



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 3, 2018

Weather Study

METEOROLOGY

WPR18FA075

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A. ACCIDENT

Location: Concord, California
Date: January 29, 2018
Time: about 0945 Pacific standard time
1745 universal coordinated time (UTC)
Airplane: Cessna 152; registration: N93316

B. METEOROLOGIST

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

C. SUMMARY

On January 29, 2018, about 0945 Pacific standard time, a Cessna 152, N93316, impacted terrain near the Military Ocean Terminal Concord facility, on the Navy Base Realignment and Closure (BRAC) property, Concord, California. The Airline Transport pilot was fatally injured. The airplane was registered to and operated by the pilot as a 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions prevailed for the flight and no flight plan had been filed. The flight originated from the Buchanan Field Airport (CCR) Concord, California, about 0937.

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 on January 29, 2018, local time is +8 hours to UTC, and UTC=Z. The NWS airport and station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 38.001111° North and longitude 121.988611° West, at an elevation of approximately 160 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 (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 latest addition of the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H.

1.1 Surface Analysis Chart

The northwest section of the NWS NCEP Surface Analysis Chart for 1000 PST (1800Z) on January 29, 2018 with the accident site marked by a red star is included as figure 1. The chart depicted a low-pressure system at 972-hectopascals (hPa)¹ in the Gulf of Alaska associated with an occluded frontal system wrapping around the low and extending southward along the British Columbia Pacific coast of Canada and changing to a cold front off the Washington and Oregon coast. To the south of the cold front and west of the accident site off the California coast was a high-pressure system at 1025-hPa with another high-pressure system was located over southern Oregon at 1032-hPa. A trough of low pressure was depicted to the west of the accident site off the California coast. A col² or neutral point in pressure was located over north-central California. Several other high-pressure systems were located over northern Utah at 1036-hPa and over Colorado at 1044-hPa.

A close-up of the 1000 PST Surface Analysis Chart with the station models is included as figure 2. The chart depicted numerous stations over California surrounding the accident site reporting fog, mist, and/or haze, with light to calm wind, with temperatures in the 50’s degrees Fahrenheit (°F), with dew point temperatures a few degrees cooler in the high 40’s (°F), with temperature-dew point spreads of 2° F or less.

¹ Hectopascal (hPa) is the new standard term for referencing sea level pressure and is interchangeable with the term millibar (mb), with the same units. Standard sea-level pressure is 1013.25-hPa.

² A col is a common location associated with the synoptic location favoring the formation of radiation type fog formation and is often referred to a saddle back or deformation zone in the wind field.

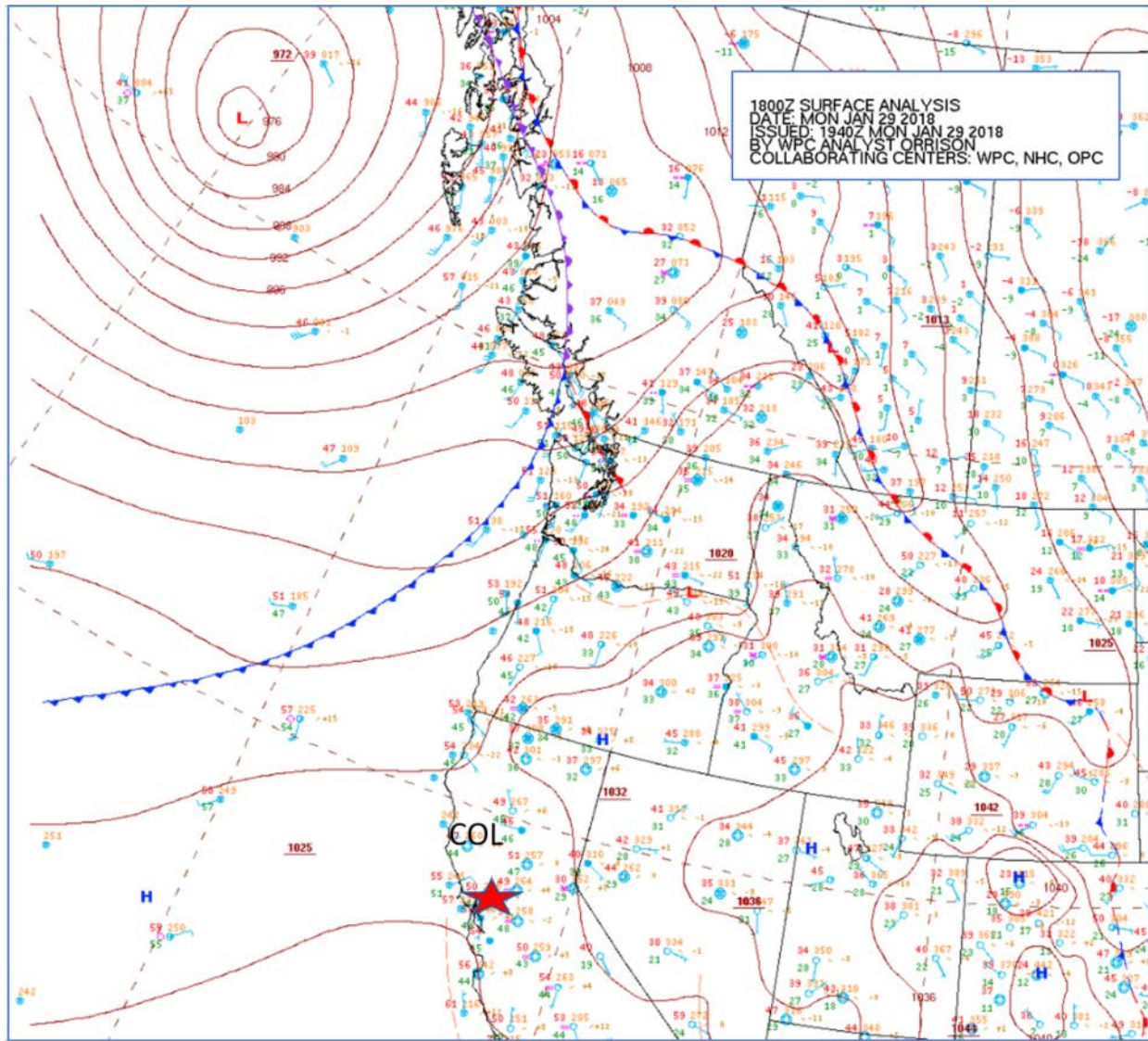


Figure 1 - Northwest section of the Surface Analysis Chart for 1000 PST

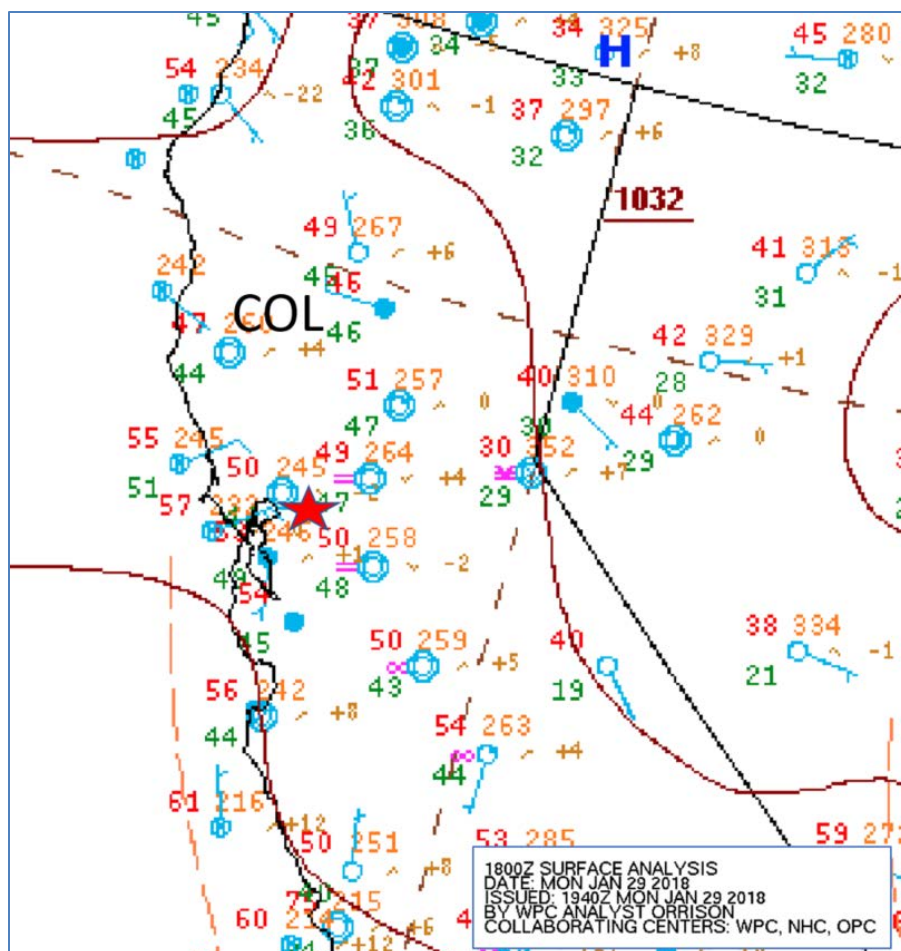


Figure 2 - Close-up of the Surface Analysis Chart station model plot for 1000 PST

1.2 Weather Depiction Chart

A composite of the western section of the NWS Weather Depiction Charts for 0500 PST (1300Z), 0800 PST (1600Z), and 1100 PST (1900Z) are included as figure 3, depicting the general flight categories³ of IFR, MVFR, and VFR conditions being reported at the time.

³ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

**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.

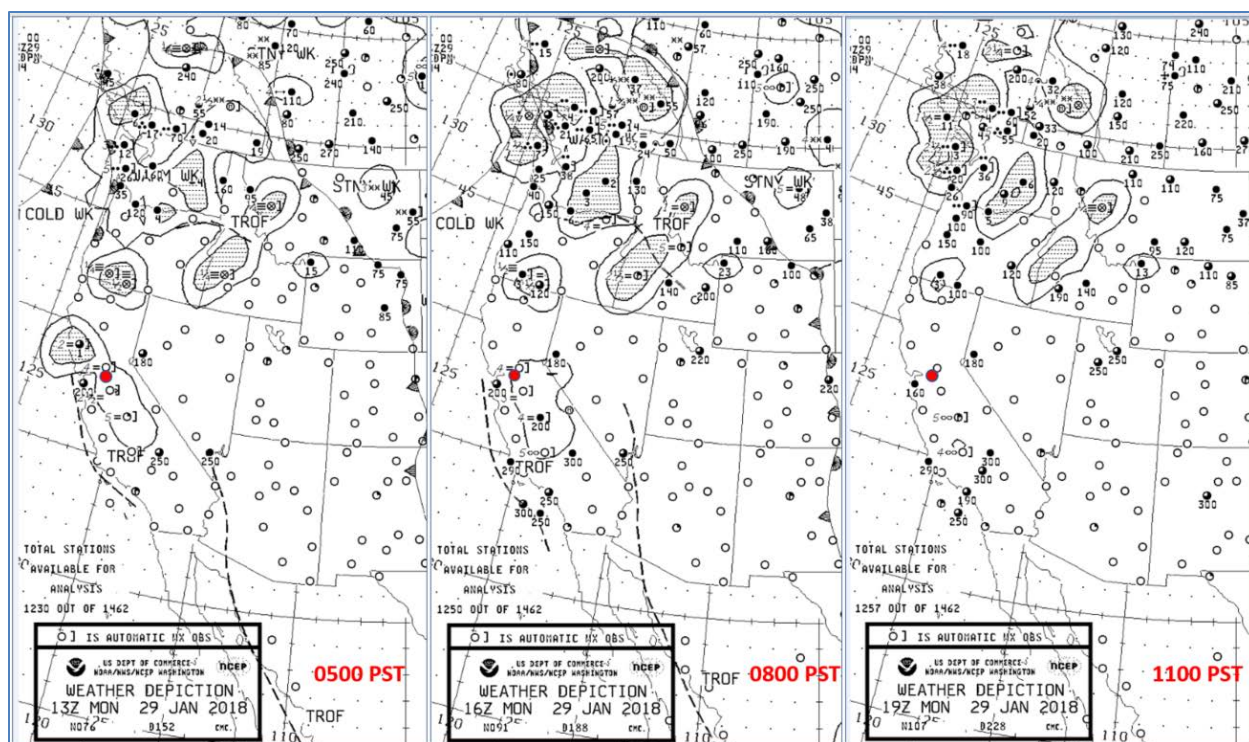


Figure 3 - Western section of the Weather Depiction Charts for 0500, 0800, and 1100 PST

The 0500 PST portion of figure 3 (left) depicted an area of IFR conditions by the shaded contour line over northern California and in the vicinity of the accident site and north of the San Francisco area, with a larger area of MVFR conditions by the unshaded contour line over the interior section of California and encompassed the accident site. The station models depicted visibility from 2 to 5 miles in mist, with ceilings broken at 100 ft agl in the area northwest of the accident site. Further north over Washington and Canada, near the frontal system several stations were reporting light to moderate rain and snow.

The 0800 PST (center image of figure 3) depicted an area of MVFR conditions over interior California enclosing the accident site, with station models indicating visibility 3 to 4 miles in mist, with clear skies within the hour.

The 1100 PST image (right in figure 3) depicted VFR conditions over the area in the vicinity of the accident site. The Pacific northwest continued to depict numerous stations impacted with IFR conditions and light to moderate rain and snow.

1.3 12-hour Surface Prognostic Chart

Figure 4 is the NWS NCEP 12-hour Surface Prognostic Chart valid at the time prior to the accident aircrafts departure, which depicted the expected surface features and precipitation over the area at 2200 PST. A surface low-pressure system at 992-hPa was located over Alberta, Canada associated with the occluded front moving ashore. The front became a cold front over Washington, into Oregon, where another low-pressure system at 1016-hPa was expected to form along the front. A large area of greater than 55% probability of precipitation in the form of rain and mixed freezing

precipitation was depicted over Idaho, Washington, and Oregon. A high-pressure system at 1031-hPa was located over western Colorado with a ridge of high pressure extending westward. A col or neutral point in pressure was inferred by the isobars over central California in the vicinity of the accident site with no precipitation expected over the region.

12 Hours Surface Prognostic

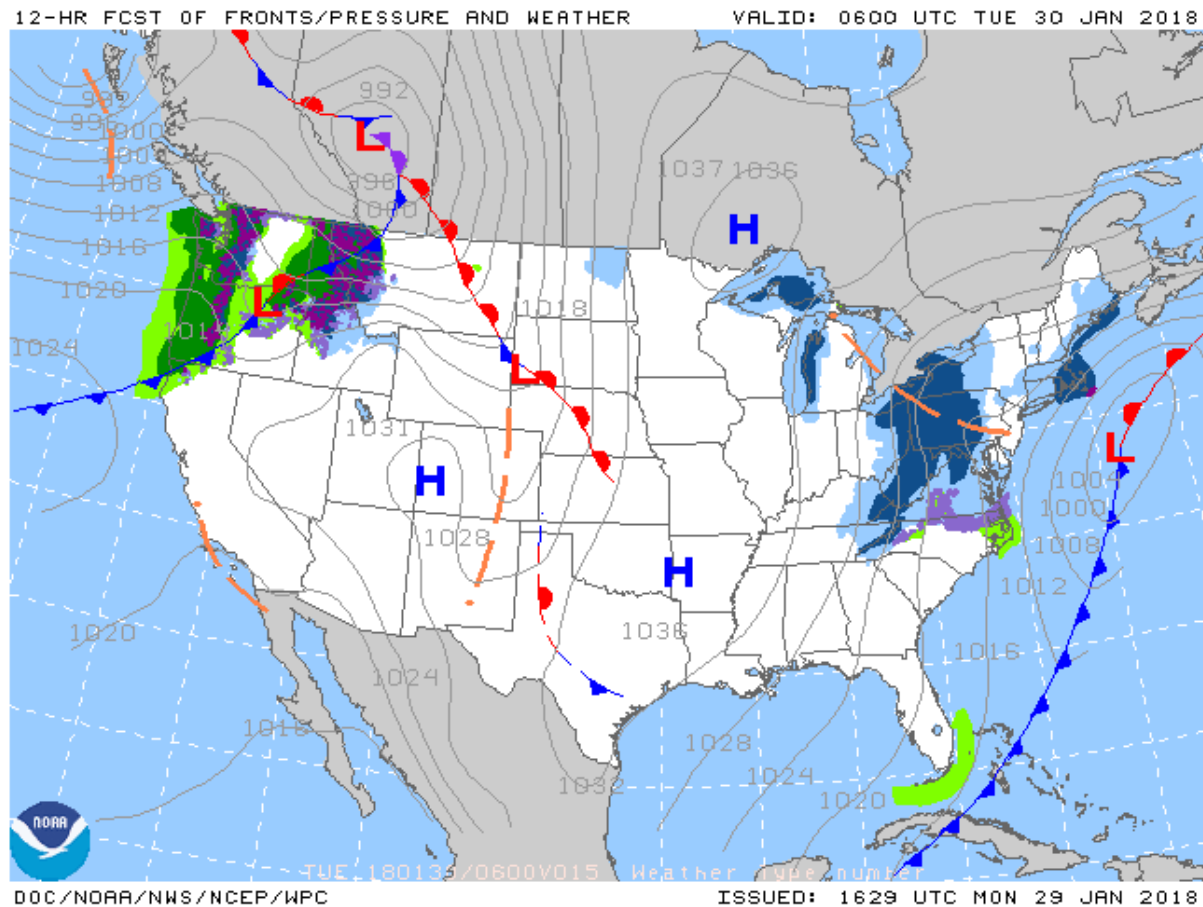


Figure 4 - 12-hour Surface Prognostic Chart valid for 2200 PST

1.4 12- and 24-hour Low-Level Significant Weather Prognostic Chart

The 12-hour (left side) and 24-hour (right side) Low-Level Significant Weather Prognostic Chart current at the time is included as figure 5 and depicted the general flight categories, low-level turbulence expected, and freezing level information.

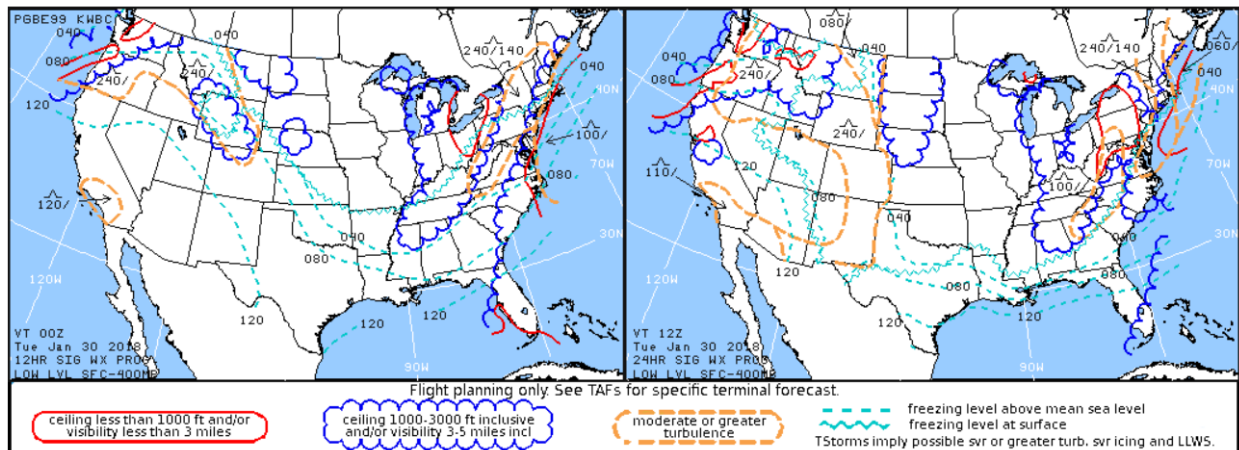


Figure 5 - 12-hr and 24-hr Low-Level Significant Weather Prognostic Chart

The 12-hour chart valid for 1600 PST (left side of figure 5) depicted VFR conditions over all of California and over the accident site. No significant turbulence (brown dashed line) was depicted over central California and the freezing level (blue dashed line) was above 12,000 ft. The 24-hour portion of the chart (right side) was valid for 0400 PST on January 30, 2018 depicted a small area of IFR conditions expected over central California in the vicinity of the accident site with an area of MVFR conditions immediately south and extending over the San Francisco area.

2.0 Observation

The closest official weather observation was from Buchanan Field Airport (KCCR), Concord, CA, located approximately 3 miles west of the accident site at an elevation of 25 ft. KCCR listed a magnetic variation of 14° East. The airport had an Automated Surface Observation System (ASOS) which was augmented by certified weather observers. At the approximate time of the accident the following conditions were being reported:

KCCR weather observation at 0953 PST, wind calm, visibility 5 miles in mist, clear skies below 12,000 ft agl, temperature 11° Celsius (C), dew point 9° C, altimeter 30.29 inches of mercury (Hg).

The raw observations and general flight category (color coded) reported surrounding the period were as follows, the bold observation is the one decoded above:

VFR METAR KCCR 291253Z AUTO 0000KT 9SM CLR 07/05 A3027 RMK AO2 SLP236 T00670050=

MVFR METAR KCCR 291353Z AUTO 32008KT 3SM BR CLR 08/07 A3029 RMK AO2 SLP243 T00780067=

MVFR METAR KCCR 291453Z 27003KT 3SM BR CLR 08/07 A3028 RMK AO2 SLP241 T00780067 52003=

MVFR METAR KCCR 291553Z 16004KT 4SM BR CLR 07/06 A3029 RMK AO2 SLP241 T00720061=

MVFR METAR KCCR 291653Z 00000KT 5SM BR CLR 09/07 A3028 RMK AO2 SLP240 T00890072=

Accident 1745Z

MVFR METAR KCCR 291753Z 5SM BR CLR 11/09 A3029 RMK AO2 SLP242 T01110089 10111 20056 53002=

VFR METAR KCCR 291853Z 00000KT 7SM CLR 13/09 A3029 RMK AO2 SLP242 T01330094=

A review of the observations from 0553 through 0953 PST indicated that MVFR conditions due to visibility restrictions in mist were reported at the station, with no defined ceiling.

2.1 Napa County Airport

The next closest weather reporting location was from Napa County Airport (KAPC), Napa, CA, 19 miles northwest of the accident site at an elevation of 35 ft. The airport had an Automated Surface Observation System (ASOS) and reported the following conditions at the time of the accident:

KAPC weather observation at 0954 PST, wind calm, visibility 10 miles or more, sky clear below 12,000 ft, temperature 10° C, dew point 8° C, altimeter 30.28 inches of Hg.

A review of the observations surrounding the period from 0354 through 0954 PST and the general flight categories were as follows:

LIFR METAR KAPC 291154Z AUTO 00000KT 3/4SM BR VV002 05/04 A3027 RMK AO2 VIS 1/2V2 SLP242 T00500039 10100 20044 56006=

IFR SPECI KAPC 291205Z AUTO 00000KT 1 1/4SM BR FEW002 05/04 A3027 RMK AO2 T00500044=

MVFR SPECI KAPC 291208Z AUTO 00000KT 3SM BR FEW002 06/05 A3028 RMK AO2 T00560050=

MVFR METAR KAPC 291254Z AUTO 34003KT 5SM BR CLR 06/05 A3028 RMK AO2 SLP243 T00560050=

IFR SPECI KAPC 291303Z AUTO 00000KT 1 1/2SM BR FEW002 05/04 A3027 RMK AO2 T00500044=

LIFR SPECI KAPC 291306Z AUTO 33003KT 3/4SM BR VV002 04/04 A3027 RMK AO2 T00440039=

LIFR SPECI KAPC 291315Z AUTO 29003KT 1/2SM FG VV002 04/04 A3028 RMK AO2 T00440039=

LIFR SPECI KAPC 291327Z AUTO 32003KT 1SM BR VV002 04/03 A3028 RMK AO2 T00390033=

IFR SPECI KAPC 291330Z AUTO 00000KT 2 1/2SM BR SCT002 04/03 A3028 RMK AO2 T00390033=

LIFR SPECI KAPC 291341Z AUTO 00000KT 1SM BR VV002 05/04 A3029 RMK AO2 T00500044=

IFR SPECI KAPC 291348Z AUTO 00000KT 3/4SM BR CLR 04/03 A3029 RMK AO2 VIS 1/2V2=

LIFR METAR KAPC 291354Z AUTO 00000KT 3/4SM BR VV002 04/03 A3028 RMK AO2 SLP245 T00390033=

LIFR SPECI KAPC 291401Z AUTO 08003KT 1/4SM FG VV002 04/03 A3027 RMK AO2 T00390033=

LIFR SPECI KAPC 291411Z AUTO 08003KT 1SM BR VV002 06/05 A3027 RMK AO2 T00560050=

IFR SPECI KAPC 291414Z AUTO 09004KT 2 1/2SM BR FEW002 05/05 A3027 RMK AO2 T00500050=

VFR SPECI KAPC 291421Z AUTO 10004KT 9SM FEW002 04/04 A3027 RMK AO2 T00440039=

VFR METAR KAPC 291454Z AUTO 30004KT 9SM CLR 04/04 A3029 RMK AO2 SLP247 T00440039 53005=

VFR METAR KAPC 291554Z 08006KT 10SM CLR 10/07 A3026 RMK AO2 SLP238 T01000072=

VFR METAR KAPC 291654Z VRB03KT 10SM CLR 09/07 A3028 RMK AO2 SLP246 T00890072=

Accident 1745Z

VFR METAR KAPC 291754Z 00000KT 10SM CLR 10/08 A3028 RMK AO2 SLP245 T01000078 10100 20028 56002=

A review of the observations indicated that LIFR conditions prevailed during the morning hours from 0354 through 0614 PST with dense fog at 1/4 mile and then mist, with ceilings at 200 ft agl. VFR conditions were reported 0621 and continued through the time of the accident.

2.2 Metropolitan Oakland International Airport

Metropolitan Oakland International Airport (KOAK), Oakland was located approximately 20 miles southwest of the accident site at an elevation of 9 ft. The airport had an ASOS and was augmented by FAA certified weather observers.

KOAK weather observation at 0953 PST, wind from 170° at 3 knots, visibility 10 miles or more, ceiling broken at 14,000 ft agl, overcast at 18,000 ft, temperature 12° C, dew point 9° C, altimeter 30.26 inches of Hg.

The raw observations and general flight categories were as follows from 0453 through 0953 PST, with VFR conditions being reported during the period:

VFR METAR KOAK 291253Z 07003KT 10SM OVC250 07/07 A3025 RMK AO2 SLP242 T00720067=

VFR METAR KOAK 291353Z 34003KT 10SM FEW250 08/07 A3027 RMK AO2 SLP248 T00830072=

VFR METAR KOAK 291453Z 13004KT 10SM SCT250 08/07 A3026 RMK AO2 SLP246 T00780072 56003=

VFR METAR KOAK 291553Z 13006KT 10SM SCT180 OVC250 10/07 A3027 RMK AO2 SLP249 T01000072=

VFR METAR KOAK 291653Z 15003KT 10SM BKN180 OVC250 11/09 A3027 RMK AO2 SLP249 T01060094=

Accident 1745Z

VFR METAR KOAK 291753Z 17003KT 10SM BKN140 OVC180 12/09 A3026 RMK AO2 SLP246 T01170094 10122 20061 50001=

2.3 Charles M. Schulz – Soma County Airport, Santa Rosa

Charles M. Schulz – Soma County Airport (KSTS), Santa Rosa, CA, was located 47 miles northwest from KCCR, at an elevation of 129 ft. The airport had an ASOS and reported the following conditions surrounding the period:

KSTS weather observation at 0953 PST, wind calm, visibility 10 miles or more, ceiling broken at 25,000 ft agl, temperature 8° C, dew point 8° C, altimeter 30.27 inches of Hg.

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

LIFR SPECI KSTS 291122Z AUTO 32004KT 3/4SM BR VV001 04/04 A3027 RMK AO2 T00390039=

LIFR METAR KSTS 291153Z AUTO 35004KT 1 1/4SM BR OVC002 04/04 A3026 RMK AO2 SLP242 T00440044 10089 20039 58005=

LIFR SPECI KSTS 291203Z AUTO 36003KT 1/2SM FG VV002 04/04 A3026 RMK AO2 T00440044=

LIFR METAR KSTS 291253Z AUTO 00000KT 3/4SM BR VV002 05/05 A3026 RMK AO2 SLP241 T00500050=

LIFR METAR KSTS 291353Z AUTO 00000KT 1/2SM FG VV003 05/05 A3026 RMK AO2 SLP241 T00500050=

LIFR METAR KSTS 291453Z 12003KT 7SM BCFG BKN002 05/05 A3025 RMK AO2 SLP239 T00500050 58003=

VFR SPECI KSTS 291515Z 00000KT 7SM BCFG SCT002 05/05 A3025 RMK AO2 T00500050=

VFR METAR KSTS 291553Z 00000KT 10SM BCFG FEW002 BKN200 05/05 A3027 RMK AO2 SLP243 T00500050=

VFR METAR KSTS 291653Z 27003KT 10SM CLR 06/06 A3027 RMK AO2 SLP246 T00610061=

Accident 1745Z

VFR METAR KSTS 291753Z 00000KT 10SM BKN250 08/08 A3027 RMK AO2 SLP244 T00830078 10083 20039 50005=

A review of the observations indicated during the early morning hours between 0322 through 0853 PST LIFR conditions prevailed due to low visibility in fog and mist, with ceilings between 200 and 300 ft agl before clearing at 0753 PST prior to the accident.

2.4 METAR Display

A display of the surrounding station observations from the NWS Aviation Weather Center's website⁴ at 0900 and 1000 PST are included as figure 6 and 7 with the accident site marked by a red star. The stations models reported MVFR conditions in mist in the vicinity of the accident site and southeast at Byron (KC83) and Stockton (KCKK), and northeast at Sacramento (KSAC). No stations were noted reporting IFR conditions at 0900 and 1000 PST in the immediate vicinity.

⁴ <https://aviationweather.gov/metar>

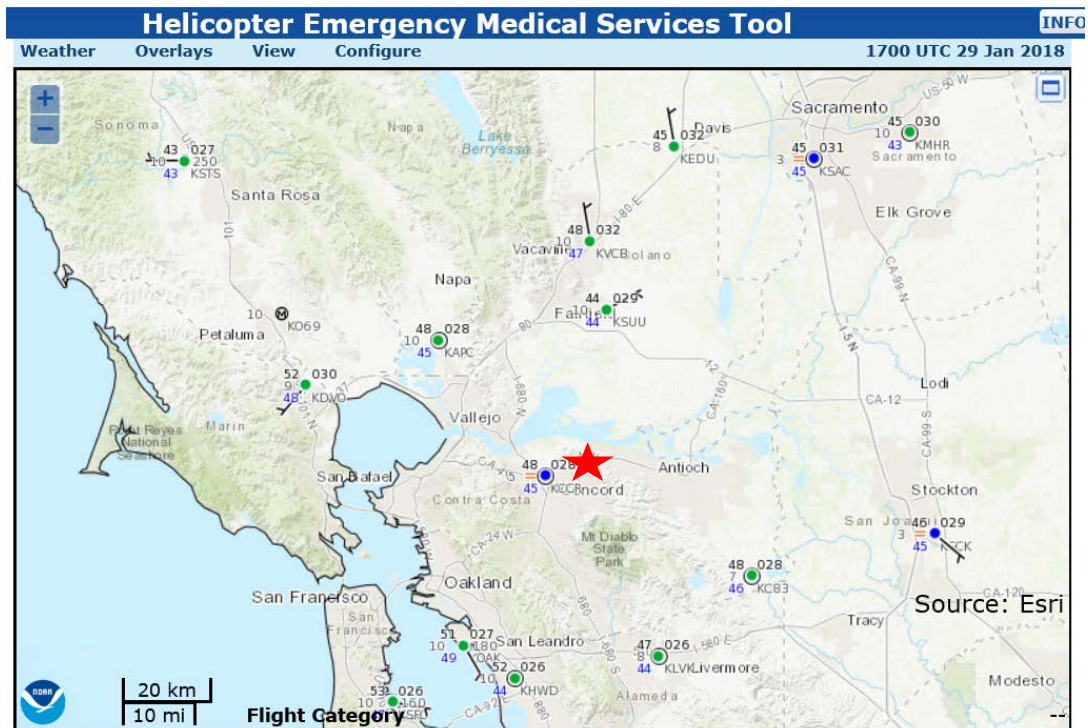


Figure 6 - METAR display at 0900 PST

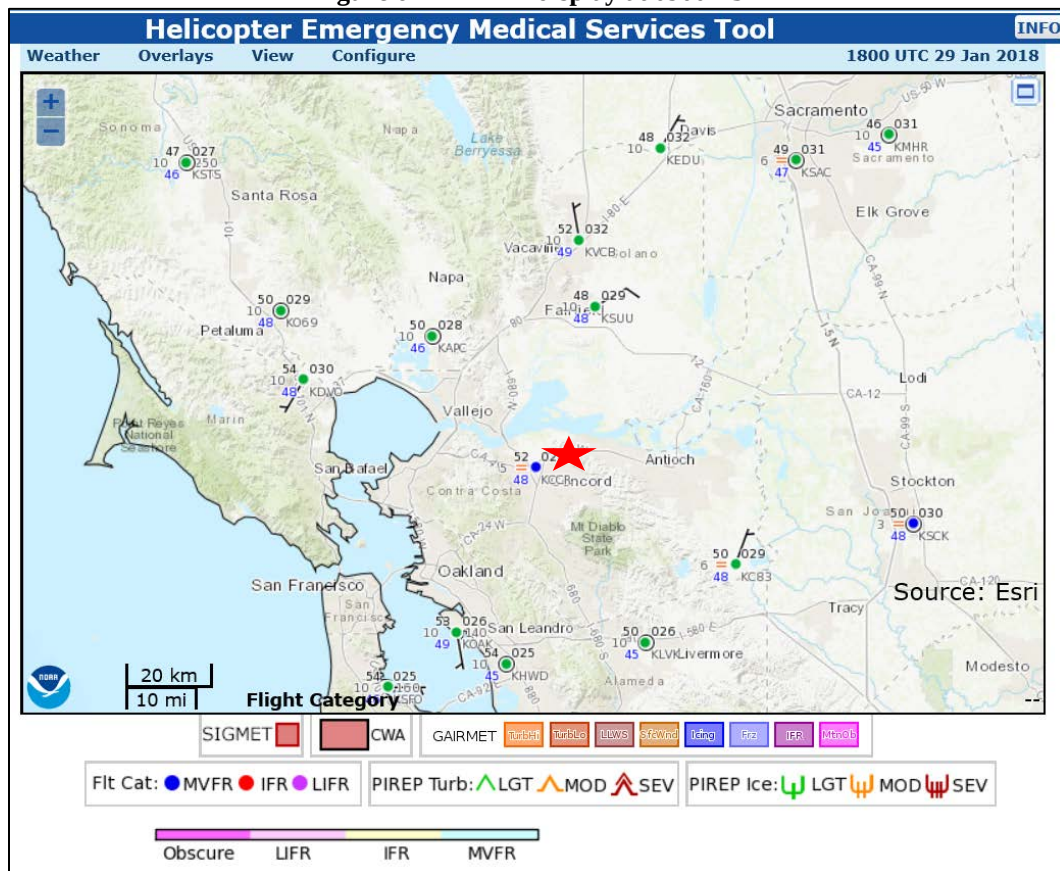


Figure 7 - METAR display at 1000 PST

3.0 Sounding

A High Resolution Rapid Refresh (HRRR)⁵ numerical model data was obtained from the NOAA Air Resource Laboratory for 0900 PST over the accident site coordinates. The data was plotted on a standard skew T log P diagram⁶ using RAOB software⁷ from the surface to 500-hPa or approximately 18,000 ft is included as figure 8.

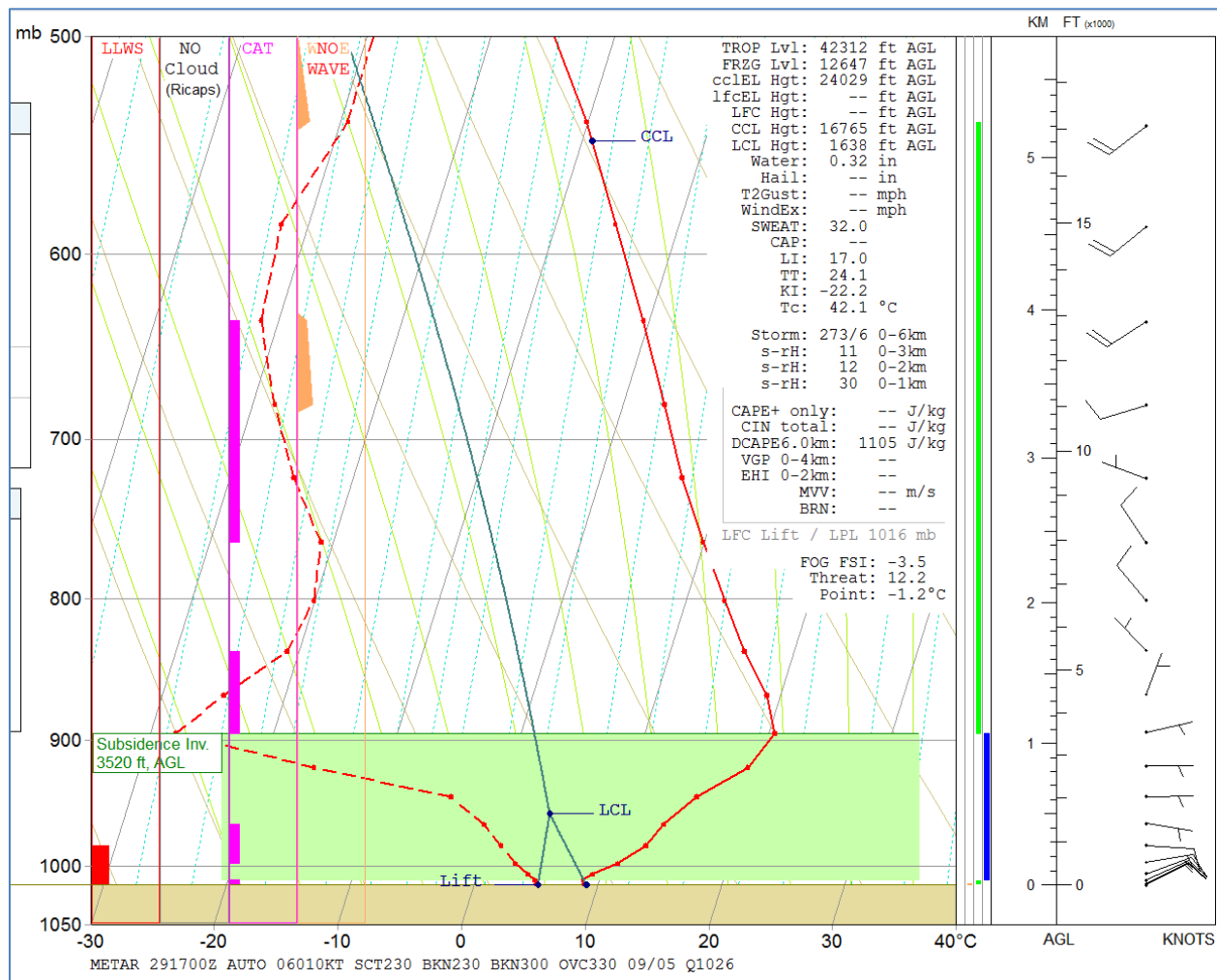


Figure 8 - HRRR numerical model over the accident site at 0900 PST

The HRRR model sounding indicated an elevation of 279 ft, with a surface wind from 060° at 10 knots, a temperature of 9.1° C (48.4° F), a dew point temperature of 5.2° C (41.4° F), a relative humidity of 77%, a precipitable water value of 0.32 inches, and a sea level pressure of 1026-hPa.

⁵ HRRR – High-Resolution Rapid Refresh (HRRR) is a NOAA real-time 3-kilometer (km) resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by 3-km grids with 3-km radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a 1-hour period.

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 software – The complete Rawinsonde Observation program is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania, for plotting and analyzing upper air data.

The sounding indicated a lifted condensation level (LCL)⁸ at 1,638 ft agl, and a convective condensation level (CCL)⁹ at 16,765 ft agl. A surface-based temperature inversion was noted to 3,500 ft agl, with the Lifted Index (LI) indicated +17.0, which indicated a stable atmosphere. The freezing level was identified at about 12,926 ft.

The wind profile indicated a surface wind from northeast or from 060° at 10 knots with wind veering to the east through 3,500 ft within the inversion layer and backing to the northwest and then southwest with height. Wind speeds were less than 20 knots below 20,000 ft. The mean 0 to 6 kilometer or 18,000 ft wind was from 240° at 9 knots. The RAOB software identified only a probability of light turbulence aloft, and a weak or light potential for low-level wind shear (LLWS).

A table of the HRRR model data of height, pressure (Pres), temperature (T), dew point temperature (Td), relative humidity in percent (RH), wind direction (DD) and wind speed (FF), and RAOB derived intensity of clear air turbulence (CAT), low-level wind shear (LLWS), icing type, and mountain wave potential from the surface through 18,000 ft is included in figure 9.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)	Wave/x---W---Turb nm fpm max
279	1016	9.1	5.2	77	61 / 10				
306	1015	8.9	5.0	77	61 / 10	LGT	LIGHT		
386	1012	8.7	4.8	76	64 / 13		LIGHT		
521	1007	9.3	4.1	70	69 / 14		LIGHT		
766	998	11.1	2.8	57	80 / 14	LGT	LIGHT		
1182	983	12.9	1.2	45	94 / 10	LGT			
1663	966	13.8	-0.7	37	100 / 6				
2302	944	15.8	-4.1	25	89 / 7				
2992	921	19.2	-15.9	8	89 / 6				
3799	895	20.5	-27.9	3	76 / 5	LGT			
4694	867	18.9	-25.0	4	19 / 4	LGT			
5711	836	16.0	-21.0	6	318 / 6				
6894	801	13.1	-20.1	8	322 / 8				
8224	763	9.9	-21.0	9	328 / 8	LGT			
9681	723	6.6	-24.8	8	291 / 7	LGT			
11320	680	3.3	-28.2	8	252 / 11	LGT			2.04 341 LIGHT

Figure 9 - HRRR numerical model parameters and derived turbulence, low-level wind shear, icing, and mountain wave potential

The HRRR sounding fog indices indicated a Fog Stability Index (FSI)¹⁰ of -3.5, a threat index of 12.5 indicated a high likelihood for radiation type fog formation, with the fog point temperature of -1.2° C.

⁸ Lifted 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 cumuliiform clouds, which are normally produced from surface heating and thermal convection.

¹⁰ Fog Stability Index (FSI) and threat index are U.S. Air Force derived fog forecasting indexes developed for use in Germany but can be applied to similar climates. References are available in USAF publication 2WW/TN-79/008 and 2WW/FM-90/001.

4.0 Satellite Imagery

The GOES-15 infrared image at 0945 PST at 2X magnification with a standard MB temperature enhancement curve applied is included as figure 10, with the accident site marked by the white square and the surface pressure systems and fronts overlaid. The radiative cloud top temperature over the accident site was 229° Kelvin or -44.16° C, which corresponded to high cirriform type clouds with tops near 33,000 ft.

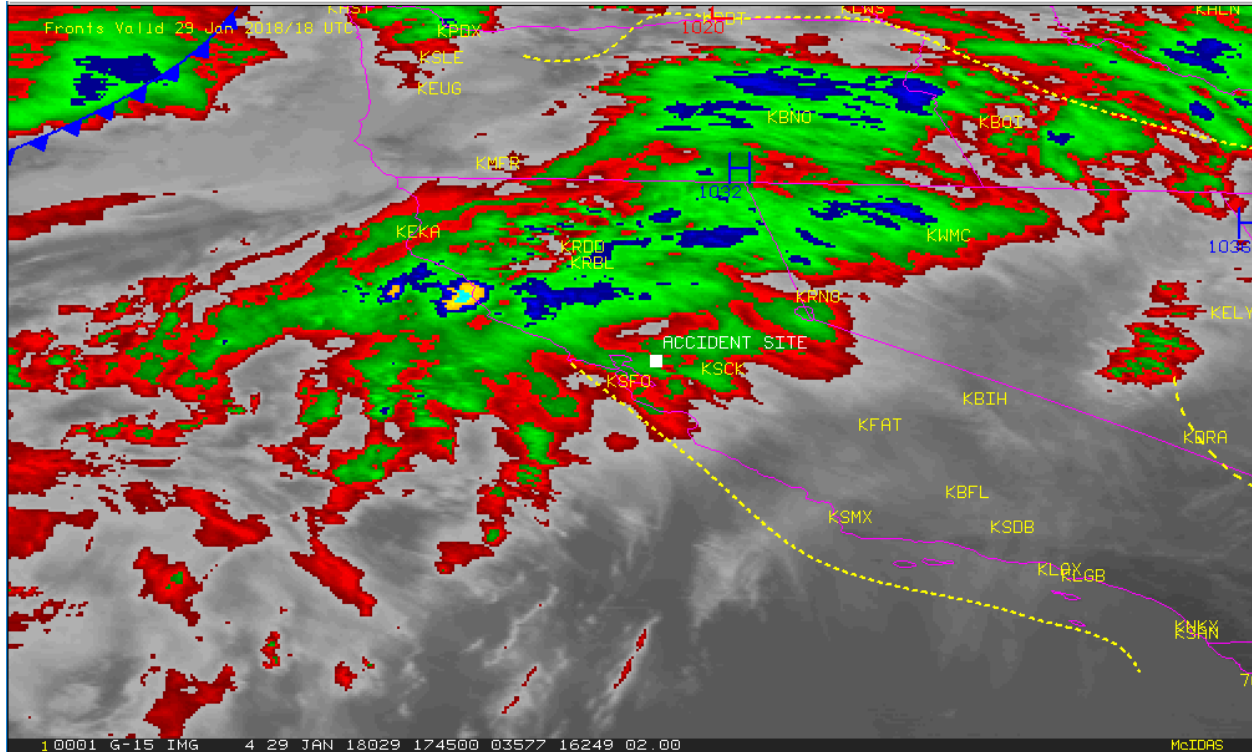


Figure 10 - GOES-15 infrared image at 0945 PST

Figure 11 is the GOES-15 visible image at 4X magnification for the same period at 0945 PST, with the accident marked by the white square. The image depicts an extensive area of mid to high cirrostratus type clouds obscuring the accident site.

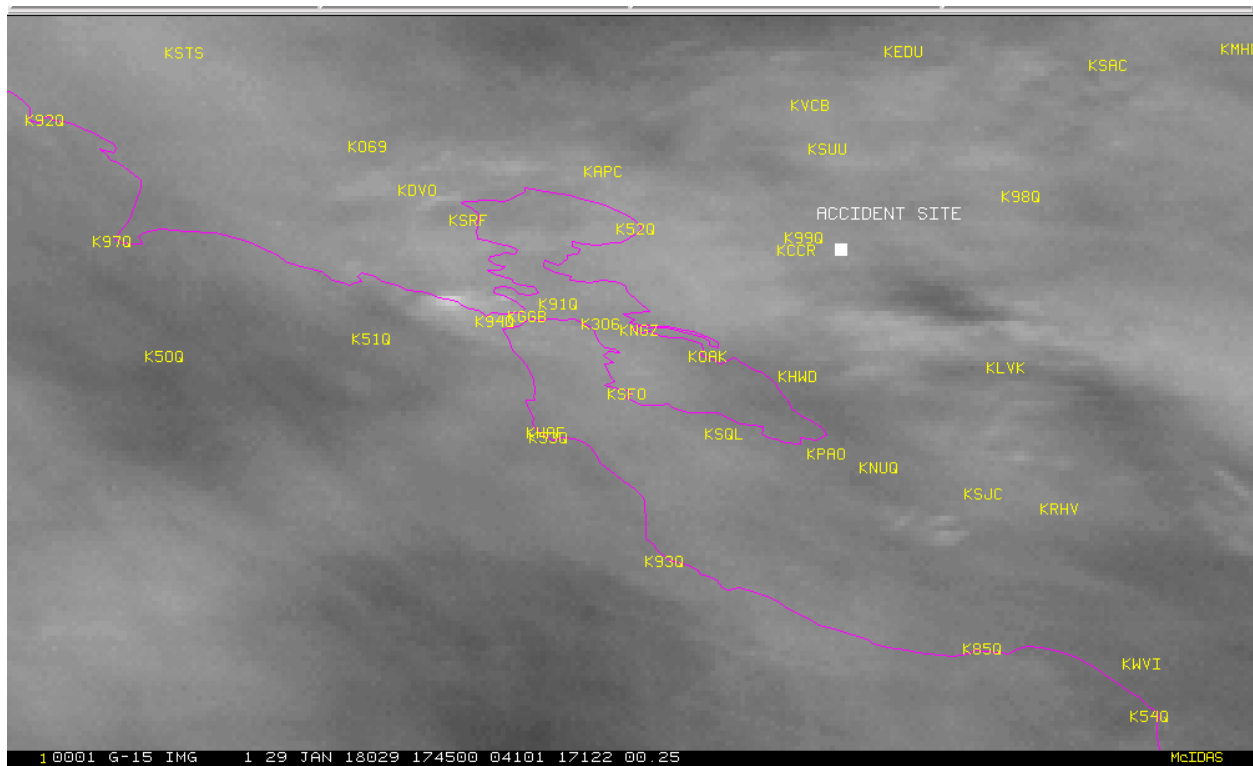


Figure 11 - GOES-15 visible image at 4X magnification for 0945 PST

5.0 Pilot Reports

A search of pilot reports (PIREPs) within 150 miles of the accident site from 0600 through 1200 PST below 18,000 ft resulted in the following reports, which have been decoded from standard code and abbreviations, with time converted to local time. The reports were as follows, and likely were from the same aircraft:

San Francisco International Airport (SFO) routine pilot report (UA); Over – SFO VORTAC¹¹ 318° azimuth at 14 miles; Time – 1049 PST; Altitude – 1,300 ft; Type aircraft – Luscombe 8 single engine airplane; Turbulence – moderate.

San Francisco International Airport (SFO) routine pilot report (UA); Over – Sausalito (SAU) VORTAC 133° azimuth at 2 miles; Time – 1052 PST; Altitude – 1,300 ft; Type aircraft – Luscombe 8 single engine airplane; Turbulence – moderate.

6.0 NWS Forecasts and Advisories

The following forecasts were issued by the NWS applicable to the flight.

¹¹ VORTAC – is a navigational aid that consists of a co-located VHF omnidirectional range (VOR) beacon and a tactical air navigation system (TACAN) which provides distance measuring information. The system provides radial or azimuth and distance from the station.

6.1 Terminal Aerodrome Forecasts

The NWS San Francisco Bay Area (KMTR) Weather Forecast Office (WFO) was responsible for the Concord area. No TAFs are issued for KCCR and the closest Terminal Aerodrome Forecast (TAF) to the accident site was for KOAK located 18 miles southwest of the accident site KSTS 47 miles northwest. A TAF is only valid for a 5-mile radius from the specific airport, it provides a more time specific forecast of expected wind, visibility, weather, and clouds. The forecasts issued during the period were as follows:

TAF KOAK 291124Z 2912/3018 00000KT P6SM BKN250
FM291700 VRB03KT P6SM BKN250
FM292100 29007KT P6SM SCT250
FM300400 VRB04KT P6SM SCT250=

The forecast for KOAK expected VFR conditions to prevail for the period with light and variable winds at 3 knots, visibility better than 6 miles, with high broken ceilings at 25,000 ft.

The following forecasts were issued for KSTS during the period:

TAF KSTS 291124Z 2912/3012 VRB03KT 1/4SM FG VV002
FM291800 VRB03KT 6SM BR FEW006
FM291930 16004KT P6SM FEW200
FM300500 00000KT 2SM BR FEW200
FM300600 00000KT 1/4SM FG VV002=

AMD TAF KSTS 291503Z 2915/3012 VRB03KT 4SM BR BKN008
TEMPO 2915/2918 1/2SM FG VV002
FM291800 VRB03KT 6SM BR FEW006
FM291930 16004KT P6SM FEW200
FM300500 00000KT 2SM BR FEW200
FM300600 00000KT 1/4SM FG VV002=

AMD TAF KSTS 291519Z 2915/3012 VRB03KT 4SM BR SCT002
TEMPO 2915/2918 1/2SM FG VV002
FM291800 VRB03KT 6SM BR FEW006
FM291930 16004KT P6SM FEW200
FM300500 00000KT 2SM BR FEW200
FM300600 00000KT 1/4SM FG VV002=

AMD TAF KSTS 291616Z 2916/3012 VRB03KT 4SM BR SCT002
FM291800 VRB03KT 6SM BR FEW006
FM291930 16004KT P6SM FEW200
FM300500 00000KT 2SM BR FEW200
FM300600 00000KT 1/4SM FG VV002=

TAF KSTS 291723Z 2918/3018 VRB03KT P6SM BKN200
FM292000 16004KT P6SM BKN200
FM300700 00000KT 2SM BR FEW200
FM301000 00000KT 1/4SM FG VV002
FM301700 VRB03KT 4SM BR SCT002=

The forecast for KSTS expected LIFR conditions in fog during the early morning, which resulted in multiple amendments be issued with VFR conditions expected after 1000 PST with visibility 6 miles in mist, and a few clouds at 600 ft agl.

6.2 Area Forecast Discussion

The Area Forecast Discussion (AFD) issued by the KMTR WFO discussing the meteorological conditions influencing the area and further insight into their forecast that was issued at 0853 PST was as follows, the aviation section applicable to the TAFs is in bold print:

*FXUS66 KMTR 291653
AFDMTR*

*Area Forecast Discussion
National Weather Service San Francisco Bay Area
853 AM PST Mon Jan 29 2018*

.SYNOPSIS...Look for dry weather to continue through at least the middle of next week as the main storm track remains well to our north. Daytime temperatures will generally be well above seasonal averages, while nights remain seasonably cool.

.DISCUSSION...As of 8:50 AM PST Monday...Just the right conditions this morning lead to beautiful sunrises across the San Francisco and Monterey Bay region. That has given way to another round of quiet weather today along with warmer than normal temperatures. The only sticking point for the forecast is how much of an impact high clouds will have on temperatures this afternoon. Guidance has slightly backed off on projections for this afternoon, so now looking less likely for potential record highs. However, will still be quite warm for a late January day -- 60s and 70s across the board.

12Z GFS just in continues to show the storm track well to our north leaving us dry the next 10 days. Guidance also indicates a Rex block setting up along the coast next week that will remain fairly stationary.

.PREVIOUS DISCUSSION...Conditions early this morning are much the same as yesterday morning. Skies are mostly clear except for areas of thin high clouds. Patchy fog has developed once again in the North Bay Valleys. Offshore gradients remain relatively robust with more than a millibar offshore from SAC to SFO and nearly 8 mb offshore from WMC to SFO. These offshore gradients continue to drive locally gusty northeast winds in the hills. Meanwhile, the synoptic pattern remains pretty much unchanged with a strong upper ridge holding firm over California. Expect temperatures to remain well above seasonal averages today. However, a couple factors may result in a slightly cooler temperatures compared to yesterday's balmy readings. First, incoming high clouds associated with a system approaching the Pacific Northwest are expected to be more widespread and thicker than yesterday. Second, offshore gradients are forecast to relax today which will result in a reduction in offshore flow. In any case, high temperatures today will remain well above normal.

The system approaching the Pacific Northwest is forecast to move inland well to our north tonight and weaken the ridge over California slightly by Tuesday. However, model guidance holds temperatures near persistence on Tuesday, except near the coast where increasing onshore flow by afternoon will knock temperatures back a few degrees. Slight cooling is expected to continue into Wednesday, although temperatures will remain several degrees warmer than normal.

The models agree that the upper ridge will once again strengthen near the West Coast late in the week and into the upcoming weekend, resulting in renewed warming with more widespread highs in the 70s.

Longer range models offer little hope of an end to dry conditions across California. The latest GEFS ensemble mean keeps a ridge locked in place along the West Coast all the way through mid February. The Climate Prediction Center's 8-14 Day Outlook and 3-4 Week Outlook both indicate warmer and drier than normal conditions persisting across the West.

.AVIATION...as of 3:30 AM Monday...For 12Z TAFs. High clouds spilling over the ridge of high pressure will continue to traverse the region through much of the forecast period. Dense fog will persist over KSTS until around 18z this morning. Light winds will continue.

High confidence.

Vicinity of KSFO...VFR conditions with mainly high clouds will prevail through much of the period. Light winds are forecast through this morning with a slight sea breeze expected this afternoon.

SFO Bridge Approach...Similar to SFO.

Monterey Bay Terminals...VFR conditions with mainly high clouds expected through much of the forecast period. Light winds.

.MARINE...as of 8:50 AM PST Monday...Light to moderate winds and seas will continue through tonight as high pressure sits over the region. Increasing northerly winds across the waters tomorrow as a dry cold front moves through. Moderate winds and seas will then persist through the forecast period.

*.MTR WATCHES/WARNINGS/ADVISORIES...
Today...NONE.*

*PUBLIC FORECAST: Bell/Dykema
AVIATION: CW
MARINE: AS*

The AFD aviation section indicated high cirrus clouds were expected over the area spilling over from the high pressure over the region with light winds, and that dense morning fog conditions were expected over KSTS until 1000 PST with no other specific airports mentioned for any impact.

6.3 Graphic Aviation Forecast

The NWS AWC Graphic Aviation Forecast (GFA) wind, expected weather, and general flight categories issued at 0800 PST and valid from 1000 PST for the west-central United States is included as figure 12. The chart depicted calm winds in the vicinity of the accident site with an area of IFR and MVFR conditions over the interior of California, which extended over the accident site. The GFA forecast also included the existing AIRMET Sierra for IFR conditions which was current at the time, which extended over the accident site.

Figure 13 is the Graphic Aviation Forecast depiction of cloud bases and tops for the west-central for the same period of 1000 PST. The GFA expected high cirrus type clouds over the accident site

and was west of an area of overcast clouds with bases near 500 ft with tops at 1,000 ft, with cirrus above. Another area of overcast clouds with bases at 300 ft and tops to 500 ft was located west-northwest of the accident site off the coast. The image also depicted the AIRMETs current for mountain obscuration and icing, which depicted the area of extreme northwest California, Washington and Oregon.

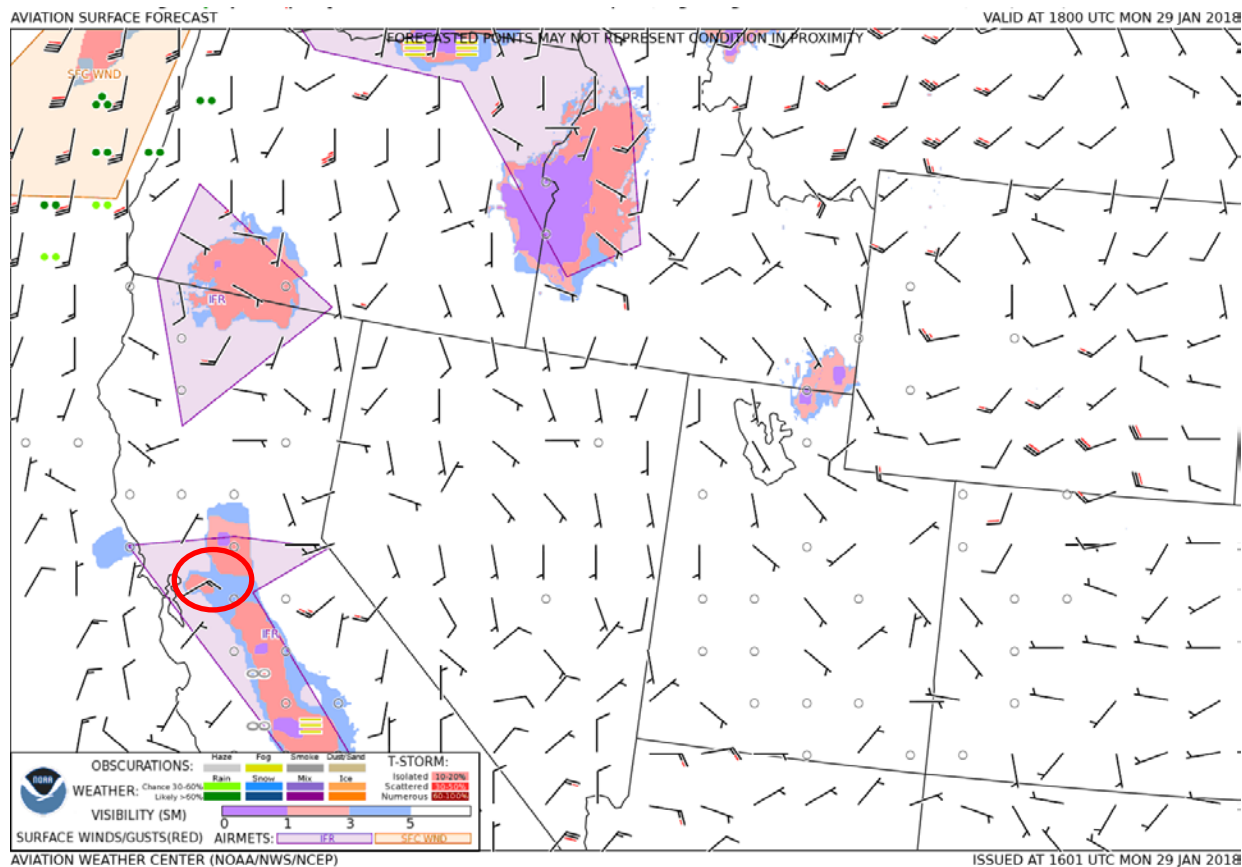


Figure 12 - Graphic Aviation Forecast for wind, flight categories, and AIRMETs for IFR conditions

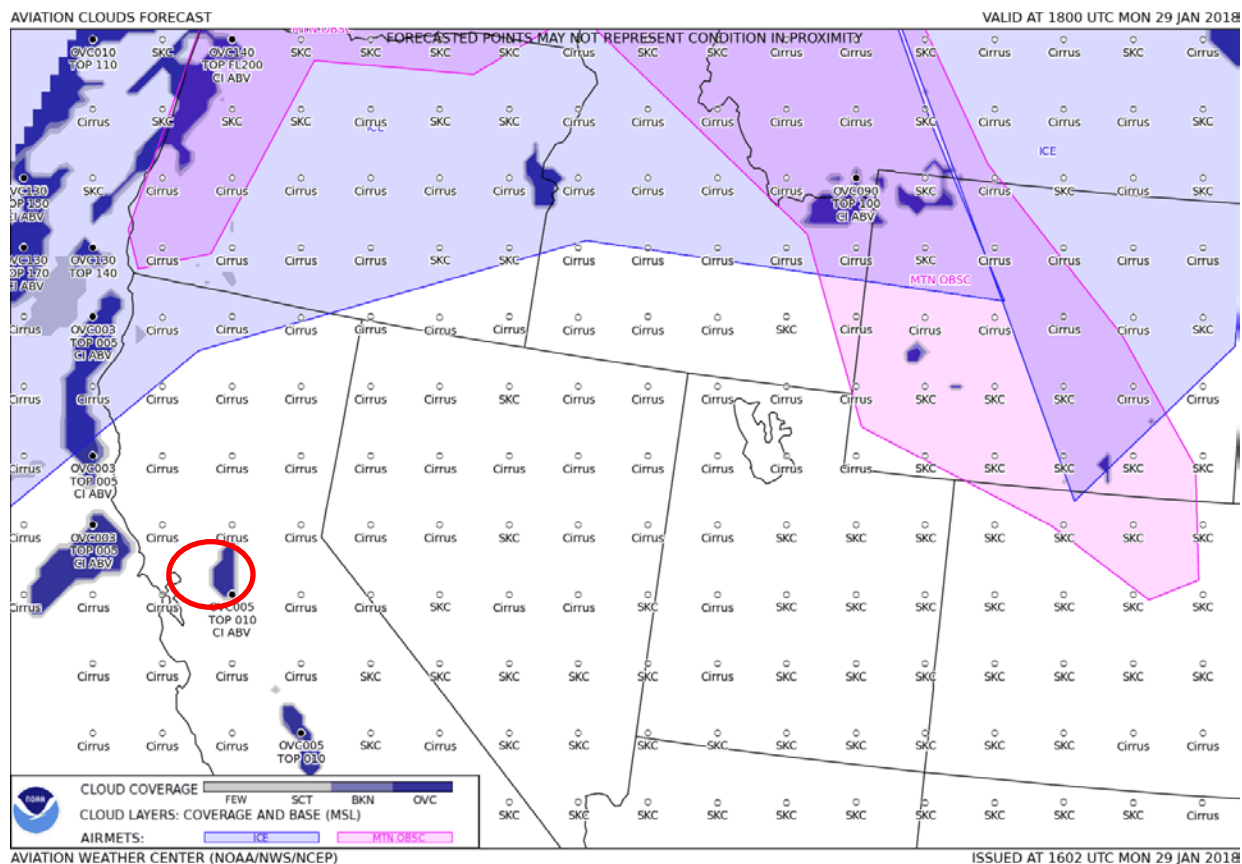


Figure 13 - Graphic Aviation Forecast cloud bases and tops, and AIRMETs for icing and mountain obscuration

6.4 Inflight Weather Advisories

No Significant Meteorological Information (SIGMET), Convective SIGMETs, or Center Weather Advisories from KZOA Oakland Center were issued surrounding the period applicable to the accident flight. The NWS AWC had issued a series of Airmen's Meteorological Information (AIRMET) advisories for the western United States during the period. Specifically, AIRMET Sierra update 3 for IFR conditions for the interior portions of California at 0645 PST and valid through 1300 PST and is included in graphic form by G-AIRMET Sierra in figure 14, AIRMET Tango for turbulence is included in figure 15 which was current above 18,000 ft over the region.

SIERRA 2018-01-29 18:00:00

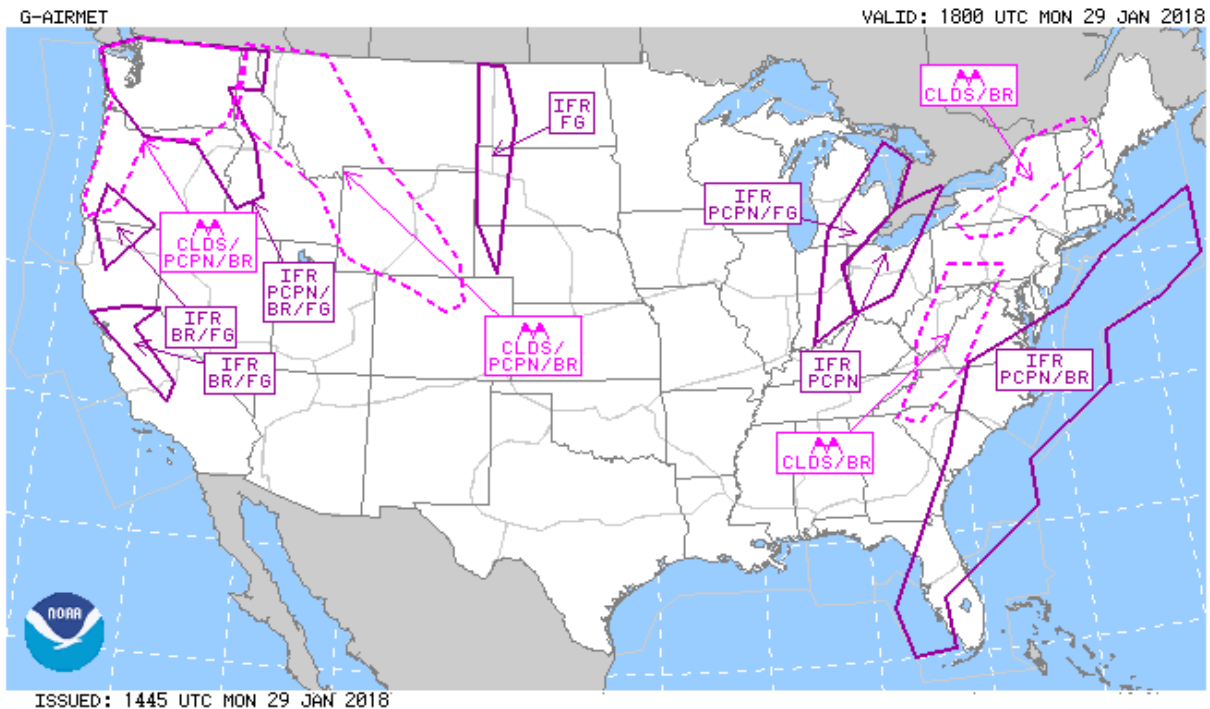


Figure 14 - G-AIRMET Sierra issued at 0645 PST for IFR conditions

WAUS46 KPCI 291445

WA6S

-SFOS WA 291445

AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 292100

.
AIRMET IFR...WA OR CA ID MT AND CSTL WTRS
FROM 40SSW YQL TO 50WSW HLN TO 40ESE GEG TO 50E BOI TO 40SSW BOI TO 30SW PDT
TO 20ENE ONP TO 140WNW FOT TO 120W ONP TO 150W HQM TO 30NNW TOU TO 40SSW YQL
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 21Z THRU 03Z.

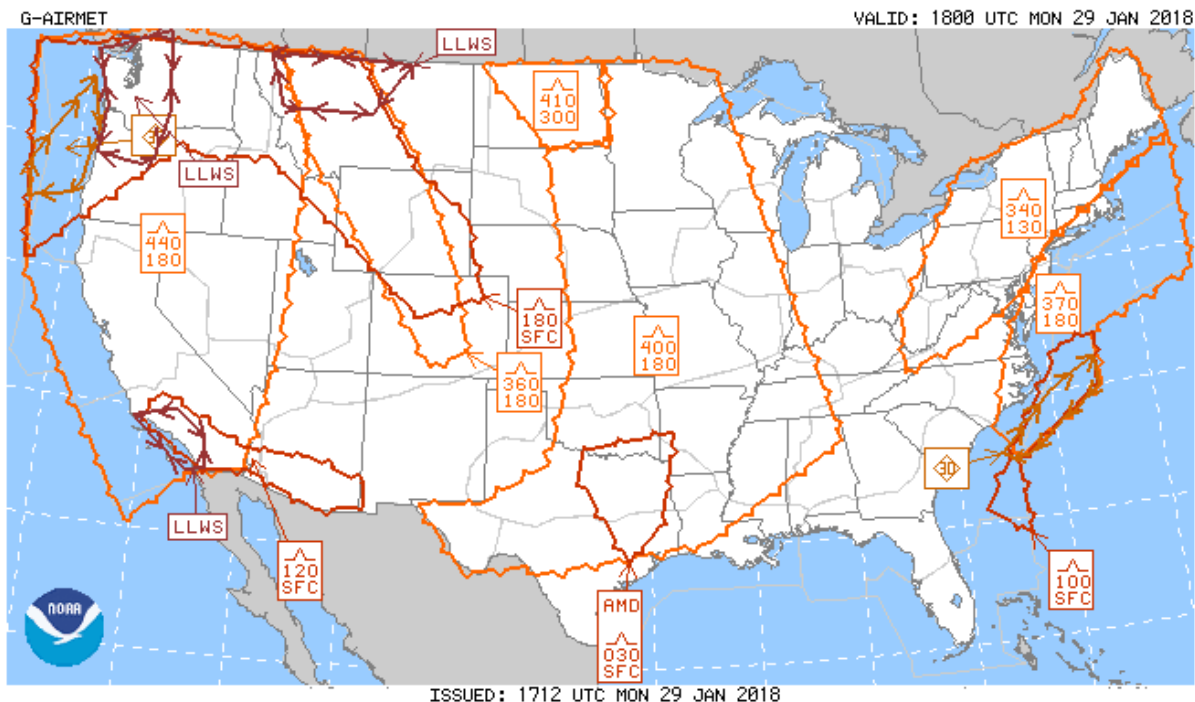
.
AIRMET IFR...OR CA
FROM 30SSW EUG TO 20SSE LKV TO 30WSW RBL TO 50WSW OED TO 30SSW EUG
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 21Z.

.
AIRMET IFR...CA AND CSTL WTRS
FROM 30N SAC TO 40SSW FMG TO 40ESE SAC TO 50NE EHF TO 20SSE EHF TO 40SW ENI
TO 30N SAC
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 21Z.

.
AIRMET MTN OBSCN...WA OR CA
FROM 60WSW YXC TO 70SSE GEG TO 20SSE PDT TO 40NNE DSD TO 50NE
RBL TO 20S FOT TO 70W OED TO 20SE HQM TO TOU TO HUH TO 60WSW YXC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

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TANGO 2018-01-29 18:00:00



WAUS46 KPCI 291728 AAA

WA6T

-SFOT WA 291728 AMD

AIRMET TANGO UPDT 3 FOR TURB STG WNDZ AND LLWS VALID UNTIL 292100

AIRMET TURB...WA OR CA ID MT WY NV UT AZ AND CSTL WTRS
FROM 30S YXC TO MTU TO TBC TO 70SW DRK TO 60ESE BZA TO BZA TO
20S MZB TO 220SW MZB TO 140WSW FOT TO 140W TOU TO 20N TOU TO 30S
YXC
MOD TURB BTN FL180 AND FL440. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET TURB...WA OR CA ID MT WY NV UT CO AND CSTL WTRS
FROM HUH TO 30NW HVR TO 20ENE SHR TO 60NNW BFF TO GLD TO 30SE
DBL TO DNJ TO 60WSW BKE TO 140WSW FOT TO 140W TOU TO HUH
MOD TURB BLW FL180. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET TURB...CA AZ CSTL WTRS
FROM EHF TO 20NE SSO TO 60SSE SSO TO 50S TUS TO BZA TO 20S MZB
TO 40W RZS TO EHF
MOD TURB BLW 120. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET STG SFC WNDZ...WA OR CA AND CSTL WTRS
FROM 40S TOU TO 20SSE HQM TO 20SSE ONP TO 80W OED TO 140WNW FOT
TO 150W ONP TO 40S TOU
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD 21Z
ENDG 00-03Z.

LLWS POTENTIAL...WA OR AND CSTL WTRS

BOUNDED BY 60WSW YXC-20E GEG-EPH-40SW LKV-20NE EUG-60SW EUG-30SSE HQM-TOU-20S YDC-60WSW YXC
LLWS EXP. CONDS CONTG BYD 21Z THRU 03Z.

.
LLWS POTENTIAL...CA AZ AND CSTL WTRS
BOUNDED BY 50SE EHF-20NNW TRM-30S EED-40ENE PHX-70WSW TUS-BZA-30SW MZB-50W RZS-50SE EHF
LLWS EXP. CONDS ENDG 21Z.

WAUS46 KKCI 291445
WA6Z
-SFOZ WA 291445
AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 292100

.
AIRMET ICE...WA OR CA ID MT WY NV UT AND CSTL WTRS
FROM 20NE HUH TO 30S YQL TO 30NE DLN TO 50WSW BOY TO 60SSW LKV TO 20NW PYE TO 120WSW PYE TO 140WSW FOT TO 160WSW TOU TO 30WNW TOU TO 20NE HUH
MOD ICE BTN FRZLVL AND FL210. FRZLVL 060-120. CONDS CONTG BYD 21Z THRU 03Z.

.
FRZLVL...RANGING FROM SFC-140 ACRS AREA
MULT FRZLVL BLW 120 BOUNDED BY 40E HUH-50NNW ISN-70SW RAP-GLD-50W LBL-30ESE TBE-INK-ELP-50S TUS-70SW SJN-50W BTY-50SW OED-20NNW YKM-40E HUH
040 ALG 160WSW HQM-120WSW TOU-70WNW TOU
080 ALG 160WSW ONP-40SW SEA-50W EPH-30ENE GEG
080 ALG 40W BOI-30N REO-40SSW REO
120 ALG 130WSW ENI-40NNE SAC-60SSW FMG-40S BTY-40W LAS

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6.5 Winds and Temperatures Aloft Forecast

The Winds and Temperature Aloft Forecast valid for 1000 PST and for use between 0600 through 1300 PST was as follows:

WINDS ALOFT FORECASTS
DATA BASED ON 291200Z
VALID 291800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
SFO	9900	9900+15	2707+08	2415+02	2322-14	2521-25	284241	285552	296562
SAC	9900	2606+15	2510+08	2418+02	2328-15	2524-25	273941	285453	297063

The forecast for San Francisco for 3,000 and 6,000 ft was for light and variable winds with wind speeds less than 10 knots, with the temperature at 6,000 ft at +15° C.

7.0 Astronomical Conditions

The United States Naval Observatory website was used to determine the astronomical conditions Concord, Contra Costa County, California on January 29, 2018:

Begin civil twilight	0647 PST
Sunrise	0715 PST
Accident	0945 PST
Sun transit	1221 PST
Sunset	1728 PST
End civil twilight	1756 PST

At the time of the accident the Sun was 23° above the horizon and at an azimuth of 139° or southeast.

Submitted by:

Don Eick
Senior Meteorologist

