NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 22, 2021

Specialist's Factual Report

METEOROLOGY

DCA20FM024

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A. ACCIDENT

Location: New Orleans, Louisiana
Date: August 2, 2020
Time: 1402 central daylight time
1902 Coordinated Universal Time (UTC)
Vehicles: *C/V CMA CGM BIANCA*

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation, but gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). This specialist factual contains the meteorological factors perinate to the weather surrounding the accident time. All times are central daylight time (CDT) on August 2, 2020, and are based upon the 24-hour clock, where local time is -5 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The approximate accident site location was latitude 29.9116° N, longitude 90.115° W.

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 (NCEP), the Ocean Prediction Center (OPC), and the Weather Prediction Center (WPC), located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H[1] and in the NWS Directive System.[2]

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1300 CDT is provided as figure 1 with the approximate location of the accident site marked by the red circle. A stationary front stretched from central Texas eastward into Louisiana and southern Mississippi and then northeastward into Alabama, Georgia, and the Carolinas. Fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. No low or high pressure centers were located near the accident site at the accident time. The station models around the accident site (figure 1) depicted air temperatures in the upper 70s to 90 degrees Fahrenheit (F), a variable wind of 5 knots, partly cloudy skies, and thunderstorms were reported at Louis Armstrong New Orleans International Airport (KMSY).

[1] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

[2] https://www.nws.noaa.gov/directives/

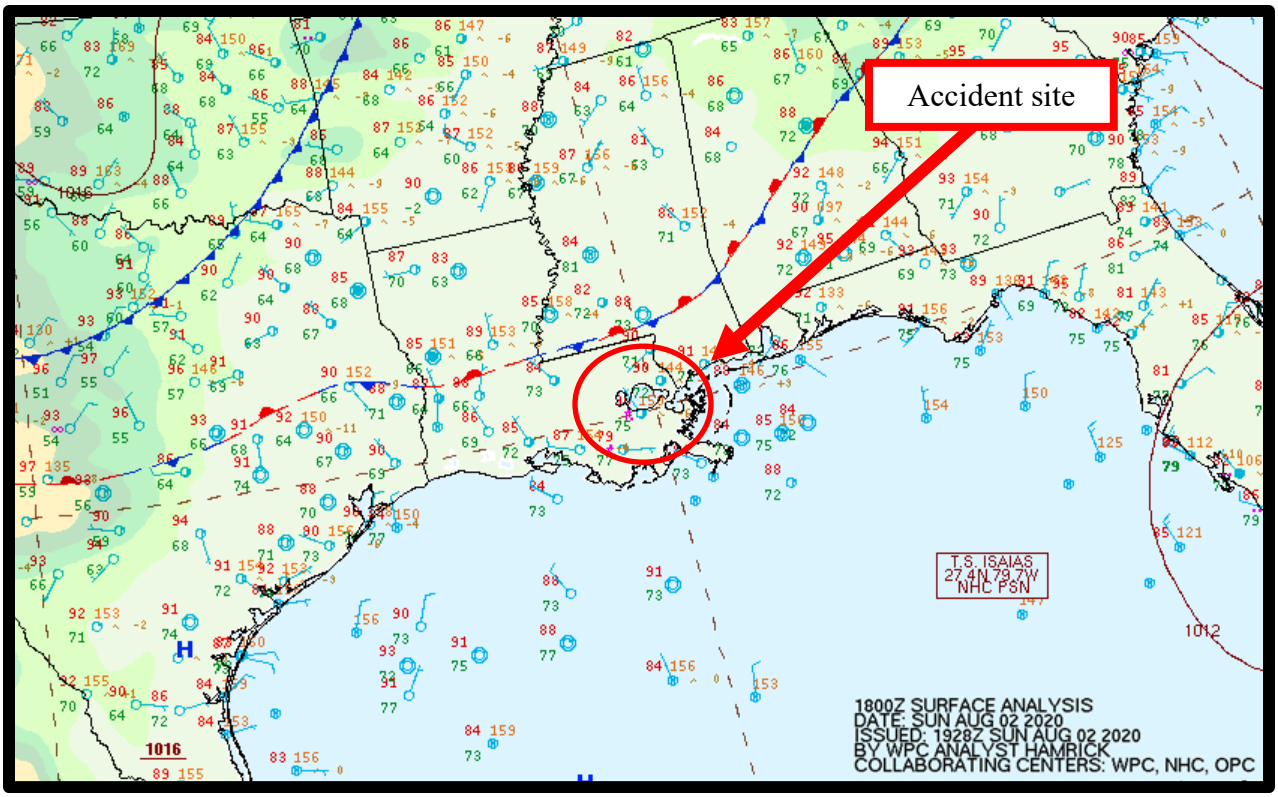


Figure 1 – NWS Surface Analysis Chart for 1300 CDT

2.0 Surface Observations

The area surrounding the accident site was documented using official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language with visibility reported in statute miles for this section. Figure 2 is a Google Earth map with the accident site and the closest weather reporting locations marked.

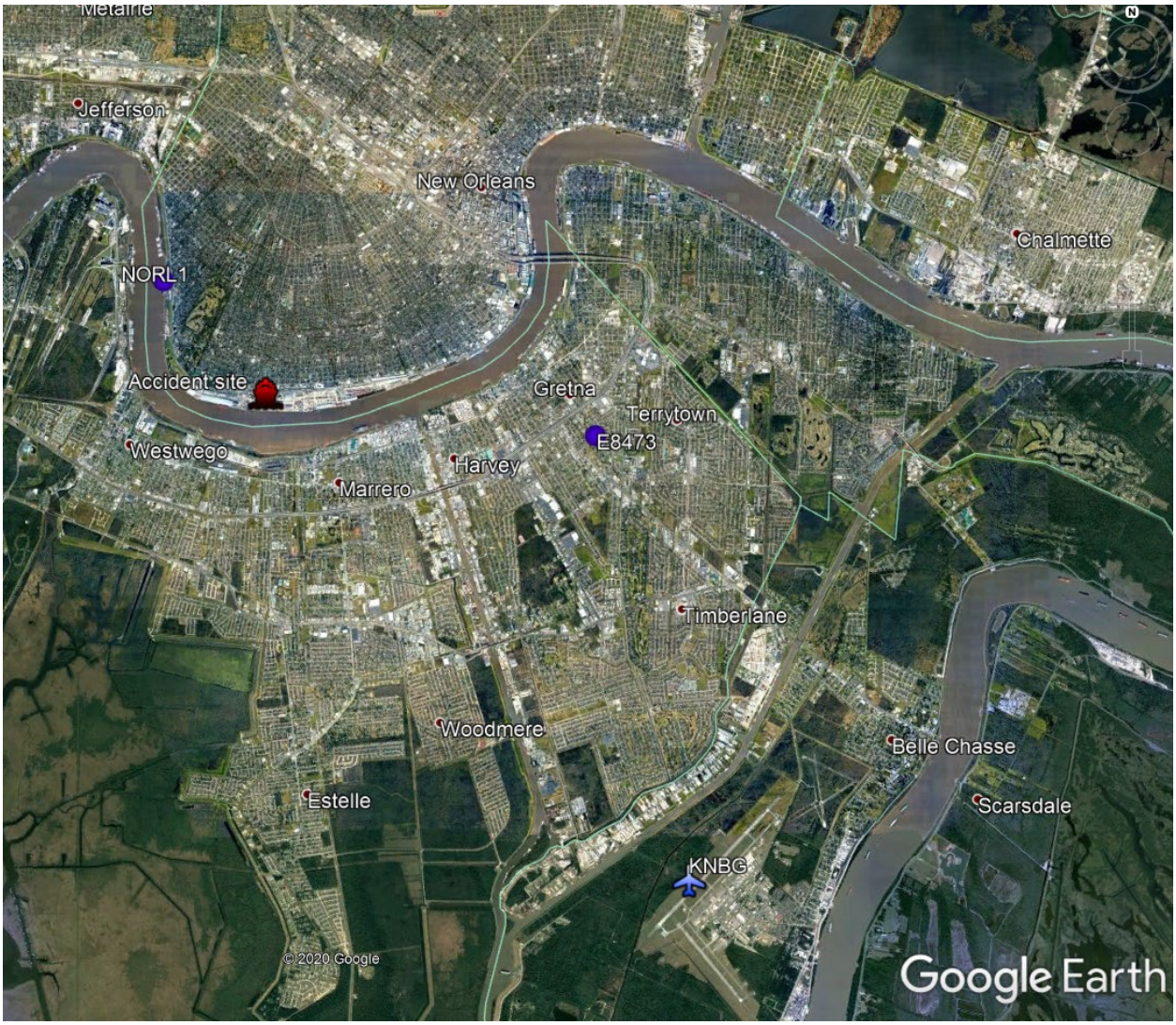


Figure 2 – Google Earth map of accident area with the location of the accident site and surface observation sites

New Orleans Naval Air Station Joint Reserve Base (KNBG) was the closest official surface weather station to the accident site. KNBG had a weather observing system whose reports were supplemented by official observers. KNBG was located 7 miles southeast of the accident site, at an elevation of 2 feet (ft), and had a 1° westerly magnetic variation[3] (figure 2). The following observations were taken and disseminated during the times surrounding the accident:[4]

[1055 CDT] METAR KNBG 021555Z 25004KT 10SM SCT038 BKN250 31/24 A2998 RMK AO2 SLP153 T03110239 $=

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

[4] The bold sections in this NWS product and the rest of products in this report are intended to highlight the sections that directly reference the weather conditions that affected the accident location around the accident time. The local times in section 2.0 next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1216 CDT] SPECI KNBG 021716Z VRB05KT 10SM TS SCT020CB BKN045 BKN250 33/24 A2997 RMK AO2 TSB15 OCNL LTGICCCCG N TS N MOV NE T1 SET T03280239 $=

[1247 CDT] SPECI KNBG 021747Z 02009KT 10SM FEW020 SCT045 BKN070 BKN250 31/23 A2997 RMK AO2 TSB15E47 OCNL LTGIC DSNT NE AND SW CB DSNT NE AND SW T1 SET T03110228 $=

[1255 CDT] METAR KNBG 021755Z 02007KT 10SM FEW020 SCT045 BKN070 BKN250 29/23 A2997 RMK AO2 TSB15E47 SLP147 OCNL LTGIC DSNT NE AND SW CB DSNT NE AND SW T1 SET T02940228 10328 20239 58003 $=

[1346 CDT] SPECI KNBG 021846Z 04004KT 10SM -TSRA FEW020CB SCT050 BKN100 BKN250 29/23 A2996 RMK AO2 RAB42 OCNL LTGICCCCG SW TS SW MOV NE T1 SET P0000 T02940233 $=

[1355 CDT] METAR KNBG 021855Z 01004KT 10SM -TSRA FEW020CB SCT050 BKN100 BKN250 29/24 A2997 RMK AO2 RAB42 TSB52 SLP146 OCNL LTGICCCCG SW TS SW MOV NE T1 SET P0000 T02940239 $=

ACCIDENT TIME 1402 CDT

[1419 CDT] SPECI KNBG 021919Z 29010G27KT 270V330 1 1/2SM +TSRA BR BKN035CB 24/22 A2998 RMK AO2 PK WND 29027/1913 FRQ LTGICCCCG OHD-N TS OHD-N MOV NE T1 SET P0002 T02440222 $=

[1433 CDT] SPECI KNBG 021933Z 33008KT 5SM -TSRA BR SCT035CB BKN055 24/23 2996 RMK PK WND 29027/1913 OCNL LTGICCCCG NE AND E TS NE AND E MOV NE T1 SET P0003 T02390228=

[1455 CDT] METAR KNBG 021955Z 33008KT 10SM -TSRA FEW020CB FEW045 BKN250 26/24 A2995 RMK AO2 PK WND 29027/1913 SLP140 OCNL LTGICCCCG E AND S TS E AND S MOV NE T1 SET P0003 T02560244 $=

[1511 CDT] SPECI KNBG 022011Z 20003KT 10SM FEW025 SCT035 SCT090 BKN250 27/24 A2995 RMK AO2 RAE02 TSE10 OCNL LTGIC DSNT E AND S CB DSNT E AND S T1 SET P0000 T02670244 $=

KNBG weather at 1355 CDT, wind from 010° at 4 knots, 10 miles or greater visibility, thunderstorm and light rain, few cumulonimbus clouds at 2,000 ft above ground level (agl), scattered clouds at 5,000 ft agl, a broken ceiling at 10,000 ft agl, broken skies at 25,000 ft agl, temperature of 29° Celsius (C), dew point temperature of 24°C, and an altimeter setting of 29.97 inches of mercury (inHg). Remarks, station with a precipitation discriminator, rain began at 1342 CDT, thunderstorms began at 1352 CDT, sea level pressure 1014.6 hectopascals (hPa), occasional in-cloud, cloud to cloud, and cloud-to-ground lightning to the southwest, thunderstorm southwest

moving northeast, severe thunderstorm conditions[5] are forecasted within 10 miles of KNBG (attachment 7), a trace of precipitation since 1255 CDT, temperature 29.4°C, dew point temperature 23.9°C, maintenance is needed on the system.

KNBG weather at 1419 CDT, wind from 290° at 10 knots with gusts to 27 knots, wind direction varying between 270° and 330°, 1 and a half miles visibility, thunderstorm and heavy rain, mist, a broken ceiling of cumulonimbus clouds at 3,500 ft agl, temperature of 24°C, dew point temperature of 22°C, and an altimeter setting of 29.98 inHg. Remarks, station with a precipitation discriminator, peak wind from 290° at 27 knots at 1413 CDT, frequent in-cloud, cloud to cloud, and cloud-to-ground lightning overhead through north, thunderstorm overhead through north moving northeast, severe thunderstorm conditions are forecasted within 10 miles of KNBG, 0.02 inches of precipitation since 1355 CDT, temperature 24.4°C, dew point temperature 22.2°C, maintenance is needed on the system.

Non-official weather observations sites the Carrollton Gage at New Orleans (NORL1) and EW8473 Gretna (E8473) were located closer to the accident site than KNBG and provided supplemental observation information around the accident time.[6] NORL1 was located 2 miles northwest of the accident site and E8473 was located 3 miles east of the accident site (figure 2). Additional information can be found in figures 3 and 4.

[5] Thunderstorm Condition I (T1) is set when thunderstorms are within 10 nm and/or are expected to influence the Naval Complex or Activity--normally within 1 hour--with winds less than 50 knots and hail less than ¾ inch. Thunderstorm Condition II (T2) is set when thunderstorms are probable or expected within a twenty-five (25) nm radius or in 6 hours with winds less than 50 knots and hail less than ¾ inch.
[6] See https://mesowest.utah.edu/ for more information.

STATION: NORL1
STATION NAME: MISSISSIPPI RIVER AT CARROLLTON GAGE AT NEW ORLEANS
LATITUDE: 29.93472
LONGITUDE: -90.13611
ELEVATION [ft]: 20
STATE: LA

Station_ID	Date_Time	air_temp_	relative_h	wind_spe	precip_ac	wind_dire	precip_ac	T_water_t	dew_poin	wind_chil	wind_carc	heat_index_set_1d
		Fahrenhe	%	Miles/hou	Inches	Degrees	Inches	Fahrenhe	Fahrenhe	Fahrenhe	code	Fahrenheit
NORL1	08/01/2020 23:00 UTC	89.42	68	7.1	0	134	568.63	80.2	77.5		SE	102.94
NORL1	08/02/2020 00:00 UTC	88.52	74	11.9	0	127	568.63	80.2	79.19		SE	104.08
NORL1	08/02/2020 01:00 UTC	86.18	83	10	0	127	568.63	80.2	80.42		SE	101.96
NORL1	08/02/2020 02:00 UTC	84.92	88	7.2	0	138	568.63	80.1	80.97		SE	100.42
NORL1	08/02/2020 03:00 UTC	84.2	89	5.31	0	139	568.63	80.1	80.61		SE	98.51
NORL1	08/02/2020 04:00 UTC	81.86	91	3.3	0	158	568.63	80.1	78.97		SSE	91.96
NORL1	08/02/2020 05:00 UTC	81.5	93	2.4	0	220	568.63	80.1	79.28		SW	91.61
NORL1	08/02/2020 06:00 UTC	81.14	95	1.6	0	148	568.63	80.1	79.57		SSE	91.23
NORL1	08/02/2020 07:00 UTC	80.78	99	2.3	0	124	568.63	80.1	80.47		SE	91.48
NORL1	08/02/2020 08:00 UTC	79.52	100	1.7	0	237	568.63	79.9	79.52		WSW	
NORL1	08/02/2020 09:00 UTC	79.34	100	1.5	0	218	568.63	80.1	79.34		SW	
NORL1	08/02/2020 10:00 UTC	79.7	100	2	0	229	568.63	79.9	79.7		SW	
NORL1	08/02/2020 11:00 UTC	79.7	100	2.9	0	235	568.63	80.1	79.7		SW	
NORL1	08/02/2020 12:00 UTC	79.34	97	1.5	0	116	568.63	79.9	78.41		ESE	
NORL1	08/02/2020 13:00 UTC	82.94	82	0.3	0	324	568.63	79.9	76.88		NW	91.78
NORL1	08/02/2020 14:00 UTC	85.1	70	0.49	0	351	568.63	80.1	74.23		N	92.93
NORL1	08/02/2020 15:00 UTC	87.26	67	1.11	0	120	568.63	80.1	74.99		ESE	96.76
NORL1	08/02/2020 16:00 UTC	87.98	96	2.3	0	284	568.63	80.1	86.7		WNW	117.81
NORL1	08/02/2020 17:00 UTC	82.58	85	5.6	0.15	8	568.78	80.1	77.61		N	91.72
NORL1	08/02/2020 18:00 UTC	86.72	92	1.8	0	1	568.78	80.1	84.12		N	109.42
NORL1	08/02/2020 19:00 UTC	72.86	100	10.5	0.42	250	569.2	80.1	72.86		WSW	
NORL1	08/02/2020 20:00 UTC	84.2	70	2.6	0.39	248	569.59	79.9	73.36		WSW	90.91
NORL1	08/02/2020 21:00 UTC	84.92	73	1.5	0	143	569.59	80.1	75.31		SE	93.67
NORL1	08/02/2020 22:00 UTC	85.46	75	1.9	0	121	569.59	80.2	76.64		ESE	95.88
NORL1	08/02/2020 23:00 UTC	84.92	83	1.2	0	240	569.59	80.2	79.18		WSW	97.92

Figure 3 – NORL1 observation information around the accident time

STATION: E8473
STATION NAME: EW8473 Gretna
LATITUDE: 29.90750
LONGITUDE: -90.04883
ELEVATION [ft]: 13
STATE: LA

Station_ID	Date_Time	altimeter_	air_temp_	relative_h	wind_spe	wind_dire	wind_gus	precip_ac	precip_ac	precip_ac	dew_poin	wind_chil	wind_carc	pressure_	sea_level	heat_index_set_1d
		INHG	Fahrenhe	%	Miles/hou	Degrees	Miles/hou	Inches	Inches	Inches	Fahrenhe	Fahrenhe	code	INHG	INHG	Fahrenheit
E8473	08/02/2020 17:46 UTC	29.98	85	76	4	46	9	0		0	76.59		NE	29.97	29.92	95.09
E8473	08/02/2020 17:50 UTC	29.98	85	72	5.99	59	12	0		0	74.97		ENE	29.97	29.92	93.47
E8473	08/02/2020 17:55 UTC	29.98	85	73	3	86	12	0		0	75.38		E	29.97	29.92	93.87
E8473	08/02/2020 18:01 UTC	29.98	85	73	3	59	9	0		0	75.38		ENE	29.97	29.92	93.87
E8473	08/02/2020 18:05 UTC	29.97	85	71	2	13	5.99	0		0	74.55		NNE	29.96	29.91	93.08
E8473	08/02/2020 18:10 UTC	29.98	85	72	2	57	5	0		0	74.97		ENE	29.97	29.92	93.47
E8473	08/02/2020 18:16 UTC	29.98	85	71	3	59	7	0		0	74.55		ENE	29.97	29.92	93.08
E8473	08/02/2020 18:20 UTC	29.98	85	70	1	62	7	0		0	74.13		ENE	29.97	29.92	92.7
E8473	08/02/2020 18:25 UTC	29.97	85	70	2	72	4	0		0	74.13		ENE	29.96	29.91	92.7
E8473	08/02/2020 18:31 UTC	29.97	86	70	1	61	4	0		0	75.09		ENE	29.96	29.91	95.07
E8473	08/02/2020 18:35 UTC	29.97	86	69	2	70	5	0		0	74.66		ENE	29.96	29.91	94.64
E8473	08/02/2020 18:40 UTC	29.96	86	72	3	43	5	0		0	75.93		NE	29.95	29.9	95.95
E8473	08/02/2020 18:45 UTC	29.97	85	71	1	82	5.99	0		0	74.55		E	29.96	29.91	93.08
E8473	08/02/2020 18:51 UTC	29.97	85	69	3	61	5	0		0	73.7		ENE	29.96	29.91	92.33
E8473	08/02/2020 18:55 UTC	29.96	85	69	2	107	7	0		0	73.7		ESE	29.95	29.9	92.33
E8473	08/02/2020 19:00 UTC	29.98	85	70	1	276	7	0		0	74.13		W	29.97	29.92	92.7
E8473	08/02/2020 19:05 UTC	29.98	84	68	7	265	14.99	0		0	72.31		W	29.97	29.93	89.84
E8473	08/02/2020 19:11 UTC	29.99	82	71	9	221	14.01	0		0	71.67		SW	29.98	29.94	86.66
E8473	08/02/2020 19:18 UTC	30	80	73	8	248	23	0		0	70.56		WSW	29.99	29.95	
E8473	08/02/2020 19:21 UTC	30	77	79	13	311	28	0.33		0.33	69.97		NW	29.99	29.95	
E8473	08/02/2020 19:26 UTC	29.98	76	84	2	16	28	0.74		0.74	70.8		NNE	29.97	29.93	
E8473	08/02/2020 19:32 UTC	29.98	75	87	3	30	10	0.86		0.86	70.85		NNE	29.97	29.93	
E8473	08/02/2020 19:35 UTC	29.97	75	88	2	39	10	0.88		0.88	71.19		NE	29.96	29.92	
E8473	08/02/2020 19:40 UTC	29.97	74	90	1	325	5.99	0.88		0.88	70.87		NW	29.96	29.92	
E8473	08/02/2020 19:45 UTC	29.95	75	92	4	88	5.99	0.88		0.88	72.51		E	29.94	29.9	
E8473	08/02/2020 19:50 UTC	29.96	76	92	1	96	7	0.88		0.88	73.5		E	29.95	29.91	
E8473	08/02/2020 19:55 UTC	29.96	76	93	0		5.99	0.88		0.88	73.82			29.95	29.91	
E8473	08/02/2020 20:00 UTC	29.96	77	94	1	19	3	0.88		0.88	75.13		NNE	29.95	29.9	

Figure 4 – E8473 observation information around the accident time

The observations from KNBG, NORL1, and E8473 indicated wind gusts as high as 27 knots or 31 mph as the thunderstorms moved across the area. Up to 0.88 inches of rain fell in 17 minutes (figure 4).

3.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)[7] model sounding was created for the accident site for 1400 CDT with a station elevation of 0 ft.[8] The 1400 CDT HRRR sounding was plotted on a standard Skew-T Log P diagram[9] with the derived stability parameters included in figure 5 with data from the surface to 600-hPa (or approximately 14,000 ft msl). These data were analyzed using the RAOB[10] software package. The sounding depicted the lifted condensation level (LCL)[11] at 2,026 ft agl, the level of free convection (LFC)[12] at 2,196 ft agl, and the convective condensation level (CCL)[13] at 3,455 ft agl. The freezing level was located at 15,220 ft msl. The precipitable water value was 2.41 inches. The mean storm motion was from 272° at 8 knots.

[7] 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.
[8] HRRR sounding was created using NOAA Air Resource Laboratory: https://ready.arl.noaa.gov/READYamet.php
[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] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.
[11] LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.
[12] 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.
[13] 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.

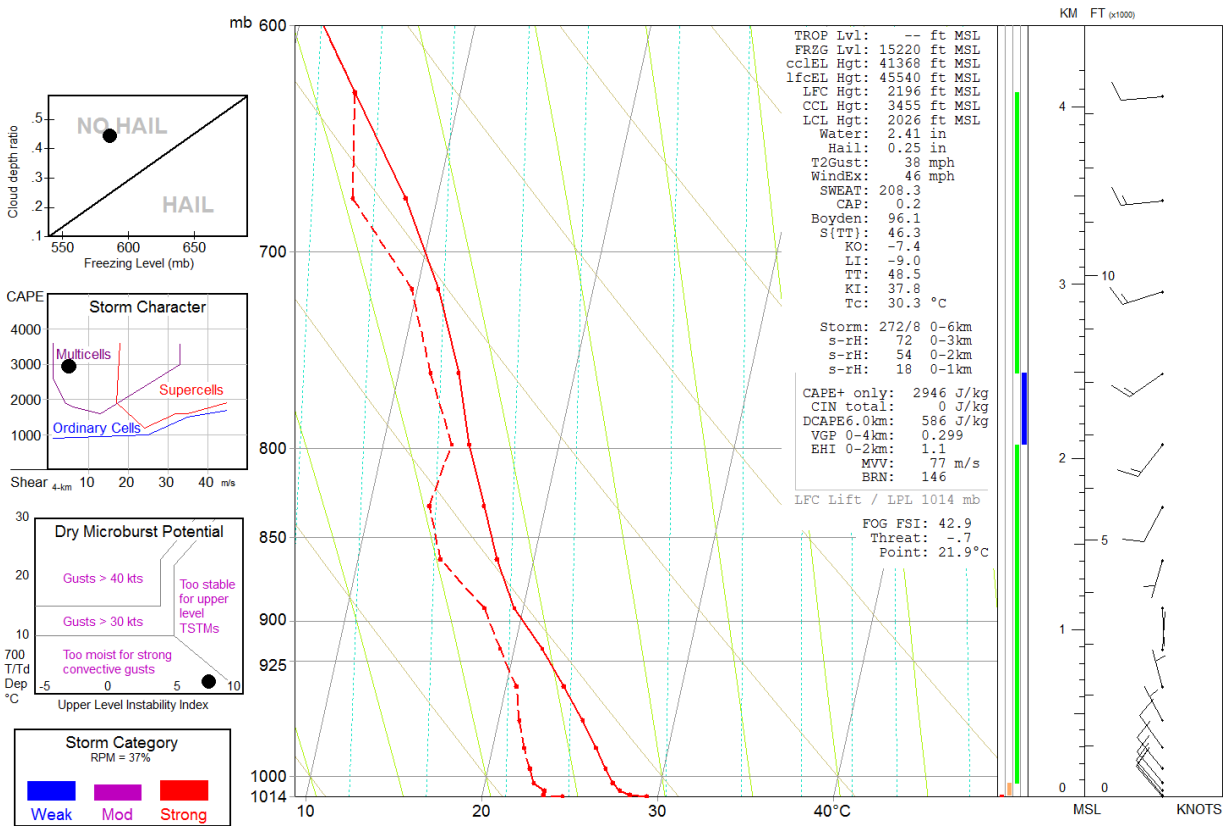


Figure 5 – 1400 CDT HRRR sounding

The 1400 CDT HRRR sounding indicated a conditionally unstable environment from the surface through 6,500 ft. 2,946 Joules/kilogram (J/kg) of CAPE[14] were indicated on the sounding and the maximum vertical velocity (MVV) for this atmosphere was calculated as 77 meters/second (about 15,156 ft per minute).[15] Given the environment, RAOB indicated a high probability of multicell thunderstorm development was possible with no hail and RAOB indicated that the sounding was likely too moist for strong convective wind gusts at the surface. Downdraft CAPE (DCAPE; 6 kilometers agl)[16] was measured at 586 J/kg. If rain showers or thunderstorms formed in this environment, RAOB indicated the strongest wind speeds possible at the surface (due to, for example, a microburst, outflow boundary, or gust front) would have been 46 mph (40 knots) according to the WindEx parameter.

The HRRR sounding wind profile indicated a surface wind from 321° at 8 knots with the wind remaining northwesterly through 2,000 ft. By 10,000 ft the wind was westerly at 15 knots.

[14] Convective Available Potential Energy (CAPE) – CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.
[15] MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.
[16] The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts.

4.0 Satellite Data

The 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 1200 CDT through 1600 CDT and reviewed, and the closest images to the time of the accident were documented.

Figure 6 presents the GOES-16 visible imagery at 1400 CDT at 2X magnification with the accident site highlighted with a red square. The visible imagery indicated an extensive layer of cloud cover with cumuliform cloud cover above the accident site. Figure 7 presents the GOES-16 infrared imagery from 1400 CDT at 6X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated cloud cover over the accident site. The lower brightness temperatures (blue and green colors; higher cloud tops) were located above and to the northeast of the accident site. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1400 CDT HRRR sounding, the approximate cloud-top heights over the accident site were 33,000 ft at 1400 CDT (240 Kelvin). It should be noted these figures have not been corrected for any parallax error.

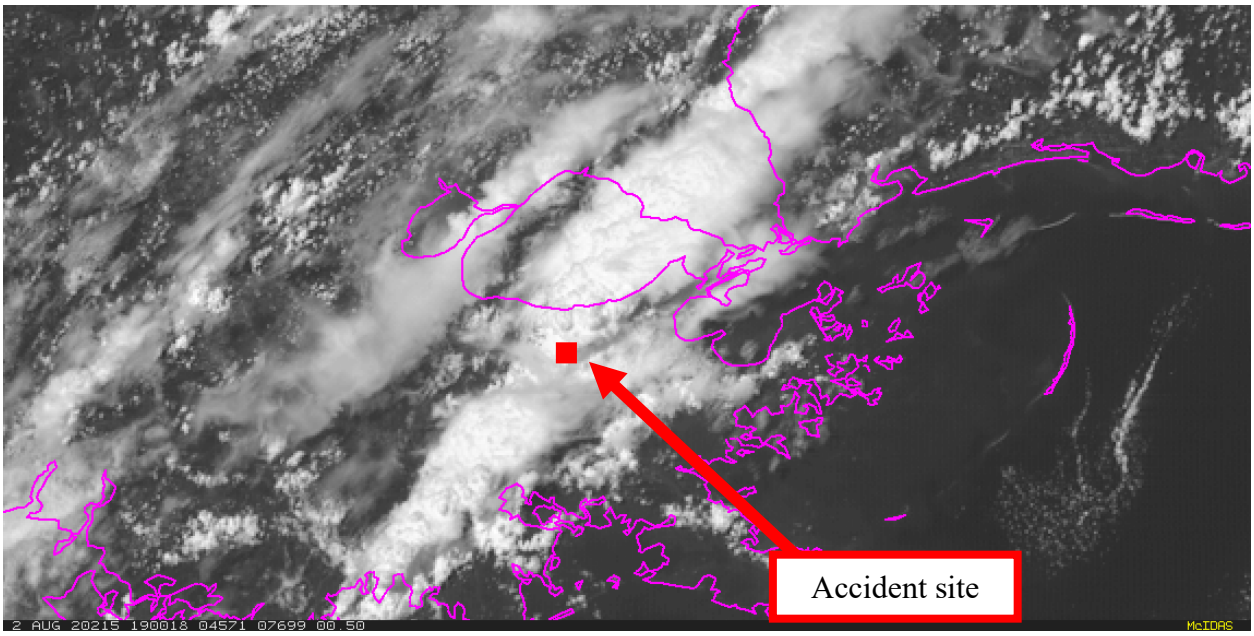


Figure 6 – GOES-17 visible image at 1400 CDT

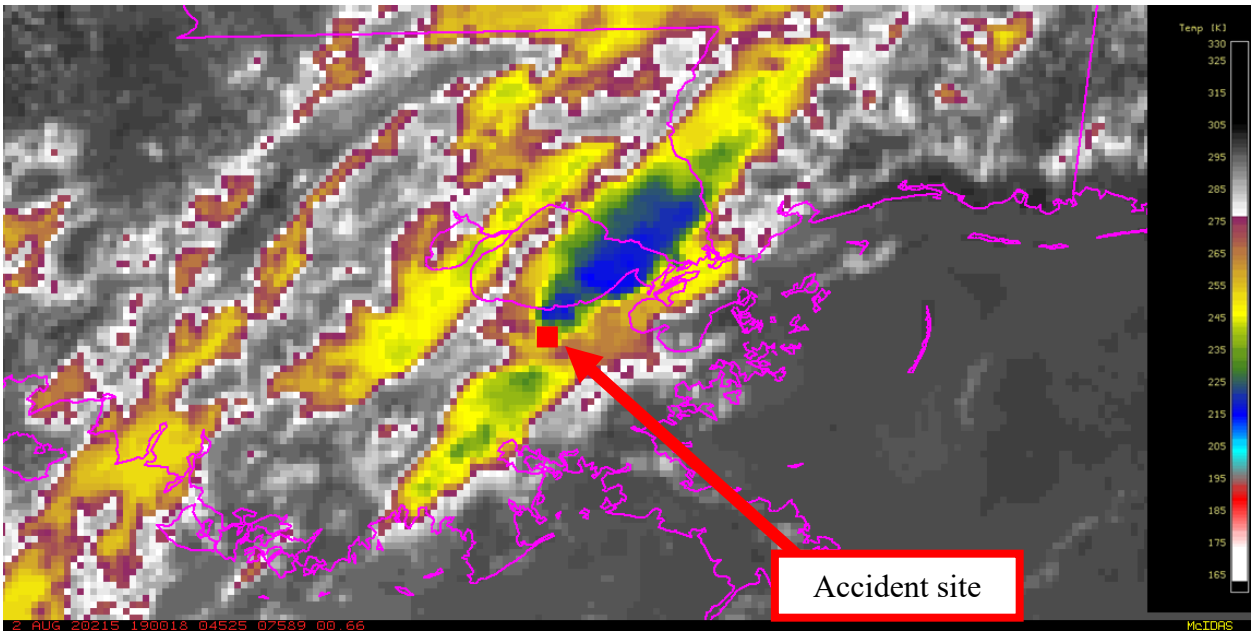


Figure 7 – GOES-17 infrared image at 1400 CDT

5.0 Regional Radar Imagery Information

A regional view of the NWS national composite radar mosaic is included as figure 8 for 1400 CDT with the approximate location of the accident site marked within a black circle. The image depicted echoes from 50 to 60 decibels (dBZ[17]) above the accident site.

[17] dBZ – A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

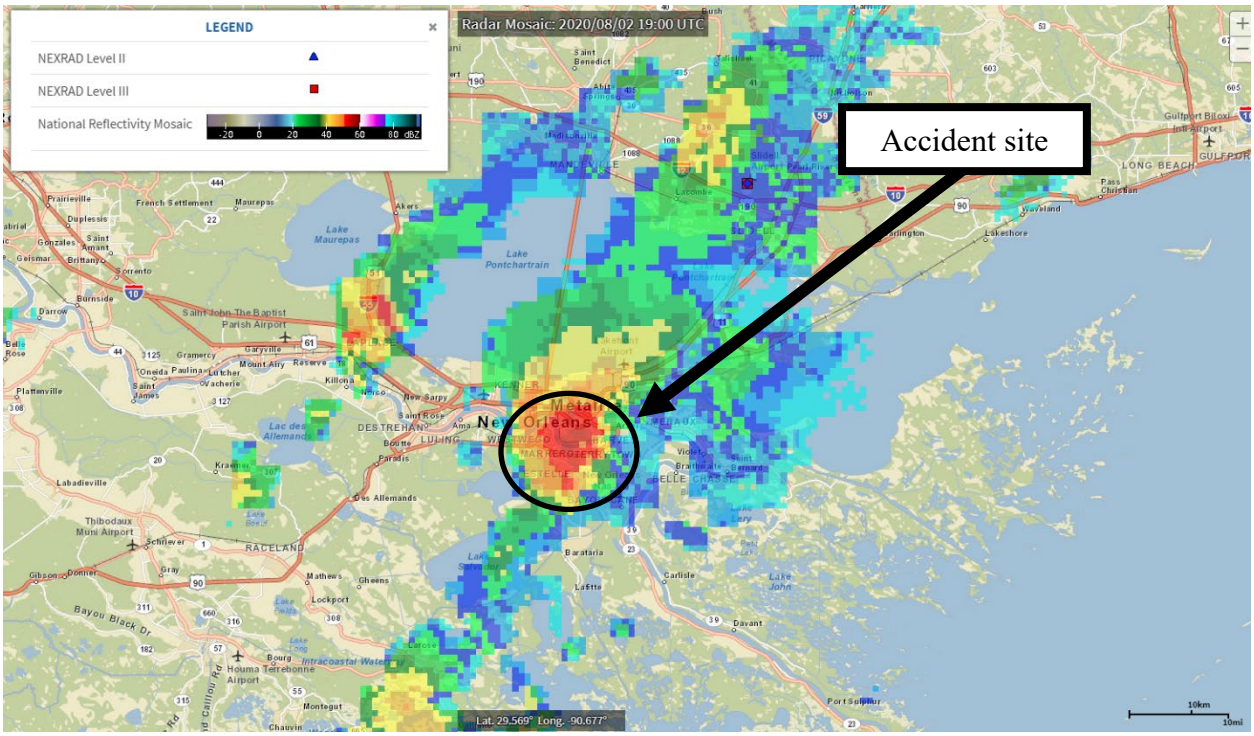


Figure 8 – Regional Composite Reflectivity image for 1400 CDT

6.0 Radar Imagery Information

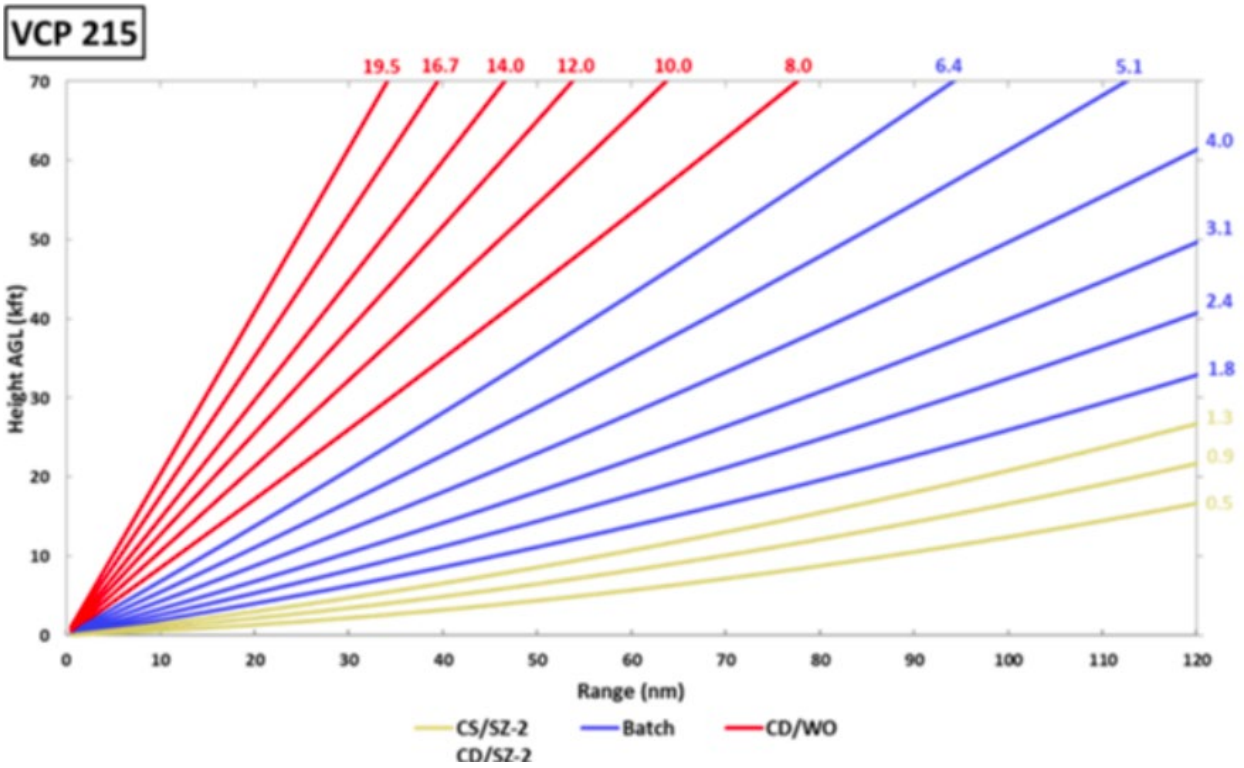
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[18] to the accident site was Slidell, Louisiana (KLIX) located 30 miles northeast of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

6.1 Volume Scan 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. Products that require data from multiple elevation scans are not available until the end of the five to ten minute volume scan.

[18] The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 215 (VCP-215). 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 KLIX WSR-88D radar was operating in the precipitation mode VCP-215. 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-215 Precipitation Mode Scan Strategy[19]

[19] Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values.
Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.
W – With range unfolding (W)
WO – Without range unfolding (WO)

6.2 Beam Height Calculation

Assuming standard refraction[20] of the KLIX WSR-88D radar beam with the antenna elevation at 179 ft, and considering a beamwidth[21] of 0.95°, the following table shows the approximate heights for the radar beam center, base and top for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KLIX 0.5°	2,420 ft	940 ft	3,900 ft

Based on the radar height calculations, the elevation scans from KLIX listed in the above table depicted the conditions between 940 ft and 3,900 ft msl over the accident site and these scans "saw" the closest altitudes to the ground.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[22] 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 dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C[23], "Thunderstorms," dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be "light." For dBZ values between 30 and 40, the terminology should be "moderate." "Heavy" terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme."

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

[21] Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

[22] Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

[23] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

6.4 Base Reflectivity and Lightning Data

Figures 9 through 11 present the KLIX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1358:47, 1402:16, and 1405:46 EST, respectively, with a resolution of 0.5° X 250 m. Reflectivity values between 40 and 55 dBZ were located above the accident site at the accident time and were indicative of heavy to very heavy rainfall (section 7.3). The thunderstorm was moving eastward with time (attachment 1). The base velocity data showed a divergent wind signature[24] at the accident site around the accident time (attachment 2, section 10.0).

There were 235 lightning flashes[25] within 5 miles of the accident site between 1350 and 1405 CDT.[26]

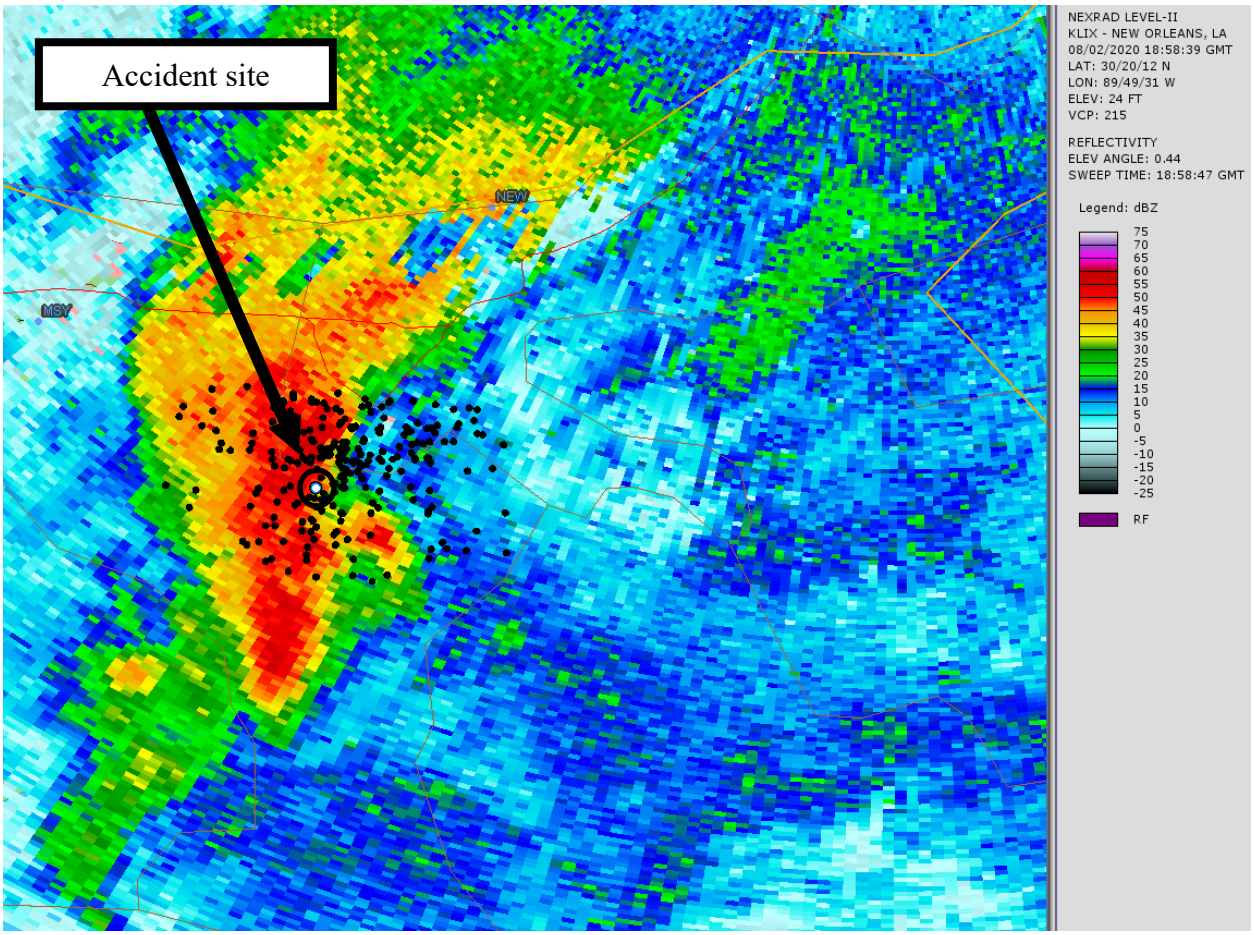


Figure 9 – KLIX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1358:47 CDT with the accident site marked with black circle and lightning flashes marked by black dots

[24] https://www.nssl.noaa.gov/publications/dopplerguide/chapter4.php
https://www.weather.gov/ohx/downbursts
https://www.weather.gov/lmk/downburst

[25] Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

[26] A review of Earth Networks Total Lightning network was done.

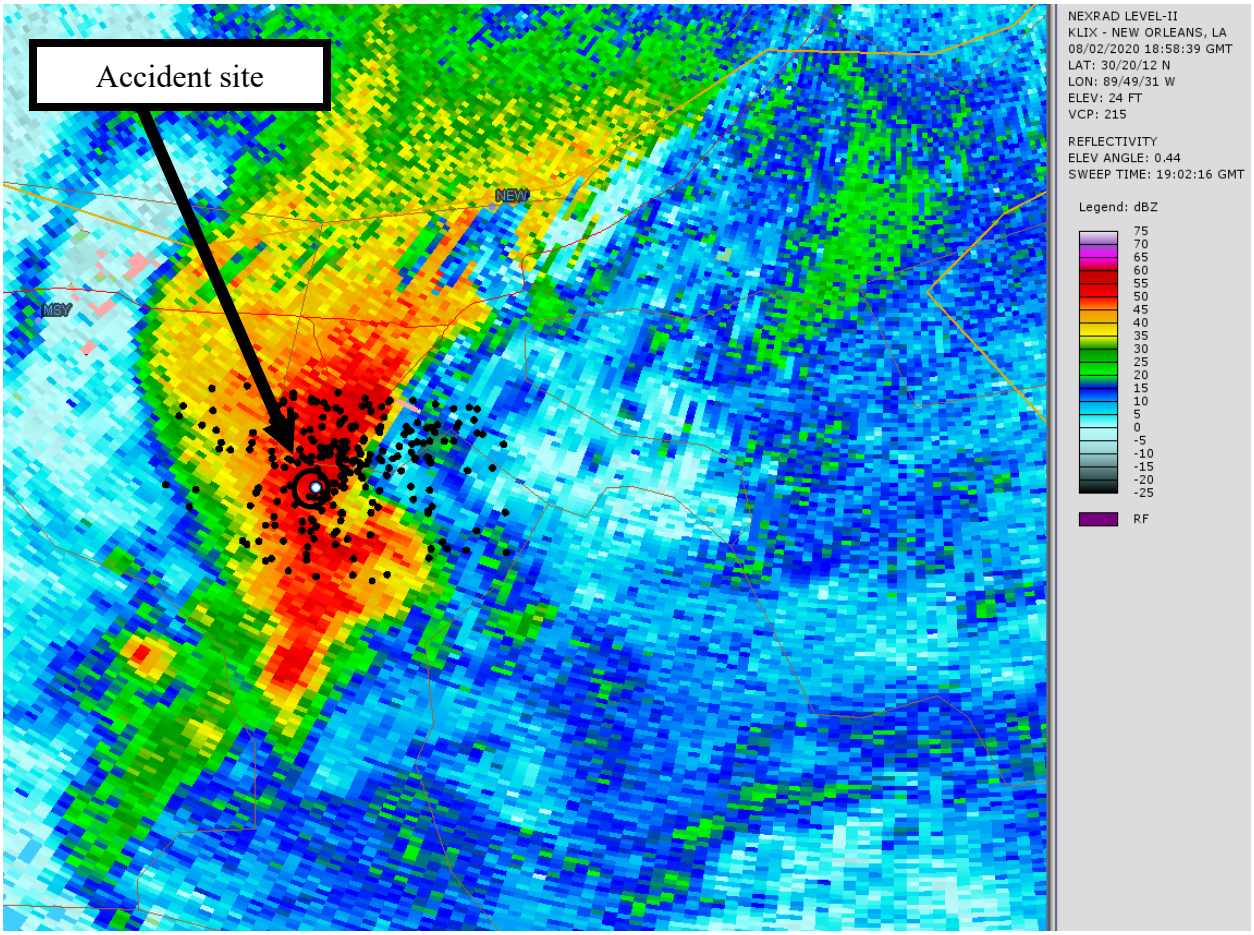


Figure 10 – KLIX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1402:16 CDT with the accident site marked with black circle and lightning flashes marked by black dots

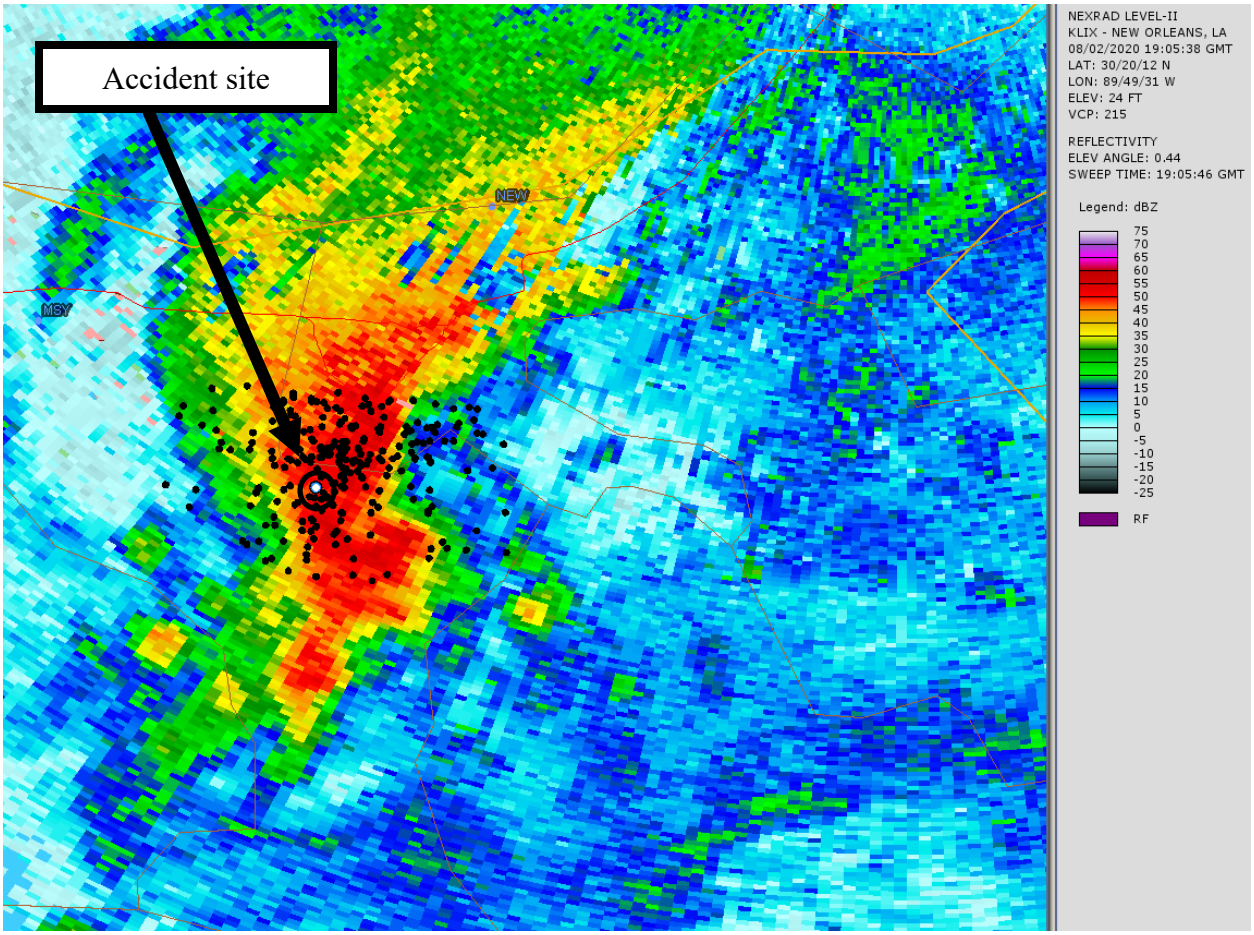


Figure 11 – KLIX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1405:46 CDT with the accident site marked with black circle and lightning flashes marked by black dots

7.0 NWS Area Forecast Discussion

The NWS Office in New Orleans, Louisiana, (LIX) issued the following Area Forecast Discussions (AFD) at 1330 and 0354 CDT (closest AFD to the accident time). The 1330 AFD updated the aviation section of the AFD. The 0354 CDT AFD discussed scattered showers and thunderstorms that may develop and that gusty winds were possible but not expected due to a stable warm layer between 5,000 and 10,000 ft msl:

FXUS64 KLIX 021830
AFDLIX

Area Forecast Discussion
National Weather Service New Orleans LA
130 PM CDT Sun Aug 2 2020

.AVIATION...

VFR conditions expected at all terminals this afternoon and
tonight. However, scattered showers and thunderstorms are expected

through 23z and affect KHUM, KMSY, KASD, KNEW, and KGPT. This activity will temporarily drop ceilings and reduce visibility for a short time. Moderate steering winds will push convection northeast this afternoon and any taf site that do experience a storm will be brief. Will cover with a tempo TSRA through 22z.

&&

.LIX WATCHES/WARNINGS/ADVISORIES...
LA...None.
GM...None.
MS...None.
GM...None.
&&

$$

FXUS64 KLIX 020854
AFDLIX

AREA FORECAST DISCUSSION
National Weather Service New Orleans LA
354 AM CDT Sun Aug 2 2020

.SHORT TERM...
An upper level trough extends across the entire country from the Great Lakes to the northwestern Gulf of Mexico and will generally remain in that position through the first half of this upcoming week. That means the frontal boundary associated with the trough will not make it past our CWA. A moisture axis exists ahead of this boundary from just south of Texas through our CWA and across southern MS to central AL. Its along this feature that scattered showers and thunderstorms may develop today. Coverage should be more than yesterday but not expecting numerous showers and storms. Guidance average POPS is in the 20 to 40% range. While a random gusty wind will be possible with storms today, stable warm layer below 750mb will make it hard for anything to reach the surface. Near normal highs expected today, which is on the high side of guidance.

Rain chances look to slide back to more isolated along sea breeze boundaries Monday and Tuesday as the moisture axis shifts east and PW's fall down below 1.5". This time of year, less rain/clouds means warmer temps. Luckily, that trough in place will keep them limited to lower/mid 90s which is right along climo. At the same time, lower dewpoints will keep heat indicies at bay as well.

MEFFER
&&

.LONG TERM...
Medium range guidance is in general agreement with the pattern deamplifying. L/W trough will begin to leave Wednesday as ridging builds across the area. Overall latest NBM guidance looked good, however highs may be a touch to cool. Will adjust up some for daily highs Wed-Fri but other than that will stick pretty close to NBM.

Wed through Fri the L/W trough that had been dominating the eastern CONUS will slowly begin to lift out. As that happens the ridge over the desert SW will slide east and eventually connect with the the ridge across the Atlantic, likely around Friday. LL temps will slowly increase from around 23C to 25-26C and this will translate to slightly warmer highs. Still looks rather hot this weekend as the ridge will be centered just off to our west.

As for rain chances with the trough still over the region Wednesday you would think there would be a decent shot of rain however, we will by quite dry for this time of the year with PWs likely hanging around or possibly even below 1.5". Dewpoints will also be quite low. Thursday could be the day we begin to transition as LL flow starts to slowly return out of the south allowing moisture to creep back up. This may allow for isolated storms during the afternoon but by Friday isolated to scattered storms look a little better. We will have deeper southerly flow providing more moisture and this should allow the slightly closer to typical Summer seabreeze activity to develop Friday and into the weekend however the ridge will be controlling the area. /CAB/

&&

.AVIATION...
VFR conditions expected at all terminals for the majority of the day and through the night. But there will be some sh/ts activity around which will have an equal chance at affecting any given site.

&&

.MARINE...
Winds will remain fairly light (10 knots or less) to moderate (10 to 15 knots) through the period with seas remaining mostly 3 feet or less through the remainder of the week. A cold front will stall near the coast and remain there well into the week. Winds could become very light or even northerly for a short duration by mid week.

&&

.PRELIMINARY POINT TEMPS/POPS...
MCB 90 72 91 72 / 20 10 10 0
BTR 90 72 92 72 / 30 10 10 0
ASD 90 73 92 73 / 40 10 20 0
MSY 93 76 94 76 / 40 10 20 0
GPT 90 75 90 75 / 30 10 10 0
PQL 92 73 93 72 / 30 10 10 0

&&

.LIX WATCHES/WARNINGS/ADVISORIES...
LA...None.
GM...None.
MS...None.
GM...None.
&&

$$

8.0 NWS Zone Forecast Product

LIX issued the following zone forecast product (ZFP) at 0357 CDT, which forecasted a 40 percent chance of showers and thunderstorms for the accident site with a northwest wind to 5 mph:

FPUS54 KLIX 020857
ZFPLIX

Zone Forecast Product
National Weather Service New Orleans LA
357 AM CDT Sun Aug 2 2020

LAZ062-030015-
Orleans-
Including the cities of East New Orleans and New Orleans
357 AM CDT Sun Aug 2 2020

.TODAY...Partly cloudy with a 40 percent chance of showers and thunderstorms. Highs in the lower 90s. Northwest winds to 5 mph.
.TONIGHT...Mostly clear. Lows in the upper 70s. Southwest winds to 5 mph shifting to the west after midnight.
.MONDAY...Sunny. A 20 percent chance of showers and thunderstorms in the afternoon. Highs in the lower 90s. Northwest winds to 5 mph.
.MONDAY NIGHT...Mostly clear. Lows in the upper 70s. West winds to 5 mph.
.TUESDAY...Sunny. Highs in the lower 90s. West winds to 5 mph.
.TUESDAY NIGHT...Mostly clear. Lows in the mid 70s.
.WEDNESDAY...Sunny. A 20 percent chance of showers and thunderstorms in the afternoon. Highs in the lower 90s.
.WEDNESDAY NIGHT...Mostly clear. Lows in the mid 70s.
.THURSDAY...Sunny. A 20 percent chance of showers and thunderstorms in the afternoon. Highs in the lower 90s.
.THURSDAY NIGHT...Mostly clear. Lows in the mid 70s.
.FRIDAY...Sunny. A 20 percent chance of showers and thunderstorms in the afternoon. Highs in the lower 90s.
.FRIDAY NIGHT...Mostly clear. Lows in the upper 70s.
.SATURDAY...Sunny with slight chance of showers and thunderstorms in the morning, then partly cloudy with chance of showers and thunderstorms in the afternoon. Highs in the upper 80s. Chance of precipitation 40 percent.

9.0 NWS Warning information and Storm Report

LIX did not issue a severe thunderstorm warning or special marine warning for the thunderstorm that affected the accident site at the accident time, but LIX did issue a special weather statement (SPS) at 1319 CDT which warned that a strong thunderstorm would affect the accident area with frequent lightning and brief periods of heavy rainfall that could lead to localized flooding. The SPS was updated at 1413 CDT for the continued strong thunderstorm moving east across New Orleans:

WWUS84 KLIX 021819
SPSLIX

Special Weather Statement
National Weather Service New Orleans LA
119 PM CDT Sun Aug 2 2020

LAZ060>062-021845-
Orleans-St. Charles-Upper Jefferson-
119 PM CDT Sun Aug 2 2020

...A STRONG THUNDERSTORM WILL AFFECT NORTHEASTERN ST. CHARLES...WEST CENTRAL ORLEANS AND NORTHWESTERN JEFFERSON PARISHES...

At 117 PM CDT, a strong thunderstorm was located over St. Rose, or near Hahnville, moving east at 15 mph.

The main threats from this thunderstorm will be frequent lightning and brie periods of heavy rainfall that could lead to ponding of water in low lying and poor drainage areas.

Locations impacted include...
New Orleans, Metairie, Marrero, Harvey, Avondale, Jefferson, Gretna, Harahan, Westwego, Woodmere, Elmwood, Luling, Bridge City, River Ridge, Ama, Destrehan, Estelle, Waggaman, St. Rose and Boutte.

Frequent cloud to ground lightning is occurring with this storm. Lightning can strike 10 miles away from a thunderstorm. Seek a safe shelter inside a building or vehicle.

This storm is also producing heavy rainfall which could lead to some minor street flooding as well as reduced visibility along area roadways including Interstates 10 and 310. Motorists should use caution and be prepared for sudden changes in visibility.

LAT...LON 2986 9038 3006 9035 3005 9026 3002 9018
3002 9011 3004 9006 3003 9004 2984 9006
TIME...MOT...LOC 1817Z 272DEG 12KT 2996 9030

$$

WWUS84 KLIX 021913
SPSLIX

Special Weather Statement
National Weather Service New Orleans LA
213 PM CDT Sun Aug 2 2020

LAZ061>064-021945-
Orleans-Upper St. Bernard-Upper Plaquemines-Upper Jefferson-
213 PM CDT Sun Aug 2 2020

...A STRONG THUNDERSTORM MOVING EAST ACROSS METRO NEW ORLEANS...

At 211 PM CDT, a strong thunderstorm was located over Gretna, or over Harvey, moving east at 15 mph.

The main threats from this thunderstorm will be frequent lightning and brie periods of heavy rainfall that could lead to ponding of water in low lying and poor drainage areas.

Locations impacted include...
New Orleans, Chalmette, Marrero, Harvey, Timberlane, Belle Chasse, Gretna, Woodmere, Violet, Terrytown, Meraux, Poydras, Estelle and Arabi.

Frequent cloud to ground lightning is occurring with this storm. Lightning can strike 10 miles away from a thunderstorm. Seek a safe shelter inside a building or vehicle.

This storm is also producing heavy rainfall which could lead to some minor street flooding as well as reduced visibility along area roadways including Interstates 10 and 610, as well as the west bank expressway. Motorists should use caution and be prepared for sudden changes in visibility.

LAT...LON 2979 9013 3000 9012 3006 8985 2978 8987
TIME...MOT...LOC 1911Z 270DEG 12KT 2993 9007

$$

At 1657 CDT a local storm report was issued by LIX for a measured 73 mph wind gust from a vessel located a half mile southwest of the accident site location. The 73 mph wind gust occurred at 1400 CDT:

NWUS54 KLIX 022157
LSRLIX

PRELIMINARY LOCAL STORM REPORT
NATIONAL WEATHER SERVICE NEW ORLEANS LA
457 PM CDT SUN AUG 2 2020

..TIME... ...EVENT... ...CITY LOCATION... ...LAT.LON...
..DATE... ....MAG.... ..COUNTY LOCATION..ST.. ...SOURCE....
..REMARKS..

0200 PM TSTM WND GST MARRERO 29.89N 90.11W
08/02/2020 M73 MPH JEFFERSON LA BROADCAST MEDIA

SHIP ON THE MISSISSIPPI RIVER MEASURED A 73 MPH WIND
GUST. MULTIPLE REPORTS OF TREES DOWN IN JEFFERSON AND
ORLEANS PARISHES. MINOR STRUCTURAL DAMAGE ALSO OBSERVED.

&&

$$

10.0 Downburst and Microburst Information[27]

Rain showers, thunderstorms, and convective clouds can produce downdrafts, outflow boundaries, and gust fronts during the mature stage of their life cycle. A downdraft, outflow boundary, or gust front can create an environment favorable for unexpected changes in wind direction and speed. Downbursts create many hazards for surface transportation and often cause damaging wind at the surface. An exemplar diagram of a downburst from a rain shower or thunderstorm cloud base is shown in figure 12. Further information on the hazards of a downburst and microburst can be found from the University Corporation for Atmospheric Research (UCAR)[28].

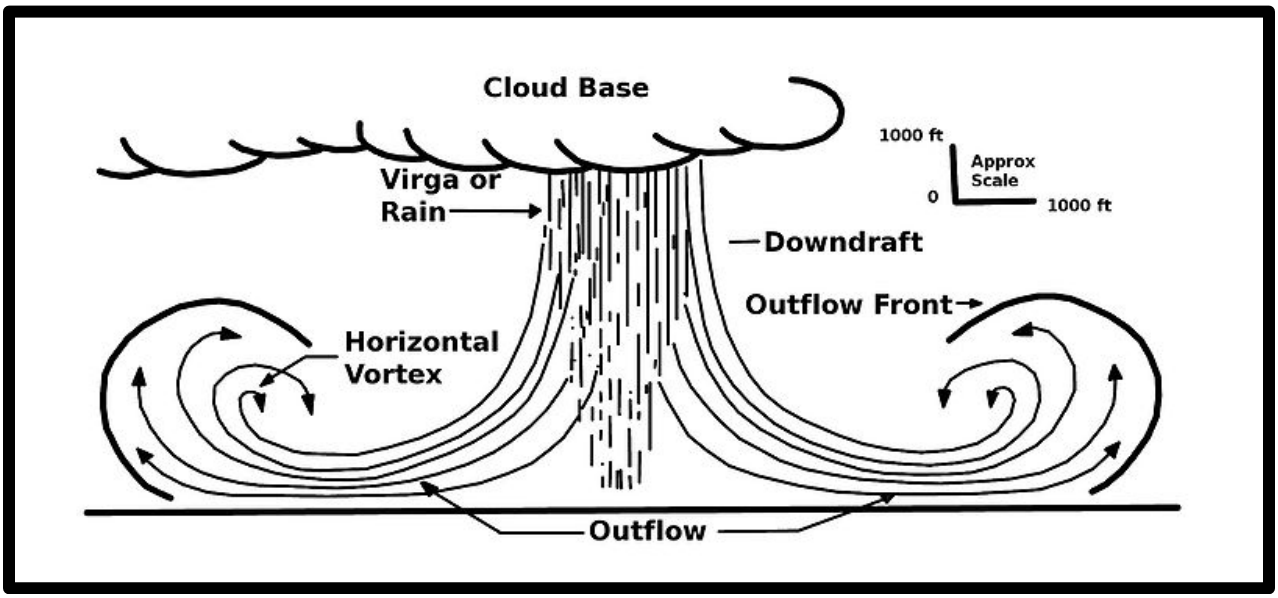


Figure 12 – Exemplar diagram of a downburst and outflow

11.0 Weather Briefing Information

It is unknown what, if any, weather information was received or reviewed by the captain or crew before the accident time.

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[27] https://www.nssl.noaa.gov/publications/dopplerguide/chapter4.php
https://www.weather.gov/ohx/downbursts
https://www.weather.gov/lmk/downburst

[28] UCAR's Collaboration among Education and Training Programs (COMET) Meteorology Education and Training (MetEd) module on Thunderstorm Downdrafts:
https://www.meted.ucar.edu/tropical/synoptic/local_storms/navmenu.php?tab=1&page=2.0.0&type=flash

12.0 Witness Information and Images

Information was received from the accident vessel's Master along with the crane operators working alongside the accident vessel. The accident vessel's Master stated that at 1400 CDT a storm force wind with heavy rain hit the vessel. At that time the accident vessel started moving away from the berth while cargo operations were in progress with 2 cranes. For more information please see attachment 3.

The crane operators alongside the accident vessel stated that in a matter of seconds it went from rainy conditions to violent winds. Both crane operators recalled seeing the rain off in the distance and it seemed like a normal summer storm shower. Only one of the crane operators recalled hearing an alarm.[29] For more information please see attachments 4 and 5.

Imagery from two video cameras were obtained around the accident time for the "Nashville 5 Way" point and "CAM 20 – Outbound" point located in figure 13 with these locations 1,000 ft west-northwest of the accident site, and 4,000 ft east-northeast of the accident site, respectively. The "Nashville 5 Way" imagery from 1355, 1358, 1403, 1409, and 1411 CDT are provided in figures 14 through 18. Between 1355 and 1358 the horizontal visibility decreased in the direction of the accident vessel and between 1358 and 1403 CDT horizontal visibility could not be maintained. The horizontal visibility decreased again between 1404 through 1409 CDT with the accident vessel having moved away from the dock by 1411 CDT (figure 18) from its original position at 1355 CDT (figure 14). The "CAM 20 – Outbound" imagery pointed in the direction of the accident vessel from 1355, 1400, 1402, 1403, and 1412 CDT are provided in figures 19 through 23. The imagery showed rain obscuring horizontal visibility beyond the accident vessel at 1355 and the horizontal visibility decreasing below 4,000 ft between 1400 and 1402 CDT. By 1403 CDT the horizontal visibility was completely obscured in the direction of the accident vessel until 1412 CDT. For the full video imagery please see the docket of this accident.

[29] The cranes were equipped with an audible alarm system which toned when a certain wind threshold was reached to warn crane operators of the high winds.

Figure 13 – Accident site location and location of video imagery

Figure 14 – Nashville 5 Way imagery pointing towards accident vessel from 1355 CDT

Figure 15 – Nashville 5 Way imagery pointing towards accident vessel from 1358 CDT

Figure 16 – Nashville 5 Way imagery pointing towards accident vessel from 1403 CDT

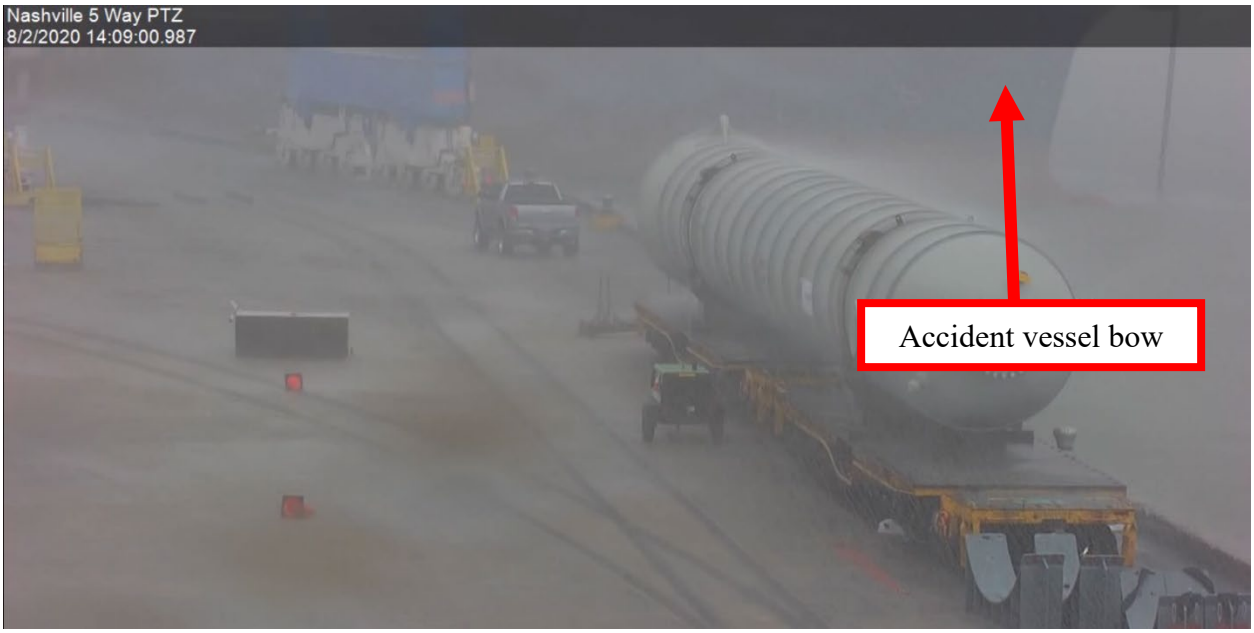

Figure 17 – Nashville 5 Way imagery pointing towards accident vessel from 1409 CDT

Figure 18 – Nashville 5 Way imagery pointing towards accident vessel from 1411 CDT

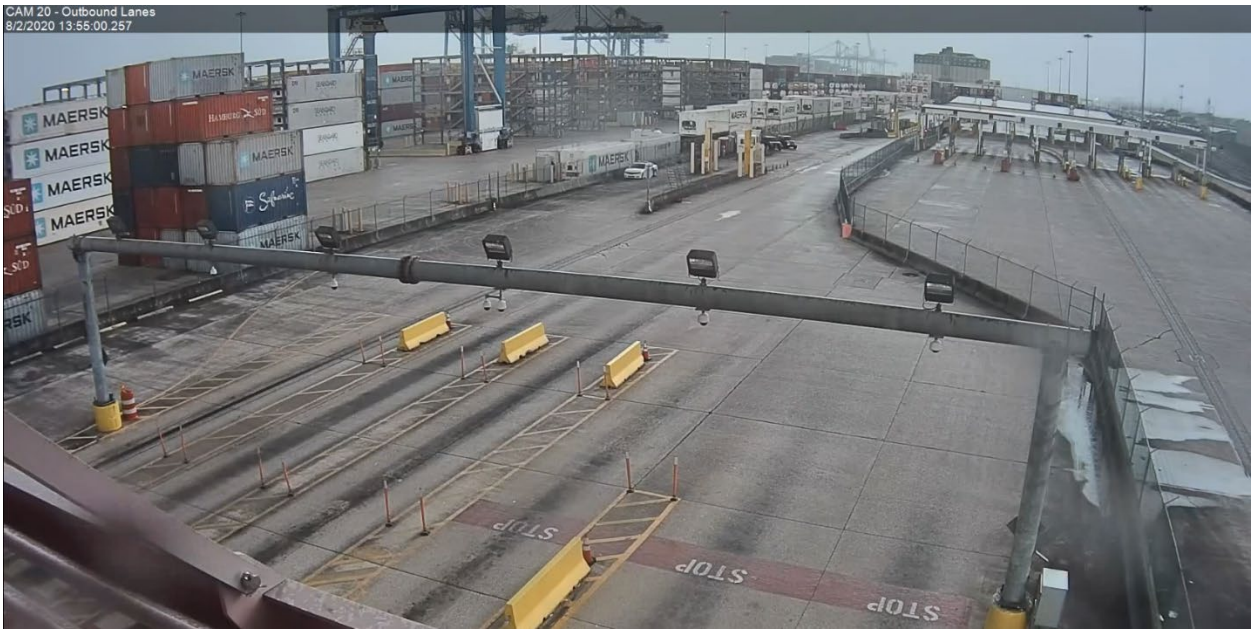

Figure 19 – CAM 20 – Outbound imagery pointing towards accident vessel from 1355 CDT

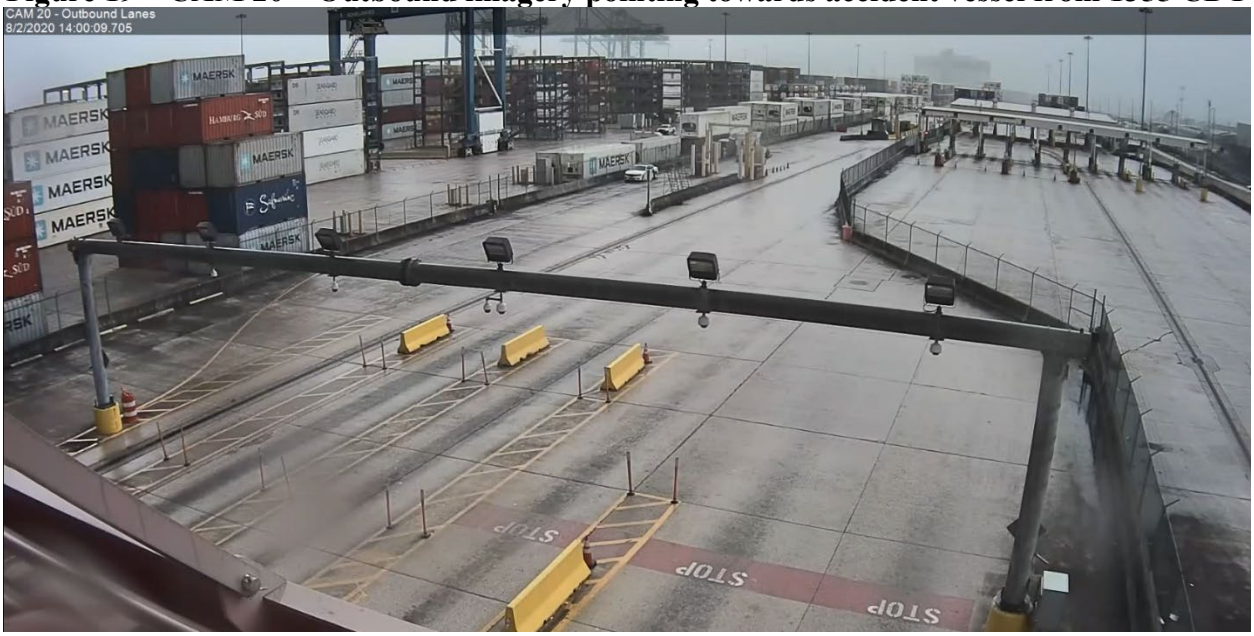

Figure 20 – CAM 20 – Outbound imagery pointing towards accident vessel from 1400 CDT

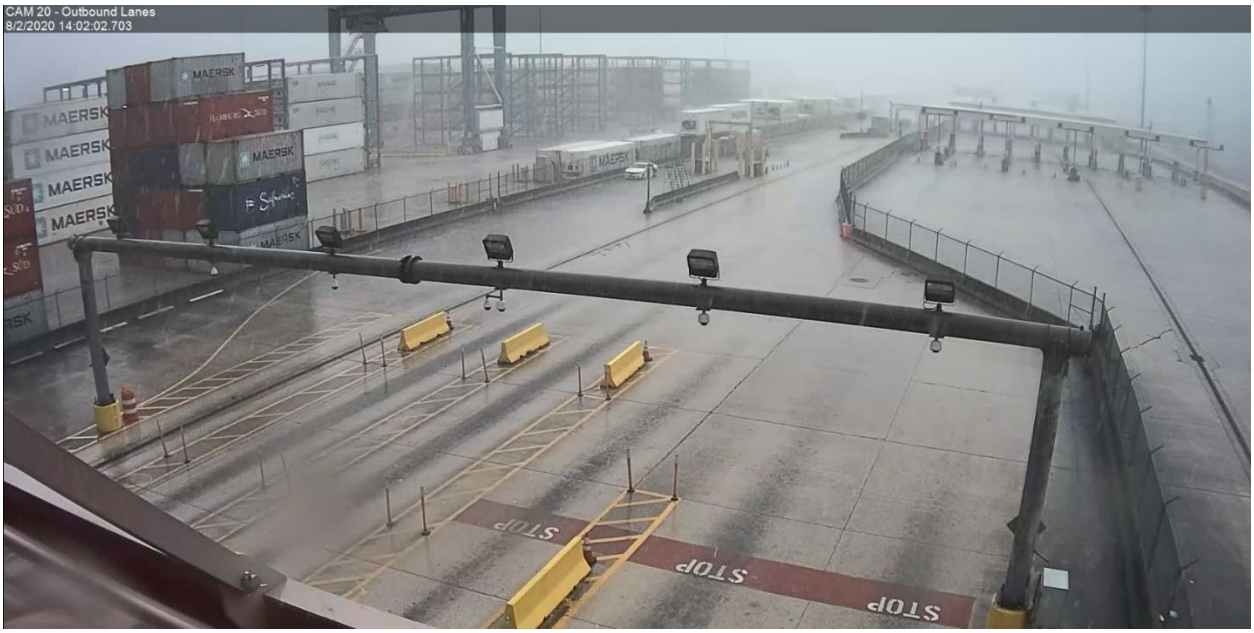

Figure 21 – CAM 20 – Outbound imagery pointing towards accident vessel from 1402 CDT

Figure 22 – CAM 20 – Outbound imagery pointing towards accident vessel from 1403 CDT

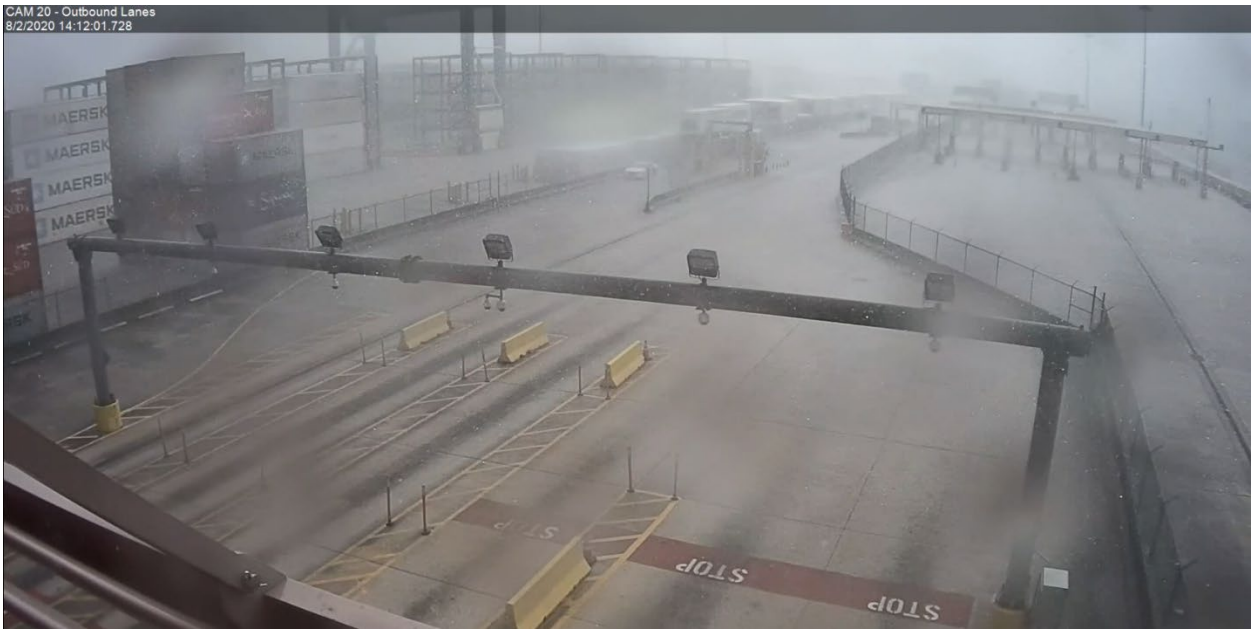

Figure 23 – CAM 20 – Outbound imagery pointing towards accident vessel from 1412 CDT

The source of the 73 mph wind gust information on the LIX LSR (section 9.0) was from a vessel located between 2,000 and 2,500 ft south-southwest of the accident vessel and a still image from that video is provided in figure 24 with the wind gust information circled in red. For more information please see attachment 6.

Figure 24 – Wind gust information from vessel located south-southwest of the accident vessel at the accident time

13.0 VDR Weather information

The Voyage Data Recorder (VDR) from the accident vessel did record wind information at the accident time, however, the weather instrumentation including the anemometer was located on a folding mast which was folded in the downward position (see figure 25) at the accident time. For more information on the VDR and data therein, please see the docket for this accident.

Figure 25 – Representative location of weather instrumentation on accident vessel during the accident time

14.0 Astronomical Data

The astronomical data obtained[30] for the accident site on August 2, 2020, indicated the following:

SUN	
Begin civil twilight	0555 CDT
Sunrise	0620 CDT
Sun transit	1307 CDT
Accident time	**1402 CDT**[31]
Sunset	1953 CDT
End civil twilight	2018 CDT

E. LIST OF ATTACHMENTS

Attachment 1 – Animation of KLIX base reflectivity between 1331 CDT and 1428 CDT

[30] https://www.suncalc.org/#/29.9116,-90.115,11/2020.08.02/14:02/1/0
[31] Inserted accident time for reference and context.

Attachment 2 – Animation of KLIX base velocity between 1331 CDT and 1428 CDT

Attachment 3 – Accident vessel's Master statement of fact

Attachment 4 – Interview of crane operator 1

Attachment 5 – Interview of crane operator 2

Attachment 6 – Documentation of LSR report

Attachment 7 – Weather criteria definition

Submitted by:

_____
Paul Suffern
Senior Meteorologist

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