National Transportation Safety Board

Office of Aviation Safety
Washington, D.C. 20594-2000
July 7, 2008

METEOROLOGICAL FACTUAL REPORT

CHI08FA128

A. ACCIDENT

Location: La Crosse, Wisconsin
Date: May 10, 2008
Time: 2245 central daylight time (0345 UTC[1] on May 11, 2008)
Aircraft: Air Methods Eurocopter EC-135; registration: N135UW

B. METEOROLOGICAL SPECIALIST

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C. SUMMARY

On May 10, 2008, about 2245 central daylight time, a Eurocopter Deutschland EC 135 T2+ air medical configured helicopter, N135UW, operated by Air Methods Corporation, was destroyed during an in-flight collision with trees and terrain near La Crosse, Wisconsin. The flight was conducted in accordance with Title 14 Code of Federal Regulations Part 135 without a flight plan. The helicopter's position was being monitored according to the operator's flight following procedures. Night visual meteorological conditions prevailed. The pilot, physician and flight nurse sustained fatal injuries. The flight departed La Crosse Airport (KLSE), La Crosse, Wisconsin, at 2234. The intended destination was the University of Wisconsin Hospital Heliport (WS27) in Madison, Wisconsin.

The helicopter was equipped with global positioning system (GPS) tracking equipment that provided departure, arrival and en route position information to the operator's Operations Control Center. Flight progress was automatically updated every three minutes. According

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

the GPS flight-following data, the flight initially departed WS27 about 2038 en route to Prairie du Chien Memorial Hospital, Prairie du Chien, Wisconsin. The flight arrived at Prairie du Chien about 2113 and picked up a patient. The flight subsequently departed about 2131 and proceeded to Gunderson-Lutheran Hospital in La Crosse, arriving about 2154. After dropping off the patient, the crew departed about 2209 and repositioned the helicopter to KLSE for refueling. The flight departed KLSE, elevation 654 feet, at 2234 with the intention of returning to WS27. No further position updates were received from the accident helicopter.

Local authorities received a 911 call from a resident stating that they thought they had heard an aircraft crash. At 2304, the helicopter operator notified local authorities that the aircraft was missing. A search subsequently located the helicopter wreckage about 0900 the next morning.

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorology specialist was not on scene for this investigation and gathered all the weather data for this investigation from the Washington D.C. office from official National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), and National Climatic Data Center (NCDC) sources. All times are Coordinated Universal Time (UTC) based upon the 24 hour clock. Local time of central daylight time (CDT) is +5 hours to UTC, and UTC=Z. Directions are referenced to true north and distances are 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 plots are based on the last recorded position at latitude 43.8419° North and longitude 91.1655° West.

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) located in Camp Springs, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45.

1.0.1 Surface Analysis Chart

The NWS Surface Analysis Charts for 2200 CDT May 10, 2008 (0300Z May 11, 2008) and 0100 CDT (0600Z) on May 11, 2008, are included as figures 1 and 2 respectively. A

small circle marks the approximate location of the accident site. The charts depicted the primary synoptic features at the surface surrounding the period of the accident.

The NWS Surface Analysis Chart for 2200 CDT on May 10, 2008 (figure 1) depicted a low pressure system with a central pressure of 995-hectopascals (hPa)[2] to the south of the accident site over northern Missouri with an occluded front extending southward from the low. Several troughs of low pressure extended from the main low south, north, and northeastward across Iowa and into northwestern Illinois in the vicinity of the accident site. Another low pressure system with a central pressure of 1005-hPa was located to the west over south-central Minnesota with a stationary front extending north-northeast through Minnesota, northern Wisconsin, Lake Superior, into northern Michigan. The stationary front was immediately west and northwest of Minneapolis and the accident site. To the south-southwest of the low a dissipating (frontolysis[3]) cold front was depicted from Minnesota, Iowa, southeastern Nebraska, into eastern Kansas. The station models depicted an extensive area of overcast clouds and rain north of the low and along the occluded front, and a defined cyclonic circulation in the wind field around the deep low pressure system over Missouri. To the north of the low, the chart indicated a slightly weaker pressure gradient with a deformation zone[4] noted between the two low pressure systems, which resulted in an area of calm winds over western Wisconsin. The La Crosse station mode indicted calm wind, continuous light rain, temperature of 50 degrees Fahrenheit (F), a dew point temperature of 46 degrees F, a sea level pressure of 1006.3-hPa, and a decreasing pressure tendency of 1.5-hPa over 3-hours.

[2] Hectopascal is the new standard unit for pressure and is interchangeable with the term millibar.

[3] Frontolysis – the dissipation of a front or frontal zone. In general, a decrease in the horizontal pressure gradient of an air mass property, principally density, and the dissipation of the accompanying features of the wind field.

[4] Deformation zone – a region of the atmosphere where the of the velocity field results in a change in shape of a fluid mass by spatial variations in the velocity field, specifically by stretching or shearing.

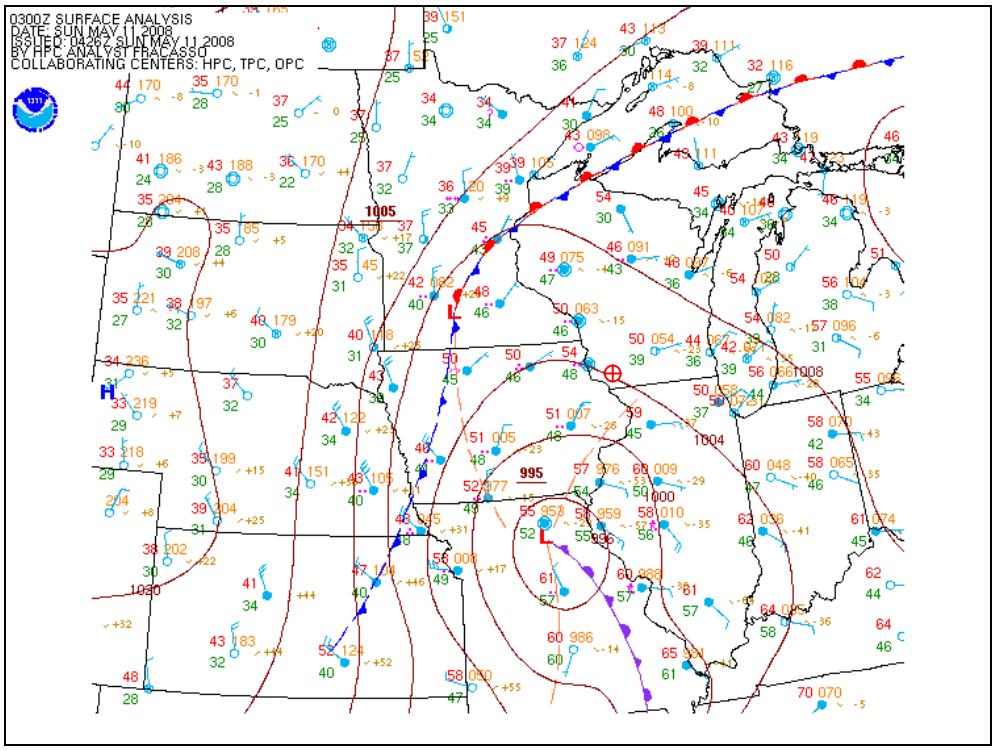


Figure 1 – NWS Surface Analysis Chart for 2200 CDT

The NWS Surface Analysis for 0100 CDT on May 11, 2008 (figure 2) immediately after the accident indicated that the primary low pressure system had moved into southeast Iowa and had deepened to 990-hPa, with an occluded front extending southward from the low into western Illinois and into the boot heal of Missouri. A trough of low pressure extended from the low northeastward into eastern Iowa and northern Illinois, immediately south of the accident site. The stationary front continued to be depicted over Minnesota, northern Wisconsin, Lake Superior, into northern Michigan, to the west and northwest of the accident site and in the immediate vicinity of Minneapolis. The second low pressure system and dissipating cold front over Minnesota were no longer depicted on the chart. The station models in the vicinity of the accident site indicated winds from the north at 5 knots, continuous rain, overcast skies, temperature of 49 degrees F, a dew point temperature of 46 degrees F, sea level pressure 1004.4-hPa, with pressure decreasing of 1.8-hPa over 3-hours.

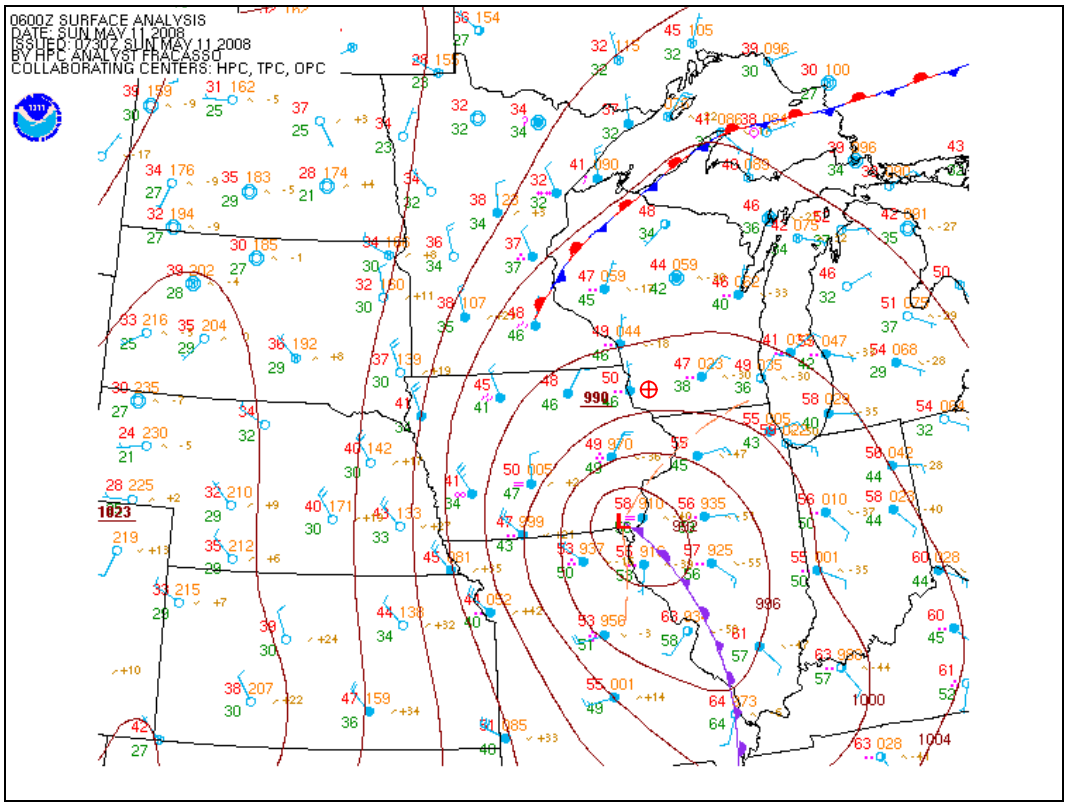


Figure 2 – NWS Surface Analysis Chart for 0100 CDT

1.0.2 Weather Depiction Chart

The north-central section of the NWS Weather Depiction Chart for 2300 CDT (0400Z on May 11, 2008) is included as figure 3. The chart depicted an area of instrument flight rule (IFR) conditions[5] over northern and southern Minnesota, and portions of Iowa by a shaded contour line. Surrounding that area was an area of marginal visual flight rules (MVFR) conditions[6] indicated by an unshaded contour over most of Minnesota, Iowa, western Wisconsin and Illinois, and northern Missouri. Visual flight rule (VFR) conditions[7] without a contour line extended over central and eastern Wisconsin and Illinois. The general route of flight, the accident site and the destination were in the area of MVFR conditions, with visibility restricted in rain and low overcast sky conditions.

[5] IFR conditions – are defined as a ceiling or lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration of less than 1,000 feet above ground level (agl) and/or visibility less than 3 statute miles.

[6] MVFR conditions – are defined as a ceiling between 1,000 and 3,000 feet agl inclusive and/or visibility 3 to 5 miles inclusive.

[7] VFR conditions – are defined as no ceiling or a ceiling greater than 3,000 feet agl and visibility greater than 5 miles.

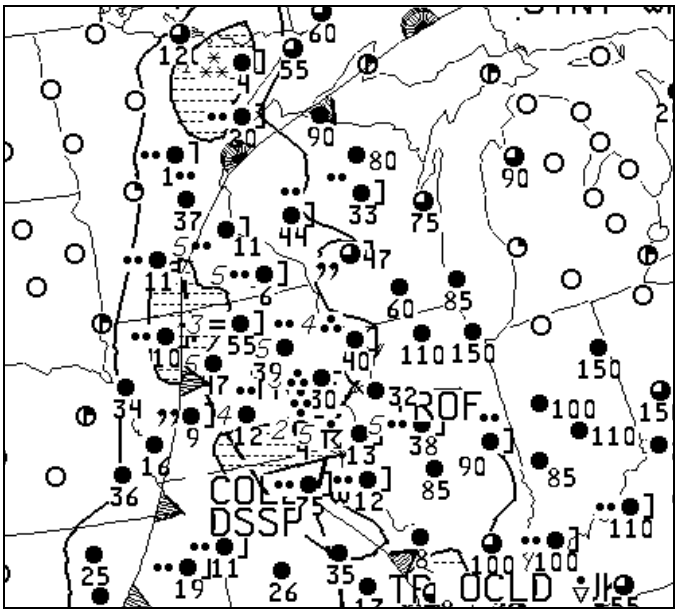


Figure 3 – NWS Weather Depiction Chart for 2300 CDT

1.0.3 Radar Mosaic Chart

The north-central portion of the NWS hourly radar mosaic image for 2300 CDT (0400Z on May 11, 2008), from the NCDC archive site is included as figure 4. The image depicted a large comma shaped precipitation pattern associated with the occluded front over Iowa, Missouri, Illinois, into southwestern Wisconsin, with echoes in the 35 to 45 decibel (dBZ) range. A second band of echoes extended in an east-to-west orientation across southeastern Minnesota, Wisconsin, into Lake Michigan, with echoes in the range of 20 to 30 dBZ. This band was in the general vicinity of the accident site.

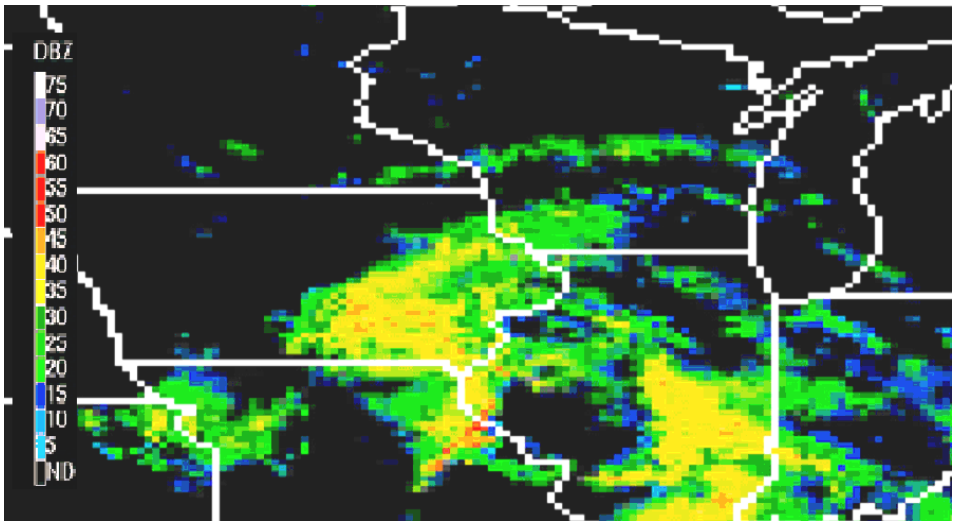


Figure 4 - NWS radar mosaic for 2300 CDT

Based on the radar mosaic image depicted the potential for echoes in the vicinity of the accident site, therefore closest weather surveillance radar was documented and is included in section 5.0 of this report.

2.0 Surface Observations

The surrounding area was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations are taken from standard code provided in plain language, with cloud heights reported above ground level (agl). All the airports below had an Automated Weather Observation Systems (AWOS-3) or Automated Surface Observation System (ASOS) installed.

2.0.1 La Crosse Municipal Airport (KLSE), La Crosse, Wisconsin

The closest weather reporting facility to the accident site was from La Crosse Municipal Airport (KLSE), La Crosse, Wisconsin, located approximately 5 miles northwest of the accident site. The airport was located east of the Mississippi River at an elevation of 656 feet msl. The airport had an augmented ASOS system installed and reported the following conditions surrounding the period:

2153 CDT - *METAR KLSE 110253Z AUTO 00000KT 4SM -RA BR SCT013 OVC035 10/08 A2972 RMK AO2 RAB0154 SLP063 P0004 60008 T01000078 56015*
2253 CDT - *METAR KLSE 110353Z AUTO 00000KT 8SM -RA FEW014 OVC050 10/08 A2970 RMK AO2 SLP056 P0008 T01000078*
2330 CDT - *SPECI KLSE 110430Z AUTO 04004KT 6SM -RA BR BKN014 BKN032 OVC050 09/07 A2968 RMK AO2 P0003*
2353 CDT - *METAR KLSE 110453Z AUTO 00000KT 6SM -RA BR SCT014 BKN032 OVC048 09/07 A2967 RMK AO2 SLP048 P0005 T00940072*

The KLSE weather observation closest to the time accident at 2253 CDT indicated winds calm, visibility 8 miles in light rain, a few clouds at 1,400 feet, ceiling overcast at 5,000 feet, temperature 10 degrees Celsius (C), dew point 8 degrees C, altimeter 29.70 inches of Mercury (Hg). Remarks: automated observation system, sea level pressure 1005.6-hPa, hourly precipitation 0.08-inches, temperature 10.0 degrees C, dew point 7.8 degrees C.

A review of the KLSE ASOS 5-minute observations indicated that at 2145 CDT the system reported winds variable at 3 knots, visibility 7 miles in light rain, ceiling overcast at 5,000 feet, temperature 9 degrees C, dew point 8 degrees C, altimeter 29.70 inches of Hg. Remarks: automated observation system, hourly precipitation 0.08 inches.

The 5-minute ASOS data indicated visibility varied from 4 to 8 miles in light rain within an hour surrounding the accident, with ceilings as low as 1,400 feet after the accident. At no time was IFR conditions reported.

Figure 5 is a Google Earth image of the accident site relative to the airport, which also provides details to the terrain features in the immediate vicinity of the accident site.

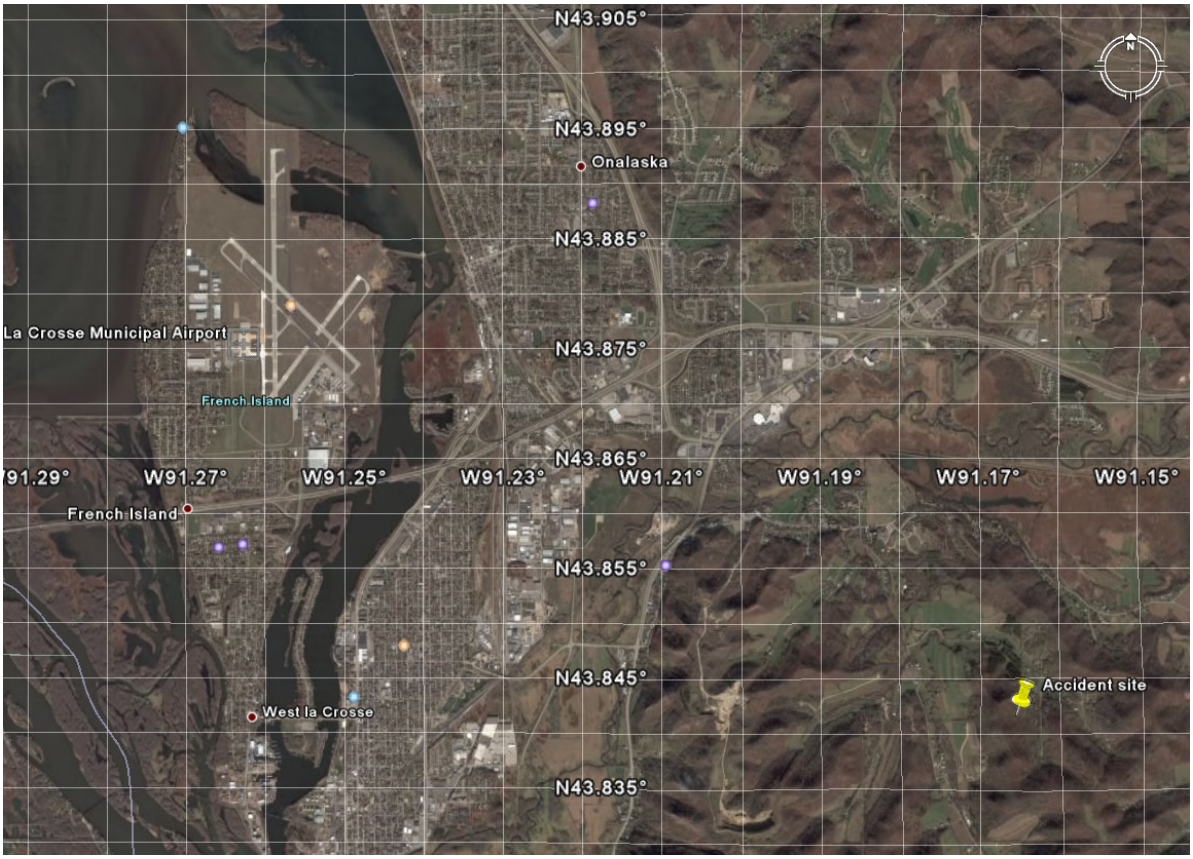


Figure 5 – local terrain features in the vicinity of the accident site

2.0.2 Sparta/Fort Mc Coy Airport (KCMY), Sparta, Wisconsin

Sparta/Fort Mc Coy Airport (KCMY), Sparta, Wisconsin, was located approximately 20 miles northeast of the accident site at an elevation of 837 feet msl. The following conditions were reported surrounding the period:

2235 CDT - *METAR KCMY 110335Z AUTO 04003KT 5SM -RA SCT037 BKN045 OVC050 07/06 A2972 RMK AO2*
2255 CDT - *METAR KCMY 110355Z AUTO 04005KT 7SM -RA SCT031 BKN037 OVC050 07/06 A2971 RMK AO2*
2315 CDT - *METAR KCMY 110415Z AUTO 04004KT 7SM -RA OVC037 07/06 A2970 RMK AO2*
2335 CDT - *METAR KCMY 110435Z AUTO 05004KT 5SM RA BKN037 OVC050 07/06 A2970 RMK AO2*
2355 CDT - *METAR KCMY 110455Z AUTO 05005KT 5SM -RA SCT010 SCT014 OVC035 07/06 A2969 RMK AO2*

2.0.3 Winona Municipal Airport-Max Conrad Field (KONA), Winona, Minnesota

Winona Municipal Airport-Max Conrad Field (KONA) was located 27 miles northwest of the accident site and located immediately west of the Mississippi River at an elevation of 656 feet msl. The following conditions surrounding the period:

2235 CDT - *METAR KONA 110335Z AUTO 08003KT 7SM DZ SCT011 OVC022 10/08 A2973 RMK AO2 P0003*
2255 CDT - *METAR KONA 110355Z AUTO 00000KT 7SM DZ SCT011 OVC020 10/08 A2973 RMK AO2 P0004*
2315 CDT - *METAR KONA 110415Z AUTO 05003KT 7SM DZ SCT013 OVC018 10/08 A2972 RMK AO2*
2335 CDT - *METAR KONA 110435Z AUTO 09004KT 7SM -DZ BKN011 OVC018 10/07 A2971 RMK AO2 P0001*
2355 CDT - *METAR KONA 110455Z AUTO 00000KT 5SM -DZ OVC013 10/08 A2970 RMK AO2 P0001*

2.0.4 Praire du Chien Municipal Airport (KPDC), Praire du Chien, Wisconsin

The departure airport was from Praire du Chien Municipal Airport (KPDC) located approximately 49 miles south of the accident site in the southeast corner of the state of Wisconsin and immediately east of the Mississippi and north of the Wisconsin River, at an elevation of 661 feet msl. The following conditions surrounding the period:

2155 CDT - *METAR KPDC 110255Z AUTO 00000KT 7SM -RA OVC070 12/09 A2965 RMK AO2 P0001*
2215 CDT - *METAR KPDC 110315Z AUTO 00000KT 7SM -RA OVC060 12/09 A2965 RMK AO2*
2235 CDT - *METAR KPDC 110335Z AUTO 00000KT 5SM RA SCT019 SCT036 OVC060 11/09 A2964 RMK AO2 P0003*
2255 CDT - *METAR KPDC 110355Z AUTO 35003KT 5SM -RA SCT019 BKN055 OVC065 11/09 A2963 RMK AO2 P0005*
2315 CDT - *METAR KPDC 110415Z AUTO 36007KT 7SM -RA SCT048 OVC055 11/09 A2962 RMK AO2 P0002*
2335 CDT - *METAR KPDC 110435Z AUTO 03004KT 7SM -RA OVC055 11/09 A2961 RMK AO2 P0003*
2355 CDT - *METAR KPDC 110455Z AUTO 01004KT 7SM -RA BKN044 BKN049 OVC055 11/09 A2960 RMK AO2 P0004*

2.0.5 Boscobel Airport (KOVS), Boscobel, Wisconsin

Boscobel Airport (KOVS) was located approximately 46 miles south-southeast of the accident site and along the Wisconsin River at an elevation of 673 feet msl. The following conditions were reported surrounding the period:

2153 CDT - *METAR KOVS 110253Z AUTO 07003KT 7SM -RA OVC065 11/09 A2967 RMK AO2 SLP050 P0001 60005 T01110094 58023*
2253 CDT - *METAR KOVS 110353Z AUTO 06004KT 7SM -RA OVC070 11/09 A2965 RMK AO2 SLP042 P0001 T01110089*
2353 CDT - *METAR KOVS 110453Z AUTO 03006KT 7SM -RA FEW050 OVC060 11/08 A2961 RMK AO2 SLP029 P0002 T01060083*

3.0 Sounding Data

The closest upper air sounding or rawinsonde observation (RAOB) representative of the air mass was from the NWS Davenport (KDVN), Iowa, site number 74455, located approximately 130 miles south of the accident site at an elevation of 751 feet msl. The observation was obtained from the University of Wyoming's Internet site. The observation was then plotted and analyzed utilizing RAOB[8] software. Figure 6 is the 1900 CDT sounding (0000Z on May 11, 2008) from KDVN plotted on a standard Skew-T log P diagram[9] with the observed and derived stability parameters from the surface to 500-mb or 18,000 feet. The sounding depicted a dry low-level environment with the lifted condensation level (LCL)[10] at 792-hPa or 5,721 feet agl (6,472 feet msl), a convective condensation level (CCL)[11] at 665-hPa or 10,717 feet agl (11,469 feet msl). An inversion was noted between 5,500 and 7,500 feet due to subsidence. The freezing level was identified at 9,922 feet msl. The tropopause height was identified at 37,202 feet msl. The precipitable water value was 0.59 inches.

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

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

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

[11] Convective Condensation Level (CCL) - is the height to which a parcel of air, if heated sufficiently from below, will rise adiabatically until condensation starts. This is typically used to identify the base of cumuliform clouds, which are normally produced from surface heating and thermal convection.

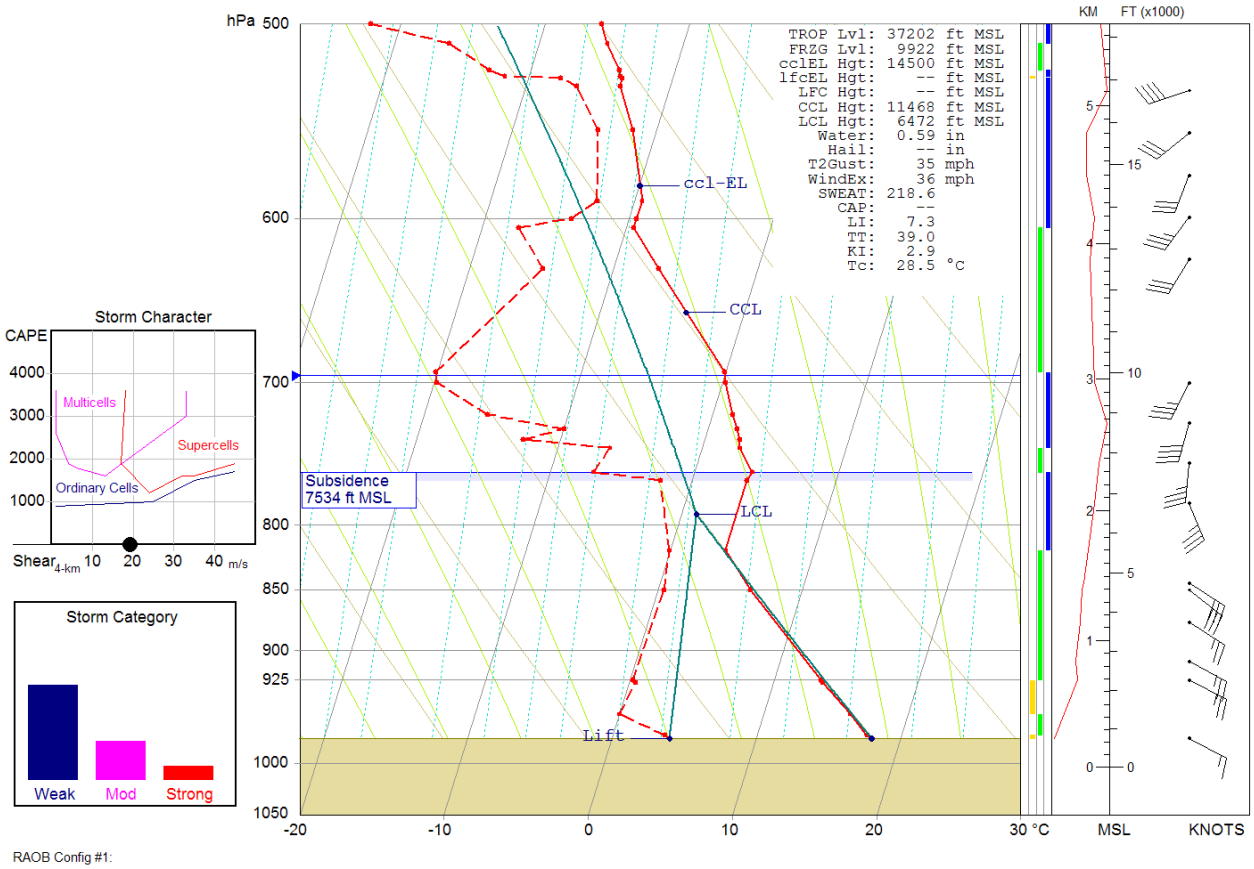


Figure 6 –KDVN 1900 CDT sounding

The sounding stability indices indicated a Lifted Index (LI)[12] of 7.3 and a K-index[13] of 2.9 both of which indicated a stable environment unfavorable for thunderstorm development. The individual layer stability is indicated on the right hand portion of the chart with yellow indicating unstable layer, green conditionally unstable, and blue stable.

The observed heights, pressure, temperature, dew point temperature, relative humidity (RH), wind direction and speed, turbulence and icing potential through 18,000 feet are included below.

[12] Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to some higher level (around 18,000 feet, usually) and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

[13] K-Index - The measure of thunderstorm potential based on the vertical temperature lapse rate, the moisture content of the lower atmosphere and the vertical extent of the moist layer. The higher the K-Index, the greater the probability of air mass type thunderstorms development.

Level	Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (AF)	LLWS	Icing - Type (AF @ 75% RH)
1	751	977.0	18.0	4.0	39	120 / 15			
2	837	974.0	17.6	3.6	39				
3	1387	955.0	16.0	0.0	34				
4	2212	927.0	13.4	0.4	41		L-M		
5	2272	925.0	13.2	0.2	41	120 / 26			
6	2751	908.9				120 / 25	LGT		
7	3751	876.2				125 / 27			
8	4577	850.0	6.4	0.4	65	130 / 28			
9	4751	844.5				125 / 29			
10	5573	819.0	3.8	-0.1	76		L-M		
11	6751	783.6				160 / 34			
12	7324	767.0	3.8	-2.2	65				
13	7534	761.0	4.0	-7.0	45		L-M		
14	7751	754.8				185 / 36			
15	8135	744.0	2.6	-6.4	51				
16	8350	738.0	2.4	-12.6	32				
17	8603	731.0	2.0	-10.0	41		L-M		
18	8751	726.9				195 / 40			
19	8967	721.0	1.4	-15.6	27		L-M		
20	9746	700.0	0.2	-19.8	21	205 / 34			
21	10010	693.0	-0.1	-20.1	21				
22	12523	629.0	-6.9	-14.9	53				
23	12751	623.4				210 / 32			
24	13515	605.0	-9.5	-17.5	52				
25	13726	600.0	-9.5	-14.0	70		LGT		Base:594 mb
26	13751	599.4				215 / 34			
27	14152	590.0	-9.5	-12.6	78		L-M		TRC Rime
28	14751	576.2				200 / 30	L-M		
29	15751	553.8				230 / 30			
30	15834	552.0	-11.7	-14.1	82		L-M		LGT Rime
31	16751	532.2				250 / 40			
32	16854	530.0	-13.5	-16.5	78				LGT Rime
33	17043	526.0	-13.5	-17.8	70				
34	17091	525.0	-13.7	-21.7	51				
35	17234	522.0	-13.9	-22.9	47				
36	17861	509.0	-15.3	-26.3	38		LGT		
37	18303	500.0	-16.1	-32.1	24	260 / 37			
38	18402	498.0	-16.3	-33.3	22				

The sounding wind profile indicated surface winds from 120 degrees at 15 knots with little change in direction through 5,000 feet with winds increasing to 30 knots. Above the inversion at 5,000 feet, winds veered to the south with a low-level wind maximum of 80 knots and then veered to the southwest through 18,000 feet and then to the west. The level of maximum wind was at 41,751 feet above the tropopause, with winds from the west-southwest at 83 knots.

4.0 Aircraft Reports

Data was obtained from the NOAA Forecast Systems Laboratory (FSL) aircraft based observation database of ARINC (Aeronautical Radio Incorporated) Meteorological Data Collection and Reporting System (MDCRS) or internationally known as Aircraft Meteorological Data Relay (AMDAR) reports. Both MDCRS/AMDAR reports are designed to support and improve weather forecasting, particularly for upper-air wind and severe weather. Observations are downlinked from the aircraft to MDCRS via the Aircraft Communications Addressing and Reporting System (ACARS), which is a communication system that reports a number of aircraft parameters such as passenger loading, and dispatch information along with weather information. The observations are then made available to

users through a NWS web site, where ascent and descent soundings are made available to participating users of the system and the NWS. A search of aircraft observations surrounding the period of the accident was conducted and at 1841 CDT (2341Z) an MDCRS equipped aircraft, designated as aircraft #5551 departed from La Crosse Municipal Airport (KLSE) to Minneapolis. The aircraft derived sounding of temperature and dew points is included as figure 7. The report did not include wind information.

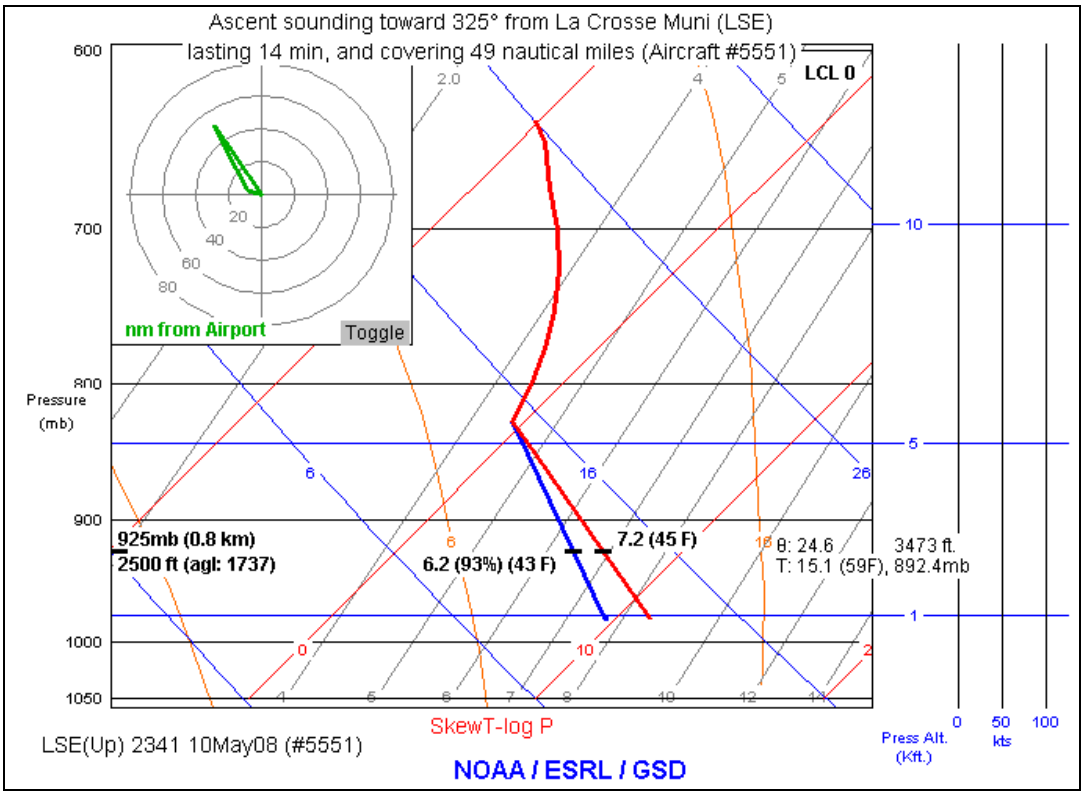


Figure 7 – KLSE Aircraft ascent sounding at 1841

The sounding indicated a more apparent moist low-level environment than the Davenport sounding with relative humidity greater than 90 percent from 1,000 to 12,000 feet. At 2,500 feet, the temperature was 7.2 degrees C, with a dew point temperature of 6.2 degrees C, with a relative humidity of 93 percent. A marked change in lapse rate was noted at 5,000 feet, where the sounding indicated 100 percent saturation, with the freezing level at 5,500 feet.

5.0 Satellite Data

The Geostationary Operations Environmental Satellite number 12 (GOES-12) data was obtained and displayed on the National Transportation Safety Board's Man-computer Interactive Data Access System (McIDAS) workstation. The infrared imagery was obtained surrounding the time of the accident. The infrared imagery (band 4) at a wavelength of 10.7 microns (µm) provided a 4-kilometer (km) resolution with radiative cloud top temperatures. The satellite imagery surrounding the time of the accident were reviewed and the closest images documented below.

Figure 8 is the GOES-12 infrared band 4 image at 2240 CDT (0340Z on May 11, 2008) at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops associated with deep convection. The image depicts and extensive area of low, mid, and high level cloud cover extending over the region and the accident site. The radiative cloud top temperature over the accident site was observed at 240.10 degrees Kelvin (K) or –33.06 degrees C, which according to the KDVN sounding indicated cloud tops in the range of 25,000 feet. The areas in red indicated cloud heights above approximately 29,000 feet and in green tops between 34,000 and 36,000 feet, and were associated with clouds with nimbostratus type clouds with more vertical development.

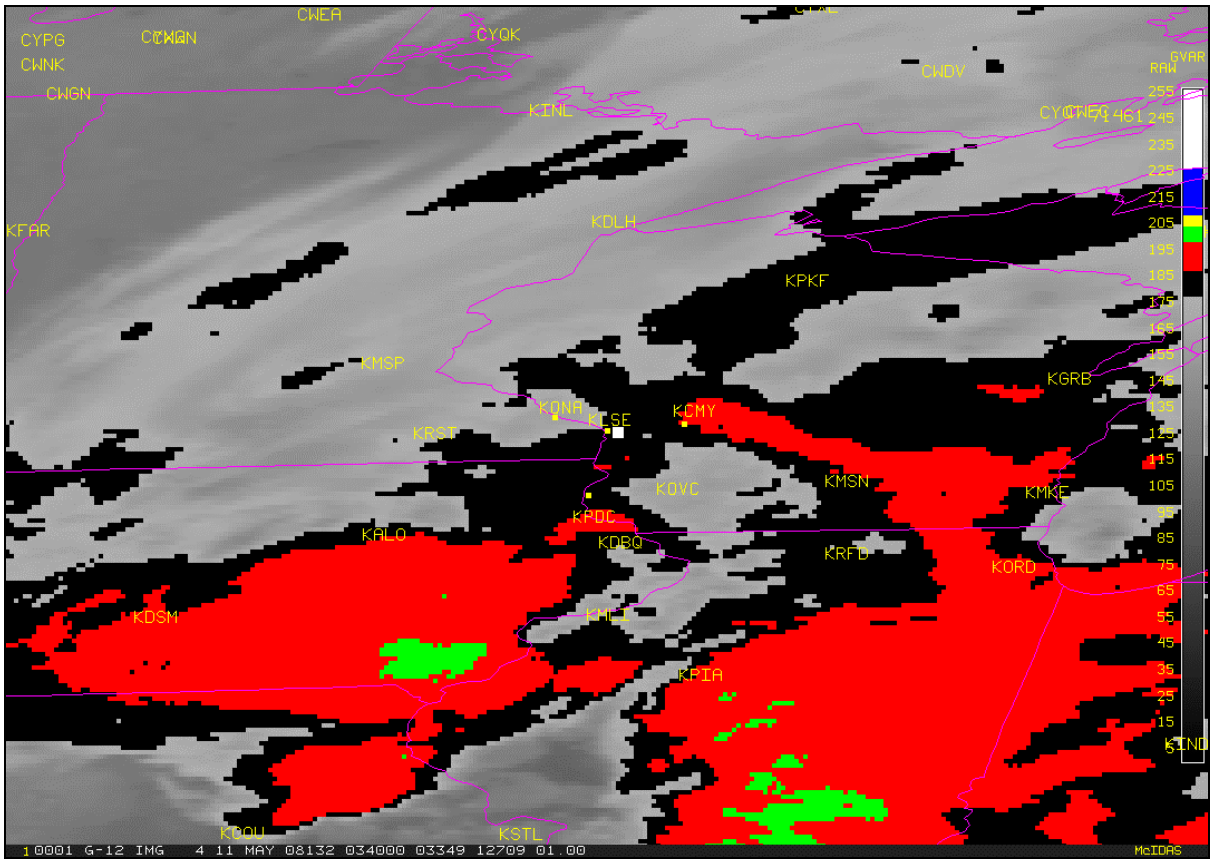


Figure 8 – GOES-12 infrared image at 0340Z

6.0 Weather Radar Information

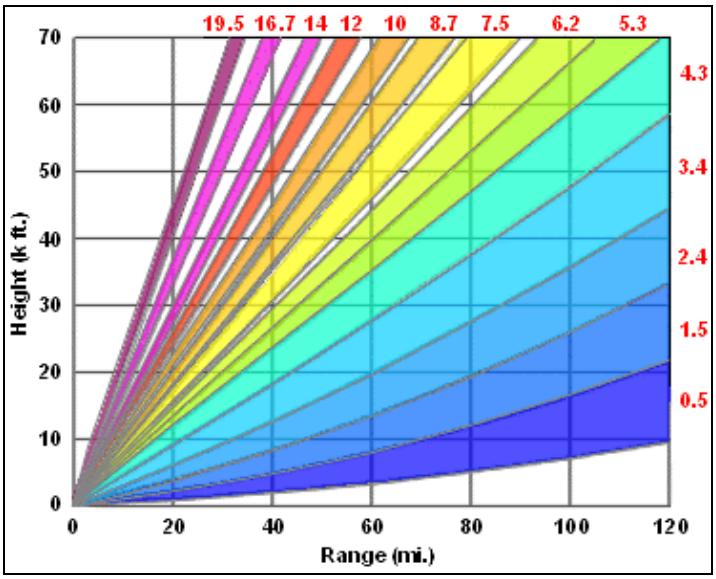
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was located at La Crosse (KARX), approximately 1.6 miles west-southwest of the accident site. The Level II archive data was obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using NEXRAD Interactive Viewer and Data Exporter software.

The WSR-88D is an S-band 10 centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95-degree beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

6.0.1 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 six 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 two common scanning strategies. A common mode A precipitation scan where the radar makes 14 elevation scans from 0.50 to 19.5 degrees every 5 minutes. This particular scanning strategy is documented as volume coverage pattern 11 (VCP-11). VCP-11 is used primarily for severe and non-severe convective events. 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 KARX WSR-88D radar was operating in the normal precipitation mode (Mode A, VCP-11). 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-11 Precipitation Mode Scan Strategy

6.0.2 Beam Height Calculation

Assuming standard refraction[14] of the 0.95 degree radar beam of the KARX WSR-88D radar with the antenna at an elevation of 1,357 feet, the following table shows the approximate beam height and width information 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	1,440 feet	1,360 feet	1,520 feet	160 feet

6.0.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[15] 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[16]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

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

[15] 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 glaze ice.

[16] Reflected intensities are measured in dBZ (decibels of Z). As the strength of the signal returned to the radar increases the dBZ values increases. The Doppler radar does not determine where rain is located, only areas of returned energy. The "dB" in the dBZ scale is logarithmic and has no numerical value, but is used only to express a ratio. The "z" is the ratio of the density of water drops (measured in millimeters, raised to the 6th power) in each cubic meter (mm^6/m^3). Mathematically: dBZ= 10 * log (z/z0). Where Z = reflectivity factor and Z0 is defined to be 1 mm^6/m^3

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0 1 2	< 5 5 to 9 10 to 14	 Trace
1 Very Light	3 4 5	15 to 19 20 to 24 25 to 29	.01 in/hr .02 in/hr .04 in/hr
2 Light to Moderate	6 7	30 to 34 35 to 39	.09 in/hr .21 in/hr
3 Strong	8	40 to 44	.48 in/hr
4 Very Strong	9	45 to 49	1.10 in/hr
5 Intense	10	50 to 54	2.49 in/hr
6 Extreme	11 12 13 14 15	55 to 59 60 to 64 65 to 69 70 to 74 > 75	>5.67 in/hr

The Federal Aviation Administration (FAA) Advisory Circular AC 00-24B titled “Thunderstorms” dated January 2, 1983, also defines the echo intensity levels and potential weather phenomena associated with those levels. If the maximum VIP Level is 1 “weak” and 2 “moderate”, then light to moderate turbulence is possible with lightning. VIP Level 3 is “strong” and severe turbulence is possible with lightning. VIP Level 4 is “very heavy” and severe turbulence is likely with lightning. VIP Level 5 is “intense” with severe turbulence, lightning, hail likely, and organized surface wind gusts. VIP Level 6 is “extreme” with severe turbulence, lightning, large hail, extensive surface wind gusts and turbulence. These levels are also referenced in the Aeronautical Information Manual (AIM) under the Pilot/Controller Glossary under radar weather echo intensity levels.

Air traffic control (ATC) weather display systems also use radar weather processors with the ability to determine precipitation intensity, with controllers instructed to describe the intensity to pilots based on the following scale:

(a) "Light" (< 30 dBZ)
(b) "Moderate" (30 to 40 dBZ)
(c) "Heavy" (> 40 to 50 dBZ)
(d) "Extreme" (> 50 dBZ)

6.0.4 Base Reflectivity

Figure 9 is the KARX WSR-88D base reflectivity image for the 0.5 degree elevation scan completed at 2245 CDT (0345Z on May 11, 2008) provided with a resolution of 1° X 1 kilometers. The accident site is marked by a magenta circle and is located immediately northeast of the radar antenna identified by a black circle. The image depicts an extensive area of precipitation over the region, with the accident site located on the southern edge of an east-to-west band of echoes moving northward with time. Echoes ranged from 25 to 30 dBZ or VIP level 1 "very light to light" intensity echoes over the accident site and KLSE.

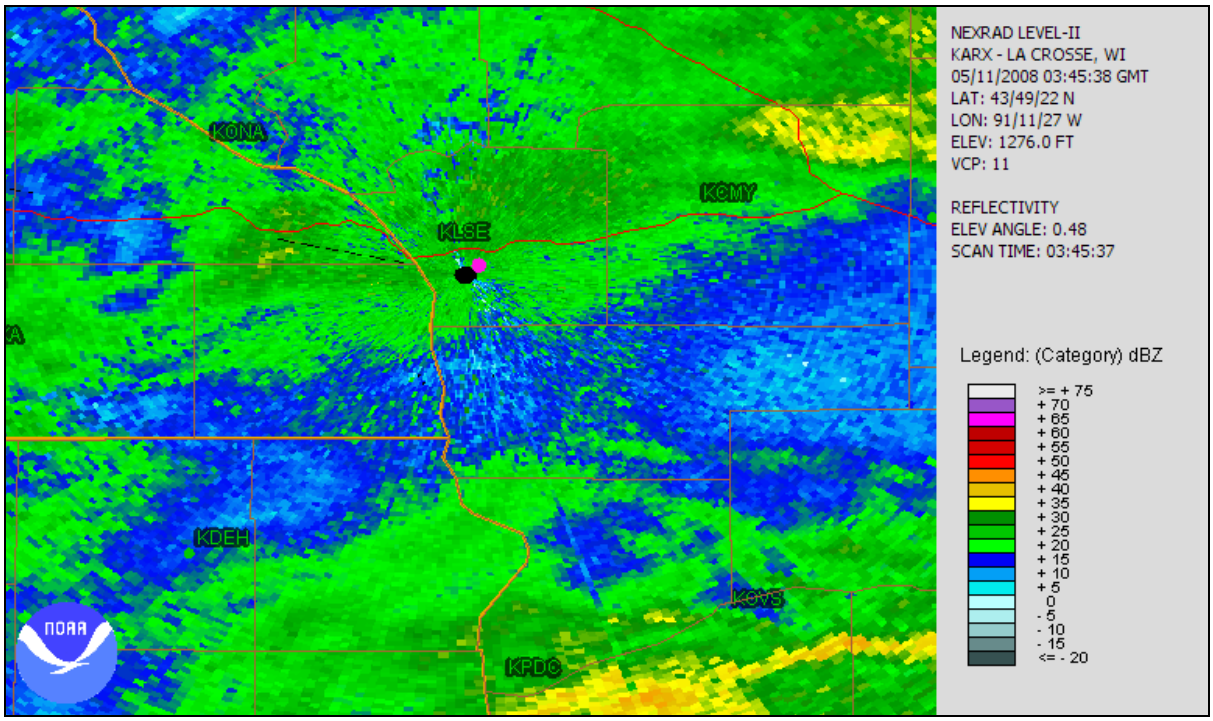


Figure 9 – KARX WSR-88D 0.5 degree elevation scan for 0345Z

The KARX radial velocity data (not reproduced due to lack of any significant features) indicated easterly winds over the accident site with winds of 10 to 20 knots. No defined changes in wind direction or wind speed were identified over the accident site. The spectrum width product also depicted no significant shears or changes in wind speed in the immediate vicinity of the accident site.

7.0 Pilot Reports

The following pilot reports or PIREPs were recorded over Wisconsin at 1355 and 1450 CDT respectively prior to the accident:

EAU UA /OV EAU305020/TM 1855/FL120/TP SF34/TA M10/IC LGT RIME=

EAU UA /OV EAU/TM 1950/FL090/TP SF34/TA M06/IC MOD MX/RM BL 093=

The reports confirmed the existence of icing in clouds and in-precipitation above 9,000 feet. There were no other low altitude pilot reports that indicated IFR conditions, turbulence, and/or any other low-level hazards.

8.0 Area Forecast

The Area Forecast (FA) is a forecast of visual flight rules (VFR) clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIMET Sierra (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The FA is a 12-hour forecast of VFR clouds and weather significant to flight operations plus a 6-hour outlook. The forecast includes a synopsis section, which is a brief summary of the location and movement of fronts, pressure system, and circulation patterns. Area Forecasts are issued 3 times a day from Kansas City Aviation Weather Center (AWC). The region that covers Wisconsin is under the Chicago (KCHI) regional forecast. The forecast available to the pilot for preflight briefing was the forecast issued at 2045 CDT (0145Z on May 11, 2008), and was valid until 0900 CDT (1400Z) on May 11, 2008. The forecast current for the route was as follows:

The forecast for southwest Wisconsin was overcast clouds at 6,000 feet with tops to 15,000 feet. From 0000 CDT (0550Z), ceilings overcast at 2,000 feet agl, visibility 3 to 5 miles in light rain and mist. The extended outlook beyond 0900 CDT (1400Z) was for MVFR conditions due to low ceilings and visibility restricted in rain, with winds over 25 knots to prevail.

9.0 In-Flight Weather Advisories

The NWS issues in-flight weather advisories designated as Severe Weather Forecast Alerts (AWW's), Convective SIGMET's (WST's), SIGMET's (WS's), Center Weather Advisories (CWA's), and AIRMET's (WA's). In-flight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions, which may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate on the basis of experience and the operational limits of the aircraft. Figure 10 is a plot of the primary AIRMETs current at the time of the accident over the region.

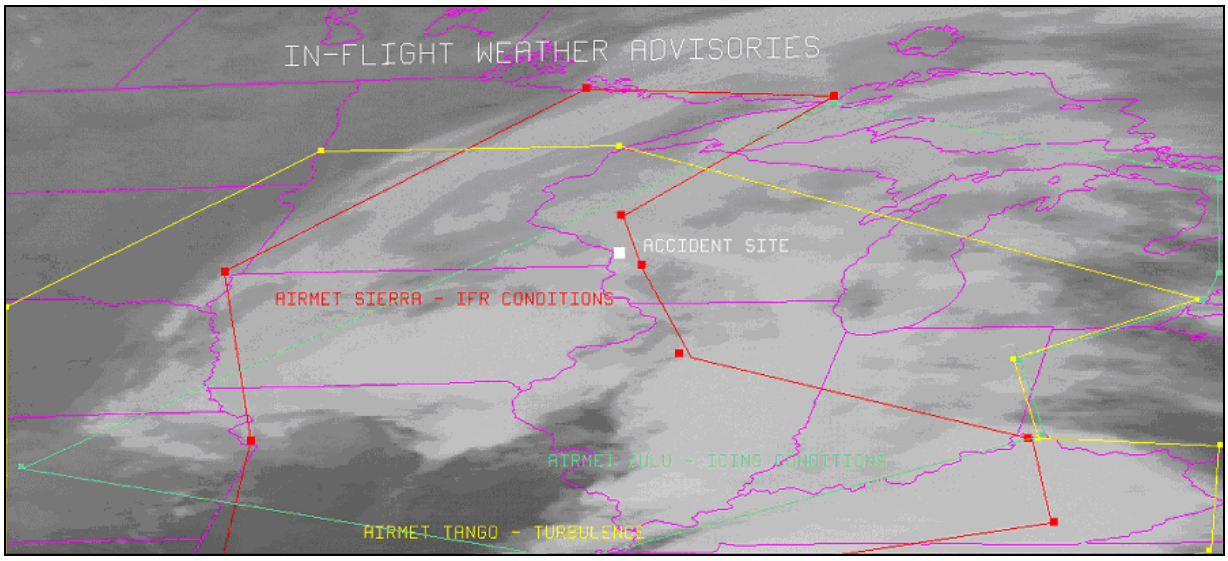


Figure 10 – AIRMETs current at the time of the accident

The full text of the advisories issued at 2145 CDT were as follows:

WAUS43 KKCI 110245
CHIS WA 110245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 110900
.
AIRMET IFR...SD KS MN IA MO WI LS IL IN KY AR TN
FROM INL-YQT-EAU-DLL-BDF-CVG-LOZ-MEM-RZC-MCI-FSD-INL
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 09Z ENDG 13-15Z W OF EAU TO BWG LN AND CONTG ELSW THRU 15Z.
.
CHIT WA 110245
AIRMET TANGO FOR TURB AND STG SFC WNDS VALID UNTIL 110900
.
AIRMET TURB...ND SD NE KS MN IA MO WI LM LS MI IL IN KY OK TX AR TN LA MS AL
FROM DLH-DXO-FWA-CVG-HNN-HMV-GQO-LGC-AEX-SJT-TXO-50W LBL-GLD-FAR-DLH
MOD TURB BLW 120. CONDS CONTG BYD 09Z ENDG 12-15Z W OF FAR TO ACT LN AND CONTG ELSW THRU 15Z.
.
AIRMET TURB...ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY OK TX AR TN MS AL
FROM 50S YWG-YQT-SSM-YVV-50ENE ECK-30SE ECK-DXO-FWA-CVG-HNN-HMV-GQO-INK-50W LBL-GLD-BFF-50S YWG
MOD TURB BTN FL240 AND FL400. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET STG SFC WNDS...SD NE KS IA MO
FROM FSD-MCI-OSW-50E LBL-MCK-FSD
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
.
CHIZ WA 110245
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 110900
.
AIRMET ICE...NE KS MN IA MO WI LM LS MI LH IL IN KY
FROM YQT-YVV-30SE ECK-DXO-FWA-CVG-30NNW DYR-SLN-YQT

MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-100. CONDS CONTG BYD 09Z ENDG 12-15Z W OF YQT TO IRK TO PXV LN AND CONTG ELSW THRU 15Z.

.

FRZLVL...RANGING FROM SFC-115 ACRS AREA
MULT FRZLVL 030-090 BOUNDED BY 50SSE FSD-40N SGF-30NE RZC-20W OSW-ICT-40ENE HLC-50SSE FSD
SFC ALG 40ENE AKO-40SW ANW-50NNW FSD-60SSE FAR-20ESE FAR-40SSW GFK-70WSW GFK-20WSW BIS-50WNW RAP
040 ALG 60NW MOT-40E ISN-80SW DIK
040 ALG 20NNW GLD-60NW SLN-40SSW MCI-30SSE MCI-40E OVR-20WNW FOD-50SW MSP-50NNE MSP-40SSW YQT-40ESE YQT
080 ALG RZC-50E RZC-60NW ARG-20WNW FAM-50SE IOW-40N BDF-20NE DXO

No SIGMETs, Convective SIGMETs, or Severe Weather Forecast Alerts were current over Wisconsin and none were required by definition.

10.0 Terminal Aerodrome Forecast (TAF)

The KLSE Terminal Aerodrome Forecast (TAF) issued at 1830 CDT (2330Z) on May 10, 2008, is included below. The forecast indicated winds from 130 degrees at 7 knots, visibility better than 6 miles in light rain, scattered clouds at 3,500 feet agl, and a ceiling overcast at 5,000 feet.

KLSE 102330Z 110024 13007KT P6SM -RA SCT035 OVC050
FM0500 02006KT 5SM -RA BR OVC025
FM0900 04014KT 4SM -RA BR OVC015
FM1200 36017G26KT 6SM -RA BR BKN015 OVC025
FM2000 36013G22KT P6SM OVC025
TEMPO 2024 -RA=

The forecast was amended after the accident at 2356 CDT (0456Z), and expected from 0000 to 0400 CDT winds from 040 degrees at 5 knots, visibility 6 miles in light rain, and a ceiling broken at 1,500 feet agl. The full forecast is as follows:

TAF AMD
KLSE 110456Z 110524 04005KT 6SM -RA BKN015
FM0900 02014KT 4SM -RA BR OVC015
FM1200 36017G26KT 6SM -RA BR BKN015 OVC025
FM2000 36013G22KT P6SM OVC025
TEMPO 2024 -RA=

11.0 Weather Briefing

Attachments 1 and 2 are the Automated Flight Service Station (AFSS) weather briefing transcript and the AFSS briefer's archive of the products, weather alerts, and notices to

airmen they reviewed in providing a weather briefing to the pilot of N135UW between 2117 and 2126 CDT (0217Z and 0226Z on May 11, 2008).

The AFSS brief provided a synopsis of the current conditions, the AIRMETs, current conditions and forecast for the route. The brief indicated that deteriorating weather conditions were expected after 0300Z with IFR conditions.

The METAR and TAFs for KLSE were provided in that briefing, which indicated VFR conditions during the period. The observations along the route of flight indicated overcast skies with visibility restricted in rain, with VFR to MVFR conditions.

Included in the adverse weather section was AIRMET Sierra update number 7 issued for IFR conditions at 1545 CDT (2045Z) and current until 2200 CDT (0300Z on May 11, 2008). Figure 11 is the GOES-12 infrared satellite image with AIRMET Sierra update 7 overlaid. The accident site and route of flight was located immediately north of the boundary of the advisory. The advisory was as follows:

WAUS43 KKCI 102045
CHIS WA 102045
AIRMET SIERRA UPDT 7 FOR IFR VALID UNTIL 110300
.
OTLK VALID 0300-0900Z...IFR MN IA MO WI IL IN KY
BOUNDED BY MSP-BDF-PXV-FAM-STL-FOD-MSP
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS DVLPG AFT 03Z AND CONTG THRU 09Z.

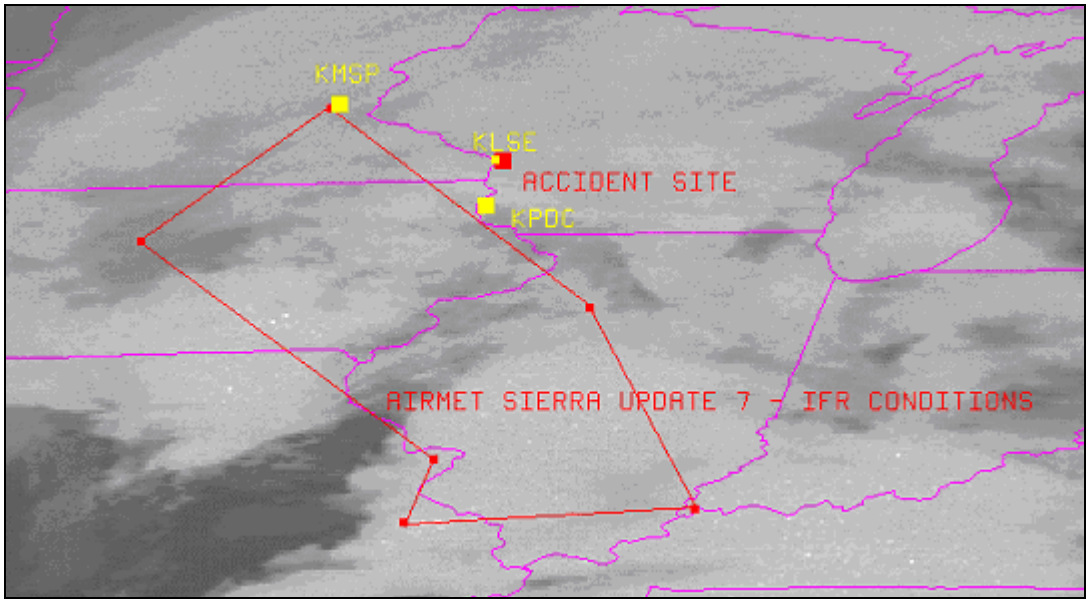


Figure 11 – AIRMET Sierra update 7 valid from 1545 to 2200 CDT

12.0 NWS Experimental HEMS Low Level Weather Tool

The NWS Experimental Aviation Digital Data Service (ADDS) Internet site (www.weather.aero/hems) has a product designed for Helicopter Emergency Medical Services (HEMS) use in analyzing low ceilings and visibility, and in helping pilot's make the go/no-go decision. Weather products in the HEMS tool include grids of various weather parameters as well as NWS textual weather observations and forecasts. Some gridded products are three-dimensional including temperature, relative humidity, winds, and icing. Other gridded products are two-dimensional and may represent a "composite" of a three-dimensional weather phenomenon (for instance the convection product) or a surface weather variable such as horizontal visibility. The tool also displays the flight categories (IFR, MVFR, and VFR conditions) based on a 5-kilometer model. Air Methods Corporation has the approval from the FAA Principle Operations Inspector (POI) in their Operations Specifications section A 10 the ADDS HEMS Internet tool approved for their use, but there is no record of the flight crew utilizing it before the flight.

The Experimental ADDS site data is not archived by the NWS and was not able to be recreated for this case to determine if any IFR conditions or any other warning of reduced visibility would have been indicated along the route of flight. The product is also still designated as "experimental" by the FAA and is not fully operational.

13.0 Astronomical Data

The United States Naval Observatory astronomical data for La Crosse, Wisconsin, indicated the following conditions:

SUN

Sunset:	2019 CDT (0119Z)
End of civil twilight:	2052 CDT (0152Z)
Elevation of Sun at 2245:	more than 15 degrees below the horizon

MOON

Moonrise:	1037 CDT (1537Z)
Moonset:	0154 CDT May 11, 2008 (0654Z)
Moon phase:	Waxing crescent
Elevation of Moon at 2245:	31.7 degrees above the horizon
Azimuth of Moon at 2245:	266 degrees
Illumination:	39 % of disk illuminated

Donald E. Eick
NTSB Senior Meteorologist