

# National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN23FA187

## **METEOROLOGY**

Specialist's Factual Report

June 30, 2023

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## **A. ACCIDENT**

Location: Chambers, Nebraska  
Date: May 14, 2023  
Time: 2125 central daylight time (CDT)  
0225 coordinated universal time (UTC) May 15, 2023  
Airplane: Cessna 172D; Registration: N2946U

## **B. METEOROLOGY SPECIALIST**

Donald Eick  
National Transportation Safety Board  
Washington, DC

## **C. SUMMARY**

On May 14, 2023, about 2125 central daylight time, a Cessna 172 D airplane was substantially damaged when it was involved in an accident near Chambers, Nebraska. The pilot sustained fatal injuries. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 personal flight. The flight had departed from Newton City - County Airport (EWK), Newton, Kansas, at about 1930 CDT with the planned destination of Glen Ullin, North Dakota (D57).

## **D. DETAILS OF THE INVESTIGATION**

The National Transportation Safety Board's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data 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 report documents the general weather products and forecasts over the region during the period and the pertinent meteorological parameters related to the accident. All times are reported as CDT based upon the 24-hour clock, local time is -5 hours from UTC, and UTC=Z. NWS airport and weather 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. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site is based on the reported wreckage location at latitude 42.241217° N and longitude 98.623517° W, at an elevation of 2,053 ft.

## **1.0 Synoptic Conditions**

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 WPC located in College Park, 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 Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28<sup>1</sup>.

### **1.1 Surface Analysis Chart**

The north central section of the NWS Surface Analysis Chart for 2200 CDT is included as figure 1 with the approximate accident site marked by the red star. The chart depicted a low-pressure system with a central pressure of 1021-hectopascals (hPa)<sup>2</sup> over eastern Kansas along a stationary front, which extended across Missouri, eastern Kansas and into Oklahoma. A trough<sup>3</sup> extended northward from the low across Kansas into eastern Nebraska immediately east of the accident site, rotating around the low. A high-pressure system at 1033-hPa was located to the northeast of the accident site over northern Wisconsin with a ridge extending westward through Minnesota and into eastern South Dakota to the north of the accident site. While to the northwest of the accident site, another high-pressure system at 1035-hPa was located over northeastern Wyoming with a ridge extending north and south.

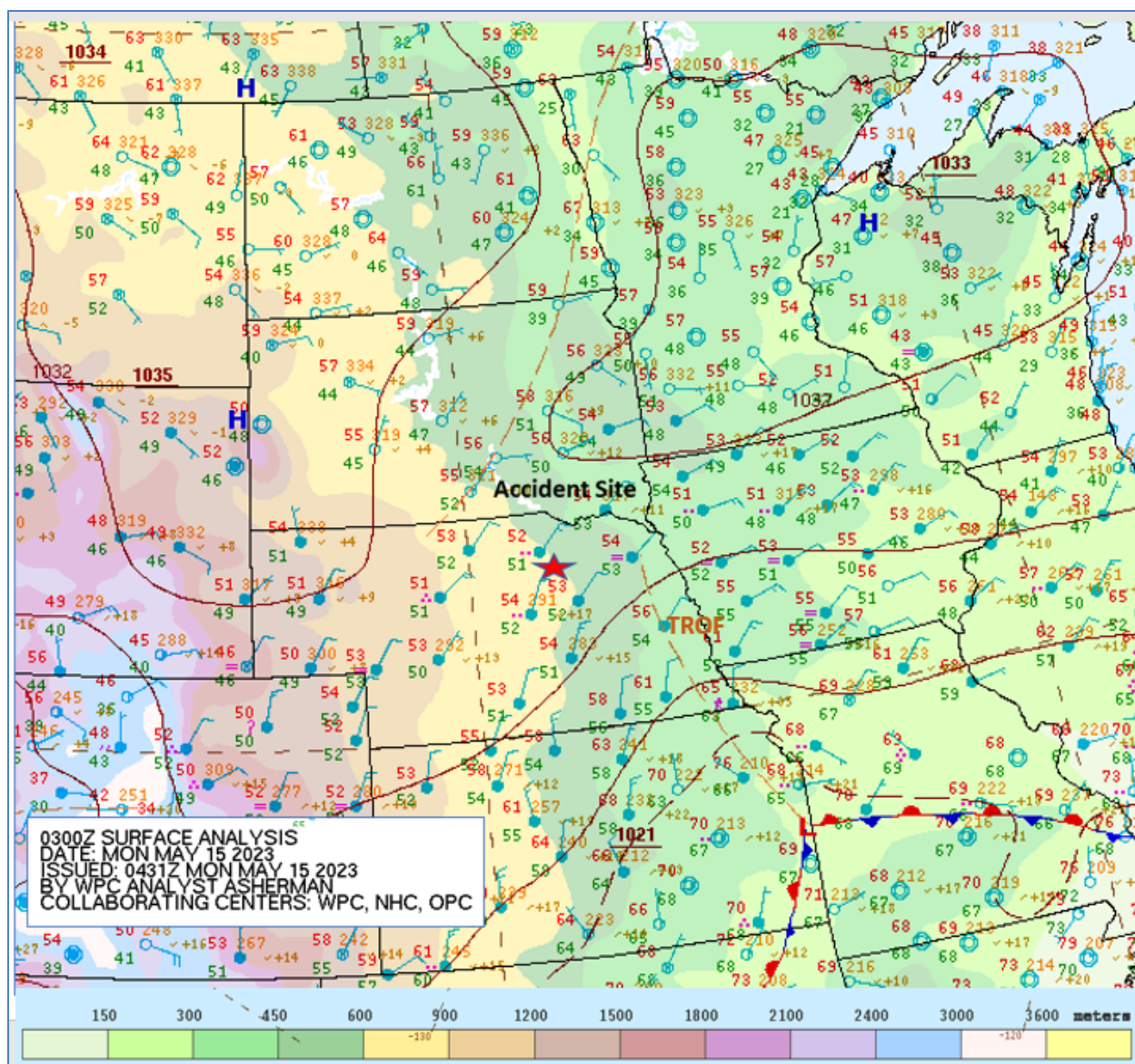
The station models in the vicinity of the accident site depicted wind from the northeast at about 5 knots, light continuous rain and/or mist, overcast clouds with temperatures and dew point temperatures in the 50's degrees Fahrenheit (F), with temperature-dew point spreads of 2° F or less. While conditions over the Dakota's immediately north of the accident site indicated light easterly to calm winds over the planned destination, clear skies, temperatures into the mid 50's to low 60's °F, with no significant weather indicated over the Dakota's.

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<sup>1</sup> <https://www.faa.gov/regulationspolicies/handbooksmanuals/aviation/faa-h-8083-28-aviation-weather-handbook>

<sup>2</sup> Hectopascals (hPa) is the standard unit for reporting pressure and is interchangeable with the former term millibar (mb) with the same units. The International Standard Atmosphere (ISA) is based on a sea-level pressure of 1013.25-hPa or 29.92 inches of mercury (inHg), at a temperature of 59° F or 15° Celsius (C).

<sup>3</sup> Trough (abbreviated as TROF) is an elongated area of low-pressure and is often associated with an area of general convergence, a wind shift, and rising motion that resulting in clouds and precipitation.

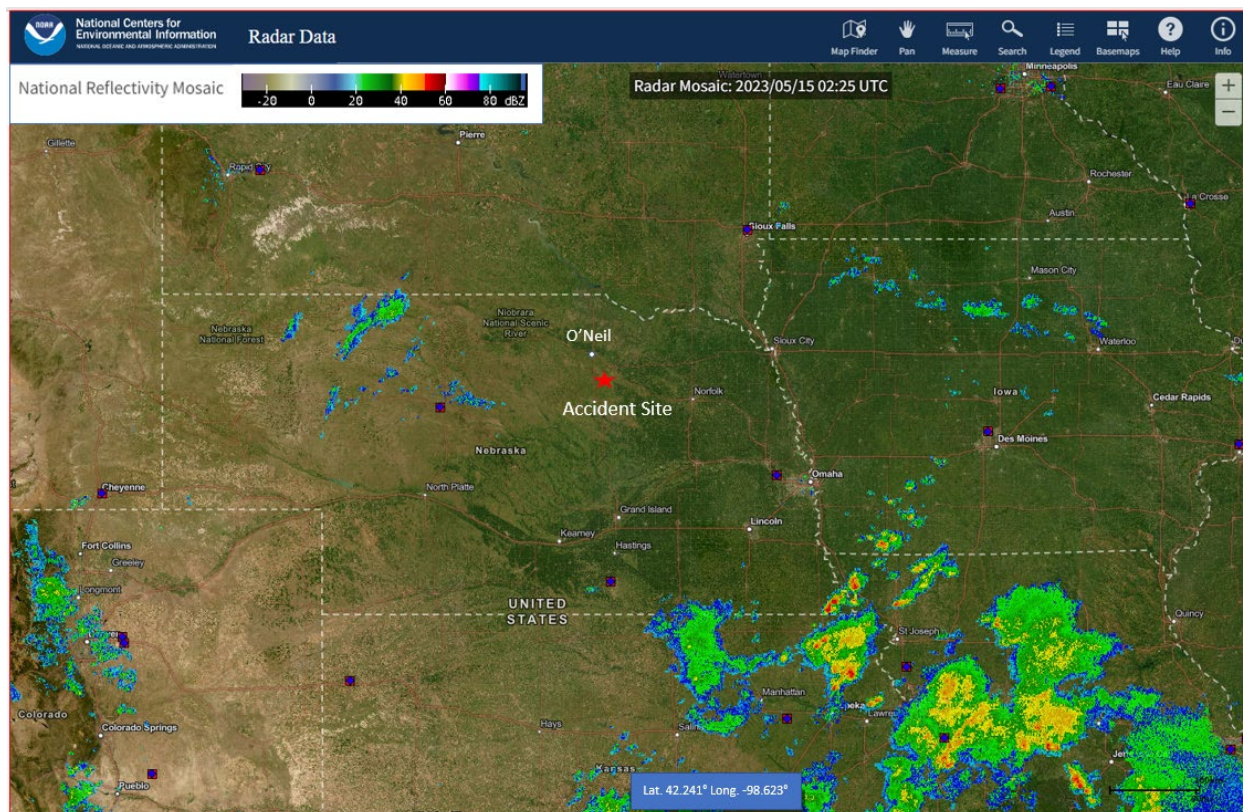


**Figure 1 - NWS Surface Analysis Chart for 2200 CDT with the general topography and the approximate accident site marked by the red star.**

## 1.2 National Composite Radar Imagery

The NWS National Composite Radar Mosaic for 2125 CDT over the area is included as figure 2, with the approximate accident site marked by the red star. The locations of the NWS weather surveillance radars are noted by the red and blue squares. The closest NWS weather radar from North Platte, Nebraska, was about 110 miles west of the accident site, with no radar coverage below approximately 8,000 ft in the vicinity of the accident site. The image depicted no significant echoes over the accident site that extended above 8,000 ft. Several areas of light intensity echoes were depicted over western Nebraska and over northern Kansas, with areas of moderate to

heavy intensity echoes over northeastern Kansas and into Missouri and southwestern Iowa.

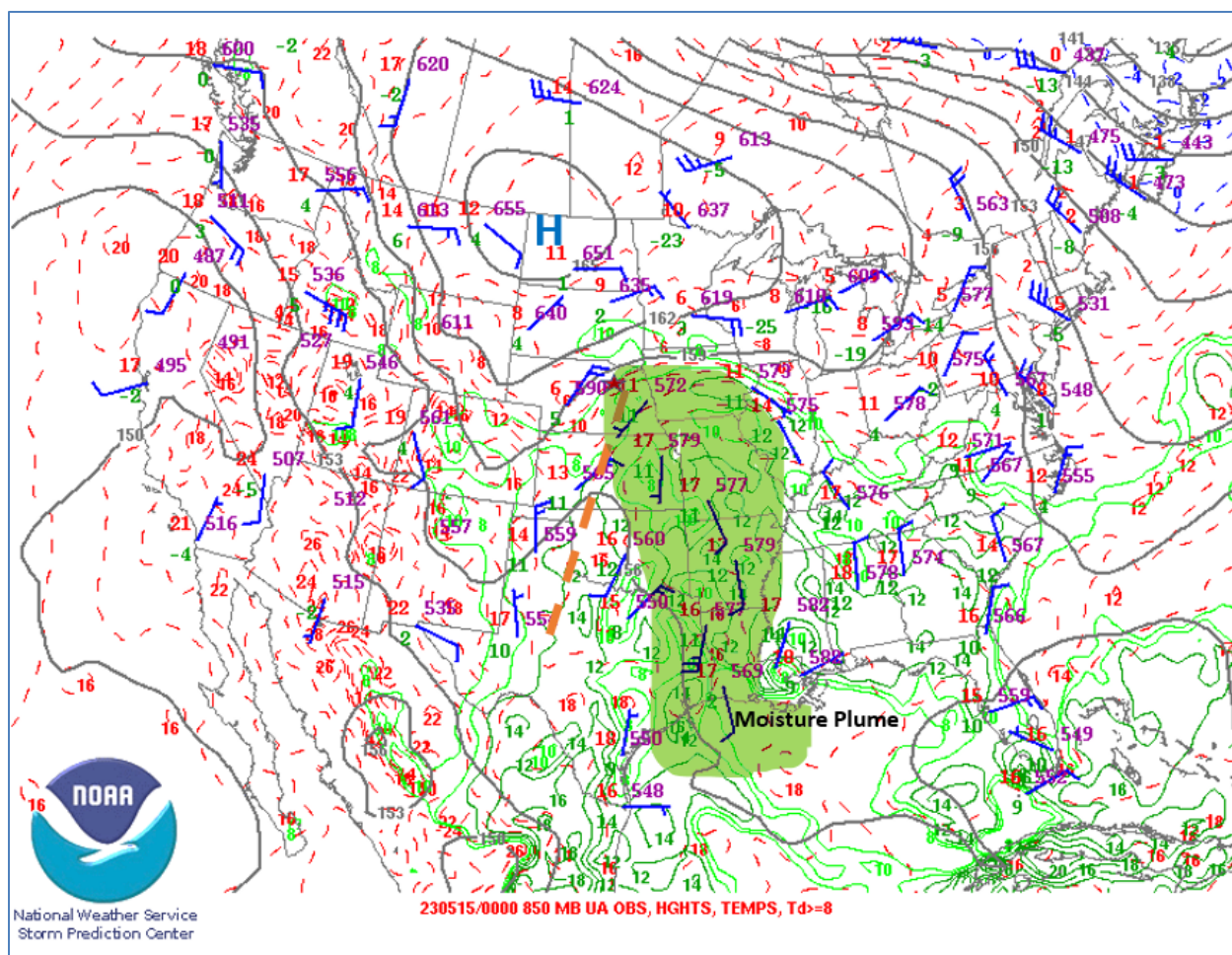


**Figure 2 - NWS Composite Radar Mosaic for 2125 CDT with the accident site marked and the NWS network weather radar locations.**

### 1.3 Upper Air Chart

The NWS Storm Prediction Center's 850-hPa constant pressure chart for 1900 CDT is included as figure 3 with the approximate accident site noted by the red star. A short-wave trough extended from Texas northward across Oklahoma, Kansas, and into Nebraska. A moisture plume<sup>4</sup> is highlighted in green where moist southerly winds were noted immediately east of the trough and was referenced in forecast discussions (section 7.2) as a factor in the weather conditions over Nebraska during the period.

<sup>4</sup> The moisture plume was also indication of warm-moist air advection over the area and overrunning conditions over the frontal surface, which often results in an extensive area of low clouds and embedded thunderstorms mentioned in the forecast discussion.

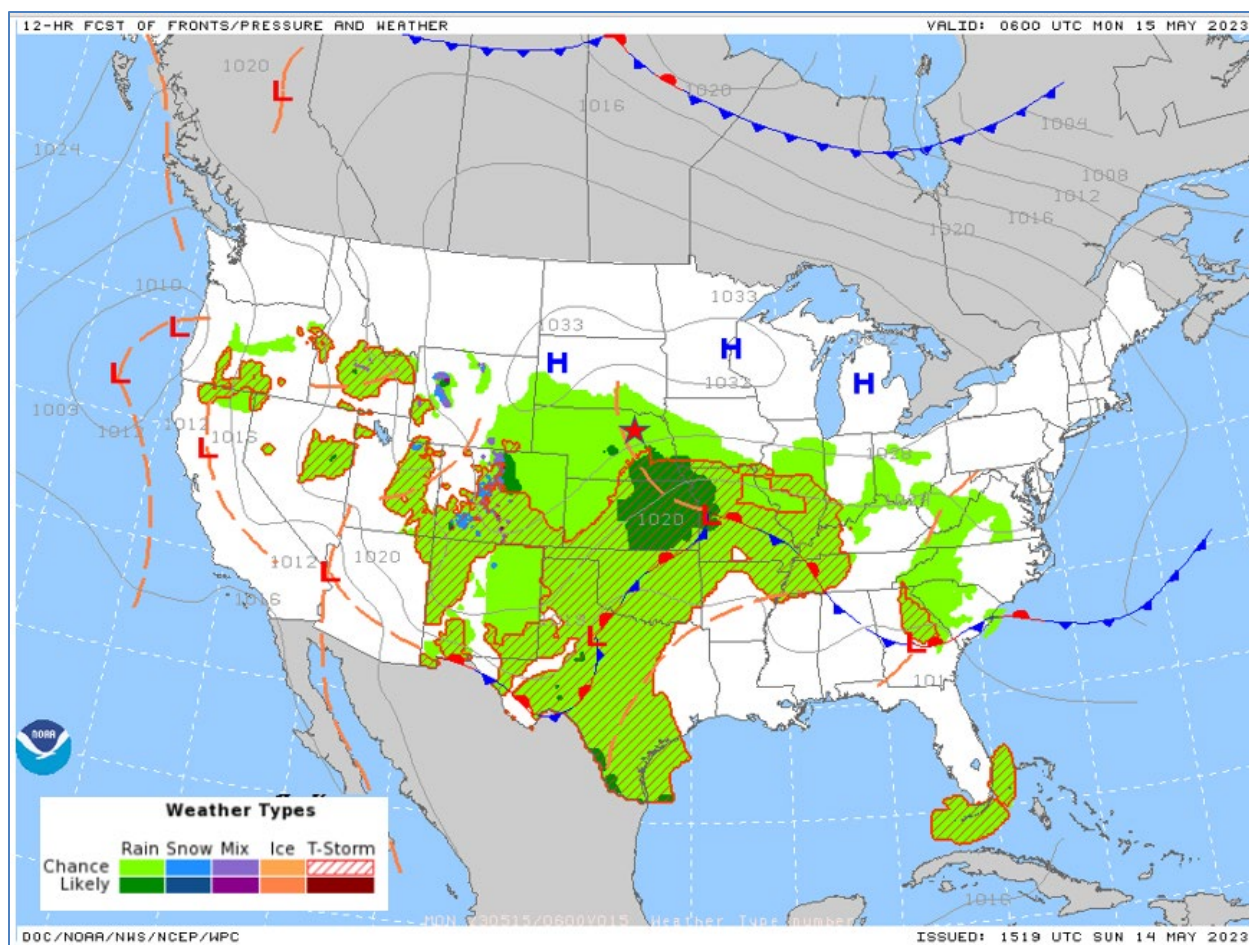


**Figure 3 - NWS 850-hPa Constant Pressure Chart for 1900 CDT with moisture plume noted.**

## 1.4 NWS 12-hour Surface Prognostic Chart

The 12-hour Surface Prognostic Chart based on conditions from 1300 CDT and valid for 0100 CST on May 15, 2023, is included as figure 4 with the approximate accident site marked by the red star. The chart depicted the low-pressure system and associated front moving into Missouri with the trough of low pressure extending northwestward located to the west of the accident site. An area of likely<sup>5</sup> rain and/or thunderstorms over southeast Nebraska, eastern Kansas, and western Missouri, with a chance or rain over the rest of Nebraska, which included the accident site.

<sup>5</sup> Likely is defined as between a 60% to 70% probability of occurrence, or numerous.



**Figure 4 - NWS 12-hour Short Term Forecast valid for 0100 CDT May 15, 2023 with the accident marked by the red star.**

## 1.5 NWS 12-hour Low-level Significant Weather Prognostic Chart

The NWS 12- and 24-hour Low-level Significant Weather Prognostic Chart depicts the general flight categories<sup>6</sup> expected (IFR, MVFR, and VFR), the freezing levels, and expected areas of turbulence up to 24,000 ft or FL240<sup>7</sup> during the period.

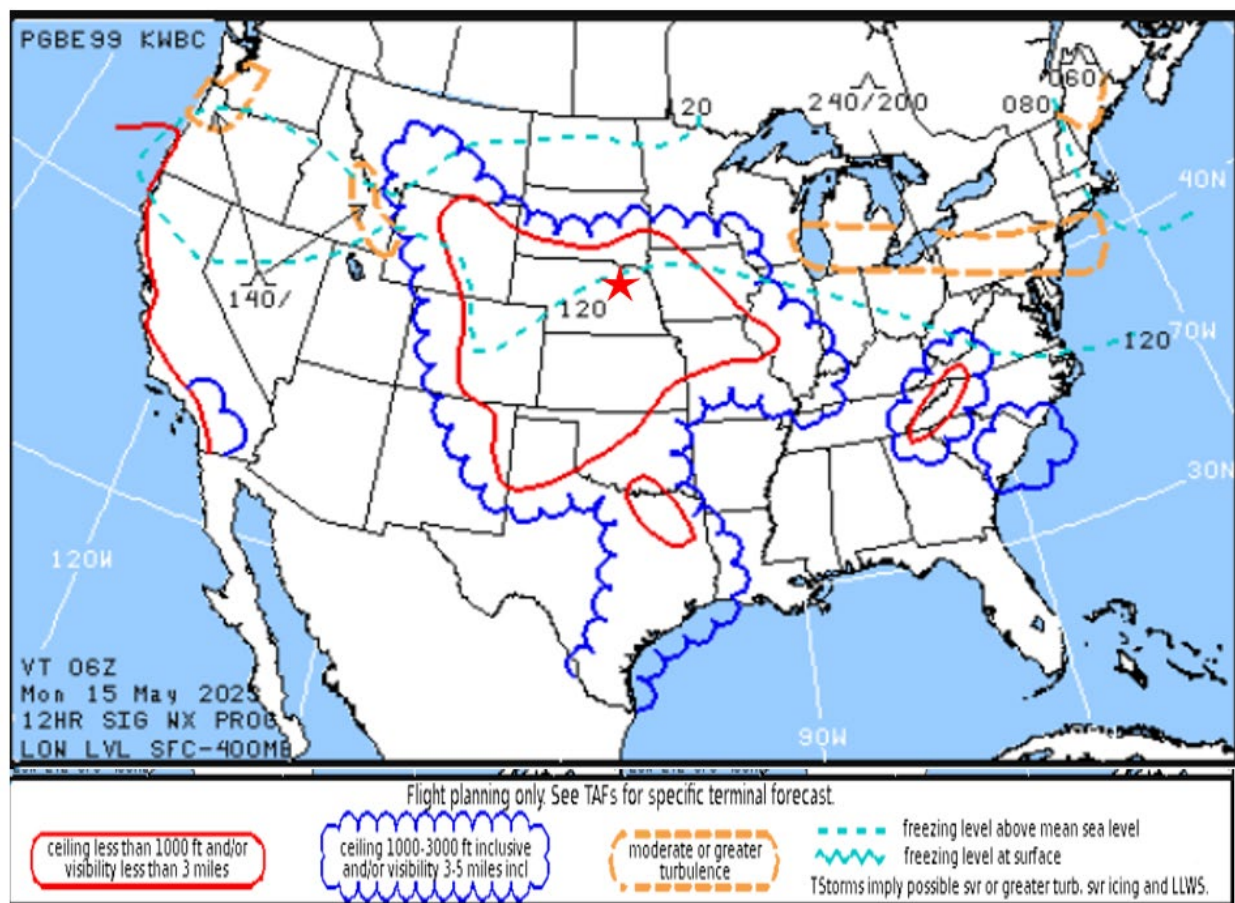
<sup>6</sup> As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

<sup>7</sup> Flight Level (FL) is reference to pressure altitude based on the standard sea-level pressure of 29.92 inHg or 1013.25-hPa, with height in hundreds of ft. Aircraft operating above 18,000 ft typically reference

Figure 5 is the NWS 12-hour Low-Level Significant Weather Prognostic Chart valid for 0100 CDT on May 15, 2023, with the approximate accident site marked by a red star. The accident site was located within a large area of instrument flight rule (IFR) conditions (red line) defined as a ceiling or lowest layer of broken or overcast clouds, or the vertical visibility into a surface based obscuration less than 1,000 ft above ground level (agl) and/or visibility less than 3 miles. The freezing level (depicted by light blue dashed line) was depicted above 12,000 ft. No significant clear air turbulence (brown dash line) was depicted over the general route of flight.



**Figure 5 - NWS 12-hour Low-Level Significant Weather Prognostic Chart valid for 0100 CDT on May 15, 2023, with the approximate accident site marked by the red star.**

## 2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METAR) and Aviation Selected Special Weather Reports (SPECI). Cloud heights are reported above ground level (agl) in the following section,

their altitude by flight levels.

and the magnetic variation was estimated at 4° east based on the latest sectional chart for the area.

## 2.1 O'Neill, Nebraska

The closest official weather reporting site to the accident site was from the O'Neill Municipal Airport - John L. Baker Field (KONL), O'Neill, Nebraska, located about 16 miles north of the accident site at an elevation of 2,034 ft. The airport had an Automated Weather Observation System (AWOS) which was not augmented by any human observers and broadcasted weather every minute locally on 121.125 MHz<sup>8</sup> and disseminated reports long-line on FAA and NWS weather circuits to users in near real-time every 20-minutes. At the time of the accident, the following conditions were reported long-line.

*Weather observation for KONL at 2135 CDT, automated, wind from 040° at 12 knots gusting to 19 knots, visibility 5 miles in light rain, ceiling overcast at 300 ft agl, temperature 12° C, dew point temperature 11° C, altimeter 30.42 inHg. Remarks: automated observation system with a precipitation discriminator, hourly precipitation since 2055 CDT 0.07 inches, temperature 11.5° C, dew point 10.7° C.*

The general flight categories and raw observations as they were disseminated to users from 1835 through 2300 CDT were as follows. The observation for 2135 CDT is in bold type below.

*IFR METAR KONL 142335Z AUTO 04013KT 4SM -RA OVC005 12/11 A3038 RMK AO2 P0001 T01180110=*  
*IFR METAR KONL 142355Z AUTO 03013G18KT 2 1/2SM -RA OVC005 12/11 A3038 RMK AO2 P0002 60004 T01180111 10123 20115=*  
*LIFR METAR KONL 150015Z AUTO 03014KT 2 1/2SM -DZ OVC003 12/11 A3038 RMK AO2 T01170111=*  
*LIFR METAR KONL 150035Z AUTO 03011G17KT 3SM BR OVC003 12/11 A3038 RMK AO2 T01180111=*  
*LIFR METAR KONL 150055Z AUTO 04013KT 3SM BR OVC003 12/11 A3038 RMK AO2 P0001 T01180112=*  
*LIFR METAR KONL 150115Z AUTO 04013KT 3SM BR OVC003 12/11 A3038 RMK AO2 T01180112=*  
*LIFR METAR KONL 150135Z AUTO 05010KT 5SM -RA OVC003 12/11 A3040 RMK AO2 P0001 T01180111=*  
*LIFR METAR KONL 150155Z AUTO 06009KT 4SM -RA OVC003 12/11 A3040 RMK AO2 P0002 T01170110=*  
*LIFR METAR KONL 150215Z AUTO 04011G17KT 5SM -RA OVC003 12/11 A3041 RMK AO2 P0004 T01160110=*  
**Accident 0225Z**  
*LIFR METAR KONL 150235Z AUTO 04012G19KT 5SM -RA OVC003 12/11 A3042 RMK AO2 P0007 T01150107=*  
*IFR METAR KONL 150255Z AUTO 04013G18KT 5SM -RA OVC005 11/11 A3042 RMK AO2 P0009 60012 T01120105=*  
*IFR METAR KONL 150315Z AUTO 04014KT 4SM RA OVC005 11/11 A3043 RMK AO2 P0002 T01120105=*  
*IFR METAR KONL 150335Z AUTO 05013KT 7SM DZ OVC005 11/11 A3043 RMK AO2 P0003 T01120105=*  
*IFR METAR KONL 150355Z AUTO 04012KT 7SM OVC005 11/11 A3043 RMK AO2 P0004 T01120105=*

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<sup>8</sup> MHz - abbreviation for megahertz.

## 2.2 Albion, Nebraska

The next closest weather reporting station was from Albion Municipal Airport (KBVN), Albion, Nebraska, located about 36 miles south-southeast of the accident site at an elevation of 1,806 ft, and immediately east of the accident airplane's flight path. The airport had an AWOS which was not augmented by any human observers and broadcasted on 118.575 MHz every minute and disseminated observations every 20-minutes longline. The following conditions were reported as the aircraft was in the vicinity prior to the accident.

*Weather observation for KBVN for 2115 CDT, automated, wind from 040° at 12 knots, visibility 10 miles or more, ceiling overcast at 700 ft agl, temperature 12° C, dew point temperature 11° C, altimeter 30.36 inHg. Remarks: automated station with a precipitation discriminator, temperature 11.6° C, dew point 11.4° C.*

The general flight categories and observations disseminated to users from 1815 through 2300 CDT were as follows.

*IFR* METAR KBVN 142315Z AUTO 02011G18KT 7SM OVC007 12/12 A3032 RMK AO2 T01200118=  
*IFR* METAR KBVN 142335Z AUTO 03011KT 10SM OVC007 12/12 A3032 RMK AO2 T01200118=  
*IFR* METAR KBVN 142355Z AUTO 02011G16KT 10SM OVC007 12/12 A3033 RMK AO2 T01200117  
10139 20118=  
*IFR* METAR KBVN 150015Z AUTO 03012KT 5SM BR OVC005 12/12 A3034 RMK AO2 T01180117=  
*IFR* METAR KBVN 150035Z AUTO 03012G15KT 10SM OVC005 12/12 A3034 RMK AO2 T01180116  
*IFR* METAR KBVN 150055Z AUTO 02012G17KT 10SM OVC005 12/12 A3034 RMK AO2 T01170116  
*IFR* METAR KBVN 150115Z AUTO 02011KT 10SM OVC007 12/11 A3034 RMK AO2 T01170113=  
*IFR* METAR KBVN 150135Z AUTO 04012KT 10SM OVC009 12/11 A3035 RMK AO2 T01190111=  
*IFR* METAR KBVN 150155Z AUTO 04010G14KT 10SM OVC009 12/11 A3036 RMK AO2 T01170112  
*IFR* **METAR KBVN 150215Z AUTO 04012KT 10SM OVC007 12/11 A3036 RMK AO2  
T01160114=**

### **Accident 0225Z**

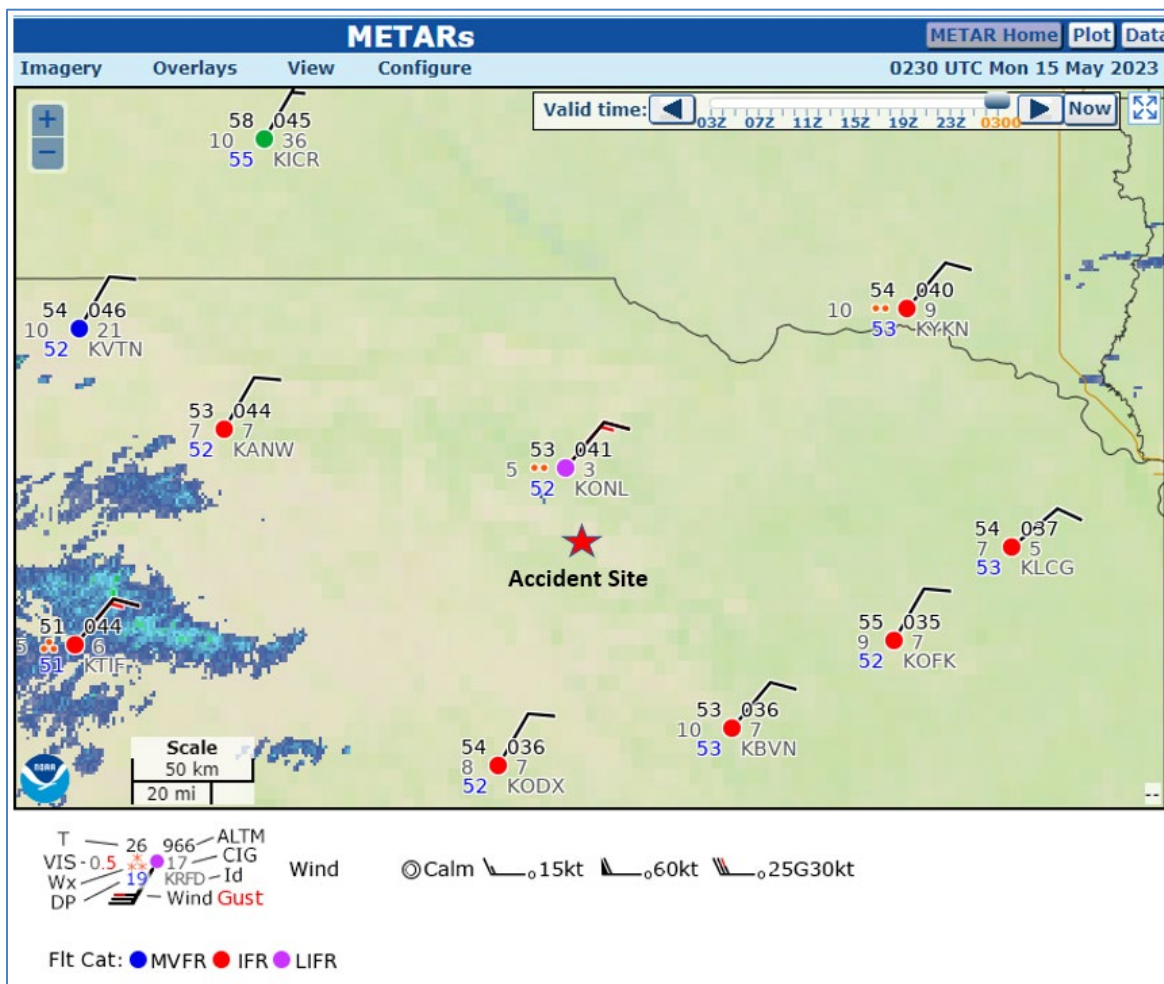
*IFR* METAR KBVN 150235Z AUTO 05011G16KT 10SM OVC007 12/11 A3036 RMK AO2 T01160114  
*IFR* METAR KBVN 150255Z AUTO 04009G17KT 10SM OVC007 12/11 A3037 RMK AO2 T01150110  
*IFR* METAR KBVN 150315Z AUTO 04011G15KT 10SM OVC007 12/11 A3038 RMK AO2 T01150109  
*IFR* METAR KBVN 150335Z AUTO 05011G17KT 10SM OVC009 12/11 A3039 RMK AO2 T01150108  
*IFR* METAR KBVN 150355Z AUTO 05010KT 10SM OVC009 12/11 A3039 RMK AO2 T01150109=

## 2.3 Depiction of METARs

A depiction of the conditions over the region from the NWS Aviation Weather Center's METAR display<sup>9</sup> for 2130 CDT is included as figure 6, with the approximate accident site marked by the red star. Temperature and dew point temperatures are displayed in °F, and cloud heights in agl heights. The image depicted IFR to LIFR

<sup>9</sup> <https://www.aviationweather.gov/metar>

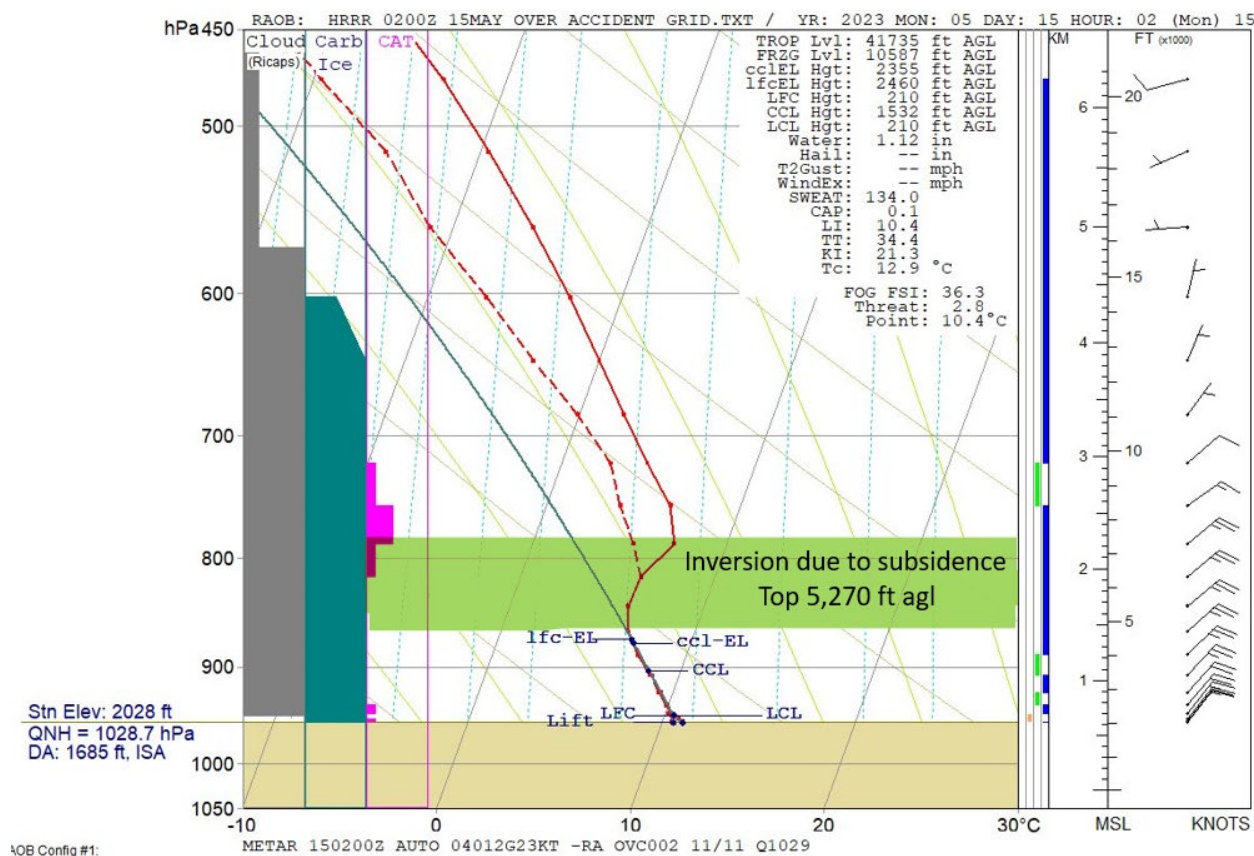
conditions surrounding the accident site, with the closest station KONL reporting LIFR conditions with visibility 5 miles in light rain with a ceiling overcast at 300 ft agl, winds from the northeast at about 10 knots gusting to 15 knots, a temperature of 53° F, and a dew point of 52° F. The radar overlay depicted light intensity echoes west of the accident site, while several station including KONL reporting rain with no weather echoes over the station being depicted.



**Figure 6 - NWS METAR display with the radar mosaic overlaid for 2130 CDT with the approximate accident site noted by a red star. The station identifiers are color coded for the general flight categories.**

### 3.0 Sounding

A High-Resolution Rapid Refresh (HRRR) numerical model<sup>10</sup> data were obtained from the NOAA Air Resource Laboratory for the nearest grid point<sup>11</sup> to the accident site for 2100 CDT. The data were then plotted on a standard Skew T log P diagram<sup>12</sup> using the RAOB Analysis software<sup>13</sup> and is depicted as figure 7 from the surface to 450-hPa or about 22,000 ft.



**Figure 7 - High-Resolution Rapid Refresh (HRRR) numerical model sounding for 2100 CDT over the closest grid point to the accident site.**

The sounding depicted the elevation over the grid point as 2,028 ft, with a near surface temperature of 11.1° C (52° F), a dew point temperature of 10.6° C (51° F), a

<sup>10</sup> The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

<sup>11</sup> Grid point used was latitude 42.24° N and longitude 98.62° W.

<sup>12</sup> Skew T log P diagram is a standard meteorological plot or thermodynamic diagram 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.

<sup>13</sup> RAOB -The Universal RAOBsonde OBservation program is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

relative humidity of 97%, and a pressure of 1028.7-hPa or 30.38 inHg<sup>14</sup>. The lifted condensation level (LCL)<sup>15</sup> and level of free convection (LFC)<sup>16</sup> were at 210 ft agl, and the convective condensation level (CCL)<sup>17</sup> at 1,532 ft agl, with the precipitable water content of 1.12 inches. An inversion<sup>18</sup> due to subsidence was noted between 5,000 ft and about 7,250 ft (light green shading across sounding). The sounding was saturated<sup>19</sup> from the LCL through 16,000 ft and the RAOB Analysis program supported an overcast layer of nimbostratus clouds (gray bar on left axis) with rain. The freezing level was identified at 12,615 ft and the RAOB program did not support any structural icing above this level; however, the program did support a high probability of serious carburetor<sup>20</sup> or induction type icing from the surface through 12,000 ft (marked by blue-green bar on left of diagram) at cruise or climb power settings.

The HRRR wind profile indicated a near surface wind from 040° at 12 knots with potential gusts to 23 knots, with little variation in wind direction through 10,000 ft. The mean 0 to 6 kilometers (km) or 18,000 ft wind was from 035° at 7 knots.

A table of the HRRR sounding parameters of height, pressure, temperature (T), dew point temperature (Td), relative humidity (RH), wind direction and speed, and RAOB derived Clear Air Turbulence (CAT), and Low-Level Wind Shear (LLWS) potential based on FAA definitions from the surface through 11,000 ft is included below.

| Height<br>(ft msl) | Pres<br>(hPa) | T<br>(°C) | Td<br>(°C) | RH<br>(%) | Wind<br>(dir/kts) | CAT<br>(FAA) | LLWS<br>(FAA) |
|--------------------|---------------|-----------|------------|-----------|-------------------|--------------|---------------|
| 2028               | 956           | 11.1      | 10.6       | 97        | 035/ 12           |              |               |
| 2057               | 955           | 11.1      | 10.5       | 96        | 035/ 11           | LGT          | MODRT         |
| 2143               | 952           | 10.8      | 10.5       | 98        | 036/ 15           |              | LIGHT         |
| 2287               | 947           | 10.3      | 10.2       | 99        | 036/ 17           | LGT          | LIGHT         |
| 2548               | 938           | 10.0      | 9.9        | 99        | 037/ 20           |              |               |
| 2929               | 925           | 9.4       | 9.3        | 99        | 039/ 22           |              |               |

<sup>14</sup> The HRRR model sounding was found to be consistent with the conditions reported at KONL located about 16 miles north of the grid point at the time of the accident.

<sup>15</sup> Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

<sup>16</sup> Level of Free Convection (LFC) - the level where a parcel becomes buoyant, or "warmer" than the environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

<sup>17</sup> Convective Condensation Level (CCL) - the height at which a parcel of air, when heated sufficiently from below, rises and becomes saturated. It is where newly forming convective clouds should form bases.

<sup>18</sup> A temperature inversion is where the temperature increases with altitude and creates a stable layer resisting vertical motions.

<sup>19</sup> Saturated means the relative humidity is 100% and implies a change in state from gas to liquid, forming a cloud.

<sup>20</sup> RAOB program uses icing probabilities from a study from the Department of Transportation (DOT) by Gardner and Moon, which provides carburetor icing categories as a function of ambient temperature, and dew point temperatures. Serious carburetor icing at cruise or climb power being the highest and most severe category.

|       |     |     |      |     |         |     |
|-------|-----|-----|------|-----|---------|-----|
| 3434  | 908 | 8.6 | 8.5  | 99  | 040/ 24 |     |
| 4039  | 888 | 7.5 | 7.5  | 100 | 042/ 24 |     |
| 4717  | 866 | 6.6 | 6.6  | 100 | 045/ 25 |     |
| 5475  | 842 | 6.1 | 6.1  | 100 | 048/ 26 |     |
| 6320  | 816 | 6.2 | 6.2  | 100 | 047/ 26 | LGT |
| 7298  | 787 | 7.3 | 5.2  | 87  | 048/ 23 | MDT |
| 8420  | 755 | 6.4 | 3.8  | 83  | 052/ 14 | LGT |
| 9658  | 721 | 4.4 | 2.5  | 87  | 046/ 9  |     |
| 11063 | 684 | 2.3 | -0.1 | 84  | 034/ 7  |     |

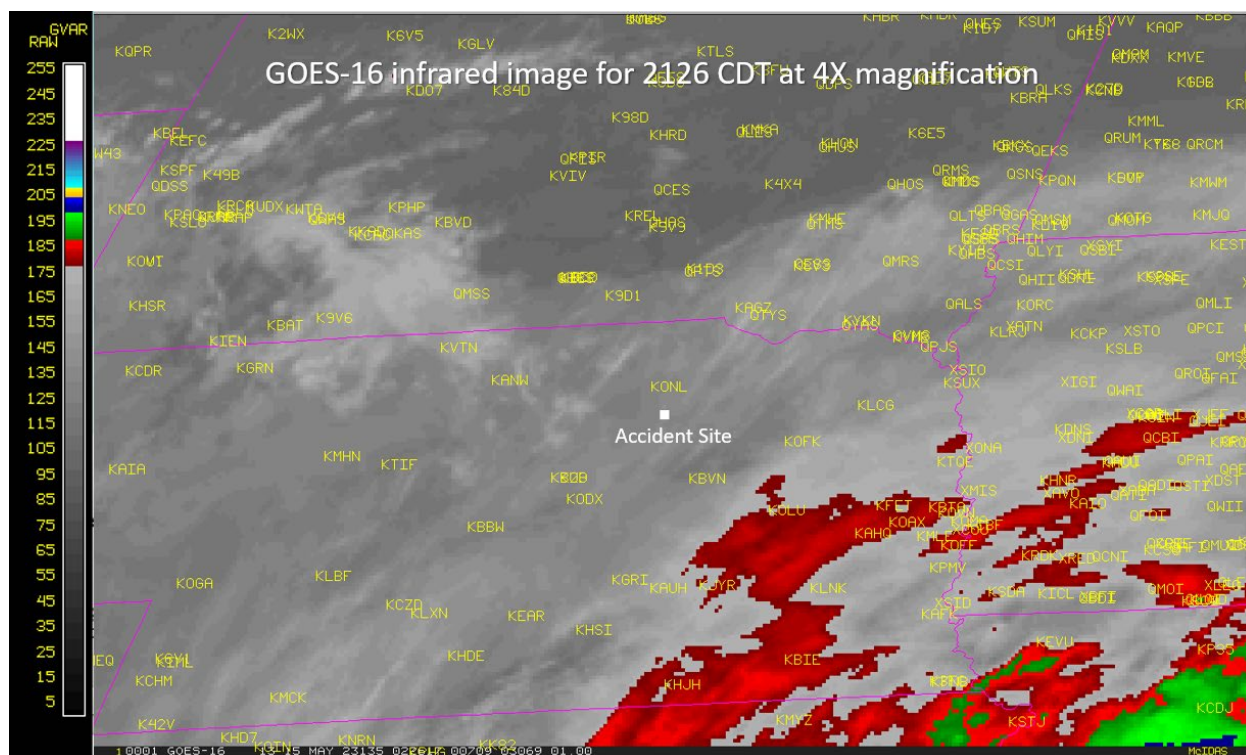
## 4.0 Satellite Imagery

Geostationary Operational Environmental Satellite number 16 (GOES-16) imagery were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software<sup>21</sup>. The infrared imagery surrounding the period were reviewed and the closest images to the accident time were documented. The infrared band 13 imagery at a wavelength of 10.3 microns (  $\mu\text{m}$ ) provided a resolution of 2 km and provided radiative cloud top temperatures. Due to the low sun angle no useful visible imagery was available at the time of the accident.

Figure 8 is the GOES-16 infrared image for 2126 CDT at 4X magnification and a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops typically associated with deep convection and high cirriform clouds. The accident site is marked by the white square and was under an overcast layer of clouds with a radiative cloud top temperature of 262 Kelvin or  $-11.16^{\circ}\text{C}$ , which corresponded to cloud tops near 19,000 ft based on the HRRR sounding. No defined enhanced clouds associated with cumulonimbus clouds were identified over the accident site.

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<sup>21</sup> McIDAS is an open source, visualization and data analysis software package.



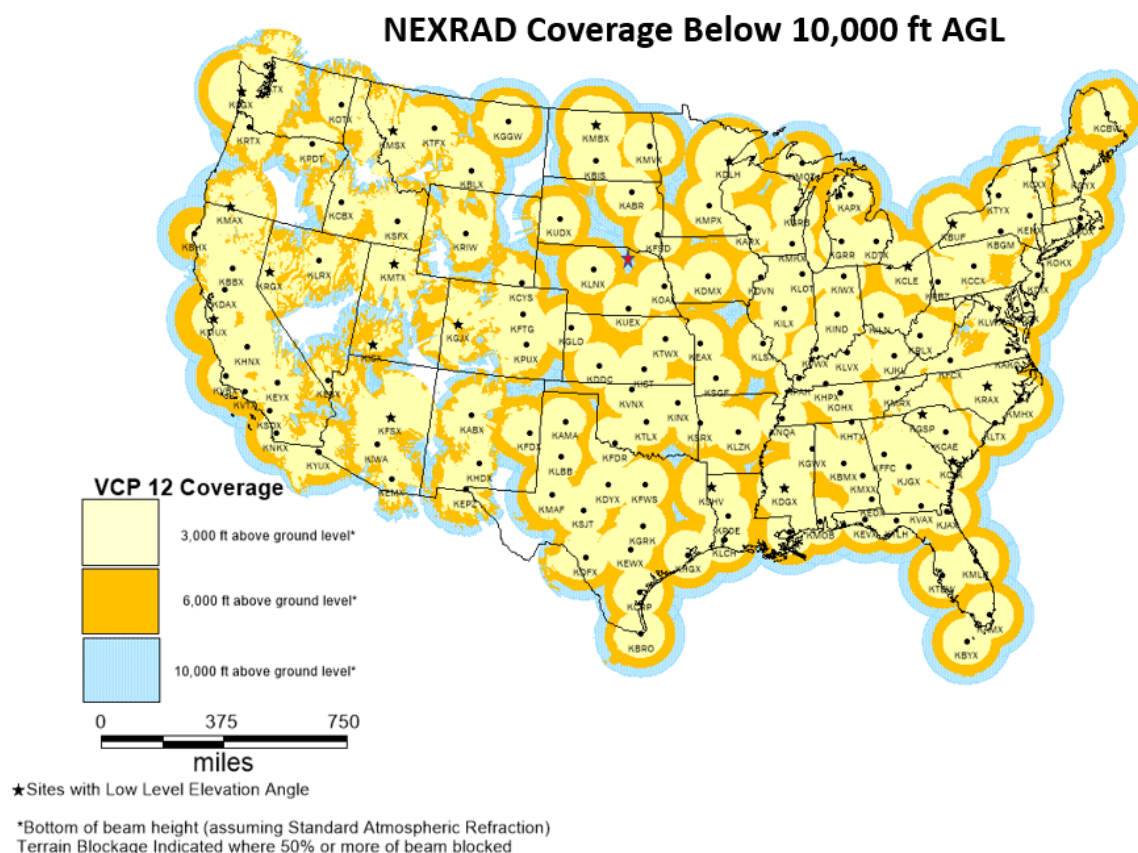
**Figure 8 - GOES infrared image for 2126 CDT at 4X magnification with a standard MB temperature enhancement curve applied. The accident site is marked by the white square.**

## 5.0 Weather Radar Imagery

There were four NWS Weather Surveillance Radar-1988 Dopplers (WSR-88D)<sup>22</sup> surrounding the accident site; Sioux Falls (KFSD), South Dakota at 134 miles northeast, North Platte (KLNK)<sup>23</sup> at 103 miles west, Hastings (KUHX) at 132 miles south, and Omaha (KOAX), Nebraska at 132 miles southeast of the accident site. Figure 9 is a depiction of the NWS radar network and general radar coverage. All four radar locations were reviewed, and the present WSR-88D volume scanning patterns for 0.5° depicted no significant meteorological echoes over the accident site during the period.

<sup>22</sup> The WSR-88D is a 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° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

<sup>23</sup> The closest NWS KLNx WSR-88D was 103 miles from the accident site, with the radar's lowest elevation scan of 0.5°, the center of the beam was near 15,930 ft and scanning the altitudes between 10,740 to 21,120 ft.



**Figure 9 - Current NWS WSR-88D radar coverage at 4,000 ft, 6,000 ft, and for 10,000 ft agl over the United States. The approximate accident site is noted by a red star in an area of no radar coverage below 6,000 ft agl.**

## 6.0 Pilot Reports

The following pilot reports or PIREPs were disseminated longline<sup>24</sup> into the FAA database within 120 miles of the accident site between 1700 and 2400 CDT and below 18,000 ft. The time of the accident has been added for reference in bold type.

EAR UA /OV EAR/TM 2223/FL060/TP SR22/SK BASE026-TOP053  
 EAR UA /OV EAR/TM 0046/FL050/TP S22T/SK BASE032-TOP053/RM DURD  
 EAR UA /OV EAR/TM 0118/FL030/TP E145/SK BASE030/IC NEG/RM DURD  
**Accident 0225Z**

All the reports were more than 110 miles north of the accident site in the vicinity of Kearney, Nebraska, and reported clouds with bases near 2,600 to 3,200 ft with tops to 5,300 ft.

<sup>24</sup> Includes only the reports official recorded and disseminated as a PIREP and may not include "ride reports" broadcasted or other conditions solicited by air traffic controllers and not entered in the formal PIREP format coding. These reports are available to users in near real-time.

## 7.0 NWS Forecasts and Advisories

### 7.1 Terminal Aerodrome Forecast

The NWS Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions significant to aviation for a specified time period, usually 24-hours and within 5 statute miles of the center of the airport's runway complex (terminal). The NWS does not issue TAFs for KONL or KBVN the two closest airports to the accident site.

### 7.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each Weather Forecast Office (WFO) to describe the short-term weather conditions within their region with an aviation section that includes the general conditions as they relate to the creation of the Terminal Aerodrome Forecast (TAF). These are useful for additional aviation-related issues that cannot be encoded into the TAF and provide some reasoning behind the forecast. These are generated roughly every 6 hours and correspond to the release of the latest TAFs for that office. The NWS North Platte, Nebraska, WFO issued the AFD at 1832 CDT describing the conditions over the area as follows, the long term section has been excluded.

*FXUS63 KLBK 142332  
AFDLBF*

*Area Forecast Discussion  
National Weather Service North Platte NE  
632 PM CDT Sun May 14 2023*

*...Updated Aviation Discussion...*

*.SYNOPSIS...  
Issued at 204 PM CDT Sun May 14 2023*

*Key Messages:*

- Dreary conditions continue through Monday morning with mild temperatures expected.*
- Temperatures climb back into the at or above normal range by the middle of the week.*
- Isolated rain showers with a few rumbles of thunder are possible Tuesday afternoon/evening for areas primarily west of Highway 61.*
- A system will cross the area Wednesday bringing increased chances for scattered showers and thunderstorms to the area for Wednesday and Thursday.*

*Recent GOES-16 WV and RAP 500-mb analysis showed a broad ridge of high pressure across the southeastern CONUS. Further northwest of this feature, an upper-level low*

pressure system was retrograding from northern Nevada into the PNW. Just south of this feature, an upper-level shortwave was apparent across the Baja Peninsula into portions of western Mexico. An upper-level ridge of high pressure has continued to hold strong across Alberta, encompassing much of the Canadian Provinces. Closer to home, **a weakening low pressure system has stalled out across portions of the northern Plains into the Midwest. At the surface, associated low pressure was noted across far northwest Missouri with two stationary fronts accompanying it.** One is extending southwest across the southern Plains while the other is extending northeast across the Mid-Mississippi Valley. Broad surface high pressure was noted across much of Canada, pushing south into portions of the northern Plains. **A moisture plume surging north out of the Gulf of Mexico was evident and ample low-level moisture continuing on the backside of the weakening low pressure system. This has resulted in a dreary and breezy day with the entire area encompassed by low-level clouds with areas of light rain showers and drizzle developing across portions of the Sandhills into north central Nebraska.** As of 2 PM CT, temperatures ranged from 50 degrees at Gordon to 57 degrees at Imperial.

.SHORT TERM...(This evening through Monday night)  
Issued at 204 PM CDT Sun May 14 2023

**The aforementioned system currently impacting the region takes it's time to exit resulting in persistent light rain showers/drizzle tonight into Monday morning.** Deep layer moisture continues into Monday which is depicted by NAEFS and ENS ensemble guidance continuing to suggest that the mean PWAT will meet or exceed the 99th percentile across much of the area. These rain showers/drizzle will taper off through the late morning/early afternoon on Monday as the previously mentioned Canadian surface high pressure pushes further south into the High Plains. Total rainfall amounts will be much less than the area has seen the past few days of only a tenth of an inch to near three tenths of an inch. Subsidence behind the system will lead to gradually clearing skies Monday evening into Monday night.

In regards to temperatures, overnight lows Sunday and Monday will be in the above normal range in the 40s and 50s. Mild daytime highs in the upper 50s to low 60s is forecast for Monday.

**.AVIATION...**(For the 00Z TAFS through 00Z Monday evening)  
Issued at 631 PM CDT Sun May 14 2023

**Few showers located across northern zones heading southwestward with most areas seeing a VSBY restriction in the SHRA of 3-5SM along with MVFR to IFR CIGS. Would expect the showers to drift south through the evening and although won't amount to much precip, will reduce VSBYs somewhat and trend toward IFR to LIFR conditions as the showers end and areas of fog develop.** Would expect any fog to develop first over the north central areas and have introduced lower VSBY with this TAF cycle at KVTN, then KLBF toward daybreak. Have used the NBM VSBYs as it best aligns with somewhere between the 10th and 25th percentiles of HREF VSBYs which seemed to handle the idea best.

.LBF WATCHES/WARNINGS/ADVISORIES...NONE.

### 7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) is a graphical depiction of surface wind, thunderstorms, precipitation, color coded general flight categories, and cloud cover bases and tops reported in msl heights, from graphical output from the NWS's National Digital Forecast Database (NDFD) with the Graphic-Airmen's Meteorological Information (G-AIRMET) for IFR conditions, mountain obscuration, icing conditions, and strong surface wind overlaid. The GFA provides a forecast for the enroute phase of flight and for locations without a TAF. The GFA is available at the NWS AWC website and through other weather briefing services.

The north-central GFA 6-hour forecasts based on data from 1600 and issued about 1700 CDT prior to the flight's departure and available for preflight weather briefing and valid for 2200 CDT are included as figures 10 and 11 with the approximate accident site marked by the red star. The GFA 6-hour surface forecast (figure 10) depicted a large band of visibility restrictions in rain and mist across Kansas, western Iowa, northern and western Missouri, and northern Kansas. The GFA surface forecast over the accident site indicated a northeast wind of 15 knots with gusts to 20 knots, visibility less than 3 miles with a chance<sup>25</sup> of rain. A G-AIRMET for IFR conditions was depicted over the area. While the GFA 6-hour cloud forecast (figure 11) depicted overcast clouds with bases at 2,600 ft msl layered to 14,000 ft. Two G-AIRMET for icing conditions were depicted east and west of the accident site, with no structural icing indicated over the accident site.

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<sup>25</sup> Chance is defined as scattered in coverage with a 30% to 50% chance of precipitation.

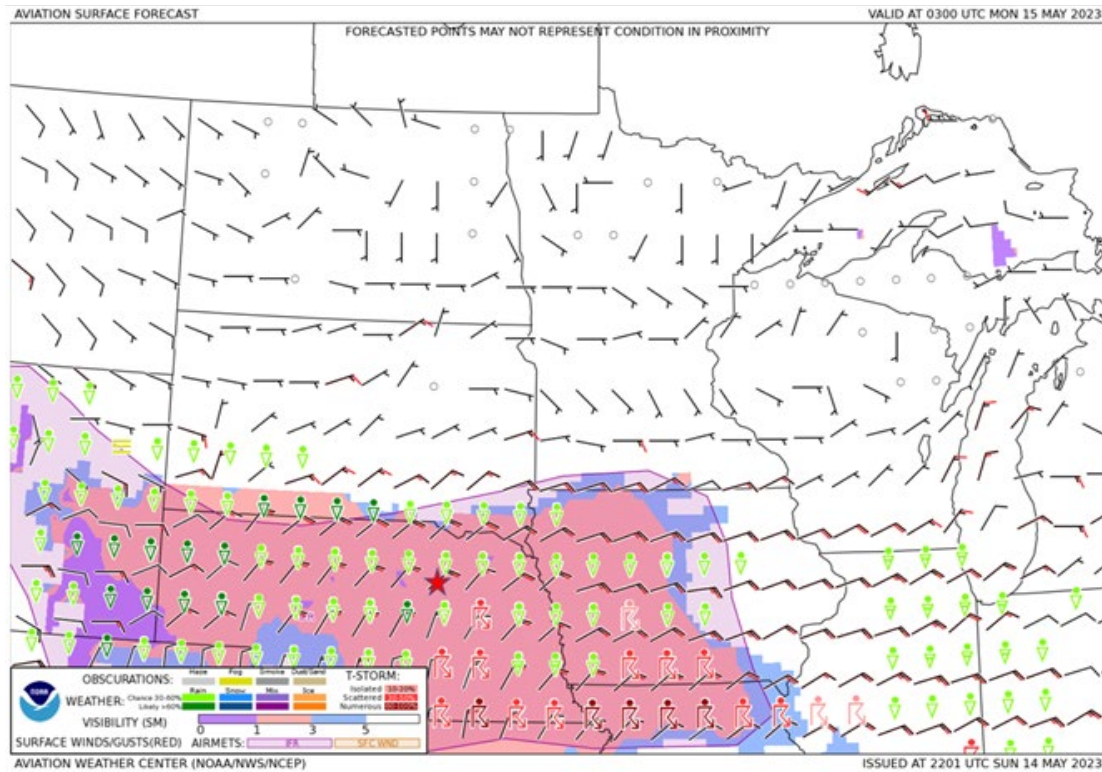


Figure 10 - NWS 6-hour Graphic Forecast for Aviation Surface Forecast valid for 2200 CDT.

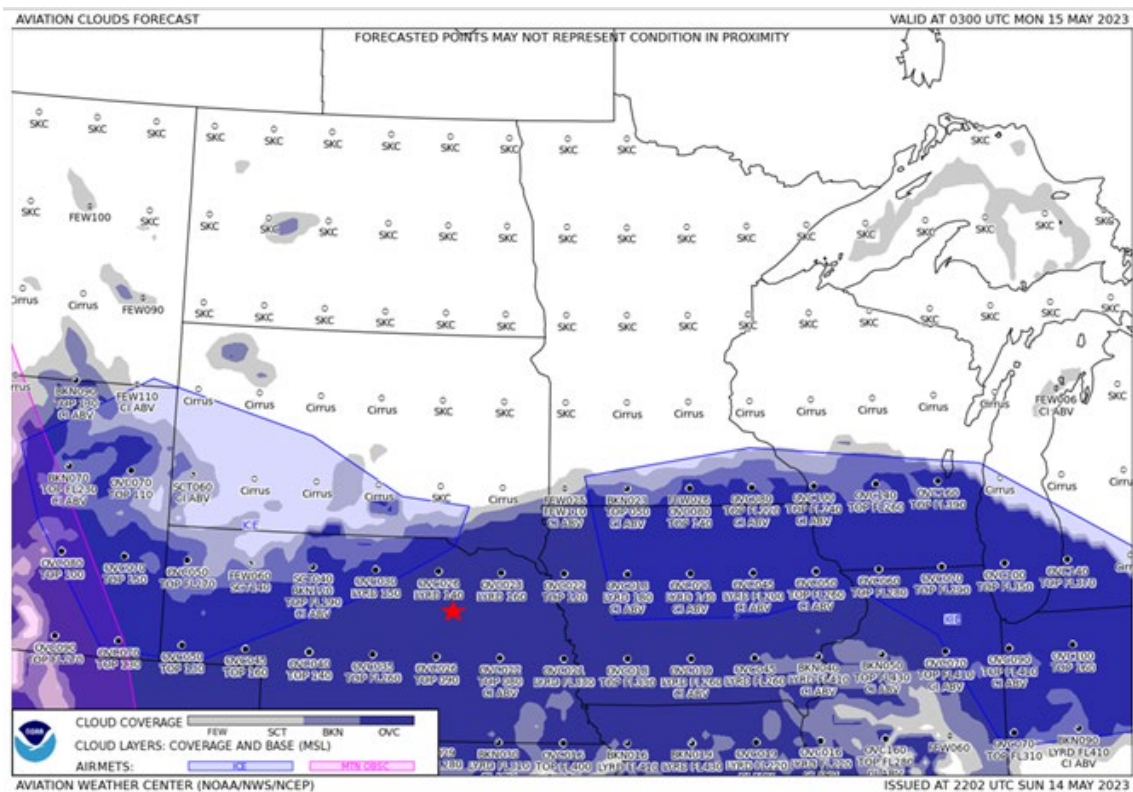


Figure 11 - NWS 6-hour Graphic Forecast for Aviation Cloud Forecast valid for 2200 CDT.

## 7.4 Winds and Temperature Aloft Forecast

The NWS Winds and Temperature Aloft Forecast valid for the period was as follows for the general route of flight. The forecast was valid for 1900 CDT and for use between 1500 through 2200 CDT.

*FBUS31 KWNO 142001*

*FD1US1*

*-DATA BASED ON 141800Z*

*VALID 150000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000*

*FT 3000 6000 9000 12000 18000 24000 30000 34000 39000*  
*-SLN 0512 0710+12 1208+08 1707+02 2013-09 1930-20 215136 215346 205558*  
*-GRI 0610+10 2105+07 2317+02 2410-10 2326-22 223436 226046 226859*  
*-ONL 632+08 0510+05 0607+01 2607-10 2515-23 233137 235247 236758*  
*-PIR 0617+08 0820+03 0721-01 0709-13 9900-23 222540 233148 223057*  
*-ABR 0516 0715+08 0718+04 0617-02 0209-13 3211-24 272439 253149 253458*  
*-MOT 0205+09 1005+04 0708-01 0607-13 0817-26 082242 082351 060959*

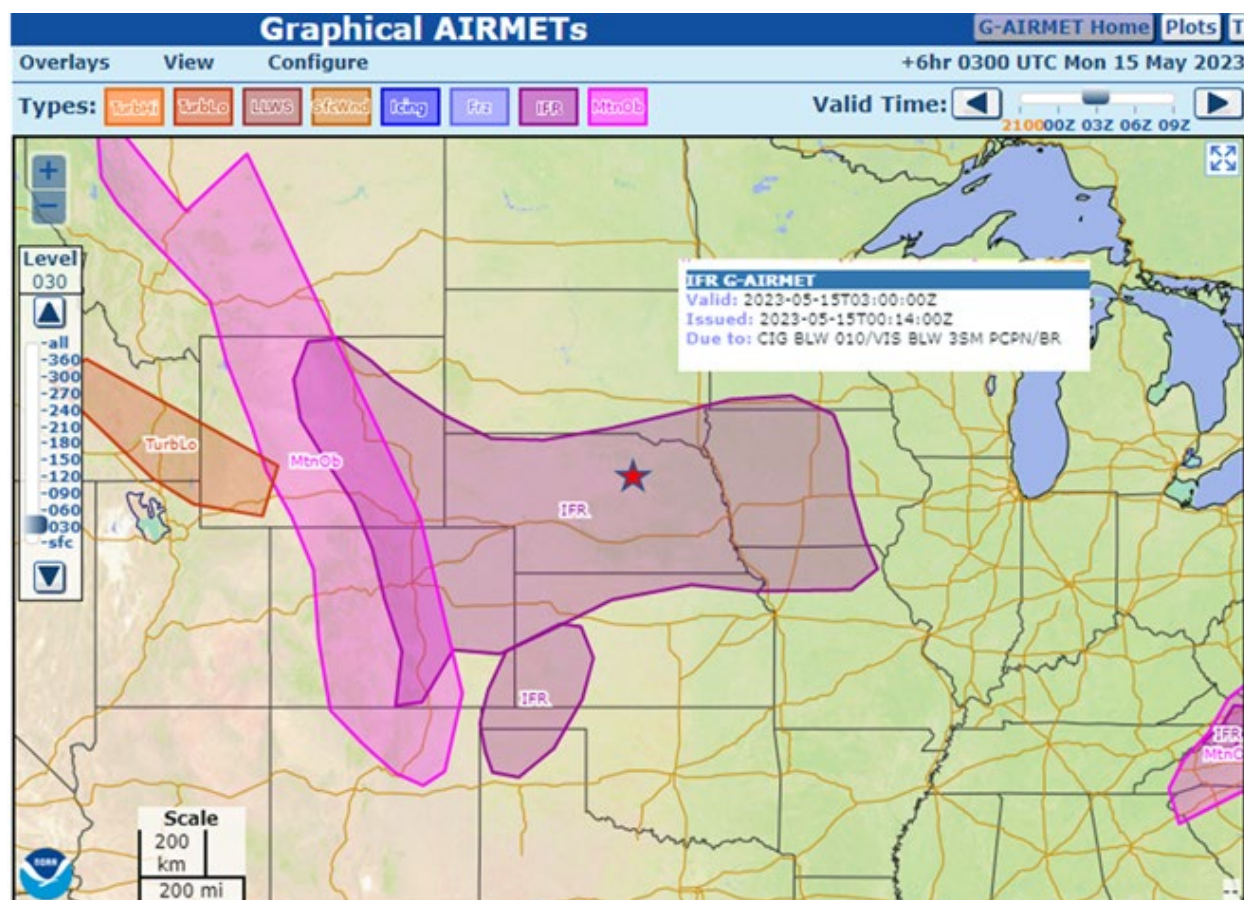
The closest forecast point was for O'Neil, Nebraska (ONL) and expected a wind at 6,000 ft from 060° at 32 knots with a temperature of 8° C, at 9,000 ft wind from 050° at 10 knots with a temperature of 5° C, and at 12,000 ft a wind from 060° at 7 knots with a temperature of 1° C.

## 7.5 NWS Inflight Weather Advisories

In-flight Aviation Weather Advisories are forecasts that advise en route aircraft of the development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) at the various Air Route Traffic Control Centers (ARTCCs). There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the G-AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en-route pilots of the possibility of encountering hazardous flying conditions that 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 based on experience and the operational limits of the aircraft. Once issued they are broadcast by FAA air traffic controllers upon issuance and available on inflight weather broadcasts.

At the time of the accident the NWS had no SIGMETs, Convective SIGMETs, CWA's current over the route of flight, but had a G-AIRMET current for an area of IFR conditions over the route and the accident site due to low ceilings below 1,000 ft agl

and/or visibilities below 3 miles in precipitation and mist. Figure 12 is a depiction of the NWS AWC G-AIRMETs display at 2130 CDT<sup>26</sup> for conditions at 3,000 ft.



**Figure 12 - NWS Aviation Weather Center's depiction of G-AIRMETs current at 2130 CDT (displayed as 0300Z). with the approximate accident site marked by the red star.**

## 8.0 Weather Briefing

The FAA contract Automated Flight Service Station (AFSS) provider Leidos nor any 3rd party users of the Lockheed Flight System (LFS) had any contact with the pilot on May 14 or 15th. A separate search of Foreflight indicated that the pilot had an account with the company and had entered the route KEWK to ONL for 8,000 ft at 1707 CDT but did not obtain any weather briefings or review any weather graphic images during the period. At 2124 CDT or immediately prior to the accident, the pilot updated the route string from Chamberlain, SD (9V9) to Newton, Iowa (KTNU) at a cruising level of 8,000 ft. It is unknown what weather products the pilot reviewed prior to departure or was aware of enroute.

<sup>26</sup> Displayed as 2200 CDT (0300Z), but specific review was at the approximate time of the accident.

## 9.0 Astronomical Conditions

The United States Naval Observatory's website<sup>27</sup> was used to obtain the astronomical conditions over the accident site on May 14, 2023. The time of the accident is included in bold italic type for reference.

| <u>Sun</u>             | <u>Time (CDT)</u>  |
|------------------------|--------------------|
| Begin Civil Twilight   | 0543               |
| Sunrise                | 0615               |
| Upper Transit          | 1331               |
| Sunset                 | 2048               |
| End Civil Twilight     | 2120               |
| <b><i>Accident</i></b> | <b><i>2125</i></b> |

| <u>Moon</u>            | <u>Time (CDT)</u>  |
|------------------------|--------------------|
| Moonrise               | 0543               |
| Upper Transit          | 0935               |
| Moonset                | 1524               |
| <b><i>Accident</i></b> | <b><i>2125</i></b> |

At the time of the accident the sun was  $-6.89^{\circ}$  below the horizon at an azimuth of  $303^{\circ}$ . The moon was also below the horizon. The phase of the moon was a waning crescent with 26% of the moon's disk illuminated when visible.

## 10.0 Witness Statements

There were two witnesses in the area of the accident site that provided additional information on the weather conditions at the time. Their full statements are included in the docket but are summarized below.

The three individuals in the same house described hearing a low flying aircraft in the vicinity of their house while they were watching the television. All three described the weather as misty and foggy nighttime with minimal wind.

Another witness observed a low flying aircraft in the vicinity of the above neighbor's residence and observed the flashing strobe light of the aircraft. He commented on its low altitude but did not reference any weather.

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<sup>27</sup> <https://aa.usno.navy.mil/data/index>

Submitted by:

Donald Eick  
NTSB Senior Meteorologist