NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 8, 2018

Weather Study

METEOROLOGY

WPR17FA066

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A. ACCIDENT

Location: Riverside, California
Date: February 27, 2017
Time: 1641 Pacific standard time
0041 Universal Coordinated Time (UTC) on February 28, 2017
Airplane: Cessna T310Q; Registration: N1246G

B. METEOROLOGIST

Don Eick
NTSB Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. SUMMARY

On February 27, 2017, about 1641 Pacific standard time, a Cessna T310Q, N1246G, was destroyed and consumed by postcrash fire during a collision with a residential area following the airplane's departure from Riverside Municipal Airport (RAL), Riverside, California. The airline transport pilot and three passengers were fatally injured and two passengers received serious injuries. The personal flight was operated under the provisions of Title 14 *Code of Federal Regulations* Part 91. Instrument meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan was filed for the cross-country flight that departed RAL at 1640, and was destined for Norman Y. Mineta Airport San Jose International Airport (SJC), San Jose, California.

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 Pacific standard time (PST) based upon the 24 hour clock, local time is +8 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 33° 57'23.28" N and longitude 117° 25'12.59" W, at an elevation of 818 ft.

E. WEATHER INFORMATION

1.0 Synoptic Conditions

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction 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 00-45H.

1.1 Surface Analysis Chart

The southwest section of the NWS WPC Surface Analysis Chart for 1600 PST (0000Z on February 28, 2017) is included in figure 1 with the approximate accident site marked by a red star. The chart depicted a low pressure system at 1004-hectopascals (hPa)[1] over southern Nevada with a cold front extending southwestward across southern California, immediately southeast of the accident site. The surrounding station models depicted light northwest winds of 5 knots or less with light to moderate rain, and overcast cloud cover. The closest station was from March Air Force Base (KRIV), located in Riverside and about 10 miles southeast of the accident site indicated light rain, overcast clouds, with a temperature and dew point of 51° Fahrenheit (F), with a sea level pressure of 1009.5-hPa.

[1] Hectopascals (hPa) is the new standard term to refer to sea level pressure and is interchangeable with the term millibars (mb) with the same units. Standard sea level pressure is 1013.25 hPa at 15° Celsius (C).

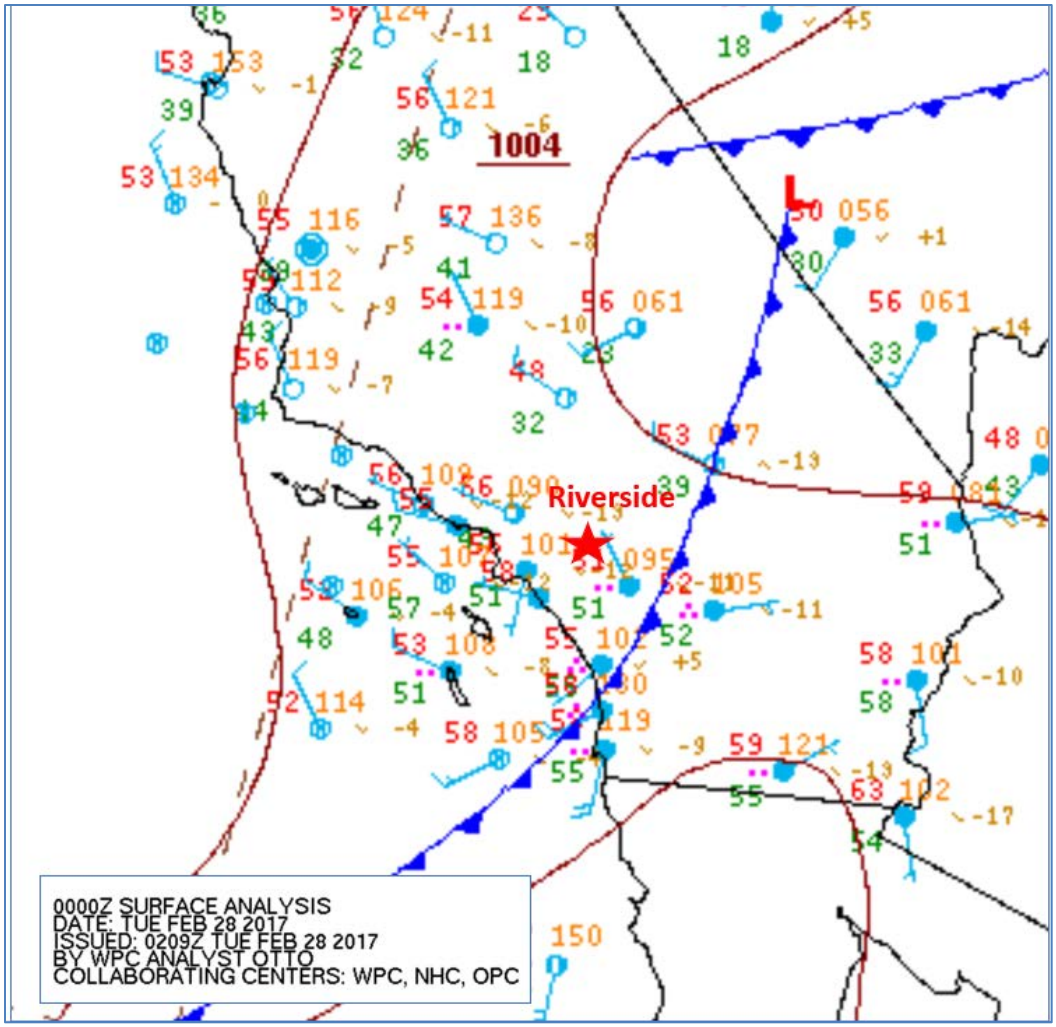

Figure 1 - Southwest section of the NWS Surface Analysis Chart for 1600 PST

1.2 National Composite Reflectivity Image

The NWS National Composite Reflectivity image obtained from the NCEI for 1640 PST on February 27, 2017 over southern California is included as figure 2 with the accident site marked by a red star. The radar image depicted a large area of echoes over southern California, Nevada, and Arizona during the period.

Figure 3 is an enlarged image of the National Composite Reflectivity image over the Riverside area with the accident site marked by a red star. The image depicted a band of echoes associated with rain over southern California, located to the north, east through the south of the accident site with several areas of strong to intense echoes depicted by the dark yellow and orange shades with echoes over 50 dBZ indicating intense to extreme intensity. A small area of echoes was identified immediately north of the accident site associated with very light intensity echoes; however, the main band of precipitation had already passed through the Riverside area at the time of the accident.

Figure 2 - NCEI National Composite Reflectivity Image for southern California for 1640 PST

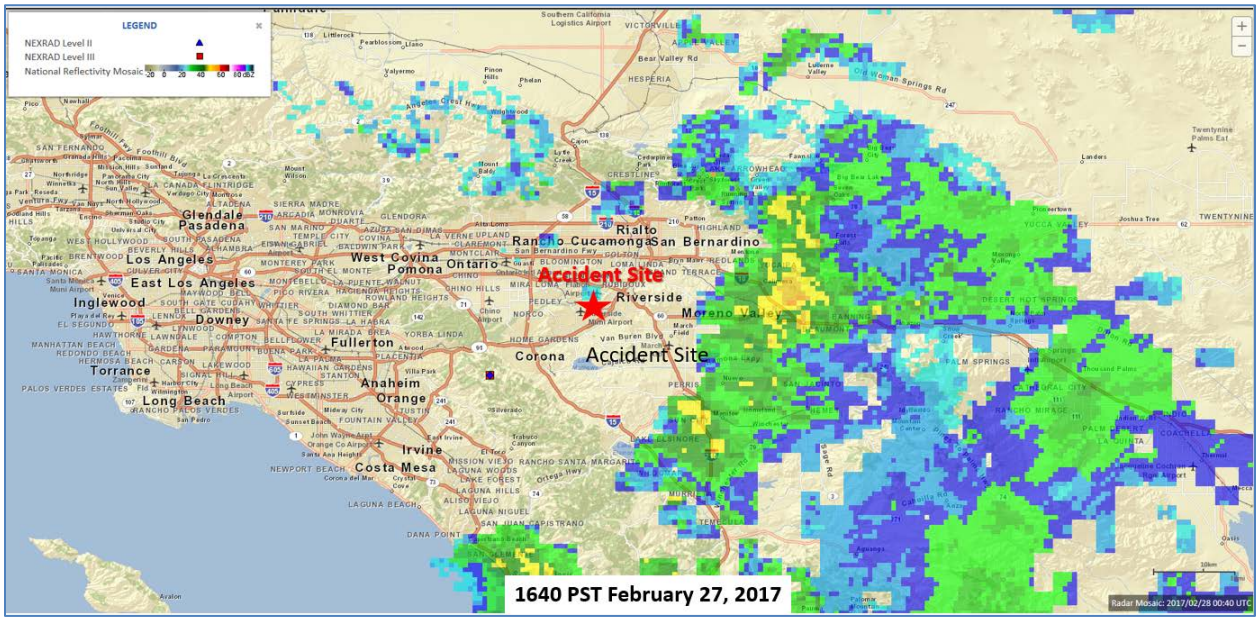

Figure 3 – Enlarge National Composite Reflectivity image over Riverside area at 1640 PST

Although no significant weather echoes were identified over the accident site, the closest weather surveillance radar to the accident site will be documented in section 5.0 of this report to verify the National composite image.

1.3 12-hour Surface Prognostic Chart

The NWS WPC 12-hour Surface Prognostic Chart valid for 2200 PST and current at the time of the accident is included as figure 4, and depicted the expected trends and movement of the pressure systems, fronts, and expected precipitation. The chart continued to depict a low pressure system associated with the cold front moving southeastward in southern Nevada, with another low pressure system developing in southern California to the south of the accident site. The chart depicted rain by the green shading with probabilities over 50% by a dark shading, which was shown over Arizona during the period. Snow was shown in blue, with freezing precipitation in purple, which was also indicated over northern Arizona, western New Mexico, Utah, and Colorado with a developing winter storm.

Except for a small area of rain over southern California the route of flight between Riverside and San Jose, California, did not expect any significant precipitation behind the cold front over the region.

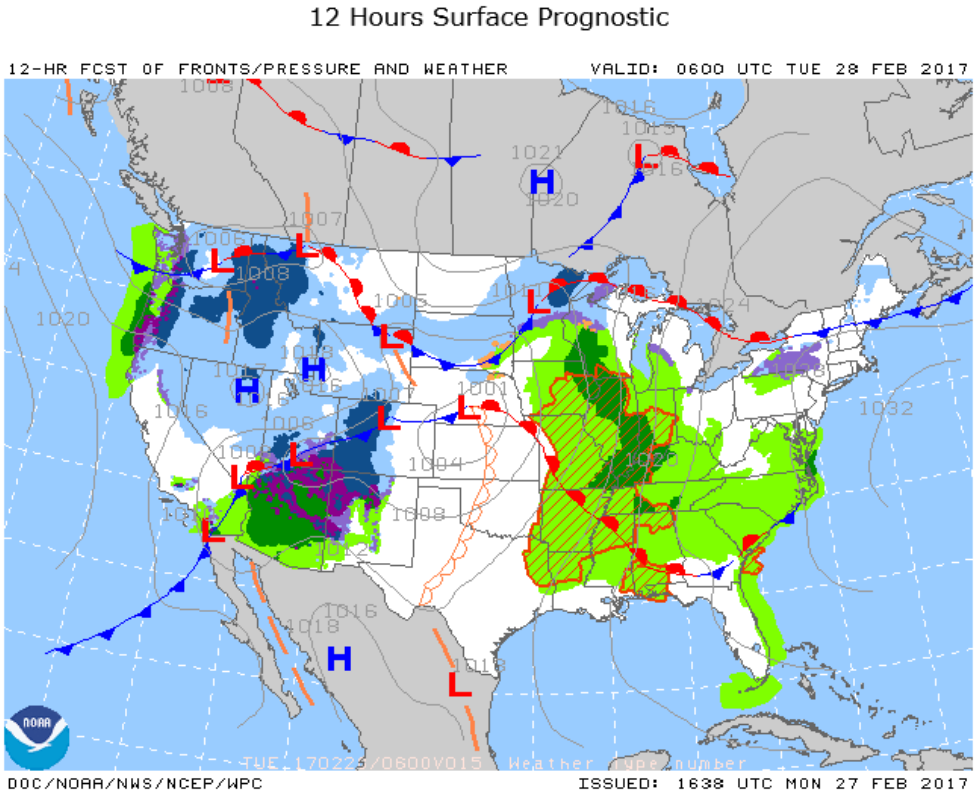

Figure 4 – NWS 12-Hour Surface Prognostic Chart valid for 2200 PST

2.0 Observations

The area was documented using the official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECI). Cloud heights are reported above ground level (agl) in the following section. The magnetic variation over the area was estimated as 14° East.

2.1 Riverside, California

The accident airplane departed from the Riverside Municipal Airport (KRAL), Riverside, California, located 1 mile south-southwest of the accident site at an elevation of 819 ft. The airport had a federally installed and maintained Automated Surface Observation System (ASOS), which was augmented by air traffic control personnel. The following conditions were reported within the hour prior to the flight's departure:

> *Riverside Municipal Airport special weather observation at 1600 PST (0000Z), wind calm, visibility 2 miles in light rain and mist, ceiling[2] overcast at 700 ft agl, temperature and dew point 11° Celsius (C), altimeter 29.83 inches of mercury (Hg). Remarks; automated observation system with a precipitation discriminator, hourly precipitation[3] less than 0.01 of an inch (trace), temperature 11.1° C, dew point 10.6° C.*
>
> *Riverside Municipal Airport special weather observation at 1637 PST (0037Z), wind calm, visibility 2 miles in light rain and mist, scattered clouds at 600 ft agl, ceiling overcast at 4,200 ft, temperature and dew point 11° C, altimeter 29.82 inches of Hg. Remarks; automated observation system with a precipitation discriminator, hourly precipitation 0.01 of an inch, temperature 11.1° C, dew point 11.1° C.*
>
> *Riverside Municipal Airport special weather observation at 1647 PST (0047Z), wind calm, visibility 2 miles in light rain and mist, scattered clouds at 600 ft agl, ceiling overcast at 4,000 ft, temperature and dew point 11° C, altimeter 29.82 inches of Hg. Remarks; automated observation system with a precipitation discriminator, hourly precipitation 0.01 of an inch.*

The raw observations and general flight categories[4] surrounding the period were as follows, with the flight categories color codes with VFR in black type, MVFR in blue, IFR in red, and LIFR in purple:

VFR *METAR KRAL 271753Z 02003KT 10SM OVC070 11/08 A2990 RMK AO2 SLP118 T01060078 10106 20078 50005=*

VFR *METAR KRAL 271853Z 00000KT 10SM FEW050 OVC060 12/08 A2990 RMK AO2 SLP118 T01170083=*

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[2] A ceiling is defined as the lowest layer of clouds reported as broken, overcast, or the vertical visibility into a surface based obscuration.

[3] At Riverside the hourly precipitation starts at hh+53, the time of the METAR observation.

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

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

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

MVFR *METAR KRAL 271953Z 00000KT 10SM -RA BKN030 OVC048 12/08 A2988 RMK AO2 RAB52 SLP111 P0000 T01170083=*

MVFR *METAR KRAL 272053Z 29003KT 4SM -RA BR FEW041 BKN048 OVC060 11/10 A2986 RMK AO2 SLP103 P0006 60006 T01060100 58015=*

MVFR *SPECI KRAL 272121Z 00000KT 10SM -RA BKN023 BKN034 OVC04111/11 A2984 RMK AO2 P0000 T01110106=*

IFR *SPECI KRAL 272151Z 24003KT 1 3/4SM +RA BR OVC020 11/10 A2984 RMK AO2 P0005=*

IFR *METAR KRAL 272153Z 00000KT 1 1/4SM +RA BR FEW014 OVC020 11/10 A2983 RMK AO2 SLP094 P0007 T01060100=*

IFR *METAR KRAL 272253Z 00000KT 1 1/4SM RA BR FEW014 OVC020 11/11 A2982 RMK AO2 SLP092 P0013 T01060106=*

IFR *SPECI KRAL 272300Z 00000KT 2SM -RA BR FEW003 BKN025 OVC060 11/11 A2982 RMK AO2 P0000 T01060106=*

IFR *METAR KRAL 272353Z AUTO 20004KT 2SM -RA BR FEW003 BKN025 OVC060 11/11 A2983 RMK AO2 SLP092 P0003 60029 T01110111 10117 20106 55010=*

IFR ***SPECI KRAL 280000Z 00000KT 2SM -RA BR OVC007 11/11 A2983 RMK AO2 P0000 T01110106=***

IFR ***SPECI KRAL 280037Z 00000KT 2SM -RA BR SCT006 OVC042 11/11 A2982 RMK AO2 P0001 T01110111=***

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IFR ***SPECI KRAL 280047Z 00000KT 2SM -RA BR SCT006 OVC040 11/11 A2982 RMK AO2 P0001=***

IFR *METAR KRAL 280053Z 00000KT 2SM BR FEW006 BKN045 OVC050 11/11 A2982 RMK AO2 RAE52 SLP091 P0001 T01110111=*

VFR *SPECI KRAL 280100Z 20003KT 8SM SCT006 BKN045 OVC050 11/11 A2983 RMK AO2 T01110111=*

VFR *METAR KRAL 280153Z 00000KT 9SM SCT041 BKN055 OVC070 11/11 A2982 RMK AO2 SLP090 T01110111=*

VFR *SPECI KRAL 280205Z 18003KT 9SM -RA SCT004 SCT040 OVC070 11/11 A2983 RMK AO2 RAB03 P0000 T01110111=*

VFR *METAR KRAL 280253Z 22003KT 6SM -RA BR BKN034 OVC046 11/11 A2982 RMK AO2 RAB03E19B46 SLP090 P0000 60001 T01110111 55001=*

VFR *SPECI KRAL 280316Z 00000KT 10SM SCT008 OVC036 11/11 A2983 RMK AO2 RAE06 P0001 T01110111=*

VFR *METAR KRAL 280353Z 00000KT 8SM FEW043 BKN080 OVC100 11/11A2982 RMK AO2 RAE06 SLP091 P0001 T01110111=*

A review of the observations indicated that rain began at 1152 PST and continued through 1652 PST, with a period of heavy rain about 2 ½ hours prior to the accident, and very light precipitation and mist at the time of the accident. During the period of the rain, IFR conditions prevailed at

KRIV primarily due to visibility restrictions, with a low ceiling overcast at 700 ft agl within the hour prior to the accident. The total rainfall at the time of the accident up until the accident was 0.30 inches of precipitation. Immediately after the accident, between 1803 through 1906 PST another period of light rain was reported with an additional 0.01 inches or precipitation, with VFR conditions during this period.

2.2 Ontario, California

Ontario International Airport (KONT), Ontario, California was located about 9 miles northwest of KRAL at an elevation of 819 ft, and also had an ASOS. At the approximate time of the accident the following conditions were reported:

> *Ontario International Airport weather observation at 1653 PST, wind from 200° at 3 knots, visibility 3 miles in mist, ceiling overcast at 300 ft agl, temperature and dew point 11° C, altimeter 29.82 inches of Hg. Remarks; automated observation system with a precipitation discriminator, rain ended at 1631 PST, sea level pressure 1009.8-hPa, visibility east 2 miles, present weather rain showers in the vicinity, hourly precipitation less than 0.01 of an inch, temperature 10.6° C, dew point 10.6° C.*

At the time of the accident LIFR conditions prevailed at KONT due to low overcast ceilings at 300 ft agl and reduced visibility in mist. The general flight categories and raw observation in standard code and abbreviations surrounding the period were as follows:

MVFR *KONT 271753Z 31003KT 10SM FEW016 BKN023 BKN032 11/07 A2991 RMK AO2 RAB25E52 SLP129 VCSH NW-NE P0000 60000 T01060067 10106 20083 51006*

MVFR *METAR KONT 271853Z 00000KT 10SM SCT019 BKN025 BKN060 11/07 A2990 RMK AO2 RAB1754E04 SLP128 VCSH NE AND NW P0000 T01110067*

VFR *METAR KONT 271953Z 15004KT 10SM FEW019 SCT025 BKN040 12/07 A2988 RMK AO2 SLP118 VCSH S-SW T01170072*

IFR *SPECI KONT 272008Z 19004KT 2 1/2SM R26L/6000VP6000FT RA BR FEW019 BKN025 OVC040 11/07 A2988 11/07 A2988 RMK AO2 RAB02 P0001 T01110072*

IFR *SPECI KONT 272010Z 18004KT 2SM R26L/5000VP6000FT RA BR FEW019 BKN025 OVC040 11/07 A2988 RMK AO2 RAB02 P0001 T01110072*

IFR *SPECI KONT 272019Z 17004KT 1 1/2SM +RA BR FEW012 BKN025 OVC040 11/08 A2987 RMK AO2 RAB02 P0006 T01060078*

IFR *SPECI KONT 272032Z 18005KT 2 1/2SM RA BR FEW012 BKN025 OVC040 10/09 A2987 RMK AO2 RAB02 P0009 T01000089*

IFR *SPECI KONT 272045Z 19004KT 2 1/2SM RA BR FEW006 SCT014 BKN030 10/09 A2986 RMK AO2 RAB02 P0010 T01000094*

IFR *METAR KONT 272053Z 18005KT 1 3/4SM RA BR SCT006 SCT016 BKN025 10/09 A2986 RMK AO2 RAB02 SLP113 P0013 60013 T01000089 58015*

IFR *SPECI KONT 272108Z 00000KT 2 1/2SM RA BR FEW006 SCT016 BKN030 10/10 A2984 RMK AO2*

P0004 T01000100

MVFR *SPECI KONT 272113Z 00000KT 4SM -RA BR FEW006 SCT016 BKN030 10/10 A2984 RMK AO2*

IFR *SPECI KONT 272128Z 00000KT 1 3/4SM R26L/5500VP6000FT RA BR FEW006 SCT016 BKN030 10/09 A2984 10/09 A2984 RMK AO2 P0006 T01000094*

IFR *SPECI KONT 272144Z 00000KT 1 3/4SM RA BR BKN005 BKN020 OVC038 10/09 A2983 RMK AO2 P0009 T01000094*

IFR *METAR KONT 272153Z 00000KT 1 3/4SM RA BR BKN005 BKN020 OVC038 10/09 A2983 RMK AO2 SLP104 P0011 T01000094*

LIFR *SPECI KONT 272227Z 18005KT 4SM -RA BR BKN005 OVC020 10/09 A2982 RMK AO2 CIG 003V007 P0002 T01000094*

LIFR *METAR KONT 272253Z 22004KT 1 1/2SM -RA BR OVC005 10/10 A2982 RMK AO2 SLP102 CIG 003V007 P0002 T01000100*

LIFR *SPECI KONT 272349Z 19004KT 3SM -RA BR BKN003 OVC030 11/11 A2981 RMK AO2 P0003*

LIFR *METAR KONT 272353Z 19004KT 3SM -RA BR BKN003 OVC030 11/11 A2982 RMK AO2 SLP098 VIS E 2 P0003 60029 T01060106 10122 20094 56014*

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LIFR *METAR KONT 280053Z 20003KT 3SM BR OVC003 11/11 A2982 RMK AO2 RAE31 SLP098 VIS E 2 PRESENT WX VCSH P0000 T01060106*

LIFR *METAR KONT 280153Z 20005KT 5SM BR BKN003 OVC030 11/11 A2982 RMK AO2 SLP098 T01110111*

IFR *SPECI KONT 280234Z 22006KT 10SM BKN008 OVC015 11/11 A2981 RMK AO2 CIG 005V010*

IFR *METAR KONT 280253Z 22007KT 7SM VCFG BKN008 OVC015 11/11 A2981 RMK AO2 SLP096 CIG 005V010 60000 T01110106 58002*

MVFR *SPECI KONT 280348Z 25004KT 5SM BR SCT008 BKN040 11/11 A2982 RMK AO2 SCT V BKN*

MVFR *METAR KONT 280353Z 24005KT 5SM BR SCT008 BKN040 11/11 A2982 RMK AO2 SLP099 T01060106*

MVFR *METAR KONT 280453Z 26008KT 5SM BR SCT008 BKN015 OVC080 10/09 A2982 RMK AO2 SLP099 BKN V SCT T01000094*

3.0 Sounding

The closest upper air observations or soundings was from the NWS Montgomery-Gibbs Executive Airport (KMYF), San Diego, site number 72293, located about 66 miles south of the accident site, and Vandenberg Air Force Base (KVBG), Lompoc, site number 72393, located 162 miles northwest of the accident site. Given the synoptic conditions at the time of the accident, the San Diego sounding was located in the warm air sector ahead of the cold front and Vandenberg in the cold air sector but outside the frontal system influence, and both did not represent the upper conditions or wind field over the Riverside area at the time of the accident. Therefore, a High Resolution Rapid Refresh (HRRR) numerical model was obtained from the NOAA Air Resource

Laboratory database for the approximate location of the accident for 1600 PST (0000Z on February 28, 2017) and plotted on a standard Skew-T log P diagram[5] from the surface to 500-hPa or 18,000 ft utilizing RAOB software[6]. The sounding is included as figure 5.

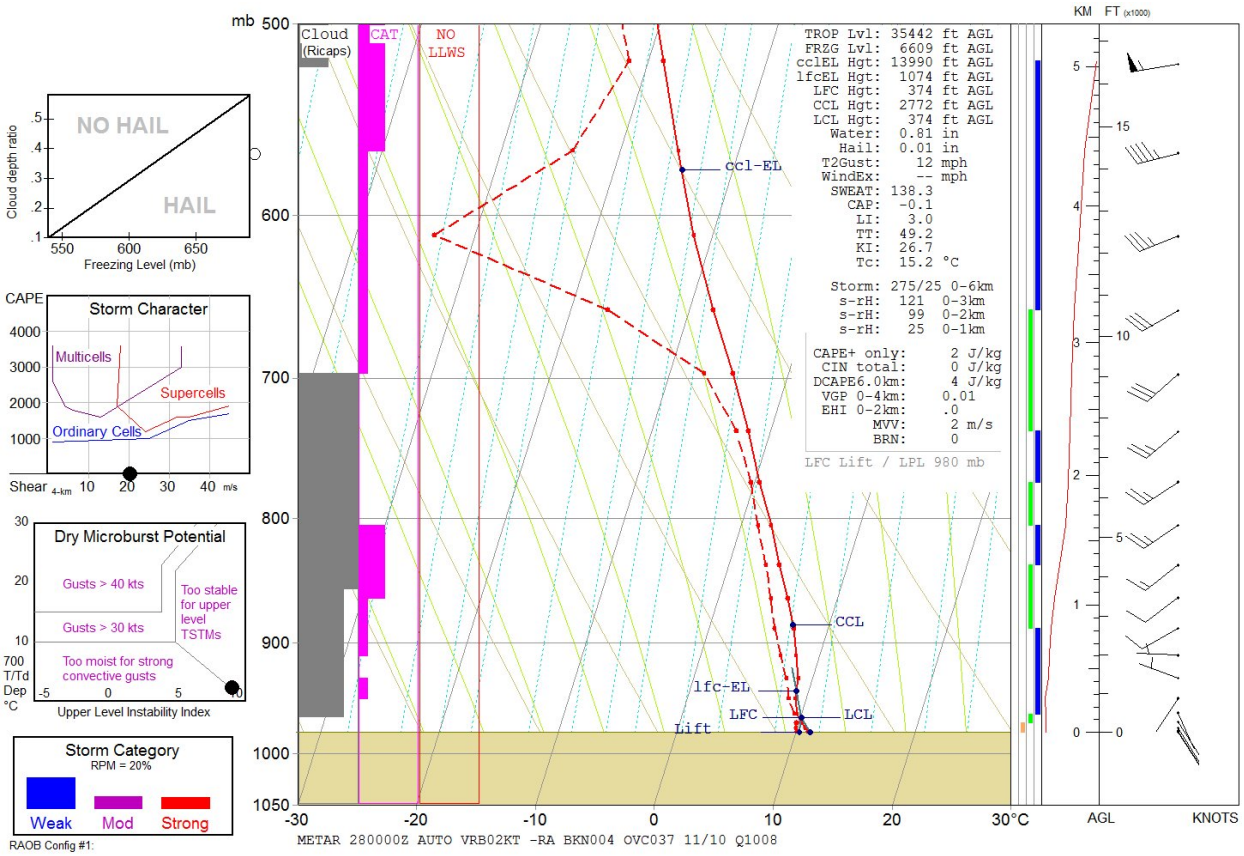

Figure 5 - HRRR numerical model sounding for 1600 PST over the accident site

The HRRR numerical model depicted a variable wind at 2 knots, a surface temperature of 11.2° C (52.2° F), a dew point temperature of 10.3° C (50.5° F), and a relative humidity of 94%. The sounding depicted a moist low-level environment with relative humidity greater than 90% from the surface to 9,000 ft, and between 28,000 to 32,000 ft. The precipitable water content was 0.81 inches. The lifted condensation level (LCL)[7] and level of free convection (LFC)[8] were identified

[5] 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.

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

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

[8] 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.

at approximately 400 ft agl, with the convective condensation level (CCL)[9] at 2,774 ft agl. With the expected top of the clouds or equilibrium level at 9,000 ft. The freezing level was identified at about 7,400 ft with potential icing in-clouds and in-precipitation above this level. The atmosphere was characterized as stable based on the Lifted Index (LI) of +3.0 and supported nimbostratus type clouds. The sounding estimated a ceiling broken at 400 ft agl and overcast clouds at 1,700 ft with visibility restricted in light rain and mist.

The HRRR model wind profile indicated light winds below 1,000 ft agl, with westerly winds with increasing speeds above 20 knots with height above 6,000 ft. Below 3,000 ft the HRRR model did not detect any strong vertical wind shears to support anything other than light turbulence, and no significant low-level wind shear was identified. The mean 0 to 6 kilometer or 18,000 ft winds were from 245° at 34 knots. The maximum wind was identified at about 38,600 ft from 250° at 107 knots, which was located above the tropopause at 35,400 ft.

The HRRR model data parameters of height (ft msl), pressure (mb), temperature (°C), dew point (°C), relative humidity (RH%), wind direction and speed, clear air turbulence (CAT) potential, icing intensity and type from the surface through 18,000 ft is included in figure 6.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
794	980	11.2	10.3	94	149 / 2			
822	979	11.0	10.1	94	149 / 2			
906	976	10.7	9.9	95	150 / 2			
1047	971	10.2	9.8	97	149 / 2			
1273	963	9.6	9.4	99	157 / 2			
1672	949	9.1	8.5	96	212 / 1	LGT		
2193	931	8.8	7.8	93	292 / 5			
2783	911	8.0	6.7	91	273 / 6	LGT		
3475	888	7.1	5.5	90	238 / 8	LGT		
4245	863	5.8	4.4	91	231 / 11	MDT		
5098	836	4.2	3.1	93	230 / 17	MDT		
6105	805	2.5	1.4	92	234 / 23			
7179	773	0.4	-0.3	95	235 / 26			
8466	736	-1.9	-2.9	93	228 / 27			TRC Rime
9881	697	-4.7	-7.1	83	227 / 29	LGT		
11438	656	-8.0	-16.9	49	238 / 32	LGT		
13237	611	-11.6	-33.4	15	247 / 37	LGT		
15236	564	-15.1	-24.0	47	254 / 43	MDT		
17332	518	-18.7	-21.6	78	260 / 55	MDT		LGT Rime
19226	479				253 / 68			

Figure 6 - HRRR model parameters

The HRRR sounding temperature and moisture profile also indicated a severe or high potential for carburetor type icing conditions from the surface to 9,000 ft, which could potentially impact non-fuel injected reciprocating engine performance.

[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.

4.0 Satellite Imagery

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 in Madison, Wisconsin, and processed using the 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 and reviewed. 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.

The GOES-15 infrared satellite image at 1630 PST (0030Z) at 2X magnification with the frontal positions overlaid is included as figure 7. The image depicted an extensive area of clouds over southern California along the cold front with clouds extending over the accident site and to about 120 miles north to near Bakersfield (KBFL) with low stratus, nimbostratus, and high cirriform type clouds. The radiative cloud top temperature over the accident site was recorded at 230° Kelvin or -43.16° C, which corresponded to cloud tops near 29,000 ft.

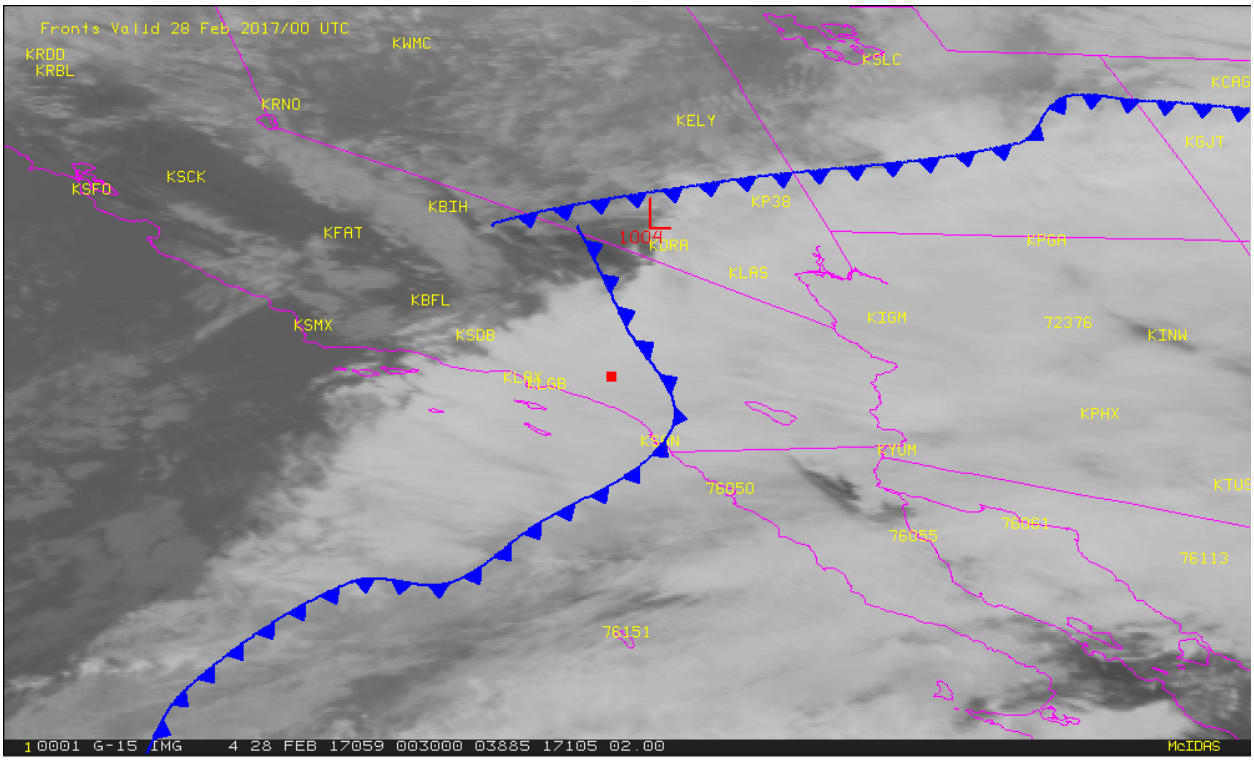

Figure 7 - GOES-15 infrared image at 1630 PST at 2X magnification

Figure 8 is the GOES-15 visible image at 4X magnification at 1630 PST and depicted a thick layer of clouds extending over the accident site consistent with nimbostratus type clouds producing rain across the area.

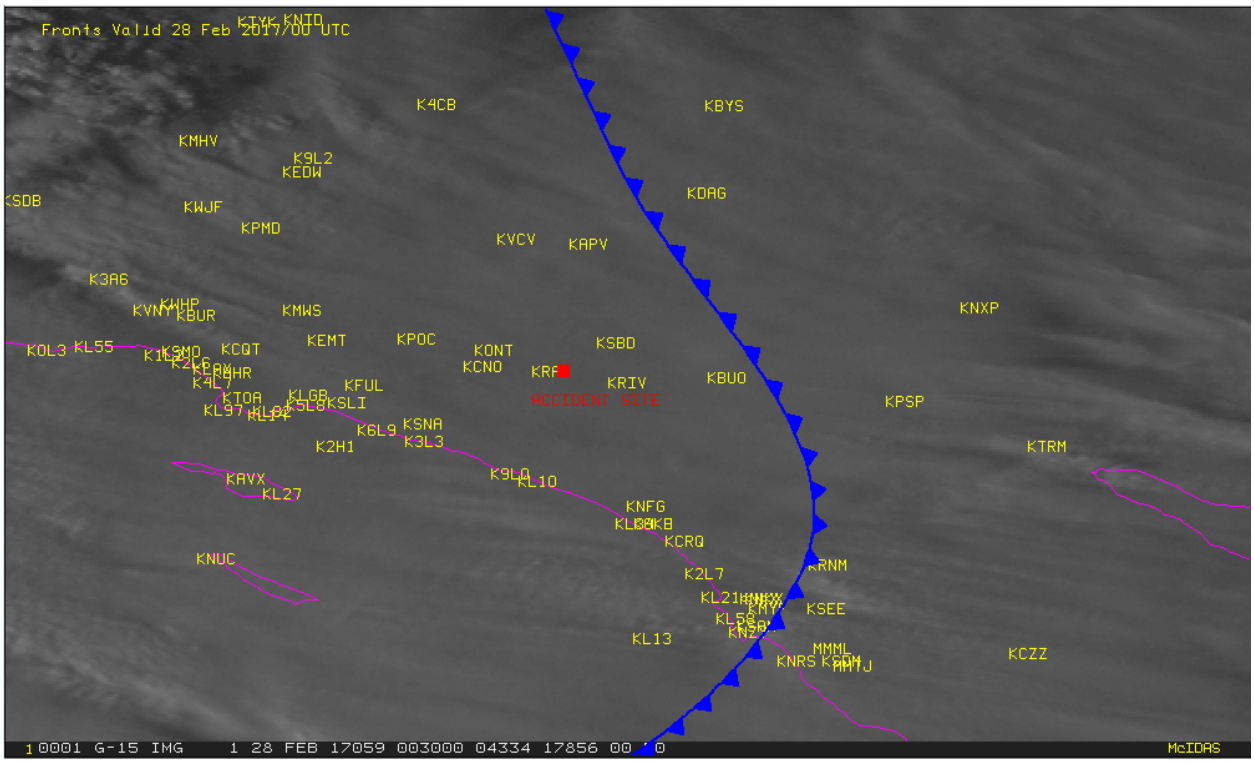

Figure 8 - GOES-15 visible image at 1630 PST

5.0 Weather Radar Imagery

The closest Weather Surveillance Radar-1988, Doppler (WSR-88D) to the accident site was the NWS Santa Ana Mountains (KSOX) site location about 14 miles southwest of the accident site. The level II archive data was obtained from the NCEI using the Hierarchical Data Storage System 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.

5.1 Precipitation Modes

The WSR-88D operates in several different scanning modes, identified as Mode A "precipitation" and Mode B "clear air". Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four minutes. This particular scanning strategy is documented as volume coverage pattern 12 (VCP-12). During the period surrounding the time of the accident, the KSOX WSR-88D was operating in this precipitation mode VCP-12.

5.2 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors, 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), and is a general measure of echo intensity. The following table is referenced for pilots in Advisory Circular AC 00-24C – "Thunderstorms".

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
< 30 dBZ	Light
30 – 40 dBZ	Moderate
>40 – 50 dBZ	Heavy
>50 dBZ	Extreme

Figure 9 is the KSOX WSR-88D 0.5° base reflectivity image for 1642 PST depicted an area of strong echoes about 20 miles east and northeast of the accident site (marked by a red star) with echoes of 45 to 50 dBZ associated with heavy rain and potential embedded convection. Over the accident site a large area of very light intensity echoes with reflectivity's of -10 to 15 dBZ, which were indictive of drizzle and low stratiform type clouds and mist. Echoes of 20 to 30 dBZ likely associated with rain were also identified approximately 5 miles north and south of the accident site.

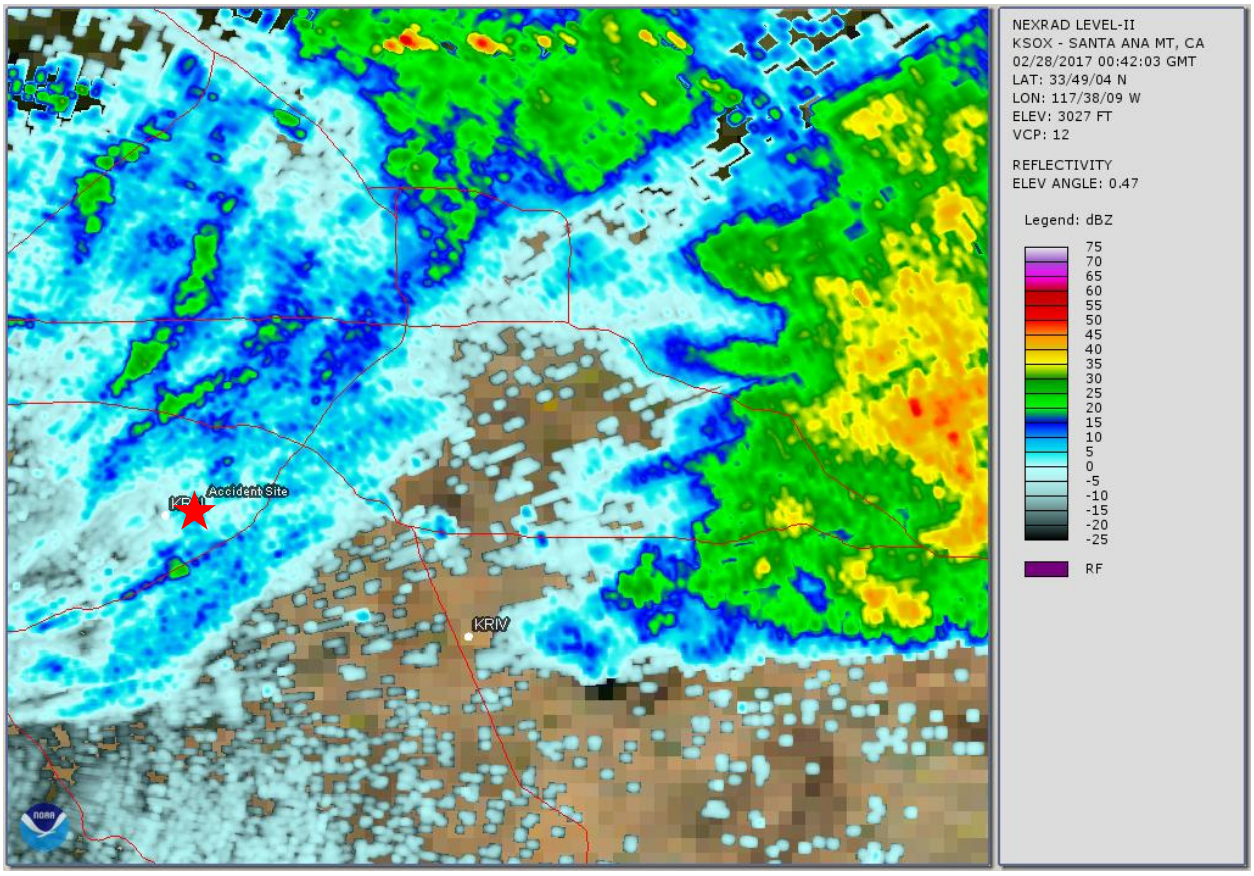

Figure 9 - KSOX WSR-88D 0.5° base reflectivity image at 1642 PST

6.0 Pilot Reports

There were numerous pilot reports (PIREPs) issued over southern California surrounding the period. The following reports between 1100 through 1900 PST below 18,000 ft were recorded. The reports are in standard code and abbreviations:

KLGB UA /OV SLI230010/TM 1900/FL035/TP C172/SK BKN/RM BASES 035

NID UUA /OV EDW320050/TM 1915/FL085/TP BE35/TB SEV/RM COR SA-ID AND MSG TYPE. ZLA CWSU

KONT UA /OV BANDS/TM 1950/FL140/TP E55P/TB MOD TURB FL180-140

GXA UA /OV POM345010/TM 2016/FL170/TP B737/TB LGT-MOD/RM FL 170-250 AWC-WEB/

LAX UA /OV 35 EAST/TM 2027/FL100/TP E175/TA M3/IC LIGHT RIME

SBP UA /OV SBP140010/TM 2033/FL080/TP SR22/SK SKC/WX FV99SM/TA M07/WV 32524KT/TB NEG/IC LGT RIME

MRY UA /OV MRY001001/TM 2040/FL080/TP DA40/TA M06/TB MOD CHOP/IC LGT RIME

RAL UA /OV KHMT/TM 2127/FL110/TP PC12/TA -7/IC LIGHT RIME

PSP UA /OV PSP290025 /TM 2202 /FL140 /TP H25B /TB LGT 140 /RM ZLAWC AWC-WEB

SJC UA /OV SJC100035/TM 2204/FL080/TP CL30/TA M8/IC LGT RIME

SBA UA /OV SBA040010/TM 2210/FL080/TP SR22/TA M01/IC LGT RIME

CMA UA /OV CMA360002/TM 2213/FL080/TP C172/SK OVC-TOP075/TA M01/TB NEG/IC TRACE RIME 065-075/RM DURC

PSP UA /OV PSP290025/TM 2216/FL160/TP C510/TB MOD 160/RM ZLAWC AWC-WEB/

IZA UA /OV RZS300005/TM 2240/FL060/TP C172/IC MOD ICING

SNA UA /OV SNA/TM 2245/FL110/TP B350/IC LIGHT RIME ICING

EDW UA /OV L26/TM 2310/FL110/TP TBM8/TA M7/IC LGT MIX

FAT UA /OV FAT130040/TM 2320/FL110/TP CRJ9/TA M12/IC TRACE RIME

IGM UA /OV HEC250020 /TM 2336 /FL160 /TP CL30 /TA M08 /IC MOD RIME /RM ZLAWC AWC-WEB

IGM UA /OV PDZ162020 /TM 2355 /FL170 /TP B737 /TB MOD /RM ZLAWC AWC-WEB

SJC UA /OV SJC105030/TM 2358/FL090/TP B712/TA 03/IC LGT RIME/RM DURD LGT RIME BETWEEN 090 TO 070

Accident 0041Z

RIV UA /OV HMT/TM 0053/FL140/TP BE20/TA -4/IC LT RIME ICING 105 TO 140

SNA UA /OV SNA160010/TM 0102/FL075/TP BE9L/IC LGT RIME 075

SLI UA /OV SLI175017/TM 0116/FL125/TP A319/TB MOD 125

RAL UA /OV REI/TM 0250/FL100/TP P46T/TA -6/IC LGT RIME

There were 2 reports of encounters with a trace of rime type ice, 12 reports of light rime, 1 report of light mixed type icing, and 2 reports of moderate rime icing conditions. The altitude of the encounters ranged from 6,000 ft through 16,000 ft, with the majority of the reports occurring at 8,000 ft and 11,000 ft. There were also 7 reports of turbulence during the period; 4 reports characterized the turbulence as moderate, and one reported it as severe at 8,500 ft. There were no significant PIREPs noted below 5,000 ft, and no low-level wind shear or strong turbulence was reported in the vicinity of the accident site.

7.0 NWS Forecasts and Advisories

The aviation weather forecast products issued by the NWS San Diego Weather Forecast office (WFO) responsible for the Riverside area and the issuance of the Terminal Aerodrome Forecast (TAF), the NWS Aviation Weather Center (AWC) for the enroute forecast and inflight weather advisories, and NWS NCEP winds and temperature aloft forecast during the period were documented.

7.1 Terminal Aerodrome Forecast

The NWS San Diego WFO was responsible for the Riverside area and the closest TAF was issued for KONT, about 9 miles northwest of the accident site. The forecasts current during the period was as follows:

KONT 272103Z 2721/2824 23011KT 4SM RA BR BKN023 BKN040
TEMPO 2721/2724 2SM RA BR BKN015
FM280000 VRB04KT 5SM -SHRA BR SCT015 BKN025
FM280500 VRB05KT P6SM BKN020
FM281800 VRB06KT P6SM SCT030=

The forecast was issued at 1302 PST (2103Z) and s valid for a 27-hour period, beginning at 1300 PST. The forecast valid for 1600 PST or the time of the accident expected MVFR conditions to prevail with light and variable winds at 4 knots or less, visibility of 5 miles in light rain showers and mist, with scattered clouds at 1,500 ft agl, and a ceiling broken at 2,500 ft.

The next scheduled forecast for KONT was issued at 1537 PST or immediately prior to the accident and was as follows:

TAF KONT 272337Z 2800/0106 VRB04KT 3SM -RA BR OVC010
FM280100 VRB04KT 5SM -SHRA BR SCT010 BKN020
FM280500 VRB04KT P6SM BKN020
FM281800 VRB04KT P6SM SCT030=

The forecast continued to expect MVFR conditions to prevail with light and variable winds, visibility 3 miles in light rain and mist, with a ceiling overcast at 1,000 ft agl at the time of the accident.

7.2 Area Forecast

The NWS Area Forecast issued by the AWC at 1245 PST was as follows:

FAUS46 KKCI 272045
FA6W
-SFOC FA 272045
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 281500
CLDS/WX VALID UNTIL 280900...OTLK VALID 280900-281500
WA OR CA AND CSTL WTRS
.
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..LRG TROF EXTDG NELY TO SW ACRS CNTRL CA AND CSTL WTRS. MOD-STG SW FLOW E OF TROF. MOD NW FLOW W OF TROF. LIGHT W-NW FLOW VCNTY TROF. BY 15Z TROF AXIS WILL BE OVR SERN CA. LRG RIDGE BUILDING IN ELSW.
SFC..LOW PRES SRN CA CSTL WRS WITH CDFNT EXTDG SWWD. WK STNR FNT CNTRL CA. BY 15Z WK WRMFNT PAC NW CSTL WTRS. WK HI PRES ELSW.
…..
NRN CA...STS-SAC-TVL LN NWD
CSTL SXNS...
N HLF...BKN025 TOP 140. WDLY SCT -SHRA. BKN020. SCT -SHRA. OTLK..MVFR CIG SHRA.
S HLF...SCT050. 02Z SCT050 BKN100 TOP 140. ISOL -SHRA. OTLK...VFR SHRA.
SAC VLY...SCT050. BECMG 2302 SCT050 BKN100 TOP 140. ISOL -SHRA. OTLK...VFR SHRA.
SHASTA-SISKIYOUS-NERN CA...BKN085 TOP 140. BECMG 2302 SCT065 BKN080 TOP 160. VIS 5SM WDLY SCT -SHSN. OTLK...MVFR CIG SHSN.
NRN SIERNEV...SCT095 SCT CI. 04Z BKN130 TOP FL180. OTLK...VFR.
.
CNTRL CA
CSTL SXNS...SCT025 SCT060. OTLK...VFR.
SAN JOAQUIN VLY...
N HLF...SCT060. OTLK...VFR.
S HLF...SCT060 BKN080 TOP 160. 03Z SCT080. OTLK...VFR.
SRN SIERNEV...SCT085 BKN110 TOP 160. BECMG 0205 SCT120. OTLK...VFR.
.
SRN CA..VBG-NID-60NNW BIH LN SWD
CSTL SXNS...
N HLF...SCT015 BKN050 TOP FL220. WDLY SCT -SHRA. 02Z BKN025 TOP 040. OTLK...MVFR CIG.
S HLF...OVC010 TOP FL220. VIS 3-5SM -RA. 06Z BKN025 TOP 040. OTLK...MVFR CIG.
INTR MTNS-MOJAVE-SRN DESERTS...
N HLF...SCT-BKN CI. OTLK...VFR.
S HLF...BKN080 TOP FL220. ISOL -SHRA. 06Z SCT080 SCT CI. OTLK...VFR.
IMPERIAL-COACHELLA VLYS...SCT025 BKN060 TOP FL220. -RA. WND SW G25KT. OTLK...VFR.

The forecast for southern California in the Riverside area expected overcast skies at 1,000 ft msl with tops to 22,000 ft, with visibility 3 to 5 miles in light rain through 2200 PST. The weather conditions were improving further north over central California in the destination area.

7.3 Inflight Weather Advisories

The NWS AWC had the following Airman Meteorological Information (AIRMETs) current during the period; AIRMET Sierra update 4 for IFR conditions and mountain obscuration (figure 10), AIRMET Tango for moderate turbulence from the surface to 24,000 ft (figure 11), and AIRMET Zulu for moderate icing between the freezing level which extended between 6,000 to 8,000 ft through 22,000 ft (figure 12). There were no Significant Meteorological Advisories (SIGMETs), Convective SIGMETs, Center Weather Advisories (CWA), or Severe Weather Forecast Alerts (AWW) current surrounding the period.

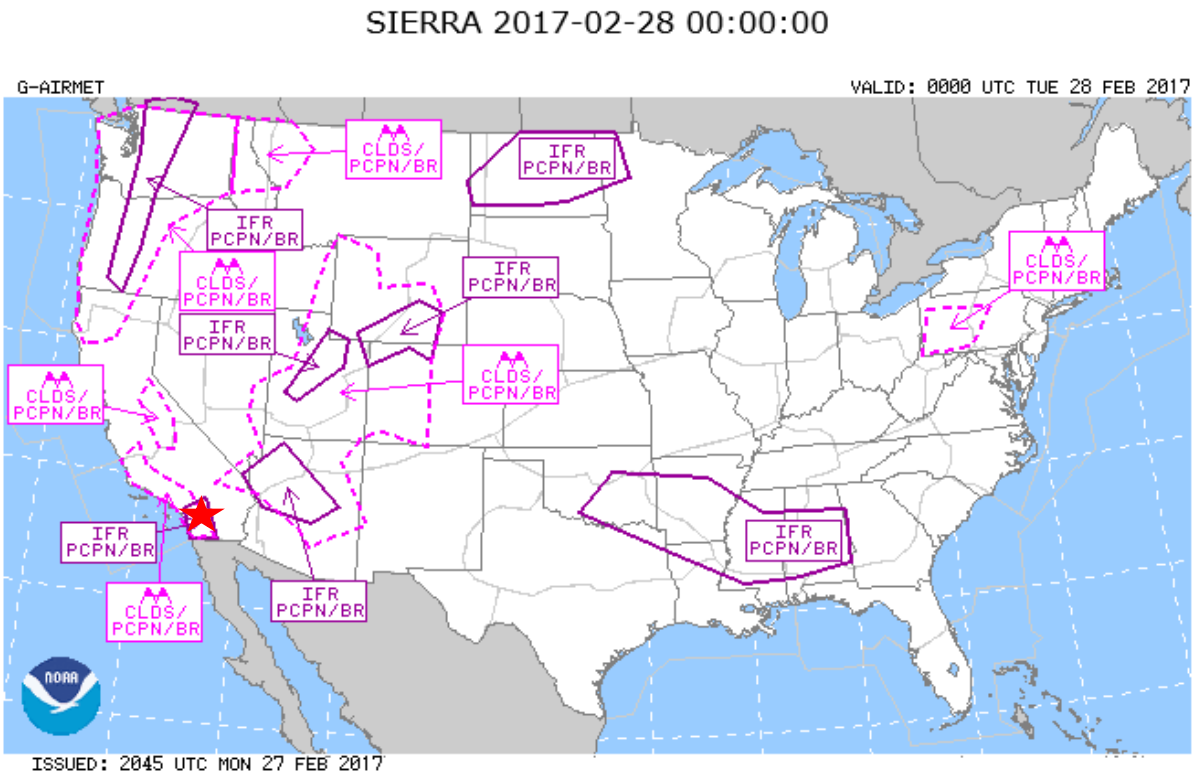

Figure 10 - G-AIRMET Sierra for IFR and mountain obscuration conditions valid for 1600 PST

WAUS46 KKCI 272045
WA6S
-SFOS WA 272045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 280300
.
AIRMET IFR...CA AND CSTL WTRS
FROM 20SW HEC TO 60SSE TRM TO 20S MZB TO LAX TO 20SW HEC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET IFR...WA OR CA
FROM YDC TO 50E YDC TO 20WNW EPH TO 30S DSD TO 50SE OED TO 20WNW
OED TO 30NW BTG TO HUH TO YDC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.

AIRMET MTN OBSCN...CA ID WY NV UT CO AZ NM
FROM 70ESE DLN TO 20ENE DDY TO 20ENE CYS TO 50WNW DEN TO 50S ALS TO 60NNE SJN TO 40W TCS TO 20W TUS TO PHX TO HEC TO 60NNE LAS TO 60E OAL TO 50W ELY TO 60SSE BVL TO 30NNW TWF TO 70ESE DLN
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...WA OR CA
FROM 50SW YXC TO 90SSE GEG TO 60ENE LKV TO 20NE RBL TO 50SSE FOT TO 20WNW FOT TO 80WNW OED TO 40S HQM TO TOU TO 20WSW HUH TO 50SW YXC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...CA
FROM 40ESE SNS TO 30W EHF TO 50WSW HEC TO 50S TRM TO 20S MZB TO 20SE LAX TO 40W RZS TO 60SSE SNS TO 40ESE SNS
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...CA
FROM 60SSW FMG TO 50SW OAL TO 50NE EHF TO 50SSE CZQ TO 30ENE MOD TO 60SSW FMG
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z ENDG 03-06Z.
.
OTLK VALID 0300-0900Z
AREA 1...IFR WA OR ID MT
BOUNDED BY 60E YDC-30SSE YXC-20N FCA-70SE MLP-50NE DNJ-60N TWF-20SW BOI-20S PDT-40NNW EPH-60E YDC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS DVLPG 03-06Z. CONDS CONTG THRU 09Z.
.
AREA 2...MTN OBSCN WA OR CA ID NV
BOUNDED BY 50SW YXC-90SSE GEG-30WSW DNJ-50SE REO-30W BAM-20ENE RBL-40NW ENI-20W FOT-90SW EUG-HQM-TOU-50SW YXC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
....

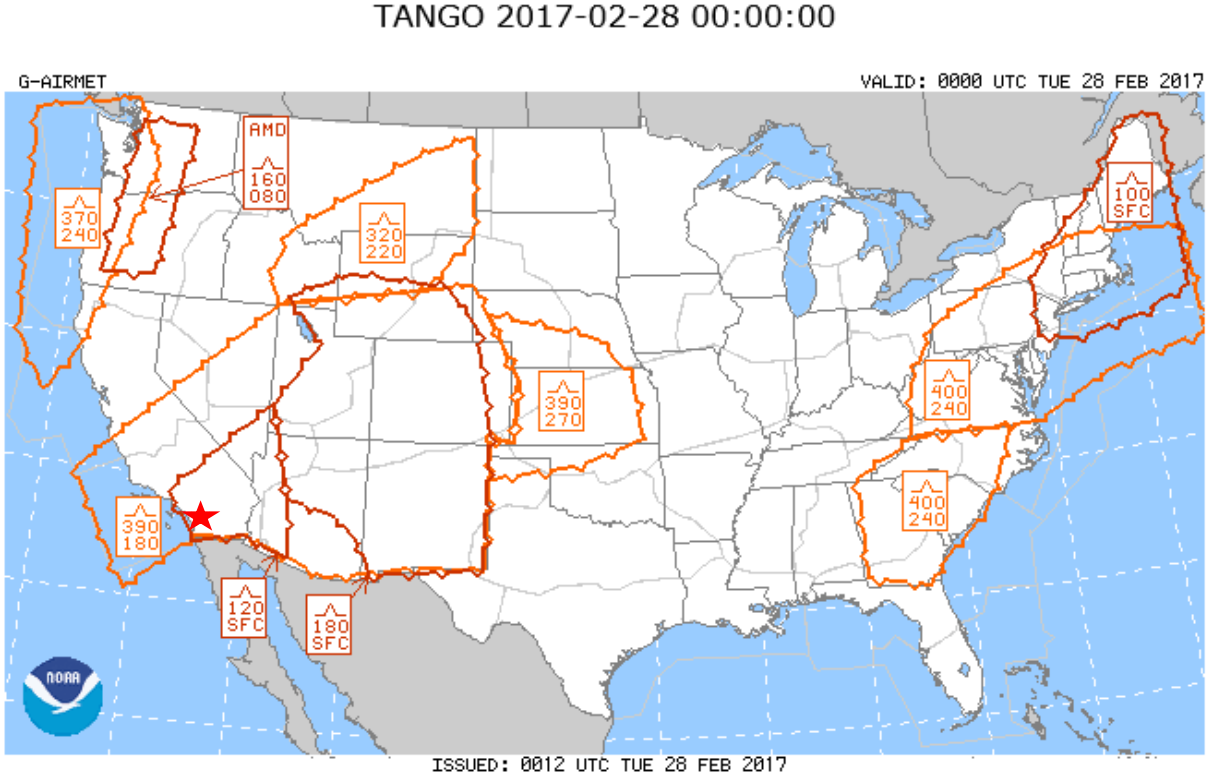

Figure 11 - G-AIRMET Tango for moderate turbulence valid at 1600 PST

WAUS46 KKCI 280012 AAA
WA6T
-SFOT WA 280012 AMD
AIRMET TANGO UPDT 4 FOR TURB VALID UNTIL 280300
.
AIRMET TURB...WA OR CA AND CSTL WTRS
FROM YDC TO 50S EPH TO 150SW SNS TO 140WSW FOT TO 140W TOU TO YDC
MOD TURB BTN FL240 AND FL370. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...CA ID WY NV UT CO AZ NM AND CSTL WTRS
FROM 70SW RAP TO GLD TO 50W LBL TO 30ESE TBE TO INK TO ELP TO
50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 140SW SNS TO 30SE TWF
TO 70SW RAP
MOD TURB BTN FL180 AND FL390. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...CA NV UT AZ NM AND CSTL WTRS
FROM 20ESE ILC TO 20SW DRK TO 60SW SJN TO 60SSE SSO TO 50S TUS
TO BZA TO 20S MZB TO 30NW LAX TO 20ESE ILC
MOD TURB BLW 120. CONDS CONTG BYD 03Z THRU 09Z.

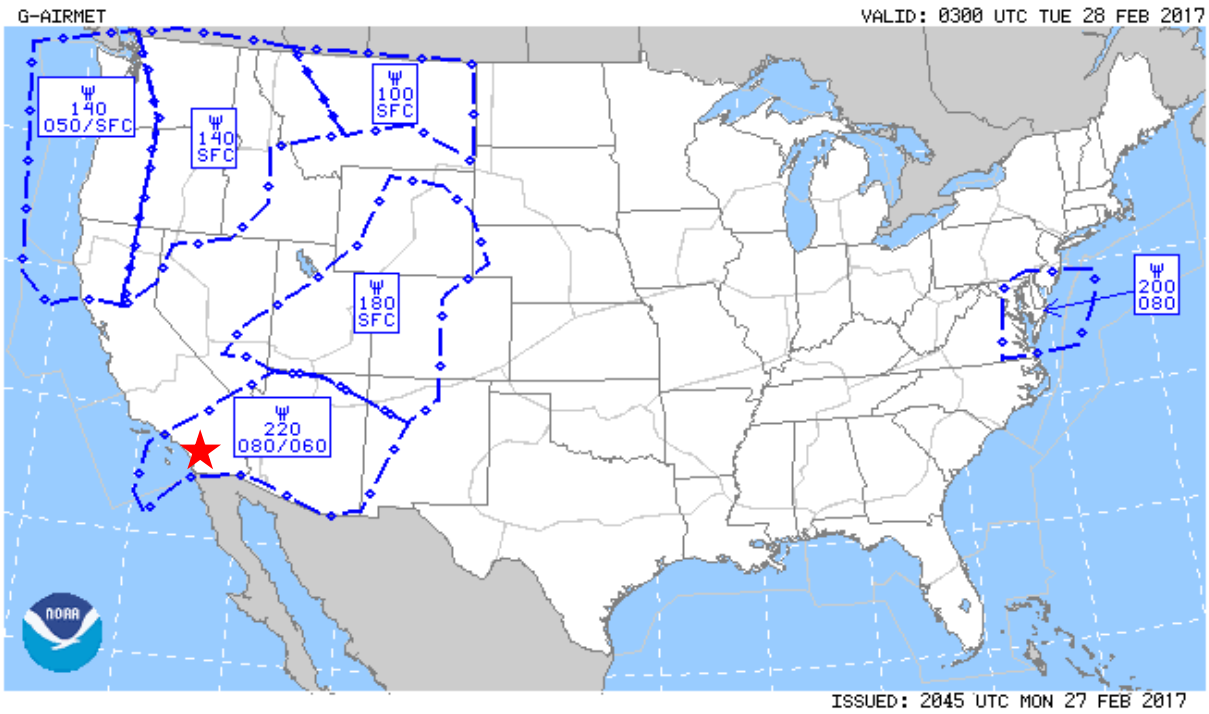

Figure 12 - G-AIRMET Zulu for moderate icing conditions valid at the period

WAUS46 KKCI 272045
WA6Z 33
-SFOZ WA 272045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 280300
.
AIRMET ICE...CA
FROM 40SSW FMG TO 40SSE OAL TO 70SSW BTY TO 30ESE EHF TO 40WSW EHF TO CZQ TO 30NNE MOD TO 40SSW FMG
MOD ICE BTN FRZLVL AND 160. FRZLVL SFC-040. CONDS ENDG 00-03Z.
.
AIRMET ICE...WA OR CA AND CSTL WTRS
FROM 20NE HUH TO 30SW YKM TO 20N SAC TO 100WSW ENI TO 150WSW FOT TO 140W TOU TO 20NE HUH
MOD ICE BTN FRZLVL AND 140. FRZLVL SFC-050. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET ICE...WA OR CA ID MT NV
FROM YDC TO 40ESE YXC TO 50SE HLN TO 30W LKT TO 70S LKT TO 50SE REO TO 100SSE LKV TO 20NW FMG TO 30N SAC TO 30SW YKM TO 20NNE HUH 4TO YDC
MOD ICE BLW 140. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET ICE...CA NV UT AZ NM AND CSTL WTRS
FROM 60NE LAS TO ABQ TO 50S SSO TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 150WSW RZS TO 30ESE EHF TO 70SSW BTY TO 60NE LAS
MOD ICE BTN FRZLVL AND FL220. FRZLVL 060-080. CONDS CONTG BYD 03Z THRU 09Z.

7.4 Winds and Temperature Aloft

The NWS Winds and Temperature Aloft Forecast current for the route of flight for the period from 1300 PST through 2000 PST on February 27, 2017 were as follows:

WINDS ALOFT FORECASTS
DATA BASED ON 271800Z
VALID 280000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	***3000***	***6000***	***9000***	*12000*	*18000*	*24000*	*30000*	*34000*	*39000*
ONT	***2109***	***2215+01***	***2231-03***	*2340-09*	*2653-22*	*2394-29*	*239146*	*730356*	*750158*
WJF		*2416+00*	*2425-05*	*2431-09*	*2641-22*	*7409-32*	*721147*	*730455*	*249258*
SAN	*2129*	*2226+03*	*2428-02*	*2527-08*	*2556-18*	*2373-29*	*238345*	*259956*	*751357*
SBA	*3010*	*3309+00*	*2612-05*	*2623-10*	*2640-22*	*2467-34*	*237948*	*248153*	*258156*
FAT	*3208*	*9900-03*	*2506-10*	*2813-14*	*2826-25*	*2744-37*	*254550*	*255054*	*255855*
SFO	*3113*	*3409-05*	*3410-11*	*3121-13*	*2927-26*	*3034-36*	*313951*	*303755*	*283855*
SAC	*9900*	*3207-04*	*3207-11*	*3116-15*	*2926-27*	*2932-38*	*303551*	*293455*	*283755*

The forecast for Ontario (ONT) for 3,000 ft expected wind from 210° at 9 knots, at 6,000 ft from 220° at 15 knots with a temperature of 1° C, and at 9,000 ft from 220° at 31 knots with a temperature of -3° C.

8.0 Astronomical Data

Data obtained from the United States Naval Observatory for February 27, 2017 for Riverside, Riverside County, California, was as follows:

Begin of civil twilight	0555 PST
Sunrise	0620 PST
Sun transit	1202 PST
Accident	1641 PST
Sunset	1745 PST
End civil twilight	1810 PST

At the time of the accident the sun was about 12° above the horizon at an azimuth of 252°, but was obscured by the overcast cloud cover.

Submitted by:

_____
Don Eick
NTSB Senior Meteorologist