NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 6, 2015

Group Chairman's Factual Report

METEOROLOGY

CEN15LA334

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A. ACCIDENT

Location: Chicago, Illinois
Date: August 2, 2015
Time: About 1437 central daylight time (1937 UTC[1])
Airplane: Air Choice One flight 2627, Cessna 208B; Registration N942AC

B. METEOROLOGY GROUP

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C. SUMMARY

On August 2, 2015, about 1437 central daylight time, a Cessna 208B, single-engine turboprop airplane, N942AC, operating as Air Choice One flight 2627, was substantially damaged by high wind during taxi at Chicago O'Hare International Airport (ORD), Chicago, Illinois. The two flight crewmembers and five passengers were not injured and two passengers sustained minor injuries. The airplane was registered to and operated by Multi-Aero, Inc. as a 14 Code of Federal Regulations Part 135 scheduled commuter passenger flight. Day instrument meteorological conditions (IMC) prevailed and an instrument flight plan had been filed. The airplane departed the ORD terminal gate at 1410 and was destined for Southeast Iowa Regional Airport (BRL), Burlington, Iowa.

The captain reported that there had been numerous reports of windshear and microburst alerts and the airplane had been stationary while waiting for departure clearance. As the airplane began to taxi high wind lifted the airplane and it impacted the concrete taxiway surface on the left wing, left main gear, and the operating propeller. Witnesses reported that after impact the airplane remained partially nose down and resting on its left wing for several seconds. The airplane then fell back upright to come to rest on all three landing gear. The engine was secured, and all occupants deplaned normally through the main cabin door. A post accident examination showed the outboard portion of the left wing was bent up about 30 degrees, the aileron was damaged, and all three propeller blades were impact damaged.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation from the Washington D.C. office, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center and the National Climatic Data Center (NCDC). All

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

times are central daylight time (CDT) based upon the 24 hour clock, local time +5 hours to UTC, and UTC=Z. 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. NWS airport and station identifiers use standard International Civil Aviation Organization (ICAO) 4-letter station identifiers versus International Air Transport Association (IATA) 3-letter identifiers which deletes the initial country code designator "K" for U.S. airports. Both codes are both used intermittently in this report.

The accident site was located at the departure ramp near runway 22L at the following coordinates, latitude 41°58'16.14" N and longitude 87°52'51.83" W at an elevation of 650 feet.

E. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP) 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 joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45G.

1.1 Surface Analysis Chart

A section of the NWS Surface Analysis Chart for 1300 CDT (1800Z) on August 2, 2015 centered over the area is included in figure 1, depicting the large scale or synoptic conditions at the surface in the hour prior to the accidents. The chart depicted a low pressure system at 1001-hectopascals (hPa) over northwestern Michigan with a cold front extending to the southwest through Wisconsin, Minnesota, into Iowa and then westward into Nebraska. To the east of the low a warm front was depicted extending across northern Wisconsin and Lake Michigan, into north-central Michigan. An outflow boundary associated with thunderstorms was depicted just east of the warm front over extreme eastern Michigan into Lake Huron. No specific boundaries were depicted over Illinois or in the vicinity of Chicago, which was located within the warm sector of the front.

The station model for Chicago O'Hare International Airport is enclosed within the red circle in figure 1, depicted at 1300 CDT wind from the southwest at approximately 10 knots, partly cloudy skies, with a temperature of 89° Fahrenheit (F), and a dew point of 63° F. Except for the approaching cold front to the northwest, no significant weather was depicted in the immediate region surrounding Chicago.

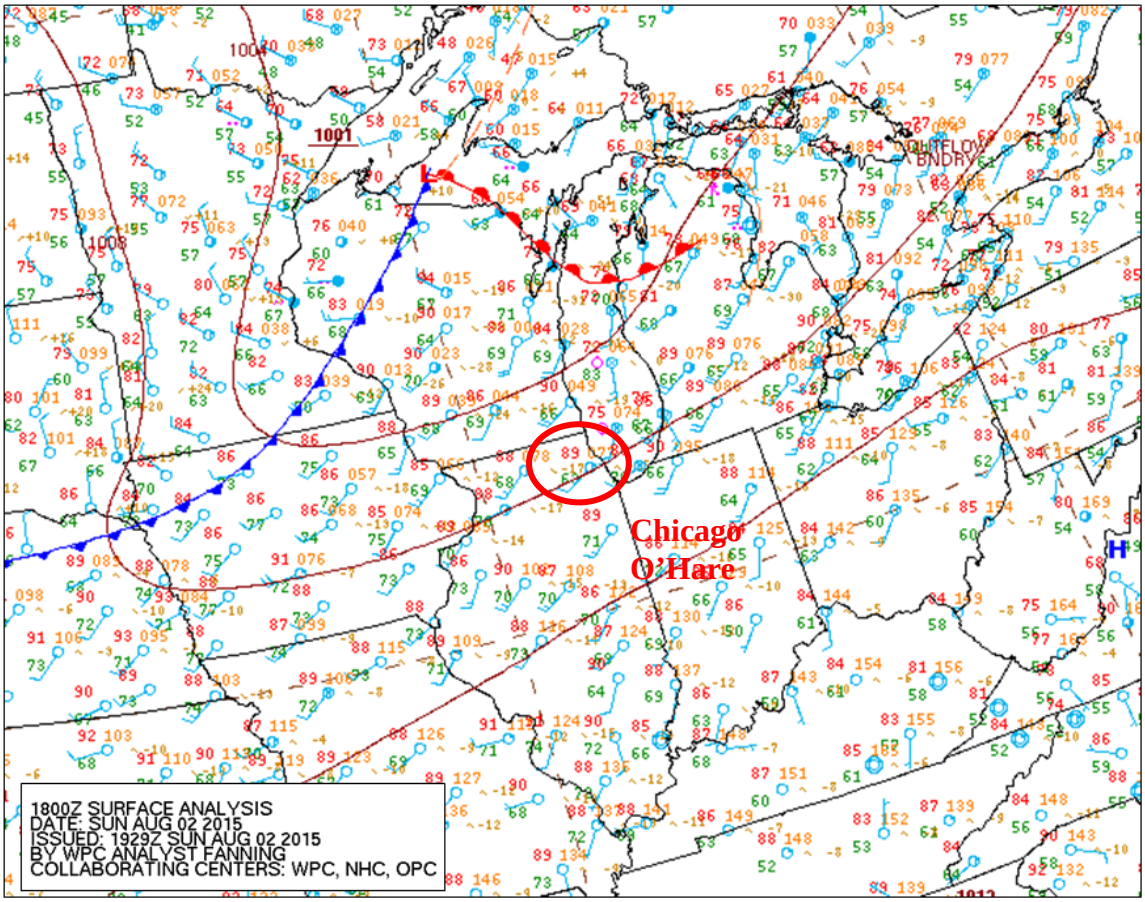

Figure 1 - NWS Surface Analysis Chart for 1300 CDT

1.2 Weather Radar Mosaic

The National Center for Atmospheric Research (NCAR) - Research Application Laboratory (RAL) regional radar mosaic image for 1435 CDT (1935Z) on August 2, 2015 is included as figure 2. The image depicted a defined line of thunderstorms over Lake Michigan and into northeastern Wisconsin in the vicinity of the warm front and another area over eastern Michigan associated with the outflow boundary on the Surface Analysis. In the vicinity of Chicago O'Hare International Airport relevant to this case was another large intense to extreme area of echoes is observed with reflectivity's of 60 to 65 dBZ is observed. This area was observed moving eastward across northern Illinois at approximately 40 knots.

The several areas of spectacled light blue or reflectivity's less than 15 dBZ around many of the radar sites across the region were false echoes associated with ground clutter and ducting of the radar beam towards the surface due to an inversion aloft.

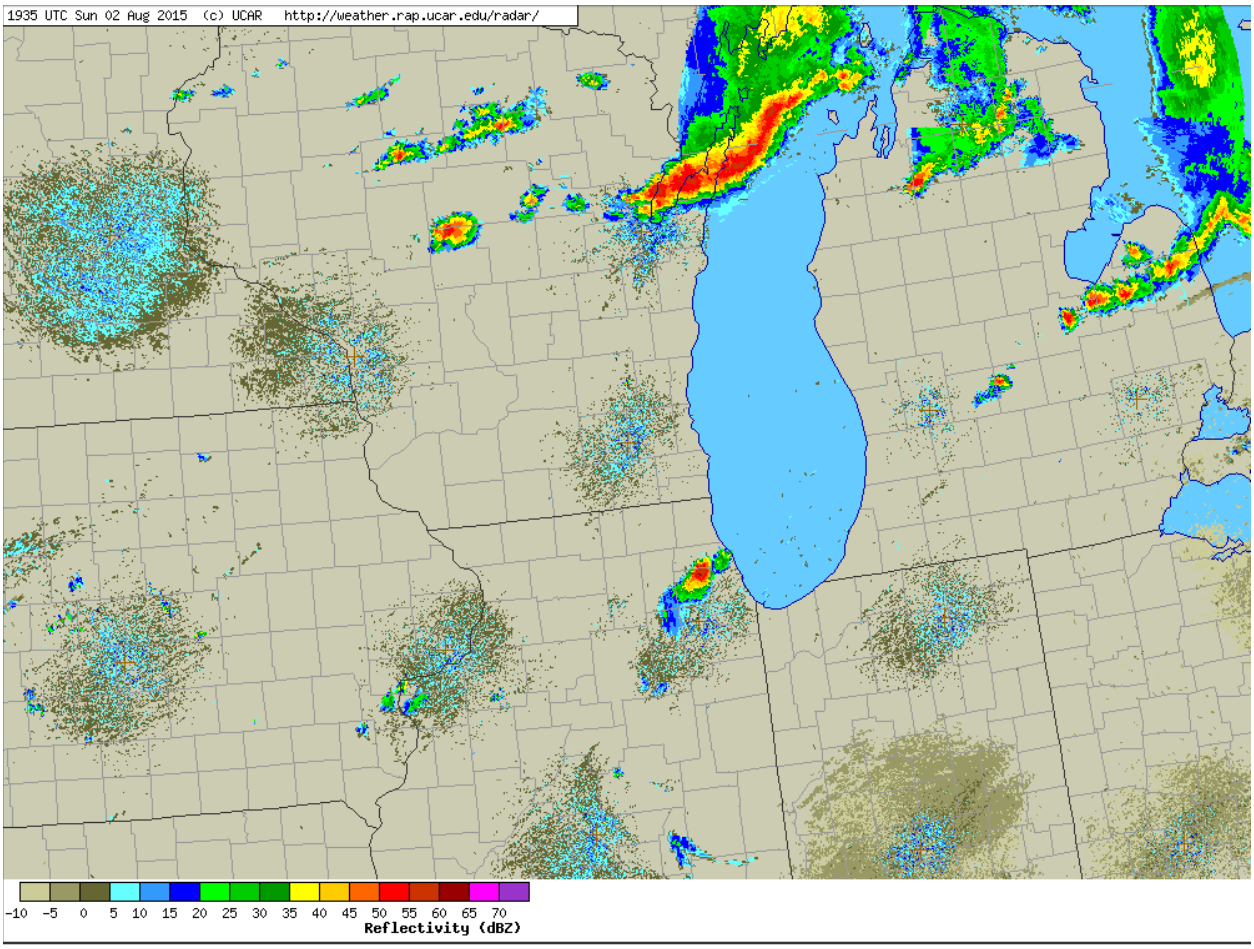

Figure 2 - NCAR regional radar mosaic for 1435 CDT

1.3 Convective Outlook

The NWS Storm Prediction Center (SPC) located in Norman, Oklahoma, issued; issued the afternoon Convective Outlook at 1116 CDT (1616Z) identifying regions where they believed organized severe thunderstorm development was expected for the next 24 hour period. Figure 3 is the chart current at the time, which depicted an enhanced potential for severe thunderstorm development over Michigan, Wisconsin, and northern Illinois, Indiana, and extreme northern Ohio. Within the area surrounding Chicago the chart indicated a greater than 30% probability of wind gusts greater than 50 knots, and a 15% probability of hail 1 inch in diameter or larger, and a 2% probability of a tornado.

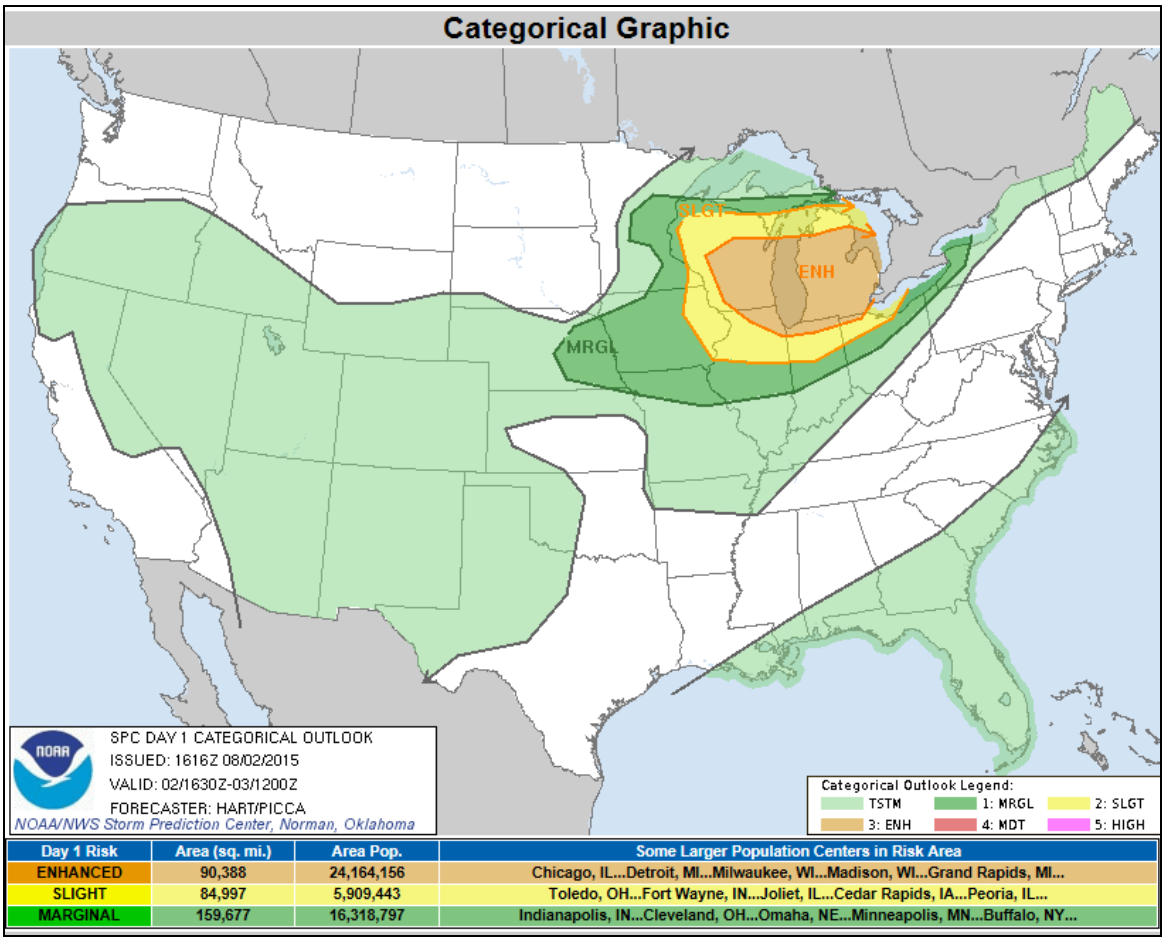

Figure 3 - NWS Convective Outlook issued at 1116 CDT

2.0 Chicago O'Hare International Airport (KORD) Surface Observations

The official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECIs) surrounding the period were documented for Chicago O'Hare International Airport (KORD), Chicago, IL, were documented. The airport had an Automated Surface Observation System (ASOS) and was augmented by NWS certified weather observers. The airport lists an elevation of 672 feet and a magnetic variation of 3° West. The following weather conditions were reported surrounding the time of the accidents, cloud heights are reported above ground level (agl).

Chicago O'Hare Airport special weather observation at 1429 CDT, wind from 230° at 17 knots gusting to 24 knots, visibility 10 miles in thunderstorm, a few clouds at 5,000 feet agl, scattered clouds at 7,000 feet, ceiling broken at 9,000 feet, and broken at 20,000 feet, temperature 31° Celsius (C), dew point 19° C, altimeter 29.74 inches of mercury (Hg). Remarks; automated observation system, peak wind from 240° at 27 knots occurred at 1402 CDT, thunderstorm began at 1428 CDT, frequent lightning in-cloud and cloud-to-ground west, thunderstorm west moving east, temperature 31.1° C, dew point 19.4° C.

Chicago O'Hare Airport special weather observation at 1443 CDT, wind from 250° at 16 knots gusting to 45 knots, runway 10L visual range 700 variable better than 6,000 feet, weather thunderstorm, hail, and moderate rain, scattered at 5,000 feet agl in cumulonimbus clouds, scattered clouds at 7,000 feet, ceiling broken at 9,000 feet, and broken at 20,000 feet, temperature 27° C, dew point 22° C, altimeter 29.76 inches of Hg. Remarks; automated observation system, peak wind from 270° at 45 knots occurred at 1440 CDT, rain began at 1942, hail began 1943, thunderstorm began 1928, pressure rising rapidly, frequent lightning in-cloud and cloud-to-ground overhead, thunderstorm overhead moving east, hourly precipitation trace, temperature 26.7° C, dew point 21.7° C.

The raw observations surrounding the period with the general flight categories[2] were as follows:

VFR METAR KORD 021751Z 24012G27KT 10SM FEW060 FEW150 SCT250 32/17 A2978 RMK AO2 PK WND 24027/1746 SLP077 T03170172 10317 20222 58015

VFR SPECI KORD 021851Z 24017G29KT 10SM FEW060 FEW250 32/19 A2975 RMK AO2 PK WND 25030/1834 SLP066 T03220189=

VFR SPECI KORD 021929Z 23017G24KT 10SM TS FEW050CB SCT070 BKN090 BKN200 31/19 A2974 RMK AO2 PK WND 24027/1902 TSB28 FRQ LTGICCG W TS W MOV E T03110194=

Accident 1937Z

IFR SPECI KORD 021943Z 25016G45KT 2SM R10L/0700VP6000FT TSGSRA SCT050CB SCT070 BKN090 BKN200 27/22 A2976 RMK AO2 PK WND 27045/1940 RAB42GSB43 TSB28 PRESRR FRQ LTGICCG OHD TS OHD MOV E P0000 T02670217=

MVFR SPECI KORD 021947Z 24012G45KT 5SM R10L/0700VP6000FT TSRA FEW012 SCT050CB BKN090 BKN200 24/21 A2975 RMK AO2 PK WND 27045/1940 RAB42GSB43E47 TSB28 FRQ LTGICCG OHD TS OHD MOV E P0012

VFR METAR KORD 021951Z 24010G31KT 10SM R10L/1800VP6000FT -TSRA FEW012 SCT050CB BKN090 BKN200 26/21 A2975 RMK AO2 PK WND 27045/1940 RAB42GSB43E47 TSB28 SLP069 FRQ LTGICCG NE-SE TS NE-SE MOV E CBMAM OHD P0012 T02560206

[2] 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 or lowest layer of clouds reported as broken, overcast or the vertical visibility into a surface based obscuration below 500 feet 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 feet agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 feet agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 feet 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 feet agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

VFR SPECI KORD 022009Z 20009KT 10SM FEW050CB SCT070 SCT100 BKN200 26/23 A2974 RMK AO2 RAE1954 TSE08 OCNL LTGICCG DSNT E CB E MOV E CBMAM S P0000 T02610228

2.1 Chicago O'Hare ASOS High Resolution Data

The Chicago O'Hare International Airport high resolution 1- and 5-minute ASOS data was also obtained for the hour surrounding the accident. The 5-minute observations immediate before and after the accident best documents the conditions being reported recorded at the time of the accident. The time has been converted to CDT with the raw 5-minute observations from 1400 through 1450 CDT are included below:

14:00:31 5-MIN KORD 021900Z 24018G26KT 10SM CLR 32/19 A2974 840 44 3000 240/18G26 RMK AO2 PK WND 24026/1852 T03220189

14:05:31 5-MIN KORD 021905Z 24022G27KT 10SM CLR 32/19 A2974 840 44 3000 240/22G27 RMK AO2 PK WND 24027/1902 T03220189

14:10:31 5-MIN KORD 021910Z 22012G27KT 10SM FEW090 32/19 A2974 840 46 3000 230/12G27 RMK AO2 PK WND 24027/1902 T03220194

14:15:31 5-MIN KORD 021915Z 24014G25KT 10SM FEW090 33/19 A2974 840 44 3100 240/14G25 RMK AO2 PK WND 24027/1902 T03280194

14:20:31 5-MIN KORD 021920Z 24013G20KT 10SM SCT095 32/19 A2974 850 46 3000 240/13G20 RMK AO2 PK WND 24027/1902 T03220194

14:25:31 5-MIN KORD 021925Z 24016G23KT 10SM FEW080 SCT095 31/19 A2974 840 49 2900 240/16G23 RMK AO2 PK WND 24027/1902 T03110194

14:30:31 5-MIN KORD 021930Z 23016G24KT 10SM TS FEW050CB SCT070 BKN090 BKN200 31/19 A2974 840 49 2900 230/16G24 RMK AO2 PK WND 24027/1902 TSB28 FRQ LTGICCG W TS W MOV E T03110194

14:35:31 5-MIN KORD 021935Z 24016G24KT 10SM TS SCT050CB SCT070 BKN090 BKN200 31/19 A2974 840 49 2900 250/16G24 RMK AO2 PK WND 24027/1902 TSB28 FRQ LTGICCG W TS W MOV E T03110194

14:40:31 5-MIN KORD 021940Z 26028G45KT 10SM R10L/1600VP6000FT TS SCT050CB SCT070 BKN090 BKN200 31/20 A2975 830 52 2800 260/28G45 RMK AO2 PK WND 27045/1940 TSB28 FRQ LTGICCG OHD TS OHD MOV E T03060200

14:45:31 5-MIN KORD 021945Z 24014G45KT 2SM R10L/0700VP6000FT +TSGSRA SCT050CB SCT070 BKN090 BKN200 24/22 A2976 820 84 2100 240/14G45 RMK AO2 PK WND 27045/1940 RAB42GSB43 TSB28 PRESRR SLP073 FRQ LTGICCG OHD TS OHD MOV E P0009 T02440217

14:50:31 5-MIN KORD 021950Z 24012G42KT 8SM R10L/0700VP6000FT -TSRA FEW012 SCT050CB BKN090 BKN200 26/20 A2975 830 71 2300 250/12G42 RMK AO2 PK WND 27045/1940 RAB42GSB43E47 TSB28 SLP069 FRQ LTGICCG NE-SE TS NE-SE MOV E P0012 T02560200

The 1-minute wind data that was measured by the ASOS during the period is included in the following table. The wind data is a running update of the 2-minute average wind, updated every minute by averaging the 5-second wind measurements during the past 2-minute period. The maximum wind data is the highest 5-second wind speed and direction during the past minute.

The following ASOS 1-minute wind data were reported between 1430 and 1500 CDT. The maximum wind was reported at 1440 CDT from 268° at 45 knots.

Time (CDT)	2-min avg. wind (°true/kt)	Max wind (°true/KT)
1430	230° 16	238° 18
1431	229° 15	224° 22
1432	223° 17	216° 24
1433	223° 16	228° 21
1434	235° 15	250° 20
1435	242° 16	245° 20
1436	247° 18	250° 23
1437	250° 20	253° 24
1438	253° 21	251° 25
1439	256° 22	268° 44
1440	260° 28	268° 45
1441	263° 32	256° 42
1442	265° 25	273° 31
1443	254° 16	236° 22
1444	242° 13	250° 17
1445	239° 14	227° 19
1446	236° 13	234° 17
1447	242° 12	259° 18
1448	249° 13	236° 18
1449	248° 13	255° 16
1450	243° 12	255° 14
1451	237° 10	228° 13
1452	231° 07	240° 08
1453	228° 06	218° 10
1454	229° 07	239° 11
1455	231° 08	245° 12
1456	237° 09	248° 15
1457	230° 09	233° 10
1458	221° 07	226° 11
1459	218° 08	206° 11
1500	215° 08	207° 12

2.2 DuPage Airport (KDPA), West Chicago, IL

The next closest weather reporting facility was from DuPage Airport (KDPA), West Chicago was located 15 miles west of the accident site, which was also impacted by the storm prior to it moving across Chicago O'Hare International Airport. The airport had an ASOS and was listed at an elevation of 759 feet. The following conditions were reported surrounding the period and the related flight category:

VFR METAR KDPA 021852Z 23018G25KT 10SM CLR 33/20 A2976 RMK AO2 PK WND 24027/1819 LTG DSNT W SLP069 T03280200=

VFR SPECI KDPA 021911Z 21019G26KT 10SM VCTS FEW090 FEW100 30/20 A2976 RMK AO2 PK WND 21026/1910 LTG DSNT SW AND W T03000200=

VFR SPECI KDPA 021920Z 25019G24KT 9SM TS FEW045 SCT070 BKN090 29/20 A2981 RMK AO2 PK WND 21026/1910 LTG DSNT SW AND W TSB14 PRESRR T02940200=

IFR SPECI KDPA 021924Z 28015G25KT 1 1/2SM +TSRAGR FEW021 SCT046 BKN070 28/22 A2981 RMK AO2 PK WND 21026/1910 LTG DSNT SW AND W RAB21GRB23 TSB14 PRESRR P0012 T02780217=

IFR SPECI KDPA 021930Z 24011G25KT 3/4SM +TSRA SCT032 SCT046 BKN070 25/22 A2977 RMK AO2 PK WND 21026/1910 LTG DSNT E AND W RAB21GRB23E25 TSB14 P0021 T02500222 RVRNO=

IFR SPECI KDPA 021935Z 22012G19KT 2SM -TSRA SCT037 BKN055 BKN070 25/22 A2977 RMK AO2 PK WND 21026/1910 LTG DSNT NE AND E RAB21GRB23E25 TSB14 P0021 T02500222=

VFR SPECI KDPA 021943Z 23010KT 10SM -TSRA FEW035 SCT055 SCT070 25/22 A2977 RMK AO2 PK WND 21026/1910 LTG DSNT NE AND E RAB21GRB23E25 TSB14 P0021 T02500222=

VFR METAR KDPA 021952Z 23008KT 10SM FEW036 26/22 A2976 RMK AO2 PK WND 21026/1910 LTG DSNT NE AND E RAB21E45GRB23E25 TSB14E51 SLP071 P0021 T02560222=

The reports indicated that the thunderstorm was first reported in the vicinity of the station at 1411 CDT, and impacted the station between 1414 and 1451 CDT with peak winds of 26 knots, hail, and 0.26 inches of rainfall.

2.3 METAR Display

The following displays in figure 4 through 6 were obtained from the NWS Aviation Weather Centers (AWC) website and depicted the observations surrounding the Chicago area plotted similar to the surface analysis, and with the radar overlaid for the period. The images depict the conditions reported art 1400, 1430, and 1500 CDT respectively.

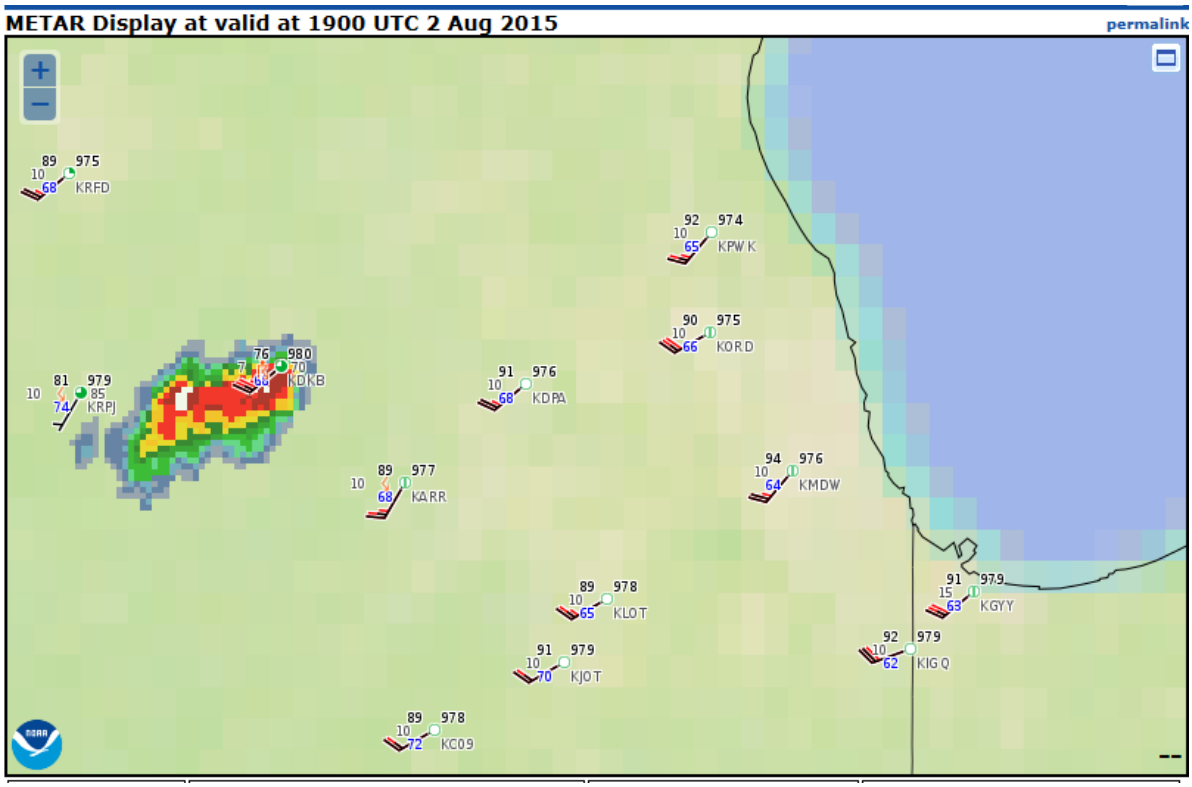

Figure 4 – AWC METAR display at 1400 CDT

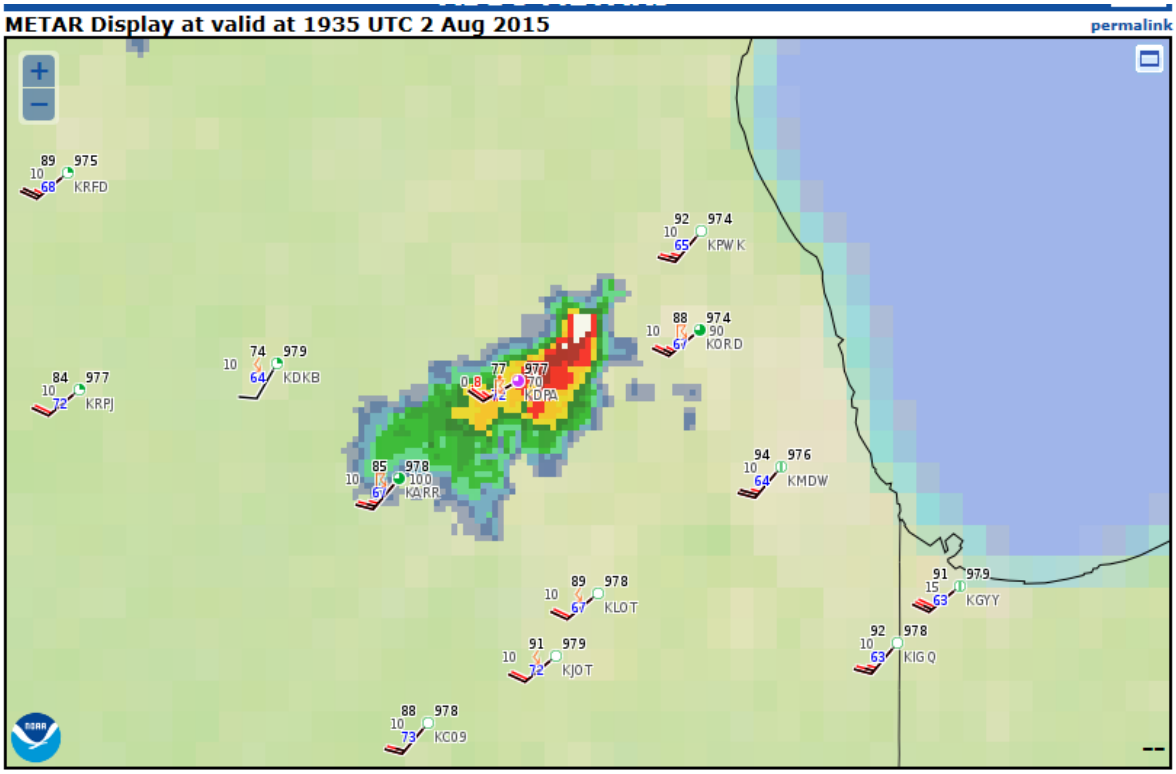

Figure 5 - AWC METAR display at 1430 CDT

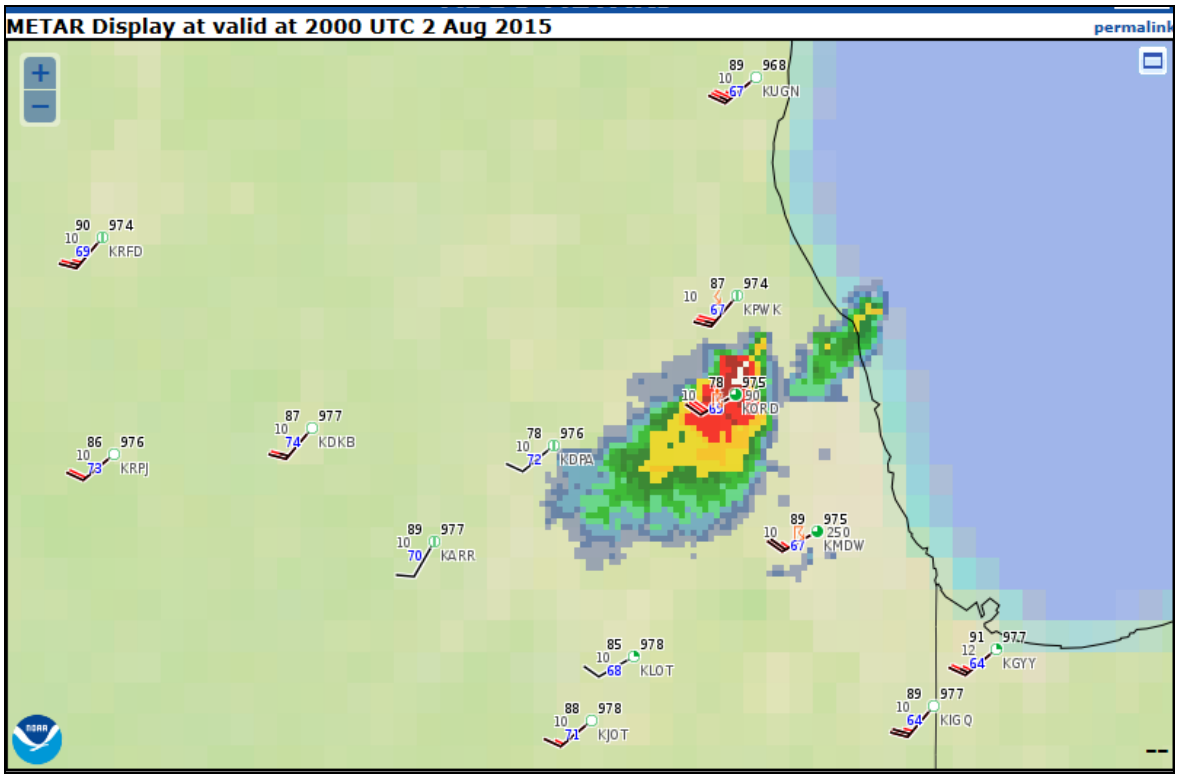

Figure 6 - AWC METAR display at 1500 CDT

3.0 NWS Terminal Aerodrome Forecast

The NWS Terminal Aerodrome Forecast (TAF) issued for KORD by the Chicago Weather Forecast Office located in Romeoville, IL, during the period were as follows:

TAF KORD 021720Z 0218/0324 24016G29KT P6SM SCT250
FM030000 24017G26KT P6SM VCSH SCT080 BKN180
TEMPO 0301/0303 3SM TSRA BKN040CB
FM030500 28008KT P6SM BKN040 BKN100
FM030900 33008KT P6SM FEW025
FM031500 30011G17KT P6SM FEW250=

TAF AMD KORD 021922Z 0219/0324 24016G29KT P6SM SCT250
FM021945 23018G35KT 1SM TSRA SCT030CB BKN070
FM022045 24016G29KT P6SM SCT070 BKN250
FM030000 24017G26KT P6SM VCSH SCT080 BKN180
TEMPO 0301/0303 3SM TSRA BKN040CB
FM030500 28008KT P6SM BKN040 BKN100
FM030900 33008KT P6SM FEW025
FM031500 30011G17KT P6SM FEW250=

The initial forecast issued by the NWS at 1220 CDT expected VFR conditions to prevail with southwest winds at 16 knots gusting to 29 knots, with high scattered cirrus clouds, with showers in the vicinity after 1900 CDT. The forecast was amended at 1422 CDT and after the aircraft departed the gate for their respective destinations. The amended forecast expected after 1445

CDT a period of IFR conditions due to a thunderstorm with heavy rain, and wind gusts to 35 knots.

4.0 Aviation Forecast Discussion

The NWS Aviation Forecast Discussion (AFD) issued at 1407 CDT by the Chicago WFO warned that a severe thunderstorm warning was current for Dekalb County, immediately west of Cook County, Chicago and that there were reports of quarter sized hail that had fallen in the area. The advisory indicated that the environmental conditions were supportive of localized strong downdrafts and severe wind gusts, as well as brief heavy rain and hail. The aviation forecast for Chicago O'Hare (KORD) and Midway Airport (KMDW) indicated gusty southwest winds near 30 knots were expected with the likelihood of thunderstorms increasing during the evening, especially after 1900 CDT. The advisory was as follows in plain language:

FXUS63 KLOT 021907 2015214 1907
AFDLOT
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE CHICAGO/ROMEOVILLE IL
207 PM CDT SUN AUG 2 2015
.MESOSCALE DISCUSSION...
203 PM CDT
CURRENTLY SEVERE THUNDERSTORM WARNED STORM IN DEKALB COUNTY HAD REPORTS OF QUARTER SIZED HAIL. THE ENVIRONMENT IT IS IN IS SUPPORTIVE FOR LOCALLY ENHANCED DOWNDRAFTS AND POTENTIALLY SEVERE WINDS. THIS STORM HAS A HISTORY OF BRIEF HEAVY RAIN AND STEADY HAIL FOR 5-7 MINUTES. IF IT HOLDS TOGETHER...IT WILL FOLLOW THE I-88/I-290 CORRIDOR REACH THE LAKEFRONT BY 300 PM.
KMD
&&
.SHORT TERM...
151 PM CDT
.THROUGH TONIGHT...
A FEW ISOLATED SHOWERS/STORMS ARE WORKING THERE WAY EASTWARD ACROSS THE AREA. THESE STORMS ARE HOLDING TOGETHER TO SOME DEGREE AS INSTABILITY IS FAVORABLE. THE STORM IN DEKALB COUNTY HAS PRODUCED SOME HAIL OF NICKEL TO QUARTER SIZE. THIS STORM WILL CONTINUE TO PROPAGATE SOUTHEASTWARD ALONG THE INTERSTATE 88 CORRIDOR. SHEAR IS WEAKER CLOSER TO THE LAKE...SO A DOWNWARD TREND IS POSSIBLE...BUT IT WILL LIKELY HOLD ITS OWN FOR A BIT LONGER. THERE IS QUITE A BIT OF INTER-CLOUD LIGHTNING WITH THIS STORM...WITH OCCASIONAL/FREQUENT CLOUD TO GROUND LIGHTNING AS WELL. WE DO STILL EXPECT AFTERNOON ACTIVITY TO REMAIN ISOLATED AS WATER VAPOR IMAGERY SUGGESTS THE BETTER SHORTWAVE ENERGY IS PASSING THROUGH CENTRAL ILLINOIS...AND EVEN MORE SO ACROSS WISCONSIN. STILL...WEAK ENERGY IN THE NORTHWEST FLOW PATTERN KEEPS THE ISOLATED/WIDELY SCATTERED STORM CHANCE IN PLACE IN AN UNCAPPED ATMOSPHERE. SHEAR IS STILL LOW THIS AFTERNOON...SO THE SEVERE THREAT AT LEAST THROUGH MID AFTERNOON APPEARS ON THE LOW SIDE...THOUGH THESE STORMS COULD LOCALLY ENHANCE THE ALREADY SYNOPTICALLY MODEST WIND FIELD AND MAY HAVE SOME MARGINALLY SEVERE HAIL. FOR THE REST OF THE AREA...JUST WARM AND BREEZY CONDITIONS REMAIN IN PLACE ACROSS THE AREA AND READINGS IN UPPER 80S/LOW 90S. AFTERNOON MIXING IS KEEPING DEWPOINTS FROM GETTING OUT OF THE LOW TO MID 60S...EXCEPT IN FAVORED OUTLYING AREAS WHERE AIDED EVAPOTRANSPIRATION LOCALLY ENHANCES THE MOISTURE READINGS. MORE ORGANIZED THUNDERSTORMS ARE EXPECTED TO SPREAD SOUTH AND EASTWARD TOWARD THE AREA AHEAD OF BETTER HEIGHT FALLS AND A MODEST COLD FRONT. STILL SOME CONCERNS OVER HOW WIDESPREAD THE CONVECTIVE COVERAGE WILL BE THIS EVENING. BEST FORCING IS TIED TO THE COLD FRONT WHICH WILL BE COMING THROUGH THE AREA JUST AFTER PEAK HEATING TIME. FOR STORMS THAT DO FORM...AMPLE SHEAR AND INSTABILITY WILL BE PRESENT FOR STORMS TO QUICKLY BECOME SEVERE...AND OUTFLOW BOUNDARIES FROM STORMS TO OUR NORTH COUPLED WITH THE COLD FRONTAL PUSH WILL COMPLICATE MATTERS. AIDED CONVERGENCE/LIFT CAN POTENTIALLY BE ENHANCED CLOSER TO THE LAKE WHERE ADDITIONAL MOMENTUM MAY KEEP THE HIGHER CHANCES FOR STORMS NORTH AND EAST CLOSER TO THE LAKE...AND POTENTIALLY IN OUR SOUTHWEST ZONES WHERE DEWPOINTS/INSTABILITY MAY BE A LITTLE HIGHER.

CONVECTIVE ALLOWING MODELS PAINTING QUITE A RANGE OF SOLUTIONS FROM A FORWARD PROPAGATING MCS IN OUR SOUTHWEST AREAS AND VERY LITTLE CLOSER TO CHICAGO...WITH ALTERNATE SOLUTIONS SUGGESTING THE FORMER SCENARIO WITH LAKE ADJACENT COUNTIES FAVORED. THE COLD FRONT WILL PUSH SOUTHEASTWARD THROUGH THE AREA TONIGHT...WITH THUNDERSTORMS EXITING TO THE SOUTHEAST.
KMD
&&
.AVIATION...
//ORD AND MDW CONCERNS...UPDATED 18Z...
** GUSTY SOUTHWEST WINDS TO AROUND 30 KT AT TIMES THIS AFTERNOON INTO THE EVENING.*
** THUNDERSTORM CHANCES INCREASING THIS EVENING...ESPECIALLY AFTER 00Z.*
BMD

5.0 Upper Air Data

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Lincoln (KILX), Illinois, forecast office site, number 74560, located approximately 128 miles south-southwest of the accident site at an elevation of 584 feet. The 1900 CDT (0000Z on August 3, 2015) sounding from the surface to 500-hPa or 18,000 feet was plotted on a standard Skew-T log P diagram[3] utilizing RAOB[4] software is included as figure 7.

The sounding depicted warm and relatively dry low-level environment with the relative humidity of approximately 50% at the surface, which resulted in the lifted condensation level (LCL)[5] at 4,600 feet agl, and the level of free convection (LFC)[6] and convective condensation level (CCL)[7] at 7,560 feet agl. The equilibrium level (EL)[8] or expected top of convective clouds was at 40,000 feet with the tropopause at identified at approximately 48,600 feet. The freezing level was identified at approximately 13,200 feet.

[3] 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.

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

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

[6] Level of Free Convection (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.

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

[8] Equilibrium Level (EL) - On a sounding, the level above the level of free convection (LFC) at which the temperature of a rising air parcel again equals the temperature of the environment. The height of the EL is the height at which thunderstorm updrafts no longer accelerate upward. Thus, to a close approximation, it represents the height of expected (or ongoing) thunderstorm tops. However, strong updrafts will continue to rise past the EL before stopping, resulting in storm tops that are higher than the EL. This process sometimes can be seen visually as an overshooting tops or anvil dome. The EL typically is higher than the tropopause, and is a more accurate reference for storm tops.

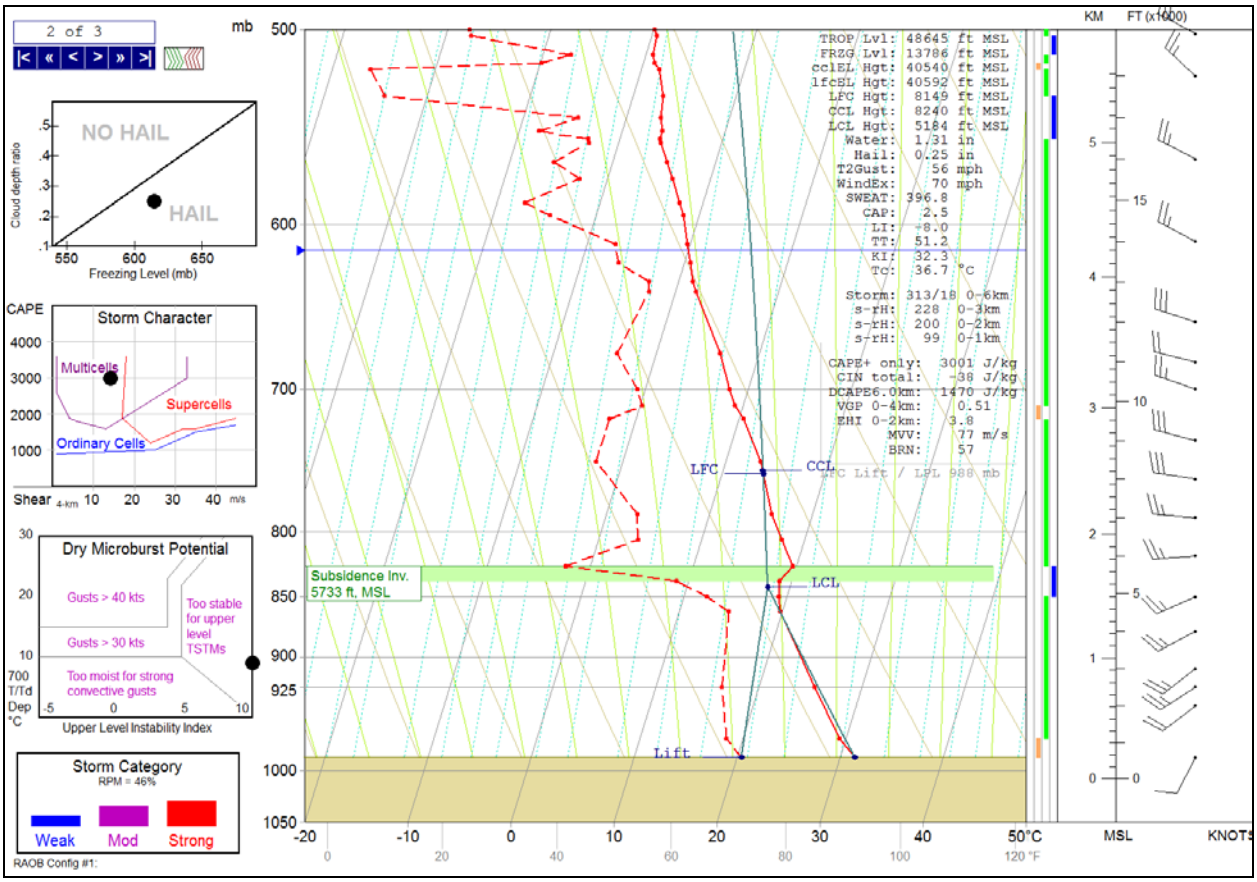

Figure 7 – Lincoln 1900 CDT upper air sounding

The stability parameters indicated a Lifted Index (LI)[9] of -8.0, a K-Index[10] of 32.3, and a Convective Available Potential Energy (CAPE)[11] of 3,001 Joules/kilogram (J/kg). The maximum vertical velocity of the potential updrafts was 77 meters/second (m/s) or 144 knots. The sounding also indicated a hail potential of 1/4 inch and a precipitable water value of 1.31 inches. The microburst index or WINDEX indicated potential outflow of 60 knots. The Bulk

[9] Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

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

[11] Convective Available Potential Energy (CAPE) – is a measure of the amount of energy available for convection. CAPE is directly related to the maximum potential vertical speed within an updraft; thus, higher values indicate greater potential for severe weather.

Richardson Number (BRN)[12] was 57.0 and the BRN Shear value was 53.0 (m^2/s^2). The sounding generally depicted a moderate to strong potential for severe multicellular type thunderstorms.

The sounding wind profile indicated a surface wind from the south-southwest or from 200° at 7 knots, with winds veering to the west and northwest with height with increasing wind speeds above 20 knots at 2,000 feet. The mean 0 to 6 kilometer or 18,000 feet wind was from 280° at 23 knots. The level of maximum wind was identified immediately below the tropopause at 40,000 feet with a wind from 290° at 75 knots.

6.0 Aircraft Sounding

A search of the NOAA Earth System Research Laboratory/Global Systems Division (ESRL/GSD) website (http://amdar.noaa.gov/) for Aircraft Meteorological Data Reports (AMDAR) provided upper air data closer to the time of the accident from an aircraft identified as #11275, which landed at Midway Airport at 1545 CDT (2045Z). Figure 8 is the aircraft descent sounding indicated a similar wind profile as the Lincoln sounding, and indicated a Lifted Index of -6.0, and a K-index of 36 at that time, still supporting a moderate to high risk of strong to severe thunderstorms.

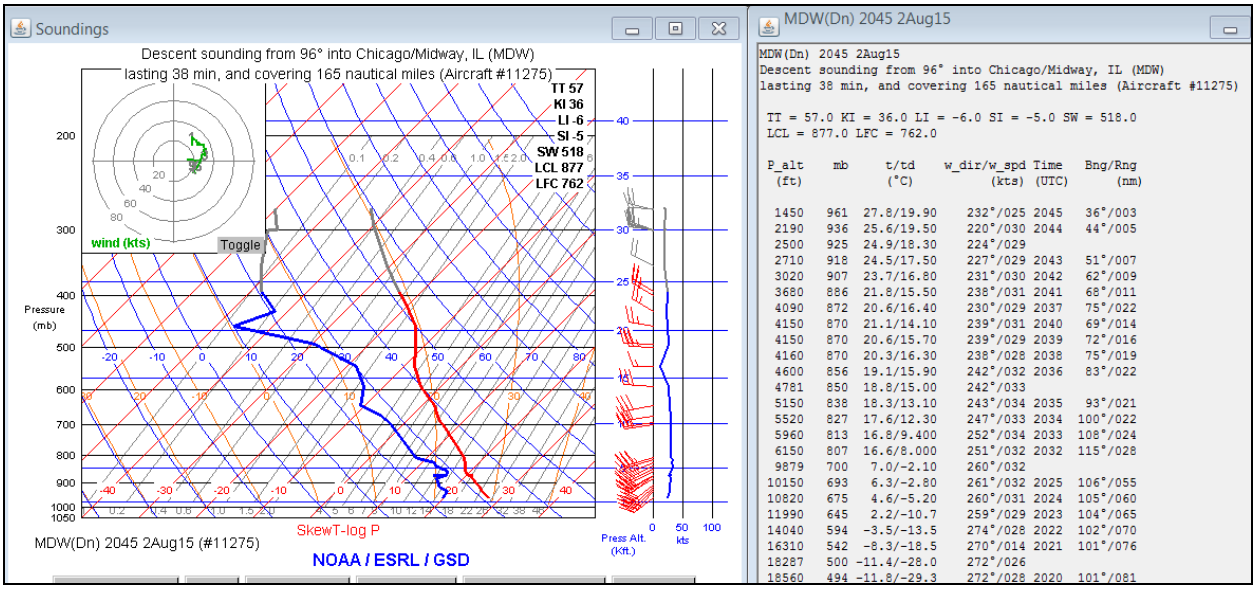

Figure 8 - AMDAR sounding from aircraft # 11275 landing at Midway at 1545 CDT

[12] Bulk Richardson Number (BRN) - is the ratio of the buoyancy (CAPE) of a lifted parcel to the vertical wind shear of the environment in which the parcel is lifted. It correlates well with observed storm type (single, multicellular, and supercells), especially for CAPEs between 1500 and 3000 J/kg. BRN's less than 45 tend to support supercell structures, with multicellular convection favored over 45. While the BRN has shown some value as a predictor of storm type, it is a poor predictor of storm rotation.

7.0 Satellite Data

The Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison (UW) in Madison, Wisconsin, and processed using the Safety Board's Man-computer Interactive Data Access System (McIDAS) software. Both the infrared long wave and visible band imagery were obtained surrounding the time of the accident. The infrared long wave imagery (band 4) at a wavelength of 10.7 microns (μm) provided standard satellite image with radiative cloud top temperatures with a resolution of 4 km. The visible imagery (band 1) at a wavelength of 0.65 μm provided a resolution of 1 km.

Figure 9 is the GOES-13 infrared image at 1430 CDT at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops associated with high cirriform clouds and deep convection, as well as the frontal positions from the 1300 CDT surface analysis. The image depicted an extensive area of cumulonimbus clouds along and north of the warm front over Wisconsin and Michigan, with several small but defined cumulonimbus clouds along the cold front over central Wisconsin and over northern Illinois approaching the Chicago area. The radiative cloud top temperature over the Chicago O'Hare International Airport was 224° Kelvin or -49.16° C, which corresponded to cloud tops near 37,000 feet based on the upper air sounding.

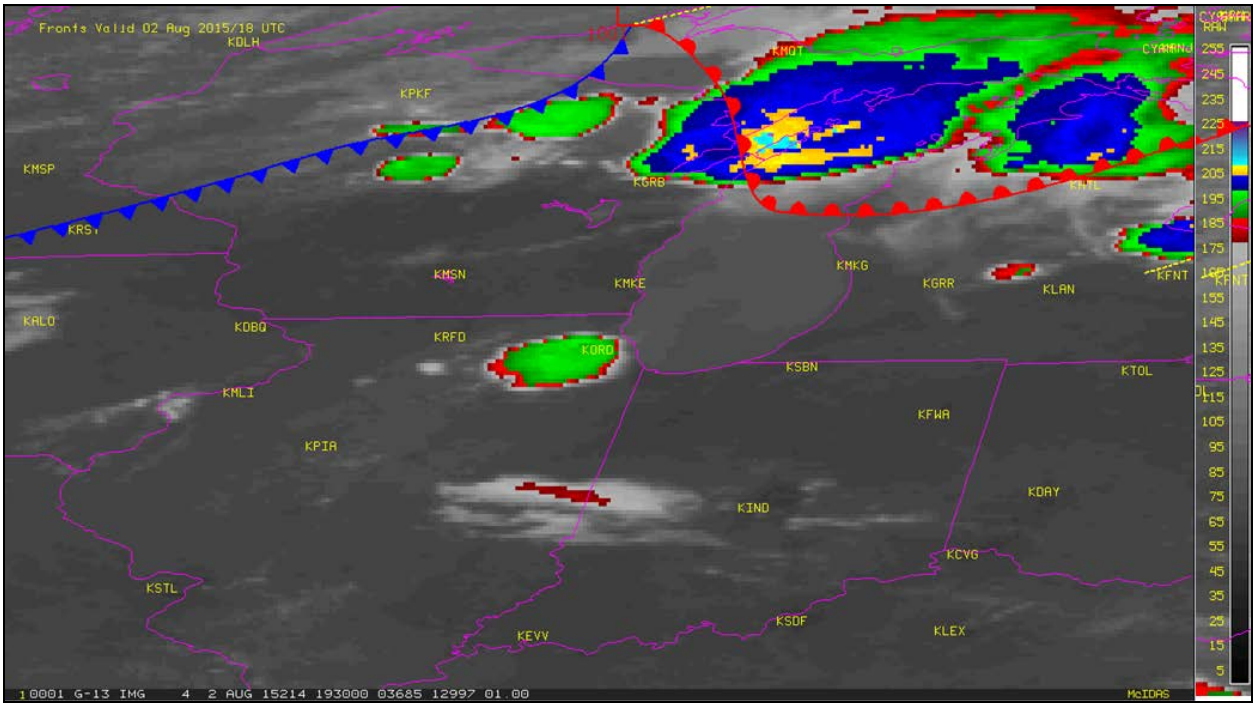

Figure 9 - GOES-13 infrared image at 1430 CDT with the frontal positions overlaid

Figure 10 is the GOES-13 visible image at 2X magnification for the same time period of 1430 CDT and depicts a large cumulonimbus cloud system approaching the Chicago area from the west.

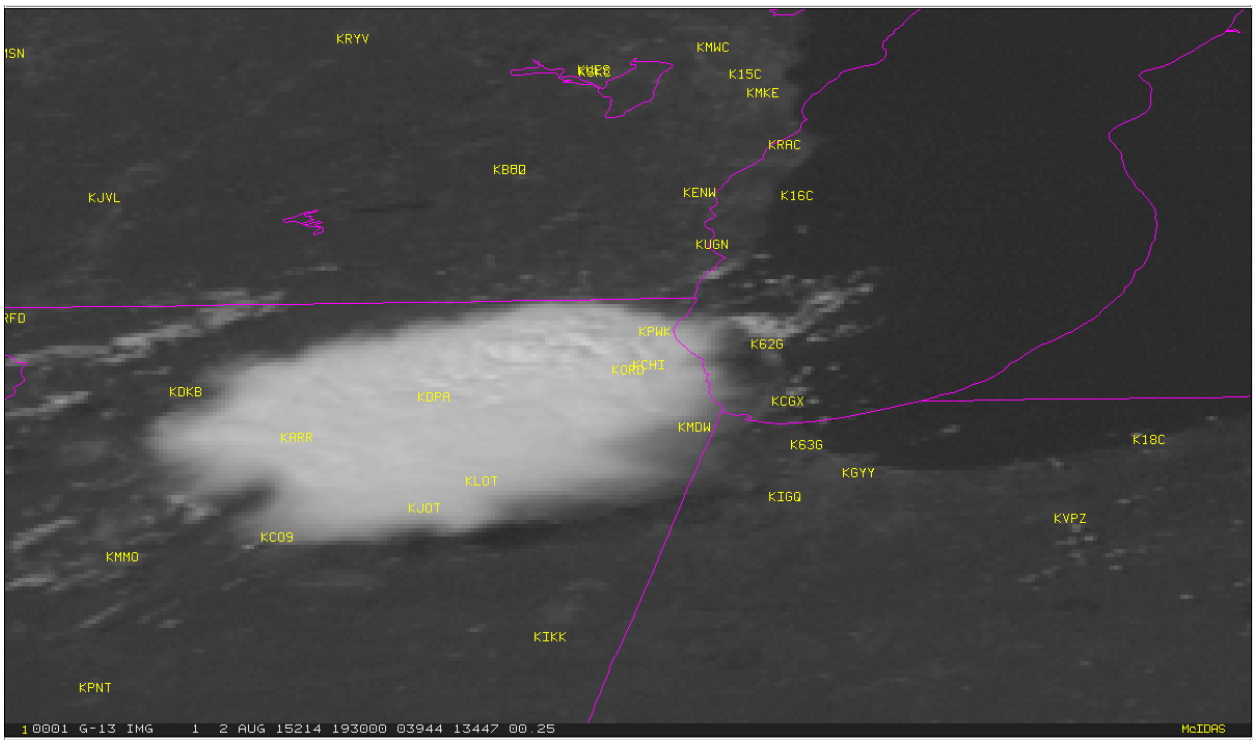

Figure 10 - GOES-13 visible image at 1430 CDT at 2X magnification

8.0 Weather Radar Information

There were two nearby weather radar sites close to the accident site, which were used to document the conditions impacting the area during the period. The FAA Chicago Terminal Doppler Weather Radar (TDWR) located 12 miles south-southwest of the airport and the NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) 24 miles south-southwest located at the Chicago WFO (KLOT), located in Romeville, Illinois. The level II and III archive data was obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

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. The TDWR is a C-band 5 centimeter wavelength radar with a 25-foot diameter radar antenna, but has twice the resolution of the WSR-88D. The TDWR due to it's shorter wavelength is affected by attenuation and is only designed for short range airport observing, with an update rate of 1 to 5 minutes.

8.1 Volume Scan Strategy

The WSR-88D is a computer controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP).

Products that require data from multiple elevation scans are not available until the end of the six minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is the non-severe convective mode where the radar makes 9 elevation scans from 0.50° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). 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 KLOT WSR-88D radar was operating in the precipitation mode VCP-212 where the radar makes 14 different elevation scans in 4 ½ minutes. This mode is typically used by the NWS during periods when rapidly evolving wide spread severe convection is expected, and allows for improved low-level vertical resolution of the storms. 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.

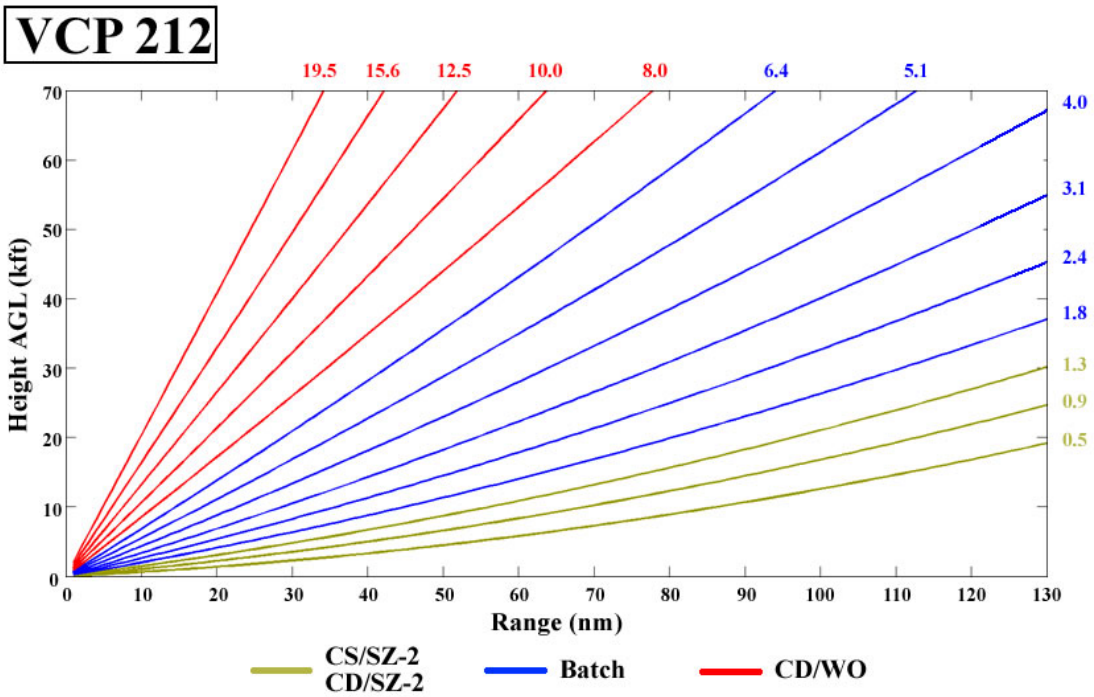

Figure 11- VCP-212 scanning mode

8.2 Beam Height Calculation

Assuming standard refraction[13] of the 0.95° radar beam of the KLOT WSR-88D with an antenna height of 760 feet and a distance of 24 miles from the radar, the following table shows the approximate beam height and width information of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

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

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	2,410 feet	1,200 feet	3,620 feet	2,420 feet

8.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[14] it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ[15]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE

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

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

[15] dBZ - 10 log Ze

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

(a) "Light"	(< 30 dBZ, NWS VIP level 1)
(b) "Moderate"	(30 to 40 dBZ, NWS VIP level 2)
(c) "Heavy"	(> 40 to 50 dBZ, NWS VIP level 3 and 4)
(d) "Extreme"	(> 50 dBZ, NWS VIP level 5 and 6)

8.4 Base Reflectivity

Figures 12 through 15 are the Chicago (KLOT) WSR-88D 0.5° base reflectivity image at 1432, 1437, 1442, and 1447 CDT respectively. The images depict a large area of extreme intensity echoes moving eastward across the area with little to no change change in intensity during the period. The images begin with the area of intense echoes immediately west of Chicago O'Hare International Airport (KORD) at 1432 CDT having already passed over DuPage Airport (KDPA), and move the KORD between 1437 and 1447 CDT with maximum echo intensity near 65 dBZ.

Figure 16 is a close up of the KLOT WSR-88D 0.5 base reflectivity image for 1442 CDT with a 30% transparency of the surface features and depicting the Chicago-O'Hare International Airport under the strong reflectivity center and the 65 dBZ core immediately west of the accident location.

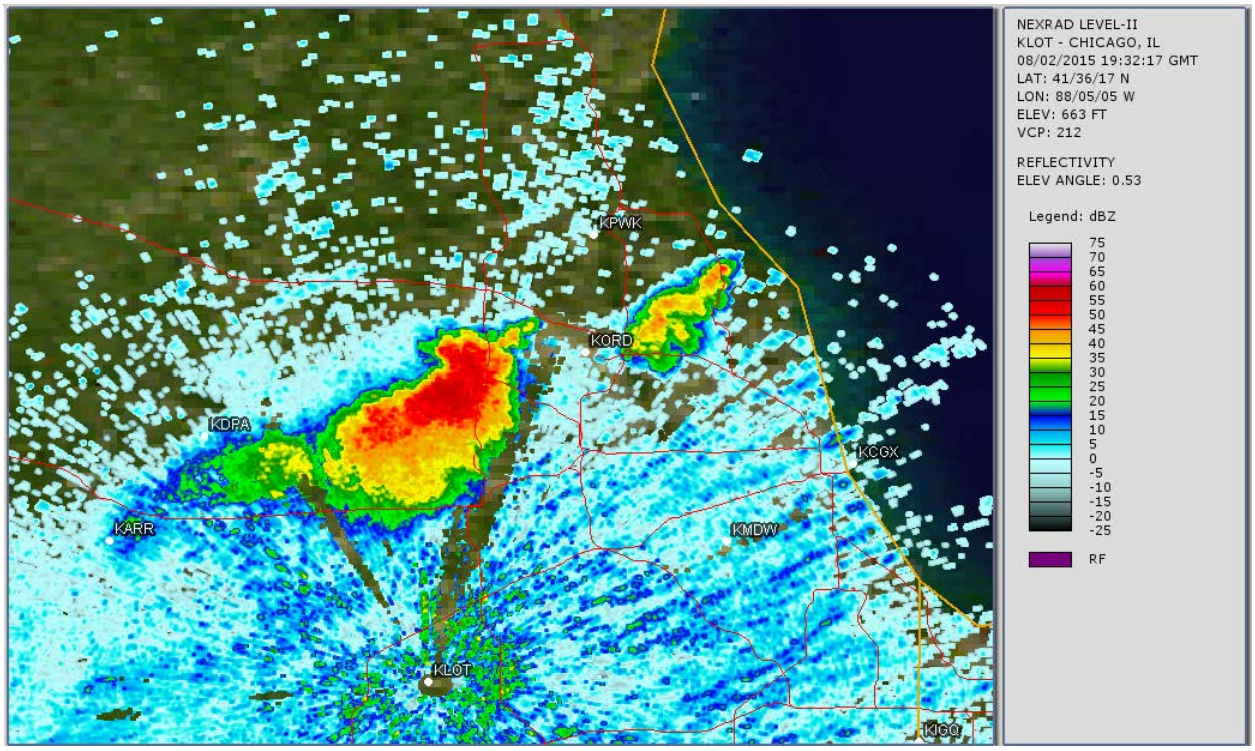

Figure 12 - Chicago WSR-88D 0.5° base reflectivity image for 1432 CDT

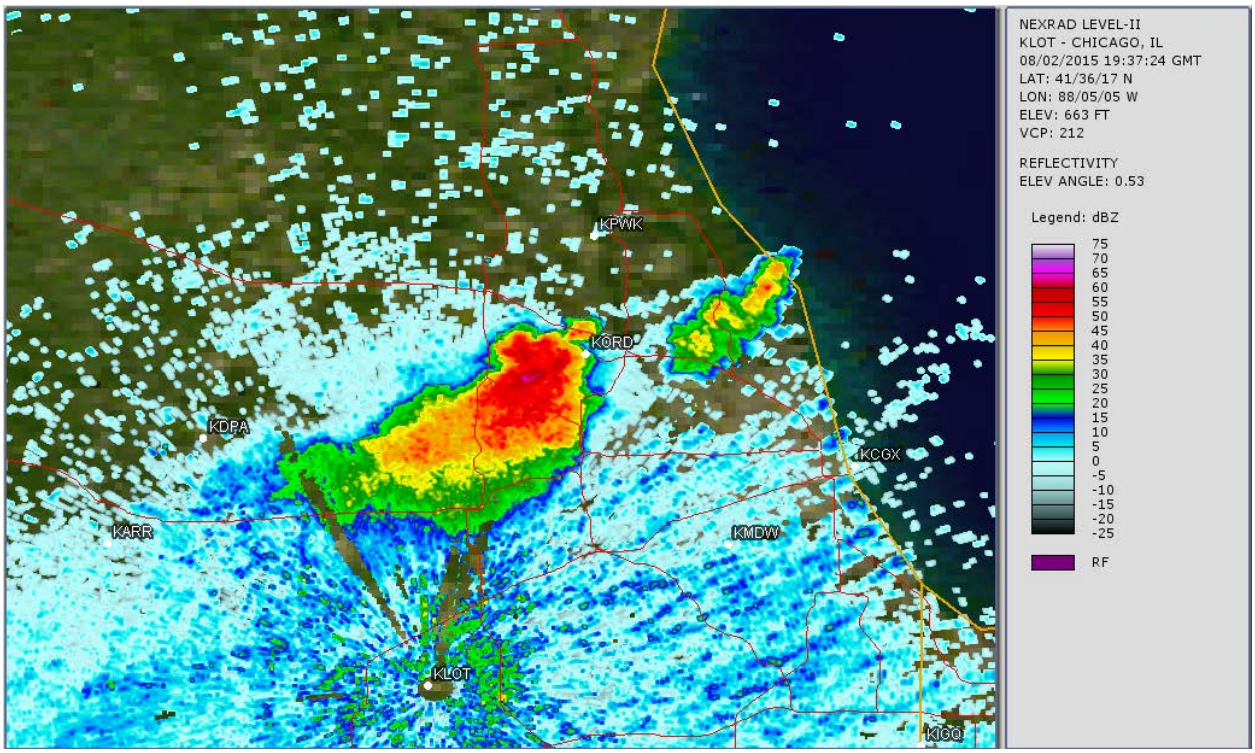

Figure 13 - KLOT WSR-88D 0.5° base reflectivity image at 1437 CDT

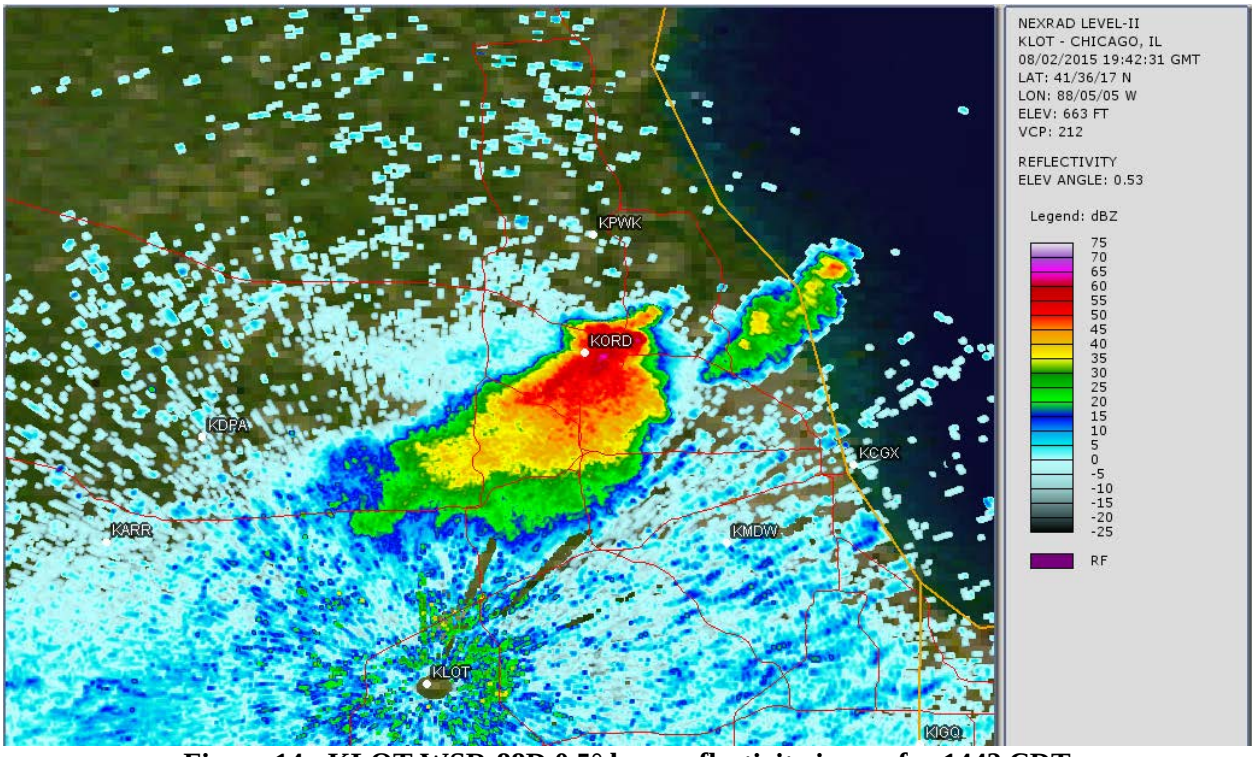

Figure 14 - KLOT WSR-88D 0.5° base reflectivity image for 1442 CDT

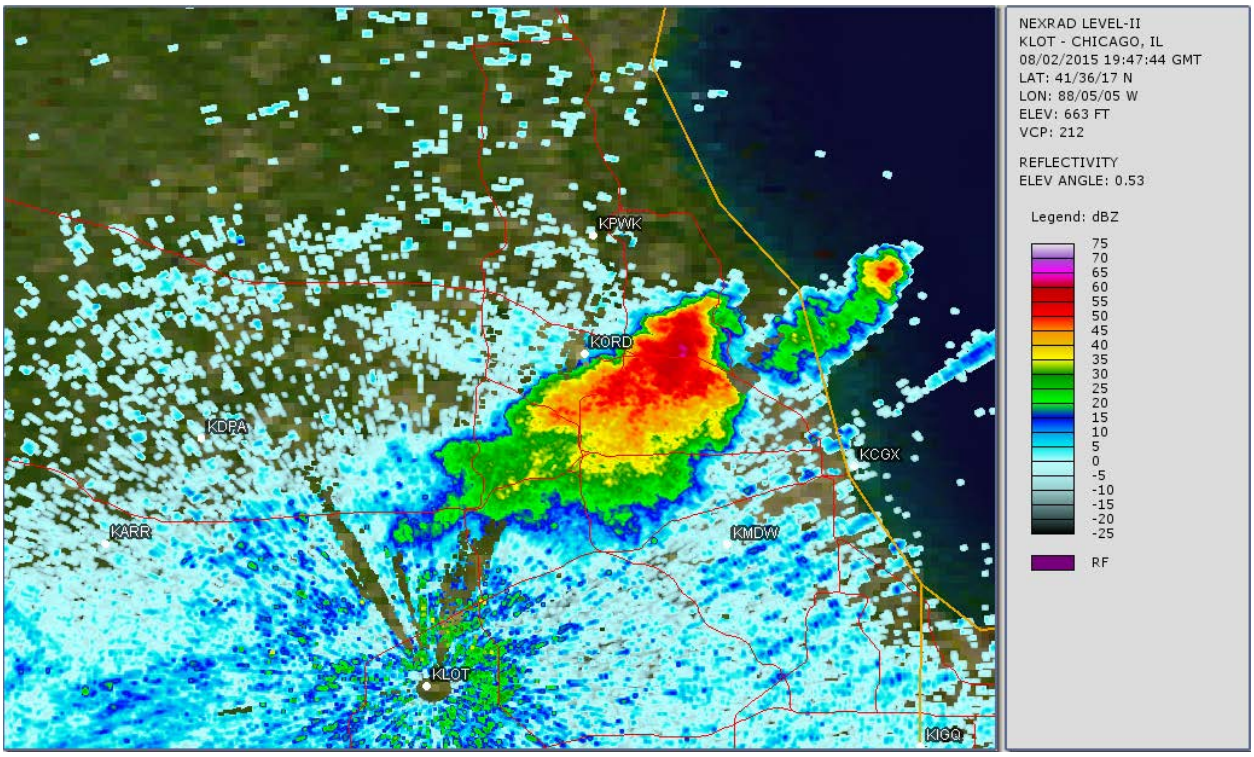

Figure 15 - KLOT WSR-88D 0.5° base reflectivity image at 1447 CDT

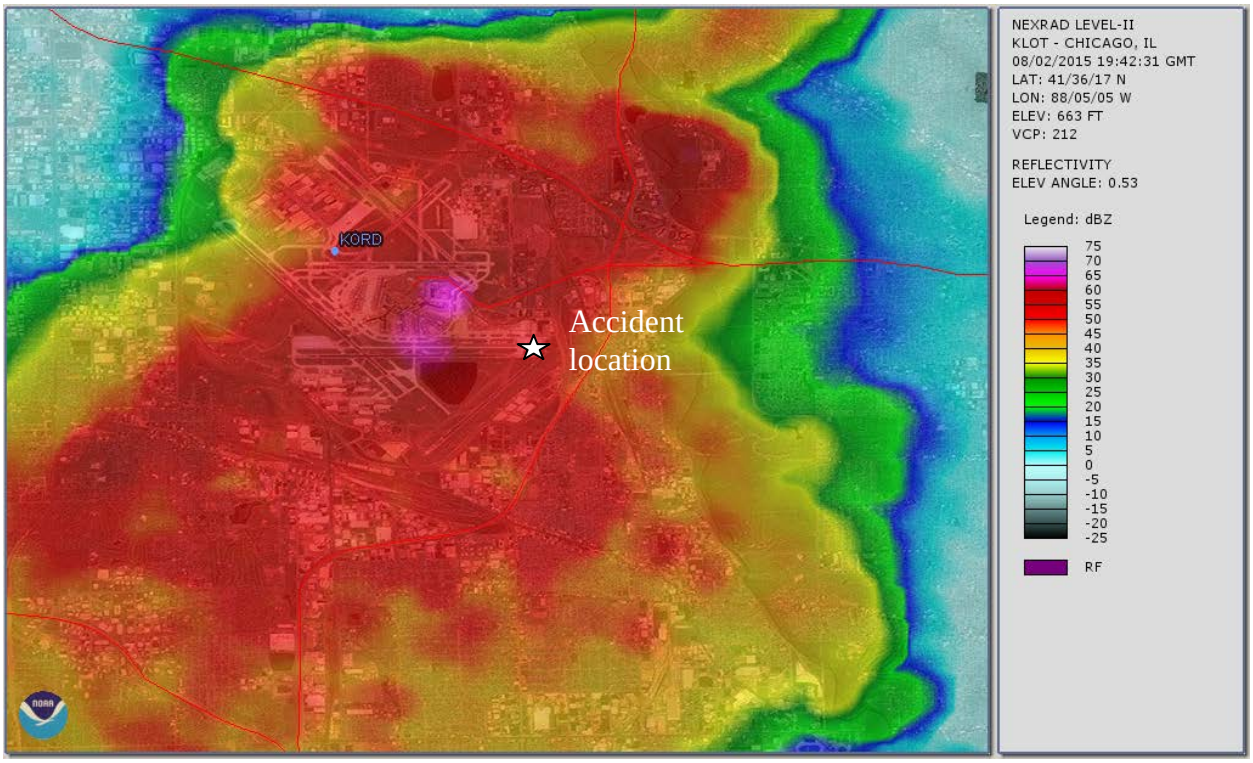

Figure 16 - KLOT WSR-88D 0.5° base reflectivity close-up at 1442 CDT

8.5 Chicago Terminal Doppler Weather Radar Imagery

Figures 17 through 19 are the Chicago O'Hare (KORD) Terminal Doppler Weather Radar (TDWR) at 1436, 1438, and 1447 CDT respectively, which were documented surrounding the period to help identify the echoes. No images were available between 1440 and 1445 CDT for unknown reasons.

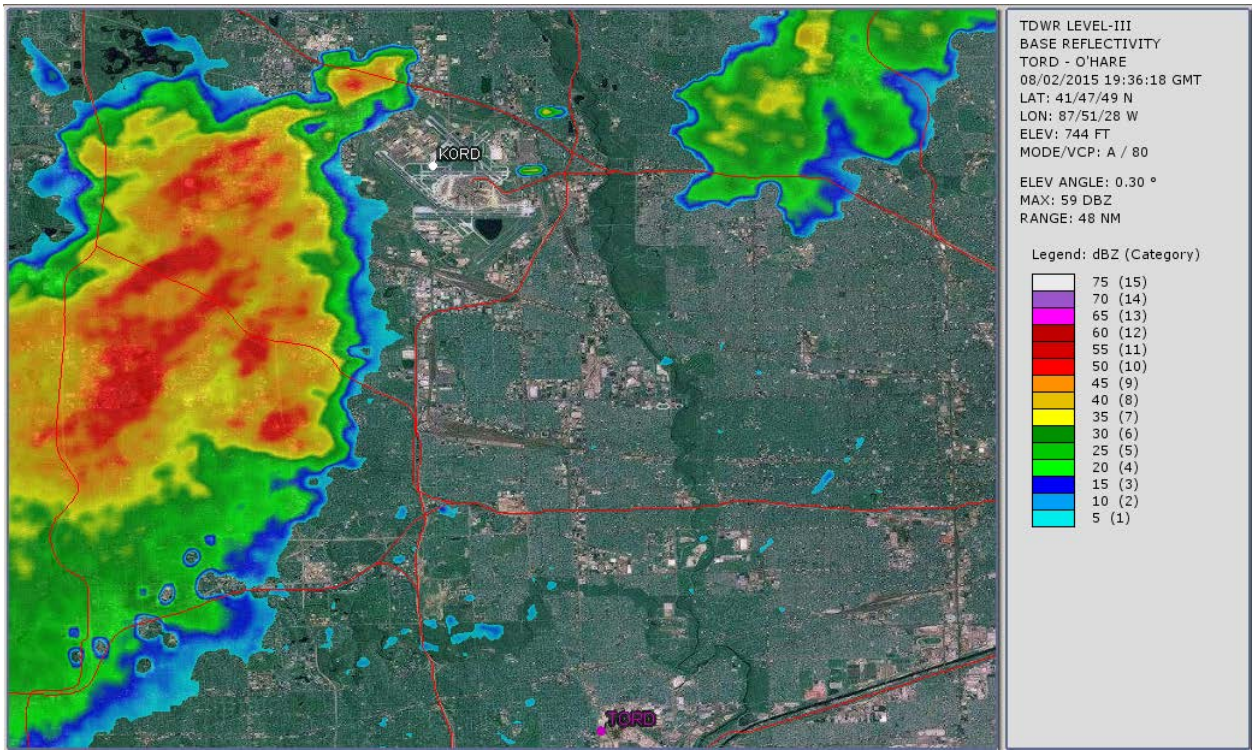

Figure 17 - KORD TDWR 0.3° base reflectivity image at 1436 CDT.

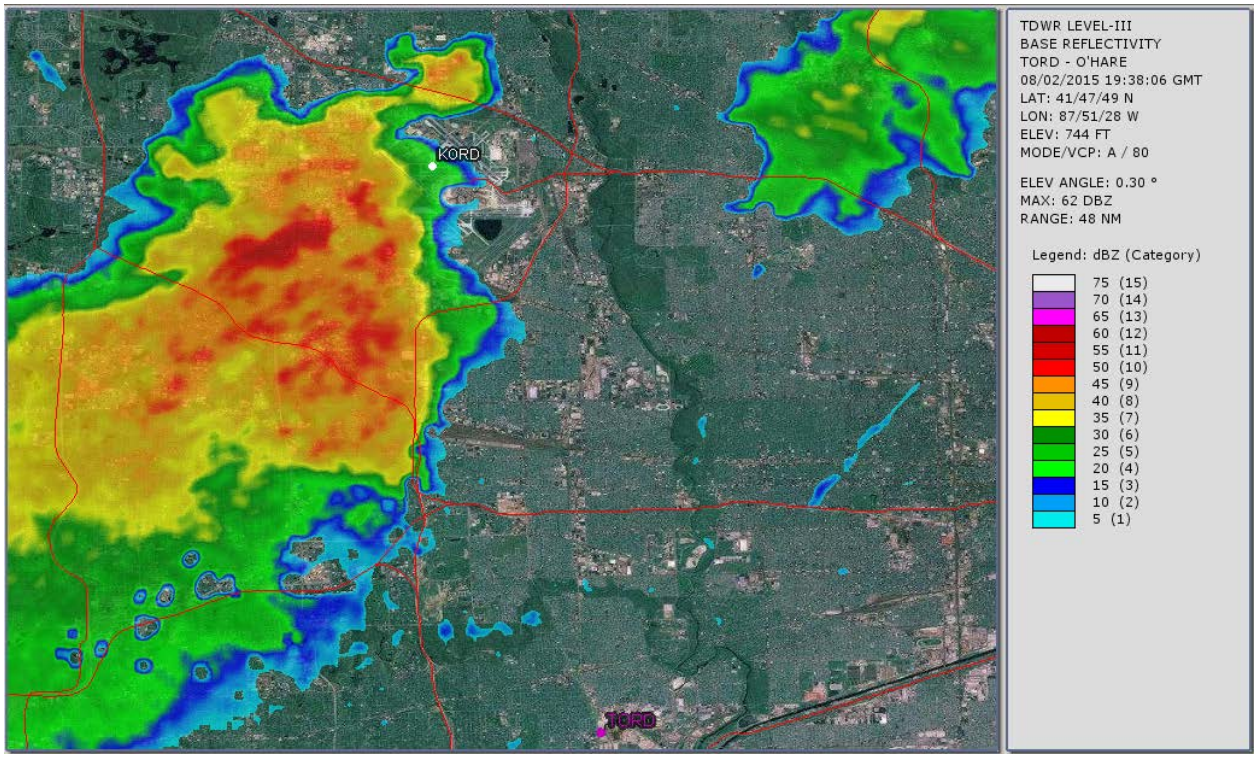

Figure 18 - KORD TDWR 0.3° base reflectivity image at 1438 CDT

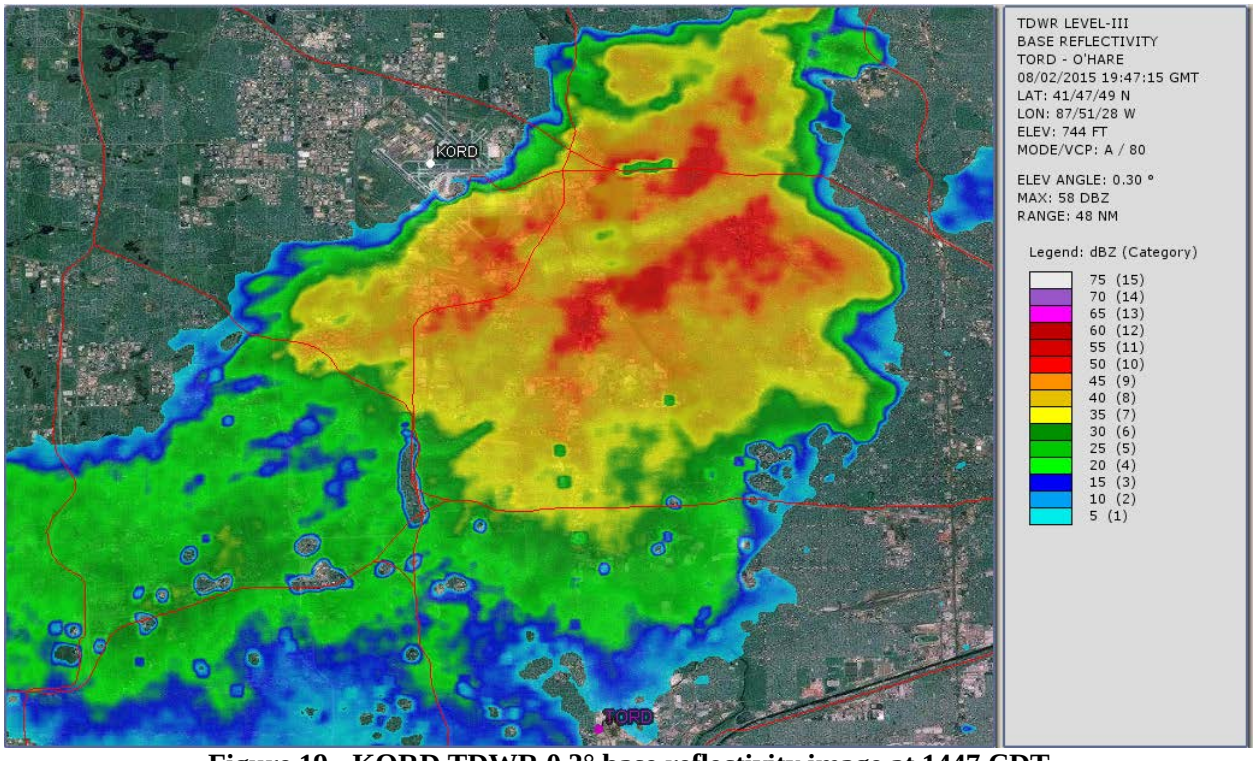

Figure 19 - KORD TDWR 0.3° base reflectivity image at 1447 CDT

9.0 Pilot Reports

The following pilot reports (PIREPs) were recorded over Illinois surrounding the period. The reports are as follows:

MDW UUA /OV MDW /TM 1705 /FLUNKN /TP B737 /RM LLWS +/-10KT BLO 035 NMRS B737 ACFT=

UGN UA /OV PWK315018/TM 1905/FL025/TP C150/TB LGT-MOD

SPI UA /OV SPI300020/TM 1935/FL300/TP MD90/TB LGT CHOP=

10.0 Area Forecast

The NWS Area Forecast issued by the Aviation Weather Center at 1345 CDT and valid through 0200 CDT on August 3, 2015 is included below.

FAUS43 KKCI 021845
FA3W
-CHIC FA 021845
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 031300
CLDS/WX VALID UNTIL 030700...OTLK VALID 030700-031300
ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...19Z HI PRES RDG SRN SASK-SW MN. CDFNT FM LOW PRES NR EAU-NW IA-SRN SD-CNTRL MT. WRMFNT EAU-NW IL-SCNTRL IL. TROF SE IA-SCNTRL NE-NERN CO. HI PRES RDG SRN WV-SRN AR. 13Z HI PRES CNTRD OVR SCNTRL ND. CDFNT SRN LH-SW LWR MI-NW IN-STL-SE KS-NW KS. TROF FM LOW PRES 50W LBL-ELP.
.
…
IL IN
NRN IL/NRN IN...SCT050 SCT120. ISOL -SHRA/-TSRA. CB TOP FL400. WND SW G25-30KT. 00Z BKN060. WDLY SCT TSRA POSS SEV. CB TOP FL450. 06Z BKN030. OTLK...MVFR CIG.
CNTRL IL...BKN080 TOP 150. ISOL -TSRA. CB TOP FL450. 04Z BKN045 BKN080 TOP FL250. SCT TSRA POSS SEV. CB TOP FL450. OTLK...VFR.
SRN IL/SRN IN...SKC. OTLK...VFR 09Z TSRA SHRA.
CNTRL IN...SKC. 04Z BKN050 TOP FL200. WDLY SCT -TSRA. CB TOP FL450. OTLK...VFR TSRA.
SRN IL/SRN IN...SKC. OTLK...VFR 10Z TSRA.
.
MN IA
NW MN...BKN060 TOP 080. 21Z SCT060. 00Z SKC. OTLK...VFR.
SW MN/NW IA...SCT060. OCNL FU ALF. 21Z SCT060. ISOL -TSRA. CB TOP FL400. 00Z SKC. OTLK...VFR.
NERN MN...BKN050 OVC080 TOP 120. WDLY SCT -SHRA TOP FL250. 23Z SCT060. WND NW G25KT. 03Z SKC. OTLK...VFR.
SE MN/NERN IA...SCT050. WND SW G25KT. 20Z ISOL -TSRA POSS SEV. CB TOP FL450. WND W G25-30KT. BECMG 0103 SKC. OTLK...VFR.
SW IA...SKC. 22Z SCT060 SCT120. ISOL -TSRA. CB TOP FL450. WND SW G25KT. 00Z BKN060 BKN120 TOP 160. WDLY SCT -TSRA. 03Z SCT050. OTLK...VFR.
SE IA...SKC. 03Z BKN050 BKN120 TOP FL200. WDLY SCT TSRA POSS SEV. CB TOP FL450. OTLK...VFR.
.

The forecast for northern Illinois and Indiana expected scattered clouds at 5,000 feet, and scattered clouds at 12,000 feet with a chance of isolated light rain showers and thunderstorms, with cumulonimbus cloud tops to 40,000 feet. The winds were expected to be from the southwest gusting to 25 to 30 knots. After 0100 CDT on August 3, 2015, the forecast expected a broken clouds at 6,000 feet with widely scattered thunderstorms and moderate rain with storms possible severe thunderstorms, with cumulonimbus cloud tops to 45,000 feet.

11.0 In-Flight Weather Advisories

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

Convective SIGMETs (WST) – the NWS issues the following advisories at 1255 and 1358 CDT for thunderstorms across the region. Convective SIGMET 69C was issued specifically for the area of weather that impacted the Chicago area, and is depicted in figure 20.

WSUS32 KKCI 021755 2015214 1747
SIGC
-MKCC WST 021755
CONVECTIVE SIGMET 67C
VALID UNTIL 1955Z
MI WI LM
FROM 50NNE RHI-60E SAW-20S TVC-30SW RHI-50NNE RHI
AREA SEV TS MOV FROM 28040KT. TOPS ABV FL450.
HAIL TO 2 IN...WIND GUSTS TO 50KT POSS.
.

WSUS32 KKCI 021858 2015214 1859
SIGC
-MKCC WST 021858
CONVECTIVE SIGMET 69C
VALID UNTIL 2055Z
IL
FROM 10W ORD-40NNW BDF
LINE TS 20 NM WIDE MOV FROM 28035KT. TOPS ABV FL450.
HAIL TO 1 IN...WIND GUSTS TO 50KT POSS.

...SPECIAL...
CONVECTIVE SIGMET 68C
VALID UNTIL 2055Z
MI WI LM
FROM 50NNE RHI-60E SAW-20S TVC-30SW RHI-50NNE RHI
AREA SEV TS MOV FROM 28040KT. TOPS ABV FL450.
HAIL TO 2 IN...WIND GUSTS TO 50KT POSS.
.

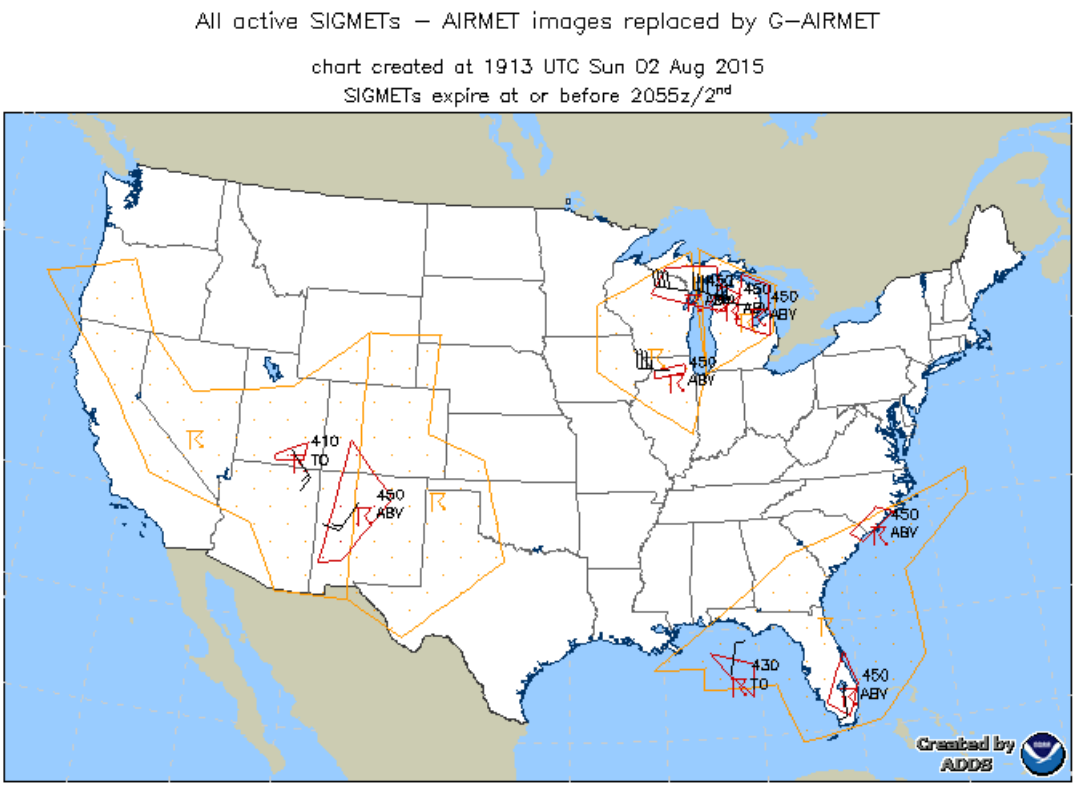

Figure 20 - Convective SIGMETs current for the period

Center Weather Advisories (CWA) – The Chicago Center Weather Service Unit (CWSU) issued the following advisories during the period.

FAUS21 KZAU 021802 *2015214 1802*
ZAU1 CWA 021802
ZAU CWA 101 VALID UNTIL 021900
FROM 51SSE BDF-36NNE AXC-3S AXC-25W AXC-51SSE BDF
AREA OF TS. TOPS FL300-FL420. MV FROM 27020KT. CONDS CONT AFT 19Z.
=

FAUS22 KZAU 021811 *2015214 1812*
ZAU2 CWA 021811
ZAU CWA 201 VALID UNTIL 021910
FROM 58W ORD-23WNW JOT-40SSE DBQ-58W ORD
AREA OF DEVELOPING SCT SHRA AND TS. TOPS FL250-FL400. MV FROM 27020KT. CONDS CONT AT 1910Z.
=

FAUS22 KZAU 021856 *2015214 1856*
ZAU2 CWA 021856
ZAU CWA 202 VALID UNTIL 021950
FROM 25N JOT-25E JOT-38NW BDF-48SE DBQ-25N JOT
AREA OF SCT SHRA AND TS. TOPS FL250-FL450. MV FROM 28030KT. CONDS CONT AFT 1950Z
=

FAUS22 KZAU 021926 *2015214 1927*
ZAU2 CWA 021926
ZAU CWA 203 VALID UNTIL 022005
FROM 8NE ORD-23SE ORD-22NW JOT-8NE ORD
AREA OF TS. TOPS FL300-FL500. MV FROM 27025KT. CONDS CONT AFTER 2005Z.
=

AIRMETs

WAUS43 KKCI 021445 *2015214 1432*
WA3S
-CHIS WA 021445
AIRMET SIERRA UPDT 2 FOR IFR VALID UNTIL 022100
.
NO SGFNT IFR EXP OUTSIDE OF CNVTV ACT.
....

WAUS43 KKCI 021445 *2015214 1437*
WA3T
-CHIT WA 021445
AIRMET TANGO UPDT 2 FOR TURB VALID UNTIL 022100
.
AIRMET TURB...MN IA WI LM LS MI LH IL IN
FROM SSM TO YVV TO 30SE ECK TO FWA TO 40S BVT TO 50NNE UIN TO 60WSW FOD TO 50WNW RWF TO 60S RHI TO 40WNW TVC TO SSM
MOD TURB BLW 080. CONDS CONTG BYD 21Z THRU 03Z.
.
OTLK VALID 2100-0300Z
AREA 1...TURB MN IA MO WI LM LS MI LH IL IN
BOUNDED BY SSM-YVV-30SE ECK-FWA-40SW ROD-30WNW TTH-30WSW IRK-60SW DSM-50WNW MCW-40ESE MSP-20NNE EAU-40NNW TVC-SSM
MOD TURB BLW 080. CONDS CONTG THRU 03Z.
.
AREA 2...TURB WI LM LS MI LH
BOUNDED BY 50ESE YQT-SSM-YVV-20S DXO-30NNE BAE-80SW YQT-20S YQT-50ESE YQT
MOD TURB BTN FL280 AND FL390. CONDS DVLPG 21-00Z. CONDS CONTG THRU 03Z.
....

WAUS43 KKCI 021445 *2015214 1437*
WA3Z
-CHIZ WA 021445
AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 022100
.
AIRMET ICE...MN WI LM LS MI LH
FROM 20SSE YQT TO SSM TO YVV TO 20SSE ASP TO 20SW TVC TO 40NNE GRB TO 50NW RHI TO 80ESE INL TO 20SSE YQT
MOD ICE BTN 120 AND FL200. CONDS CONTG BYD 21Z THRU 03Z.
.
FRZLVL...RANGING FROM 095-165 ACRS AREA
....

12.0 Winds and Temperature Aloft Forecast

The following Winds and Temperature Aloft forecast was in effect at the time:

DATA BASED ON 021200Z
VALID 021800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
JOT	2429	2533+17	2628+10	2625+03	2920-12	3025-24	302940	302948	304255
DBQ	2422	2732+19	2731+12	2729+04	2930-11	3036-23	293339	303748	304956
SPI	2315	2517+17	2715+10	2817+03	3022-10	3035-22	295638	297146	307054
BRL	2419	2622+18	2724+11	2822+03	3022-11	3134-23	304539	295846	306554

13.0 NWS Storm Prediction Center Products

The narrative of the Convective Outlook issued at 1117 CDT which was issued with the graphic forecast in section 1.3 of this report was a sfollows:

ACUS01 KWNS 021617
SWODY1
SPC AC 021616

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
1116 AM CDT SUN AUG 02 2015

VALID 021630Z - 031200Z

...THERE IS AN ENH RISK OF SVR TSTMS OVER PARTS OF WI...LOWER MI...NORTHERN IL...NORTHERN IND...AND NORTHWEST OH...

...THERE IS A SLGT RISK OF SVR TSTMS OVER MUCH OF THE GREAT LAKES REGION...

...THERE IS A MRGL RISK OF SVR TSTMS FROM THE GREAT LAKES REGION INTO THE CENTRAL PLAINS...

...SUMMARY...
SEVERE STORMS ARE EXPECTED ACROSS THE GREAT LAKES REGION TODAY...POTENTIALLY AS FAR WEST AS EASTERN NEBRASKA. THIS MAY INCLUDE ONE OR TWO ORGANIZED STORM CLUSTERS CAPABLE OF GENERATING SWATHS OF DAMAGING WIND GUSTS...IN ADDITION TO SEVERE HAIL...AND PERHAPS A COUPLE OF TORNADOES FROM THE UPPER MISSISSIPPI VALLEY AREA TO LOWER MICHIGAN.

...GREAT LAKES REGION...
CURRENT FORECAST APPEARS TO BE ON TRACK WITH NO SIGNIFICANT CHANGES MADE TO OUTLOOK.

WATER VAPOR LOOPS SHOW A VIGOROUS SHORTWAVE TROUGH DIGGING SOUTHEASTWARD ACROSS MANITOBA AND WESTERN ONTARIO INTO MN. STRONG LIFT IN ADVANCE OF THIS TROUGH WILL HELP TO INITIATE AND ORGANIZE THUNDERSTORMS THIS AFTERNOON. SCATTERED /MOSTLY ELEVATED/ THUNDERSTORMS ARE ONGOING ACROSS MUCH OF NORTHERN WI/UPPER MI INTO NORTHERN LOWER MI. THESE STORMS WILL PERSIST THROUGH THE DAY...WITH A GRADUAL INTENSIFICATION EXPECTED BY MID AFTERNOON AS DIURNAL HEATING OCCURS. LARGE HAIL IS THE MAIN THREAT FOR NOW...BUT STORMS WILL EVENTUALLY BECOME SURFACE-BASED WITH AN INCREASING RISK OF DAMAGING WIND GUSTS OR EVEN A TORNADO OR TWO.

BY MID-LATE AFTERNOON...STORMS ARE EXPECTED TO CONGEAL INTO ONE OR MORE LINEAR MCS/S THAT WILL AFFECT MUCH OF WI AND LOWER MI BEFORE POTENTIALLY SPREADING INTO NORTHERN IL/IND/OH TONIGHT. MODEL SOLUTIONS DIFFER ON SOUTHERN EXTENT OF MORE WIDESPREAD SEVERE RISK...BUT WILL MAINTAIN POSITION OF ENH RISK AREA FOR NOW AND RE-EVALUATE IN LATER UPDATES.

14.0 Air Traffic Control – Weather Displays

The Massachusetts Institute of Technology (MIT) Lincoln Labs provided images of the Integrated Terminal Weather System (ITWS) displays surrounding the period. Figures 21 through 30 are the 1-minute displays from 1434 through 1450 CDT (1934Z-1950Z). The images include a 50 mile display of the radar with the range rings centered on Chicago O'Hare International Airport on the left, the arrival and departure gate winds in the tops center, the tower Ribbon Display Alerts (RDA) of runway arrival (A) or departure (D) winds in magnetic north and speed in knots in the center bottom, which will include the windshear and microburst alerts for the runways in use when applicable. The 100 miles range radar on the top right corner, and the 5 mile radar display with the runway displays on the bottom right, which will also show the windshear alerts when reported.

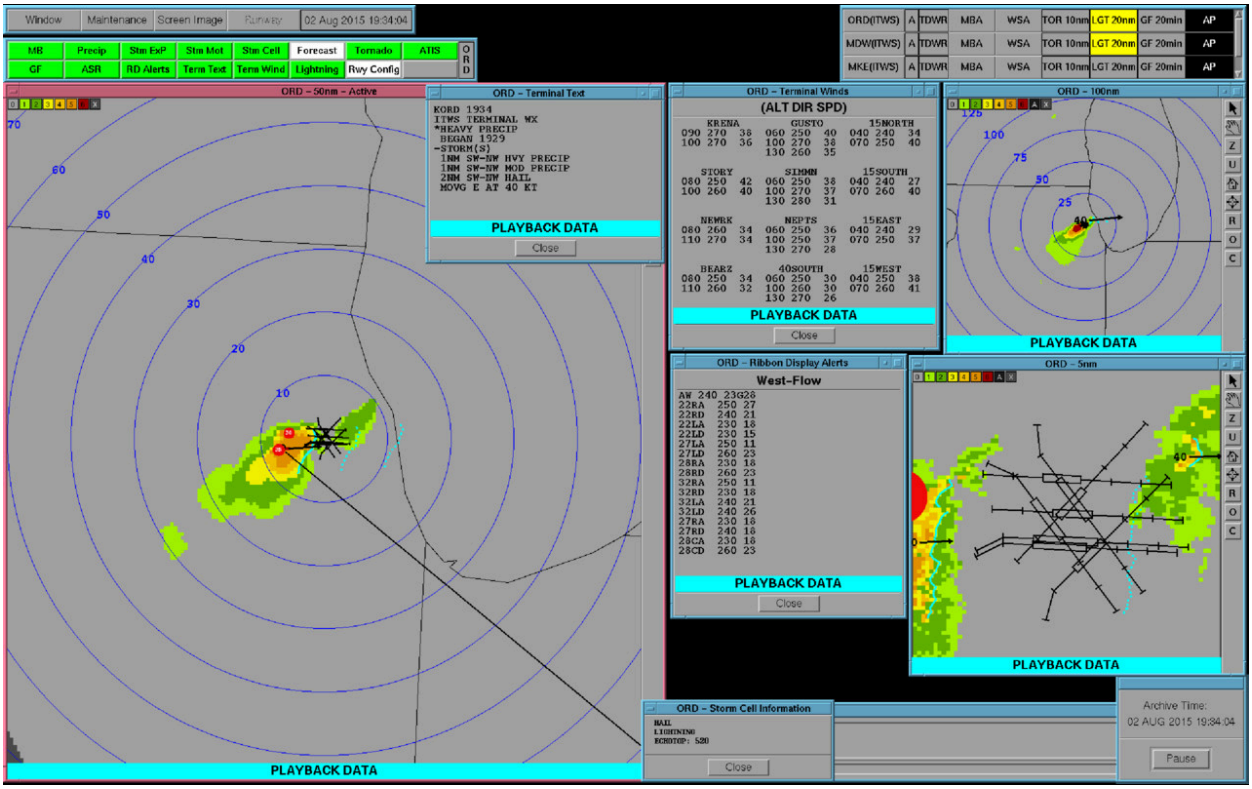

Figure 21 - ITWS Display at 1434 CDT with ribbon display of winds

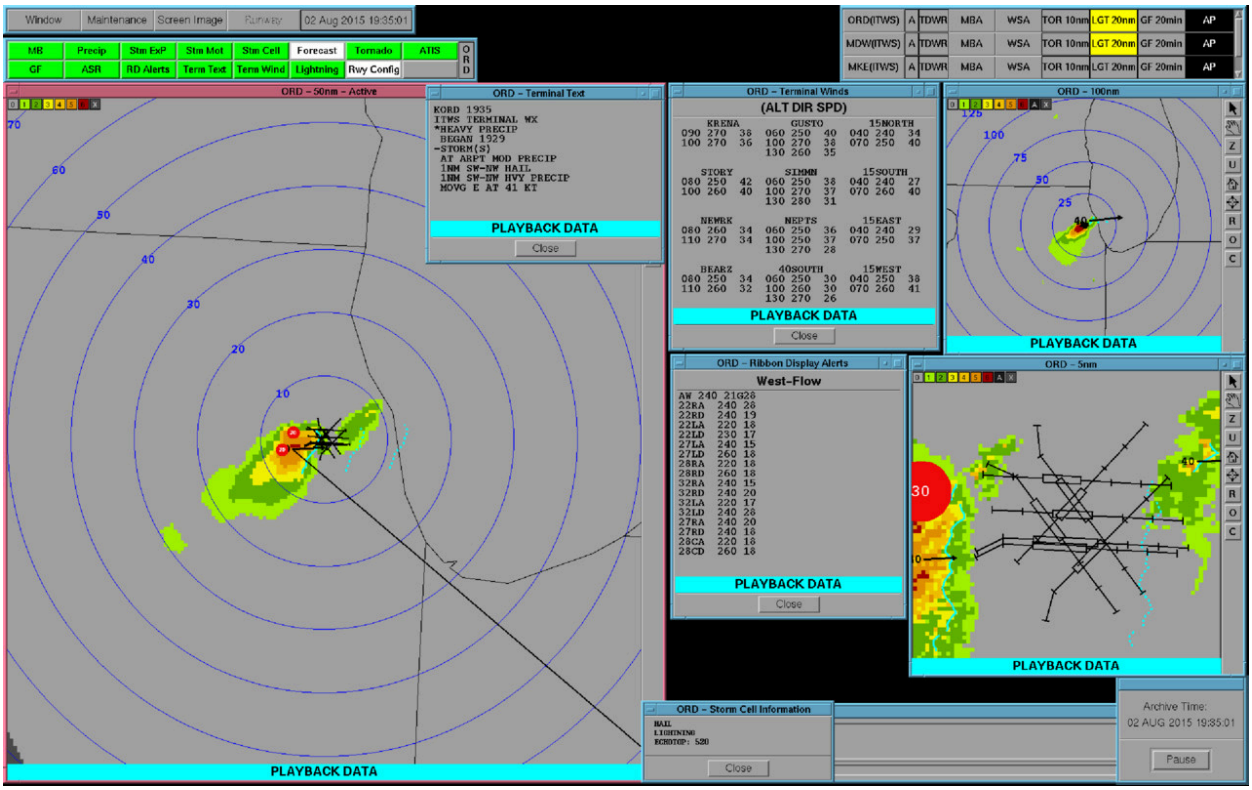

Figure 22 - ITWS display at 1435 CDT

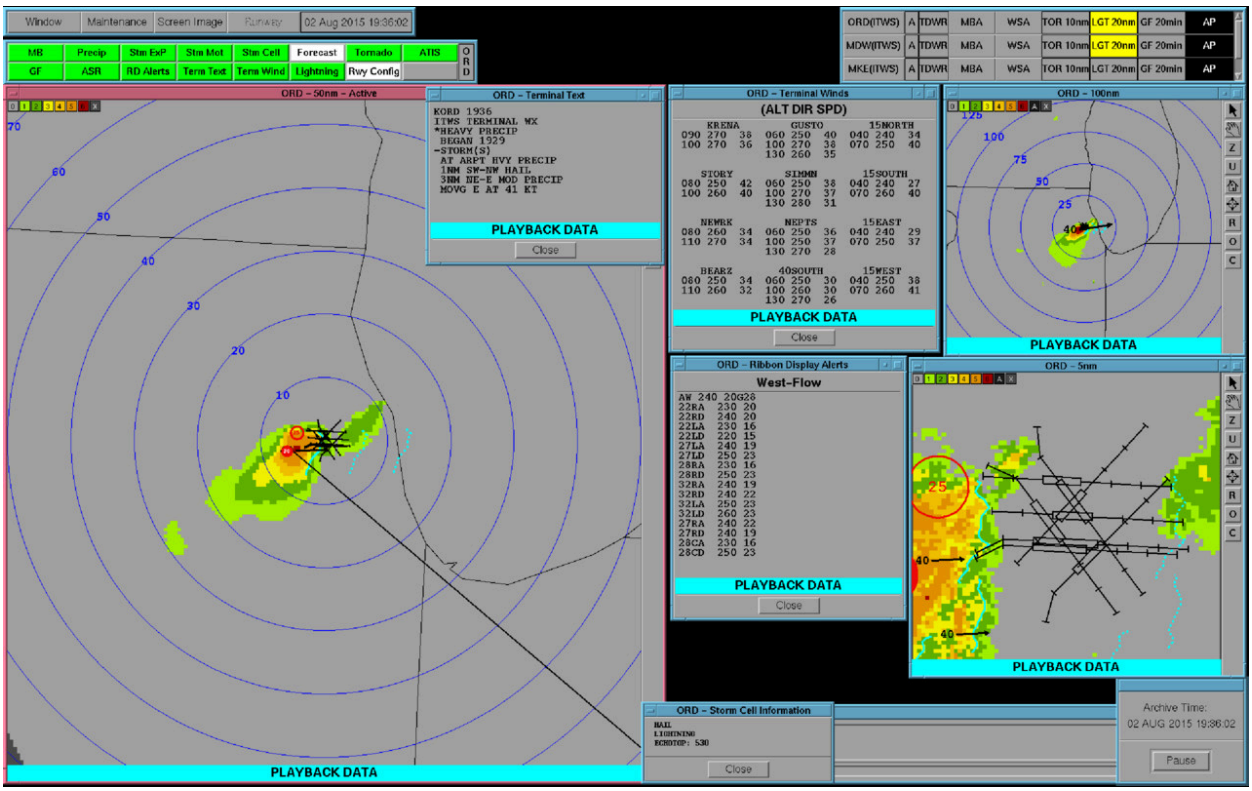

Figure 23 - ITWS display at 1436 CDT

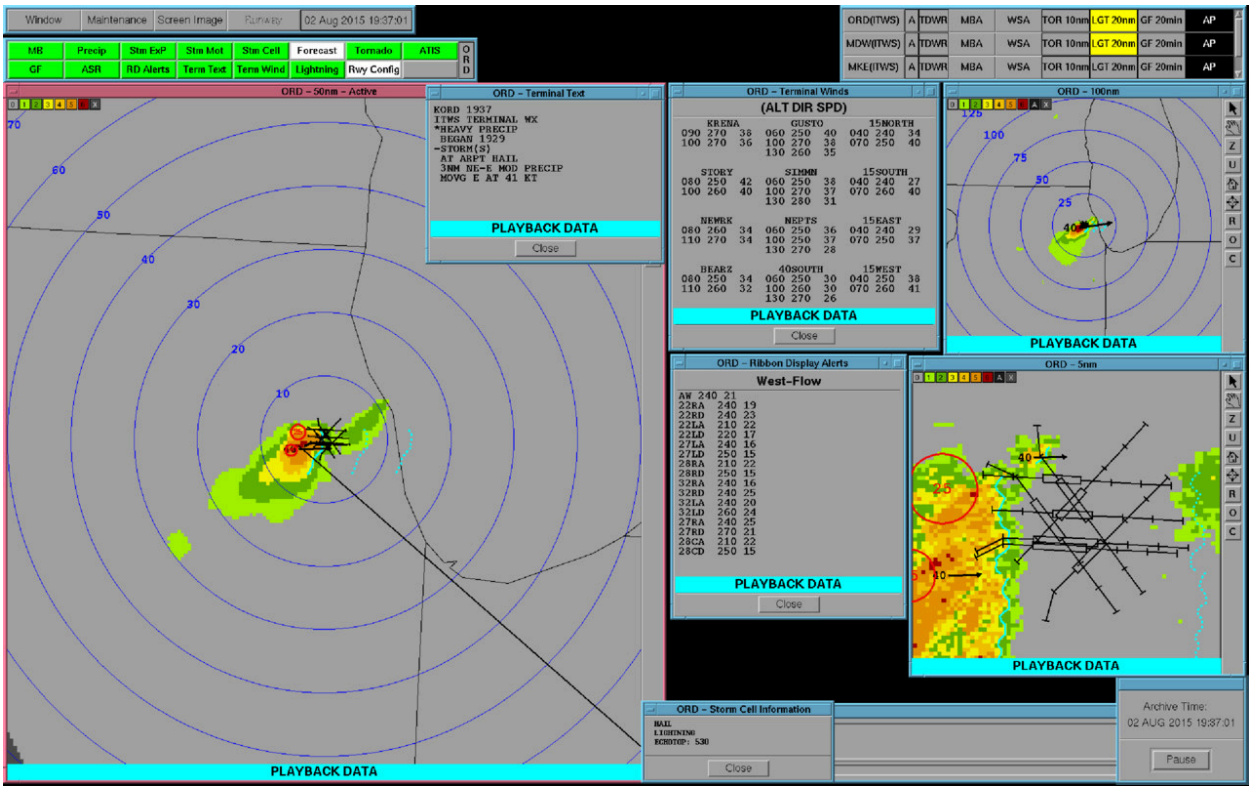

Figure 24 - ITWS display at 1437 CDT at the time of the accident

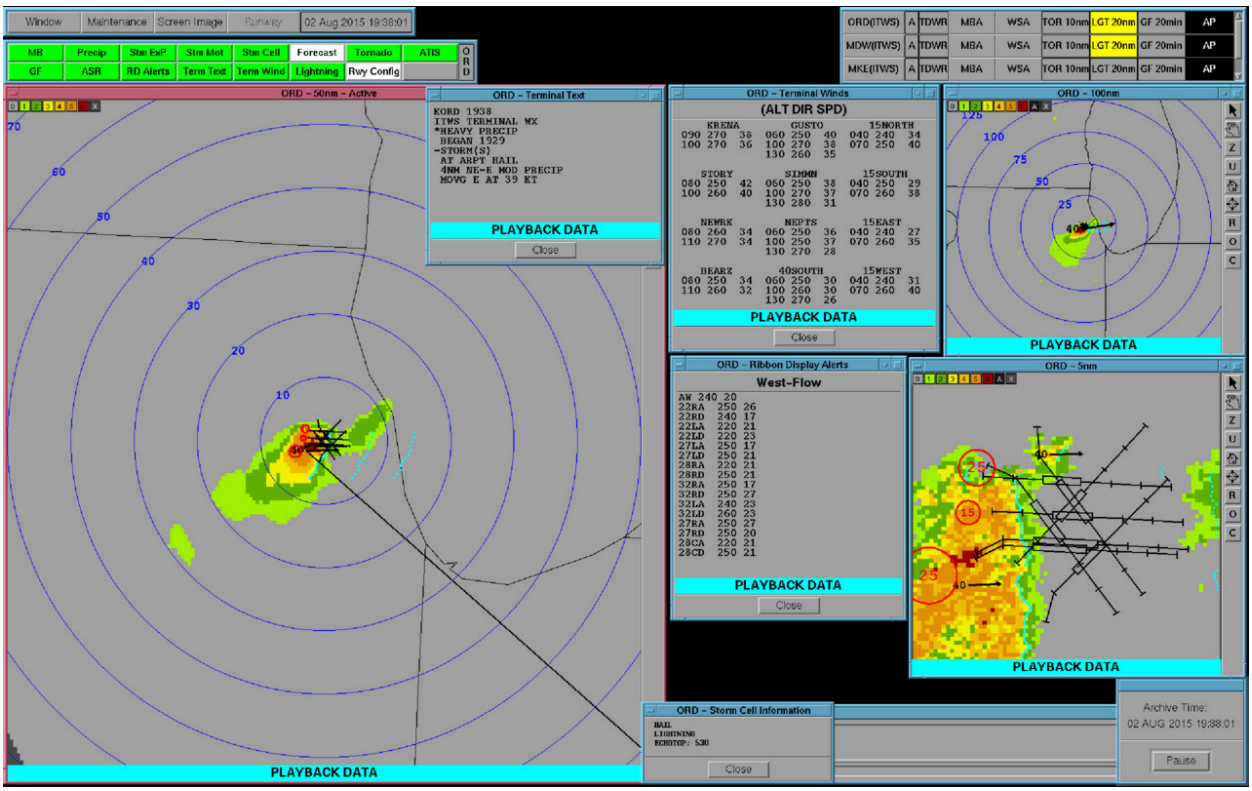

Figure 25 - ITWS display at 1438 CDT

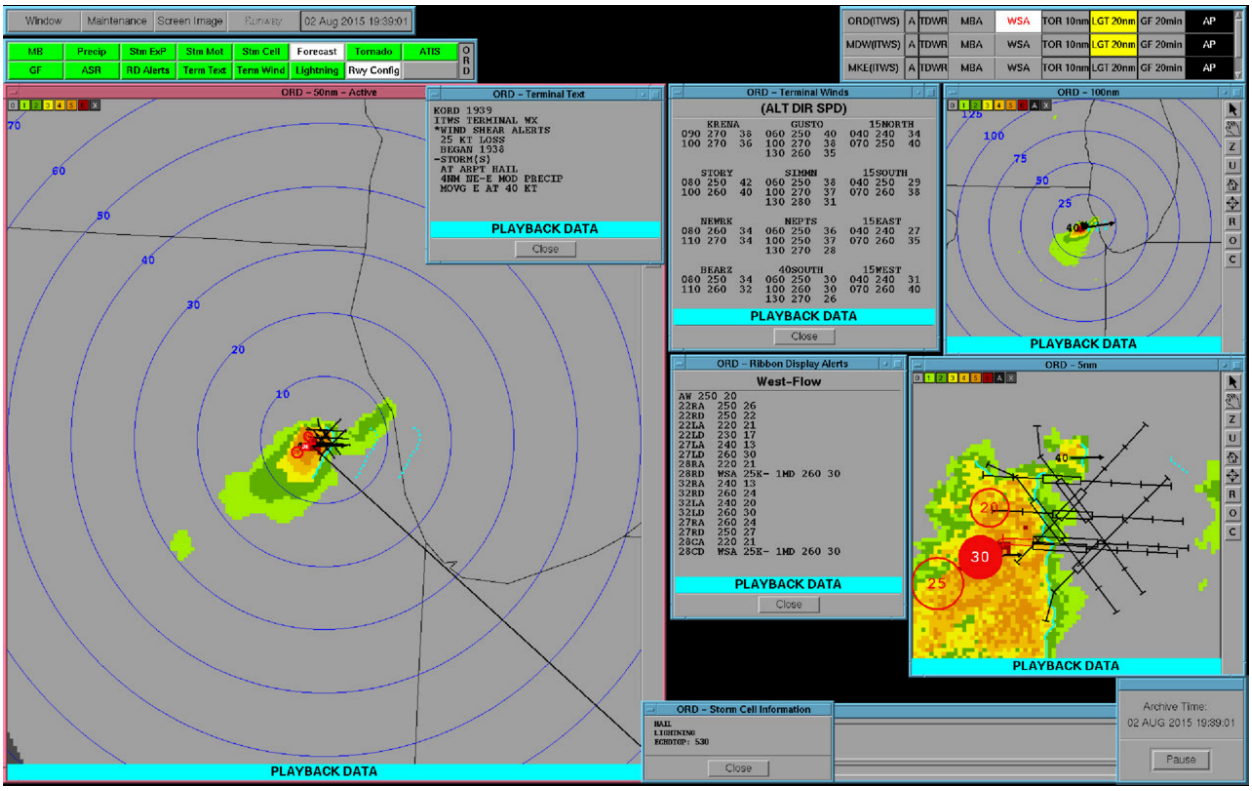

Figure 26 - ITWS display at 1439 CDT

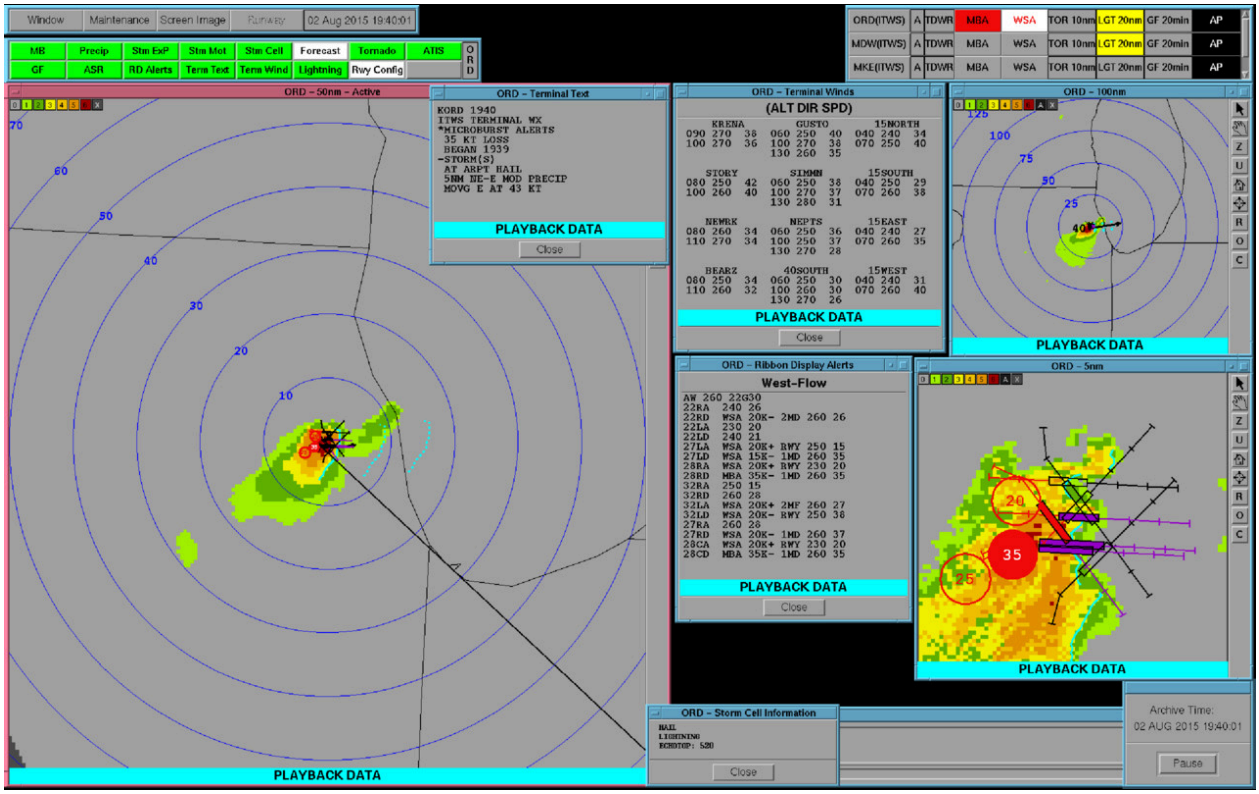

Figure 27 - ITWS display at 1440 CDT

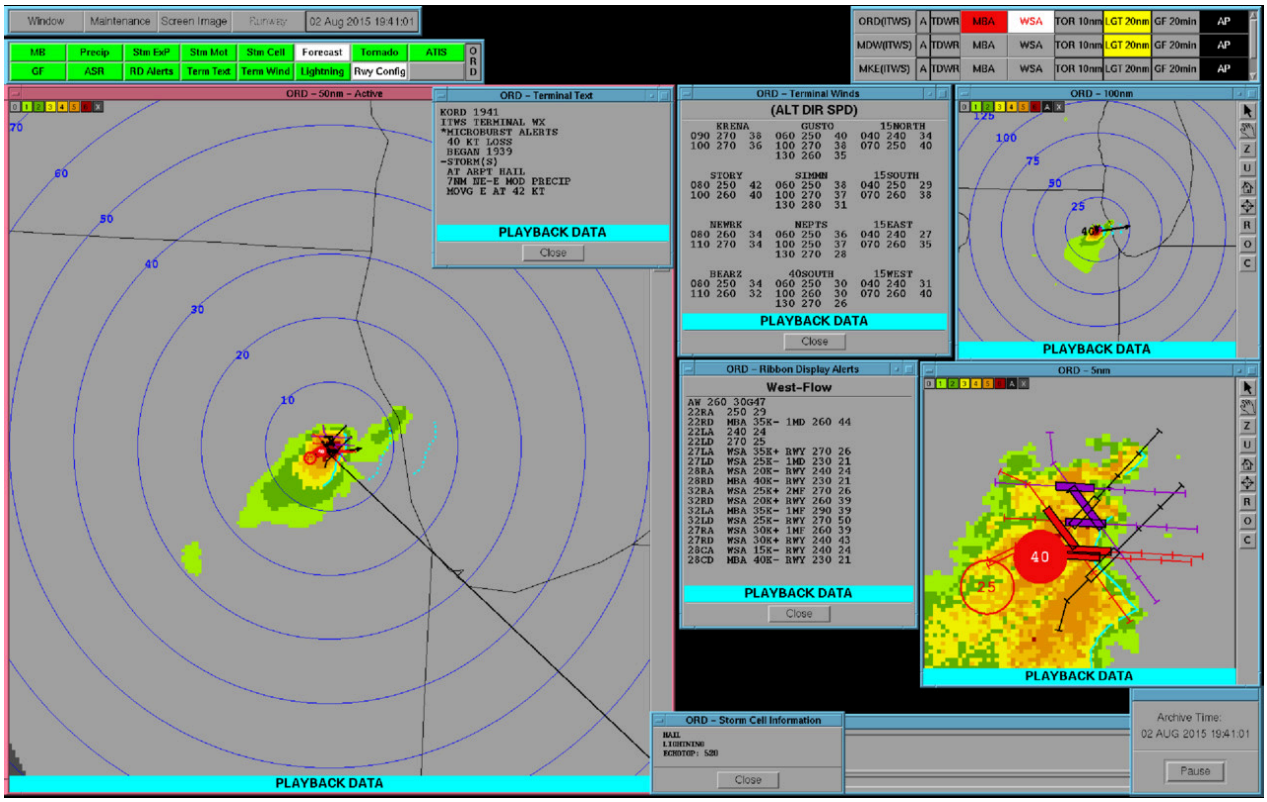

Figure 28 - ITWS display at 1441 CDT

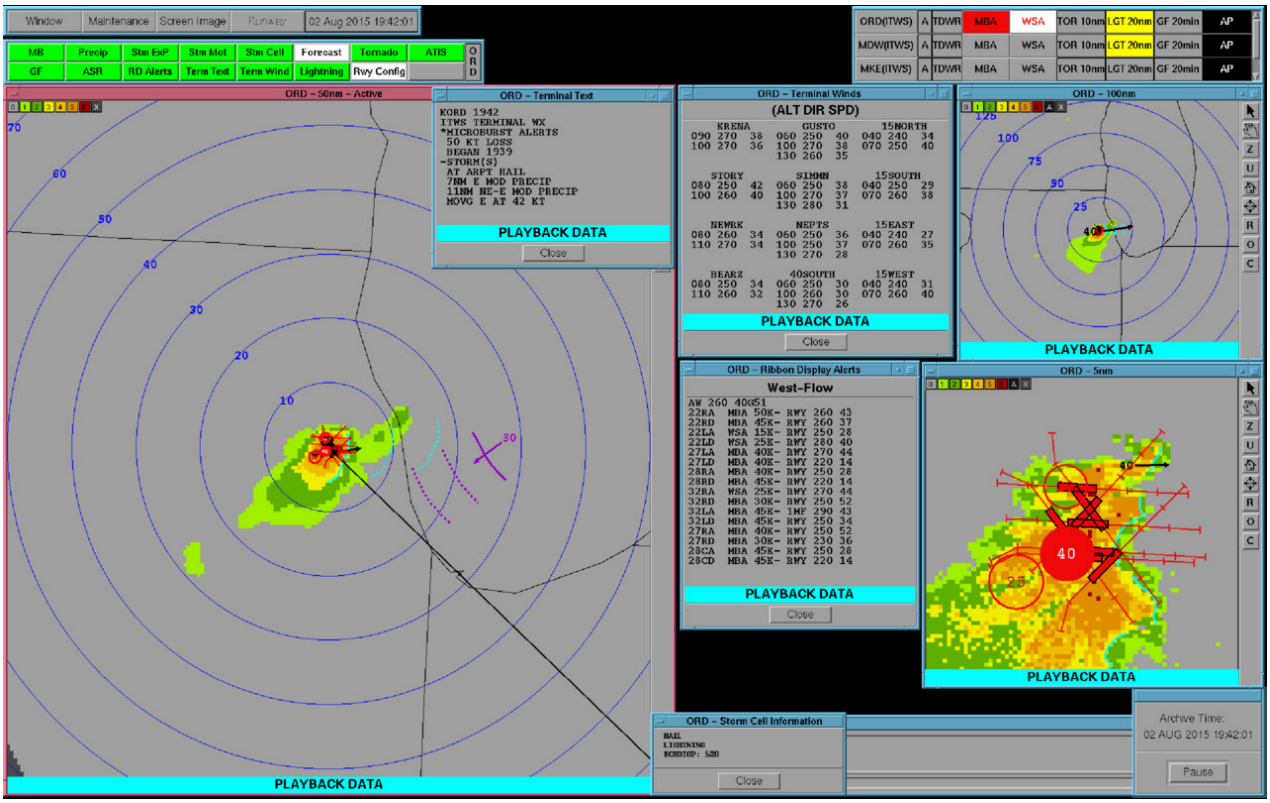

Figure 29 - ITWS display at 1442 CDT

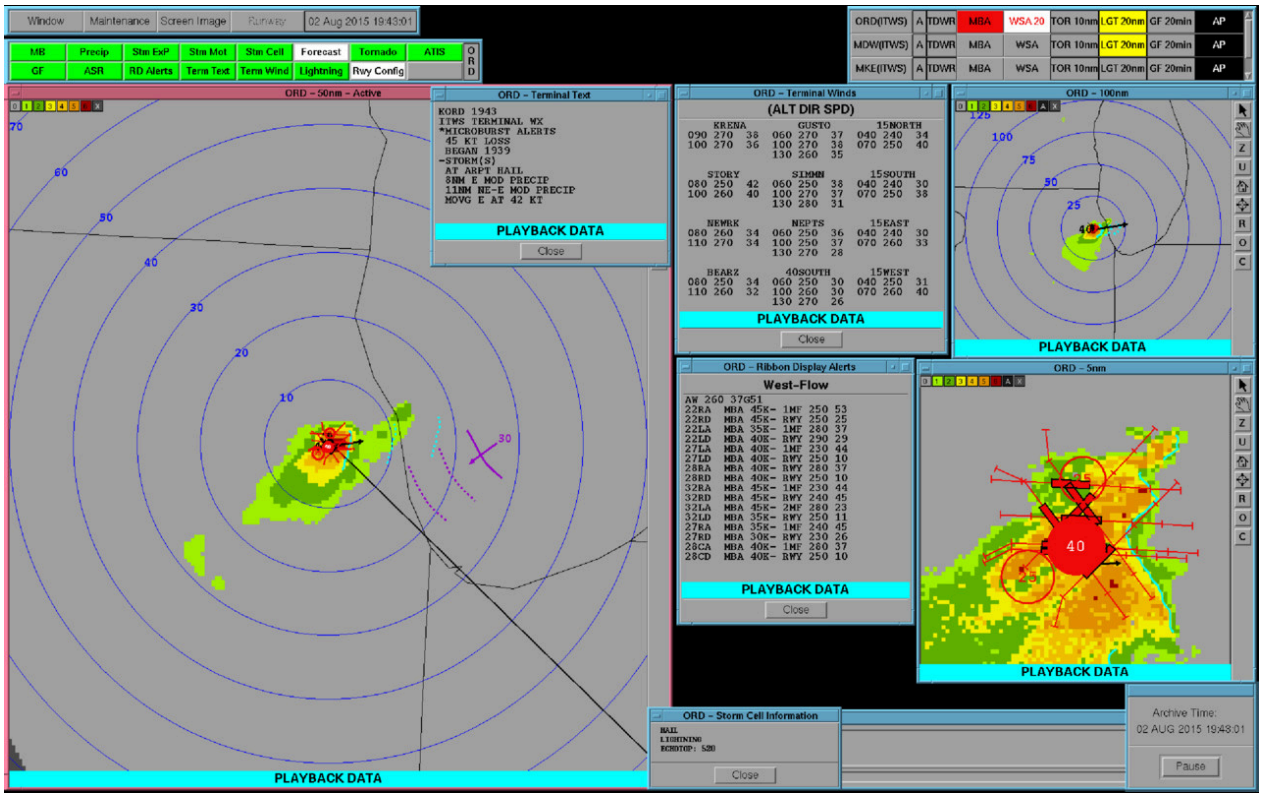

Figure 30 - ITWS display at 1443 CDT

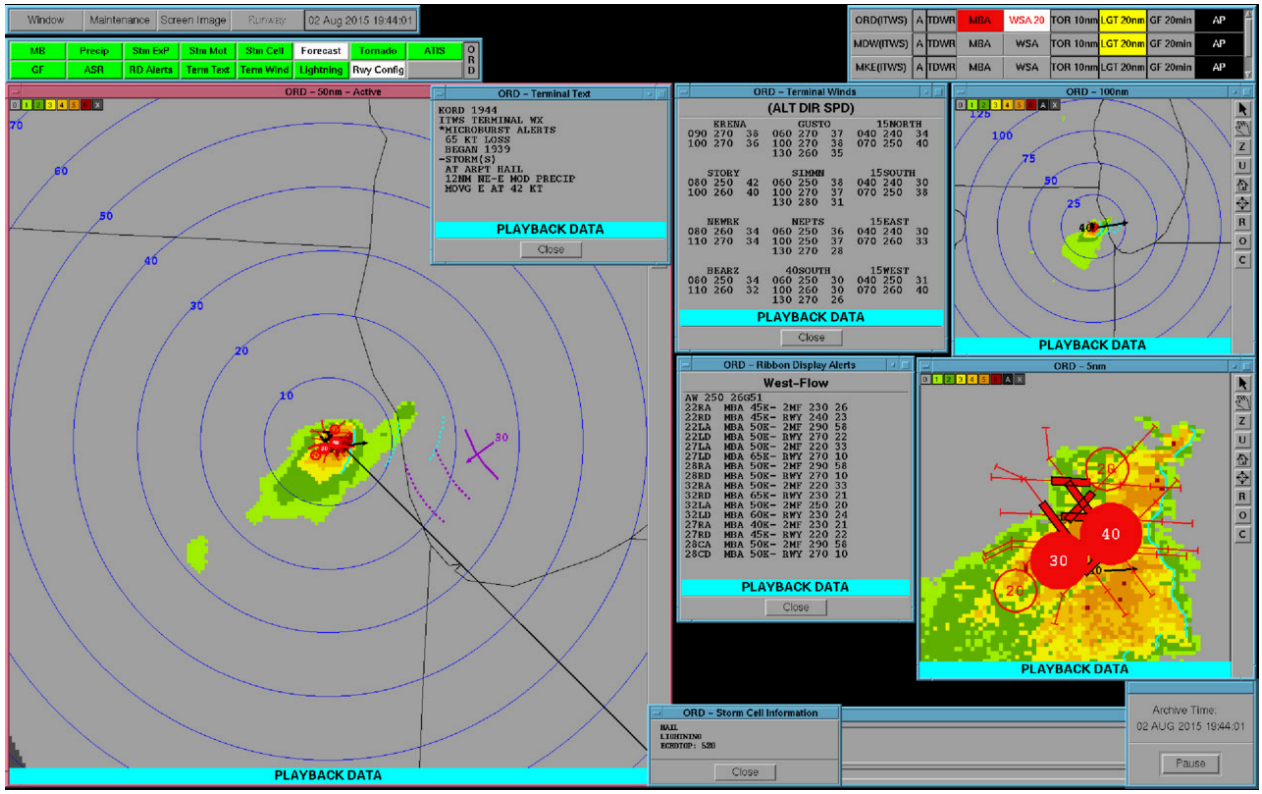

Figure 31 - ITWS display at 1444 CDT

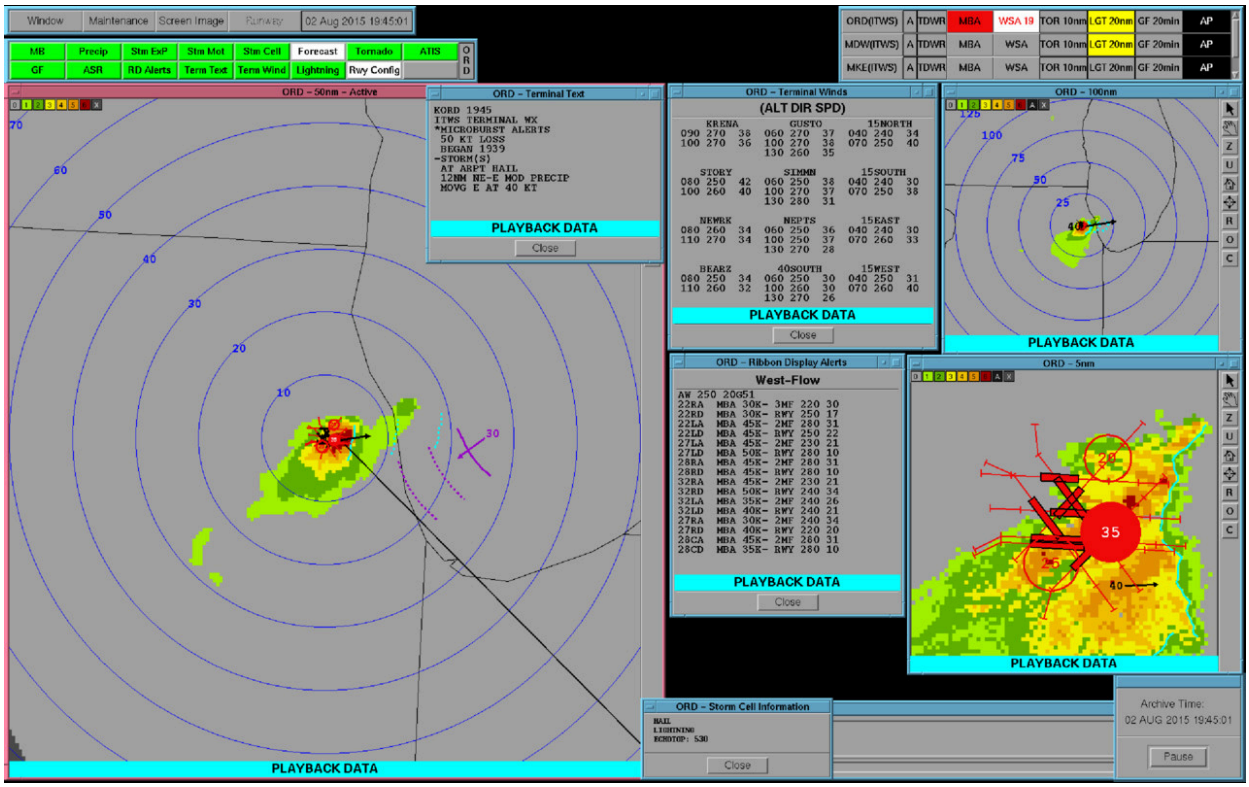

Figure 32 - ITWS display at 1445 CDT

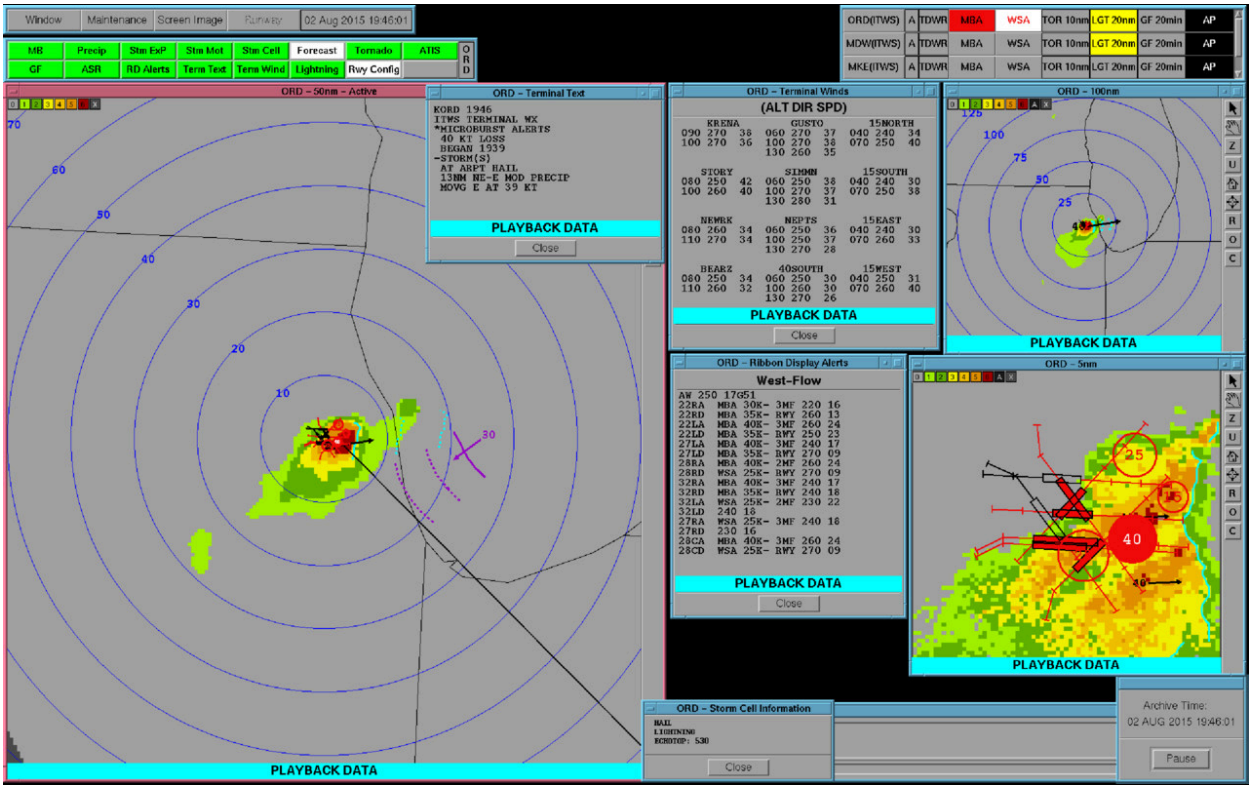

Figure 33 - ITWS display at 1446 CDT

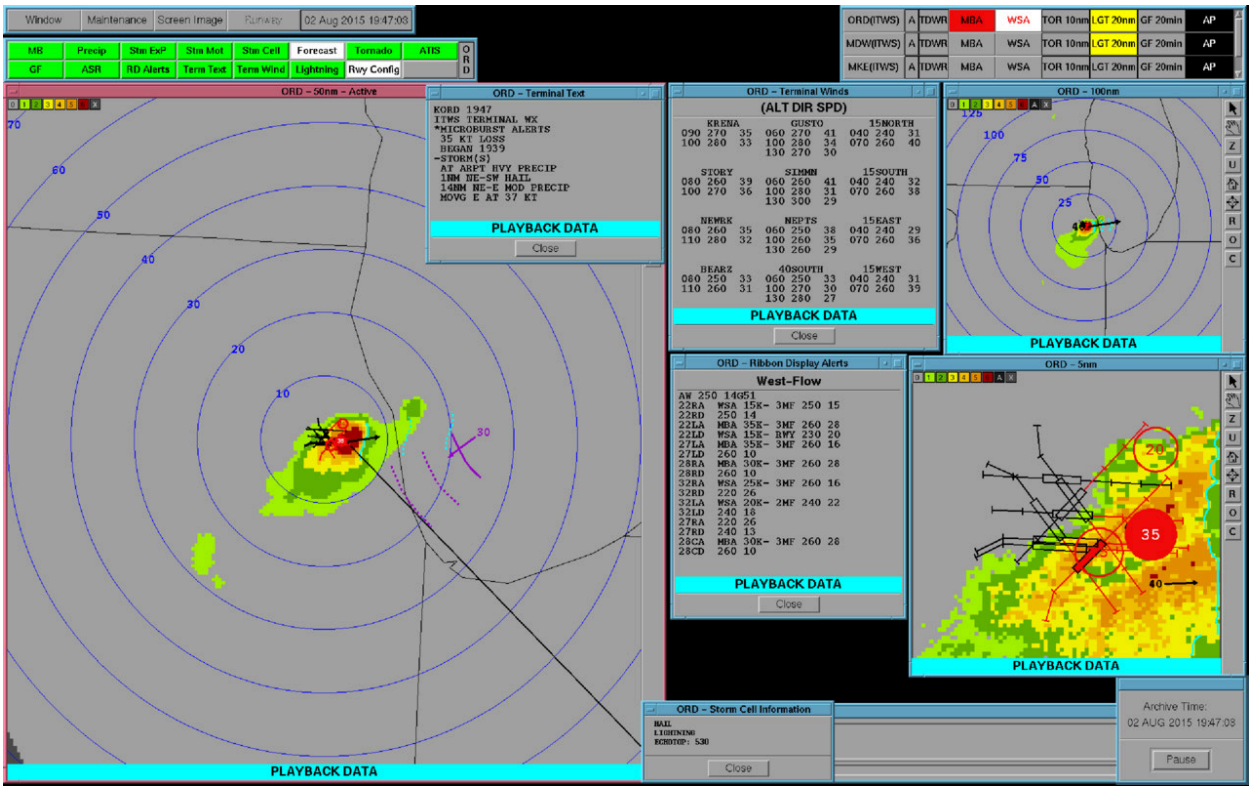

Figure 34 - ITWS display at 1447 CDT

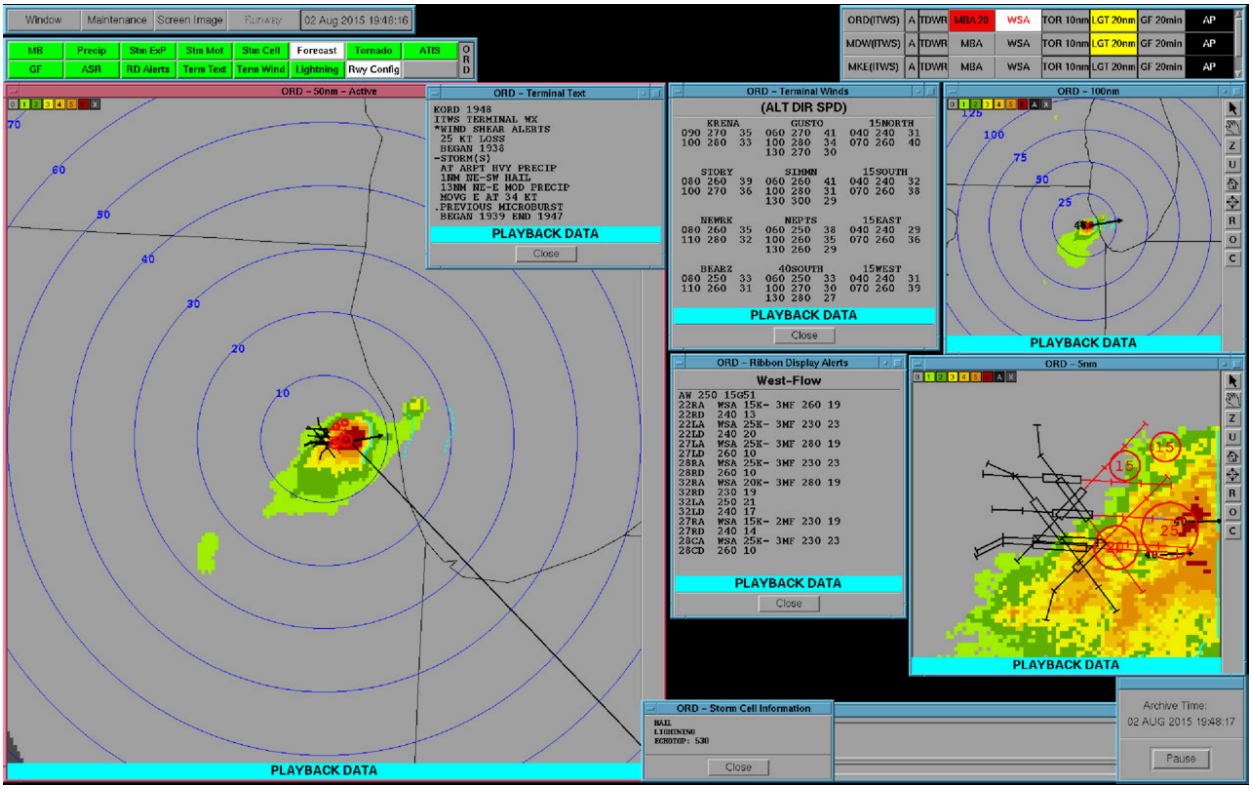

Figure 35 - ITWS display at 1448 CDT

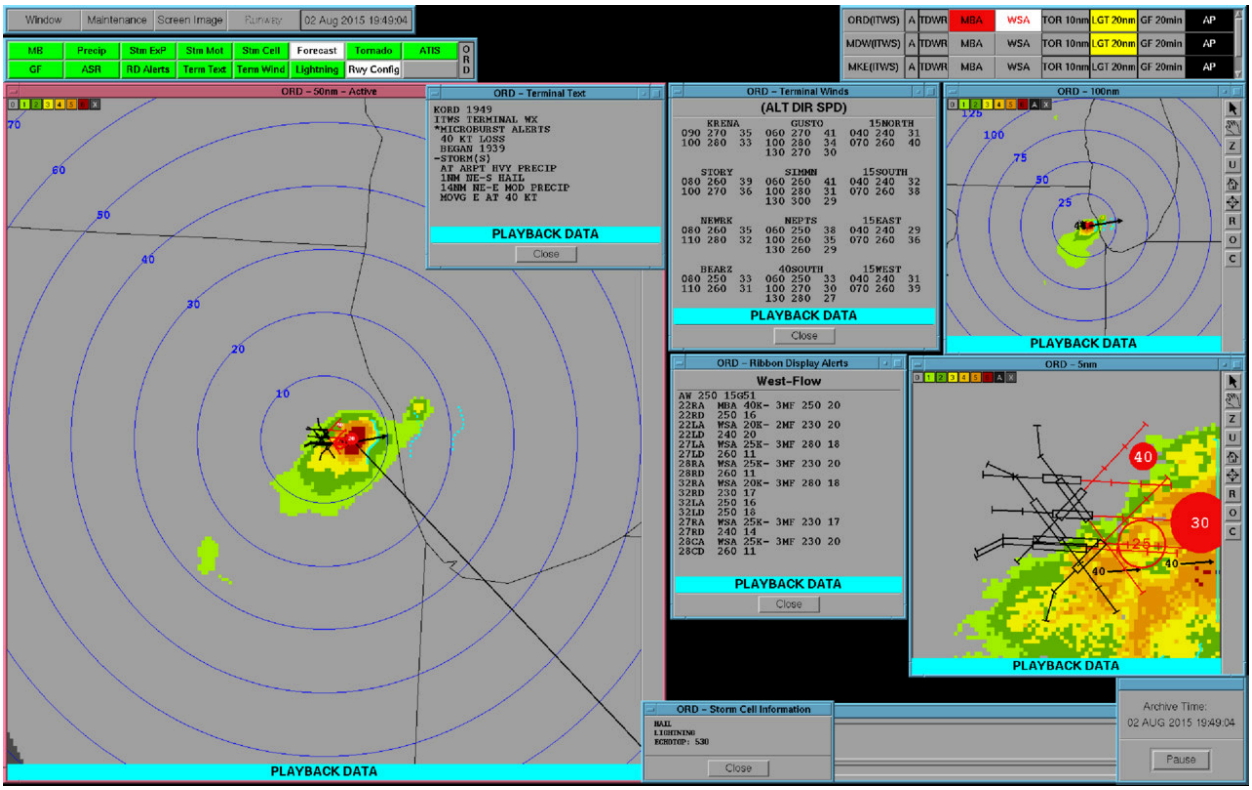

Figure 36 - ITWS display at 1449 CDT

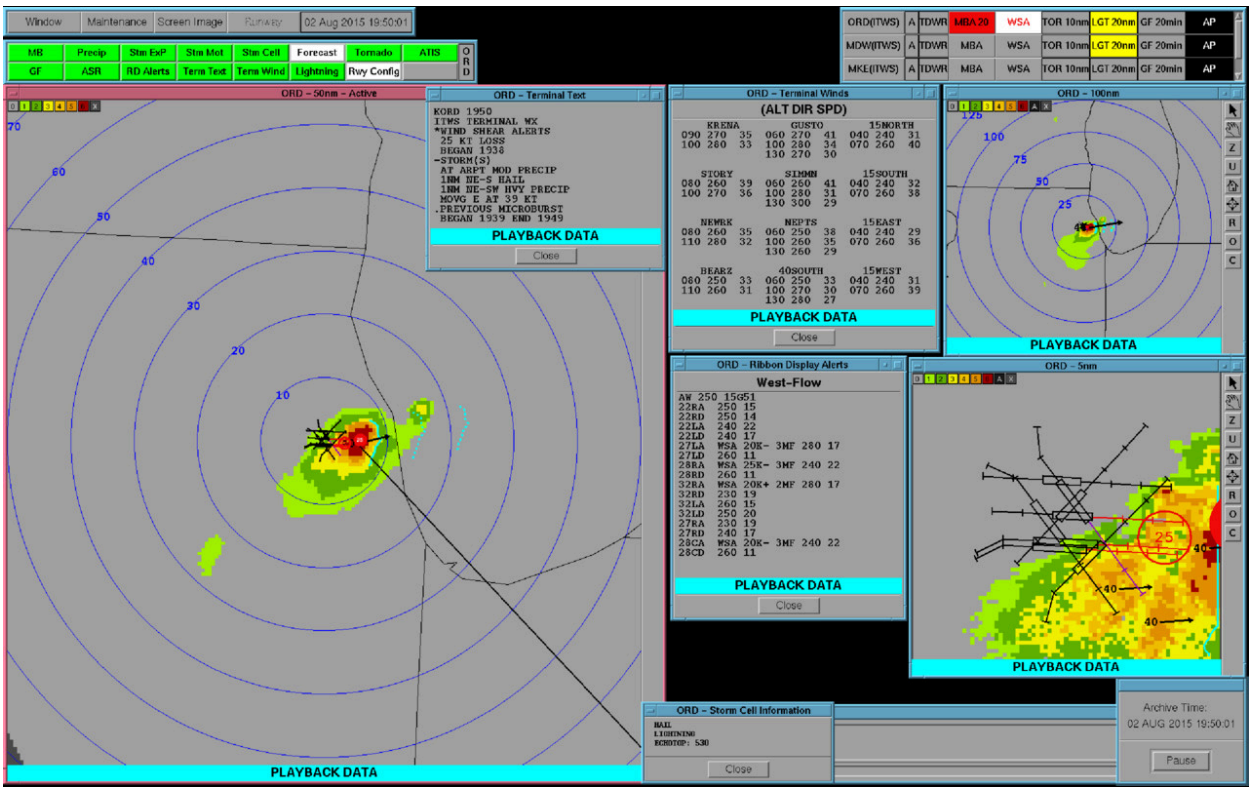

Figure 37 - ITWS display at 1450 CDT

The ITWS displays begin with lightning being detected within 20 miles of the airport with the large area of intense echoes approaching from the west, and moving east at 40 knots. At 1432 CDT heavy precipitation begins over the airport with hail being identified west through southwest with the storm, which is depicted moving eastward at 37 knots. At 1434 CDT a microburst signature is identified west of the airport. At 1437 CDT heavy rain and hail are reported at the airport with the storm moving eastward at 41 knots, the accident occurs near the leading edge of the precipitation. Windshear alerts begin to be depicted at 1439 CDT and continue through 1450 CDT, as heavy precipitation and hail impacts the airport, with peak winds of 58 knots at 1444 CDT. Microburst alerts reached a loss of 50 knots at 1444 CDT for runway 22L departures.

Submitted by:

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