NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 26, 2016

Group Chairman's Factual Report

METEOROLOGY

WPR16FA130

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A. ACCIDENT

Location:	Wikieup, Arizona
Date:	June 23, 2016
Time:	about 1420 mountain standard time (2120 UTC[1])
Airplane:	Robinson R66; registration N117TW

B. METEOROLOGY GROUP

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C. SUMMARY

On June 23, 2016, about 1420 mountain standard time, a Robinson R66, N117TW, collided with terrain under unknown circumstances near Wikieup, Arizona. Guidance Aviation was operating the helicopter under the provisions of Title 14 Code of Federal Regulations (CFR) Part 91. The commercial pilot and the commercial pilot rated passenger sustained fatal injuries. The helicopter was destroyed during the accident sequence, and the cabin area was consumed by a post impact fire. The cross-country positioning flight departed Prescott, Arizona, about 1340 with a planned destination of Riverside, California. Visual meteorological conditions prevailed, and no flight plan had been filed.

The pilot was going to Riverside to take a Part 135 chief pilot check ride with an inspector from the Federal Aviation Administration (FAA) Flight Standards District Office located there. The pilot rated passenger was the operator's Part 141 Chief Pilot.

The airplane was reported overdue when it did not arrive at the destination, and the wreckage was located about 0430 on June 24, 2016.

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 (WPC) and the National Center for Environmental Information (NCEI). All times are mountain standard time (MST) based upon the 24 hour clock,

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

local time is +7 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 used intermittently in this report.

The accident site was located at latitude 34.46124° N and longitude 113.68344° W, at an estimated elevation of 1,960 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 Camp Springs, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45G.

1.1 Surface Analysis Chart

The southwest section of the NWS Surface Analysis Chart for 1400 MST (2100Z) on June 23, 2016 is included as figure 1 with the approximate accident site marked by a red star. The chart depicted a thermal low[2] pressure system at 1005-hectopascals (hPa) over southeast California near the Arizona border to the west of the accident site, with a trough of low pressure running north and south from the low. Another thermal low was indicated over southern New Mexico at 1006-hPa with a trough extending south into Mexico and another trough extending west-northwest across Arizona towards the accident site and south of Prescott. High pressure systems at 1015-hPa and 1016-hPa were located on either side of the trough over northern and southern Arizona respectively. The station models over western Arizona indicated winds from the south at approximately 15 knots, visibility unrestricted with clear skies, with temperatures in the upper 90's to low 100's degrees Fahrenheit (F), with dew points in the 20's to 30's. No significant weather was depicted over Arizona at the time.

[2] A thermal low or heat low are non-frontal low pressure areas that occur over the continental subtropics in summers, as the result of intense heating when compared to their surrounding environments. Their circulations is typical weak and diffuse as compared to frontal low's.

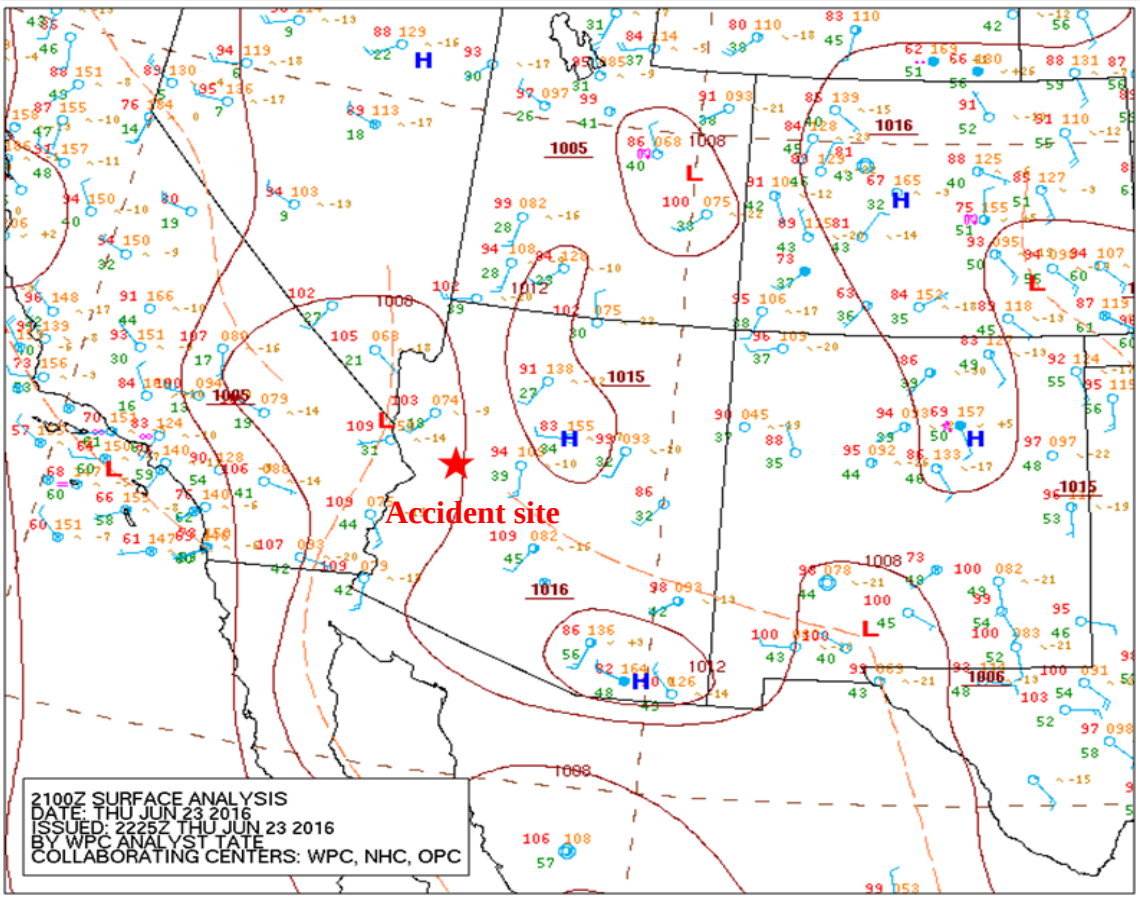

Figure 1 – Section of the NWS Surface Analysis Chart for 1400 MST

1.2 Weather Radar Mosaic

The NWS National radar mosaic for 1430 MST on June 23, 2016 is included as figure 2, with the approximate accident site marked by the red star. No significant meteorological echoes associated with precipitation were identified in the vicinity of the accident site. The only echoes during the period were in the vicinity of Tucson over the southeast portion of Arizona.

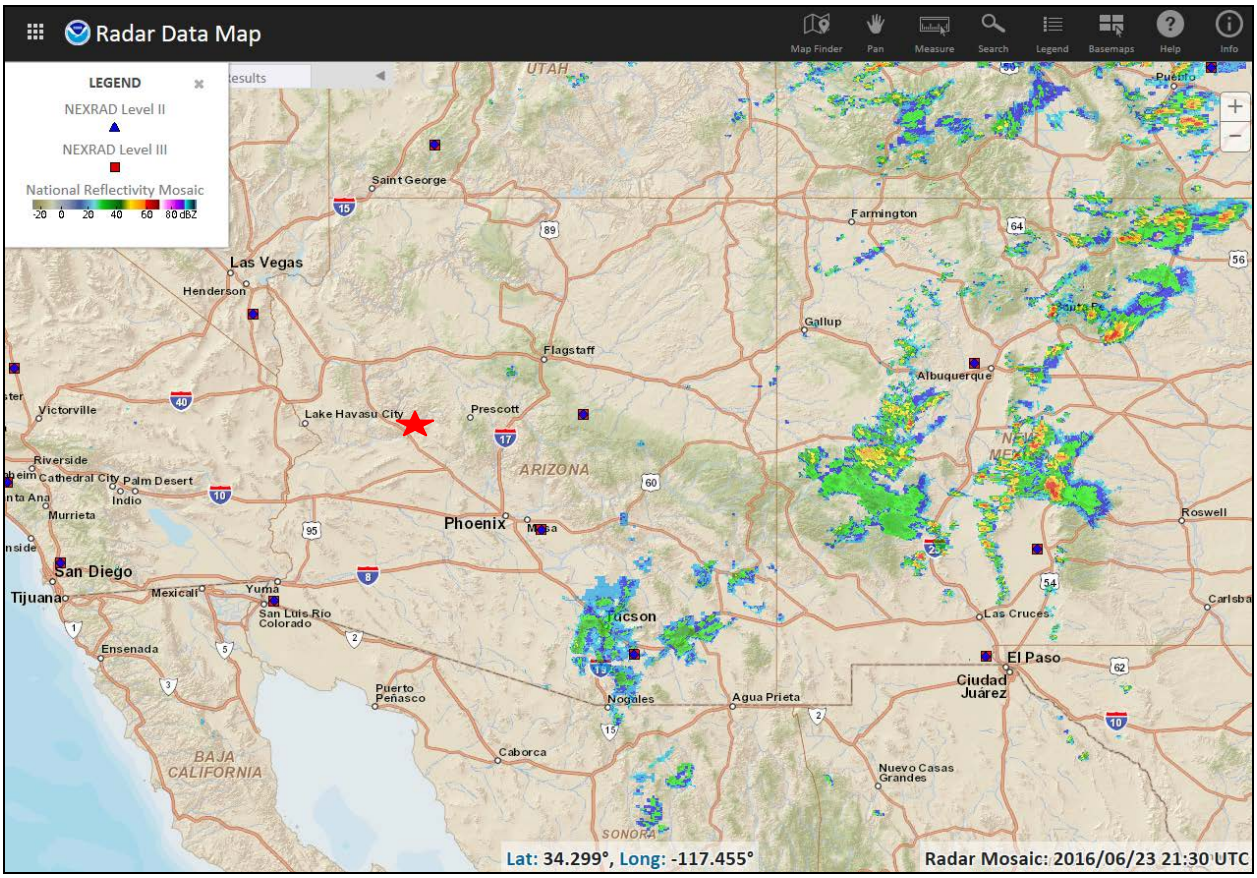

Figure 2 - National Radar Mosaic for 1430 MST

2.0 Surface Observations

The official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECIs) surrounding the period were documented for the departure and the closest airport to the accident site. The cloud heights are reported above ground level (agl).

2.1 Lake Havasu City, Arizona

The closest reporting site to the accident site was Lake Havasu City Airport (KHII), Lake Havasu, Arizona located 43 miles west at an elevation of 783 feet, and listed a 13° magnetic variation. The airport had an Automated Weather Observation System (AWOS) installed and issued observations every 20 minutes. The following conditions were reported at the approximate time of the accident:

Lake Havasu City weather at 1435 MST, automated, wind from 190° at 17 knots gusting to 22 knots, visibility unrestricted at 10 statute miles or more, sky clear, temperature 43° Celsius (C) (109° F), dew point temperature -3° C (26° F), altimeter 29.79 inches of mercury (Hg). The

calculated density altitude was 4,300 feet, with a relative humidity of 5%, based on a station pressure[3] of 28.96" of Hg.

The raw observations in standard code and the general flight categories[4] surrounding the period from 1155 through 1515 MST were as follows:

VFR METAR KHII 231955Z AUTO 14010G19KT 10SM CLR 42/02 A2982 RMK AO2=

VFR METAR KHII 232015Z AUTO 19014G20KT 10SM CLR 42/01 A2981 RMK AO2=

VFR METAR KHII 232035Z AUTO 18017G21KT 10SM CLR 42/00 A2980 RMK AO2=

VFR METAR KHII 232055Z AUTO 22014G19KT 10SM CLR 43/00 A2980 RMK AO2=

VFR METAR KHII 232115Z AUTO 21010KT 10SM CLR 42/M01 A2979 RMK AO2=

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VFR METAR KHII 232135Z AUTO 19017G22KT 10SM CLR 43/M03 A2979 RMK AO2=

VFR METAR KHII 232155Z AUTO 18015G20KT 10SM CLR 43/M05 A2978 RMK AO2=

VFR METAR KHII 232215Z AUTO 20016KT 10SM CLR 43/M03 A2977 RMK AO2=

VFR METAR KHII 232235Z AUTO 18013G20KT 10SM CLR 43/M03 A2976 RMK AO2=

VFR METAR KHII 232255Z AUTO 20014G18KT 10SM CLR 43/M02 A2976 RMK AO2=

VFR METAR KHII 232315Z AUTO 21012G19KT 10SM CLR 43/M02 A2975 RMK AO2=

[3] Station Pressure – is the atmospheric pressure computed using station elevation as the reference datum level. Station pressure is usually the base value from which sea level pressure, altimeter setting and density altitude are determined.

[4] 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.

2.2 Kingman, Arizona

Kingman Airport (KIGM), Kingman, AZ, was located approximately 49 miles north-northwest of the accident site at an elevation of 3,449 feet. The airport had a federally installed and maintained Automated Surface Observations System (ASOS) and reported a 12° E magnetic variation. The following conditions were reported at the approximate time of the accident:

Kingman Airport weather at 1451 MST, automated, wind from 220° at 17 knots gusting to 28 knots, visibility unrestricted at 10 miles or more, sky clear, temperature 39° C (102° F), dew point temperature -6° C (21° F), altimeter 29.99 inches of Hg. Remarks: automated observation system with a precipitation discriminator, peak wind from 220° at 31 knots occurred at 1453 MST, sea level pressure 1007.4-hPa, temperature 38.9° C, dew point -6.1° C, and maintenance indicator[5] on. The calculated density altitude was 6,870 feet, with a relative humidity of 5%, based on a station pressure of 26.43" of Hg

The raw observations reported surrounding the period were as follows:

VFR METAR KIGM 231951Z AUTO 21020G29KT 10SM CLR 39/M07 A3001 RMK AO2 PK WND 22029/1945 SLP077 T03941072 $=

VFR METAR KIGM 232051Z AUTO 22022G31KT 10SM CLR 39/M08 A3000 RMK AO2 PK WND 22031/2045 SLP074 T03941078 57009 $=

VFR METAR KIGM 232151Z AUTO 22017G28KT 10SM CLR 39/M06 A2999 RMK AO2 PK WND 22031/2053 SLP074 T03891061 $=

VFR METAR KIGM 232251Z AUTO 23020G33KT 10SM CLR 38/M13 A2998 RMK AO2 PK WND 21033/2246 SLP070 T03831128=

2.3 Prescott, Arizona

The next closest reporting site was from Ernest A. Love Field (KPRC), Prescott, Arizona, where the helicopter departed from at approximately 1340 MST. The airport was located 63 miles east of the accident site at an elevation of 5,045 feet, and had a federally installed and maintained Automated Surface Observation System (ASOS) and reported the following conditions at the approximate time of the accident:

Ernest A. Love Field weather at 1453 MST, wind from 230° at 14 knots gusting to 25 knots, visibility unrestricted at 10 miles or more, sky clear, temperature 35° C (95° F), dew point 3° C (37° F), altimeter 30.14 inches of Hg. Remarks: automated surface observation station with a precipitation discriminator, peak wind from 170° at 26 knots occurred at 1412 MST, sea level pressure 1010.3-hPa, temperature 35.0° C, dew point 2.8° C. The calculated density altitude was 8,280 feet, with the relative humidity of 13%, based on a station pressure of 25.03" of Hg.

The raw observations and flight categories surrounding the period were as follows:

[5] Maintenance indicator indicates that one or more of the sensors requires maintenance or is out of calibration.

VFR METAR KPRC 231953Z 16014G18KT 10SM FEW090 34/03 A3017 RMK AO2 SLP114 T03390028

Departed at 2040Z

VFR METAR KPRC 232053Z 18016G20KT 10SM CLR 34/04 A3015 RMK AO2 SLP109 T03440039 58010

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VFR METAR KPRC 232153Z 23014G25KT 10SM CLR 35/03 A3014 RMK AO2 PK WND 17026/2112 SLP103 T03500028

VFR METAR KPRC 232253Z 23014G22KT 10SM CLR 34/03 A3013 RMK AO2 SLP103 T03440028

3.0 Upper Air Data

The closest upper air sounding to the accident was from U.S. Army Yuma Proving Grounds, Arizona, site number #74004, located approximately 90 miles south from the accident site. A 1500 MST (2200Z) sounding on June 23, 2016 was available and plotted on a standard Skew-T log P diagram[6] from the surface to 500-hPa or 18,000 feet utilizing RAOB software[7] and is included as figure 3.

The Yuma sounding depicted a warm and dry low level environment with a surface temperature of 43.2° C (109.8° F), a dew point temperature of 9.2° C (48.6° F), with a relative humidity of 13%. Based on the station elevation of 322 feet and the temperature and dew point provided a density altitude of 3,980 feet. The thermal profile supported strong thermals through 8,500 feet (which are depicted on the left hand side of the diagram in tan). The lifted condensation level (LCL)[8] was identified at approximately 13,700 feet agl, the convective condensation level (CCL)[9], and the level of free convection (LFC)[10] at approximately 16,100 feet agl. The sounding did not indicate any specific cloud layers and no level below 18,000 feet had a relative humidity greater than 30%. The freezing level was identified at 16,100 feet and the sounding analysis did not support any icing conditions below 18,000 feet.

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

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

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

[9] 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.

[10] 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.

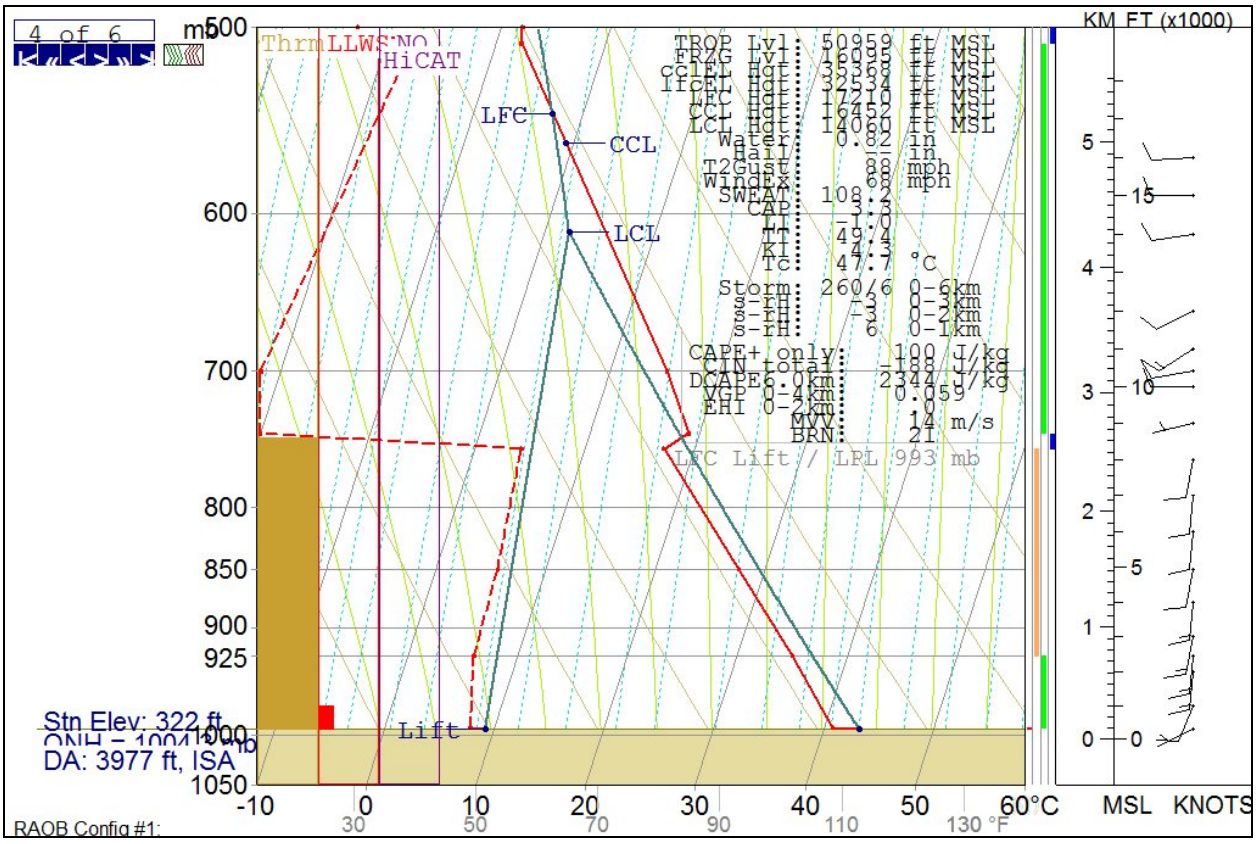

Figure 3 - Yuma Providing Grounds sounding at 1500 MST

The Lifted Index[11] was -1.0, and K-index[12] of 4.3, which indicated a weak or low risk of thunderstorm development over the region. The thermal structure indicated an unstable low-level environment below 8,000 feet agl, where the temperature decreased at a rate of 3° C per 1,000 feet. With the first layer below 50 feet indicating a super-adiabatic lapse rate which exceeded the 3° rate, this often occurs with intense surface heating and can produce significant updrafts or thermals of rising air and dust devils.

The sounding wind profile indicated a surface wind from 240° at 5 knots with wind direction backing to the south (counterclockwise with height) with a slight increase in wind speed to 14 knots at 2,600 feet agl. The wind shifted to the west immediately above 8,000 feet where a slight temperature inversion was noted, where temperature increased in height and the lapse rate became closer to the dry-adiabatic rate. The mean 0 to 6 kilometer or 18,000 feet wind was from 230° at 8 knots, and the level of maximum wind was identified at 32,000 feet with the wind from

[11] 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.

[12] 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 value the greater the probability of air mass type thunderstorm development across the region.

180° at 32 knots. In the lowest 1,000 feet a light low-level wind shear (LLWS) was indicated due to the change in wind direction and speed; however, no other strong vertical shears were noted to indicate any significant turbulence. Figure 4 below provides the observed height, pressure (Pres), temperature (T), dew point temperature (Td), relative humidity (RH), wind direction and speed, clear air turbulence (CAT), LLWS, and icing potential through 10,000 feet.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD/FF (deg/kts)	CAT (AF)	LLWS	Icing - Type (S-F clouds)
322	993	43.2	9.2	13	240/5			
353	992	40.8	7.8	14			LIGHT	
1000	971				200/10			
2000	939				185/13			
2451	925	35.0	6.0	17	185/13			
3000	908				190/14			
4000	877				185/14			
4935	850	27.6	5.6	25	190/12			
6000	819				185/10			
7000	791				185/10			
8000	763				190/9			
8315	755	17.2	4.2	42				
8727	744	19.0	-20.0	6				
9000	737				255/6			
10000	711				270/10			

Figure 4 - Yuma 1500 MST sounding parameters

The NOAA Air Resources Laboratory (ARL) archive data was also reviewed to reproduce the North American Mesoscale (NAM) numerical model of the conditions over the approximate accident site at 1400 MST (2100Z). Figure 5 is the NAM model sounding plotted on a similar Skew-T log P diagram, which depicted a warm and dry low level environment with a surface temperature of 39.6° C (103° F), a dew point temperature of 4.1° C (39° F), with a relative humidity of 11%. The calculated density altitude was 5,690 feet. The model sounding also supported strong thermals to 11,000 feet and is depicted on the left hand side of the diagram. The lifted condensation level (LCL) was identified at approximately 14,310 feet agl, and the convective condensation level (CCL) at 15,580 feet agl. The sounding did not indicate any specific cloud layers and no level below 18,000 feet had a relative humidity greater than 30%, and depicted a similar freezing level and did not support any icing conditions outside of convective activity.

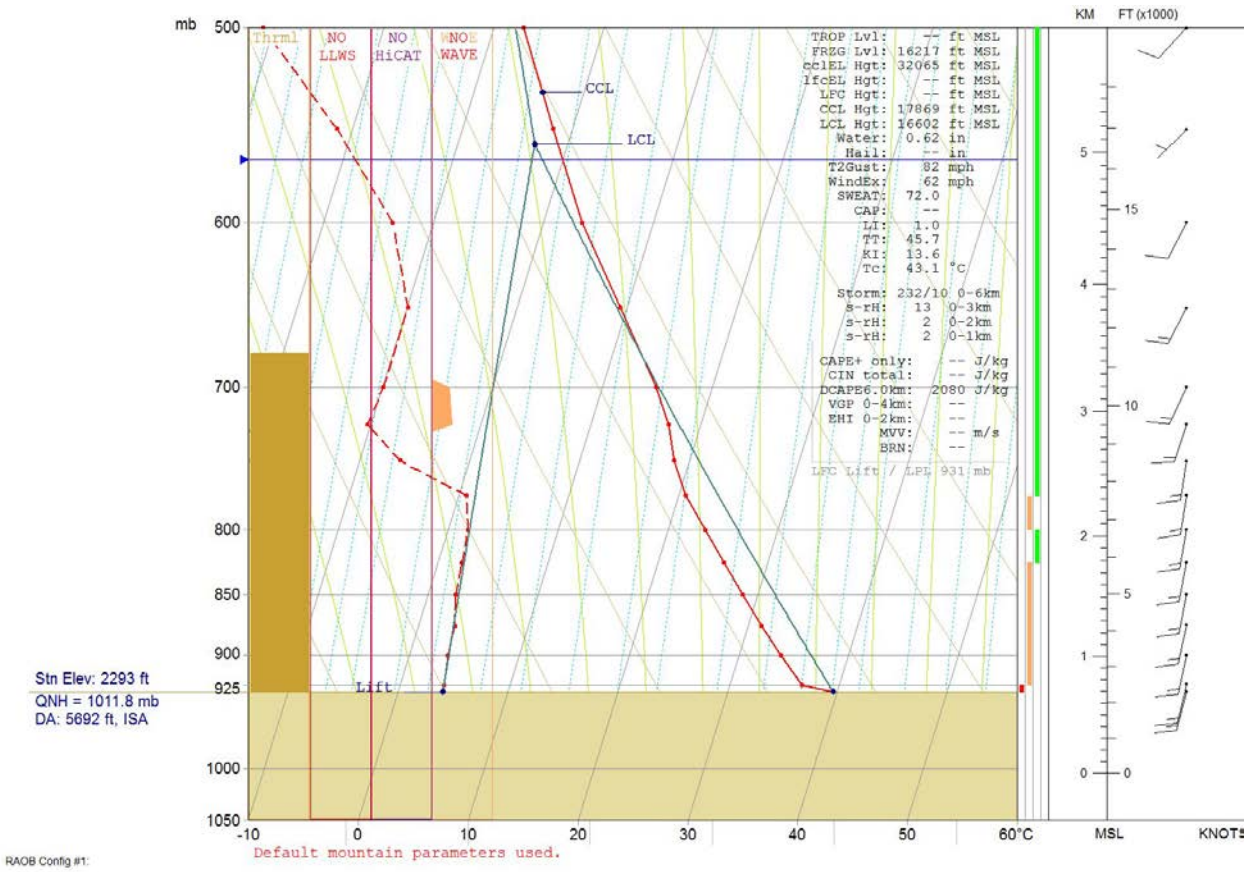

Figure 5 - NAM numerical model for 1400 MST over the accident site

The Lifted Index was 1.0, and K-index of 13.6, which indicated a weak or low risk of thunderstorm development. The stability indices indicated an unstable low-level environment due to dry and super-adiabatic lapse rate below 5,000 feet agl where the temperature decreased at a rate of 3° C and greater per 1,000 feet, with a conditional unstable layer above.

The NAM wind profile indicated a surface wind from 190° at 14 knots, with little change in wind direction or speed through 12,000 feet. The mean 0 to 6 kilometer or 18,000 feet wind was from 200° at 13 knots. The maximum wind was identified at 250-hPa or approximately 36,000 feet from 200° at 35 knots. There were no strong vertical wind shears noted on the sounding to support any significant turbulence or low-level wind shear, other than the strong thermal activity.

Figure 6 is a table of the NAM model sounding data elements and potential for CAT, LLWS, icing, and mountain wave activity indicated from the sounding data.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD/FF (deg/kts)	CAT (AF)	LLWS	Icing - Type (S-F clouds)	Wave/x—W—Turb nm	fpm	max
2293	931	39.6	4.1	11	193/14						
2487	925	36.6	4.0	13	192/14						
3302	900	33.8	3.5	15	191/15						
4132	875	31.2	3.3	17	191/15						
4979	850	28.6	2.5	19	190/16						
5844	825	26.0	2.2	21	190/16						
6728	800	23.4	1.8	24	189/16						
7632	775	20.7	0.7	26	188/16						
8557	750	18.6	-6.3	18	188/17						
9507	725	17.1	-10.3	14	197/17				2.86	567	LT-MD
10484	700	14.9	-9.9	17	203/17				4.38	596	LT-MD
12519	650	9.4	-9.9	24	206/15						
14673	600	3.5	-13.7	27	206/10						
16967	550	-1.7	-21.4	21	223/7						
19429	500	-7.3	-31.0	13	220/10						

Figure 6 - NAM model sounding elements

4.0 Satellite Data

The Geostationary Operational Environmental Satellite number 15 (GOES-15) 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 Man-computer Interactive Data Access System (McIDAS) software. Both the infrared long wave and the 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 5 is the GOES-15 visible image at 1430 MST at 2X magnification site with the surface features plotted and the accident marked by the red square. The image depicted clear skies over the region with a few cumulus clouds north and northeast of the Prescott area. No significant cloud features were noted on the image or confirmed in a replay of the images surrounding the period.

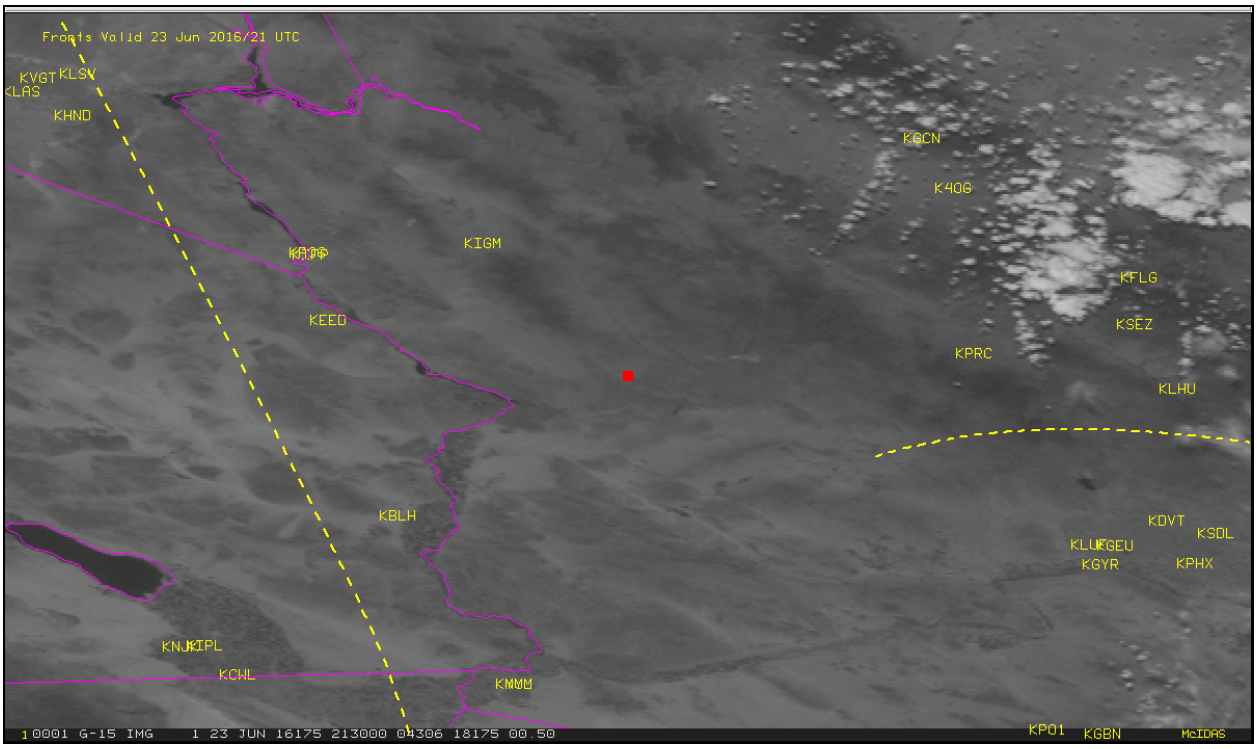

Figure 7 - GOES-15 visible satellite image at 1430 MST

5.0 Pilot Reports

There were no low-level pilot reports noted in the data base over southwestern Arizona or over southwestern California on June 23, 2016. There were several reports above 12,000 feet reported to the northeast and southeast of the region in the vicinity of the scattered cumulus clouds, which did not represent conditions over the accident site. The raw pilot reports were as follows:

GCN UA /OV GCN242037/TM 2036/FL125/TP AC90/TB LGT-MOD/RM ZLAWC=

PHX UA /OV PXR120050/TM 2313/FL170/TP GLEX/SK TOPS145/TA UNK/IC LGT RIME 170-150/RM ZAB=

FLG UA /OV FLG005042/TM 2315/FL190/TP LJ31/IC LGT RIME 190-180/RM ZAB=

6.0 Terminal Aerodrome Forecast

The closest NWS Terminal Aerodrome Forecast (TAF) was issued for the departure airport at Prescott by the NWS Flagstaff forecast office. The forecast issued at 1020 MST was as follows:

TAF KPRC 231720Z 2318/2418 21012G20KT P6SM FEW120 FEW250
FM240200 20006KT P6SM FEW250
FM241700 18010G18KT P6SM SKC=

The forecast expected southerly winds from 210° at 12 knots gusting to 20 knots, visibility unrestricted at 6 miles or more, with a few clouds at 12,000 feet agl, and at 25,000 feet through 1900 MST.

The next amended forecast was issued 1325 MST or approximately 15 minutes prior to the helicopter's departure from the airport. The forecast made a slight correction to the wind direction and speed, to 180° at 14 knots gusting to 22 knots. No other hazards or LLWS were identified in the forecast, which was as follows:

TAF AMD KPRC 232025Z 2320/2418 18014G22KT P6SM FEW100 FEW250
FM240300 20006KT P6SM FEW250
FM241700 18010G18KT P6SM SKC=

7.0 Aviation Forecast Discussion

The NWS Flagstaff forecast office issued an Area Forecast Discussion describing the general meteorological conditions relating to their forecasts issued during the period. The aviation discussion relating to the TAF is included below:

FXUS65 KFGZ 231222
AFDFGZ
Area Forecast Discussion
National Weather Service Flagstaff AZ
520 AM MST THU JUN 23 2016
.SYNOPSIS...Expect mainly dry and warm conditions heading into the weekend. Moisture will return by early next week as a more monsoonal circulation develops, leading to increased shower and thunderstorm activity.
&&
.DISCUSSION...Light westerly flow aloft will keep most moisture to the west and south of our area. Some circulation around the high to our east will keep a slight chance going mainly over the White Mtns and portions of the eastern Rim through the weekend.
By next week, the high will push back westward and amplify. This will lead to a more favorable circulation. Shower and thunderstorm activity should increase as a result.
Temperatures will remain above normal through the period, especially over the weekend.
&&
.AVIATION...For the 12Z Package...Primarily VFR for the next 24 hours. Smoke downwind of area wildfires may impact visibility at times. Isolated -SHRA/-TSRA along the Mogollon Rim and White Mtns btwn 17z-02z, with strong gusty outflow winds possible. SFC winds light til 17z then btwn 17z-02z Fri, SW 10-20kts, gusts to 25kts.
Aviation discussion not updated for TAF amendments.

8.0 Area Forecast

The Area Forecast (FA) is a forecast of VFR clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIRMET Sierra (IFR)

bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a TAF issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues specials reports as necessary usually in the form of an AIRMET. The Salt Lake City (KSLC) regional forecast that was current at the time of the accident was issued at 1245 MST and valid through 0100 MST on June 24, 2016. The forecast was as follows:

FAUS45 KKCI 231945
FA5W
-SLCC FA 231945
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 241400
CLDS/WX VALID UNTIL 240800...OTLK VALID 240800-241400
ID MT WY NV UT CO AZ NM
.
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...ALF...UPR LOW IS OVR THE WA CSTL WTRS WITH CRCLN EXTDG
INTO SRN BC. MOD SWLY JTST EXTDS FM OR CSTL WTRS-NW MT. LOW WL
MOV EWD INTO CNTRL WA BY 12Z WITH CRCLN EXTDG FM SRN BC TO CNTRL
OR. MOD SWLY JTST WL EXTD FM SW OR TO NRN ID-SRN ALTA.
SFC...CDFNT EXTDS FM WK LOW N CNTRL MT-SW ID-NRN SIERNEV. STNR
FNT EXTDS FM N CNTRL MT-NERN CO. BY 12Z LOW WL MOV TO MT/ND
BORDER. CDFNT WL EXTD SWWD TO WRN WY-W CNTRL NV-NRN SIERNEV.
.
AZ
NERN SXNS...SCT120-140 SCT CI. ISOL -TSRA. CB TOPS FL370. 03Z FEW130 SCT CI.
OTLK...VFR.
SERN SXNS...BKN120-140 TOPS FL180. ISOL -SHRA/-TSRA. CB TOPS FL360.
03Z SCT140 SCT-BKN CI. OTLK...VFR.
WRN SXNS...SKC. OTLK...VFR.
.

9.0 In-Flight Weather Advisories

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

During the period there was only a Center Weather Advisory issued by the Albuquerque (ZAB) Center Weather Service Unit for a small area of thunderstorms located over New Mexico. This advisory did not impact the route of flight and is included below. There were no other Convective SIGMETs, Severe Weather Forecast Alerts, or SIGMETs issued over Arizona, and

no AIRMETs for any organized areas of turbulence, wind shear, icing, outside of any convective activity along the route or over the accident site.

ZAB2 CWA 231855
ZAB CWA 202 VALID UNTIL 231955
FROM 57N TCS-42WNW DMN
AREA ISOLD TS...40NM WIDE. MVG LTL...TOPS TO FL450.

Figure 6 is a plot of the Convective SIGMETs issued at the time of the accident, and figure 7 and 8 the graphic AIRMETs Sierra for IFR and mountain obscuration conditions and Tango for turbulence, LLWS, and strong gusting winds, none of which were in effect for the area.

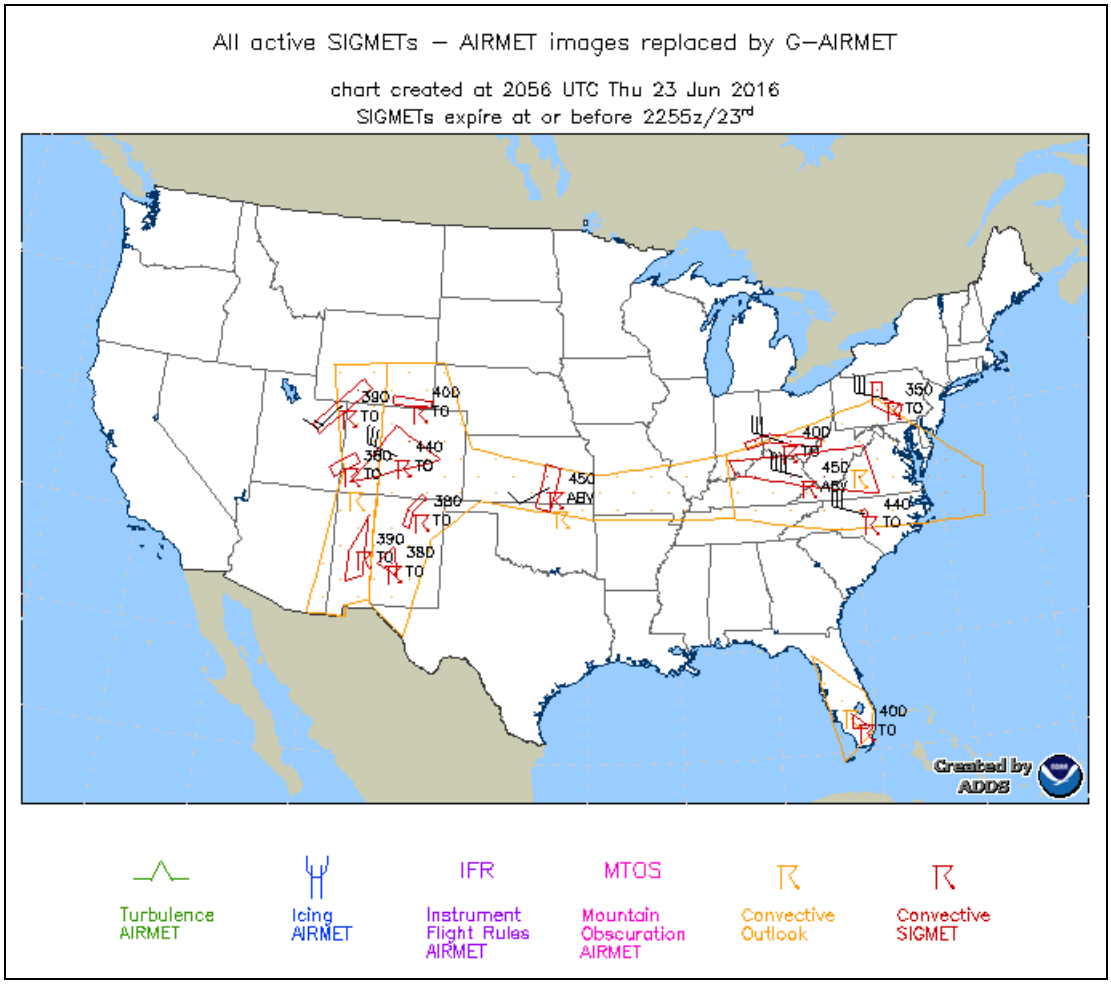

Figure 8 - NWS Convective SIGMETs current during the period

AIRMETs – are issued every 6 hours. No large areas of IFR, mountain obscuration, turbulence, LLWS, strong gusting winds, or icing conditions were identified over the region, except for near convective activity. The AIRMETs were as follows:

WAUS45 KKCI 232045

WA5S
-SLCS WA 232045
AIRMET SIERRA UPDT 3 FOR IFR VALID UNTIL 240300
.
NO SGFNT IFR EXP OUTSIDE OF CNVTV ACT.
.

WAUS45 KKCI 232045
WA5T
-SLCT WA 232045
AIRMET TANGO UPDT 3 FOR TURB VALID UNTIL 240300
.
NO SGFNT TURB EXP OUTSIDE OF CNVTV ACT.

WAUS45 KKCI 232045
WA5Z
-SLCZ WA 232045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 240300
.
NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT.
.
FRZLVL...RANGING FROM 100-175 ACRS AREA
120 ALG 30ENE BKE-40N DNJ-30S YQL
160 ALG 60SSW SSO-50SSW SSO-TUS-30W TUS-60WSW TUS
160 ALG 40SSW OAL-BVL-30NE BPI-20SW LAR-30SSE SNY
....

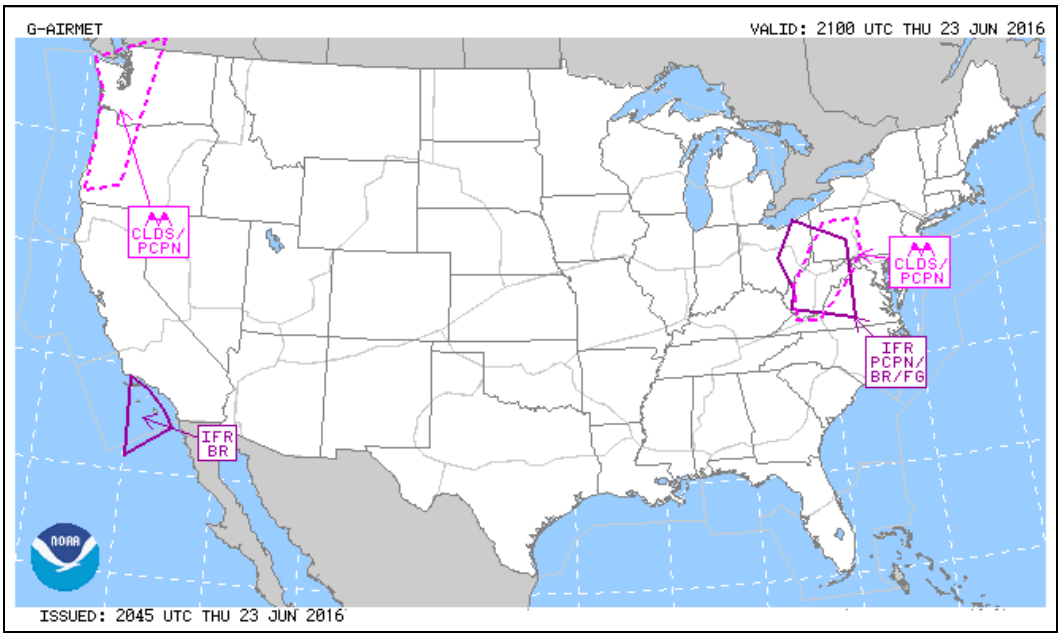

Figure 9- AIRMET Sierra for IFR and mountain obscuration conditions

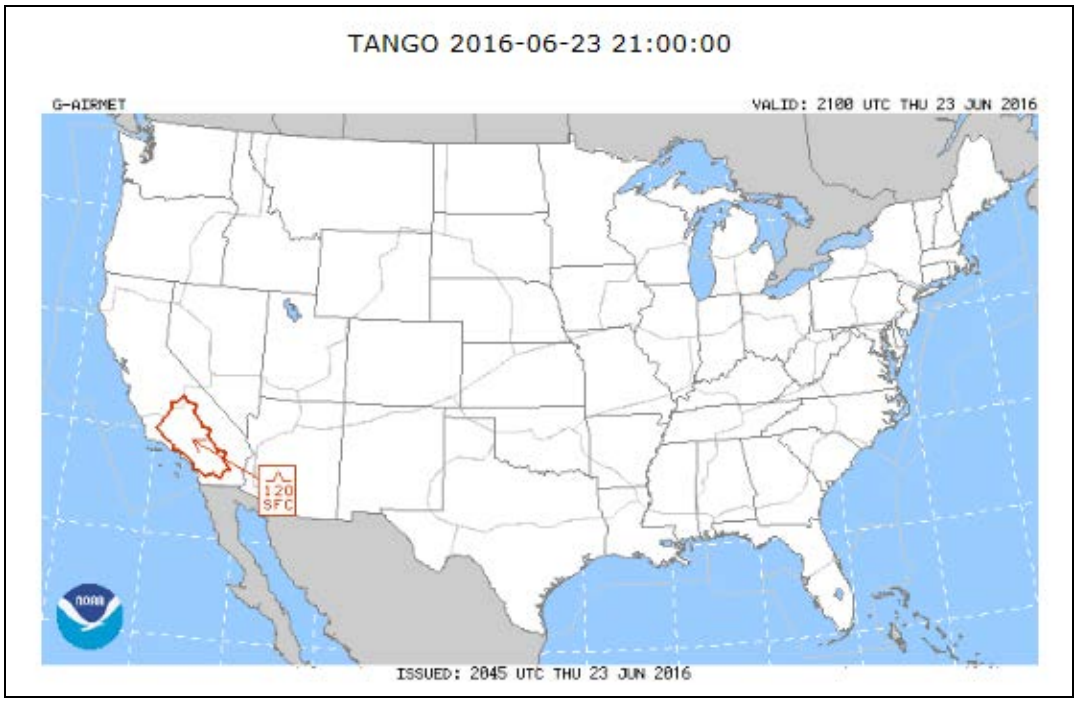

Figure 10 - AIRMET Tango for turbulence, LLWS, and strong winds

10.0 Astronomical Data

The United Stated Naval Observatory website provided the following astronomical data for Prescott, Yavapai County, Arizona on June 23, 2016:

SUN	
Beginning of civil twilight	0449 MST
Sunrise	0518 MST
Sun transit	1232 MST
Accident	1430 MST
Sunset	1946 MST
End of civil twilight	2016 MST

At the time of the accident the sun was 62° above the horizon at an azimuth of 254°.

11.0 Statements on the Weather Conditions

There were two aviation professionals who provided statements regarding the weather conditions they encountered on June 23, 2016 over southwestern Arizona. Both of the individuals were familiar with the operation of Robinson helicopters and considered reliable witnesses of the environmental conditions. The general locations of their observations are included in the map in figure 11.

The first statement came from Scott Outlaw, an airframe and powerplant (A&P) mechanic who worked in Prescott and was returning from California on Interstate highway US 60 North East towards Aguila, AZ, to the south of the accident site. Between 1500 and 1600 MST, between Wenden and Congress, AZ, he observed numerous large dust devils[13] on both sides of the road, with as many as five spotted simultaneously.

The second statement came from Andrew Stroupe, a pilot operating a Robinson R44 helicopter immediately north of the accident site performing aerial survey work. The pilot indicated that he departed from Prescott Airport (KPRC) at 0630 and flew direct to Walnut Creek Ranch arriving at 0745 MST. During that flight at an altitude of 300 to 500 feet agl, he encountered light turbulence and winds from the south-southwest at 10 to 15 knots. He indicated that around 1130 the winds became stronger and gustier in nature, and between 1330 and 1415 he observed multiple dust devils with heights that range to an estimated 500 to 1,500 feet agl. The dust devils were observed with blowing dust and debris in the vertical column. While operating approximately 37 miles north-northwest of the accident site, Mr. Stroupe indicated he experienced an updraft in excess of 1,000 feet per minute (fpm) which lasted 15 to 30 seconds, and the turbulence increased from light to moderate in intensity. He noted the airspeed and indicated it was 6 to 8 knots out of the south-southwest and increased to 40 knots in hover. With no forward speed, the winds shifted from the east-southeast to the west-southwest. He further indicated that he was operating in the foothills of the mountains, and there was no significant change in the relatively flat terrain below him during this period. He attributed this encounter to a dust devil. Slightly after the encounter at approximately 1515 MST, he decided to discontinue flying for the day and flew back to Walnut Creek Ranch. Enroute he encountered another wind shift of 090° to 130° with a 10 to 35 knot change in wind speed. He reported landing at Kingman Airport (KIGM) at 1545 MST. Mr. Stroupe indicated that his average altitude during the period was at 3,500 feet or 300 to 500 feet agl, and the outside air temperature ranged from 35° to 43° C (95° to 109° F), and the density altitude was estimated at approximately 6,500 feet.

[13] According to the American Meteorological Society, a dust devil is defined as: "A well-developed dust whirl; a small but vigorous whirlwind, usually of short duration, rendered visible by dust, sand, and debris picked up from the ground. Dust devils are occasionally strong enough to cause minor damage (up to EF0 on the Enhanced Fujita scale). Diameters range from about 3 m to greater than 30 m; their average height is about 200 m, but a few have been observed as high as 1 km or more. They have been observed to rotate anti-cyclonically as well as cyclonically. Although the vertical velocity is predominantly upward, the flow along the axis of large dust devils may be downward. Large dust devils may also contain secondary vortices. Dust devils are best developed on a hot, calm afternoon with clear skies, in a dry region when intense surface heating causes a very steep lapse rate of temperature in the lowest 100 m of the atmosphere".

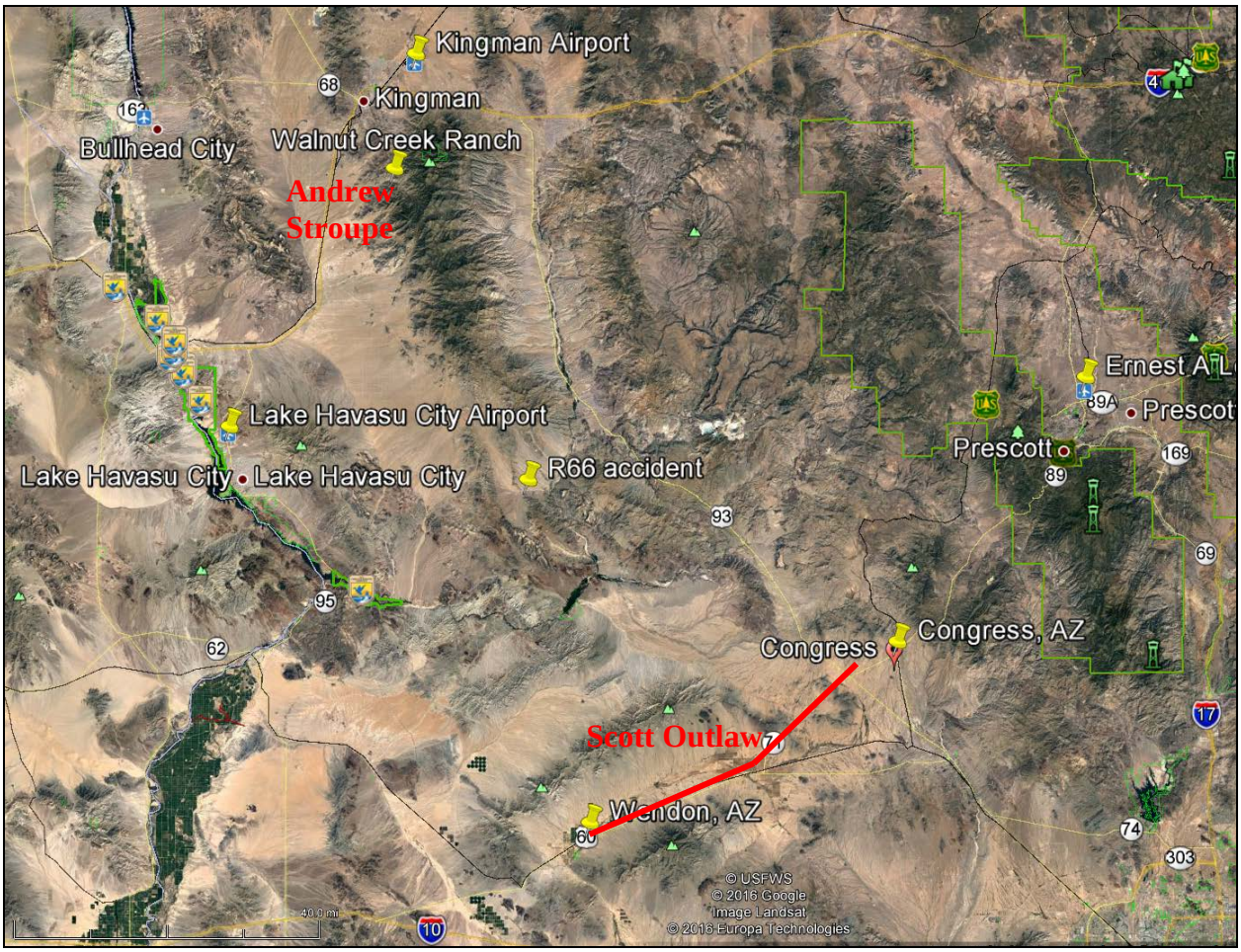

Figure 11 - Google map of witness and related airport locations

12.0 Dust Devil References

As documented in section 10.0 above from the witness statements both individuals observed significant dust devil over the flat terrain during the period, within approximately 40 miles south and north of the area where the accident occurred. A dust devil is a strong, well-formed, whirlwind of varying sizes that can range from a few feet to hundreds of feet wide, and can reach heights of several hundred feet. They often are called different names depending on their location from “dancing devils” in the Death Valley of California, “sand auger”, “dust whirl”, and internationally as “willy-willies” to “whirly-whirly” in Australia and “djin” in the middle east.

Several photographs of dust devils are included as figures 12 and 13, showing their various size diameters, vertical extent, and circulation with dirt debris. The images show vertical columns with a diameter ranging from several feet to several hundred feet, dwarfing houses, telephone and power poles in the bottom examples.

Figure 12 - Dust Devils from small barely visible tubes to well defined vortices

Figure 13 - Large Dust Devils

In the United States dust devils have been reported in every state, but are most frequently reported in the deserts and flat terrain of the southwest, with Arizona reporting the highest frequency of occurrences. The atmospheric conditions that commonly increase the likelihood of dust devil formation include; flat barren terrain, clear skies, and calm to light winds under 10 knots, and surface air temperatures over 90° F (32° C). Since dust devils are associated with intense solar heating, the maximum occurrence typically occurs between 1300 and 1400 local, at the time of maximum soil temperatures and the convective heat flux. They are also most frequent between the months of June through August in Arizona.

Dust devils have been implicated as a cause or contributing factor in approximately 50 aircraft accidents between 2000 and 2015 according to the NTSB database. While most of the events result in a loss of control on landing and cause a runway excursion, several loss of control

events have resulted in serious to fatal injuries. The highest frequency of reported events occurred in Arizona (10), New Mexico (7), Nevada (6), western Texas (6), and southern California (5).

Dust devils are also considered major hazards among skydivers as they can cause a canopy to collapse with little to no warning, at altitudes considered too low to cutaway, and contribute to serious injury or death of parachutists.

Submitted by:

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