE IN THE VAN BUREN AND ALAMA AREAS SEEK SHELTER NOW!

ZCZC OKCNOWTUL
TTAA00 KTUL 220509

SHORT TERM FORECAST
NATIONAL WEATHER SERVICE TULSA OK
1208 AM CDT MON APR 22 1996

ARZ001-002-010-011-019-220600-
BENTON AR-CARROLL AR-WASHINGTON AR-MADISON AR-CRAWFORD AR-

.NOW...
A SEVERE THUNDERSTORM WILL TRACK OVER THE ST PAUL... DUTTON... AND BOSTON AREAS OF SOUTHERN MADISON COUNTY THROUGH 1230 AM. LARGE HAIL AND DAMAGING WINDS ARE EXPECTED WITH THIS STORM... AND TORNADO DEVELOPMENT MAY OCCUR. ELSEWHERE... A LARGE AREA OF RAIN AND THUNDERSTORMS WILL CONTINUE ACROSS NORTHWEST ARKANSAS NORTH OF FORT SMITH THROUGH 1 AM.
&&
...TORNADO WARNING FOR SOUTHERN MADISON COUNTY UNTIL 1230 AM...
$$

STATUS OF ACTIONS

December 1996

Recommendation 1.1

The ability to access and display detailed ASOS data integrated with radar and other data sources needs to be incorporated in the Advanced Weather Information Processing System (AWIPS).

Status: AWIPS will have access to routine and special ASOS observations with the implementation of Build 3[1] by the end of 1997. Additional, direct access to ASOS 5-minute data is expected by Build 6.

Recommendation 2.1

Public Information Statements are designed to be used by the media to alert the populace to a predicted weather event. Information contained in such statements should be concise and easy to use.

Status: This recommendation has been provided to the Tulsa NWSFO; however, since the implication is nationwide, NWS Headquarters needs to address the issue on a national level, i.e. appropriate language in Weather Service Operations Manual (WSOM) C-40.

Recommendation 2.2a

The NWS should continue to provide training to increase the level of understanding and appropriate use of new WSR-88D products and capabilities. Each successive software build for years to come will have new products and additional functions. Continuous training using various distance learning technologies appears to be an effective method for ensuring NWS field offices have adequate knowledge of updated products and system functions.

Status: Training on the warning decision process and the proper use of the V_r shear product was giving to the staff of Tulsa NWSFO on July 9th by the Operations Training Branch (OTB) staff. The WSR-88D Operations Course material has been changed to include more about the use or potential misuse of the V_r Shear Product and to utilize the base velocity information along with the storm relative velocity products in a warning situation.

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[1] Builds refered to are major AWIPS Software releases which are part of the planned AWIPS incremental development

Recommendation 2.2b
The WSR-88D provides forecasters with a wide variety of products that assess the potential severity of storms. Forecasters diagnosing severe storms should use the system to its fullest capability by examining a representative suite of products in their evaluation.

Status: The WSR-88D Operations Course material has been changed to include more about the use or potential misuse of the V_r Shear Product and to utilize the base velocity information along with the storm relative velocity products in a warning situation.

Recommendation 2.3
A lack of damage reports, especially at night or in sparsely populated areas, should not play a significant role in the decision process regarding the issuance of severe weather warnings, especially those involving tornadoes. Forecasters should issue warnings based on the best available information derived from various technologies and reports from trained spotters.

Status: This recommendation has been provided to the Tulsa Office.

Recommendation 2.4
Accurate, descriptive reports from trained spotters provide a valuable source of ground truth which can enhance the interpretation of storm structure available from radar or other remotely observed data. These reports can appear geographically inconsistent with radar severe weather signatures for a number of reasons, including the relative location of the weather observed to the spotter's position. When discrepancies exist, attempts should be made by office personnel to resolve the discrepancies or obtain additional reports, if time allows. No spotter report should be dismissed solely on the grounds of not coinciding with the location of a radar signature.

Status: This recommendation has been provided to the Tulsa Office.

Recommendation 2.5
Forecasters should tailor "Call to Action" statements in dangerous situations to the specific conditions inherent in the storm, as this statement did.

Status: No action to date.

Recommendation 2.6a
NWS should provide further clarification of the roles of personnel in spin-down WSOs which maintain use of commissioned local warning radars.

Status: NWS Southern Region issued regionwide guidance regarding this issue on June 19, 1996.

Recommendation 2.6b
NWSFO Tulsa should enhance their working relationship with the Ft. Smith WSO so that the WSO's expertise on the local area, including the spotter network and community contacts, can be integrated more fully into the warning process.

Status: Tulsa staff began familarization trips to Ft. Smith WSO on June 25, 1996. A new Meteorologist-in-Charge (MIC) reported for duty full time at Tulsa on October 21. The Tulsa Warning Coordination Meteorologist (WCM) has visited the Ft. Smith office a couple of time, and the Tulsa MIC and WCM visited Ft. Smith on November 13. The Tulsa MIC plans to have the Ft. Smith staff come to the NWSFO for additional familiarization with the Tulsa staff.

Recommendation 3.1
The NWS should accelerate the planned transfer of administrative responsibility for the Ft. Smith WSO from Little Rock NWSFO to Tulsa NWSFO . This transfer will facilitate the planning and coordination of joint preparedness and hazard awareness activities.

Status: Transfer occurred on June 1, 1996.

Recommendation 4.1
The NWS should work with officials in Ft. Smith and surrounding areas to explore methods to improve the communication of critical warning information in a timely manner. Use of NOAA Weather Radio (NWR), two-way radio, and Emergency Manager Weather Information Network (EMWIN) should be a priority consideration. Cooperative efforts between the NWS and Federal, State, and Local emergency management agencies are essential for improving the flow of critical weather information into the Ft. Smith and Van Buren areas.

Status: A facility for EMWIN radio transmission was identified and transmissions began on August 17, 1996. Signal covers all of the immediate Ft. Smith area. The NWS supplied the transmission equipment and provided a demonstration unit which has been placed in Ft. Smith Public Library. The NWS also plans to supply four NWR SAME receivers to selected entities in the Ft. Smith area, also on loan. Current plans are to place the receivers in the Lavaca School (already in place), Ft. Smith 911 dispatch, Van Buren 911 dispatch, and at the Ft. Smith School Administration facility. The MIC at Tulsa is exploring additional possibilities, including Pagers and enhancements to the existing HAM radio links.

Recommendation 4.2
The NWS shall provide explicit guidelines clarifying the operations of the NAWAS regional circuits, and identifying protocols for calls within states and across state lines.

Local offices shall conduct training and perform drills to ensure that these guidelines are followed during warning operations.

Status: This finding was developed just prior to publication. NWS Headquarters has begun to determine what instructions have been provided with the NAWAS upgrade.

Recommendation 5.1
The NWS should develop additional partnership initiatives with the public and private sector to encourage the distribution and usage of NWR.

Status: This is an ongoing activity throughout the Southern Region in response to the Gore initiative[2]. A number of cooperator NWR transmitters have already been installed, and more are in the planning stages.

[2] This initiative for expansion of the NOAA Weather Radio network was proposed by Vice President Gore following the Palm Sunday tornado outbreak in 1994.