NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 11, 2016

Group Chairman's Weather Study Report

METEOROLOGY

DCA16LA100

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A. ACCIDENT

Location: At Lambert-St Louis International Airport, Missouri
Date: February 23, 2016
Time: approximately 2323 central standard time (0523 UTC[1] on February 24, 2016)
Aircraft: Embraer 145, registration: N856HK

B. METEOROLOGY GROUP

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Operational Factors Division, AS-30
Washington, D.C. 20594-2000

C. SUMMARY

For a summary of the accident, refer to the *Accident Summary* report, which is available in the docket for this investigation.

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 standard time (CST) on February 23, 2016, and are based upon the 24-hour clock, where local time is -6 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 38.75° N, longitude 90.37° W, at an elevation of 535 feet.

[1] UTC – is an abbreviation for Coordinated Universal Time.

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 (WPC), 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 1.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 0000 CST on February 24th is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a surface low pressure center with a pressure of 991-hectopascals (hPa) was located in western Tennessee. A surface trough[2] stretched from the low pressure center in western Tennessee northeastward into southern Kentucky and western West Virginia. A surface warm front stretched southeastward from the low pressure center in western Tennessee into central Alabama. A surface cold front stretched southward from the low pressure center in western Tennessee into central Mississippi. The station models around the accident site depicted air temperatures in the upper 30's to mid 40's Fahrenheit (F), with temperature-dew point spreads of 15° F or less, a north to northeast wind between 10 and 20 knots, cloudy skies and areas of rain, mainly south of the accident site. Given the isobars[3] (brown lines on figure 1 around low pressure center) were relatively close together, it would be expected that the surface wind speed would be relatively high and gusty. Given the proximity of the low pressure center to the accident site, clouds and precipitation would be expected near the accident site.

[2] Trough – An elongated area of relatively low atmospheric pressure or heights.
[3] Isobars – Lines of equal atmospheric pressure.

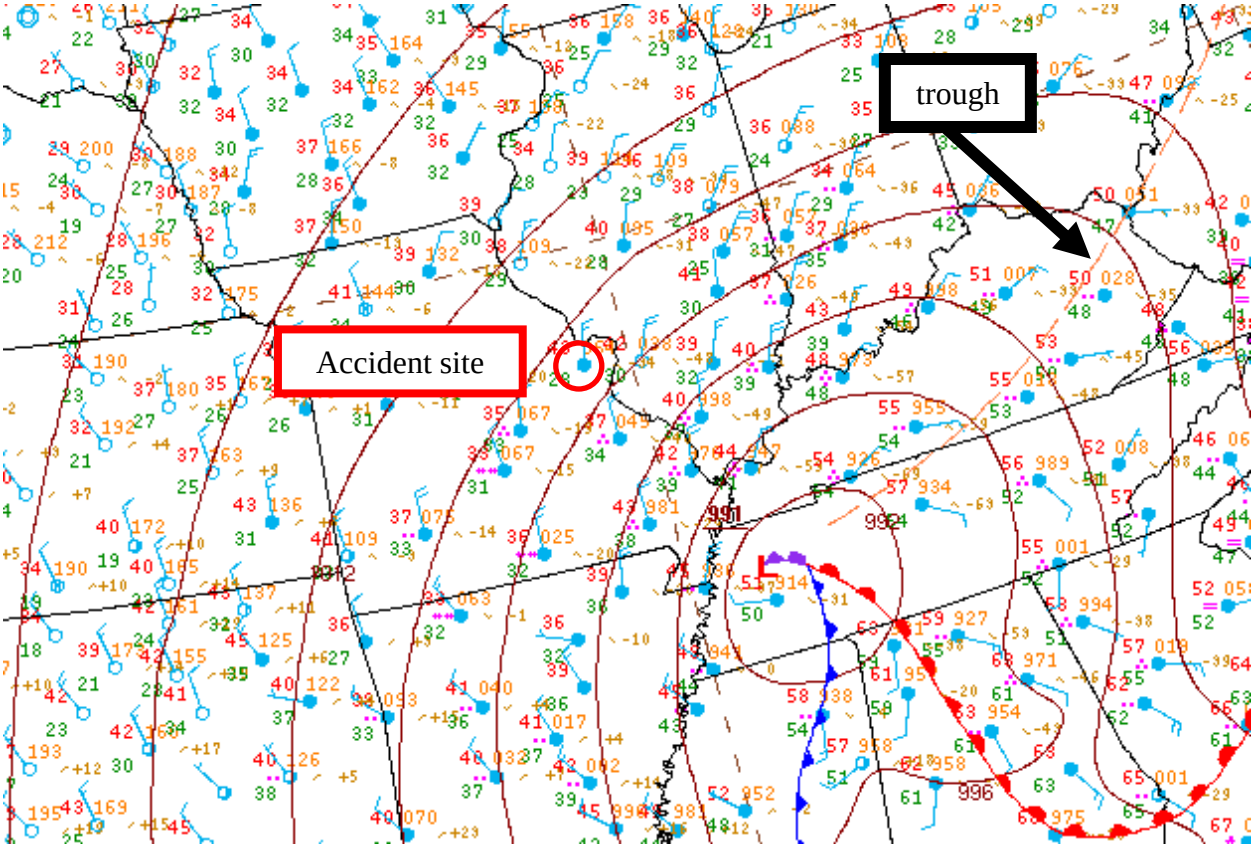

Figure 1 – NWS Surface Analysis Chart for 0000 CST on February 24

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0600 CST on February 24 at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. There was a low pressure center just southeast of the accident site located over western Kentucky and Tennessee with the low pressure center reaching from the surface (figure 1) up through 500-hPa (figure 5). It was above freezing at the surface (figure 1), but quickly dropped below freezing by 925-hPa, with a temperature around -1° Celsius (C) above the accident site. The wind remained out of the north to northeast from the surface through 700-hPa, with the wind speed between 40 to 50 knots at 925-hPa, and decreasing in speed to 35 knots by 700-hPa. At 500-hPa the wind was out of the east around 25 knots, with the wind shifting to the south by 300-hPa and a wind speed of 50 knots. The east to south wind at 500- and 300-hPa (figures 5 and 6) would have helped moisture, clouds, and precipitation move over the accident site around the accident time. With the accident site in the vicinity of the strong low pressure center clouds and precipitation would have been expected and were forecast. Gusty winds and low-level wind shear (LLWS) would have also been expected given the strong surface winds (figure 1, section 1.1) and the 40 to 50 knot wind at 925-hPa.

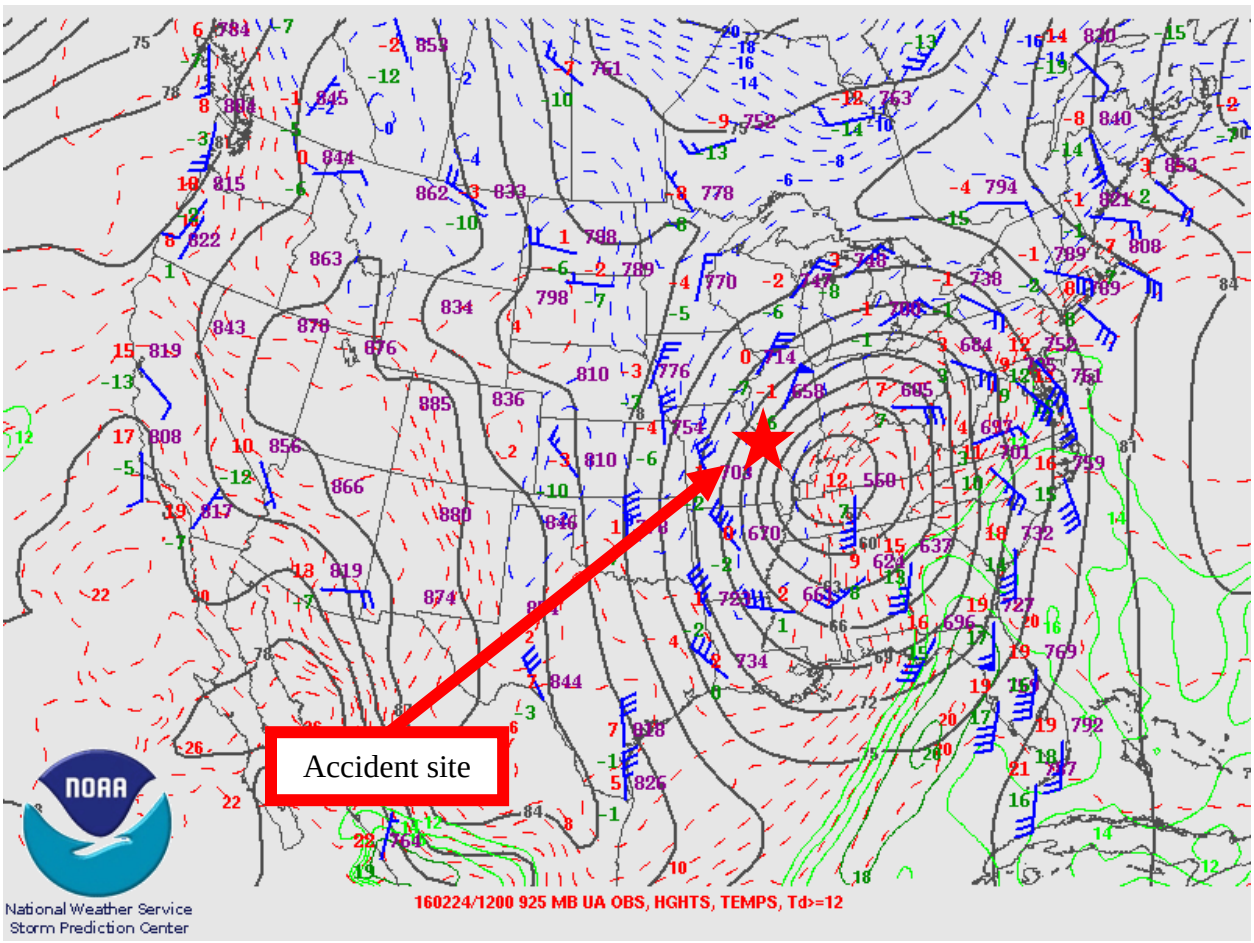

Figure 2 –925-hPa Constant Pressure Chart for 0600 CST on February 24

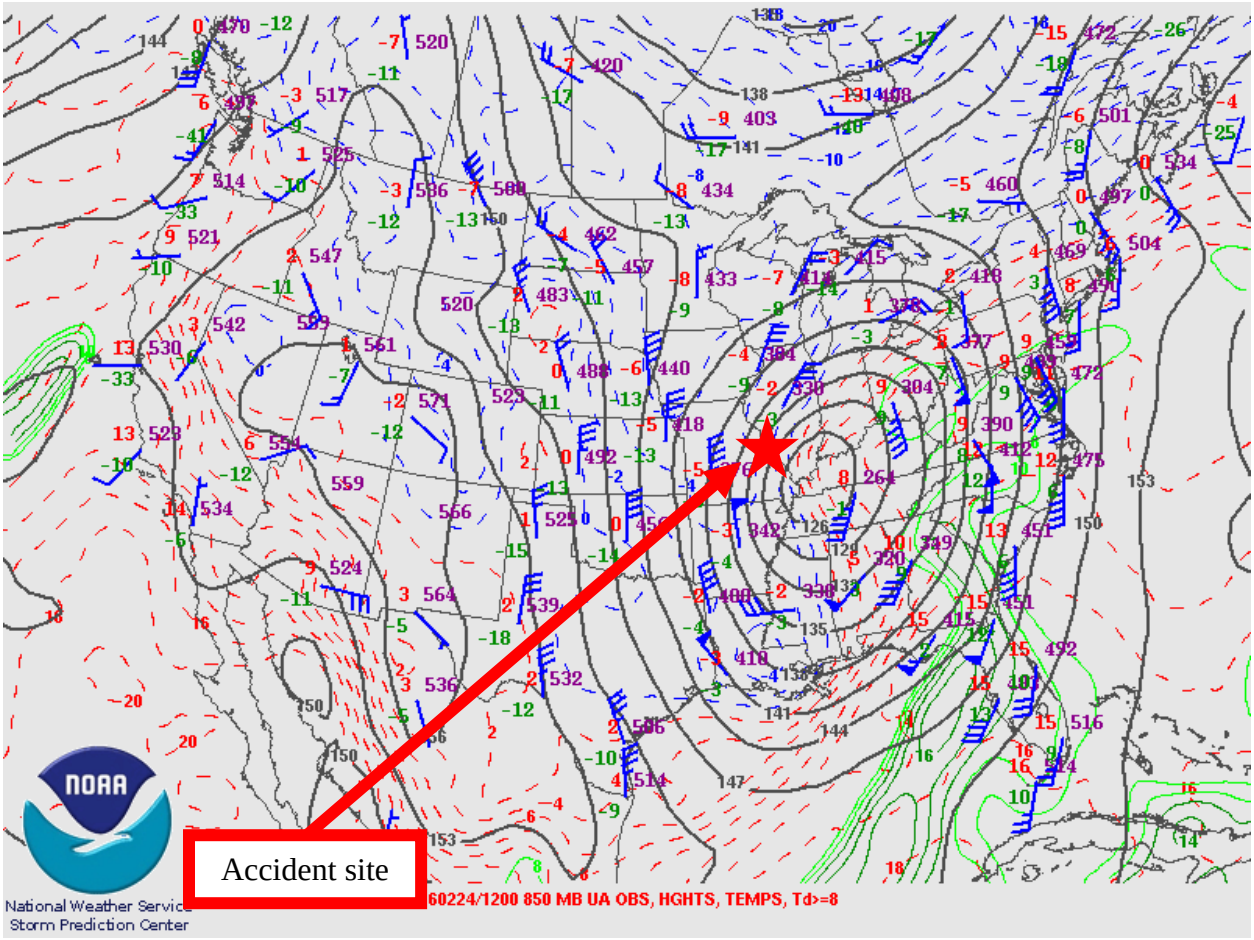

Figure 3 –850-hPa Constant Pressure Chart for 0600 CST on February 24

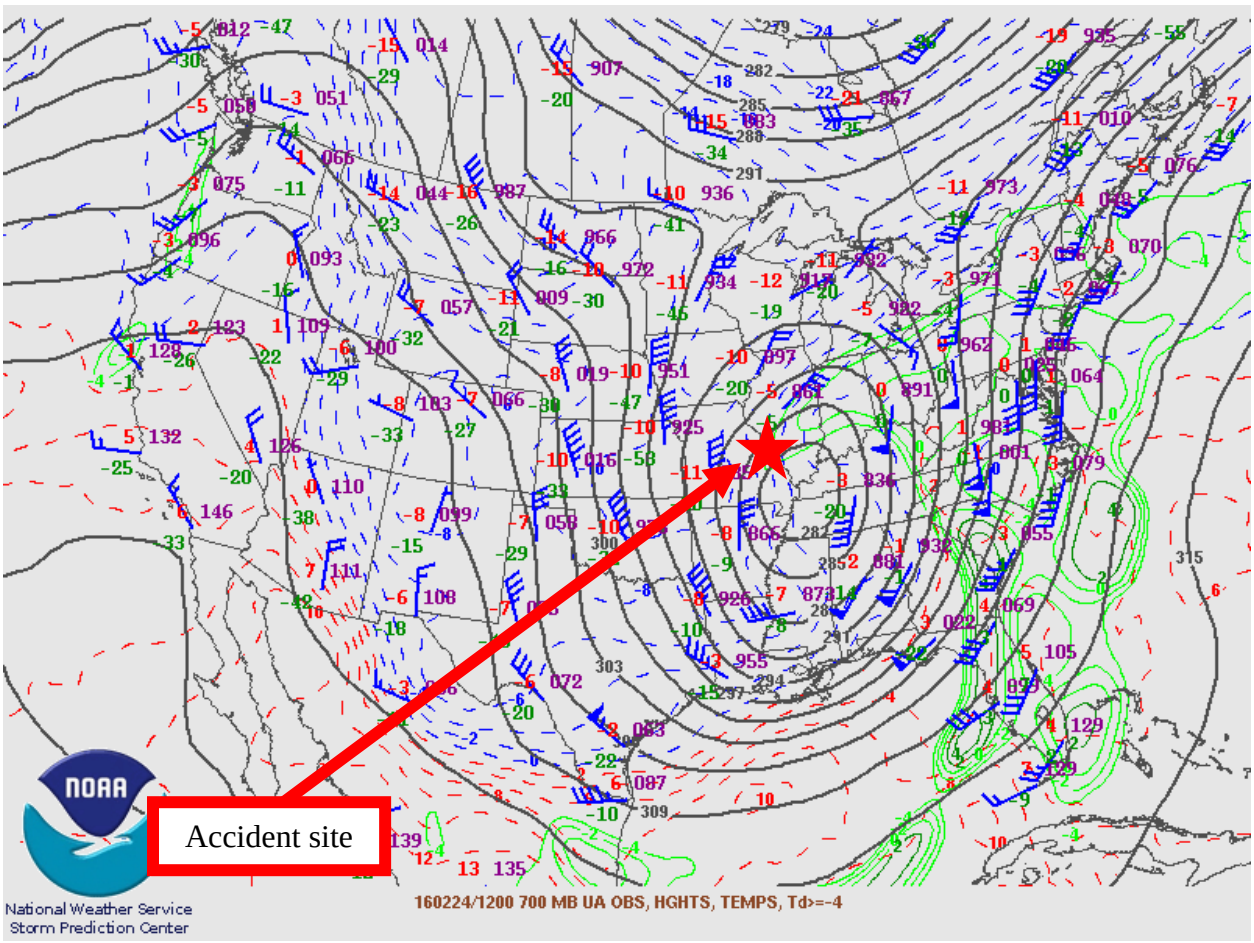

Figure 4 – 700-hPa Constant Pressure Chart for 0600 CST on February 24

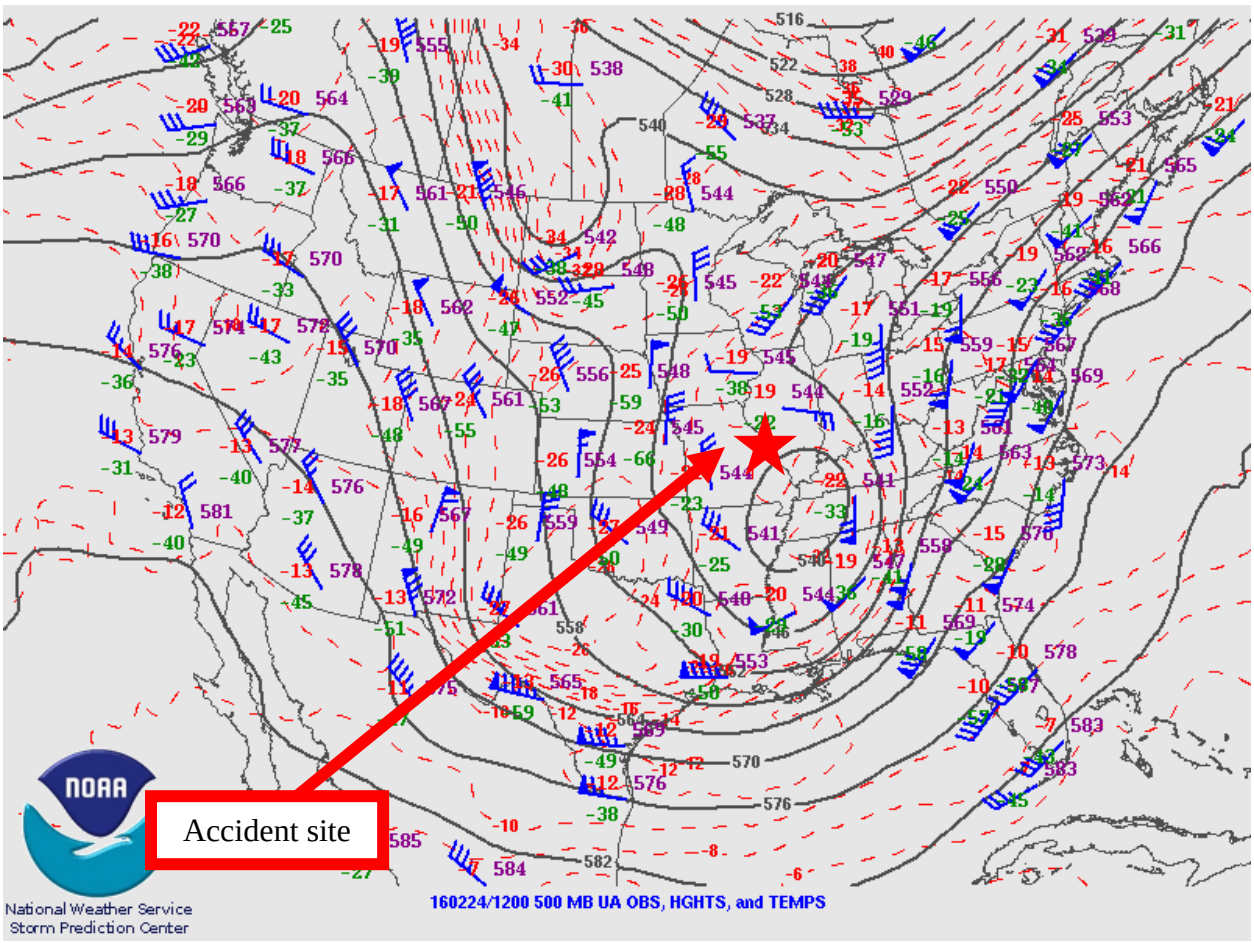

Figure 5 – 500-hPa Constant Pressure Chart for 0600 CST on February 24

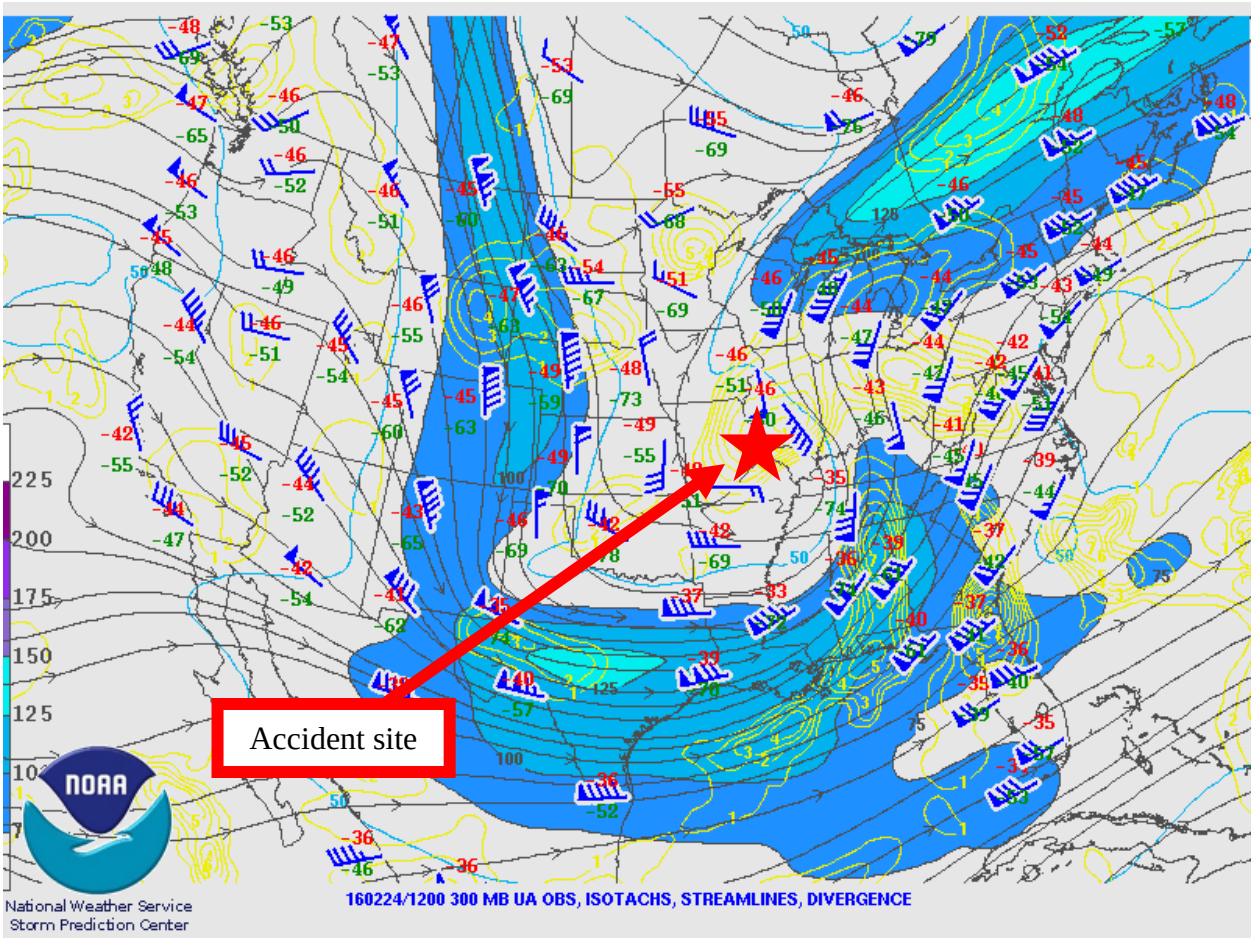

Figure 6 – 300-hPa Constant Pressure Chart for 0600 CST on February 24

2.0 Storm Prediction Center Products

No thunderstorms or severe storms were forecast.

3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and special METARS (SPECIs). The following observations were taken from standard code and are provided in plain language.

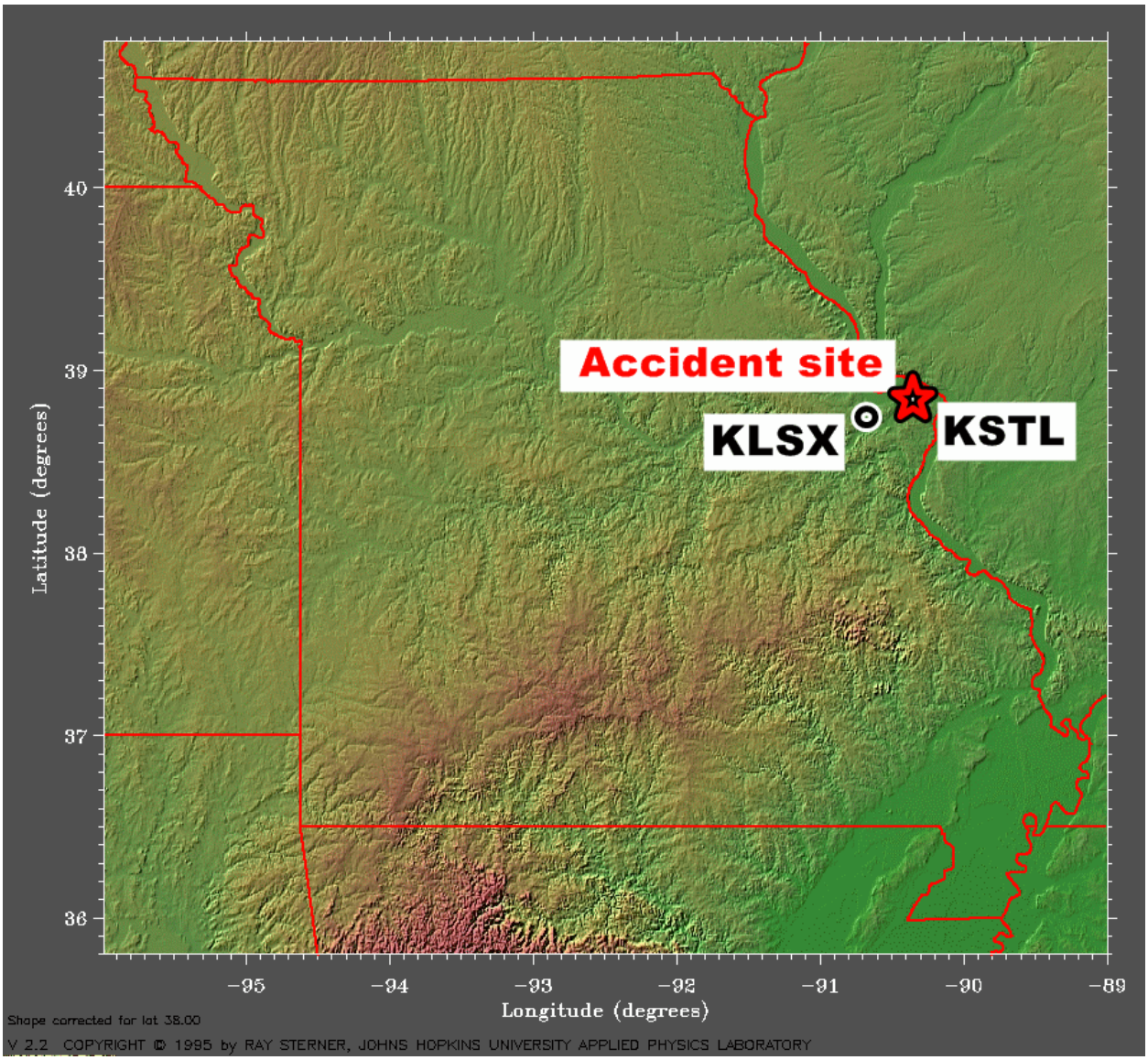

Figure 7 – Map of Missouri with the location of the accident site, surface observation site, and weather radar site

The accident occurred as the airplane was landing at Lambert-St Louis International Airport (KSTL). KSTL was located 10 miles northwest of St Louis, Missouri, and had an Automated Surface Observing System (ASOS[4]) whose reports were supplemented by an official weather observer. KSTL ASOS was located within a half mile of the accident site, at an elevation of 618 feet, and had a 0° magnetic variation[5] (figure 7). The following observations were taken and disseminated during the times surrounding the accident[6]:

[4] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.
[5] Magnetic variation – The angle (at a particular location) between magnetic north and true north.
[6] 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 are or will affect 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

[1751 CST] KSTL 232351Z 03013G18KT 10SM FEW080 OVC110 09/M01 A2986 RMK AO2 SLP116 T00891006 10100 20089 55012

[1851 CST] KSTL 240051Z 03018G28KT 10SM FEW075 OVC100 08/M01 A2983 RMK AO2 PK WND 03028/0049 SLP108 T00831011

[1951 CST] KSTL 240151Z 02015G27KT 10SM OVC100 08/M01 A2982 RMK AO2 PK WND 02027/0147 SLP104 T00831011

[2051 CST] KSTL 240251Z 04015G30KT 10SM OVC100 08/M01 A2981 RMK AO2 PK WND 03030/0244 SLP100 T00781011 56015

[2200 CST] KSTL NIL=

[2251 CST] KSTL 240451Z 03022G27KT 10SM OVC100 07/M02 A2974 RMK AO2 PK WND 36029/0439 SLP075 T00671022

ACCIDENT TIME 2323 CST

[2351 CST] KSTL 240551Z 02015G24KT 10SM OVC085 07/M03 A2970 RMK AO2 PK WND 02030/0537 SLP061 T00671028 10089 20067 401000011 58036

[0051 CST] KSTL 240651Z 01019G29KT 10SM OVC075 06/M03 A2966 RMK AO2 PK WND 36029/0647 SLP045 T00611028

[0151 CST] KSTL 240751Z 36019G28KT 10SM FEW015 OVC065 04/M01 A2961 RMK AO2 PK WND 01029/0724 PRESFR SLP031 T00391011

[0238 CST] KSTL 240838Z 36021G30KT 5SM -RASN FEW008 BKN012 OVC065 02/M01 A2961 RMK AO2 PK WND 01031/0806 RAB11SNB05 P0000=

[0241 CST] KSTL 240841Z 35019G29KT 3SM -SN BR SCT008 BKN012 OVC065 02/M01 A2961 RMK AO2 PK WND 01031/0806 RAB11E41SNB05 VIS W-N 1 1/4 P0000=

[0251 CST] KSTL 240851Z 36020G26KT 1 1/4SM -SN BR BKN009 BKN014 OVC025 02/M01 A2960 RMK AO2 PK WND 01031/0806 RAB11E41SNB05 SLP027 P0001 60001 T00171006 56035=

KSTL weather observation normally reported at 2151 CST was not available and reported as NIL.

KSTL weather at 2251 CST was reported as wind from 030° at 22 knots with gusts to 27 knots, 10 miles visibility, an overcast ceiling at 10,000 feet above ground level (agl), temperature

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and local times around the accident time.

of 7° C, dew point temperature of -2° C, and an altimeter setting of 29.74 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 360° at 29 knots occurred at 2239 CST, sea level pressure 1007.5-hPa, temperature 6.7° C, dew point -2.2° C.

KSTL weather at 2351 CST was reported as wind from 020° at 15 knots with gusts to 24 knots, 10 miles visibility, an overcast ceiling at 8,500 feet agl, temperature of 7° C, dew point temperature of -3° C, and an altimeter setting of 29.70 inches of mercury. Remarks: automated observation system with a precipitation discriminator, peak wind from 020° at 30 knots occurred at 2337 CST, sea level pressure 1006.1-hPa, temperature 6.7 °C, dew point -2.8° C, 6-hourly maximum temperature of 8.9° C, 6-hourly minimum temperature of 6.7° C, 24-hour maximum temperature of 10.0° C, 24-hour minimum temperature of 1.1° C, 3-hour pressure decrease of 3.6-hPa.

KSTL weather at 0051 CST was reported as wind from 010° at 19 knots with gusts to 29 knots, 10 miles visibility, an overcast ceiling at 7,500 feet agl, temperature of 6° C, dew point temperature of -3° C, and an altimeter setting of 29.66 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 360° at 29 knots occurred at 0047 CST, sea level pressure 1004.5-hPa, temperature 6.1° C, dew point -2.8° C.

The observations from KSTL indicated that VFR[7] ceilings and visibilities were present at the surface around the accident area and at the accident time with a gusty surface wind. The surface wind magnitudes and directions closer to the 2323 CST accident time will be further discussed in section 3.1. The gusty surface wind conditions would be the main issue for any flight attempting to land around the accident timeframe near KSTL.

3.1 One Minute Wind Observations

The one-minute KSTL ASOS surface data was provided by the NWS for the time surrounding the accident. One-minute raw wind data was provided with two separate magnitudes and wind directions[8]. The first wind data in table 1 is the two-minute average wind speed, which was updated every 5 seconds and reported once a minute. The second source of one-minute wind data is the five-second maximum wind average, which was updated every five seconds and reported once every minute (table 1). The following table provides the meteorological data in local time (CST)[9] as well as UTC time.

[7] 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 6 miles visibility.
[8] The wind directions are in reference to true north.
[9] The one-minute wind observations from an ASOS are not automatically reported in daylight time.

Time (UTC)	Time (CST)	Dir of 2min avg wind	Speed of 2 min avg wind (knots)	Dir of max 5 sec avg wind	Speed of max 5 sec avg wind (knots)
0505	2305	24	19	27	23
0506	2306	22	19	23	23
0507	2307	18	17	12	24
0508	2308	19	17	15	24
0509	2309	19	18	22	22
0510	2310	20	17	21	19
0511	2311	22	16	22	19
0512	2312	21	17	8	21
0513	2313	21	18	14	24
0514	2314	17	21	15	28
0515	2315	19	22	24	26
0516	2316	24	20	16	25
0517	2317	20	22	9	29
0518	2318	19	22	18	25
0519	2319	21	19	35	24
0520	2320	27	19	26	24
0521	2321	30	20	28	25
0522	**2322**	**24**	**19**	**22**	**24**
0523	**2323**	**18**	**18**	**35**	**23**
0524	**2324**	**19**	**20**	**24**	**28**
0525	2325	26	22	23	24
0526	2326	29	20	41	27
0527	2327	23	16	16	15
0528	2328	21	14	21	21
0529	2329	18	18	358	24
0530	2330	14	21	0	27
0531	2331	14	21	8	24
0532	2332	16	19	15	21
0533	2333	19	19	16	27
0534	2334	22	20	33	24
0535	2335	23	19	30	22
0536	2336	20	16	30	18
0537	2337	18	18	20	30
0538	2338	21	21	15	25
0539	2339	24	19	31	23
0540	2340	20	18	23	22
0541	2341	18	18	18	23
0542	2342	19	18	17	23

Table 1 – One-minute KSTL ASOS data for the time surrounding the accident

At 2322 CST, KSTL reported the two-minute average wind from 024° at 19 knots and a five-second maximum average wind from 022° at 24 knots.

At 2323 CST, KSTL reported the two-minute average wind from 018° at 18 knots and a five-second maximum average wind from 035° at 23 knots.

At 2322 CST, KSTL reported the two-minute average wind from 019° at 20 knots and a five-second maximum average wind from 024° at 28 knots.

4.0 Upper Air Data

A North American Mesoscale (NAM) model sounding was created for the accident site for 0000 CST on February 24. The 0000 CST NAM sounding was plotted on a standard Skew-T log P diagram[10] with the derived stability parameters included in figure 8 (with data from the surface to 500-hPa, or 18,000 feet msl.) This data was analyzed utilizing the RAOB[11] software package. The sounding depicted the Lifted Condensation Level (LCL)[12] at 2,947 feet msl and a Convective Condensation Level (CCL)[13] of 7,559 feet. The freezing level was located at 4,134 feet. The precipitable water value was 0.64 inches.

[10] 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.

[11] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.

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

[13] 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.

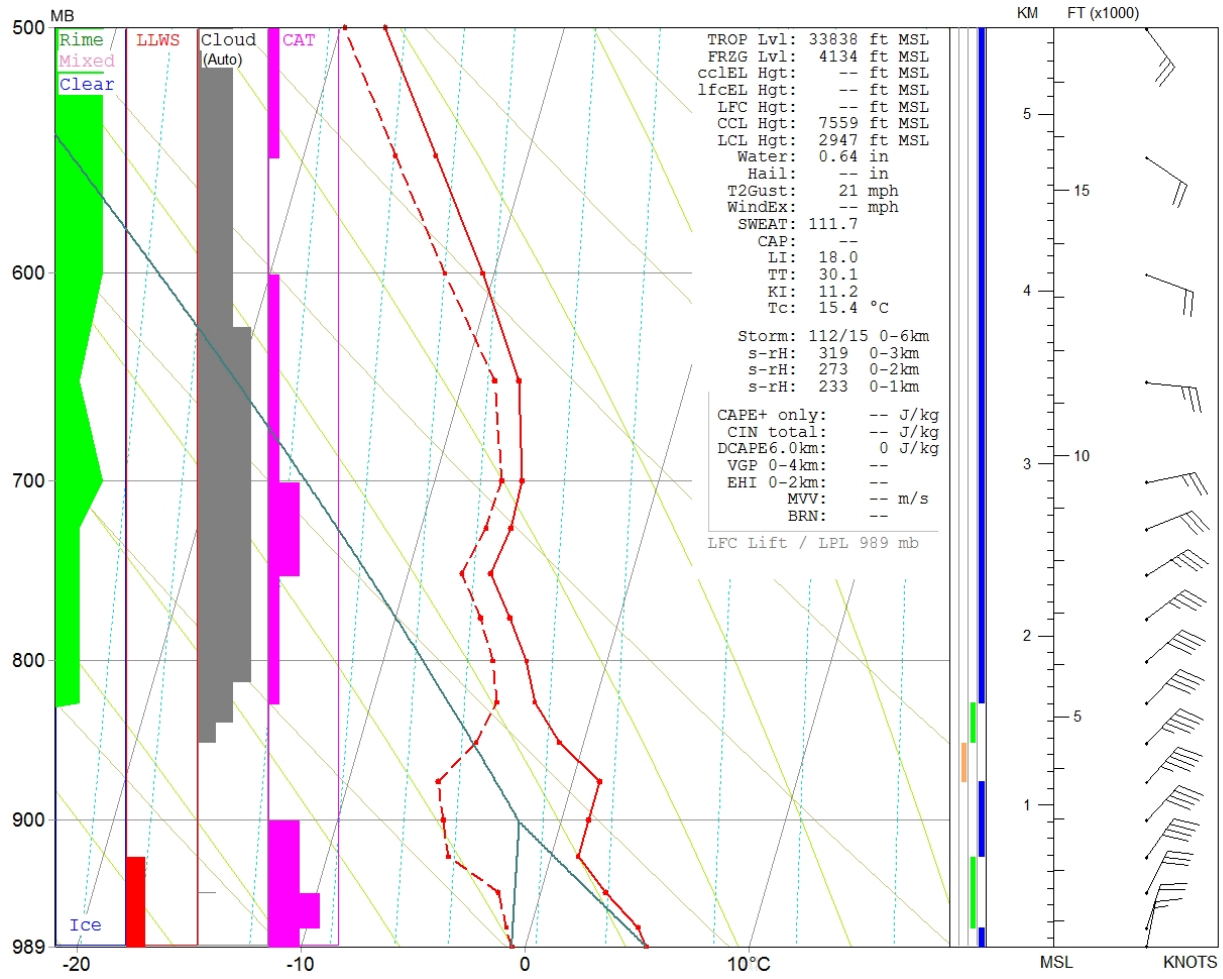


Figure 8 – 0000 CST on February 24 NAM sounding for the accident site

The 0000 CST February 24 NAM sounding indicated a relatively dry vertical environment from the surface through 4,000 feet msl. Above 4,000 feet msl there was abundant moisture and with the surface low pressure center so close to the accident site, this environment would have been conducive of cloud formation as indicated by RAOB. With the temperature below freezing above 4,000 feet msl, icing conditions would have been likely through 18,000 feet msl and icing conditions were indicated by RAOB. The accident flight was likely IMC and experiencing light to moderate icing conditions while descending into KSTL. The weather radar data further suggests that precipitation was present on the descent (section 6.4).

The sounding's wind profile indicated there was a surface wind from 011° at 14 knots and the wind speed increased quickly to 30 knots by 1,500 feet msl while remaining out of the north-northeast. LLWS was indicated by RAOB in the lowest 2,000 feet agl with several layers of possible clear-air turbulence identified by RAOB from the surface through 18,000 feet. The wind remained out of the northeast to east through 12,000 feet msl, before the wind turned to the southeast by 18,000 feet msl. The highest wind speeds were mainly confined between 1,500 and 9,000 feet msl. Given the surface wind profile and low- to mid-level wind speed and directions, the accident flight likely encountered some gusty wind conditions and low-level wind shear while landing at KSTL.

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 Safety Board's Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-13 bands 1 and 4) at a wavelength of 0.65 microns (μm) and 10.7 μm retrieved brightness temperatures for the scene. Satellite imagery surrounding the time of the accident, from 1800 CST through 0100 CST on February 24 at approximately 15-minute intervals, were reviewed and the images most applicable to the time of the accident are documented here.

Figures 9, 10, and 11 present the GOES-13 infrared imagery from 2315, 2330, and 2345 CST at 4X magnification with the accident site highlighted with a red square. The infrared imagery indicated the cloud tops moving from southeast to northwest with time over the accident site. The highest cloud tops (blue colors) remained over Kentucky and southern Indiana. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 0000 CST NAM sounding, the approximate cloud-top heights over the accident site were 30,000 feet at 2330 CST.

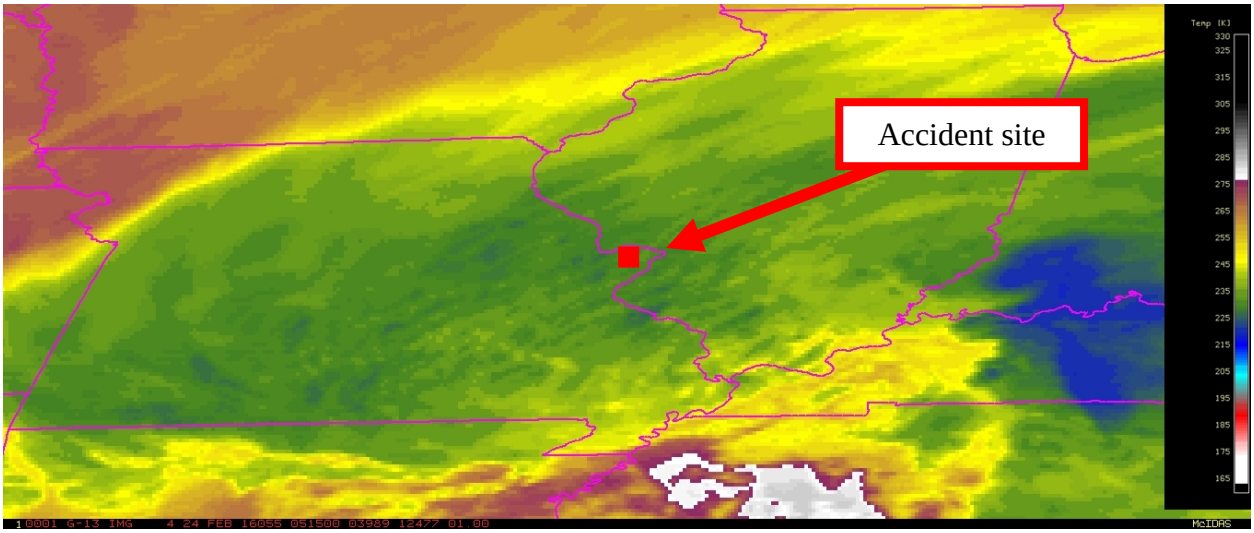


Figure 9 – GOES-13 infrared image at 2315 CST

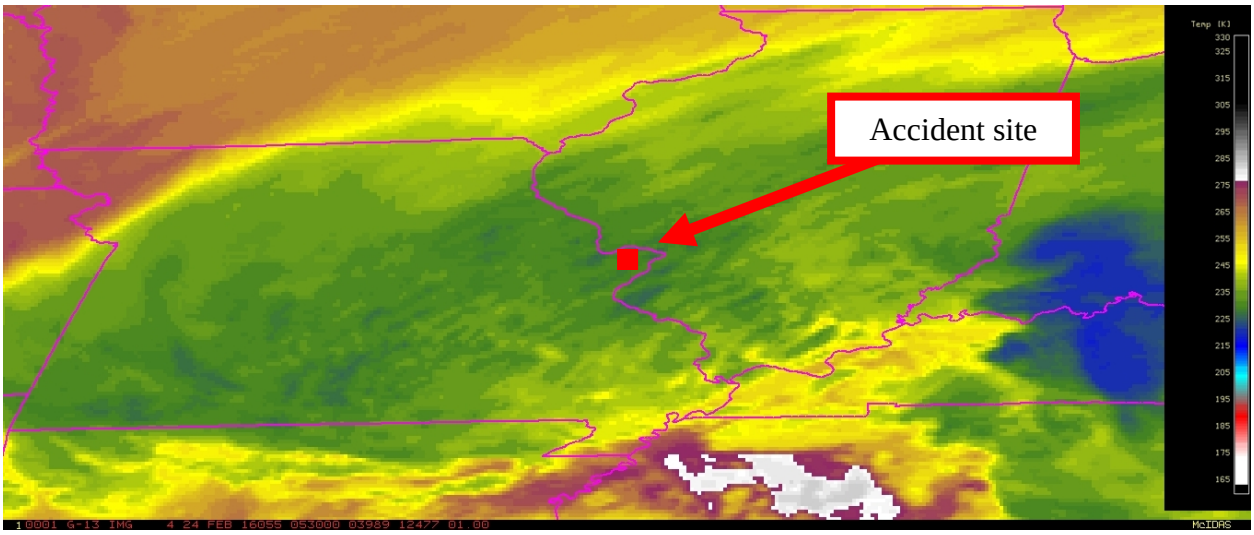


Figure 10 – GOES-13 infrared image at 2330 CST

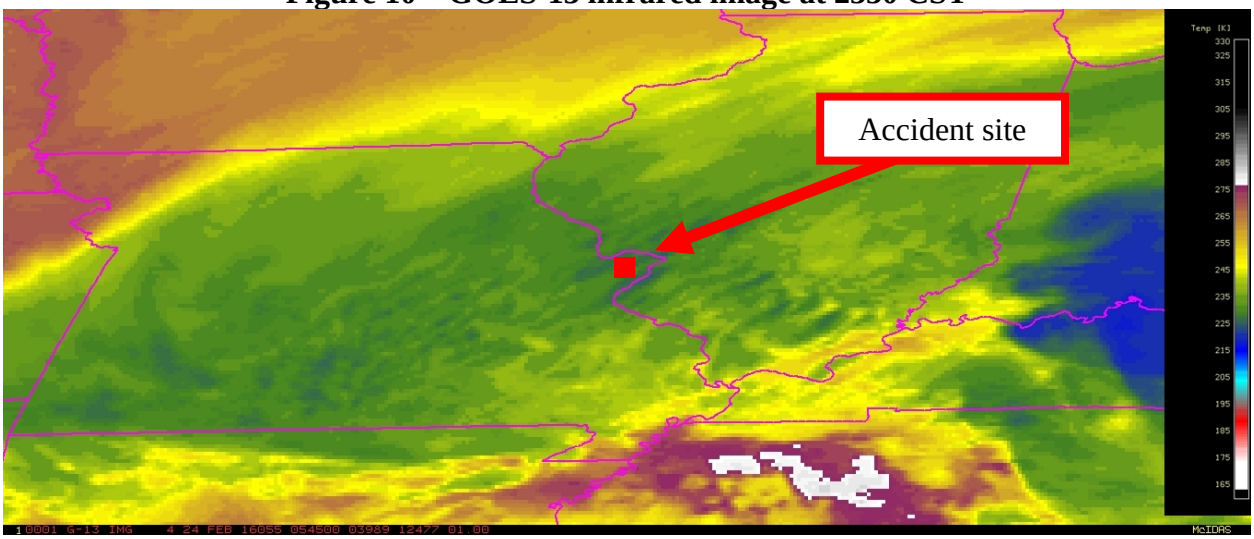


Figure 11 – GOES-13 infrared image at 2345 CST

6.0 Radar Imagery Information

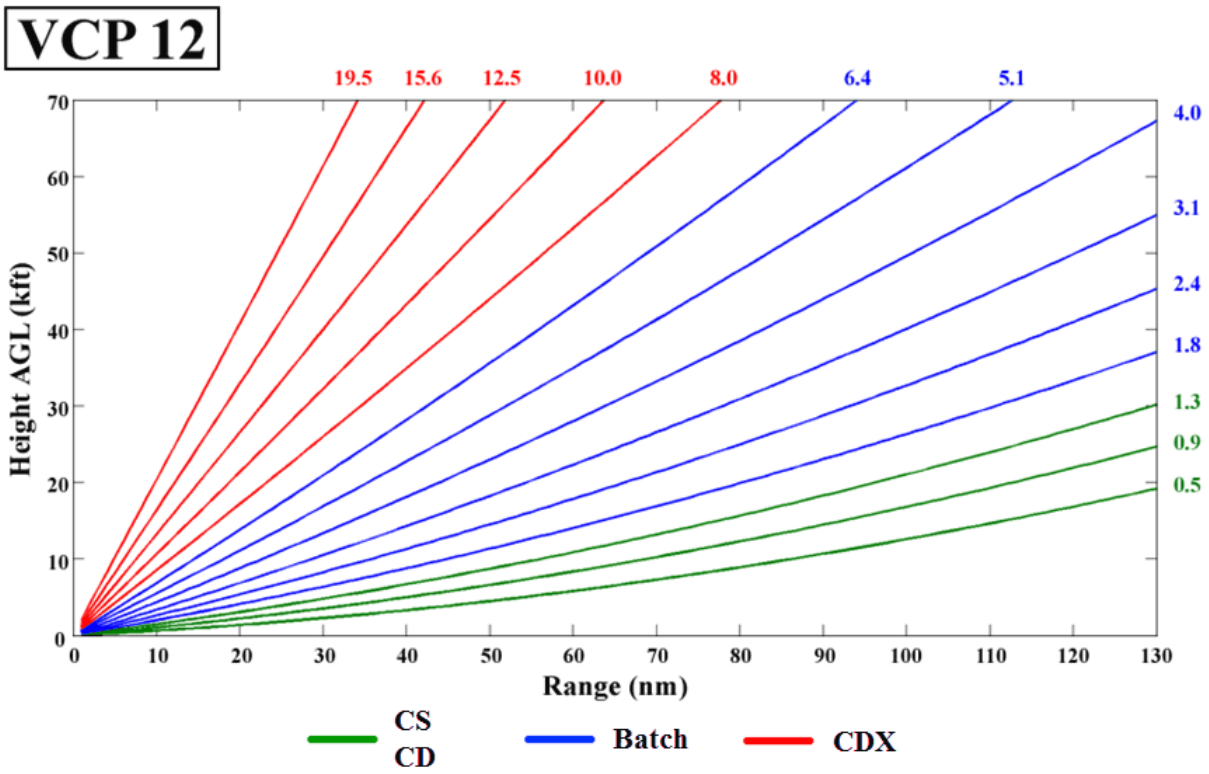
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[14] was from St Louis, Missouri, (KLSX) located 15 miles west-southwest of the accident site (figure 7) with an elevation of 608 feet. Level II and III archive radar data was obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

[14] 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.

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 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 four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 12 (VCP-12). 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 KLSX WSR-88D radar was operating in the precipitation mode (Mode A, VCP-12). 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-12 Precipitation Mode Scan Strategy[15]

[15] 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.

6.2 Beam Height Calculation

Assuming standard refraction[16] of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width[17] information[18] of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	1,570 feet	830 feet	2,310 feet	1,480 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 830 feet and 2,310 feet msl over the accident site and these are the closest altitudes to the accident flight level on descent into KSTL before the accident occurred.[19]

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[20] 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 (dBZ[21]), 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:

W – With range unfolding (W)
WO – Without range unfolding (WO)

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

[17] Beam width – A measure of the angular width of a radar beam.

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

[19] For more information please see the ATC data.

[20] 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.

[21] 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.

- 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.

6.4 Base Reflectivity and Lightning Data

Figures 12 through 14 present the KLSX WSR-88D base reflectivity images for the 0.5° elevation scan initiated at 2321, 2325, and 2329 CST with a resolution of 0.5° X 250 m. The ATC flight track is also included with the arrows pointing in the direction of travel. The accident flight track indicated that the accident flight flew through 5 to 15 dBZ base reflectivity values located along the route of flight before 2312:32 CST. There were no precipitation targets near the accident site at the accident time at the accident flight level. The precipitation targets moved little with time, with frozen and mixed precipitation being at the surface after 0200 CST on the 24th at KSTL (section 3.0). Figure 15 is the KLSX Velocity Azimuth Display (VAD) Wind Profile which indicated a 30 to 35 knot northeast wind at 2,000 feet msl at KLSX between 2342 and 2258 CST, with little change in wind magnitude over that timeframe. The KLSX VAD Wind Profile indicated similar wind conditions to the upper air sounding data (section 4.0). The wind from the surface to 7,000 feet msl was blowing close to perpendicular to the 12/30 and 11/29 runways.

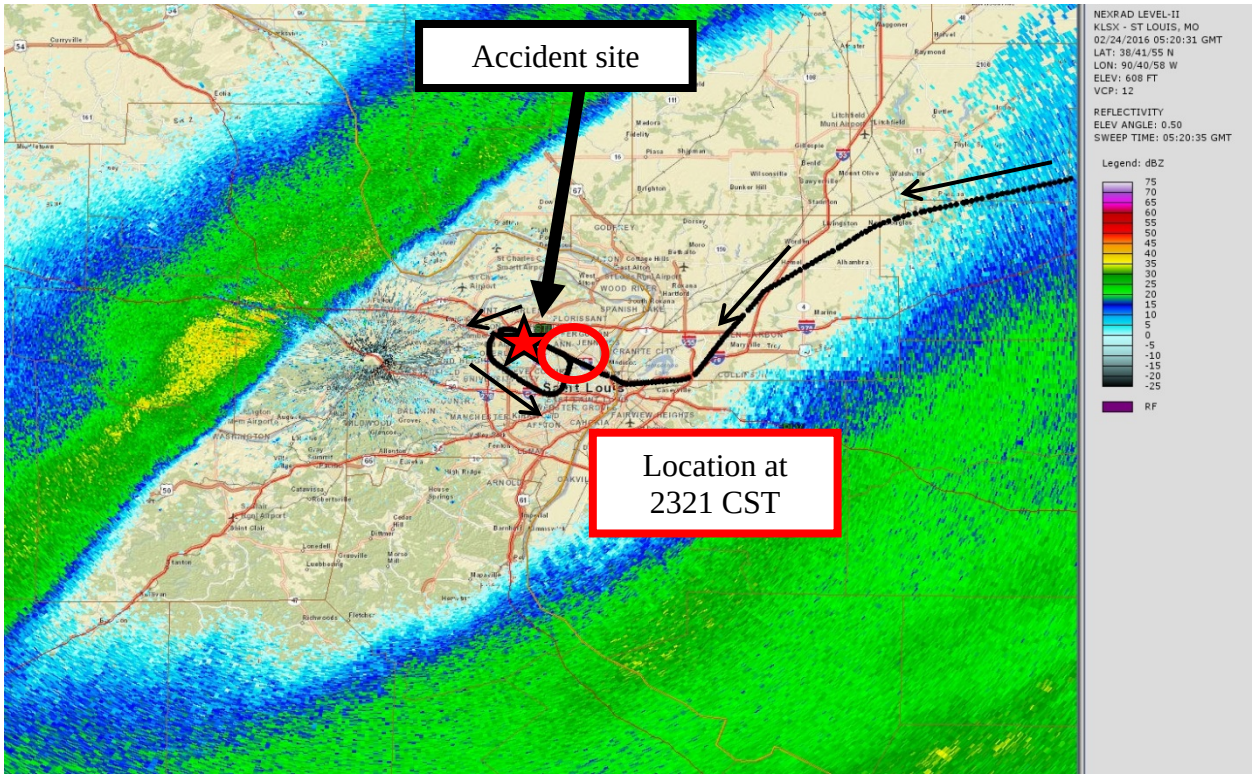


Figure 12 – KLSX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2321 CST with the ATC flight track and arrows pointing in direction of travel

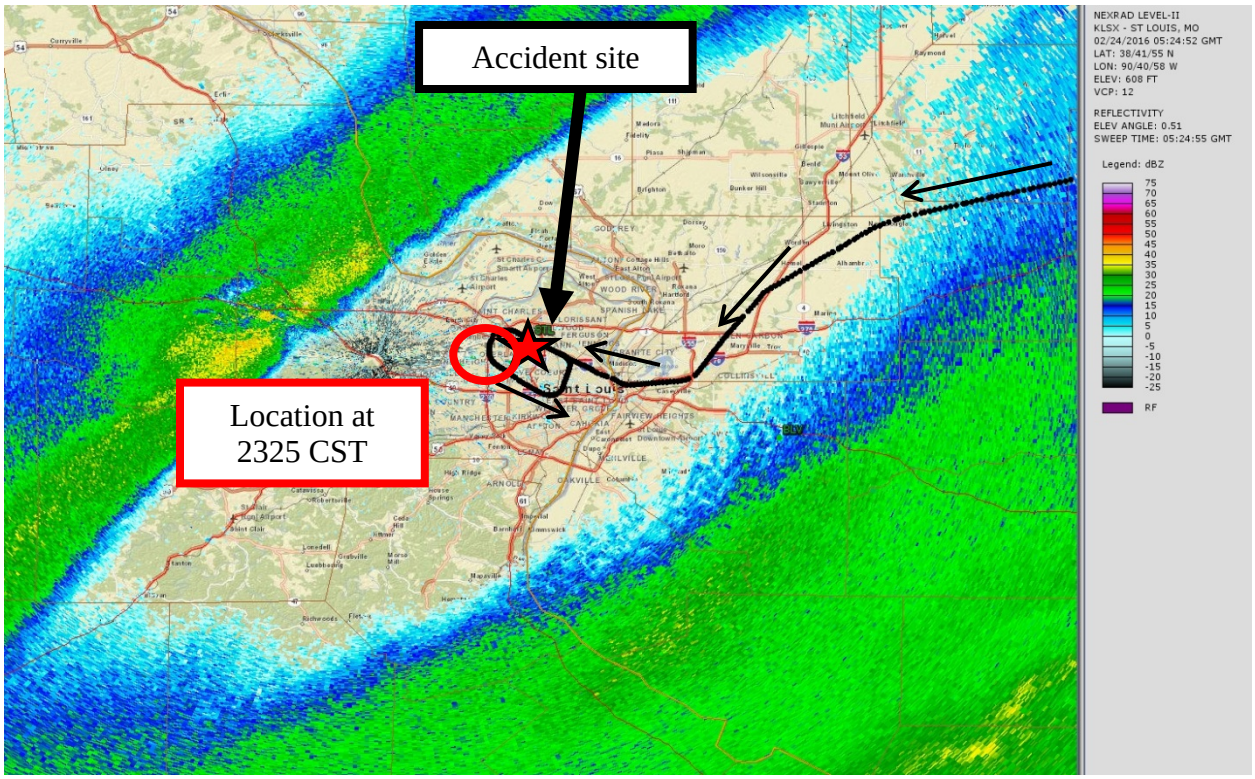


Figure 13 – KLSX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2325 CST with the ATC flight track and arrows pointing in direction of travel

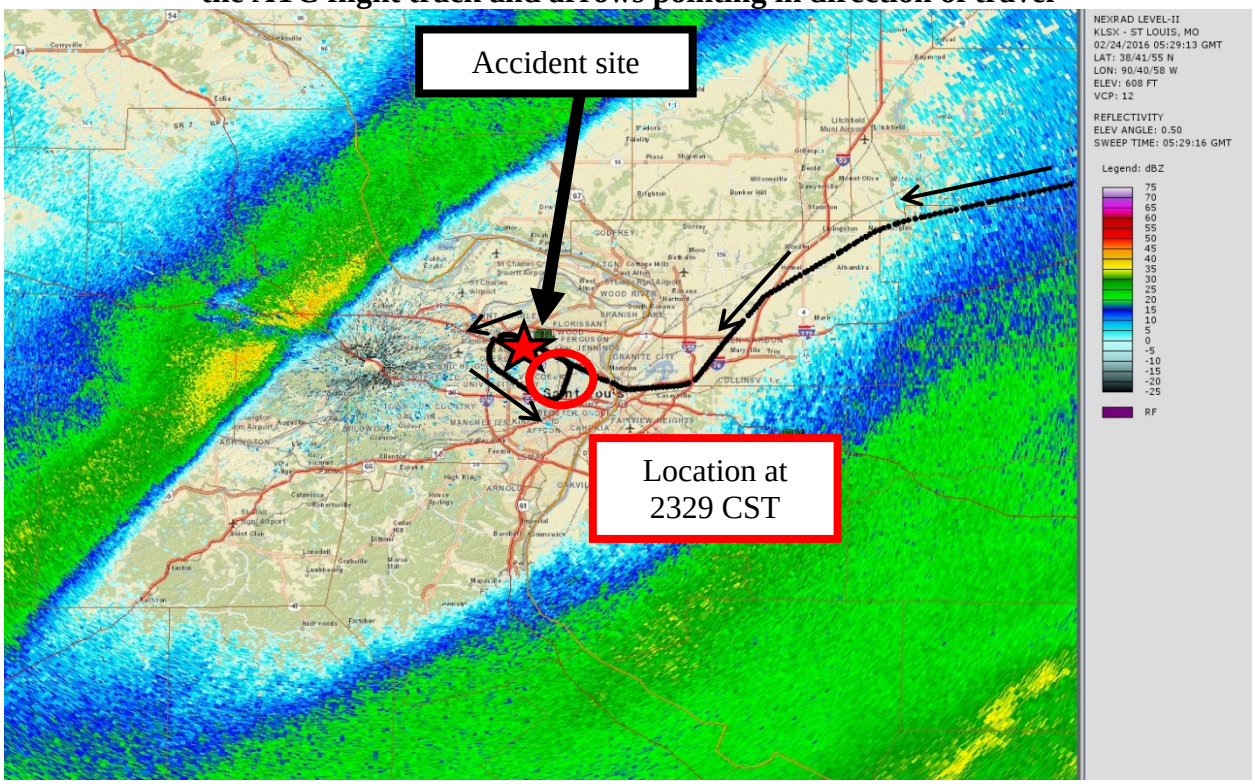


Figure 14 – KLSX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2329 CST with the ATC flight track and arrows pointing in direction of travel

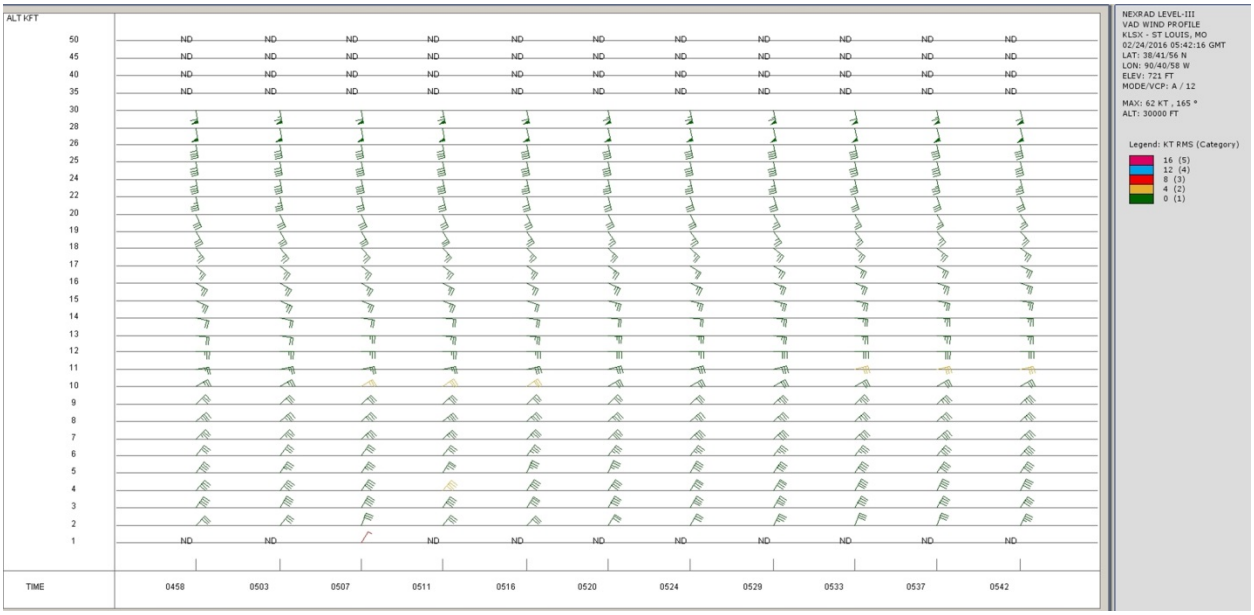


Figure 15 – KLSX VAD Wind Profile from 2342 CST (right side) to 2258 CST (left side)

7.0 Pilot Reports

All pilot reports (PIREPs) were reviewed close to the accident site, from around two hours prior to the accident time to around two hours after the accident time and no PIREPs were issued into the national airspace near the accident site at any flight level.

Lambert-St Louis International Airport (KSTL) Tower ATC recordings were reviewed from 2 hours before the accident to one hour after the accident time. Multiple wind checks were issued to the arriving aircraft, but no PIREPs were either solicited by the tower controllers during this period. Only one PIREP was initiated by a pilot and that was at 2355 EDT. The pilot stated that it was a pretty smooth ride on final for runway 6 all the way down to 1,500 feet when it got a little rougher but it wasn't too bad. The receipt of the PIREP was annotated in the daily log but no additional information was recorded and this PIREP was not available in the NAS.[22] It is understandable that PIREPs were not requested by KSTL ATC given that weather conditions were above the FAA JO 7110 order before the accident time.

8.0 SIGMET and CWSU Advisories

No SIGMET was valid for the accident site for below FL180[23] at the accident time and no Convective SIGMETs was issued for thunderstorms over the route of flight during the period.

No Center Weather Service Unit (CWSU) Advisory (CWA) or Meteorological Impact Statement (MIS) were valid for the accident site at the accident time.

[22] For more information please see the ATC data.

[23] 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

AIRMETs Tango, Zulu, and Sierra issued at 2045 CST, and valid at the accident time, were the AIRMETs valid for the accident site or accident flight track at the accident time. AIRMET Tango forecast moderate turbulence below FL180 with LLWS conditions expected. AIRMET Zulu forecasted moderate icing conditions between the freezing level and FL210. The freezing level was between the surface and 4,000 feet msl. AIRMET Sierra forecasted IFR[24] conditions for ceilings below 1,000 feet and/or visibilities below 3 miles due to precipitation and mist. The AIRMETs were current, timely, and covered the weather conditions the accident flight likely encountered:

WAUS43 KKCI 240245
WA3T
CHIT WA 240245
AIRMET TANGO FOR TURB AND LLWS VALID UNTIL 240900
.
AIRMET TURB...SD NE KS MN IA MO WI LM LS MI LH IL IN KY
FROM 50WNW YQT TO SSM TO YVV TO 30SSE ECK TO FWA TO CVG TO HNN
TO HMV TO RZC TO OSW TO 50W LBL TO 30W OBH TO 50NNW RWF TO 50WNW
YQT
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET TURB...ND SD NE KS
FROM 50NNW ISN TO 50NE MOT TO 60SSE BIS TO 20S PIR TO GLD TO BFF
TO 70SW RAP TO 50NNW ISN
MOD TURB BTN FL180 AND FL390. CONDS DVLPG 03-06Z. CONDS CONTG
BYD 09Z THRU 15Z.
.
AIRMET TURB...KS IA MO IL IN KY OK TX AR TN LA MS AL AND CSTL
WTRS
FROM 30SSE IOW TO FWA TO CVG TO HNN TO 50WSW BKW TO HMV TO GQO
TO 50SW PZD TO 40W CEW TO 130ESE LEV TO 120SSW LCH TO 80E BRO TO
90W BRO TO DLF TO 30NNE MMB TO 40W ICT TO 30SSE IOW
MOD TURB BLW FL180. CONDS CONTG BYD 09Z THRU 15Z.
.
LLWS POTENTIAL...IN KY TN MS AL
BOUNDED BY CVG-HNN-HMV-GQO-30SSE LGC-40SW IGB-50E MEM-50S PXV-
40E PXV-CVG
LLWS EXP. CONDS CONTG BYD 09Z THRU 15Z.
.
LLWS POTENTIAL...KS MO IL IN KY OK TX AR LA
BOUNDED BY 20NE UIN-40SSW BVT-20S PXV-70SW PXV-20WSW DYR-30WSW
ELD-20NW AEX-30NNE PSX-50NW CRP-30SE JCT-30WSW TTT-30SSE SPS-30W
END-40S COU-20NE UIN
LLWS EXP. CONDS CONTG BYD 09Z THRU 15Z.
.
OTLK VALID 0900-1500Z
AREA 1...TURB ND SD NE KS MN IA OK TX
BOUNDED BY 70SE YWG-30ENE FSD-40NNW SLN-40NW END-30SSW SPS-INK-

[24] 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.

30ESE TBE-50W LBL-GLD-BFF-70SW RAP-50NNW ISN-70SE YWG
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 15Z.
.
AREA 2...TURB NE KS IA MO WI LM MI IL IN KY OK TX AR TN LA MS AL
AND CSTL WTRS
BOUNDED BY 40NE BAE-40SSE ECK-FWA-CVG-HNN-HMV-GQO-50SW PZD-40W
CEW-130ESE LEV-120SSW LCH-80E BRO-90W BRO-DLF-50WSW ICT-50W PWE-
40SE DSM-40NE BAE
MOD TURB BLW FL180. CONDS CONTG THRU 15Z.
....

WAUS43 KKCI 240245
WA3S
CHIS WA 240245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 240900
.
AIRMET IFR...MO MI LH IL IN KY OK TX AR TN LA MS AL
FROM 20WNW ECK TO 30SSE ECK TO FWA TO CVG TO HNN TO HMV TO GQO
TO 40SW IGB TO 30SE MLU TO 50SW GGG TO 20NNW MLC TO 30SSW OSW TO
40NNE SGF TO 40WSW BVT TO 40ESE GIJ TO 20WNW ECK
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET IFR...MN IA WI LM LS MI
FROM 50S YWG TO 30N INL TO YQT TO 70NE SAW TO 60SW TVC TO 30E
BAE TO 40SE ODI TO 30SE DSM TO 40WNW DSM TO 40NW RWF TO FAR TO
50S YWG
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET MTN OBSCN...KY TN
FROM HNN TO HMV TO GQO TO 50WSW LOZ TO HNN
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.
.
OTLK VALID 0900-1500Z...IFR MO LM MI LH IL IN KY AR TN LA MS AL
BOUNDED BY 30SW ASP-50ENE ECK-30SE ECK-FWA-CVG-HNN-HMV-GQO-40ESE
MSL-20SW IGB-30S EIC-20N FSM-20WSW SGF-50SSW COU-30W STL-50E UIN-
20S BDF-20N ORD-40NE MKG-30SW ASP
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 15Z.
....
WAUS43 KKCI 240245
WA3Z
CHIZ WA 240245
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 240900
.
AIRMET ICE...MN IA WI LM LS MI LH IL
FROM 60ENE INL TO YQT TO SSM TO 60SE SSM TO 40SW TVC TO 50ENE BAE
TO 20WNW BDF TO 20ESE IOW TO 40SW IOW TO 20E DSM TO 30WNW MSP TO
60ENE INL
MOD ICE BTN FRZLVL AND 150. FRZLVL SFC-020. CONDS CONTG BYD 09Z
THRU 15Z.
.
AIRMET ICE...KS MO LM MI IL IN KY OK AR
FROM 30ESE MBS TO DXO TO FWA TO 50WSW ROD TO 50NE FAM TO 20ENE
ARG TO 20NW MEM TO 40NW MLC TO 40S IRK TO 20W UIN TO 40WNW PMM TO
30ESE MBS
MOD ICE BTN FRZLVL AND FL210. FRZLVL SFC-040. CONDS CONTG BYD 09Z
THRU 15Z.

.
AIRMET ICE...MO IL IN KY AR TN MS AL
FROM 50WSW ROD TO CVG TO HNN TO HMV TO GQO TO LGC TO 20SW IGB TO
30ESE SQS TO 40NNE SQS TO 20NW MEM TO 20ENE ARG TO 50NE FAM TO
50WSW ROD
MOD ICE BTN FRZLVL AND FL240. FRZLVL 040-100. CONDS CONTG BYD 09Z
THRU 15Z.
.
OTLK VALID 0900-1500Z
AREA 1...ICE ND SD
BOUNDED BY 60NE MOT-20N ABR-20SSE DPR-80SW DIK-50NNW ISN-60NE MOT
MOD ICE BTN 040 AND 150. CONDS DVLPG 09-12Z. CONDS CONTG THRU
15Z.
.
AREA 2...ICE MO IL KY OK TX AR TN LA MS AL
BOUNDED BY 30WSW PXV-30NE MSL-MEI-40SSE MHZ-20NNW LCH-20NNW
LFK-40SW FSM-RZC-20ENE SGF-30WSW PXV
MOD ICE BTN FRZLVL AND FL180. FRZLVL 020-060. CONDS CONTG THRU
15Z.
.
AREA 3...ICE IA MO WI LM MI LH IL IN
BOUNDED BY 60NW YVV-YVV-50E ECK-DXO-FWA-40WSW ROD-30WSW PXV-20ENE
SGF-30SSW COU-40NNW UIN-20SW BAE-30WSW TVC-30N ASP-60NW YVV
MOD ICE BTN FRZLVL AND FL210. FRZLVL SFC-040. CONDS CONTG THRU
15Z.
.
FRZLVL...RANGING FROM SFC-100 ACRS AREA
  MULT FRZLVL BLW 040 BOUNDED BY 30SE ANW-50SE OBH-30WSW PWE-
    20NNE SLN-50E SLN-40ENE ICT-60SSE HLC-70NW SLN-40NE LBF-
    30SE ANW
  MULT FRZLVL BLW 080 BOUNDED BY 30NW DLL-40NE BAE-20NE ORD-
    50ENE ECK-30SE ECK-FWA-50SW ROD-70ESE STL-40WSW DYR-40SW
    ARG-50ESE UIN-50SSW JOT-40WNW BDF-60S ODI-30NW DLL
  SFC ALG 60NE MMB-40SW ODI-30ESE DBQ-40NE FWA
  040 ALG 20NE ARG-20S FAM-70S AXC-50S FWA
  080 ALG 60WNW BNA-30SSE PXV-60E CVG
....

10.0 Area Forecast

The Area Forecast issued at 1345 CST, valid at the accident time, forecasted a broken ceiling at 5,000 feet msl layered clouds through FL250:

FAUS43 KKCI 231945
FA3W
_CHIC FA 231945
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 241400
CLDS/WX VALID UNTIL 240800...OTLK VALID 240800-241400
ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY
.
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...19Z CDFNT FM NCNTRL MN-SE NEB. TROUGH FM NERN
KY-SCNTRL KY. BY 14Z SFC LOW NWRN NEB WITH WRMFNT EXTDG TO SCNTRL
NEB. CDFNT FM NCNTRL NEB-SWRN NEB. CDFNT FM NRN LWR MI-NRN WI.
.
ND
W...SKC. 06Z SCT050. 08Z BKN050 LYRD FL180. ISOL -SHSN.
OTLK...VFR SHSN.
CNTRL...SCT-BKN140 LYRD FL250. 22Z SCT140. 08Z SCT050. OTLK...VFR
AFT 10Z SHSN.
E...BKN035 LYRD 160. 21Z BKN040 TOP 070. OTLK...VFR.
.
SD
W...SCT CI. TIL 23Z WND NW 25G35KT. OTLK...VFR.
CNTRL...SKC. 08Z SCT050 SCT CI. OTLK...VFR.
NERN...BKN050 TOP 070. OTLK...VFR.
SE...SCT-BKN035 TOP 050. 23Z SCT050. OTLK...VFR.
.
NE
W...SKC. TIL 00Z WND NW 20G30KT. 08Z SCT CI. OTLK...VFR.
CNTRL...SCT CI. TIL 23Z WND NW G25KT. OTLK...VFR.
E...SCT030 SCT CI. OTLK...VFR.
.
KS
NW...SCT CI. TIL 00Z WND NW 20G30KT. 01Z SKC. OTLK...VFR.
SW...SCT070 SCT CI. WND N 25G35KT. 02Z SCT CI. 06Z SKC.
OTLK...VFR.
CNTRL...BKN070 LYRD FL250. WND N 25KT. 00Z BKN-SCT CI. TIL 03Z
WND N 25KT. OTLK...VFR.
NERN...BKN CI. 21Z BKN060 LYRD FL250. 03Z SCT-BKN CI. 08Z BKN035
TOP 050. OTLK...VFR.
SE...BKN080 LYRD FL250. 06Z BKN060 TOP 080. OTLK...VFR.
.
MN
NW...OVC015 TOP 120. 22Z BKN020 TOP 070. 02Z BKN040 TOP 050.
OTLK...VFR.
NERN...OVC025 TOP 150. VIS 4SM -SN. 23Z WDLY SCT -SHSN. 03Z TOP
080. OTLK...MVFR CIG.
SW...OVC030 TOP 060. 03Z SCT030. OTLK...VFR.
SE...BKN025 TOP 070. 00Z OVC010 TOP 100. 08Z TOP 060. OTLK...MVFR
CIG.
.
IA
NW...BKN030 TOP 060. 00Z TOP 040. OTLK...MVFR CIG.
NERN...BKN050 TOP 120. 03Z OVC030 TOP 050. OTLK...MVFR CIG.
SW...SCT050 SCT CI. 23Z SCT-BKN CI. OTLK...VFR.
SE...BKN CI. OTLK...VFR.
.
MO
NW...BKN100 LYRD FL250. 03Z BKN CI. 07Z BKN030 TOP 050. WND NW
G25KT. OTLK...MVFR CIG WND.
NE...BKN CI. 03Z BKN050 LYRD FL250. 08Z BKN030 TOP 070.
OTLK...MVFR WND.
SW...OVC100 LYRD FL250. 03Z OVC025. VIS 5SM -RA BR. WND NELY
G25KT. 06Z VIS 5SM -RASN. WND N G25KT. OTLK...MVFR CIG RASN WND.
SE...BKN080 LYRD FL250. 01Z BKN040. -RA BR. WND NELY 20G30KT. 03Z
OVC010. VIS 4SM -RA. OTLK...IFR CIG RA.

.
WI
NW...OVC030 TOP 140. TIL 23Z VIS 3-5SM -SHSN BR. 08Z TOP 080.
OTLK...MVFR CIG.
NERN...OVC035 TOP 060. 22Z TOP 150. WDLY SCT -SHSN. 06Z OVC020
TOP 100. VIS 3SM BR. OTLK...IFR CIG BR.
SRN HLF...SCT025 BKN050 TOP 070. OTLK...VFR.
.
LS UPR MI
W...OVC030 TOP 160. -SN. 23Z VIS 4-5SM -SN. 06Z TOP 070.
OTLK...IFR CIG 12Z MVFR CIG.
E...BKN040 LYRD 100. 06Z BKN030 TOP 050. OTLK...MVFR CIG SN.
.
LM LWR MI LH
NRN HLF...BKN040 LYRD FL250. 08Z SCT040 BKN CI. OTLK...VFR.
SRN HLF...SCT CI. 08Z BKN015 LYRD FL250. OTLK...MVFR CIG.
.
IL
N...SCT-BKN CI. OTLK...VFR.
CNTRL...BKN CI. 05Z WND NELY G25KT. 08Z BKN060 LYRD FL250. -RA
WND NELY 25G35KT. OTLK...VFR RA WND 12Z MVFR CIG RA WND.
S...SCT035 BKN CI. 00Z BKN025 LYRD FL250. -RA. WND NELY 20G30KT.
03Z OVC010. VIS 3SM -RA BR. WND NELY 20G30KT. OTLK...IFR CIG RA
BR WND.
.
IN
N...SCT-BKN CI. 08Z SCT025 BKN100 LYRD FL250. OTLK...VFR 10Z MVFR
CIG WND AFT 12Z RASN.
CNTRL...BKN CI. 02Z OVC060 LYRD FL250. 05Z OVC020. VIS 4SM -RA
BR. WND NELY G25KT. 08Z OVC015. VIS 3SM -RA BR. WND NELY 20G30KT.
OTLK...IFR CIG RA BR WND.
S...BKN CI. 23Z BKN050 LYRD FL250. 02Z OVC020. -RA BR. WND NELY
G25KT. 04Z OVC010. VIS 3SM -RA BR. OTLK...IFR CIG RA BR WND.
.
KY
W...OVC100 LYRD FL250. 00Z OVC020. -RA BR. WND NELY 20G30KT. 02Z
OVC010. VIS 3SM -RA BR. WND NELY 20G30KT. OTLK...IFR CIG RA BR
WND.
CNTRL...BKN035 TOP 070. 00Z BKN025 LYRD FL250. BR. 02Z OVC015.
VIS 3SM SCT -SHRA BR. 06Z VIS 3SM -RA BR. WND ELY G25KT.
OTLK...IFR CIG RA BR WND.
E...BKN025 TOP 100. ISOL -SHRA. 01Z LYRD FL250. VIS 3SM SCT -SHRA
BR. OTLK...MVFR CIG SHRA BR.
....

11.0 Terminal Aerodrome Forecast

KSTL was the closest site with an NWS Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 2105 CST and was valid for a 27-hour period beginning at 2100 CST. The 2105 CST TAF was an amendment from the 1737 CST TAF and was the KSTL TAF provided to the accident pilots before their flight. The TAF for KSTL was as follows:

KSTL 240305Z 2403/2506 **02018G30KT P6SM OVC090**

FM240600 01022G32KT 5SM -RA BR OVC035
FM240900 36025G35KT 1 1/2SM -SN BR OVC012
FM241300 35025G38KT 3/4SM -SN BR OVC007
FM241600 35023G33KT 3SM -SN BR OVC015
FM241900 33022G33KT P6SM OVC025
FM242200 33021G31KT P6SM OVC050=

The forecast expected a wind from 020° at 18 knots with gusts to 30 knots, greater than 6 miles visibility, and an overcast ceiling at 9,000 feet agl.

The TAF issued before the one valid at the accident time was issued at 1737 CST and was valid for a 30-hour period beginning at 1800 CST. The 1737 CST TAF for KSTL was as follows:

TAF KSTL 232337Z 2400/2506 **02016G24KT P6SM OVC090**
FM240600 01022G32KT 5SM -RA BR OVC035
FM240900 36025G35KT 1 1/2SM -SN BR OVC012
FM241300 35025G38KT 3/4SM -SN BR OVC007
FM241600 35023G33KT 3SM -SN BR OVC015
FM241900 33022G33KT P6SM OVC025
FM242200 33021G31KT P6SM OVC050=

The forecast expected a wind from 020° at 16 knots with gusts to 24 knots, greater than 6 miles visibility, and an overcast ceiling at 9,000 feet agl. The TAFs did not include any mention of LLWS during the accident period.

12.0 Winds and Temperature Aloft Forecast

The NWS Winds and temperature aloft forecast valid for the flight is included below:

WINDS ALOFT FORECASTS
DATA BASED ON 240000Z
VALID 240600Z FOR USE 0200-0900Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
MEM	9900	2229+03	2133-02	2129-08	1843-21	1843-31	195337	215940	237440
CGI	0561	0938+04	1232-01	1432-05	1635-15	1643-27	165644	176454	216945
STL	0444	0440-05	0724-05	1116-08	1715-19	1740-29	177045	187753	214947
COU	0438	0343-05	0235-08	0218-10	1508-20	1726-31	166147	186751	233147
SPI	0535	0529-05	0519-07	1409-07	1619-20	1945-29	187645	198854	225448

The STL forecast indicated a wind at 3,000 feet from 040° at 44 knots, at 6,000 feet from 040° at 40 knots with a temperature of -5° C.

13.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in St Louis, Missouri, issued an Area Forecast Discussion (AFD) at 1453 CST. The aviation section of the AFD discussed the expected snow moving over KSTL after the accident time and when conditions would become IFR. There was no mention of the gusty surface wind conditions:

FXUS63 KLSX 232053

AFDLSX
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE ST LOUIS MO
253 PM CST TUE FEB 23 2016
.SHORT TERM: (Through Wednesday)
Issued at 245 PM CST Tue Feb 23 2016
Have made some significant adjustments to the forecast that include metro St. Louis. A winter weather advisory and a wind advisory has already been issued for late tonight and tomorrow. Water vapor shows that the upper low is bottoming out over the Southern Plains that will move northeast tonight and tomorrow morning through the Mid South into the Ohio Valley. The 12Z run of the GFS showed a slight shift to the northwest with the axis of the precipitation whereas the 12Z ECMWF is slightly farther to southeast. GFS is showing intense frontogenesis that will move along the northwestern edge of precipitation band from the eastern Ozarks into central Illinois including the St. Louis metro area from 09-15Z that will likely be producing heavy precipitation rates. Forecast soundings indicate that this will be snow. The latest runs from the HRRR, WRF, and RAP all are supporting this, showing mesoscale banding moving up into eastern Missouri and southwestern Illinois late tonight and early Wednesday. So expect precipitation to move into the area this evening and overnight through the morning hours, with more snow now given the amount of forcing slightly colder soundings.
This now justifies issuing an advisory for the southeastern half of the CWA of snowfall amounts. There will be a time in the morning where the snow could be heavy at times with big wet heavy flakes. It will also be windy as the pressure gradient will be tightening as the surface low deepens. Have also issued a wind advisory for the same location as the winter weather advisory.
Have lowered temperatures below guidance. Temperatures will be hampered from rising tomorrow by the clouds and the precipitation. Precipitation will end from west to east during the afternoon as the system begins to lift out of the area.
Britt
.LONG TERM: (Wednesday Night through Next Tuesday)
Issued at 245 PM CST Tue Feb 23 2016
Still looks like we will stay dry from Thursday into Saturday as there will not be much moisture to work with under northwesterly flow aloft. Temperatures will go from below normal to back above normal for the weekend. Still looks like a system will bring us a chance of precipitation on Sunday night.
Britt
&&
.AVIATION: (For the 18z TAFs through 18z Wednesday Afternoon)
Issued at 1130 AM CST Tue Feb 23 2016
For KUIN/KCOU...VFR and dry thru most of the period. Cigs will gradually lower this evening. Cigs shud drop into high-end MVFR at COU Wed morning. Otherwise, winds will increase and back slightly overnight.
Specifics for KSTL/KSUS/KCPS: The forecast is still being updated, but latest guidance suggests a band of SN will set up further NW than initially thought. This would place a band of SN to impact terminals late tonight thru mid Wed morning. Since exactly where this band will set up will have a huge impact on

visbys, kept visbys in low IFR for now. Snowfall amounts are also still being worked out, but latest thoughts of 3 inches, possibly more, are currently expected.
Tilly
&&
.LSX WATCHES/WARNINGS/ADVISORIES:
MO...Winter Weather Advisory from midnight tonight to 6 PM CST Wednesday FOR Crawford MO-Franklin MO-Iron MO-Jefferson MO-Madison MO-Reynolds MO-St. Charles MO-St. Francois MO-St. Louis City MO-St. Louis MO-Ste. Genevieve MO-Washington MO.
Wind Advisory from midnight tonight to 6 PM CST Wednesday FOR Crawford MO-Franklin MO-Iron MO-Jefferson MO-Madison MO-Reynolds MO-St. Charles MO-St. Francois MO-St. Louis City MO-St. Louis MO-Ste. Genevieve MO-Washington MO.
IL...Winter Weather Advisory from midnight tonight to 6 PM CST Wednesday FOR Madison IL-Monroe IL-Randolph IL-St. Clair IL.
Wind Advisory from midnight tonight to 6 PM CST Wednesday FOR Bond IL-Clinton IL-Fayette IL-Jersey IL-Macoupin IL-Madison IL-Marion IL-Monroe IL-Montgomery IL-Randolph IL-St. Clair IL-Washington IL.
Winter Weather Advisory from 6 AM to 6 PM CST Wednesday FOR Bond IL-Clinton IL-Fayette IL-Jersey IL-Macoupin IL-Marion IL-Montgomery IL-Washington IL.
&&
$$

14.0 National Weather Service Winter Weather Advisory

The National Weather Service Office in St Louis, Missouri, issued a Winter Weather Advisory (WSW) at 1425 CST. The WSW did not go into effect across the St Louis metro area until 0000 CST on February 24, when the snow was most likely to begin across the region with 2 to 5 inches of snow expected between 0000 CST and 1800 CST on February 24:

WWUS43 KLSX 232025
WSWLSX
URGENT - WINTER WEATHER MESSAGE
NATIONAL WEATHER SERVICE ST LOUIS MO
225 PM CST TUE FEB 23 2016
ILZ079-100>102-MOZ061>065-072>075-084-085-099-240830-
/O.NEW.KLSX.WW.Y.0005.160224T0600Z-160225T0000Z/
CRAWFORD MO-FRANKLIN MO-IRON MO-JEFFERSON MO-MADISON IL-
MADISON MO-MONROE IL-RANDOLPH IL-REYNOLDS MO-ST. CHARLES MO-
ST. CLAIR IL-ST. FRANCOIS MO-ST. LOUIS CITY MO-ST. LOUIS MO-
STE. GENEVIEVE MO-WASHINGTON MO-
INCLUDING THE CITIES OF...BELLEVILLE...CHESTER...EDWARDSVILLE...
FARMINGTON...ST CHARLES...ST LOUIS...UNION
225 PM CST TUE FEB 23 2016
...WINTER WEATHER ADVISORY IN EFFECT FROM MIDNIGHT TONIGHT TO 6 PM CST WEDNESDAY...
THE NATIONAL WEATHER SERVICE IN ST LOUIS HAS ISSUED A WINTER WEATHER ADVISORY FOR SNOW ...WHICH IS IN EFFECT FROM MIDNIGHT TONIGHT TO 6 PM CST WEDNESDAY.
* TIMING...ACCUMULATING SNOW IS EXPECTED LATE TONIGHT AND WEDNESDAY.
* ACCUMULATIONS...ACCUMULATIONS OF 2 TO 5 INCHES OF SNOW IS

EXPECTED.
* WINDS...NORTH 15 TO 25 MPH WITH GUSTS UP TO 45 MPH.
* IMPACTS...THE WINTRY PRECIPITATION WILL RESULT IN HAZARDOUS
TRAVEL CONDITIONS...ESPECIALLY ON BRIDGES...OVERPASSES...AND
UNTREATED ROADS. PARKING LOTS AND SIDEWALKS WILL BECOME SLIPPERY
AS WELL.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WINTER WEATHER ADVISORY IS ISSUED FOR A VARIETY OF WINTER
WEATHER CONDITIONS...SUCH AS SNOW...BLOWING SNOW...SLEET...OR
FREEZING DRIZZLE AND RAIN. IT ONLY TAKES A SMALL AMOUNT OF WINTRY
PRECIPITATION TO MAKE ROADS...BRIDGES...SIDEWALKS...AND PARKING
LOTS ICY AND DANGEROUS. IT IS OFTEN DIFFICULT TO TELL WHEN ICE
BEGINS TO FORM...SO DO NOT BE CAUGHT OFF GUARD.
&&
$$

15.0 Pilot Weather Briefing and Dispatch Information[25]

In the dispatch release for the accident flight, the accident pilots had access to weather information issued at 2150 CST that mentioned the winds aloft between the departure and destination, METARs from the departure and destination, TAFs from the departure and destination, AIRMETs, and a convective SIGMET valid across Mississippi, Louisiana, and Arkansas, well south of the accident site, and notice to airmen. No weather information was passed via ACARS messaging before, during, or after the flight.

16.0 Pilot Statements[26]

The accident flight captain mentioned encountering continuous light chop and light icing conditions from FL220 down to the approach with all the ice clear from the aircraft before starting the approach. The accident flight captain mentioned that they were clear of clouds by 5,000 to 6,000 feet with a smooth ride on the approach into KSTL. During the approach into KSTL, the accident flight captain mentioned receiving the wind from the tower as 020° at 20 knots, with the wind conditions through the approach as “remarkably smooth and stable.” The accident flight captain said that there was a strong increase in the crosswind during the flare.

The accident flight first officer, and pilot flying during the first approach into KSTL, mentioned the wind received from the tower as 020° at 20 knots with gusts to 25 knots during the approach. The accident flight first officer remembered having a 5 knot gain/loss of airspeed between 1,300 and 1,700 feet agl, with the accident airplane becoming stabilized prior to reaching 1,000 feet agl. The accident flight first officer described the approach as stable from 1,000 feet down to 100 feet agl. At the 20 foot call, the accident flight first officer had the power at idle, pitch to 3-4 degrees, left rudder to the usefulness of maintaining the aircraft longitudinal axis parallel with the runway and full right aileron. At that moment the accident flight first officer described the plane was slightly pitched up, longitude axis was parallel with that of the runway and the upwind wing was slightly more down than the downwind wing. The accident

[25] For more information see the Operational factors factual and attachments contained in the docket for this accident.
[26] For more information see the Operational factors factual and attachments contained in the docket for this accident.

flight first officer felt the airplane starting to roll to the left, the nose was starting to yaw left and pitch up all at the same time, and felt some loss of control of the aircraft so decided to go around.

None of the weather information mentioned by the accident pilots in the 2 paragraphs previous was passed along as a PIREP either to company dispatch or air traffic control. While PIREPs were not required to be solicited or given, due to the higher cloud ceiling conditions, this PIREP information would have likely benefited other flights. No other flights before or after the accident flight provided PIREP information and there were no PIREPs valid near the accident site at the accident time.

There is no knowledge of any additional weather briefing information the accident pilots received.

17.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on February 23, 2016, indicated the following:

SUN	
Begin civil twilight	0615 CST
Sunrise	0642 CST
Sun transit	1214 CST
Sunset	1747 CST
End civil twilight	1814 CST
MOON	
Moonrise	1758 CST on preceding day
Moon transit	0034 CST
Moonset	0704 CST
Moonrise	1854 CST

During the accident time the Moon would have been visible above the clouds (30,000 feet msl, section 5.0) with 99% of the Moon's visible disk illuminated.

F. LIST OF ATTACHMENTS

None.

Paul Suffern
NTSB, AS-30