

Docket No. SA-539

Exhibit No. 5-A

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Meteorology – Factual Report

(43 Pages)



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

November 1, 2016

Group Chairman's Factual Report

METEOROLOGY

DCA16MA204

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A. ACCIDENT

Location: Lockhart, Texas

Date: July 30, 2016

Time: 0742 central daylight time
1242 Coordinated Universal Time (UTC)

Aircraft: Balony Kubicek BB85Z hot air balloon, Registration: N2469L

B. METEOROLOGY GROUP

Paul Suffern

Group Chairman

Operational Factors Division (AS-30)

National Transportation Safety Board

C. SUMMARY

On July 30, 2016, about 0742 central daylight time, a Balony Kubicek BB85Z hot air balloon, registration N2469L, crashed into a field after striking high voltage powerlines near Lockhart, Texas. The 15 passengers and pilot onboard were fatally injured and the balloon was substantially damaged due to impact forces and post-crash fire. The flight was operating under 14 *Code of Federal Regulations* Part 91 as a sightseeing passenger flight.

D. 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 the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are central daylight time (CDT) on July 30, 2016, and are based upon the 24-hour clock, where local time is -5 hours from UTC, and UTC=Z (unless otherwise noted). 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.

The accident site was located at latitude 29.89° N, longitude 97.76° W, at an approximate elevation of 595 feet.

E. 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 (NCEP) 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-0045G CHG 2.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 0700 CDT is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a stationary front stretching from southeastern Colorado east-southeastward into central Oklahoma and then eastward into southern Missouri. There were no surface low or high pressure centers in Texas at 0700 CDT. The station models around the accident site depicted air temperatures in the mid 70’s degrees Fahrenheit (°F), with temperature-dew point spreads of 1° F or less, a calm to south-southwest wind at 5 knots, partly cloudy skies, and mist.

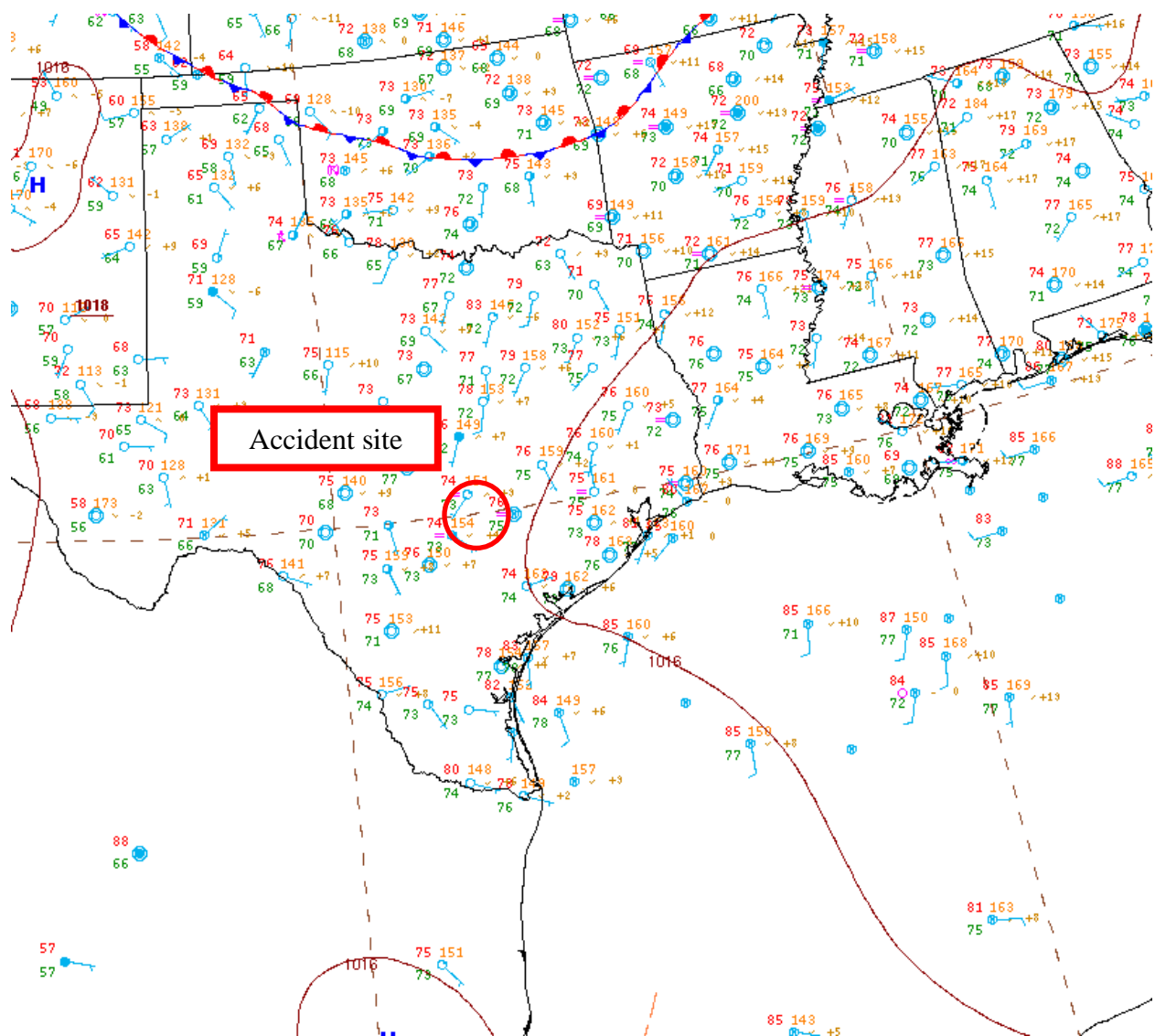


Figure 1 – NWS Surface Analysis Chart for 0700 CDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0700 CDT at 925-, 850-, 700-, 500-, and 300-hectopascals (hPa) are presented in figures 2 through 6. The 925- and 850-hPa charts depicted a south to southwest wind between 10 and 20 knots with no low-level troughs¹ near the accident site. Dew point temperatures ranged from 17° to 19° Celsius (C) at 925- and between 11° and 13° C at 850-hPa near the accident site. Between 700- and 300-hPa (figures 4, 5, and 6) there were no troughs or ridges² near the accident site and each pressure level identified a wind from various directions at magnitudes of less than 10 knots above the accident location.

¹ Trough – An elongated area of relatively low atmospheric pressure or heights.

² Ridge – An elongated area of relatively high atmospheric pressure or heights.

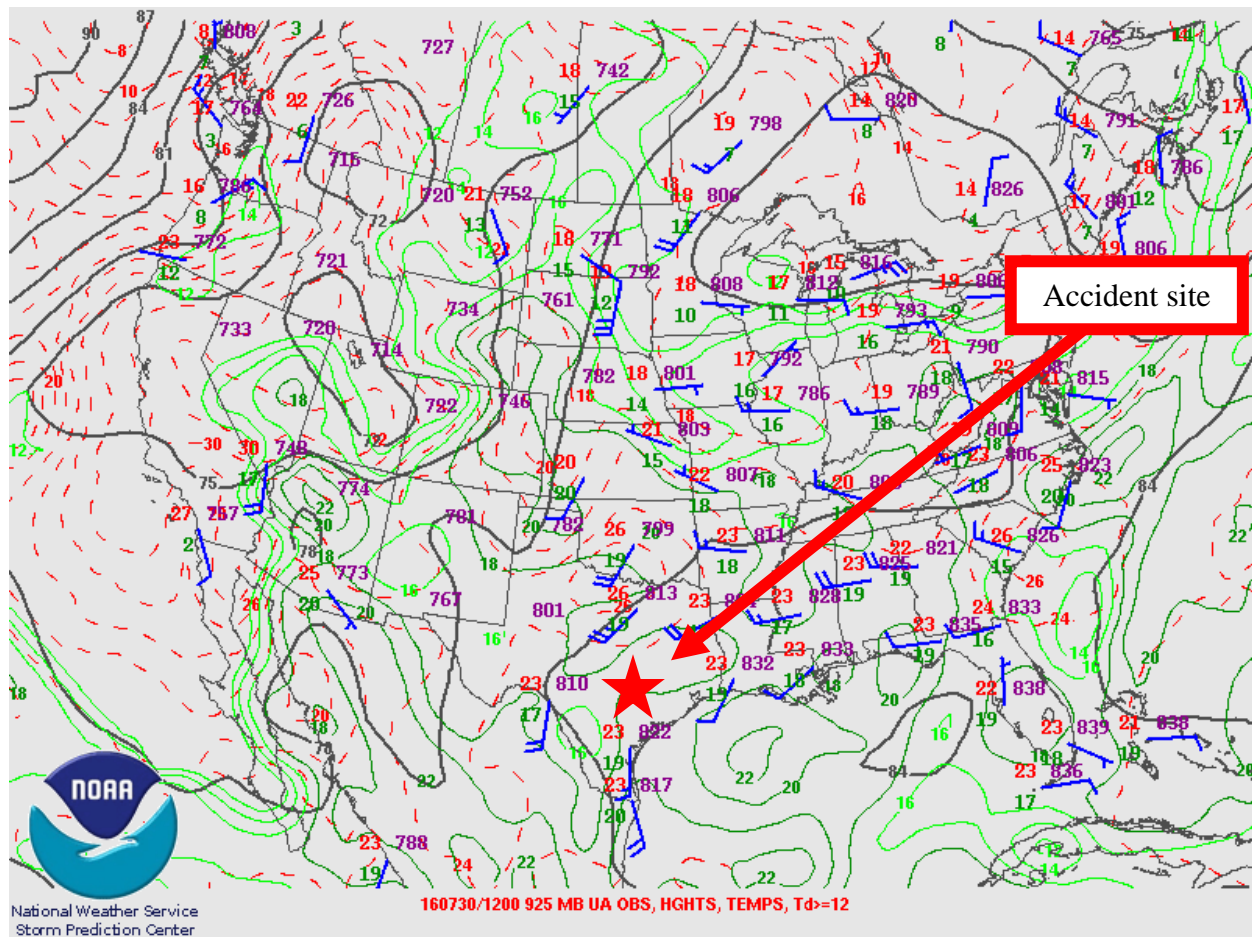


Figure 2 – 925-hPa Constant Pressure Chart for 0700 CDT

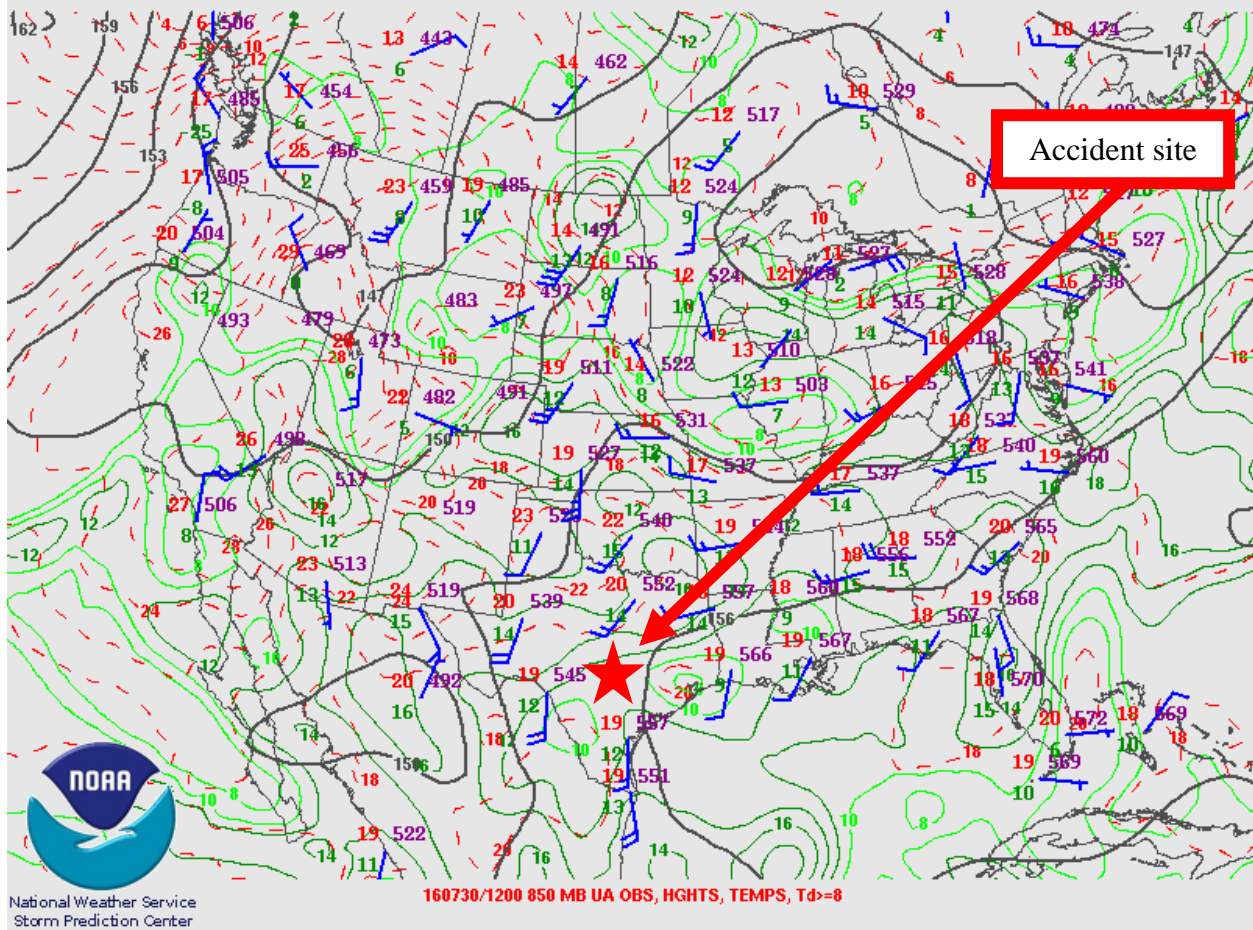


Figure 3 – 850-hPa Constant Pressure Chart for 0700 CDT

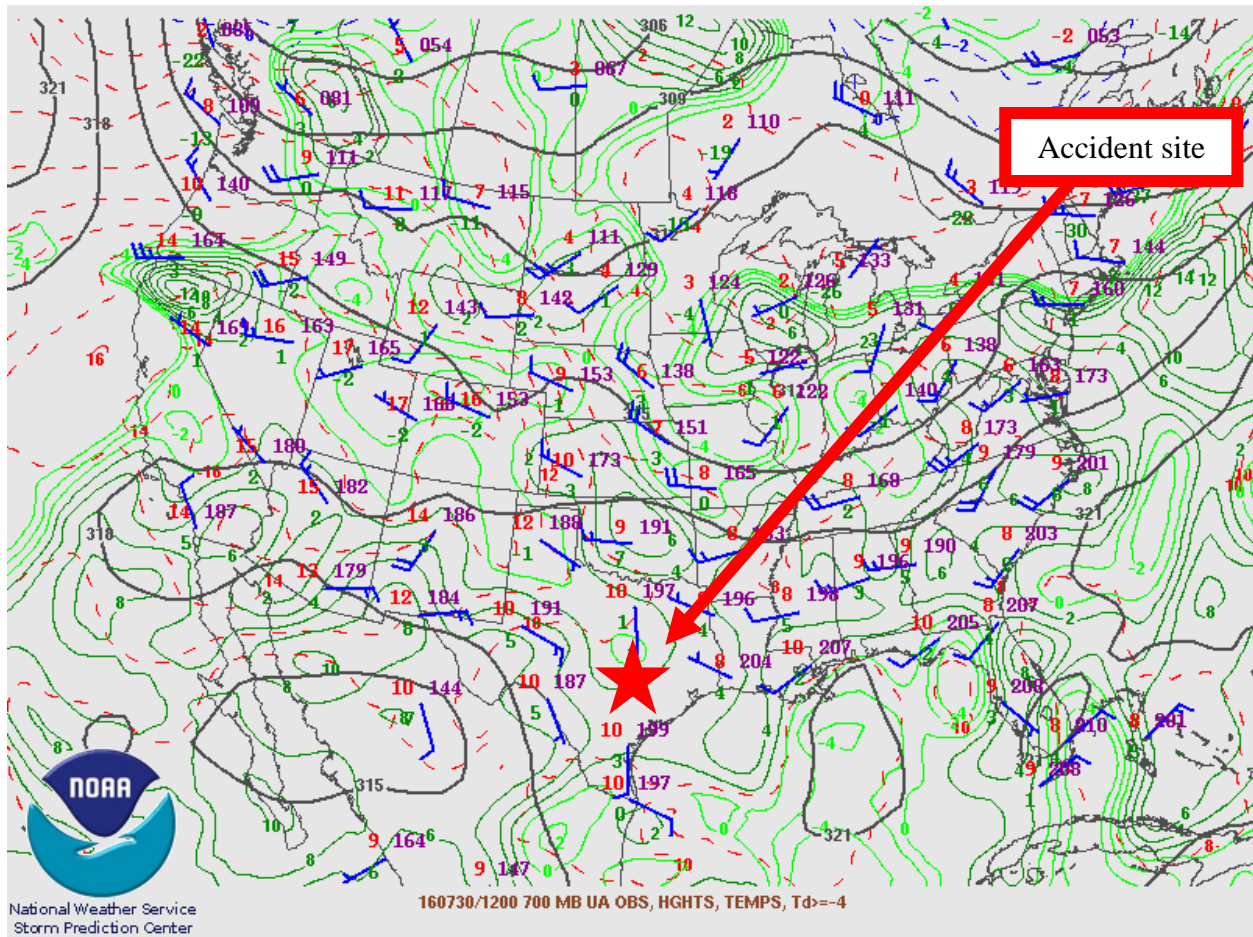


Figure 4 – 700-hPa Constant Pressure Chart for 0700 CDT

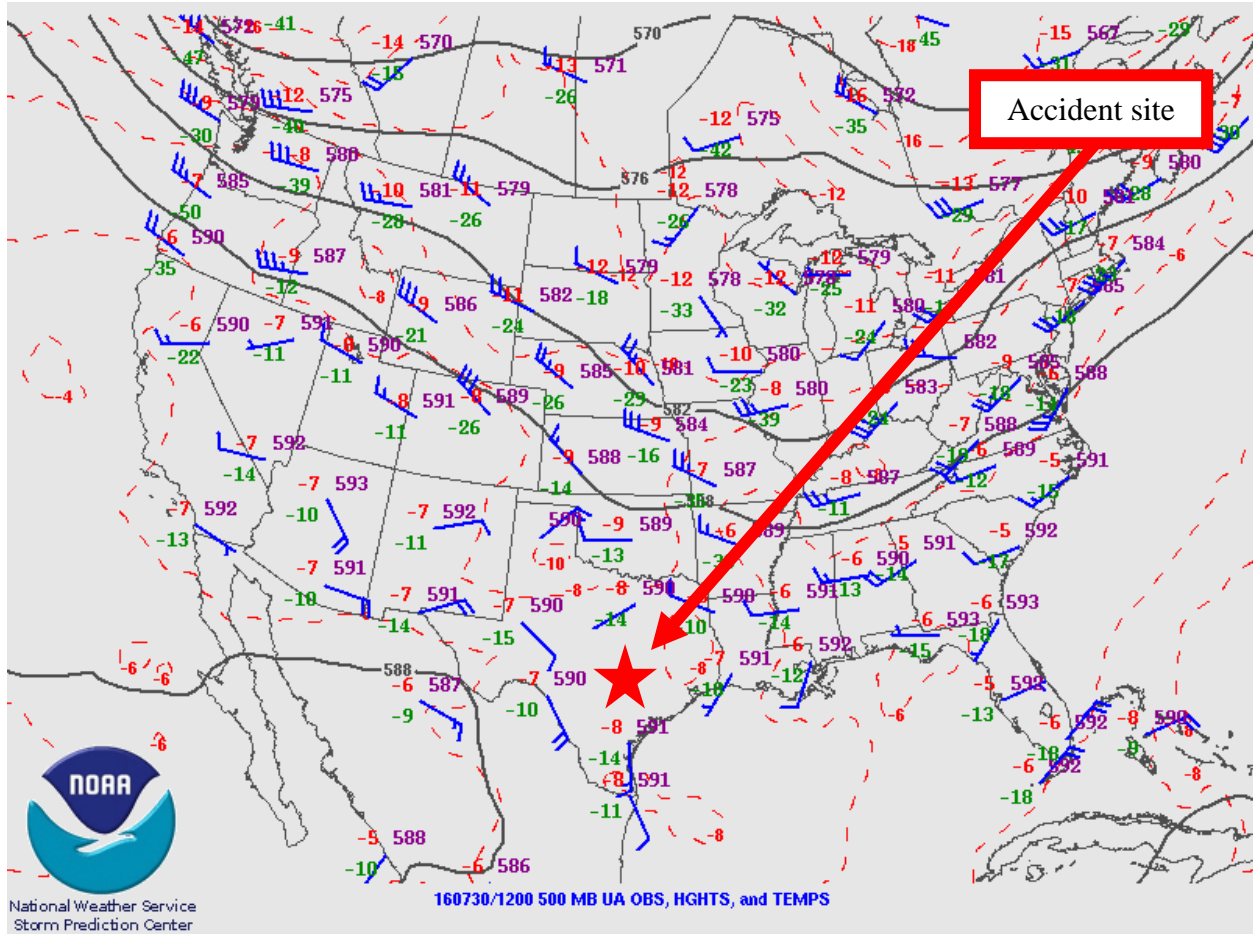


Figure 5 – 500-hPa Constant Pressure Chart for 0700 CDT

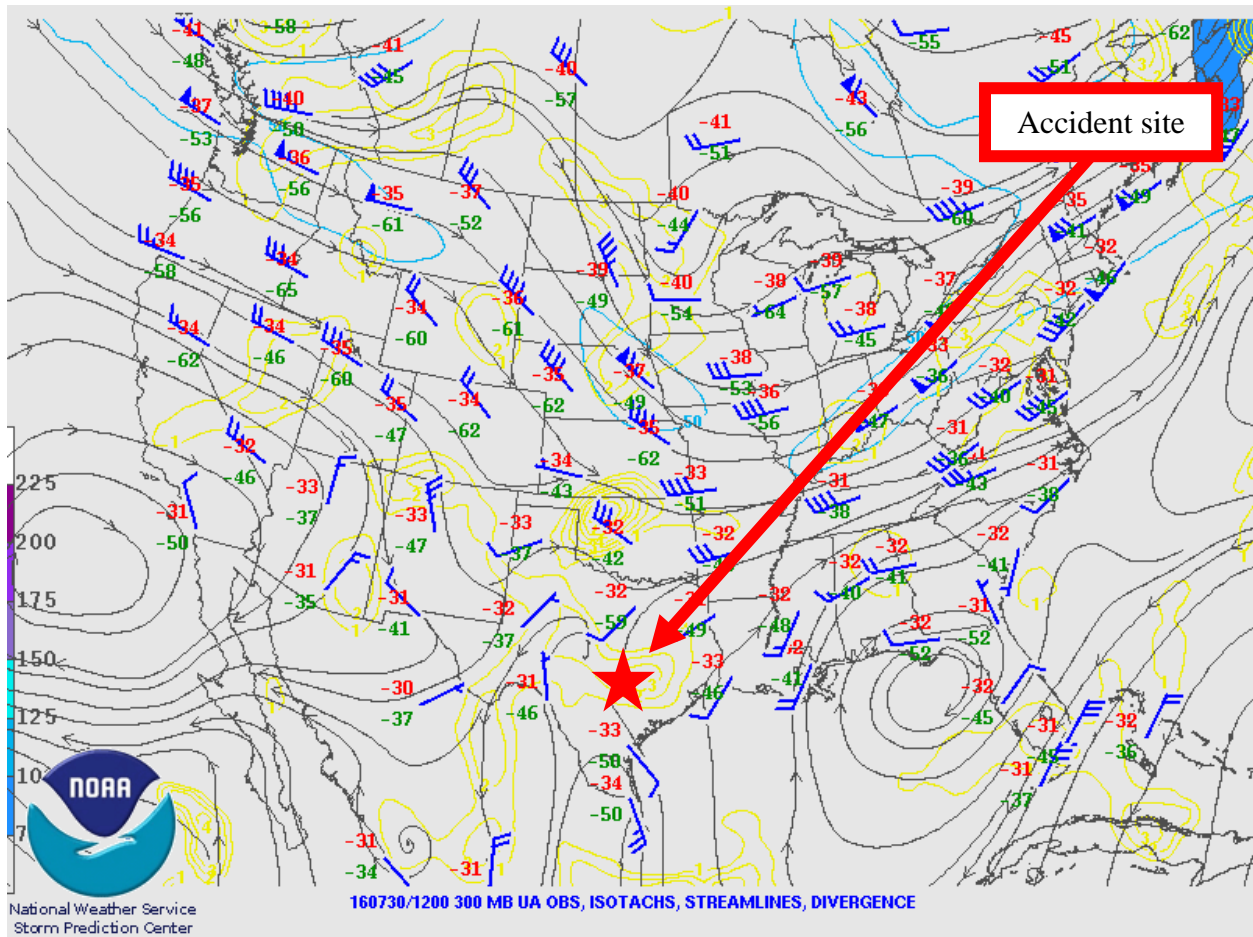


Figure 6 – 300-hPa Constant Pressure Chart for 0700 CDT

2.0 Storm Prediction Center Products

SPC issued the following Day 1 Convective Outlook at 0727 CDT (figure 7) with areas of general (non-severe) thunderstorms forecast for much of the United States (including the accident area), with the general thunderstorms forecast to occur during the afternoon of the accident day. The Day 1 Convective Outlook was as follows:

SPC AC 301227

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0727 AM CDT SAT JUL 30 2016

VALID 301300Z - 311200Z

...THERE IS A SLGT RISK OF SVR TSTMS THIS AFTERNOON INTO EARLY TONIGHT NEAR THE BLACK HILLS IN SD...

...THERE IS A MRGL RISK OF SVR TSTMS FROM ERN WY TO CENTRAL NEB/NRN KS THROUGH TONIGHT...

...THERE IS A MRGL RISK OF SVR TSTMS THIS AFTERNOON FOR CENTRAL VA

AND VICINITY...

...SUMMARY...

ISOLATED STRONG TO LOCALLY SEVERE THUNDERSTORMS ARE POSSIBLE FROM NEAR THE BLACK HILLS INTO THE CENTRAL HIGH PLAINS AND MID-ATLANTIC REGION THIS AFTERNOON AND EVENING. A FEW STRONG STORMS ARE POSSIBLE LATE TONIGHT OVER THE CENTRAL PLAINS.

...SYNOPSIS...

A MIDLEVEL TROUGH WILL PROGRESS SEWD OVER BC TO WA AND THE NRN ROCKIES BY THE END OF THE PERIOD. DOWNSTREAM...WEAK SHORTWAVE RIDGING IS EXPECTED OVER THE NRN HIGH PLAINS...WITH A TROUGH OVER THE OH VALLEY. A DIFFUSE SURFACE CYCLONE INVOF OH WILL ACCOMPANY THE MIDLEVEL TROUGH...AND A WEAK SURFACE FRONT WILL EXTEND WWD FROM THE OH VALLEY TO THE OZARK PLATEAU AND CENTRAL PLAINS. A FEW STRONG THUNDERSTORMS WITH GUSTY OUTFLOW WINDS WILL BE POSSIBLE THIS AFTERNOON IN THE WARM SECTOR AHEAD OF THE WEAK FRONT FROM PARTS OF THE UPPER OH VALLEY TO VA. STORMS SHOULD FORM OVER THE HIGH TERRAIN THIS AFTERNOON AND SPREAD EWD INTO VA...WHERE MLCAPE OF 1000-1500 J/KG AND EFFECTIVE BULK SHEAR AROUND 30 KT COULD SUPPORT ORGANIZED MULTICELL CLUSTERS CAPABLE OF PRODUCING ISOLATED DOWNBURSTS.

...CENTRAL PLAINS THROUGH TONIGHT...

LOW-LEVEL SELY FLOW AND A WEAK WAA REGIME WILL BE MAINTAINED THROUGH TONIGHT TO THE N OF THE SOMEWHAT DIFFUSE FRONT ACROSS KS. BOUNDARY LAYER DEWPOINTS IN THE MID 50S-LOW 60S BENEATH A PLUME OF STEEP MIDLEVEL LAPSE RATES WILL CONTRIBUTE TO MLCAPE OF 1500-2500 J/KG THIS AFTERNOON INVOF THE BLACK HILLS...AS SURFACE TEMPERATURES WARM WELL INTO THE 80S. A FEW STORMS ARE EXPECTED TO FORM OVER THE BLACK HILLS LATE AFTERNOON AND SUBSEQUENTLY SPREAD TO THE SE. DEEP-LAYER VERTICAL SHEAR WILL BE SUFFICIENT FOR SUPERCELLS...WITH LARGE HAIL THE PRIMARY RISK.

FARTHER E...STORM INITIATION IS A BIT LESS CERTAIN. THE ONGOING WAA STORMS ACROSS CENTRAL NEB SHOULD WEAKEN BY MIDDAY-EARLY AFTERNOON...WHILE OTHER WAA STORMS MAY FORM AGAIN TONIGHT. SURFACE-BASED CONVECTION THIS AFTERNOON MAY OCCUR ON LINGERING BOUNDARIES FROM THE MORNING CONVECTION...THOUGH CONFIDENCE IS LOW. ISOLATED LARGE HAIL WILL BE POSSIBLE WITH ANY SURFACE-BASED STORMS THAT MANAGE TO FORM THIS AFTERNOON...AND WITH THE ADDITIONAL STORMS TONIGHT.

..THOMPSON/LEITMAN.. 07/30/2016

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 1630Z

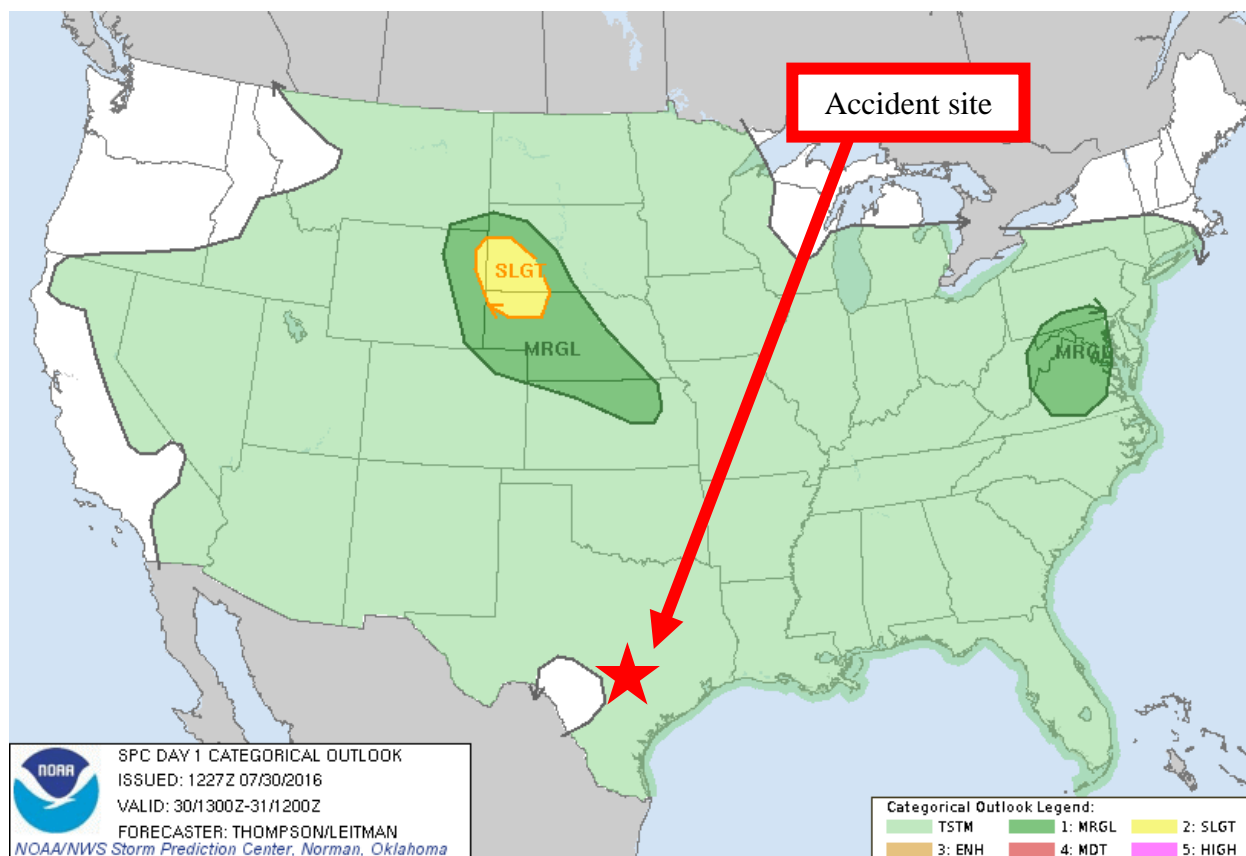


Figure 7 – Storm Prediction Center day 1 Convective Outlook valid at the time of the accident

3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 8 is a local sectional map of the region with the accident site and the closest weather reporting locations marked.

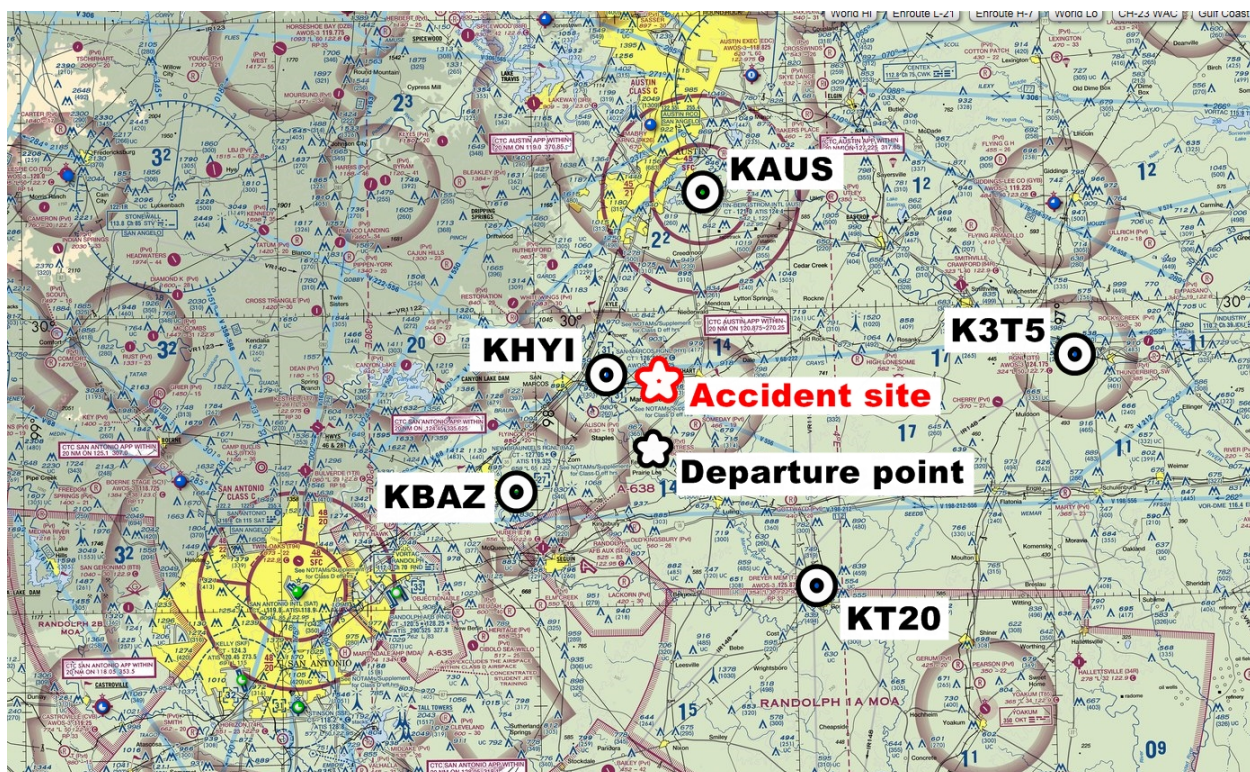


Figure 8 – Sectional chart of Texas with the location of the accident site and surface observation sites

San Marcos Regional Airport (KHYI) was the closest official weather station to the accident site located 31 miles south of Austin, Texas. KHYI had an Automated Weather Observing System (AWOS³) whose reports were supplemented by air traffic control when the air traffic control tower was in operation (which was the case at the accident time). KHYI was located 5 miles west of the accident site, at an elevation of 595 feet, and had a 7° easterly magnetic variation⁴ (figure 8). The following observations were taken and disseminated during the times surrounding the accident:⁵

[0455 CDT] KHYI 300955Z 0000KT 10SM SCT011 23/22 A3004 RMK AO1=

[0515 CDT] KHYI 301015Z 16003KT 10SM SCT011 SCT019 23/23 A3004 RMK AO1=

[0535 CDT] KHYI 301035Z 16003KT 8SM CLR 23/22 A3004 RMK AO1=

[0555 CDT] KHYI 301055Z 0000KT 4SM CLR 22/22 A3004 RMK AO1=

³ AWOS – Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to twelve thousand feet, and altimeter setting.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north.

⁵ The bold sections in this NWS product and the rest of products in the weather factual report are to highlight the individual sections that directly reference the weather conditions that affected, the accident location around the accident time. The local times in section 3.0 next to the METARs are provided for quick reference between UTC and local times around the accident time.

[0615 CDT] KHYI 301115Z 14003KT 3SM CLR 22/22 A3004 RMK AO1=

[0635 CDT] KHYI 301135Z 14003KT 5SM FEW007 22/22 A3005 RMK AO1=

[0646 CDT] KHYI 301146Z 16004KT 2SM BR BKN007 23/23 A3005 RMK FIRST=

ACCIDENT TIME 0742 CDT

[0747 CDT] KHYI 301247Z 18004KT 2SM BR OVC003 24/23 A3006=

[0847 CDT] KHYI 301347Z 21005KT 4SM BR BKN005 26/24 A3007=

[0938 CDT] KHYI 301438Z 22010KT 5SM BR SCT010 BKN024 28/24 A3007=

[0946 CDT] KHYI 301446Z 23010G15KT 5SM BR SCT018 BKN026 28/24 A3008=

[1049 CDT] KHYI 301549Z 22011KT 10SM FEW022 SCT028 BKN041 29/23 A3007=

KHYI weather at 0635 CDT was reported as wind from 140° at 3 knots, 5 miles visibility, few clouds at 700 feet above ground level (agl), temperature of 22° C, dew point temperature of 22° C, and an altimeter setting of 30.05 inches of mercury. Remarks, automated station without precipitation discriminator.

KHYI weather at 0646 CDT was reported as wind from 160° at 4 knots, 2 miles visibility, mist, a broken ceiling at 700 feet agl, temperature of 23° C, dew point temperature of 23° C, and an altimeter setting of 30.05 inches of mercury. Remarks, first observation (taken by KHYI air traffic control).

KHYI weather at 0747 CDT was reported as wind from 180° at 4 knots, 2 miles visibility, mist, an overcast ceiling at 300 feet agl, temperature of 24° C, dew point temperature of 23° C, and an altimeter setting of 30.06 inches of mercury.

KHYI weather at 0847 CDT was reported as wind from 210° at 5 knots, 4 miles visibility, mist, a broken ceiling at 500 feet agl, temperature of 26° C, dew point temperature of 24° C, and an altimeter setting of 30.07 inches of mercury.

New Braunfels Regional Airport (KBAZ) was the next closest official weather station to the accident site located 4 miles east of New Braunfels, Texas. KBAZ had an Automated Surface Observing System (ASOS⁶) whose reports were supplemented air traffic control. KBAZ was 18 miles southwest of the accident site, at an elevation of 658 feet, and had a 8° easterly magnetic variation (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

⁶ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

[0551 CDT] KBAZ 301051Z AUTO 12003KT CLR 23/23 A3000 RMK AO2 SLP149
T02330228 \$=

[0612 CDT] KBAZ 301112Z AUTO 13003KT FEW008 23/23 A3001 RMK AO2
T02330228 \$=

[0643 CDT] KBAZ 301143Z AUTO 16003KT FEW007 BKN012 BKN018 23/23
A3002 RMK AO2 T02330228 \$=

[0651 CDT] KBAZ 301151Z 13004KT 4SM BR SCT007 BKN012 BKN018 23/23
A3002 RMK AO2 SLP154 T02330228 10261 20228 53004 \$=

***[0658 CDT] KBAZ 301158Z 00000KT 4SM BR SCT005 BKN015 24/23 A3001
RMK AO2 T02390228 \$=***

***[0709 CDT] KBAZ 301209Z 00000KT 4SM BR BKN004 BKN010 BKN015 23/23
A3001 RMK AO2 T02330228 \$=***

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***[0746 CDT] KBAZ 301246Z 00000KT 4SM BR FEW003 OVC010 24/23 A3002
RMK AO2 \$=***

***[0751 CDT] KBAZ 301251Z 00000KT 4SM BR FEW003 OVC010 24/24 A3002
RMK AO2 SLP158 T02440239 \$=***

[0758 CDT] KBAZ 301258Z 00000KT BR OVC003 25/24 A3002 RMK AO2
T02500239 \$=

[0851 CDT] KBAZ 301351Z 21007KT 7SM OVC005 26/25 A3004 RMK AO2
CIG 003V009 SLP163 T02610250 \$=

[0858 CDT] KBAZ 301358Z 22008KT 7SM OVC007 26/24 A3004 RMK AO2
CIG 003V009 T02610244 \$=

KBAZ weather at 0658 CDT was reported as wind calm, 4 miles visibility, mist, scattered clouds at 500 feet agl, a broken ceiling at 1,500 agl, temperature of 24° C, dew point temperature of 23° C, and an altimeter setting of 30.01 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 23.9° C, dew point temperature 22.8° C, maintenance needed on the system.

KBAZ weather at 0709 CDT was reported as wind calm, 4 miles visibility, mist, a broken ceiling at 400 feet agl, broken skies at 1,000 agl, broken skies at 1,500 feet agl, temperature of 23° C, dew point temperature of 23° C, and an altimeter setting of 30.01 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 23.3° C, dew point temperature 22.8° C, maintenance needed on the system.

KBAZ weather at 0746 CDT was reported as wind calm, 4 miles visibility, mist, few clouds at 300 feet agl, an overcast ceiling at 1,000 agl, temperature of 24° C, dew point temperature of 23° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, maintenance needed on the system.

KBAZ weather at 0751 CDT was reported as wind calm, 4 miles visibility, mist, few clouds at 300 feet agl, an overcast ceiling at 1,000 agl, temperature of 24° C, dew point temperature of 24° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, sea level pressure at 1015.8 hPa, temperature 24.4° C, dew point temperature 23.9° C, maintenance needed on the system.

Austin-Bergstrom International Airport (KAUS) was located 5 miles southeast of Austin, Texas. KAUS had an ASOS whose reports were supplemented air traffic control. KAUS was 19 miles north-northeast of the accident site, at an elevation of 542 feet, and had a 6° easterly magnetic variation (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[0353 CDT] KAUS 300853Z 00000KT 10SM FEW015 24/23 A3000 RMK AO2
SLP148 T02390233 58007=

[0453 CDT] KAUS 300953Z 00000KT 10SM SCT019 24/23 A3001 RMK AO2
SLP150 T02390233=

[0553 CDT] KAUS 301053Z 17003KT 10SM SCT013 23/23 A3001 RMK AO2
SLP152 T02330228=

[0653 CDT] KAUS 301153Z 22003KT 5SM BR FEW010 FEW120 23/23 A3001
RMK AO2 SLP151 T02330228 10256 20228 50003=

***[0728 CDT] KAUS 301228Z 18003KT 5SM BR SCT008 SCT120 24/23 A3002
RMK AO2 T02390233=***

***[0735 CDT] KAUS 301235Z 00000KT 6SM BR BKN009 24/24 A3002 RMK
AO2 T02390239=***

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***[0753 CDT] KAUS 301253Z 20004KT 6SM BR BKN009 BKN014 BKN250 24/24
A3003 RMK AO2 SLP156 T02440239=***

***[0810 CDT] KAUS 301310Z 19003KT 7SM FEW009 FEW015 25/24 A3003
RMK AO2 T02500244=***

[0821 CDT] KAUS 301321Z 22004KT 8SM BKN007 BKN014 26/25 A3004
RMK AO2 T02610250=

[0853 CDT] KAUS 301353Z 20007KT 10SM FEW010 SCT020 27/25 A3004
RMK AO2 SLP162 T02670250=

[0936 CDT] KAUS 301436Z 22011KT 10SM BKN016 BKN022 27/23 A3005
RMK AO2 T02720233=

KAUS weather at 0728 CDT was reported as wind from 180° at 3 knots, 5 miles visibility, mist, scattered clouds at 800 feet agl, scattered clouds at 12,000 feet agl, temperature of 24° C, dew point temperature of 23° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 23.9° C, dew point temperature 23.3° C.

KAUS weather at 0735 CDT was reported as wind calm, 6 miles visibility, mist, a broken ceiling at 900 feet agl, temperature of 24° C, dew point temperature of 24° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 23.9° C, dew point temperature 23.9° C.

KAUS weather at 0753 CDT was reported as wind from 200° at 4 knots, 6 miles visibility, mist, a broken ceiling at 900 feet agl, broken skies at 1,400 feet agl, broken skies at 24,000 feet agl, temperature of 24° C, dew point temperature of 24° C, and an altimeter setting of 30.03 inches of mercury. Remarks, automated station with precipitation discriminator, sea level pressure 1015.6 hPa, temperature 24.4° C, dew point temperature 23.9° C.

KAUS weather at 0810 CDT was reported as wind from 190° at 3 knots, 7 miles visibility, few clouds at 900 feet agl, few clouds at 1,500 feet agl, temperature of 25° C, dew point temperature of 24° C, and an altimeter setting of 30.03 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 25.0° C, dew point temperature 24.4° C.

Roger M Dreyer Memorial Airport (KT20) was located 2 miles northwest of Gonzales, Texas, and had an AWOS whose reports were not supplemented. KT20 was located 26 miles southeast of the accident site, at an elevation of 354 feet, and had a 7° easterly magnetic variation (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[0555 CDT] KT20 301055Z AUTO 00000KT 7SM OVC015 24/24 A3001 RMK
AO2 T02420242=

[0615 CDT] KT20 301115Z AUTO 10003KT 7SM BKN011 24/24 A3001 RMK
AO2 T02430243=

[0635 CDT] KT20 301135Z AUTO 00000KT 7SM SCT011 24/24 A3002 RMK
AO2 T02430243=

[0655 CDT] KT20 301155Z AUTO 00000KT 5SM BR BKN009 24/24 A3002
RMK AO2 T02410241 10261 20238=

***[0715 CDT] KT20 301215Z AUTO 00000KT 4SM BR OVC009 24/24 A3002
RMK AO2 T02380238=***

***[0735 CDT] KT20 301235Z AUTO 13003KT 7SM OVC011 25/25 A3002 RMK
AO2 T02470247=***

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***[0755 CDT] KT20 301255Z AUTO 15003KT 7SM BKN011 26/26 A3002 RMK
AO2 T02550255=***

***[0815 CDT] KT20 301315Z AUTO 16003KT 10SM SCT011 26/26 A3002 RMK
AO2 T02620262=***

***[0835 CDT] KT20 301335Z AUTO 16004KT 10SM CLR 27/27 A3003 RMK
AO2 T02710270=***

***[0855 CDT] KT20 301355Z AUTO 18006KT 10SM SCT008 28/27 A3003 RMK
AO2 T02800266=***

***[0915 CDT] KT20 301415Z AUTO 20007KT 10SM SCT010 BKN014 29/26
A3004 RMK AO2 T02860263=***

KT20 weather at 0715 CDT was reported as wind calm, 4 miles visibility, mist, an overcast ceiling at 900 feet agl, temperature of 24° C, dew point temperature of 24° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 23.8° C, dew point temperature 23.8° C.

KT20 weather at 0735 CDT was reported as wind from 130° at 3 knots, 7 miles visibility, an overcast ceiling at 1,100 feet agl, temperature of 25° C, dew point temperature of 25° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 24.7° C, dew point temperature 24.7° C.

KT20 weather at 0755 CDT was reported as wind from 150° at 3 knots, 7 miles visibility, a broken ceiling at 1,100 feet agl, temperature of 26° C, dew point temperature of 26° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 25.5° C, dew point temperature 25.5° C.

KT20 weather at 0815 CDT was reported as wind from 160° at 3 knots, 10 miles visibility, scattered clouds at 1,100 feet agl, temperature of 26° C, dew point temperature of 26° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature 26.2° C, dew point temperature 26.2° C.

Fayette Regional Air Center Airport (K3T5) was located 2 miles west of La Grange, Texas, and had an AWOS whose reports were not supplemented. K3T5 had ceilometer equipment but it was not operational at the time of the accident. K3T5 was located 42 miles east of the accident site, at an elevation of 324 feet, and had a 6° easterly magnetic variation (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[0550 CDT] K3T5 301050Z AUTO 00000KT 1 1/4SM BR 25/24 A3000 RMK
AO2 T02470244=

[0610 CDT] K3T5 301110Z AUTO 00000KT 1 1/2SM BR 25/24 A3000 RMK
AO2 T02460242=

[0630 CDT] K3T5 301130Z AUTO 00000KT 1 1/4SM BR 25/24 A2999 RMK
AO2 T02470243=

[0650 CDT] K3T5 301150Z AUTO 00000KT 3/4SM BR 25/24 A3000 RMK
AO2 T02460241 10267 20245=

**[0710 CDT] K3T5 301210Z AUTO 20003KT 1/4SM FG 25/24 A3000 RMK
AO2 T02460241=**

**[0730 CDT] K3T5 301230Z AUTO 00000KT 1/4SM FG 25/25 A3001 RMK
AO2 T02490245=**

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**[0750 CDT] K3T5 301250Z AUTO 00000KT 1SM BR 25/25 A3001 RMK AO2
T02500245=**

**[0810 CDT] K3T5 301310Z AUTO 00000KT 1SM BR 26/25 A3002 RMK AO2
T02600253=**

[0830 CDT] K3T5 301330Z AUTO 18004KT 7SM 27/26 A3001 RMK AO2 T02680256=

[0850 CDT] K3T5 301350Z AUTO 19004KT 7SM 28/26 A3002 RMK AO2 T02790258=

[0910 CDT] K3T5 301410Z AUTO 24004KT 7SM 29/26 A3002 RMK AO2 T02850259=

K3T5 weather at 0710 CDT was reported as wind from 200° at 3 knots, a quarter mile visibility, fog, temperature of 25° C, dew point temperature of 24° C, and an altimeter setting of 30.00 inches of mercury. Remarks, automated station with precipitation discriminator, temperature of 24.6° C, dew point temperature of 24.1° C.

K3T5 weather at 0730 CDT was reported as wind calm, a quarter mile visibility, fog, temperature of 25° C, dew point temperature of 25° C, and an altimeter setting of 30.01 inches of mercury. Remarks, automated station with precipitation discriminator, temperature of 24.9° C, dew point temperature of 24.5° C.

K3T5 weather at 0750 CDT was reported as wind calm, 1 mile visibility, mist, temperature of 25° C, dew point temperature of 25° C, and an altimeter setting of 30.01 inches of mercury. Remarks, automated station with precipitation discriminator, temperature of 25.0° C, dew point temperature of 24.5° C.

K3T5 weather at 0810 CDT was reported as wind calm, 1 mile visibility, mist, temperature of 26° C, dew point temperature of 25° C, and an altimeter setting of 30.02 inches of mercury. Remarks, automated station with precipitation discriminator, temperature of 26.0° C, dew point temperature of 25.3° C.

Below is a summary of the weather conditions at the closest weather observation points to the accident site, with the times in sequence from the time the accident pilot received a Lockheed Martin Flight Service (LMFS, section 14.0) weather briefing at 0506 CDT, the time the accident flight departed at 0658 CDT, and the time the accident happened at 0742 CDT. At each of the times, the weather observation points are marked for general flight categories of IFR⁷, LIFR⁸, MVFR⁹, or VFR¹⁰ at the surface:

Weather at 0506 CDT:

KHYI was VFR
KBAZ was VFR
KAUS was VFR
KT20 was MVFR
K3T5 was IFR

Weather at 0658 CDT:

KHYI was IFR
KBAZ was MVFR
KAUS was MVFR
KT20 was IFR
K3T5 was LIFR

⁷ Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

⁸ Low Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. LIFR criteria means a ceiling below 500 feet agl and/or less than 1 miles visibility.

⁹ Marginal Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. MVFR criteria means a ceiling between 1,000 and 3,000 feet agl and/or 3 to 5 miles visibility.

¹⁰ Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 5 miles visibility.

Weather at 0742 CDT

KHYI was IFR
KBAZ was LIFR
KAUS was IFR
KT20 was MVFR
K3T5 was LIFR

4.0 Upper Air Data

A North American Mesoscale (NAM) model sounding was created for the accident site for 0800 CDT. The 0800 CDT NAM sounding was plotted on a standard Skew-T log P diagram¹¹ with the derived stability parameters included in figure 9 (with data from the surface to 700-hPa, or 10,000 feet msl.) This data was analyzed utilizing the RAOB¹² software package. The sounding depicted the Lifted Condensation Level (LCL)¹³ at 1,171 feet msl, a Convective Condensation Level (CCL)¹⁴ of 4,709 feet, and a Level of Free Convection (LFC)¹⁵ at 1,255 feet. The freezing level was located above 10,000 feet. The precipitable water value was 1.32 inches.

¹¹ 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.

¹² RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹³ Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹⁴ Convective Condensation Level (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.

¹⁵ Level of Free Convection (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.



The sounding wind profile indicated there was a forecast surface wind from 196° at 3 knots and the wind remained out of the south to southwest under 15 knots below 10,000 feet msl. The 3 knot surface wind increased to 8 knots from 209° by 1,230 feet msl, with the wind continue to increase to 10 knots from 210° by 1,460 feet msl. Between 1,460 feet and 4,849 feet the wind remained between 10 and 15 knots from 210° to 217°. Low-level wind shear was indicated by RAOB to be at a light to moderate strength in the lowest 2,000 feet agl due to the increase in wind speed. Two layers of possible clear-air turbulence were identified by RAOB from the surface through 2,000 feet.

DCA16MA204

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 13 (GOES-13) was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the NTSB's Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-13 bands 1 and 4, respectively) at a wavelength of 0.65 microns (μm) and 10.7 μm , respectively, retrieved brightness temperatures for the scene. Satellite imagery surrounding the time of the accident, from 0600 CDT through 1100 CDT at approximately 15-minute intervals, were reviewed and the images most applicable to the time of the accident are documented here.

Figures 10, 11, and 12 present the GOES-13 visible imagery from 0745, 0800, and 0830 CDT at 3X magnification with the accident site highlighted with a red square. Attachment 1 provides a visible animation from 0715 through 1015 CDT with the accident site marked with a red square. Inspection of the visible imagery indicated cloud cover over the accident site at the accident time with the cloud cover moving from southwest to northeast. The cloud cover around the accident site had decreased in areal coverage by 1015 CDT (attachment 1). Figure 13 presents the GOES-13 infrared imagery from 0745 CDT at 6X magnification with the accident site highlighted with a red square. The infrared imagery indicated colder brightness temperatures to the northwest and southeast of the accident site (red and yellow colors). Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 0800 CDT NAM sounding, the approximate cloud-top heights over the accident site were 3,500 feet at 0745 CDT. Inversions are known to cause difficulty in correctly identifying cloud tops based on satellite brightness temperatures (section 4.0). It should be noted these figures have not been corrected for any parallax error.

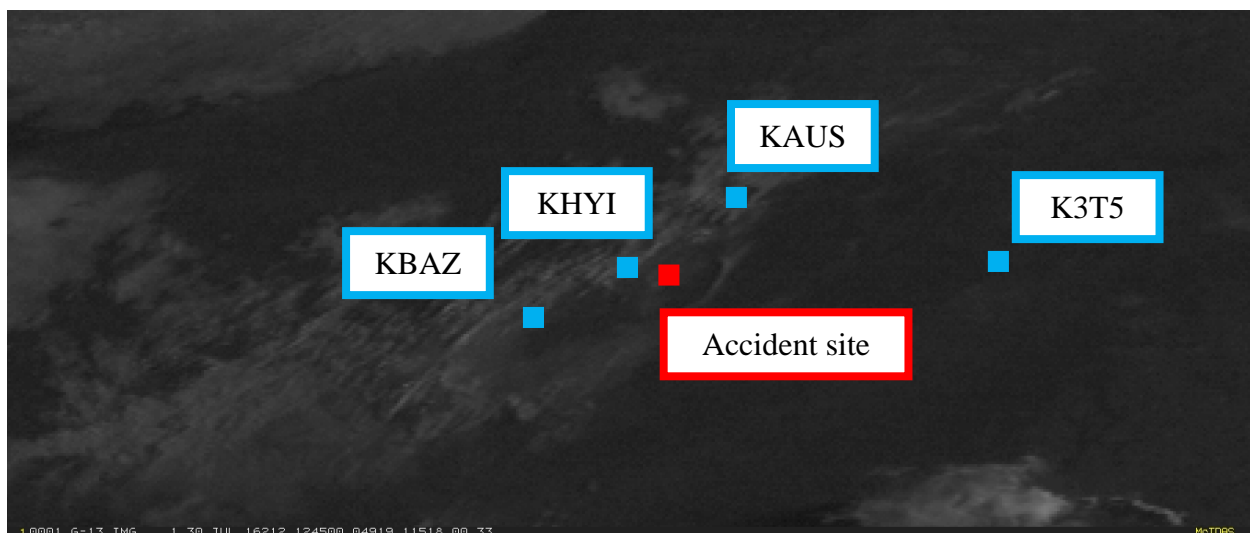


Figure 10 – GOES-13 visible image at 0745 CDT

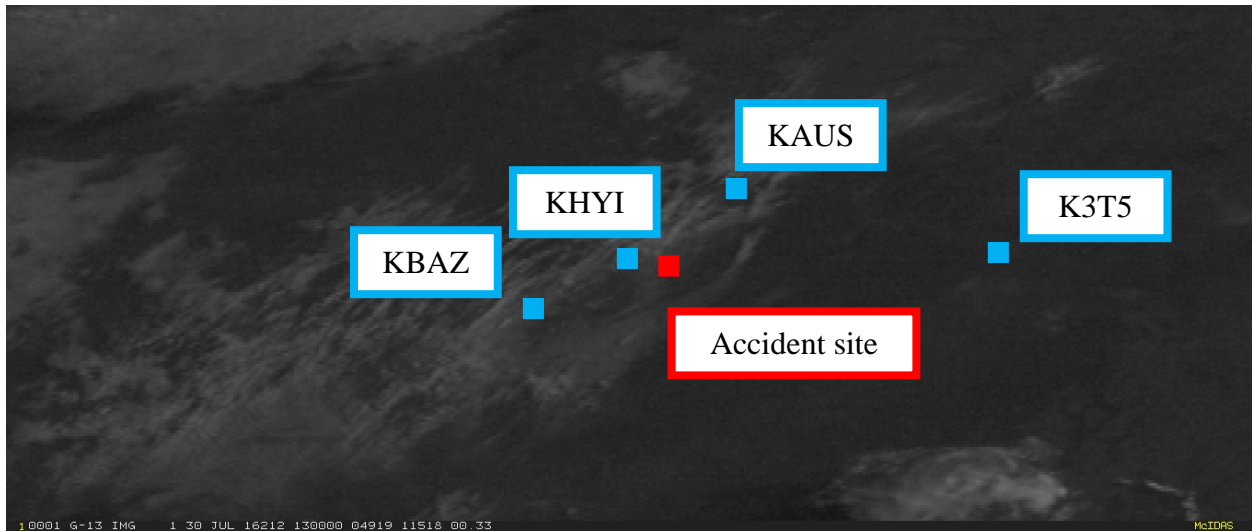


Figure 11 – GOES-13 visible image at 0800 CDT

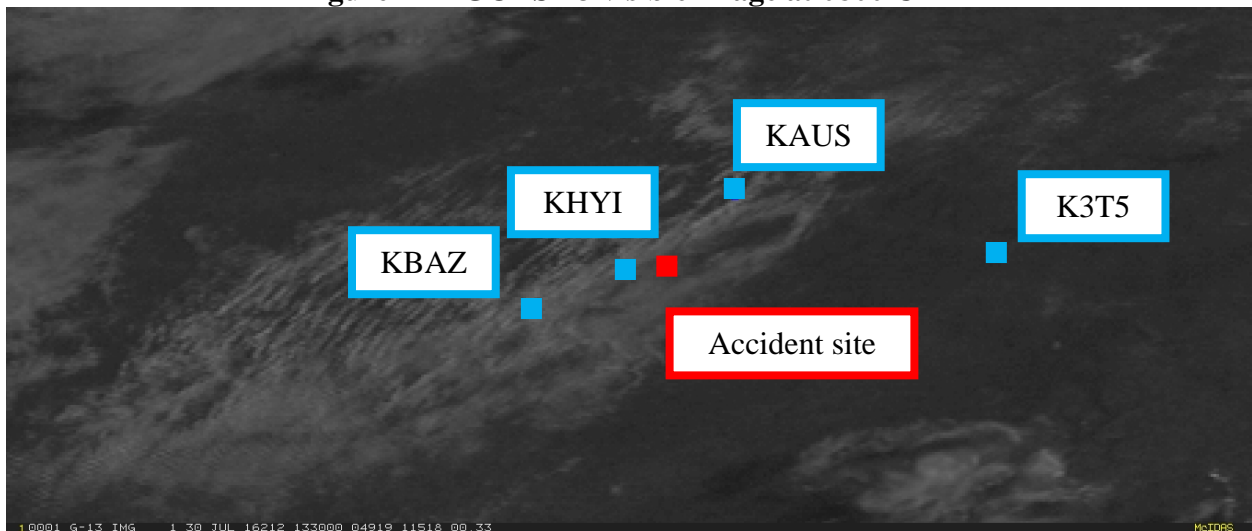


Figure 12 – GOES-13 visible image at 0830 CDT

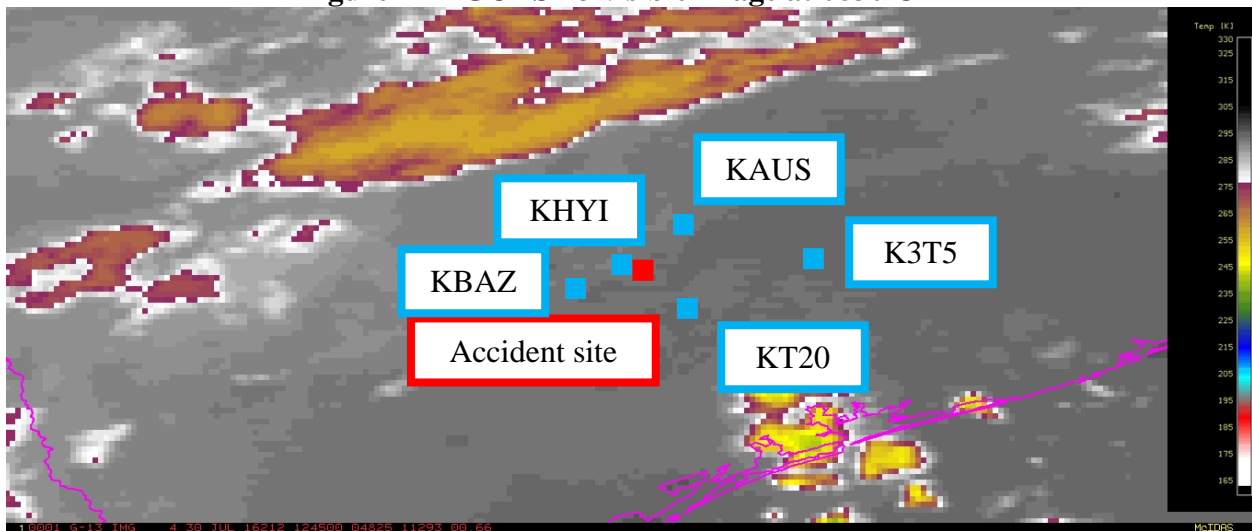


Figure 13 – GOES-13 infrared image at 0745 CDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁷ was Austin/San Antonio, Texas, (KEWX), located 18 southwest of the accident site at an elevation of 633 feet. Level II and III archive radar data was 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 Strategy¹⁸

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 on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the five to ten minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every five minutes. This particular scanning strategy is documented as volume coverage pattern 211 (VCP-211). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten minute period. During the period surrounding the accident, the KEWX WSR-88D radar was operating in the precipitation mode (Mode A, VCP-211). Attachment 2 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.

6.2 Beam Height Calculation

Assuming standard refraction¹⁹ of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width²⁰ information²¹ of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

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.

¹⁸ Contiguous Surveillance (CS)--The low 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)

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

²⁰ Beam width – A measure of the angular width of a radar beam.

²¹ Beamwidth values are shown for legacy resolution products. Super resolution products would an effective beamwidth that would be approximately half these values.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	1,820 feet	930 feet	2,710 feet	1,780 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 930 feet and 2,710 feet msl over the accident site at the accident time and these are the closest altitudes to the ground at the accident site.²²

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²³ 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 (dBZ²⁴), and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C, “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.” From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

- VIP 1 (Level 1, 18-30 dBZ) - Light precipitation
- VIP 2 (Level 2, 30-38 dBZ) - Light to moderate rain.
- VIP 3 (Level 3, 38-44 dBZ) - Moderate to heavy rain.
- VIP 4 (Level 4, 44-50 dBZ) - Heavy rain
- VIP 5 (Level 5, 50-57 dBZ) - Very heavy rain; hail possible.
- VIP 6 (Level 6, >57 dBZ) - Very heavy rain and hail; large hail possible.

²² For more information see the ATC data contained in the docket for this accident.

²³ 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.

²⁴ 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.

6.4 Base Reflectivity and Lightning Data

Figures 14, 15, 16, 17, and 18 present the KEWX WSR-88D base reflectivity images for the 0.5° elevation scan with a resolution of 0.5° X 250 m at 0741, 0745, 0750, 0753, and 0757 CDT, respectively. The reflectivity targets over the accident site at 0741 were below 5 dBZ. Between 0745 and 0757 CDT 10 to 30 dBZ values can be seen moving east-northeastward away from directly over the accident site.²⁵ There were no lightning strikes near the accident site at the accident time.

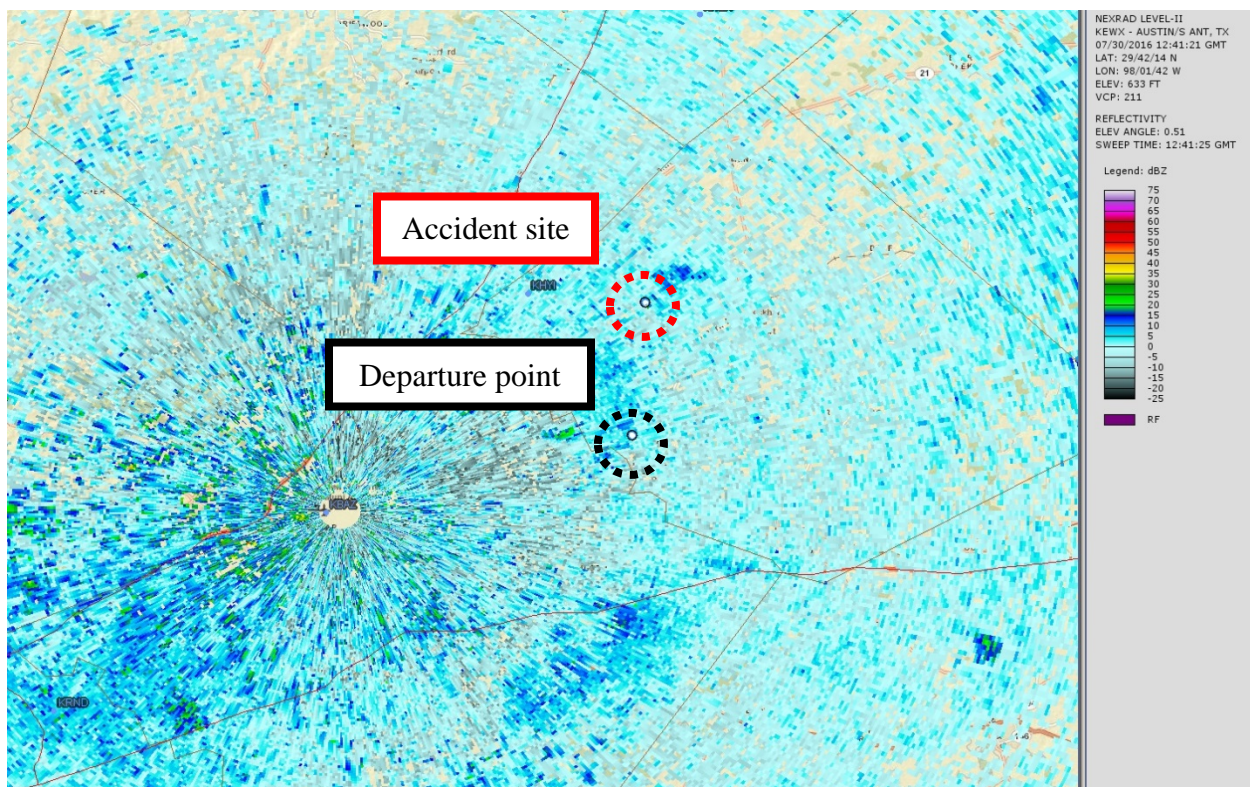


Figure 14 – KEWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0741 CDT with the accident site marked

²⁵ See accident docket for NTSB accidents DCA15MA019 and ERA15FA259A_B for similar WSR-88D patterns.

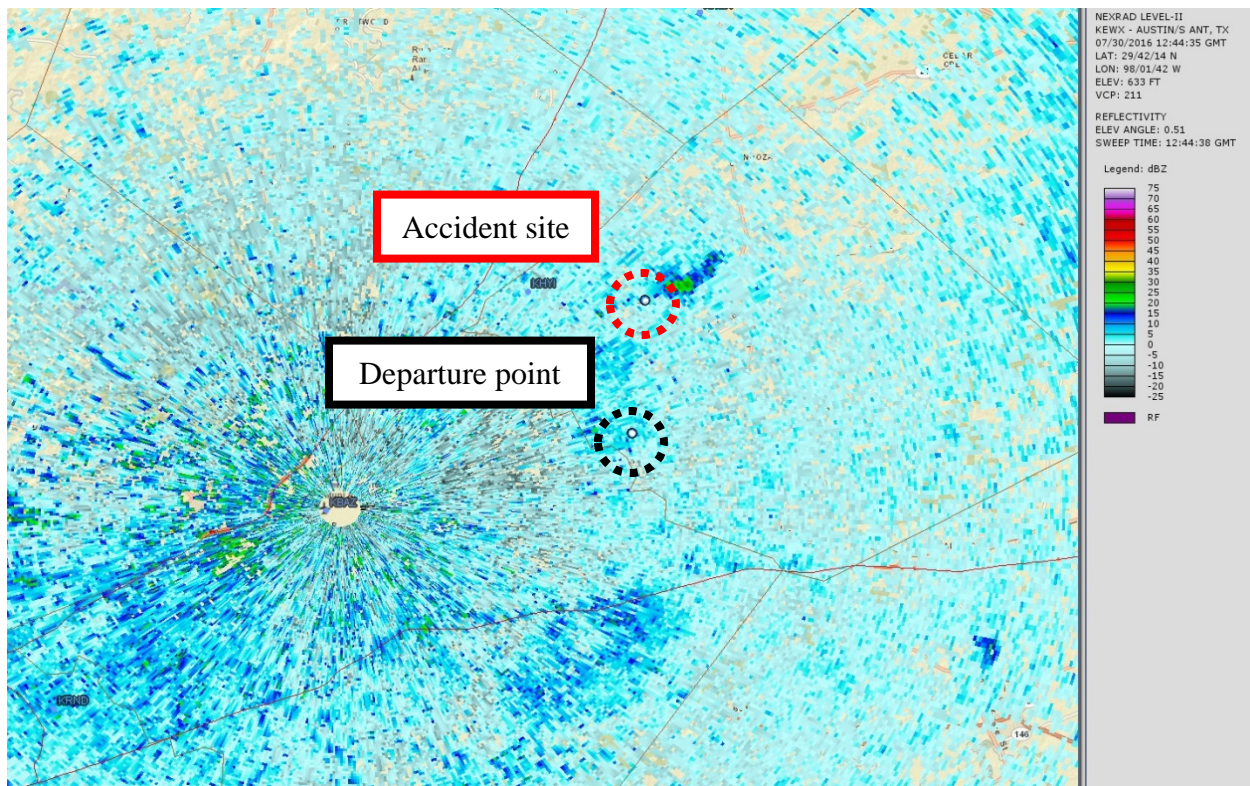


Figure 15 – KEWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0745 CDT with the accident site marked

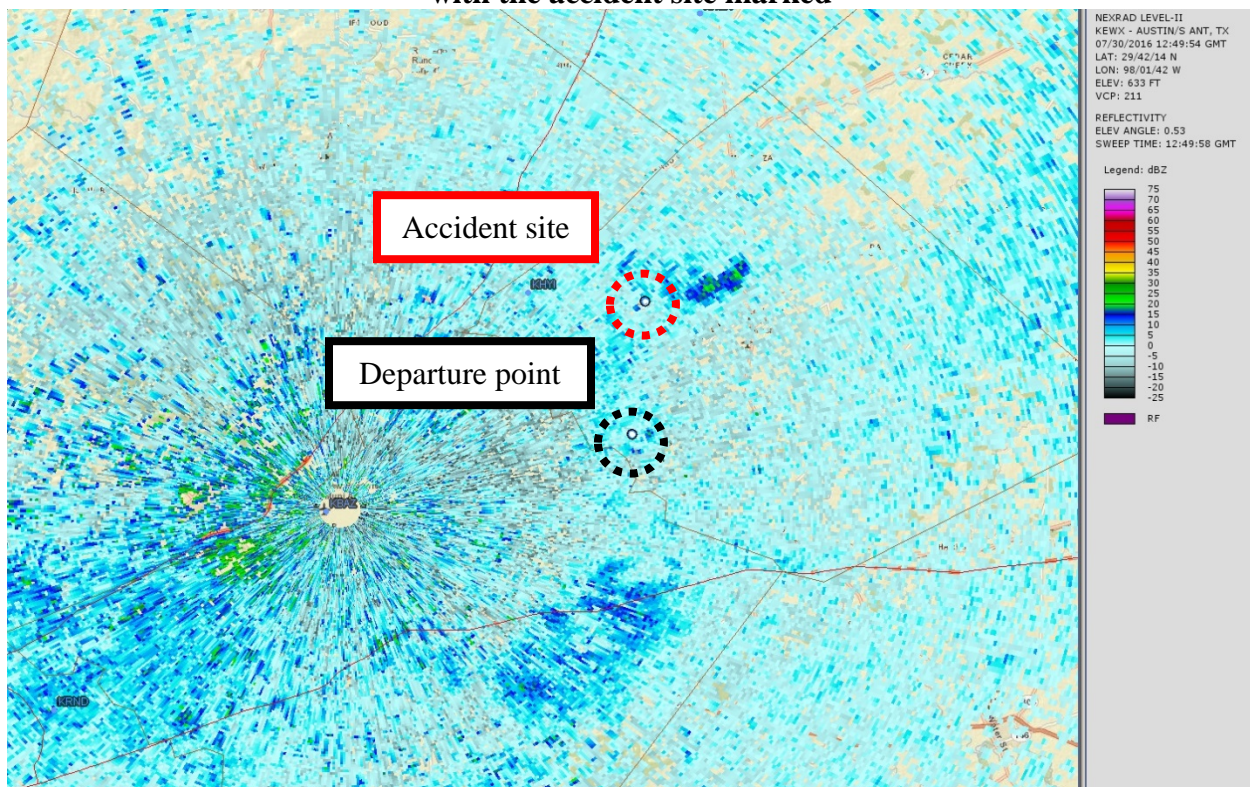


Figure 16 – KEWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0750 CDT with the accident site marked

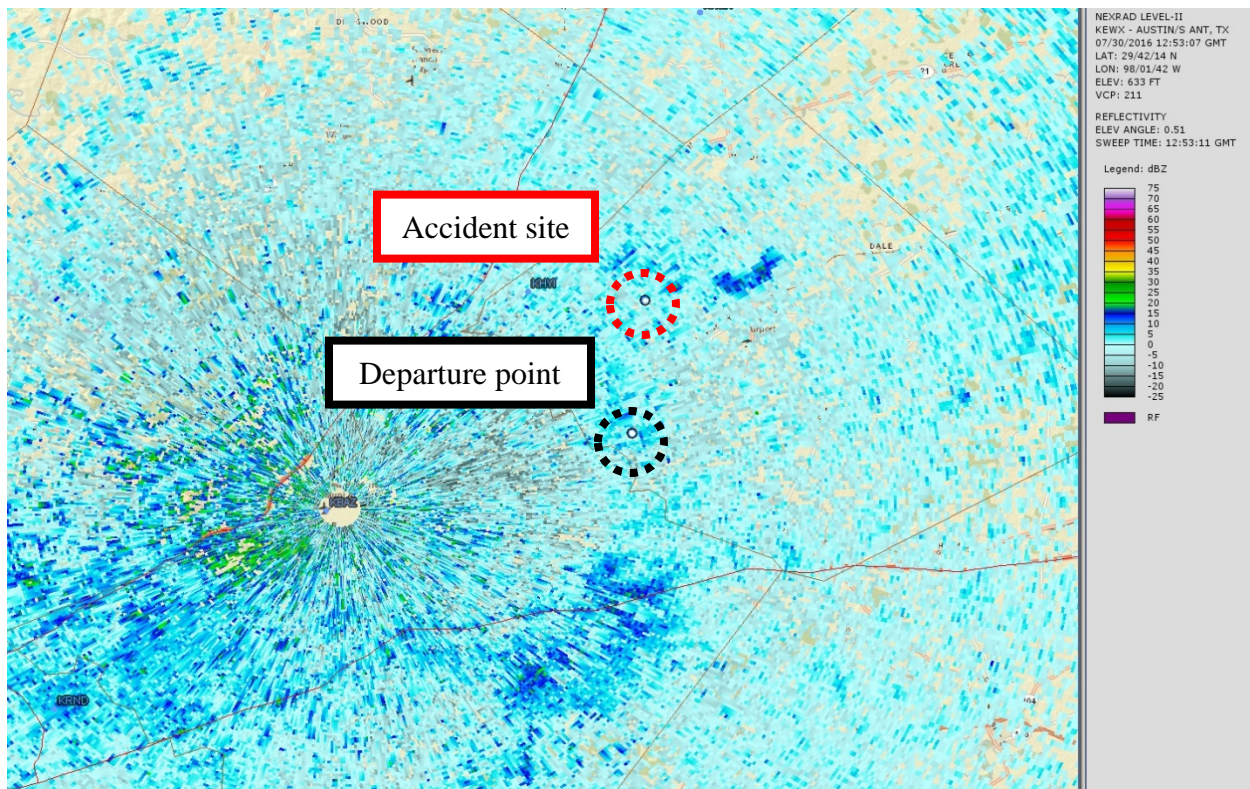


Figure 17 – KEWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0753 CDT with the accident site marked

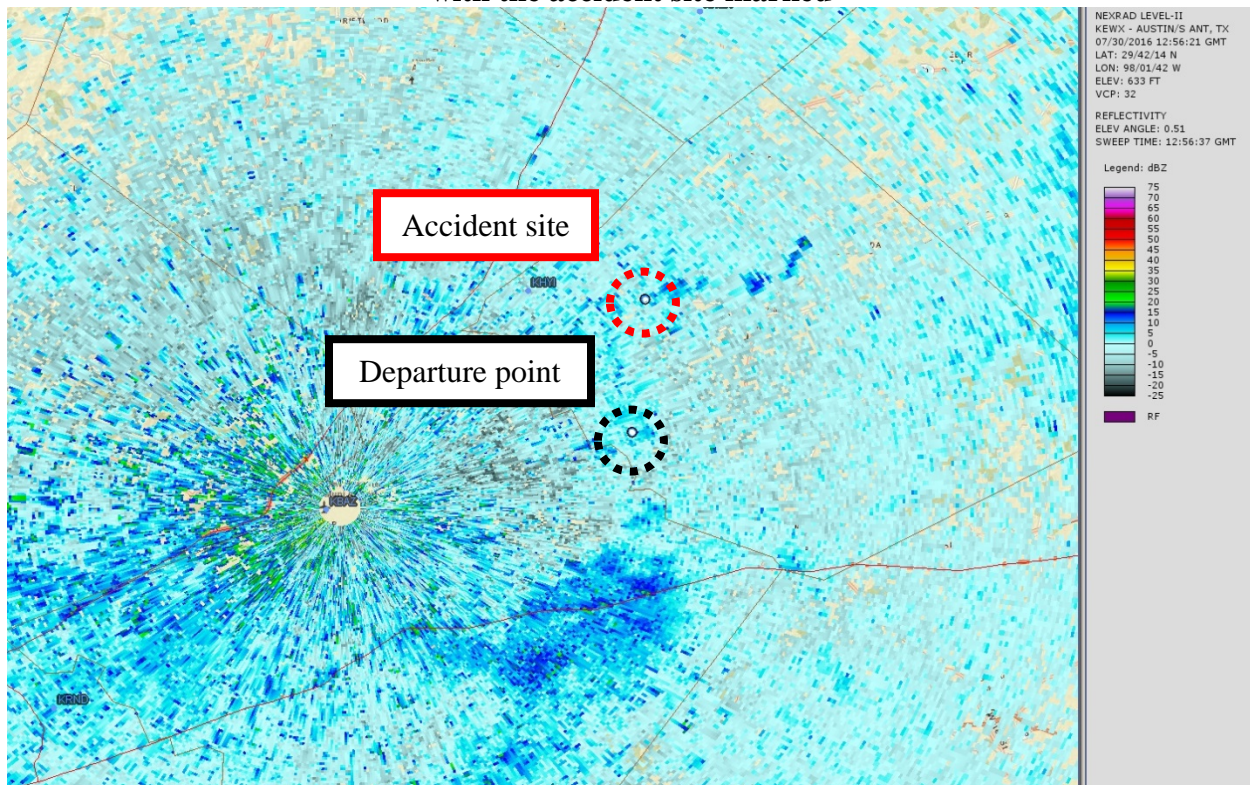


Figure 18 – KEWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0757 CDT with the accident site marked

7.0 Pilot Reports

All pilot reports (PIREPs) close to the accident site from around three hours prior to the accident time to around three hours after the accident time for altitudes below FL200²⁶ are provided below:

SAT UA /OV SAT045003/TM 1300/FL033/TP B737/SK BASES 016BKN TOPS 033BKN CLR ABOVE

ERV UA /OV KERV/TM 1305/FL025/TP C550/RM BASES AWC-WEB/

KCLL UA /OV CLL/TM 1359/FL010/TP C172/SK BKN

KCLL UA /OV CLL/TM 1510/FL020/TP C650/SK BKN/RM BASES 020 TOPS 035 BKN

Routine pilot report (UA); 3 miles from San Antonio, Texas, on the 045° radial; Time – 0800 CDT (1300Z); Altitude – 3,300 pressure feet msl; Type aircraft – Boeing 737; Sky – A broken ceiling with cloud bases at 1,600 pressure feet msl, with broken skies at 3,300 pressure feet msl, and clear skies above.

Routine pilot report (UA); Over Kerrville, Texas; Time – 0805 CDT (1305Z); Altitude – 2,500 pressure feet msl; Type aircraft – Cessna 550 Citation 2; Remarks – Bases.

Routine pilot report (UA); Over College Station, Texas; Time – 0859 CDT (1359Z); Altitude – 1,000 pressure feet msl; Type aircraft – Cessna 172; Sky – Broken.

Routine pilot report (UA); Over College Station, Texas; Time – 1010 CDT (1510Z); Altitude – 2,000 pressure feet msl; Type aircraft – Cessna Citation III; Sky – Broken; Remarks – Bases at 2,000 pressure feet msl with broken sky tops at 3,500 pressure feet msl.

8.0 SIGMET and CWSU Advisories

No SIGMET was valid for the accident site at the accident time.

No Center Weather Service Unit (CWSU) Center Weather Advisory (CWA) was valid for the accident site at the accident time.

No CWSU Meteorological Impact Statement (MIS) was valid for the accident site at the accident time.

²⁶ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average 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.

9.0 AIRMETs

No AIRMETs were valid for the accident site at the accident time. In the AIRMET package issued at 2145 CDT on July 29, the text AIRMET outlook area marked the accident site for consideration for an IFR AIRMET for between 0400 and 1000 CDT, but an AIRMET for IFR conditions was never issued in subsequent AIRMET packages.

10.0 Area Forecast

The Area Forecast issued at 0444 CDT was valid at the accident time and forecasted a broken ceiling at 2,500 feet msl with tops at 6,000 feet msl, and isolated light rain showers with tops to FL200. At 0700 CDT, the 2,500 feet msl broken ceiling was forecast to become a 2,000 feet msl scattered cloud layer:

FAUS44 KPCI 300945

FA4W

_DFWC FA 300945

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 310400

CLDS/WX VALID UNTIL 302200...OTLK VALID 302200-310400

OK TX AR TN LA MS AL

.

SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.

TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.

NON MSL HGTS DENOTED BY AGL OR CIG.

.

SYNOPSIS...QSTNRY FNT PNHDL TX-CNTRL OK-W CNTRL AR-NERN AR. SFC

RDG LWR CSTL PLAIN TX-WRN TRANSPECOS TX. 04Z WK WRM FNT SERN

KS/NERN OK BRDR-MO/AR BRDR.

.

OK

PNHDL-WRN...SCT100 SCT-BKN CI. ISOL -TSRA. CB TOP FL450. 15Z SCT

CI. 19Z SCT060. ISOL -TSRA. OTLK...VFR TIL 23Z TSRA.

ERN...SCT090 SCT CI. 17Z BKN050 TOPS FL210. WDLY SCT -TSRA. CB

TOP FL450. OTLK...VFR TIL 01Z TSRA.

.

NWRN TX

WRN...SCT CI. 16Z SCT150. OTLK...VFR.

ERN...BKN090 TOPS FL180. ISOL -TSRA. CB TOP FL450. 13Z SCT090.

OTLK...VFR.

.

SWRN TX

FAR W...SCT150. 18Z BKN090 TOPS FL230. WDLY SCT -TSRA. CB TOP FL440. OTLK...VFR TSRA.

NWRN TRANSPECOS...SKC-SCT CI. OTLK...VFR.

SERN TRANSPECOS...BKN045 TOPS FL240. 13Z SCT060. OTLK...VFR.

.

N CNTRL TX

NWRN...SCT090. ISOL -TSRA. CB TOP FL410. 12Z SCT CI. OTLK...VFR.

NERN...SCT CI. 19Z SCT060. ISOL- TSRA. CB TOP FL450. OTLK...VFR

TIL 00Z TSRA.

SRN...BKN050 TOPS FL220. 14Z SCT CI. OTLK...VFR.

.

NERN TX

SCT-BKN080 TOPS FL200. ISOL -SHRA TOPS FL220. 18Z BKN050 TOPS FL260. WDLY SCT -TSRA. CB TOP FL420. OTLK...VFR TIL 00Z TSRA.

.
SERN TX

NRN...SCT025. 19Z SCT050. OTLK...VFR.

SERN...SKC. VIS 4SM BR. 14Z SCT025. 16Z WDLY SCT -SHRA TOPS 170. 19Z SCT040. OTLK...VFR.

SWRN...SCT025. 19Z BKN040 TOPS 090. WDLY SCT -TSRA. CB TOP FL450. OTLK...VFR TIL 00Z TSRA.

.
S CNTRL TX

NWRN...BKN025 TOPS 070. 16Z SCT050. OTLK...VFR.

NERN...BKN025 TOPS 060. ISOL -SHRA TOPS FL200. 12Z SCT020. 18Z SCT040. ISOL -TSRA. CB TO FL450. OTLK...VFR TIL 00Z TSRA.

SRN...SKC-SCT CI. 14Z SCT040. 19Z ISOL -TSRA. CB TOP FL450. OTLK...VFR TIL 01Z TSRA.

.
AR

NWRN...SCT080 SCT CI. TIL 13Z ISOL -SHRA TOPS 160. 18Z BKN060 TOPS 110. WDLY SCT -TSRA. CB TOP FL440. OTLK...VFR TIL 03Z TSRA.

NERN...SCT070 BKN CI. TIL 13Z VIS 5SM BR. 19Z BKN040 TOPS 110. ISOL -TSRA. CB TOP FL450. OTLK...VFR TIL 01Z TSRA.

SRN...BKN080 TOPS FL240. WDLY SCT -SHRA/ISOL -TSRA. CB TOP FL440. 16Z BKN060. WDLY SCT -TSRA. CB TOP FL450. OTLK...VFR TIL 01Z TSRA.

.
LA

NRN-CNTRL...SCT070 SCT-BKN CI. 14Z ISOL -TSRA. CB TOP FL450. 19Z BKN045 TOPS FL200. WDLY SCT -TSRA. OTLK...VFR TIL 02Z TSRA.

SRN...SCT025. ISOL -SHRA TOPS FL190. 12Z ISOL -TSRA. CB TOP FL450. 17Z BKN030 TOPS FL280. WDLY SCT -TSRA. OTLK...VFR TIL 01Z TSRA.

.
TN

WRN-S MIDDLE...OVC020 TOPS 090. VIS 5SM BR. 13Z SCT040. 17Z BKN040 TOPS 150. 20Z ISOL -TSRA. CB TOP FL450. OTLK...VFR TIL 02Z TSRA.

N MIDDLE-ERN...OVC025 LYRD FL210. VIS 4SM BR. WDLY SCT -SHRA/ISOL -TSRA. CB TOP FL440. 15Z BKN040. WDLY SCT -SHRA. 18Z WDLY SCT -TSRA. CB TOP FL410. OTLK...MVFR CIG TIL 03Z TSRA.

.
MS

NRN...SCT040. ISOL -SHRA TOPS FL210. 17Z BKN040 TOPS FL270. WDLY SCT -TSRA. CB TOP FL440. OTLK...VFR TIL 02Z TSRA.

SRN...SCT110. 15Z ISOL -TSRA. CB TOP FL450. 18Z BKN035 TOPS FL260. WDLY SCT -TSRA. OTLK...VFR TIL 01Z TSRA.

.
AL

SKC-SCT110. 15Z SCT040. ISOL -TSRA. CB TOP FL450. 17Z BKN045 TOPS FL200. WDLY SCT -TSRA. OTLK...VFR TIL 03Z TSRA.

....

11.0 Terminal Aerodrome Forecast

KAUS was the closest site with a NWS Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 0637 CDT and was valid for a 24-hour period beginning at 0700 CDT. The TAF for KAUS was as follows:

TAF KAUS 301137Z 3012/3118 **17003KT 6SM BR SCT012**
TEMPO 3012/3014 5SM BR OVC009
FM301500 20008KT P6SM SCT030
FM302000 17010KT P6SM SCT250
FM311100 18005KT P6SM BKN011
FM311500 17008KT P6SM SCT025=

The forecast valid at the accident time expected a wind from 170° at 3 knots, 6 miles visibility, mist, and scattered clouds at 1,200 feet agl. Temporary conditions were forecast between 0700 and 0900 CDT of 5 miles visibility, mist, and an overcast ceiling at 900 feet agl, or IFR conditions.

The KAUS TAF valid at the time of the LMFS weather briefing was issued at 0027 CDT and was valid for a 24-hour period beginning at 0100 CDT. The 0027 CDT KAUS TAF was as follows:

TAF KAUS 300527Z 3006/3112 19007KT P6SM FEW060 FEW200
FM301000 17004KT P6SM BKN012
FM301500 20008KT P6SM SCT040
FM302000 17010KT P6SM SCT250
FM311100 18005KT P6SM BKN011=

The forecast valid at the accident time expected a wind from 170° at 4 knots, greater than 6 miles visibility, and a broken ceiling at 1,200 feet agl, or MVFR conditions.

12.0 National Weather Service Area Forecast Discussion

The NWS Office in Austin/San Antonio, Texas, issued an Area Forecast Discussion (AFD) at 0641 CDT. The aviation section of the AFD mentioned that a few TAF sites across south central Texas were expected to drop to IFR levels through 0900 CDT due to light wind conditions with full VFR conditions expected throughout south central Texas by 1100 CDT. The aviation section of the 0039 CDT AFD mentioned brief IFR ceilings were possible across south central Texas on the morning of the accident as soil moisture was still relatively high due to the rain in the previous few days:

FXUS64 KEWX 301141
AFDEWX
Area Forecast Discussion
National Weather Service Austin/San Antonio TX
641 AM CDT SAT JUL 30 2016
.**AVIATION... /12Z TAFS/**
A weak sfc pressure gradient will make for scattered areas of low
cigs with a few dropping to IFR levels through 14z. Mixing should
take all TAF sites to VFR by 16z with afternoon winds mostly below
12 knots. A repeat of this morning is expected late tonight with

light winds leading to intermittent low ceilings.

&&

.PREV DISCUSSION... /ISSUED 358 AM CDT SAT JUL 30 2016/
SHORT TERM (Today through Sunday)...

A TUTT trough over the Lower Rio Grande Valley drifts northwest and becomes centered over Southern Texas later today and lingers through Sunday as a mid/upper level shear axis shifts northwest across northern and southwestern Texas. The shear axis lays between Subtropical Ridges centered over the Four Corners region and over northern Gulf of Mexico coast. Also, an MCV along the Rio Grande drifts to the west across the Serranias del Burro of Mexico. Finally, the seabreeze moves inland each day. The features aloft serve to enhance the seabreeze to generate isolated showers and thunderstorms across areas near the Coastal Plains today and again on Sunday. Models show a slight drying trend and expect the showers and thunderstorms to dissipate before reaching the I-35 corridor by early evening. Also for this afternoon, isolated showers and thunderstorms are possible across Maverick county near the Rio Grande due proximity to the MCV. Due to a warming trend of daytime temperatures and a lingering humid airmass, areas east of I-35 may see heat indices of 105 to 107 for an hour or two during the mid afternoon.

LONG TERM (Sunday Night through Friday)...

Early into the middle of next week, the TUTT trough/shear axis quickly fills as the Subtropical Ridges build toward each other and then center over Texas. This means no rain chances for Monday through Wednesday as the airmass dries and becomes strongly subsident. Late in the week, the Subtropical Ridge shifts north a little allowing somewhat deeper moisture back into Southern and Central Texas. This enables the seabreeze to generate showers and thunderstorms for areas near the Coastal Plains and maintained slight chance POPS for Thursday and Friday. Heat indices will reach the 105 to 108 range each afternoon.

Just beyond this forecast, for next weekend, all models are showing some type of tropical development from the wave currently well east of the Lesser Antilles. Recent runs show a track west to the Yucatan, the Bay of Campeche/southwestern Gulf of Mexico and into Mexico. The previous run of the ECMWF showed the system moving into Southern Texas. As a result, there is uncertainty. The strength and location the Subtropical Ridge axis will determine its track.

FIRE WEATHER...

Elevated fire weather conditions are expected across the Rio Grande Plains Monday through Friday during the afternoon hours. Relative humidities of 20 to 30 percent and southeasterly wind of 10 to 15 mph are expected.

&&

.PRELIMINARY POINT TEMPS/POPS...

Austin Camp Mabry	97	77	98	77	100	/	-	-	-	0	0
Austin Bergstrom Intl Airport	96	75	97	75	99	/	-	-	-	0	0
New Braunfels Muni Airport	96	75	98	75	100	/	-	-	-	0	0
Burnet Muni Airport	96	75	97	75	98	/	-	-	-	0	0
Del Rio Intl Airport	97	77	98	78	101	/	10	-	-	0	0
Georgetown Muni Airport	96	76	98	77	99	/	-	-	-	0	0
Hondo Muni Airport	95	74	97	74	98	/	-	-	-	0	0
San Marcos Muni Airport	95	75	97	75	99	/	-	-	-	0	0

La Grange - Fayette Regional 96 76 97 77 98 / 10 - 10 - -
 San Antonio Intl Airport 96 77 96 76 98 / - - - 0 0
 Stinson Muni Airport 97 76 98 76 100 / - - - 0 0

&&

.EWX WATCHES/WARNINGS/ADVISORIES...

None.

&&

\$\$

FXUS64 KEWX 300539

AFDEWX

Area Forecast Discussion

National Weather Service Austin/San Antonio TX

1239 AM CDT SAT JUL 30 2016

.AVIATION.../06Z TAFS/

Convection near an MCV west of LRD continues to weaken, and any convection that returns later today is not expected to impact TAF sites. With high pressure aloft forecast to become better established over TX over the next day, low clouds should gradually be come less prevalent over the area. **Will stick to persistence on when the clouds break up in the late morning, but show 1 hour delays in the pre-dawn hours over the next few hours and for early Sunday morning, as gradual removal of soil moisture occurs. Brief IFR cigs are again possible, but will keep prevailing TAFs just above this level. Most afternoon winds should remain below 12 knots.**

&&

13.0 Winds and Temperature Aloft Forecast

The NWS winds and temperatures aloft forecast valid for the flight is included below and was issued at 0303 CDT:

FBUS31 KWNO 300803

FD1US1

_DATA BASED ON 300600Z

VALID 301200Z FOR USE 0800-1500Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
SAT 1817	1812+17	1606+12	1512+06	1712-08	1707-16	110632	031042	041253	
CLL 2119	1913+18	2008+12	1905+06	1705-07	1907-17	211432	201142	190653	

San Antonio, Texas, (SAT) was the closest site to the accident site with a NWS winds and temperatures forecast with SAT located 39 southwest of the accident site. The SAT forecast indicated a wind at 3,000 feet from 180° at 17 knots. College Station, Texas, (CLL) was the next closest site with a NWS winds and temperatures forecast with CLL located 82 miles northeast of the accident site. The CLL forecast indicated a wind at 3,000 feet from 210° at 19 knots.

14.0 Pilot Weather Briefing²⁷

The accident pilot called and received an official weather briefing from LMFS at 0506 CDT on the morning of the accident. A recording of the briefing indicated that the accident pilot and the weather briefer discussed that no AIRMETs were current, very light precipitation 60 miles to the south-southwest of departure point, the latest METARs from KHYI and KAUS (section 3.0), the Area Forecast (section 10.0), the TAF from KAUS (section 11.0), the winds aloft forecast (section 13.0), and the wind profiler information from KEWX (attachments 12 and 13). The weather briefer specifically mentioned “those clouds may be a problem for you...” to which the accident pilot responded, “Well, we just fly in between them. We find a hole and we go...” For more information please see attachments 3 and 4.

In addition, the accident pilot’s tablet information was reviewed after the accident and showed that the accident pilot reviewed weather information on two websites the morning of the accident flight. The first website the accident pilot reviewed for weather information was www.blastvalve.com/weather/tx with figures 19 and 20 showing exemplar images of the website and information contained therein. The information the accident pilot would have received would have been the latest METAR, TAF, and Winds and Temperature Aloft information and forecast (figure 20). The accident pilot had selected the stations selected in figure 19, but the exact information provided to the accident pilot was not able to be retrieved. The accident pilot did check this website before the LMFS weather briefing at 0506 CDT. The second website the accident pilot checked the morning of the accident was www.ryancarlton.com/wind.php with the KHYI location selected and an exemplar image provided in figure 21. While the exact weather information provided to the accident pilot was not able to be retrieved this wind aloft information was provided to the accident pilot before the 0506 CDT LMFS weather briefing. There is no record of the accident pilot receiving or retrieving any additional weather information.

²⁷ For additional information regarding the accident pilot’s tablet information please see the Electronic Devices Factual Report – Pilot located in the docket of this accident.



Balloon Search Engine & Directory

Texas Balloon Weather

Four Quick Steps for ballooning weather info:

Step 1. Choose Your Weather Stations:

Austin-Bergst. Int., TX

San Marcos, TX

San Antonio-Stinson, TX

Step 2. Choose Your Winds Aloft Stations:

Houston, TX

San Antonio, TX

Shreveport, LA

Step 3. Pick a time for winds aloft forecasts:

☒ Morning - (today until 4 hours past sunrise, then tomorrow morning)

☐ Evening - (tonight, until sunset, then tomorrow evening)

Step 4.

Get BalloonCast

3 Day 4Cast for:

SAN MARCOS

Get 3Day 4Cast

NEW

LAMP hourly forecast for:

SAN MARCOS

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BalloonCast

Weather for Balloon Pilots

Weather for hot air balloons and ballooning.

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Figure 19 – Exemplar image of Blastvalve.com website reviewed by the accident pilot the morning of the accident

Austin, TX BalloonCast

www.blastvalve.com/weather

Wednesday, October 5, 2016 Sunrise: 7:27 am Sunset: 7:10 pm Zulu Time Offset: -5 hours

	KAUS - Austin, TX	KHYI - San Marcos, TX	KSSF - San Antonio, TX
updated:	8:53 am CDT	9:30 am CDT	8:53 am CDT
Wind from:	160°	190°	130°
Wind speed:	4 Kt	6 Kt	4 Kt
Visibility:	8 miles	2 miles	6 miles
Weather:		Mist	Mist
Clouds:	Overcast 500	Overcast 300	Overcast 400
Temp:	75.0° F	73° F	75.9° F
Dewpoint:	73.9° F	73° F	73.0° F
Altimeter:	29.92 in.	29.95 in.	29.90 in.
Remarks:			
	24 hour trend	24 hour trend	24 hour trend

Forecast:	Austin, TX	San Marcos, TX	San Antonio, TX
Updated:	10/05 6:20 am CDT		10/05 6:20 am CDT
Valid:	10/05 7 am to 10/06 1 pm		10/05 7 am to 10/06 7 am
	170°@3 Kt, Vis 5 miles, Mist, Broken 600, Overcast 1000		120°@3 Kt, Vis 6+ miles, Broken 700
	From 10:00 am 180°@6 Kt, Vis 6+ miles, Broken 1200		From 10:00 am 140°@5 Kt, Vis 6+ miles, Broken 1200
	From 12:00 pm 170°@8 Kt, Vis 6+ miles, Scattered 4000		From 12:00 pm 150°@7 Kt, Vis 6+ miles, Scattered 4000
	From 3:00 am 160°@3 Kt, Vis 6+ miles, Broken 800		From 2:00 am 140°@2 Kt, Vis 6+ miles, Broken 700
	From 10:00 am 160°@6 Kt, Vis 6+ miles, Broken 1200		
	RUC Wind Profiler	RUC Wind Profiler	RUC Wind Profiler

Winds Aloft: (for use 10/05 9:00 am - 10/05 4:00 pm CDT)

	Houston, TX	San Antonio, TX	Shreveport, LA
3000	140° @ 7	140° @ 9	170° @ 13
6000	160° @ 6	140° @ 6	200° @ 17
9000	060° @ 9	light & variable	190° @ 11
12000	050° @ 8	light & variable	190° @ 11



Figure 20 – Exemplar image of Blastvalve.com website reviewed by the accident pilot the morning of the accident with METAR, TAF, and Winds Aloft information



KHYI

San Marcos, TX

Nearby Airports: [KBAZ](#) [KAUS](#) [KATT](#)

Elevation 597 ft

Gridpoint 29.90N, 97.94W

Sunrise 7:27 AM CDT

Sunset 7:11 PM CDT

Altimeter 29.95 in. Hg

KHYI LOCATION

☒ KT's ☐ MPH

☒ °F ☐ °C

☒ AGL ☐ MSL

Update Page

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	74°F 1300 UTC 8:00 AM CDT	75°F 1400 UTC 9:00 AM CDT	77°F 1500 UTC 10:00 AM CDT	79°F 1600 UTC 11:00 AM CDT	81°F 1700 UTC 12:00 PM CDT
0 ft	175 @ 02 kts	167 @ 05 kts	181 @ 06 kts	192 @ 07 kts	206 @ 06 kts
95 ft	175 @ 03 kts	169 @ 05 kts	181 @ 07 kts	192 @ 08 kts	206 @ 06 kts
266 ft	178 @ 04 kts	171 @ 06 kts	181 @ 07 kts	192 @ 08 kts	206 @ 07 kts
548 ft	195 @ 08 kts	183 @ 09 kts	182 @ 08 kts	192 @ 08 kts	206 @ 07 kts
958 ft	200 @ 13 kts	186 @ 11 kts	185 @ 10 kts	192 @ 09 kts	204 @ 07 kts
1496 ft	199 @ 15 kts	186 @ 12 kts	185 @ 11 kts	191 @ 09 kts	201 @ 07 kts
1827 ft	197 @ 15 kts	186 @ 12 kts	185 @ 11 kts	191 @ 09 kts	200 @ 07 kts
2139 ft	196 @ 15 kts	186 @ 12 kts	185 @ 11 kts	191 @ 09 kts	199 @ 07 kts
2867 ft	187 @ 12 kts	185 @ 12 kts	187 @ 11 kts	189 @ 10 kts	194 @ 08 kts
3688 ft	184 @ 10 kts	180 @ 11 kts	181 @ 10 kts	179 @ 11 kts	185 @ 10 kts
4232 ft	189 @ 09 kts	184 @ 10 kts	183 @ 09 kts	181 @ 10 kts	188 @ 09 kts
4616 ft	192 @ 09 kts	187 @ 09 kts	184 @ 09 kts	182 @ 09 kts	190 @ 08 kts
5676 ft	191 @ 08 kts	188 @ 08 kts	187 @ 08 kts	190 @ 08 kts	199 @ 08 kts
5873 ft	186 @ 04 kts	172 @ 04 kts	170 @ 05 kts	181 @ 06 kts	197 @ 06 kts
8225 ft	282 @ 01 kts	120 @ 02 kts	134 @ 05 kts	147 @ 06 kts	161 @ 07 kts
9642 ft	297 @ 03 kts	240 @ 00 kts	144 @ 03 kts	154 @ 05 kts	163 @ 07 kts
9744 ft	298 @ 03 kts	248 @ 00 kts	145 @ 03 kts	154 @ 05 kts	163 @ 07 kts
11444 ft	297 @ 08 kts	304 @ 07 kts	301 @ 05 kts	291 @ 03 kts	267 @ 03 kts
13353 ft	288 @ 10 kts	289 @ 09 kts	274 @ 08 kts	266 @ 07 kts	267 @ 06 kts
15463 ft	257 @ 10 kts	261 @ 10 kts	256 @ 11 kts	257 @ 10 kts	258 @ 09 kts

Data Accessed:
Oct 5, 2016 9:43AM

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NWS Weather Planner

Ryan Carlton can be contacted at ryan@ryancarlton.com

Information sources for this site include: [Weather Underground API Service](#) [NOAA/Earth System Research Laboratory](#), [RUC development group](#)

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Figure 21 – Exemplar image of wind aloft information reviewed by accident pilot the morning of the accident flight

15.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on July 30, 2016, indicated the following:

SUN

Begin civil twilight	0623 CDT
Sunrise	0649 CDT
Sun transit	1337 CDT
Sunset	2025 CDT
End civil twilight	2051 CDT

16.0 Video and Witness Information²⁸

A review of video and witness information provided additional insight into the weather conditions surrounding the accident time. A timeline of the witness information was constructed and it can be found as attachment 5. Witness information indicated that near Lockhart State Park, 7 miles northeast of the departure location, the sky was overcast, but visibility was “okay” at 0640 CDT. A witness image from 0707 CDT with the accident balloon 2 miles north of the departure location indicated that skies were overcast and the witness mentioned fog in the area. A witness at 0730 CDT indicated they saw the balloon partially in the fog. A witness located 4 miles east-northeast of the accident site mentioned they would normally be able to see the power line towers clearly from their vantage point, but at 0740 CDT the witness could only see the bases of the nearest towers. The witness also mentioned that the fog was so dense that one could look at the sun with no problem. One of the passengers of the accident flight took photos just before the accident time and those images are provided in figure 22. The left image was taken at 0738 CDT and showed overcast skies below the accident flight (figure 22). The right image was taken at 0740 CDT and indicated a hole in the cloud layer below the accident balloon with the shadow of the accident balloon visible and a power line tower visible beyond the hole in the cloud layer (figure 22).

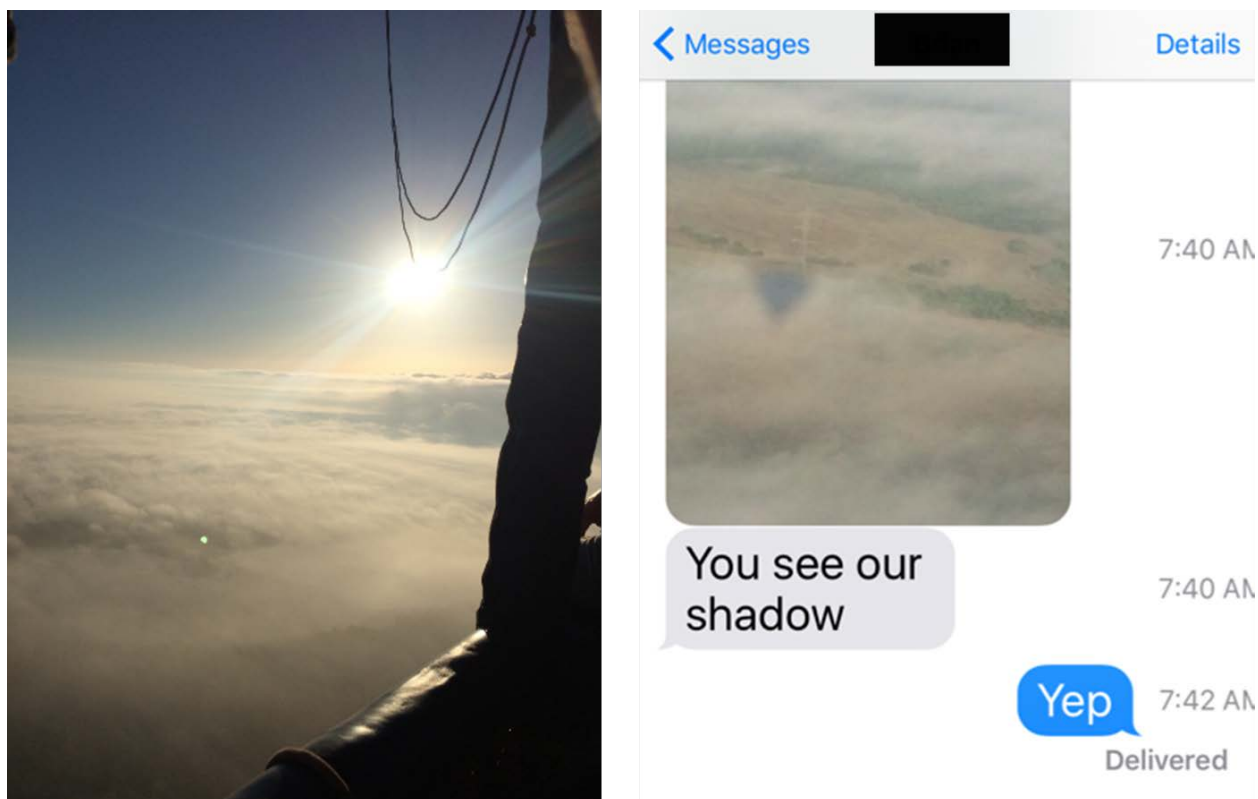


Figure 22 – Accident flight passenger’s images from 0738 CDT (left) and 0740 CDT (right)

²⁸ For more information see the factual data contained in the docket for this accident.

F. LIST OF ATTACHMENTS

Attachment 1 – GOES-13 animation from 0715 to 1015 CDT

Attachment 2 – VCP 211 standard elevation angle coverage diagram

Attachment 3 – LMFS weather briefing from 0506 CDT on July 30

Attachment 4 – LMFS transcript of weather briefing from 0506 CDT on July 30

Attachment 5 – Accident balloon timeline of witness information

Attachment 6 – Witness information

Attachment 7 – Witness information

Attachment 8 – Witness information

Attachment 9 – Witness information

Attachment 10 – Witness information

Attachment 11 – Witness information

Attachment 12 – Velocity Azimuth Display Wind Profile from KEWX from 0504 CDT

Attachment 13 – Velocity Azimuth Display Wind Profile from KEWX from 0741 CDT

Submitted by:

Paul Suffern
Senior Meteorologist

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