

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN24FA024

METEOROLOGY

Specialist's Factual Report

December 15, 2023

TABLE OF CONTENTS

A. ACCIDENT	3
B. METEOROLOGY SPECIALIST	3
C. DETAILS OF THE INVESTIGATION	3
D. FACTUAL INFORMATION	4
1.0 SYNOPTIC SITUATION	4
1.1 Surface Analysis Chart.....	4
1.2 Upper Air Charts	5
2.0 STORM PREDICTION CENTER CONVECTIVE OUTLOOK	8
3.0 SURFACE OBSERVATIONS	9
4.0 UPPER AIR SOUNDING	13
5.0 SATELLITE DATA.....	15
6.0 NATIONAL RADAR IMAGERY	16
7.0 PILOT REPORTS	16
8.0 SIGNIFICANT METEOROLOGICAL INFORMATION	17
9.0 CENTER WEATHER SERVICE ADVISORIES	17
10.0 AIRMEN’S METEOROLOGICAL INFORMATION.....	17
11.0 GRAPHICAL FORECASTS FOR AVIATION.....	18
12.0 TERMINAL AERODROME FORECAST	21
13.0 NATIONAL WEATHER SERVICE AREA FORECAST DISCUSSION	22
14.0 WINDS AND TEMPERATURE ALOFT FORECAST.....	25
15.0 PILOT WEATHER INFORMATION	25
16.0 ASTRONOMICAL DATA	26
E. LIST OF ATTACHMENTS	26

A. ACCIDENT

Location: Manitowoc, Wisconsin
Date: October 25, 2023
Time: 1829 central daylight time
2329 coordinated universal time (UTC)
Airplane: Lancair 320; Registration: N320P

B. METEOROLOGY SPECIALIST

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

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

The accident site was located at approximate latitude 44.16972° N, longitude 87.69277° W, and elevation of 665 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the 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 Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the Great Lakes Region of the United States for 1900 CDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a low-pressure system at 1017-hectopascals (hPa) located in southern Ontario, Canada. A cold front stretched from the low from southern Ontario southwestward across the Great Lakes, Wisconsin in the immediate vicinity of the accident site, and into central Iowa. Fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present.

The station model closest to the accident site depicted an air temperature of 54 degrees Fahrenheit (°F), a dew point temperature of 52°F, overcast cloud cover, mist, visibility restricted in mist, and a northeast wind of 5 knots.

¹ [FAA-H-8083-28](#)

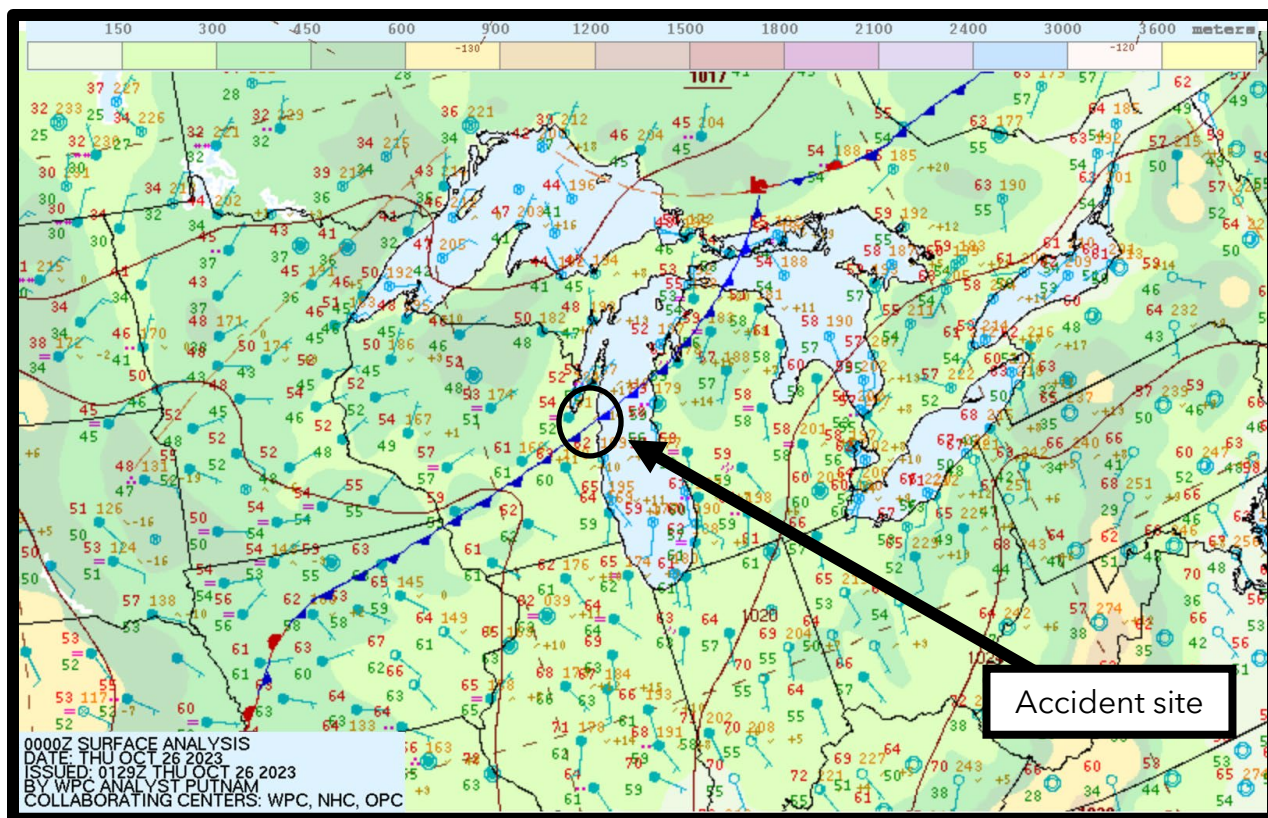


Figure 1. NWS Surface Analysis Chart for 1900 CDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1900 CDT at 925-, 850-, and 700-hPa are presented in figures 2 through 4. The charts indicated that the accident site was located northeast of a low- and mid-level trough² at 925- and 700-hPa (figures 2 and 4). The 925-hPa constant pressure chart depicted a south-southwest wind around 5 knots (figure 2) becoming a west-southwest 25 knot wind by 700-hPa (figure 4).

² Trough - An elongated area of relatively low atmospheric pressure or heights.

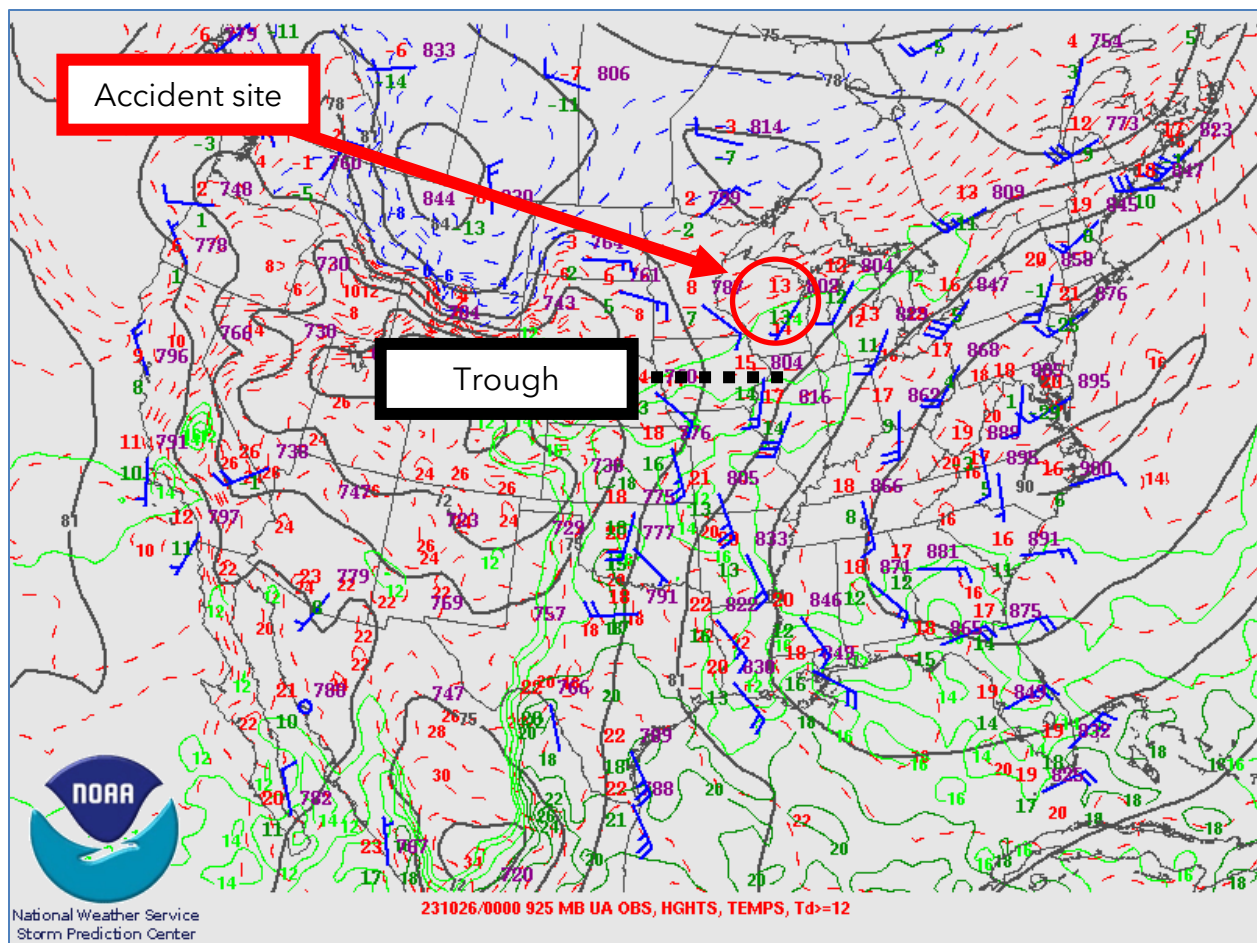


Figure 2. 925-hPa Constant Pressure Chart for 1900 CDT.

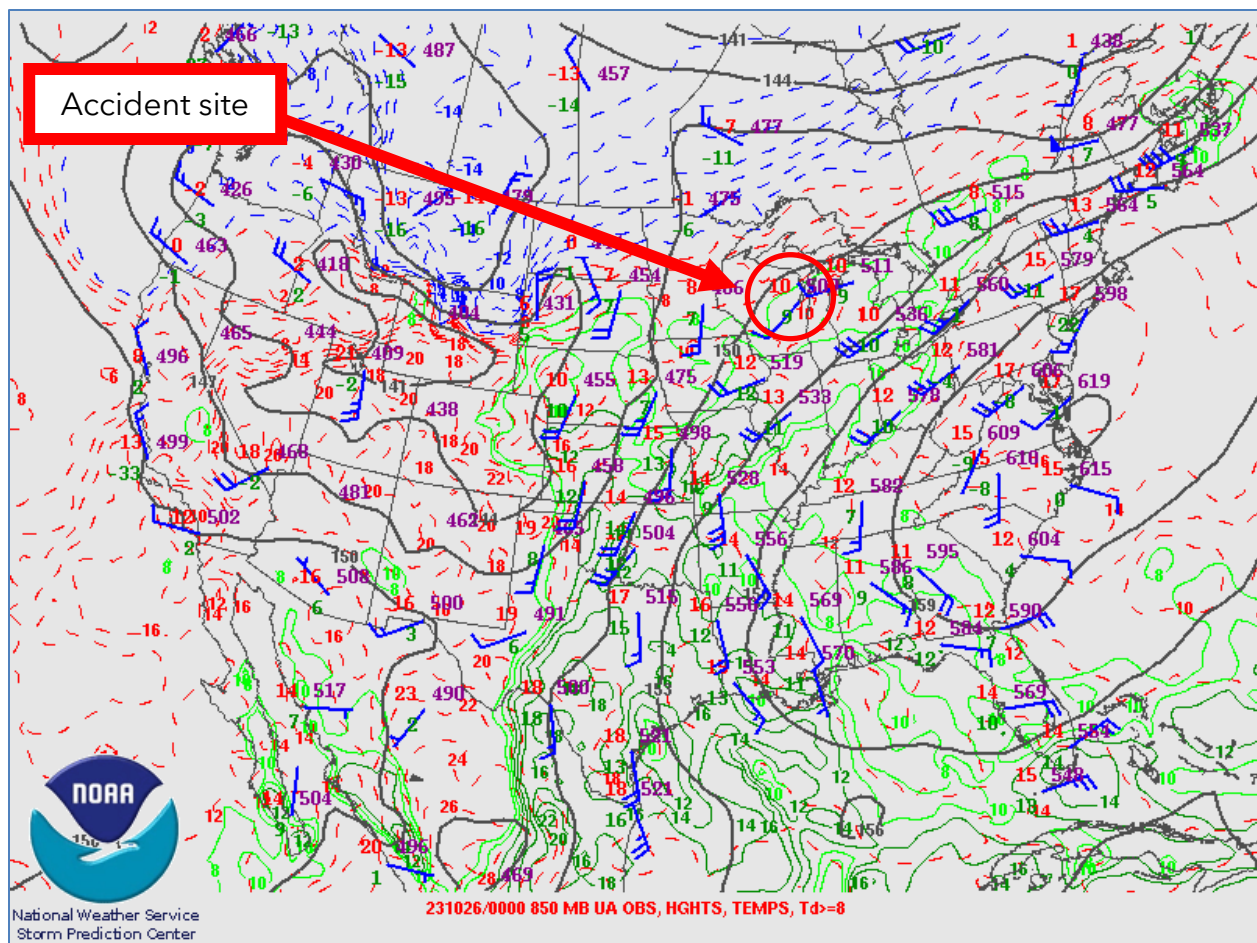


Figure 3. 850-hPa Constant Pressure Chart for 1900 CDT.

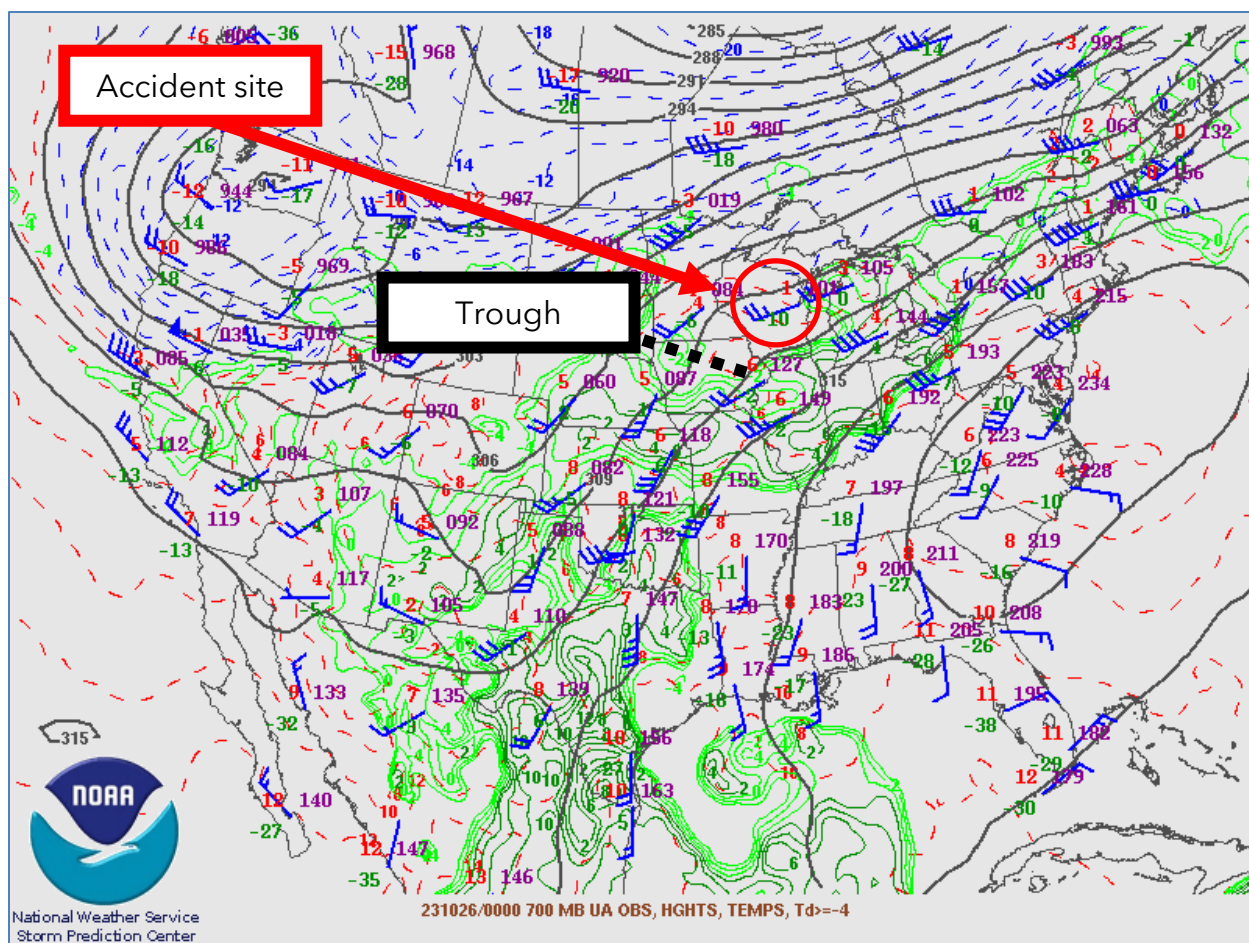


Figure 4. 700-hPa Constant Pressure Chart for 1900 CDT.

2.0 Storm Prediction Center Convective Outlook

The SPC issued a Day 1 Convective Outlook at 1442 CDT (figure 5) with areas of general thunderstorms forecast for the accident site. The SPC defines the “TSTM” area as an area where a 10% or higher probability of thunderstorms is forecast during the valid period.

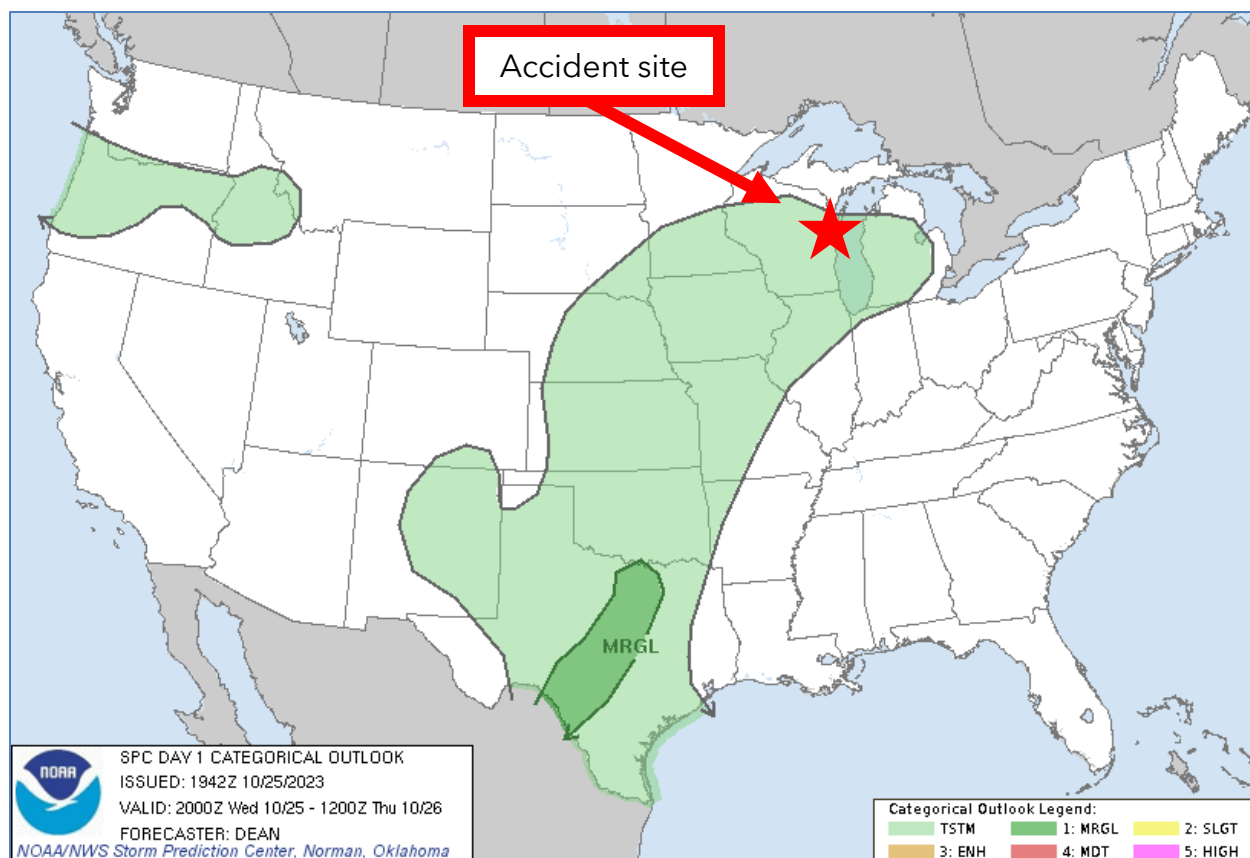


Figure 5. SPC day 1 Convective Outlook valid at the time of the accident.

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special Reports (SPECIs)³. The following observations were taken from standard code and are provided in plain language. Figure 6 is a local sectional chart with the accident site and the closest weather reporting locations marked. A magnetic variation⁴ of 4° west was indicated over the area.

³ Latest criteria for SPECIs can be found in the Federal Meteorological Handbook: [Federal Meteorological Handbook Number 1, Surface Weather Observations and Reports \(icams-portal.gov\)](https://www.federalmetbook.com/)

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

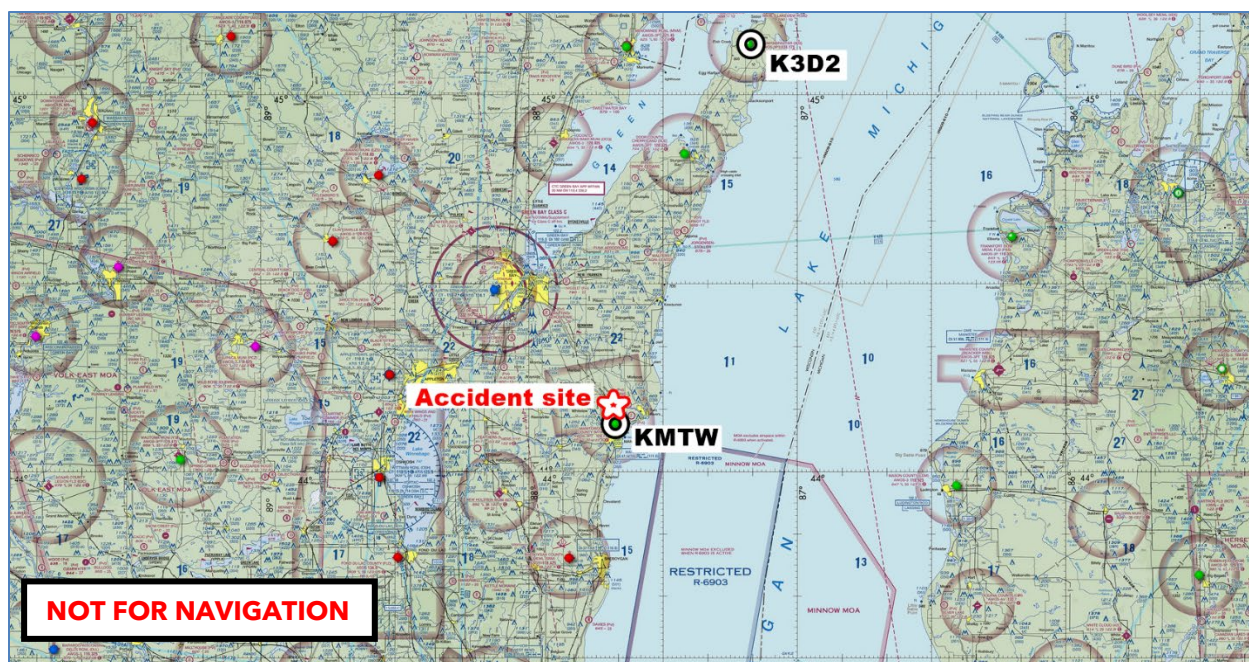


Figure 6. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation sites noted.

Manitowoc County Airport (KMTW) had the closest official weather station to the accident site and was the destination airport. KMTW had an Automated Weather Observing System (AWOS⁵) and its longline⁶ reports were not augmented. The KMTW AWOS was located 3 miles south of the accident site (figure 6) at an elevation of 651 ft, and issued the following observations surrounding the accident time:⁷

[1656 CDT] METAR KMTW 252156Z AUTO 00000KT 9SM OVC022
17/16 A3001 RMK AO2 SLP162 T01670156

[1756 CDT] METAR KMTW 252256Z AUTO 03004KT 9SM OVC020
14/14 A3004 RMK AO2 SLP174 T01440139

⁵ AWOS - Automated Weather Observing System is equipped with meteorological instruments to typically observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to 12,000 feet, and altimeter setting. AWOS are maintained by the FAA. Certain AWOS may have different reporting or observational equipment.

⁶ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the weather observations are distributed.

⁷ The bold sections of products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident region around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times.

DIVERT TIME 1807 CDT⁸

[1818 CDT] SPECI KMTW 252318Z AUTO 04004KT 4SM BR SCT004
SCT009 OVC020 14/13 A3005 RMK AO2

[1822 CDT] SPECI KMTW 252322Z AUTO 04007KT 3SM BR BKN004
OVC020 14/13 A3005 RMK AO2

**[1826 CDT] SPECI KMTW 252326Z AUTO 04005KT 1 3/4SM BR
BKN004 OVC020 13/13 A3006 RMK AO2**

ACCIDENT TIME 1829 CDT

**[1845 CDT] SPECI KMTW 252345Z AUTO 04008KT 1SM BR OVC004
13/13 A3005 RMK AO2**

[1853 CDT] SPECI KMTW 252353Z AUTO VRB04KT 3/4SM BR OVC004
13/13 A3006 RMK AO2

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

KMTW weather at 1826 CDT, automated, wind from 040° at 5 knots, visibility 1 ¾ miles, mist, broken ceiling⁹ at 400 ft above ground level (agl), overcast skies at 2,000 ft agl, temperature of 13° Celsius (C), dew point temperature of 13°C, and an altimeter setting of 30.06 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator.

KMTW weather at 1845 CDT, automated, wind from 040° at 8 knots, visibility 1 mile, mist, overcast ceiling at 400 ft agl, temperature of 13°C, dew point temperature of 13°C, and an altimeter setting of 30.05 inHg. Remarks, automated station with a precipitation discriminator.

Ephraim/Gibraltar Airport (K3D2) was the initial intended destination before diverting to KMTW around 1807 CDT. K3D2 also had an AWOS and its longline reports were not augmented. The K3D2 AWOS was located 62 miles north-northeast of the accident site (figure 6), at an elevation of 763 ft, and issued the following observations surrounding the accident time:

[1655 CDT] METAR K3D2 252155Z AUTO 03006KT 1 3/4SM BR
OVC003 10/10 A3004 RMK AO2 T01000100

⁸ For further information on accident airplane's change in destination please see the information in the docket for this accident.

⁹ Ceiling is defined as the lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration.

[1715 CDT] METAR K3D2 252215Z AUTO 03007KT 1 1/4SM BR
OVC003 10/10 A3004 RMK AO2 T01000100

[1735 CDT] METAR K3D2 252235Z AUTO 03005KT 2 1/2SM BR
OVC003 10/10 A3006 RMK AO2 T01000100

**[1755 CDT] METAR K3D2 252255Z AUTO 02007KT 2 1/2SM BR
OVC003 10/10 A3007 RMK AO2 T01000100**

DIVERT TIME 1807 CDT

**[1815 CDT] METAR K3D2 252315Z AUTO 04005KT 3SM BR
OVC003 10/10 A3006 RMK AO2 T01000100**

ACCIDENT TIME 1829 CDT

**[1835 CDT] METAR K3D2 252335Z AUTO 04007KT 4SM BR
OVC003 10/10 A3007 RMK AO2 T00980098**

[1855 CDT] METAR K3D2 252355Z AUTO 04006KT 4SM BR OVC003
10/10 A3008 RMK AO2 T00970097 10110 20097

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

K3D2 weather at 1755 CDT, automated, wind from 020° at 7 knots, visibility 2 ½ miles, mist, overcast ceiling at 300 ft agl, temperature of 10°C, dew point temperature of 10°C, and an altimeter setting of 30.07 inHg. Remarks, automated station with a precipitation discriminator, temperature 10.0°C, dew point temperature 10.0°C.

K3D2 weather at 1815 CDT, automated, wind from 040° at 5 knots, visibility 3 miles, mist, overcast ceiling at 300 ft agl, temperature of 10°C, dew point temperature of 10°C, and an altimeter setting of 30.06 inHg. Remarks, automated station with a precipitation discriminator, temperature 10.0°C, dew point temperature 10.0°C.

K3D2 weather at 1835 CDT, automated, wind from 040° at 7 knots, visibility 4 miles, mist, overcast ceiling at 300 ft agl, temperature of 10°C, dew point temperature of 10°C, and an altimeter setting of 30.07 inHg. Remarks, automated station with a precipitation discriminator, temperature 9.8°C, dew point temperature 9.8°C.

The observations from the K3D2 and KMTW AWOSs around the accident time identified LIFR¹⁰ conditions. When the accident airplane diverted from K3D2 to KMTW, the latest KMTW observations indicated MVFR conditions with 2,000 ft agl ceilings. K3D2 had LIFR observations from the accident time back through at least 1035 CDT (not shown).

4.0 Upper Air Sounding

The NWS Ashwaubenon, Wisconsin office had an upper air sounding (KGRB) that had a station ID of 72645, with a surface elevation of 702 ft. The KGRB sounding launch site was located 27 miles northwest of the accident site. The 1900 CDT KGRB sounding was plotted on a standard Skew-T Log P diagram¹¹ using the RAOB software¹² from the surface to 700-hPa (or approximately 10,000 ft) along with the derived stability parameters and is included as figure 7. The sounding depicted a near surface temperature of 12.0°C, a dew point temperature of 11.7°C, and a relative humidity of 98%. The sounding depicted the lifted condensation level (LCL)¹³ and the level of free convection (LFC)¹⁴ at 127 ft agl (829 ft msl), and the convective condensation level (CCL)¹⁵ at 4,308 ft. The freezing level was located at 11,939 ft with the precipitable water value at 1.12 inches.

¹⁰ The NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

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

¹¹ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

¹² RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.

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

¹⁴ LFC - The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

¹⁵ 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.

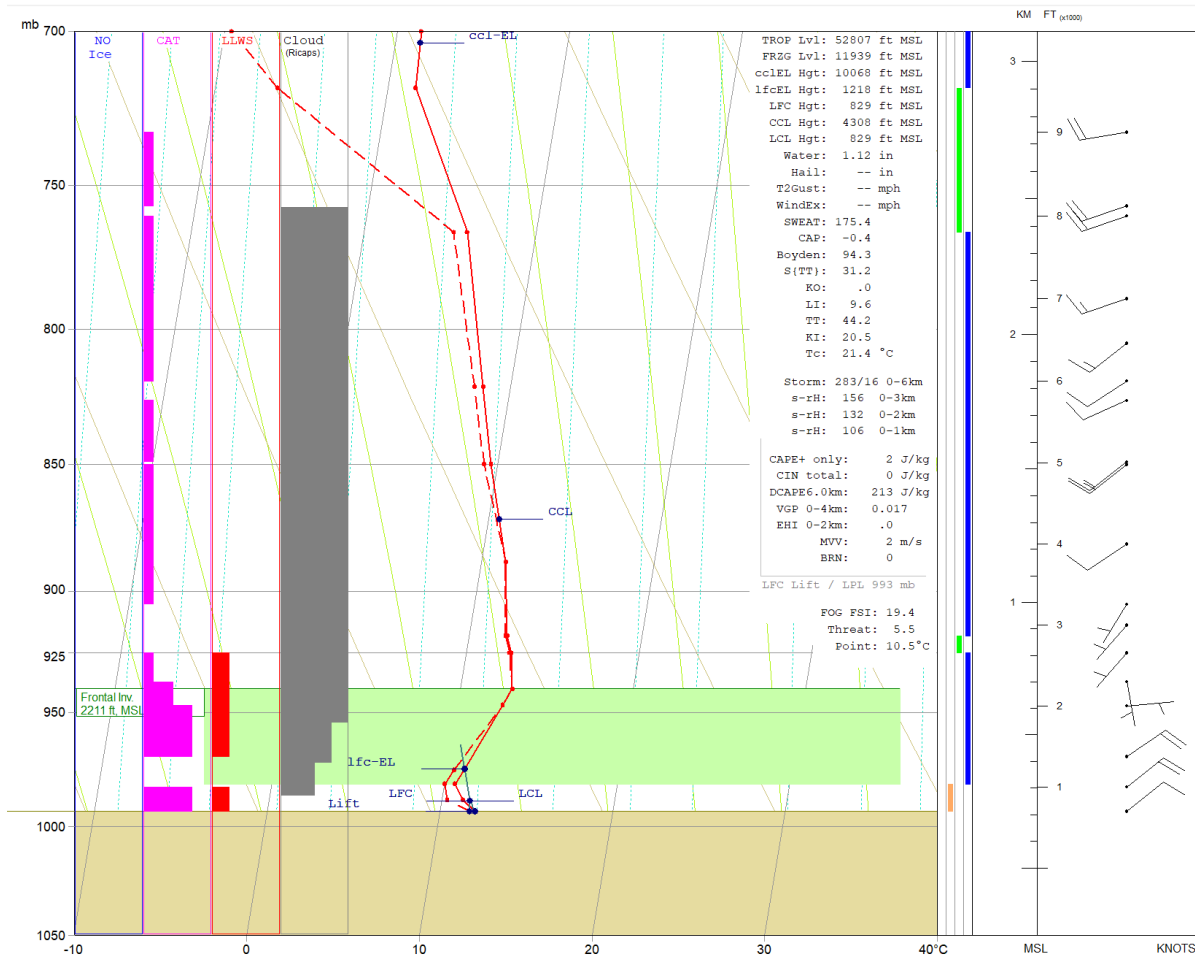


Figure 7. 1900 CDT KGRB sounding.

The 1900 CDT KGRB sounding indicated a mostly stable environment from the surface through 8,000 ft. RAOB indicated a cloud layer between 200 ft agl and 8,000 ft msl. No icing was indicated below 10,000 ft. The top of a frontal inversion¹⁶ was indicated at 2,211 ft.

The 1900 CDT KGRB sounding wind profile indicated a near-surface wind from 050° at 8 knots with the wind remaining northeasterly through 2,000 ft. The wind veered¹⁷ to the southwest above 2,000 ft and became westerly by 9,000 ft. The wind speed increased to 20 knots and remained between 10 and 20 knots through 10,000 ft. RAOB indicated the possibility of light low-level wind shear (LLWS) in two layers between the surface and 2,000 ft agl. RAOB also indicated light to moderate clear air turbulence (CAT) in several layers between the surface and 9,000 ft.

¹⁶ Inversion - A departure from the usual decrease of the value of an atmospheric property with increasing altitude; also, the layer through which this departure occurs (the "inversion layer"), or the lowest altitude at which the departure is found (the "base of the inversion").

¹⁷ Veered - Wind turning clockwise with height.

5.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1400 CDT through 2100 CDT and reviewed, and the closest images to the time of the accident were documented. Given the time of day and sun angle, the visible imagery (band 2) did not provide useful information at the accident time.

Figure 8 presents the GOES-16 infrared image at 1831 CDT at 6X magnification with the accident site highlighted with a red square. Cloud cover was indicated above the accident site with the cloud cover moving from southwest to northeast (attachment 1). The lower brightness temperatures (green colors; higher cloud tops) were located above and surrounding the accident site at the accident time. The brightness temperature of 236 Kelvin¹⁸ above the accident site would have been near 31,000 ft (not shown) based on the vertical temperature profile provided by the 1900 CDT KGRB sounding. It should be noted these figures have not been corrected for any parallax error.

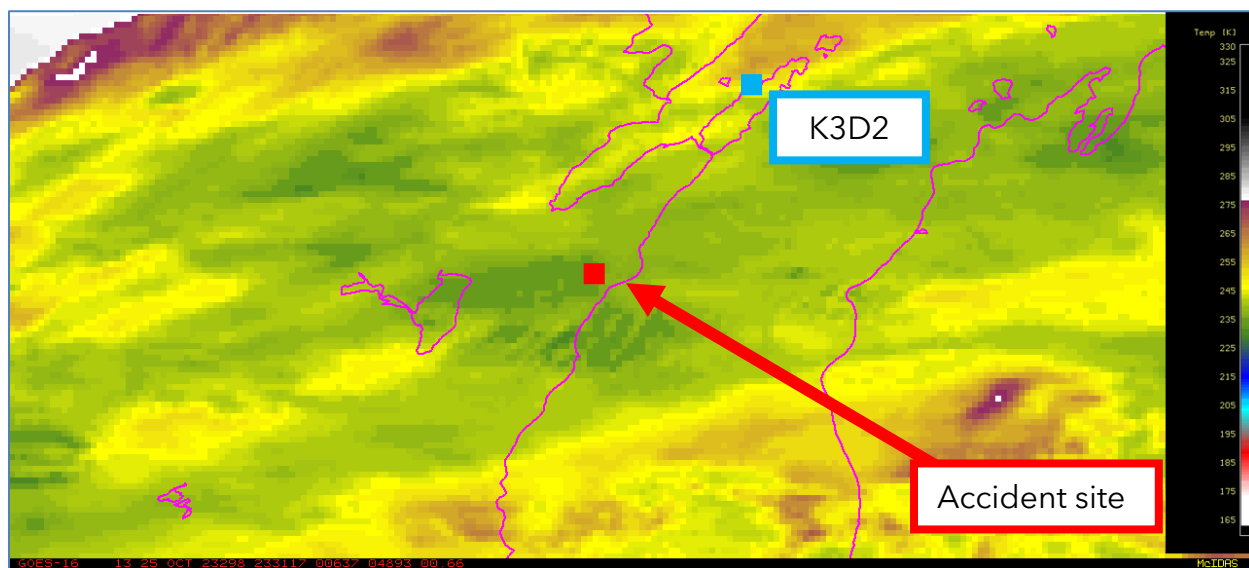


Figure 8. GOES-16 infrared image at 1831 CDT.

¹⁸ Around -37°C.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 9 for 1830 CDT with the approximate location of the accident site marked by a red circle. The image depicted no echoes above the accident site.

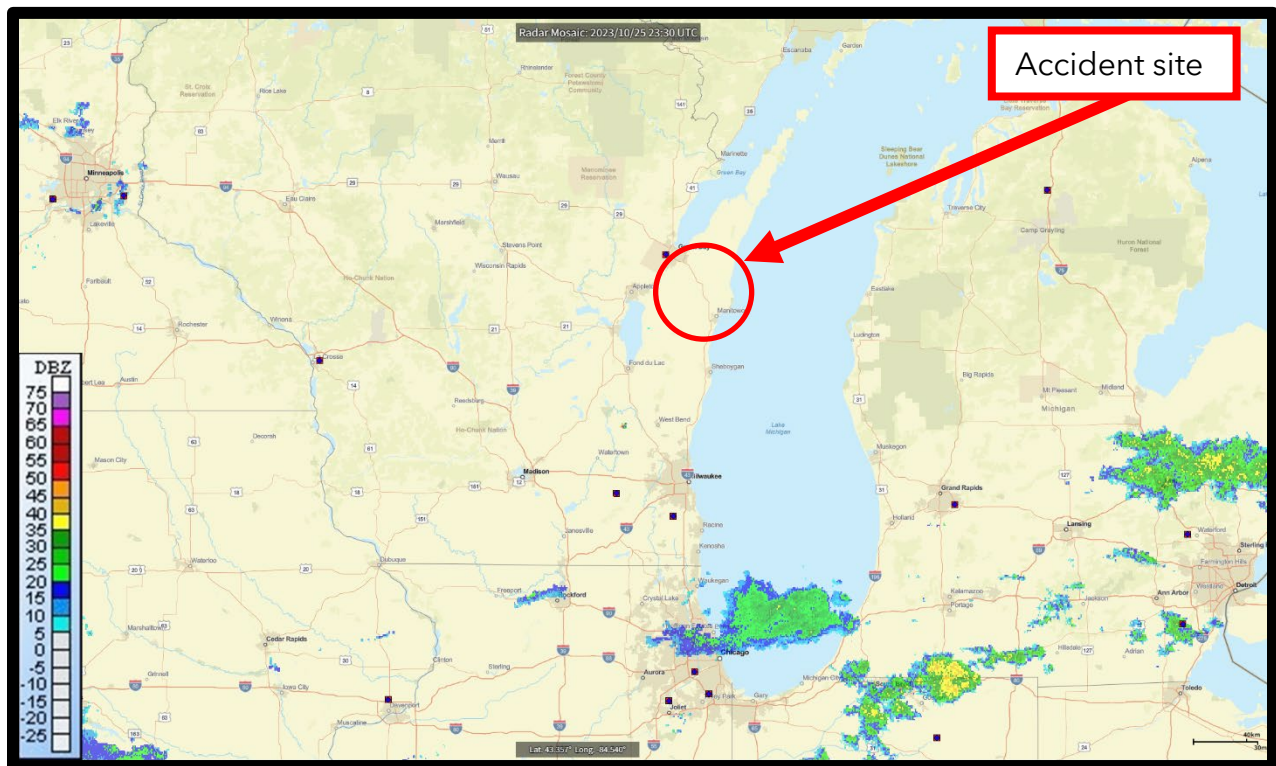


Figure 9. National Reflectivity Mosaic for 1830 CDT.

7.0 Pilot Reports

The longline-disseminated pilot reports¹⁹ (PIREPs) distributed into the national airspace system (NAS) within 2 hours either side of the accident time and within 100 miles of the accident site at altitudes below 18,000 ft are shown here:

MSN UA /OV MSN/TM 2138/FLDURGD/TP BE40/SK OVC009
MSN UA /OV MSN270005/TM 2228/FLDURGD/TP B737/SK T035
MKE UA /OV MKE075003/TM 2241/FLDURD/TP A321/SK B016
CWA UA /OV CWA/TM 2241/FL054/TP CRJ2/SK T054
MSN UA /OV MSN/TM 2301/FLDURGC/TP E170/SK B019

¹⁹ Only PIREPs with the World Meteorological Organization headers UBWI**, UBIL**, and UBMI** were considered. These do not include pilot reports only broadcast via radio.

MKG UA /OV MKG/TM 2308/FLDURGD/TP C414/SK OVC010/WX RA
MSN UA /OV MSN/TM 2326/FLDURGC/TP CRJ7/SK B018 T030
MKG UA /OV MKG/TM 2350/FL030/TP C208/SK TOPS ABV 100/WX RA/TB SMOOTH
MKG UA /OV KMKG/TM 0003/FL005/TP C208/SK BASES009/RM ILS24
CWA UA /OV CWA/TM 0010/FL017/TP C208/SK BKN003
CWA UA /OV CWA/TM 0015/FLDURGC/TP C208/SK B015 T065/TA 07/IC NEG 015
065
MSN UA /OV MSN360002/TM 0028/FLDURD/TP A306/SK BASES 018 TOPS 040
MKG UA /OV KMKG/TM 0052/FL005/TP DA40/SK BASES009/RM RNAV24

8.0 Significant Meteorological Information

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

9.0 Center Weather Service Advisories

The Minneapolis (ZMP) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There was no Center Weather Advisory (CWA) valid for the accident site at the accident time.

10.0 Airmen's Meteorological Information

The NWS Aviation Weather Center (AWC) had text Airmen's Meteorological Information (AIRMET) advisory Sierra valid for the accident site at the accident time for below 8,000 ft. The text AIRMET Sierra update 7 was issued at 1816 CDT and forecast IFR conditions due to precipitation and mist. A similar text AIRMET Sierra was issued at 1545 CDT as well:

WAUS43 KPCI 252316
WA3S
-CHIS WA 252316 AMD
AIRMET SIERRA UPDT 7 FOR IFR VALID UNTIL 260300

.
**AIRMET IFR...SD NE KS MN IA MO WI LM LS MI LH IL IN
FROM 80NNE SAW TO 70NW YVW TO 40ENE ECK TO 40SSE ECK TO FWA TO
50SSW JOT TO 50WSW COU TO 20NW RZC TO OSW TO LBL TO 20S GLD TO
80NNE SAW
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.**

.
AIRMET IFR...ND SD NE KS MN IA WI LS MI...UPDT
FROM 40SSE YWG TO 20SE YQT TO 80NNE SAW TO 30SSW GLD TO 30SSE

AKO TO 70SW RAP TO 50NNW ISN TO 40SSE YWG
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.

.
OTLK VALID 0300-0900Z...IFR ND SD NE KS MN IA MO WI LM LS MI LH
IL IN KY OK TX AR TN LA AND CSTL WTRS
BOUNDED BY 30N INL-YQT-70NW YVV-40ENE ECK-40SSE ECK-FWA-40S BDF-
40WSW COU-60NW GGG-50E PSX-20NE BRO-70SSE LRD-40NNW DLF-30WSW
GCK-30NNE LAA-60NNW BFF-50NNW ISN-30N INL
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 09Z.

....

11.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued by the AWC before the accident flight and valid at 1900 CDT are shown in figures 10 and 11 (additional GFA forecast products produced after 0800 CDT are not available due to AWC archiving constraints). The GFA surface forecasts applicable at 1900 CDT to the accident site indicated mainly VFR conditions with pockets of IFR conditions and a chance (30 to 60% probability) of rain showers with a northeast wind of 5 to 10 knots. The Graphical AIRMETs²⁰ (G-AIRMET)s from the 0801 CDT forecast were only valid through the 1600 CDT timeframe. The GFA cloud forecast applicable to the accident site for 1900 CDT from 0802 CDT indicated overcast clouds at the accident site with a cloud base at 1,500 ft and cloud tops at FL270²¹ with cirrus clouds above. The only human-generated information reflected in the two GFA products were the G-AIRMETs. The G-AIRMET Sierra for IFR conditions valid at 1600 and 1900 CDT (issued at 1545 CDT) applicable to the accident site are found in figures 12 and 13. G-AIRMET Sierra for IFR conditions covering the accident site was also issued at 0945 CDT valid for 1600 and 1900 CDT (not shown).

²⁰ Graphical AIRMETs (G-AIRMETs), found on the Aviation Weather Center webpage at <http://aviationweather.gov>, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, and 12 hours). G-AIRMETs are snap shots at discrete time intervals as defined above. The text AIRMET is the result of the production of the G-AIRMET but provided in a time smear for a 6hr valid period.

²¹ Flight Level - A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

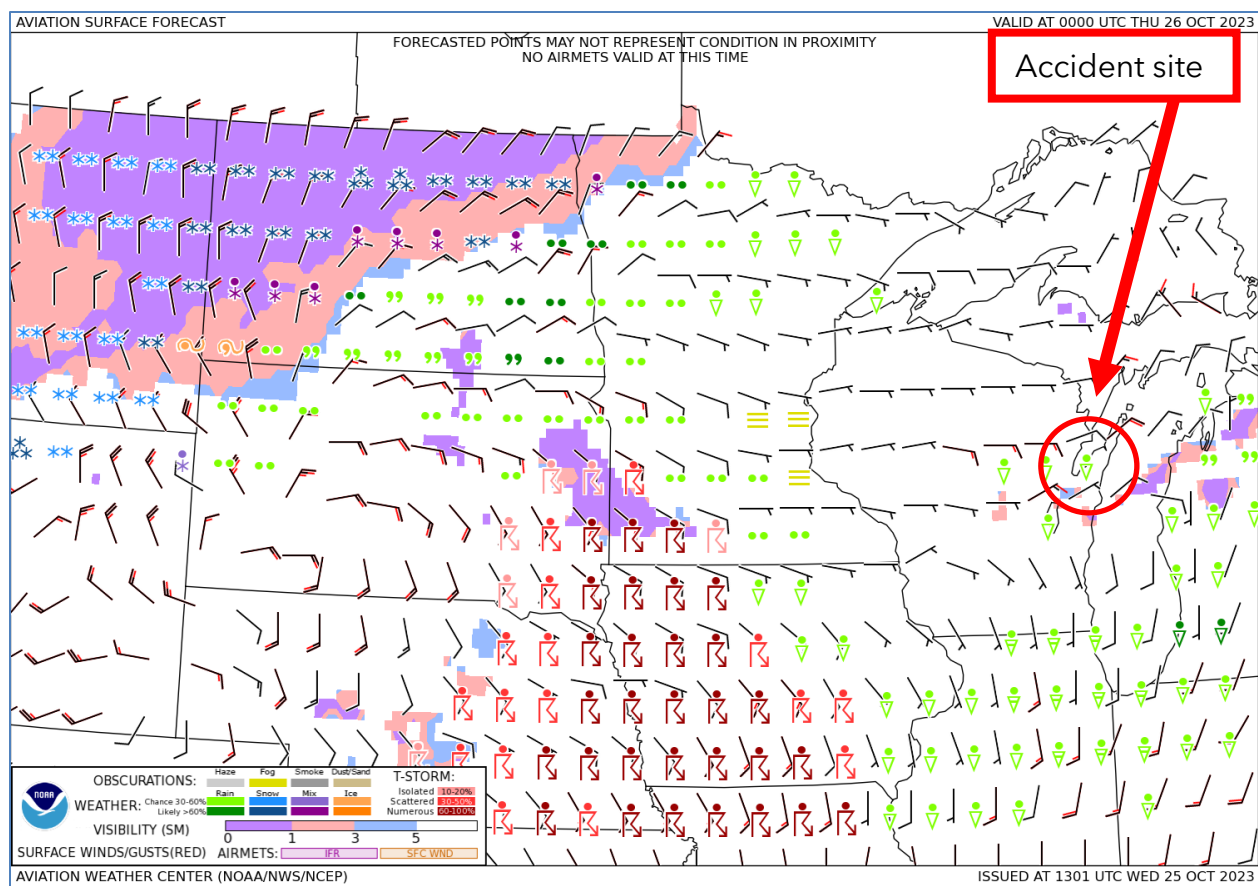


Figure 10. GFA Surface Forecast valid at 1900 CDT with forecast issued at 0801 CDT.

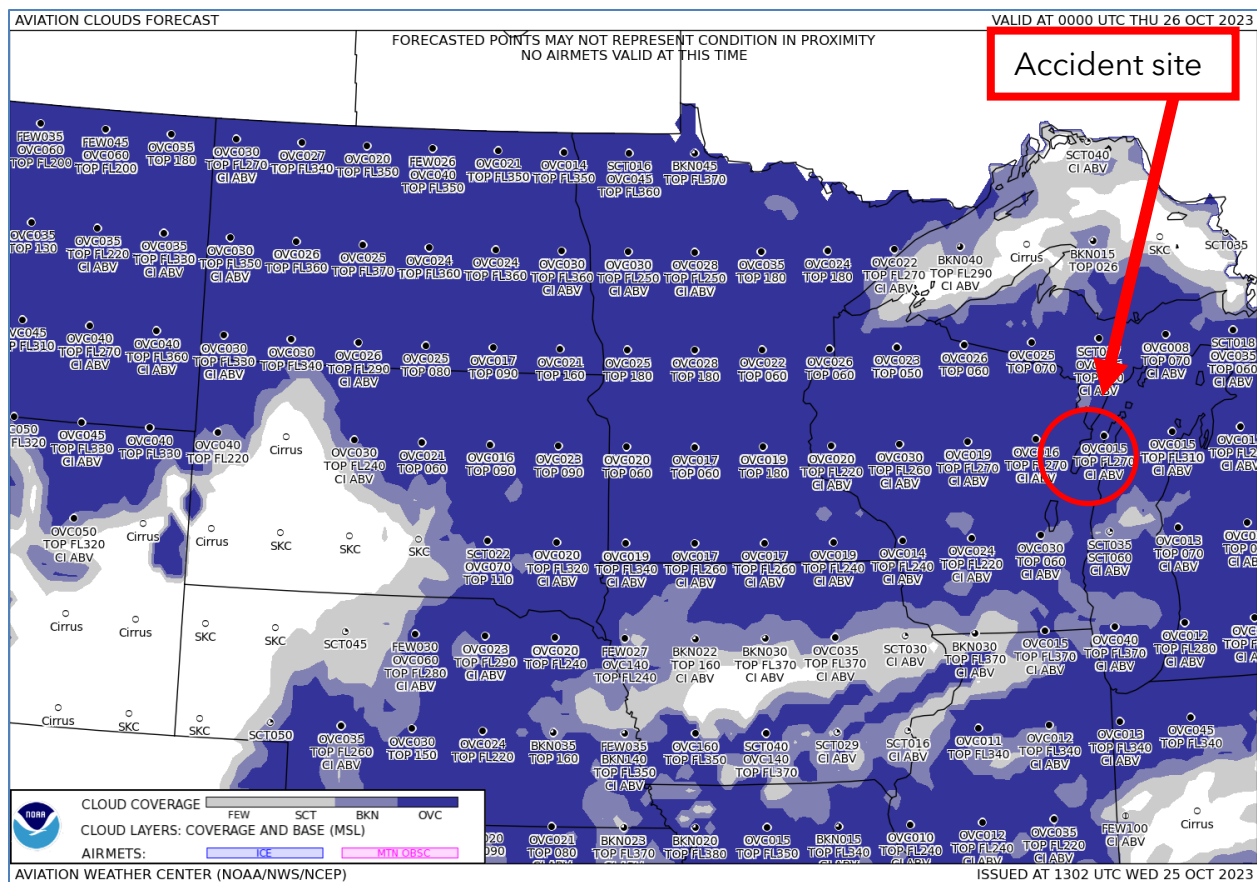


Figure 11. GFA Aviation Clouds Forecast valid at 1900 CDT with forecast issued at 0802 CDT.

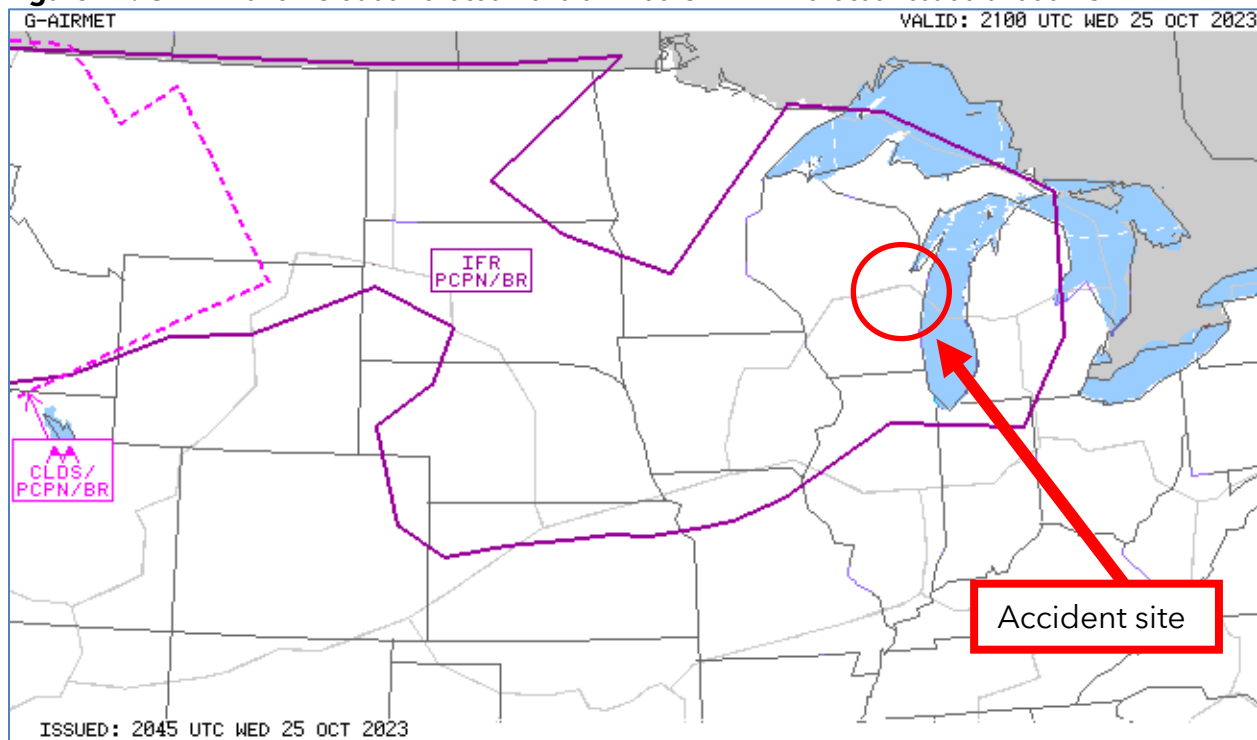


Figure 12. G-AIRMET Sierra valid at 1600 CDT with forecast issued at 1545 CDT.

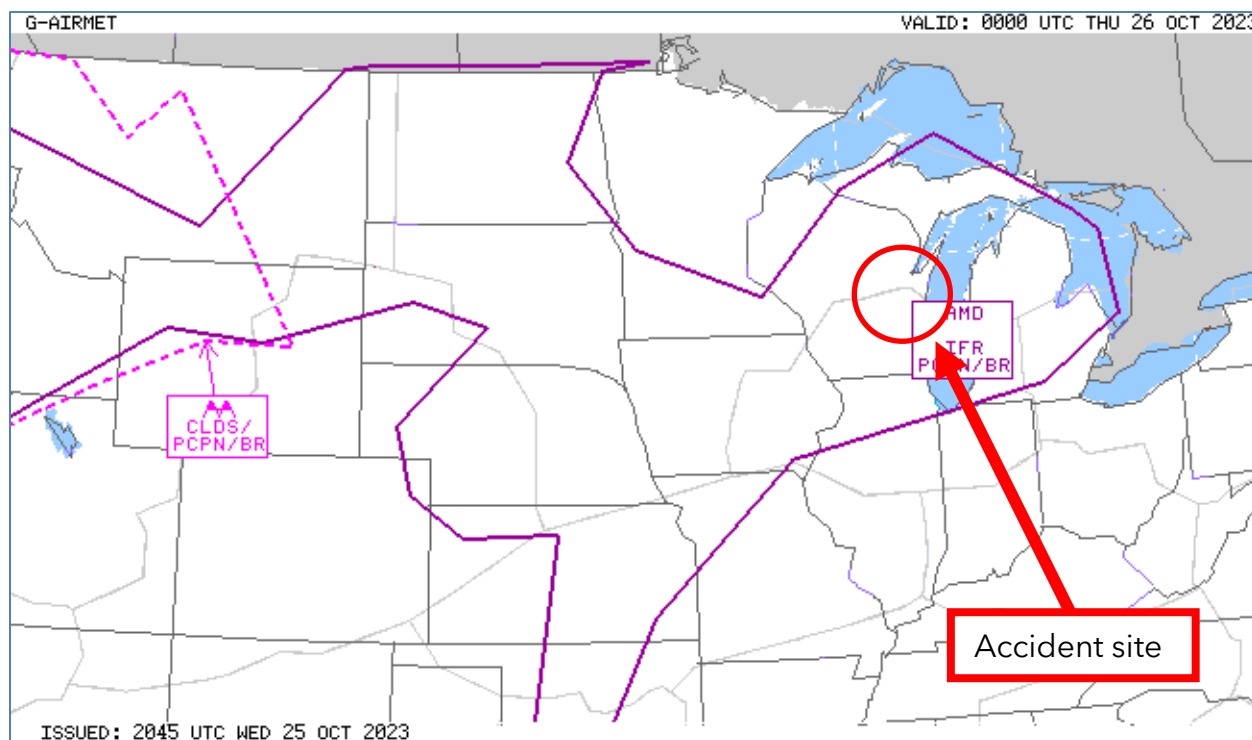


Figure 13. G-AIRMET Sierra valid at 1900 CDT with forecast issued at 1545 CDT.

12.0 Terminal Aerodrome Forecast

KMTW was the closest site with an NWS Terminal Aerodrome Forecast²² (TAF) current at the time of the accident. The amended KMTW TAF valid at the accident time was issued at 1735 CDT and was valid for a 19-hour period beginning at 1800 CDT. The amended 1735 CDT TAF for KMTW was as follows:

```
FTUS43 KGRB 252235 AAA
TAFMTW
TAF AMD
KMTW 252235Z 2523/2618 07006KT 5SM BR OVC010
FM260200 15006KT 1 1/2SM -SHRA BR OVC003
FM261200 16007KT 1 1/2SM RA BR OVC003
FM261700 20013G21KT 3SM RA BR OVC006=
```

Between 1800 and 2100 CDT the KMTW forecast expected a wind from 070° at 6 knots, 5 miles visibility, mist, and an overcast ceiling at 1,000 ft agl.

²² According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."
www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

The previous KMTW TAF was issued at 1238 CDT and was valid for a 24-hour period beginning at 1300 CDT. The 1238 CDT TAF for KMTW was as follows:

FTUS43 KGRB 251738
TAFMTW
TAF
KMTW 251738Z 2518/2618 27007KT 6SM BR VCSH OVC010
TEMPO 2518/2521 3SM BR OVC009
FM252100 05006KT 4SM BR OVC005
FM260200 15006KT 1 1/2SM -SHRA BR OVC003
FM261200 16007KT 1 1/2SM RA BR OVC003
FM261700 20013G21KT 3SM RA BR OVC006=

Between 1600 and 2100 CDT the KMTW forecast expected a wind from 050° at 6 knots, 4 miles visibility, mist, and an overcast ceiling at 500 ft agl.

13.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Green Bay, Wisconsin, (WFO GRB) was responsible for the public forecast in the region of the accident site. WFO GRB issued the following Area Forecast Discussion (AFD) at 1612 CDT, the AFD issued closest to the accident time with an aviation section:

035
FXUS63 KGRB 252112
AFDGRB

Area Forecast Discussion
National Weather Service Green Bay WI
412 PM CDT Wed Oct 25 2023

Forecast discussion for routine afternoon forecast issuance

.SHORT TERM...Tonight and Thursday
Issued at 411 PM CDT Wed Oct 25 2023

Focus over the next 30 hours (short term forecast) is on the next round of rain from late tonight through Thursday (and beyond into the long term forecast). Light to moderate rainfall is expected, with heavier rainfall amounts of 2+ inches not as likely Tuesday.

Current surface analysis shows a near stationary front remains draped from central into east-central Wisconsin; however, a mid-level dry slot and lack of forcing has kept the forecast area mainly dry today. Light, isolated showers have occurred in east-central Wisconsin at times, but not amounted to much accumulation.

Going into tonight, moisture returns with pwats ranging from 1.2

to 1.4 inches by Thursday morning, which is around 250-percent of normal for late October. Several lift sources also come into play, with some low level warm advection late tonight, in conjunction with added support from the RRQ of the upper jet at times throughout Thursday. There is some shortwave energy, but this does not look as robust as earlier. All of this arrives a little later than originally forecast, too, which pushes back the start of precipitation to late tonight/Thursday morning. Some light, scattered showers will arrive overnight, but likely will not see steadier rain until after 5AM Thursday. Rain will overspread the area from both the south and west, with the southern component bringing in the most moisture. Moisture and forcing in the Northwoods is less.

The most widespread rain will occur from about 6AM to 3PM, and then gradually become more scattered and lighter into the late afternoon and evening.

This all results in event rainfall totals which are a little less than previously forecast. From 00Z/Thu to 00Z/Fri the most likely rainfall amounts will be 0.75 to 1.25 inches from central into east-central WI (roughly along and south of Hwy 29), and less across northern WI, from about 0.25 to 0.75 inches. The probability for 2 inches or more is very low (0 to 10%) for all areas, with moderate probabilities (50 to 70%) of 1 inch or more. Feel this aligns well with the current forecast. With these amounts, also do not anticipate a major flooding concern. Will likely see some slight river rises, with a couple possibly reaching minor flood stage. Minor urban flooding/ponding of water is also possible in poor drainage areas, but anticipate this concern to be very local. Therefore, have not issued a Flood Watch at this time.

Finally, convective parameters are fairly low, with the highest CAPE of about 200 J/kg and mid-level lapse rates of 5 to 5.5 C/km. While some occasional lightning is possible, primarily with the southern wave south of Hwy 29, do not expect severe weather to be a concern.

Temperatures will remain mild, with lows in the middle 40s to middle 50s tonight, and highs in the 50s to low 60s Thursday.

.LONG TERM...Thursday Night Through Wednesday
Issued at 411 PM CDT Wed Oct 25 2023

Main focus of the extended period will be the resolution of rainfall Thursday night through Friday. Behind this, much cooler temperatures follow for the weekend and early next week.

Thursday night through Friday... The extended will start off with a fairly active as rain and thunderstorms continue from the day Thursday into the overnight hours along a frontal boundary and passing low pressure system. The departing low will then be

followed fairly quickly by a fast moving but fairly strong cold front that will sustain rain through much of Friday. Despite the continued rain chances, additional qpf for this portion of the forecast will be on the lighter side, as the better moisture will have departed earlier on Thursday. The passage of the cold front on Friday will also bring in much cooler temperatures and some stronger wind gusts behind the rain. Low temperatures Friday night are expected to range from the middle 20 to middle 30s.

The weekend... The weekend will start off dry and much cooler than the days prior, with highs on Saturday expected to range from the middle 30s to middle 40s across the area. By Saturday evening, a fast moving jet streak is expected to lift into the area, which will bring another round of light precipitation to the area. Moisture during this period will be fairly limited with the drier and cooler airmass in place, but scattered light showers will be possible across the area. Any precipitation that works its way into the far north near the Upper Peninsula border could produce a few non-accumulating flurries. Overnight, a passing system well to our south could bring some additional overrunning precipitation to our area, but the northern extent of any additional precipitation is fairly low confidence. If this system shifts further north, pops will need to be raised for our eastern areas near Lake Michigan.

Rest of the forecast...Behind this, west to northwesterly flow will dominate the region once again, with below normal temperatures for the early week. Models hint at another shortwave crossing the region, but the timing varies. Either way, moisture with any shortwave next week will be fairly minimal.
&&

.AVIATION...for 18Z TAF Issuance
Issued at 1257 PM CDT Wed Oct 25 2023

Expect primarily IFR and LIFR flight conditions through the TAF period. Currently, a low cloud deck with bases from about 300 to 1000 feet are noted, while precipitation is in a lull for most locations. A few sprinkles or isolated showers could pop up through the afternoon and evening, but most places will be dry until tonight.

Next round of rain arrives tonight, first as scattered, light showers; then, becoming more widespread and steady throughout Thursday morning and afternoon. IFR and LIFR conditions are expected as the heavier rain arrives Thursday due to lower cigs and vsbys.

Winds will remain in the 5 to 10 knot range veering from NE, to E, and then back to NE.
&&

.GRB WATCHES/WARNINGS/ADVISORIES...

None.
&&
\$\$

14.0 Winds and Temperature Aloft Forecast

The NWS 1459 CDT, Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

FBUS31 KWNO 251959
FD1US1
DATA BASED ON 251800Z
VALID 260000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
GRB 1507 2416+09 2621+05 2625+01 2537-13 2656-24 268437 760349 762458

The 1459 CDT forecast was for use between 1500 CDT and 2200 CDT.

15.0 Pilot Weather Information

Title 14 CFR 91.103 states that “Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight.” FAA AC 91-92 “Pilot’s Guide to a Preflight Planning” (dated March 15, 2021) provided pilot guidance on preflight self-briefings, including planning, weather interpretation, and risk identification/mitigation skills. The AC further stated in part:

Pilots adopting these guidelines will be better prepared to interpret and utilize real-time weather information before departure and en route, in the cockpit, via technology like Automatic Dependent Surveillance-Broadcast (ADS-B) and via third-party providers.²³

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service or through ForeFlight. It is unknown what weather information, if any, the accident pilot checked or received before or during the accident flight.

²³ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf. The AC also listed multiple online FAA resources for aviation flight planning services for adverse weather.

16.0 Astronomical Data

The astronomical data obtained²⁴ for the accident site on October 25, 2023, indicated the following:

SUN

Begin civil twilight	0648 CDT
Sunrise	0718 CDT
Sun transit	1235 CDT
Sunset	1751 CDT
End civil twilight	1821 CDT
Accident time	1829 CDT ²⁵

Moon

Moonrise	1633 CDT
Accident time	1829 CDT ²⁶
Moonset	0306 CDT October 26, 2023

At the time of the accident the Sun was -7.57° below the horizon at an azimuth of 260.14° . The moon was 18.66° above the horizon at an azimuth of 118° , with the phase of the moon a waxing gibbous with 89% of the moon's disk visible.

E. LIST OF ATTACHMENTS

Attachment 1 - GOES-16 Infrared imagery animation from 1731 to 1931 CDT

Submitted by:

Paul Suffern
Senior Meteorologist

²⁴ <https://www.suncalc.org/> and <https://www.mooncalc.org/>

²⁵ Inserted accident time for reference and context.

²⁶ Inserted accident time for reference and context.