



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 8, 2021

Specialist's Factual Report

METEOROLOGY

CEN19FA248

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A. ACCIDENT

Location: De Queen, Arkansas
Date: August 4, 2019
Time: 1650 central daylight time
2150 Coordinated Universal Time (UTC)
Airplane: Cessna 310; Registration: N310QA

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
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C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources and also from the National Centers for Environmental Information (NCEI). This Specialist Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are central daylight time (CDT), and are based upon the 24-hour clock, where local time is -5 hours from UTC. Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at latitude 34.0394° N, Longitude 94.4239° W, with an approximate elevation of 335 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the Southern Plains for 1600 CDT is provided as figure 1 with the location of the accident site within the red circle. The chart depicted a low-pressure center at 1011-hectopascals over north central Texas associated with a frontal wave, with a cold front extending southwestward through Texas and a stationary front to the east and southeast of the low across northeast Texas into western Louisiana. The accident site was located northeast of the frontal boundary in the cool airmass.

The station models around the accident site depicted air temperatures in the upper 80’s degrees Fahrenheit (°F), dew point temperatures in the mid 70’s °F with temperature-dew point spreads of 14°F or less, a variable surface wind at 5 knots, and mostly clear skies.

¹

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

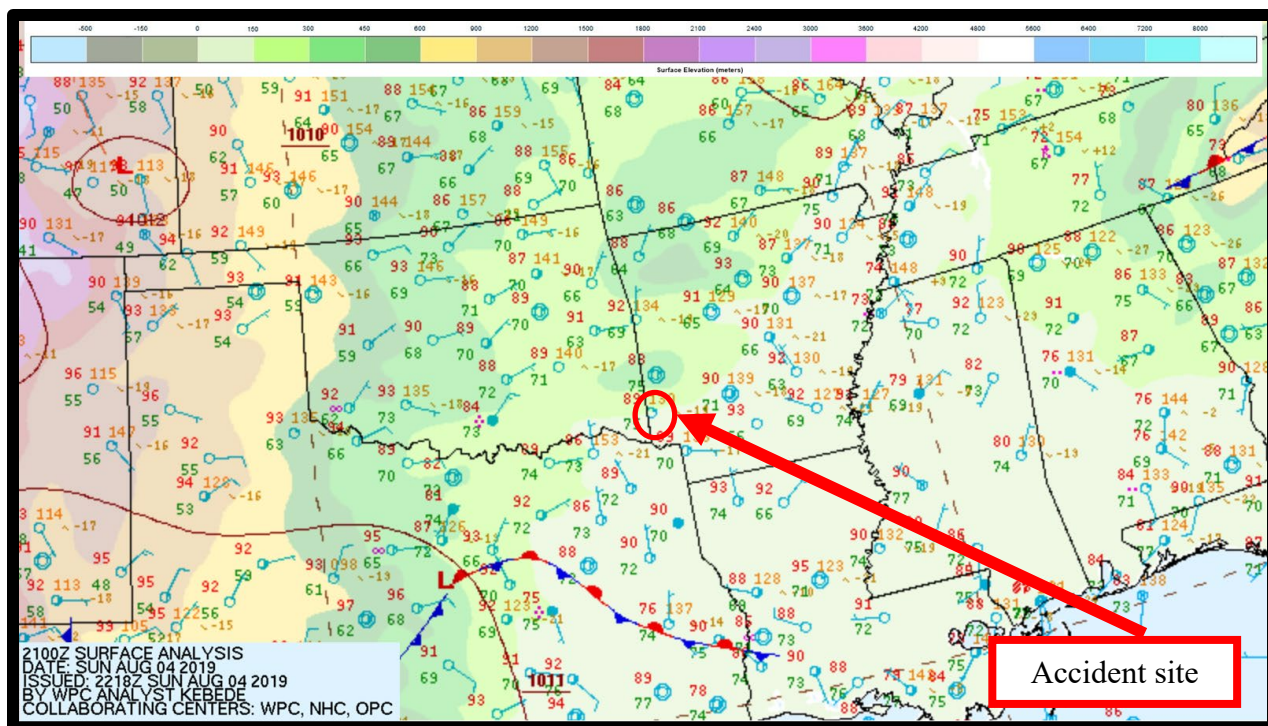


Figure 1 – NWS Surface Analysis Chart for 1600 CDT.

2.0 Storm Prediction Center Convective Outlook

The Storm Prediction Center (SPC) issued the following Day 1 Convective Outlook at 1502 CDT (figure 2) with an area of general thunderstorms expected over the area in the vicinity of the accident site. SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period.

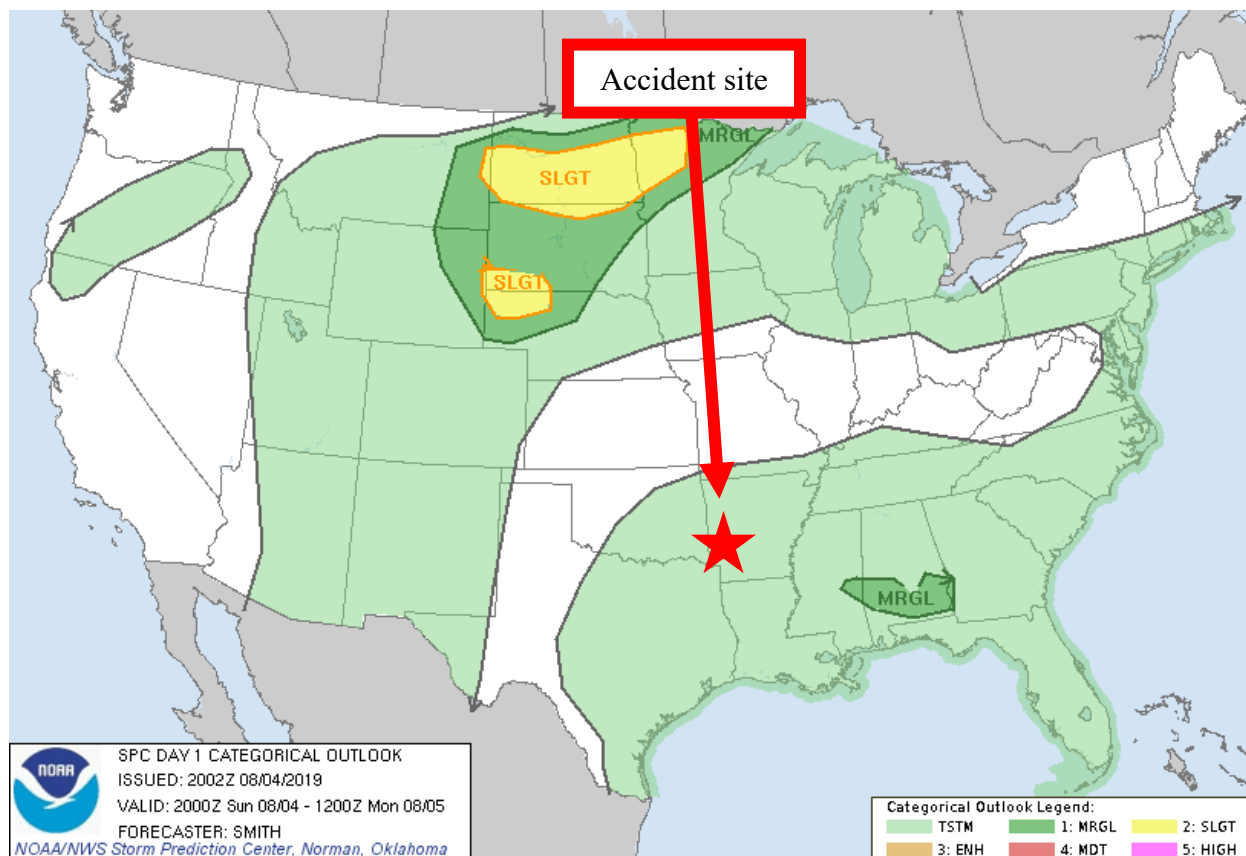


Figure 2 – SPC day 1 Convective Outlook valid at the time of the accident.

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 3 is a local sectional chart with the accident site and the closest weather reporting location marked.

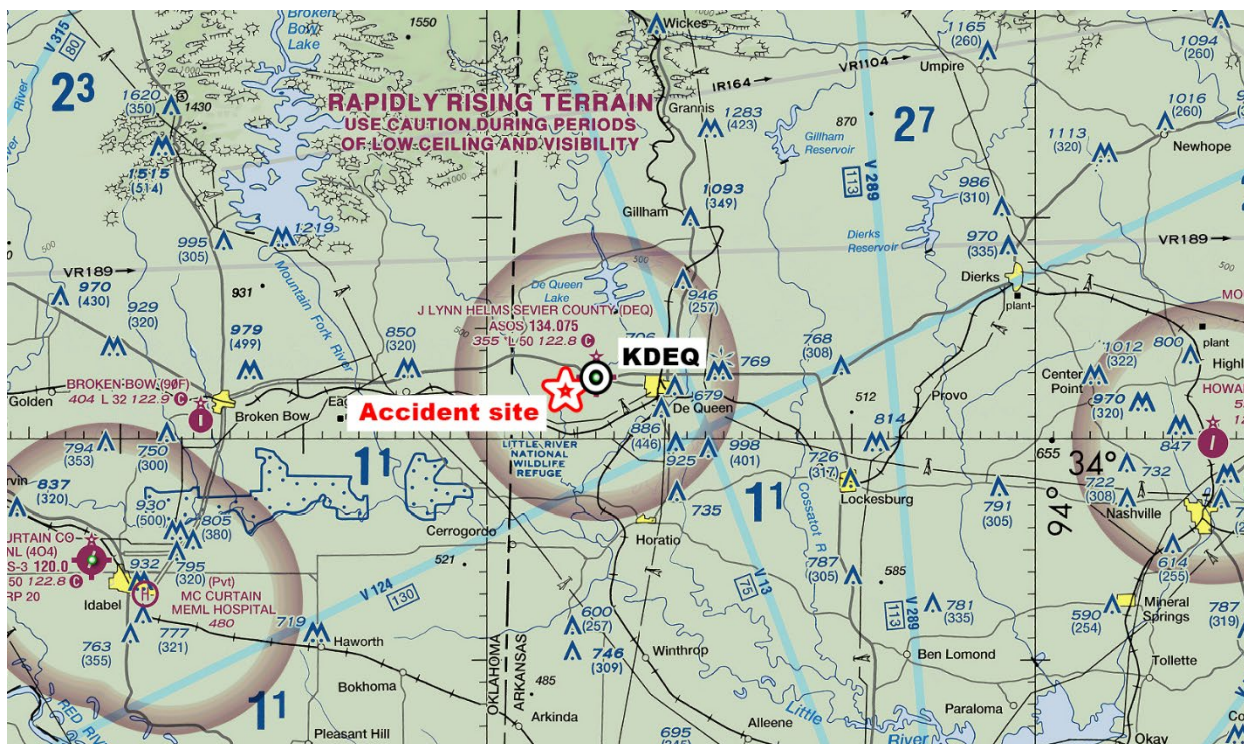


Figure 3 – Sectional map of the accident area with the location of the accident site and surface observation site.

The accident Airplane had departed from J. Lynn Helms Sevier County Airport (KDEQ), De Queen, Arkansas, immediately prior to the accident. The airport had an Automated Surface Observing System (ASOS²) whose longline³ reports were not supplemented. The KDEQ ASOS was located within a mile of the accident site, at an elevation of 355 ft, and had a 2° easterly magnetic variation⁴ (figure 3). The following automated longline observations were disseminated during the times surrounding the accident:⁵

[1153 CDT] METAR KDEQ 041653Z AUTO 25004KT 10SM BKN048 28/24 A3000 RMK AO1 SLP154 T02780239 PNO \$=

² ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather phenomena, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

³ “Longline” refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases (effectively, the whole world) and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station’s Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the general global public has access to surface weather observations, particularly outside of the aviation community.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

⁵ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1253 CDT] METAR KDEQ 041753Z AUTO VRB03KT 10SM SCT050 30/24 A2999 RMK AO1 SLP149 6//// T03000239 10300 20239 58003 PNO \$=

[1353 CDT] METAR KDEQ 041853Z AUTO 27005KT 10SM FEW023 FEW050 31/25 A2997 RMK AO1 SLP143 T03060250 PNO \$=

[1453 CDT] METAR KDEQ 041953Z AUTO 27004KT 10SM SCT025 SCT031 BKN042 31/24 A2995 RMK AO1 SLP138 T03060244 PNO \$=

[1553 CDT] METAR KDEQ 042053Z AUTO VRB04KT 10SM FEW031 32/24 A2993 RMK AO1 SLP130 6//// T03170239 58019 PNO \$=

ACCIDENT TIME 1650 CDT

[1653 CDT] METAR KDEQ 042153Z AUTO 28003KT 10SM SCT032 31/24 A2992 RMK AO1 SLP126 T03110244 PNO \$=

[1753 CDT] METAR KDEQ 042253Z AUTO 34004KT 10SM FEW085 28/26 A2992 RMK AO1 RAB09E28 SLP126 T02830261 PNO \$=

The bold type observations decoded in plain language were as follows:

KDEQ weather at 1553 CDT, automated, variable wind at 4 knots, visibility 10 miles or greater, few clouds at 3,100 ft above ground level (agl), temperature of 32° Celsius (C), dew point temperature of 24°C, and an altimeter setting of 29.93 inches of mercury (inHg). Remarks: automated station without a precipitation discriminator, sea level pressure 1013.0 hPa, 6-hourly precipitation unknown, temperature 31.7°C, dew point temperature 23.9°C, 3-hourly pressure decrease of 1.9 hPa, precipitation amount not available, maintenance indicator on.

KDEQ weather at 1653 CDT, automated, wind from 280° at 3 knots, visibility 10 miles or greater, scattered clouds at 3,200 ft agl, temperature of 31°C, dew point temperature of 24°C, and an altimeter setting of 29.92 inHg. Remarks: automated station without a precipitation discriminator, sea level pressure 1012.6 hPa, temperature 31.1°C, dew point temperature 24.4°C, precipitation amount not available, maintenance indicator on.

The observations from KDEQ surrounding the accident time indicated VFR⁶ conditions with variable surface wind of 5 knots or less.

⁶ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR

4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site coordinates for 1700 CDT which provided a surface elevation of 381 ft.⁸ The HRRR sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters included in figure 7 with data from the surface to 600-hPa (or approximately 14,000 ft msl). These data were analyzed using the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ and the level of free convection (LFC)¹² at 4,527 ft msl, and the convective condensation level (CCL)¹³ at 4,973 ft msl. The freezing level was located at 15,762 ft msl. The precipitable water value was 2.07 inches.

is a sub-category of VFR.

⁷ The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

⁸ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

⁹ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

¹⁰ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.

¹¹ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹² LFC – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

¹³ CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

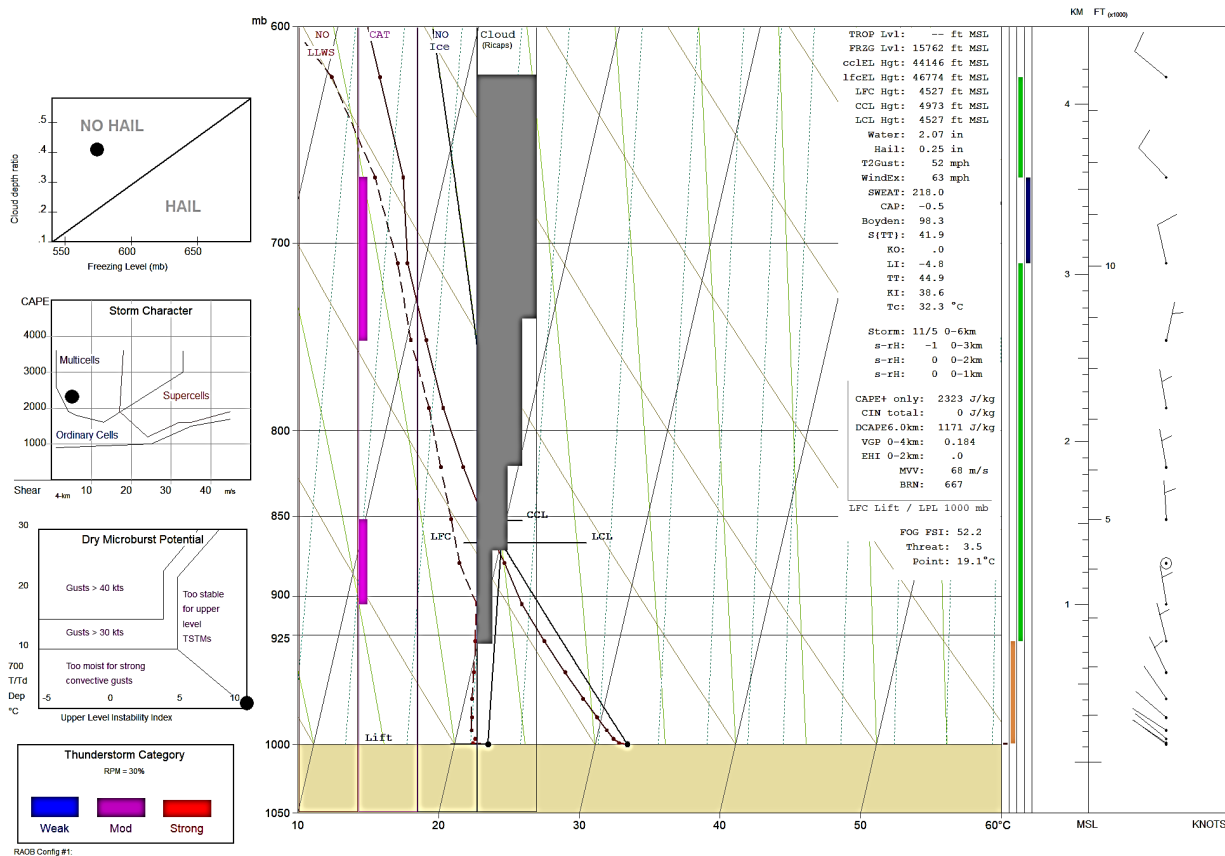


Figure 4 – 1700 CDT HRRR sounding.

The 1700 CDT HRRR sounding indicated an unstable environment, with a CAPE¹⁴ of 2,323 Joules/kilogram (J/kg) and the maximum vertical velocity (MVV) of potential updrafts was calculated as 68 meters/second (about 13,386 ft per minute).¹⁵ Given the environment, RAOB indicated that multicell rain shower or thunderstorm development was possible. Downdraft CAPE (DCAPE; 6 kilometers agl)¹⁶ was measured at 1,171 J/kg. If rain showers or thunderstorms formed in this environment, the 1700 CDT HRRR sounding indicated that the strongest wind speeds possible at the surface (due to, for example, a microburst, outflow boundary, or gust front) would have been 63 mph (55 knots) according to the WindEx and T2Gust parameters.

The 1700 CDT HRRR sounding wind profile indicated a near surface wind from 308° at 2 knots with the wind remaining from the northwest to north at or below 10 knots through 14,000 ft msl. RAOB indicated the possibility of light clear-air turbulence in two layers between the surface and 14,000 ft msl. No low-level wind shear (LLWS) was indicated by RAOB outside of thunderstorm or rain shower activity.

¹⁴ Convective Available Potential Energy (CAPE) – CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.

¹⁵ MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

¹⁶ The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts.

5.0 Satellite Data

The Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1200 CDT through 2000 CDT and reviewed, and the closest images to the time of the accident were documented. Due to sun angle the visible imagery did not provide helpful data.

Figures 5 and 6 present the GOES-16 visible imagery from 1640 and 1650 CDT at 3X magnification with the accident site highlighted with a red square. The cumuliform cloud cover was moving from north to south with cloud cover above the accident site at the accident time (attachment 1).

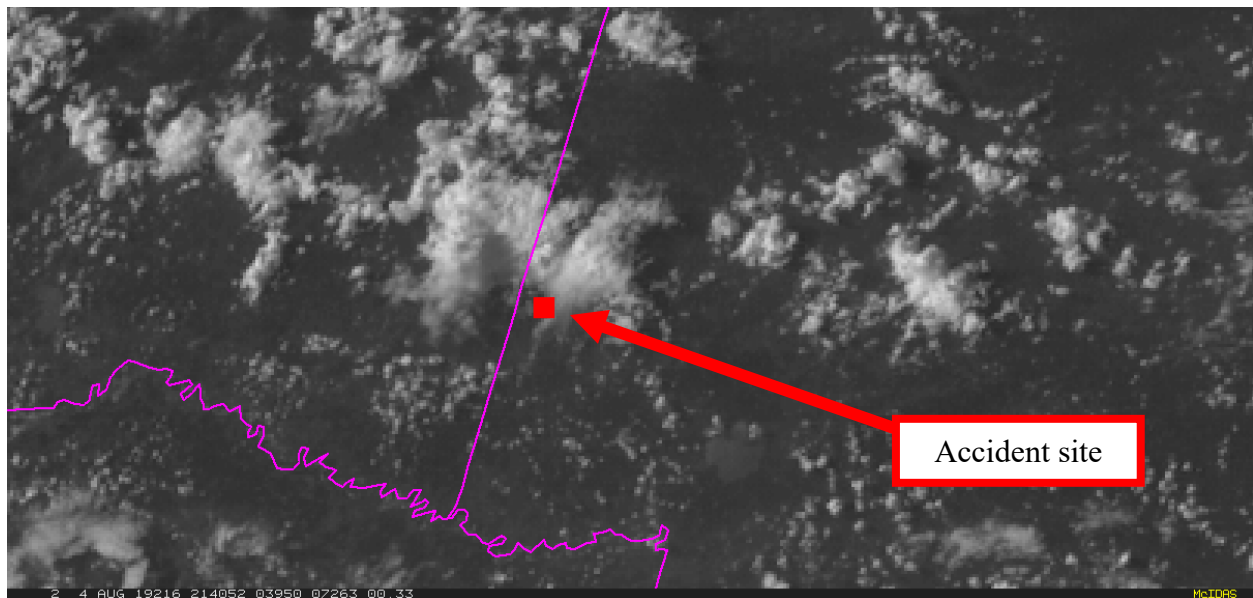


Figure 5 – GOES-16 visible image at 1640 CDT.

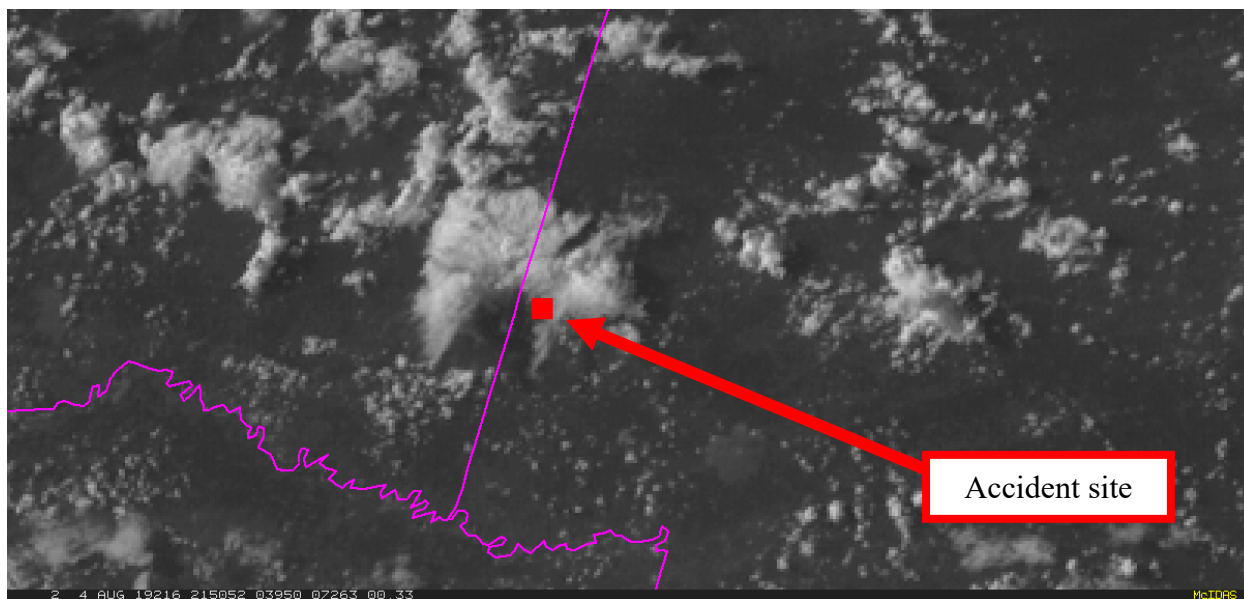


Figure 6 – GOES-16 visible image at 1650 CDT.

6.0 Radar Imagery Information

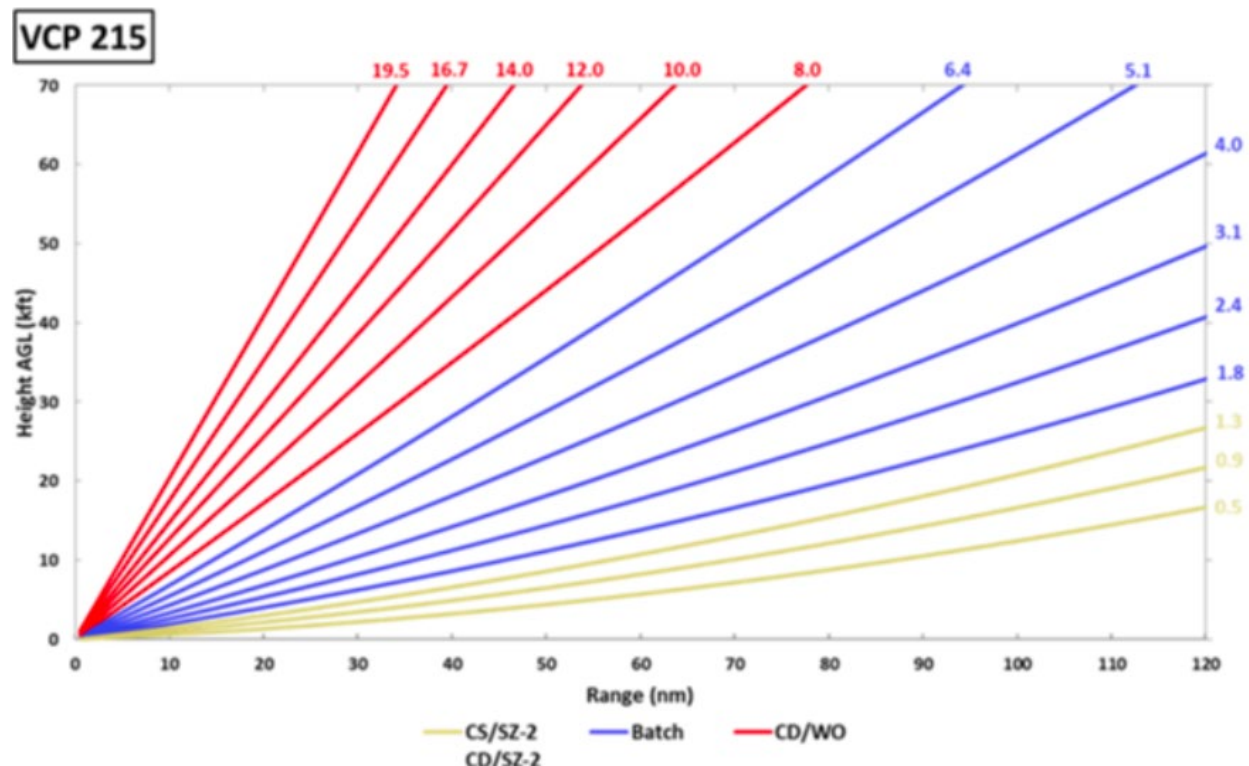
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁷ to the accident site was Fort Smith, Arkansas (KSRX) located 75 miles north of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

6.1 Volume Scan Strategy

The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available. Products that require data from multiple elevation scans are not available until the end of the four-to-ten-minute volume scan.

¹⁷ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

The WSR-88D operates in two main scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has several scanning strategies¹⁸. The most common is where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes. This scanning strategy is documented as volume coverage pattern 215 (VCP-215). Mode B is the clear-air mode, where the radar makes 9 elevation scans during a ten-minute period. During the period surrounding the accident, the KSRX WSR-88D radar was operating in the precipitation mode VCP-215. The following chart provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.



VCP-215 Precipitation Mode Scan Strategy.

¹⁸ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high $R_{\max}$ value to determine proper target location and intensity, but a low $V_{\max}$ value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low $R_{\max}$ value causing more range folded (multiple trip) echoes, but a high $V_{\max}$ value to get higher, more accurate velocity values.

Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.

W – With range unfolding (W)

WO – Without range unfolding (WO)

6.2 Beam Height Calculation

Assuming standard refraction¹⁹ of the KSRX WSR-88D radar beam with the antenna elevation at 737 ft, and considering a beamwidth²⁰ of 0.95°, the following table shows the approximate heights for the radar beam center, base, and top for an antenna elevation over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KSRX 0.5°	8,790 ft	5,090 ft	12,490 ft

Based on the radar height calculations, the elevation scan from KSRX listed in the above table depicted the conditions between 5,090 ft and 12,490 ft msl and these scans “saw” the closest altitudes to the ground and accident site.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²¹ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ²²) and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²³, “Thunderstorms,” dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be “light.” For dBZ values between 30 and 40, the terminology should be “moderate.” “Heavy” terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as “extreme.”

¹⁹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²⁰ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²¹ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth’s surface; also, any water particles blown by the wind from the earth’s surface. Hydrometeors are classified as: (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist, or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth’s surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

²² dBZ – A non-dimensional “unit” of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

²³

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

6.4 Base Reflectivity Data

Figures 7 through 9 present the KSRX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1648:13, 1654:05, and 1649:42 CDT, respectively, with a resolution of 0.5° X 250 m. There were no reflectivity values above the accident site at the accident time. An area of 10 to 30 dBZ was located between 1 to 2 miles north of the accident site and that area of indicated precipitation decreased in areal coverage and intensity between 1648:13 and 1659:42 CDT on the 0.5° elevation scan.

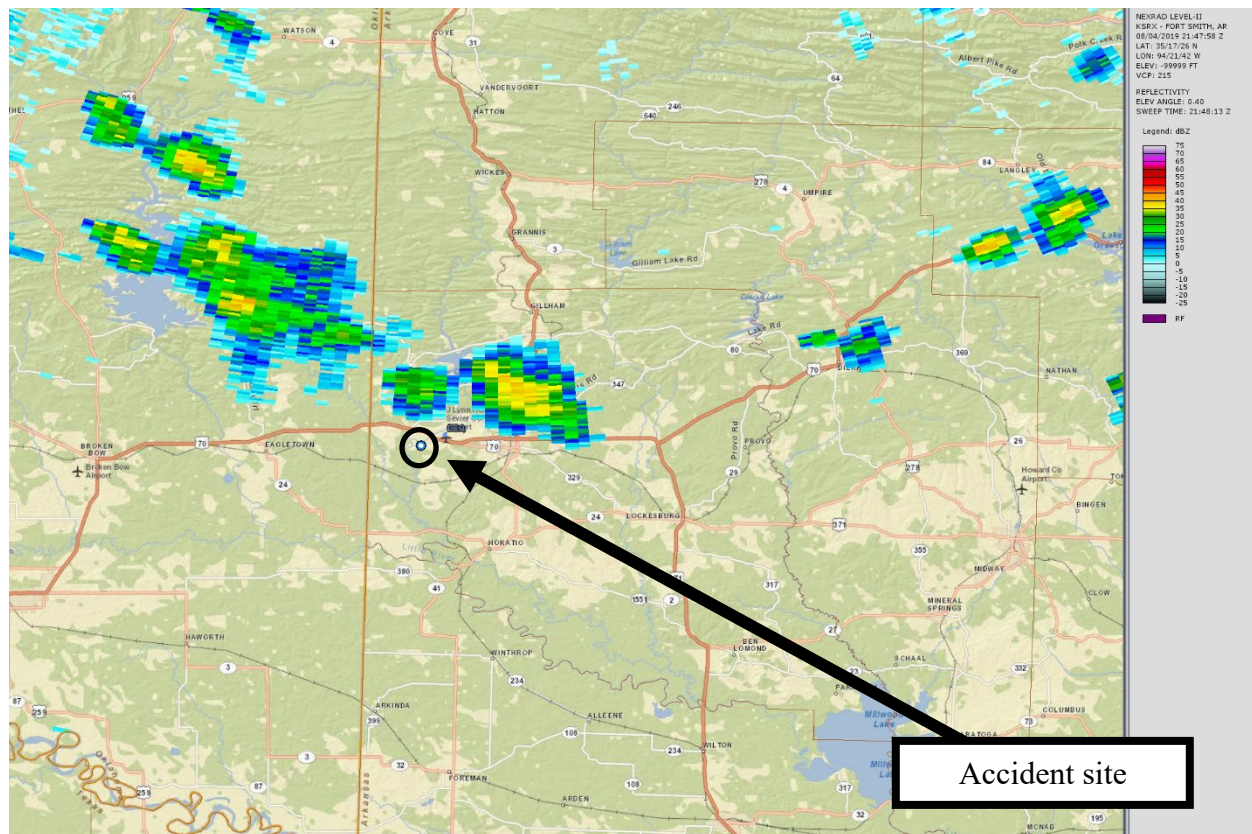


Figure 7 – KSRX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1648:13 CDT with the accident site marked with a black circle.

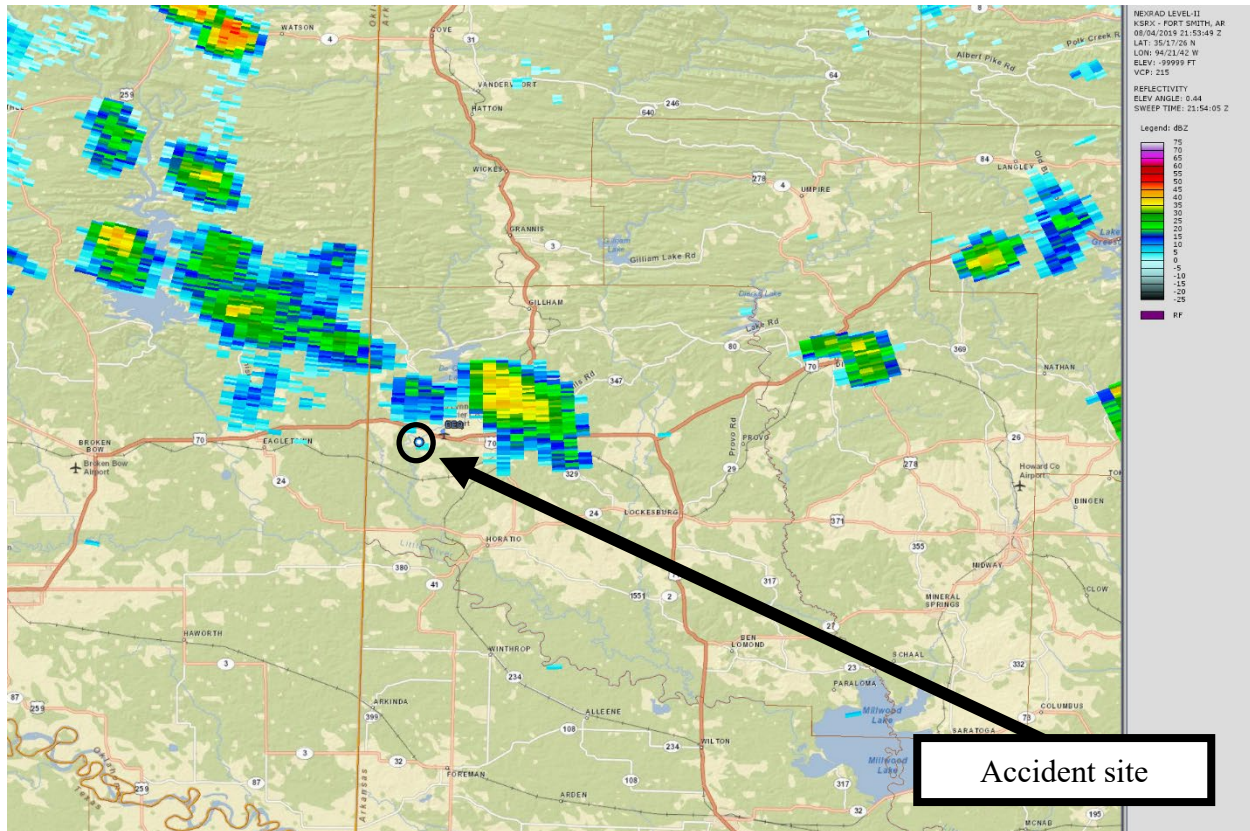


Figure 8 – KSRX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1654:05 CDT with the accident site marked with a black circle.

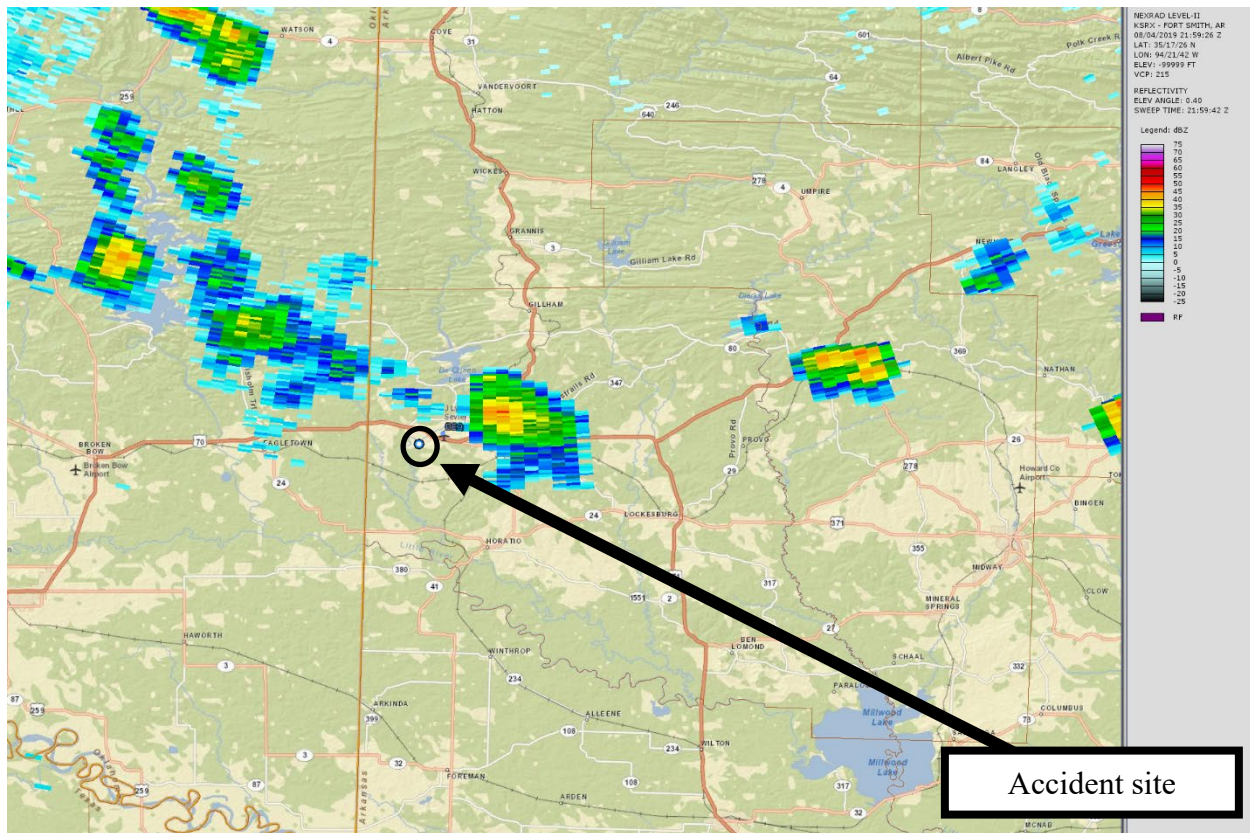


Figure 9 – KSRX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1659:42 CDT with the accident site marked with a black circle.

7.0 Pilot Reports

The longline-disseminated pilot reports²⁴ (PIREPs) distributed into the national airspace (NAS) were reviewed from about two hours prior to the accident time to two hours after the accident time and there was only one PIREP around 100 miles of the accident site for below FL200²⁵ and that PIREP is shown below.

TXK UUA /OV TXK355040/TM 2001/FL160/TP C550/TB SEV/RM SMALL JOLT ZFW AWC-WEB/

8.0 Significant Meteorological Information

There were no non-convective or convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time.

9.0 Center Weather Service Unit Advisories

The Fort Worth (ZFW) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There were no Center Weather Advisories (CWA) valid at the accident time.

10.0 Airmen's Meteorological Information

There were no Airmen's Meteorological Information (AIRMET) advisories valid for the accident site at the accident time.

11.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 1600 CDT are shown in attachment 3. The GFA surface forecast valid before departure for around the accident time indicated VFR surface visibilities with scattered (between 30 to 50 percent) thunderstorms and a surface wind from the north at 5 knots. The GFA cloud forecast valid before departure for around the accident time indicated few to scattered clouds at 4,500 ft msl. For more information, please see attachment 3.

²⁴ Only pilot reports with the World Meteorological Organization headers UBAR**, UBTX**, UBOK**, and UBLA** were considered. These do not include pilot reports only broadcast via radio.

²⁵ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

12.0 Terminal Aerodrome Forecast

There were no NWS Terminal Aerodrome Forecast (TAF)²⁶ sites located within 30 miles of the accident site.

13.0 Pilot Weather Briefing

The accident pilot did not request nor receive weather information²⁷ from Leidos Flight Service. A separate search of ForeFlight also indicated no record of the accident pilot did not request nor receive weather information prior to the accident flight. It is therefore unknown what weather information, if any, the accident pilot reviewed before or during the accident flight.

14.0 Downburst and Microburst Information

The FAA's Advisory Circular AC 00-6B titled "Aviation Weather" issued in August 2016 is a basic training guide on many weather hazards, including downbursts and microbursts. In section 19.6.3, downburst and microburst are associated with rain showers and more frequently with thunderstorm activity. Downbursts create many hazards for aviation and often cause damaging wind at the surface. An exemplar diagram of a downburst from a rain shower or thunderstorm cloud base is shown in figure 10. Further information on the hazards of a downburst and microburst and the safest courses of action for pilot can be found in the FAA's AC 00-6B, the FAA's AC 00-24C, the FAA's Aeronautical Information Manual change 2 section 7-1-26 published in January 2015, and from the University Corporation for Atmospheric Research (UCAR)²⁸.

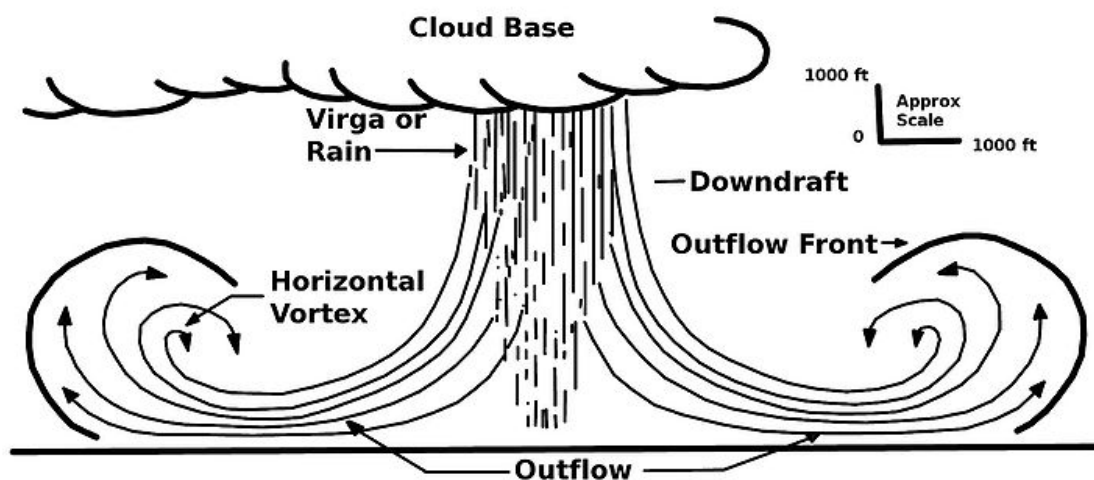


Figure 10 – Exemplar diagram of a downburst and outflow

²⁶ According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex." www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

²⁷ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf

²⁸ UCAR's Collaboration among Education and Training Programs (COMET) Meteorology Education and Training (MetEd) module on Thunderstorm Downdrafts: https://www.meted.ucar.edu/tropical/synoptic/local_storms/navmenu.php?tab=1&page=2.0.0&type=flash

15.0 Astronomical Data

The astronomical data obtained for the accident site on August 4, 2019, indicated the following:

SUN	
Begin civil twilight	0604 CDT
Sunrise	0631 CDT
Sun transit	1324 CDT
Accident time	1650 CDT²⁹
Sunset	2016 CDT
End civil twilight	2043 CDT

At the time of the accident the Sun was located at an altitude of 41.11° and azimuth of 263.25°.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 visible satellite imagery animation from 1306 to 1706 CDT

Attachment 2 – KSRX weather radar animation from 1630 to 1659 CDT

Attachment 3 – GFA valid for the accident site at accident time

Submitted by:

Paul Suffern
Senior Meteorologist

²⁹ Inserted accident time for reference and context.