



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 27, 2017

Weather Study

METEOROLOGY

WPR17FA215

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A. ACCIDENT

Location: Brinnon, Washington
Date: September 29, 2017
Time: 2213 Pacific daylight time (0513 UTC on September 30, 2017)¹
Airplane: Type: Piper PA-28-140; Registration: N9549W

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's meteorological specialist did not travel in support of this accident investigation and gathered all weather data remotely. Unless otherwise noted, all times are in Pacific daylight time (PDT) for September 29, 2017 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location: 47.76098° north latitude, 122.93652° west longitude, at an elevation of about 3,075 feet.

D. WEATHER INFORMATION

1.0 Synoptic Conditions

The National Weather Service (NWS) Surface Analysis Chart for 2300 PDT is presented in figure 1. The surface analysis chart identified a low pressure center in northeast Washington, with stationary fronts extending south and northeast from the center. Station models in northwest Washington generally indicated temperatures in the 50's degrees Fahrenheit (°F), with dew point depressions less than 5°F.

¹ UTC – abbreviation for Coordinated Universal Time

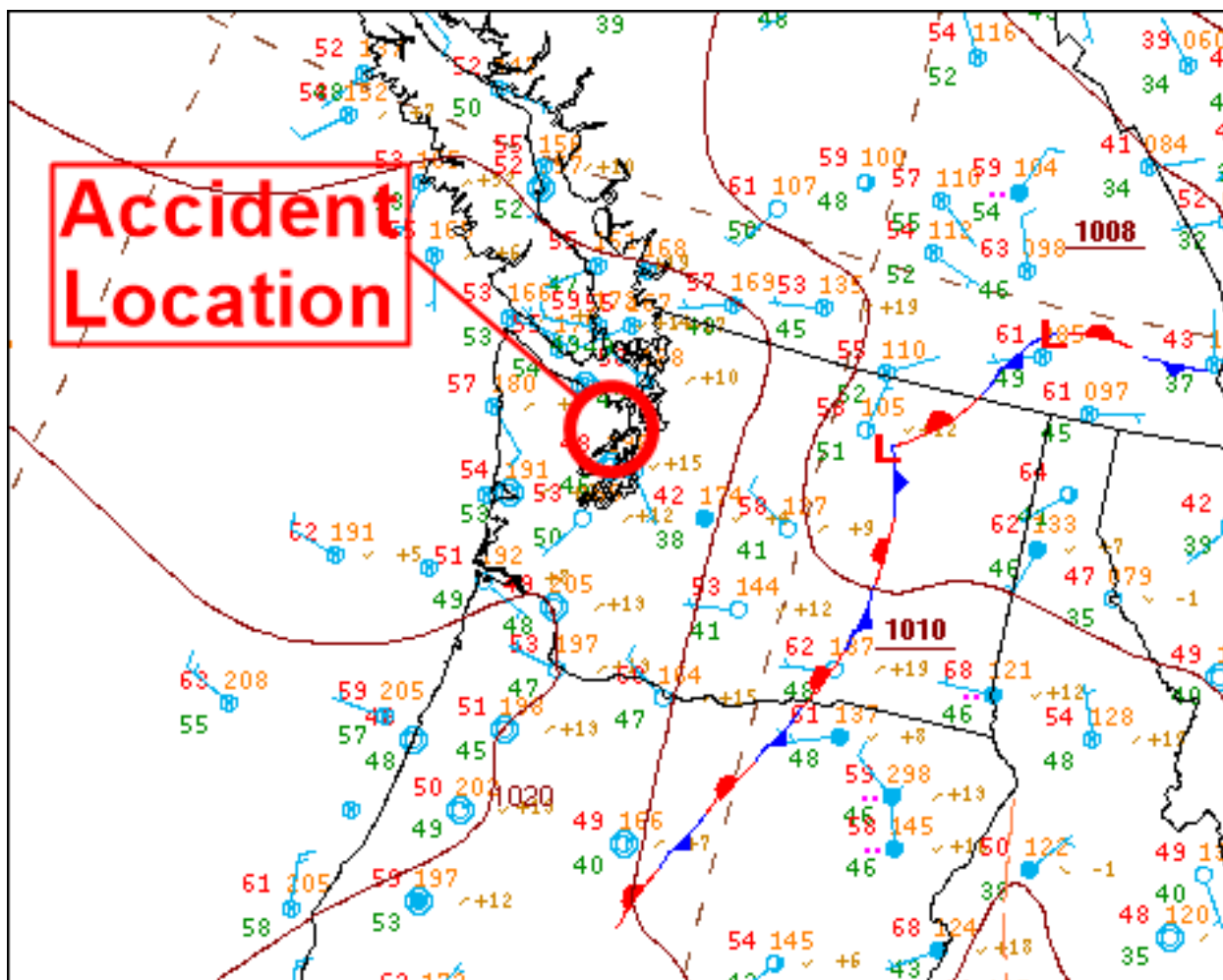


Figure 1 - NWS Surface Analysis Chart for 2300 PDT.

2.0 Surface Observations

An Automated Weather Observing System was located at Bremerton National Airport (PWT)² in Bremerton, Washington, and was located about 18 miles south-southeast of the accident location at an elevation of about 445 feet. Automated reports from PWT during the times surrounding the accident time are presented here:

[2056 PDT] METAR KPWT 300356Z AUTO 00000KT 10SM CLR 11/09 A3003 RMK AO2 SLP187 T01110094=

[2156 PDT] METAR KPWT 300456Z AUTO 00000KT 10SM FEW020 08/07 A3005 RMK AO2 SLP193 T00830072=

² The National Weather Service uses the 4-digit International Civil Aviation Organization (ICAO) format for station identifiers (as seen in the body of some formatted weather observations). This report uses the 3-digit International Air Transport Association format for station identification, which does not use the geographic designating digit ("K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the ICAO format.

[2239 PDT] SPECI KPWT 300539Z AUTO 00000KT 10SM SCT018 BKN060 08/08
A3006 RMK AO2=
[2256 PDT] METAR KPWT 300556Z AUTO 00000KT 10SM FEW040 BKN060 09/08
A3006 RMK AO2 SLP198 T00890078 10183 20078 53015=
[2356 PDT] METAR KPWT 300656Z AUTO 00000KT 10SM OVC035 11/09 A3007
RMK AO2 SLP201 T01060094=

At 2056 PDT, PWT reported a calm wind, visibility of 10 statute miles or greater, clear skies below 12,000 feet above ground level (agl), temperature of 11° Celsius (C) and a dew point temperature of 9°C, altimeter setting of 30.03 inches of mercury; remarks included: station with a precipitation discriminator, temperature of 11.1°C and dew point temperature of 9.4°C.

At 2156 PDT, PWT reported a calm wind, visibility of 10 statute miles or greater, few clouds at 2,000 feet agl, temperature of 8°C and a dew point temperature of 7°C, altimeter setting of 30.05 inches of mercury; remarks included: station with a precipitation discriminator, temperature of 8.3°C and dew point temperature of 7.2°C.

At 2239 PDT, PWT reported a calm wind, visibility of 10 statute miles or greater, scattered clouds at 1,800 feet agl, ceiling broken at 6,000 feet agl, temperature of 8°C and a dew point temperature of 8°C, altimeter setting of 30.06 inches of mercury; remarks: station with a precipitation discriminator.

At 2256 PDT, PWT reported a calm wind, visibility of 10 statute miles or greater, few clouds at 4,000 feet agl, ceiling broken at 6,000 feet agl, temperature of 9°C and a dew point temperature of 8°C, altimeter setting of 30.06 inches of mercury; remarks included: station with a precipitation discriminator, temperature of 8.9°C and dew point temperature of 7.8°C.

At 2356 PDT, PWT reported a calm wind, visibility of 10 statute miles or greater, ceiling overcast at 3,500 feet agl, temperature of 11°C and a dew point temperature of 9°C, altimeter setting of 30.07 inches of mercury; remarks included: station with a precipitation discriminator, temperature of 10.6°C and dew point temperature of 9.4°C.

Unofficial meteorological reporting station E5649 (data courtesy of APRSWXNET/Citizen Weather Observer Program) was located 3 miles south-southeast of the accident site at an elevation of 390 feet. Calibration, maintenance and siting standards of this instrument, as well as the overall quality of the data, are not known. Reports³ from E5649 during the times surrounding the accident time are presented here:

<u>Time</u>	<u>Temp</u>	<u>D-Temp</u>	<u>RH</u>	<u>W Mag</u>	<u>W Dir</u>	<u>G Mag</u>
2130	56.0	48.8	77	0.0	---	0.0
2135	56.0	49.2	78	0.0	---	0.0
2140	56.0	49.2	78	0.0	---	4.0

³ Temp=temperature(°F); D_Temp=dew point temperature(°F); RH=relative humidity(%); W_Mag=average wind magnitude(knots); W_Dir=average wind direction(true); G_Mag=gust wind magnitude(knots)

2145	56.0	49.2	78	0.0	---	4.0
2150	56.0	49.5	79	0.0	---	2.0
2155	56.0	49.2	78	0.0	---	4.0
2200	56.0	49.2	78	0.0	---	4.0
2205	56.0	49.2	78	0.0	---	3.0
2210	56.0	49.9	80	0.0	---	1.0
2220	56.0	49.5	79	0.0	---	0.0
2230	55.0	48.9	80	0.0	---	2.0
2255	54.0	50.2	87	0.0	---	0.0
2300	54.0	50.8	89	0.0	---	0.0

Unofficial meteorological reporting station JEFW1 (data courtesy of the Bureau of Land Management and the US Department of Agriculture Forest Service) was located 17 miles southwest of the accident site at an elevation of 2,408 feet. Calibration, maintenance and siting standards of this instrument, as well as the overall quality of the data, are not known. Reports from JEFW1 during the times surrounding the accident time are presented here:

<u>Time</u>	<u>Temp</u>	<u>D-Temp</u>	<u>RH</u>	<u>W Mag</u>	<u>W Dir</u>	<u>G Mag</u>
2036	47.0	43.9	89	2.0	327	4.0
2136	47.0	44.2	90	0.0	---	4.0
2236	47.0	43.3	87	1.0	271	3.0

3.0 Weather Radar

WSR-88D Level-II weather radar imagery from Seattle, Washington (KATX), are presented in figures 2-4. KATX was located approximately 32 miles north-northeast of the accident site at an elevation of about 500 feet. Assuming standard refraction and considering the 0.95° beam width for the WSR-88D radar beam, the KATX 0.5° tilt would have “seen” altitudes above the accident location of between about 1,300 and 4,500 feet msl, and the 1.5° tilt would have seen altitudes above the accident location of between about 4,700 and 7,900 feet msl. The KATX imagery surrounding the accident time identified extensive light reflectivity values across the accident region. The majority (or all) of these reflectivity values were most likely “clutter”⁴ and not meteorological targets (e.g., rain). A review of the KATX Hydrometeor Classification for the scans presented in Figures 2 and 3 indicated the majority of the reflectivity values found below (approximately) the freezing level were classified as “biological” (e.g., insects, birds). Figure 4 presents a VAD wind profile⁵ for KATX around the time of the accident. The wind profile showed 20-30 knot winds from the north through north-northwest at and below 4,000 feet.

⁴ “Clutter” is a term used for unwanted echoes in radar data, and can result from power returns from ground, sea, animals/insects, chaff and atmospheric turbulences.

⁵ VAD wind profile - A plot of horizontal winds as a function of height above a Doppler Radar. The display is plotted with height as the vertical axis and time as the horizontal axis (a so-called time-height display), which then depicts the change in wind with time at various heights.

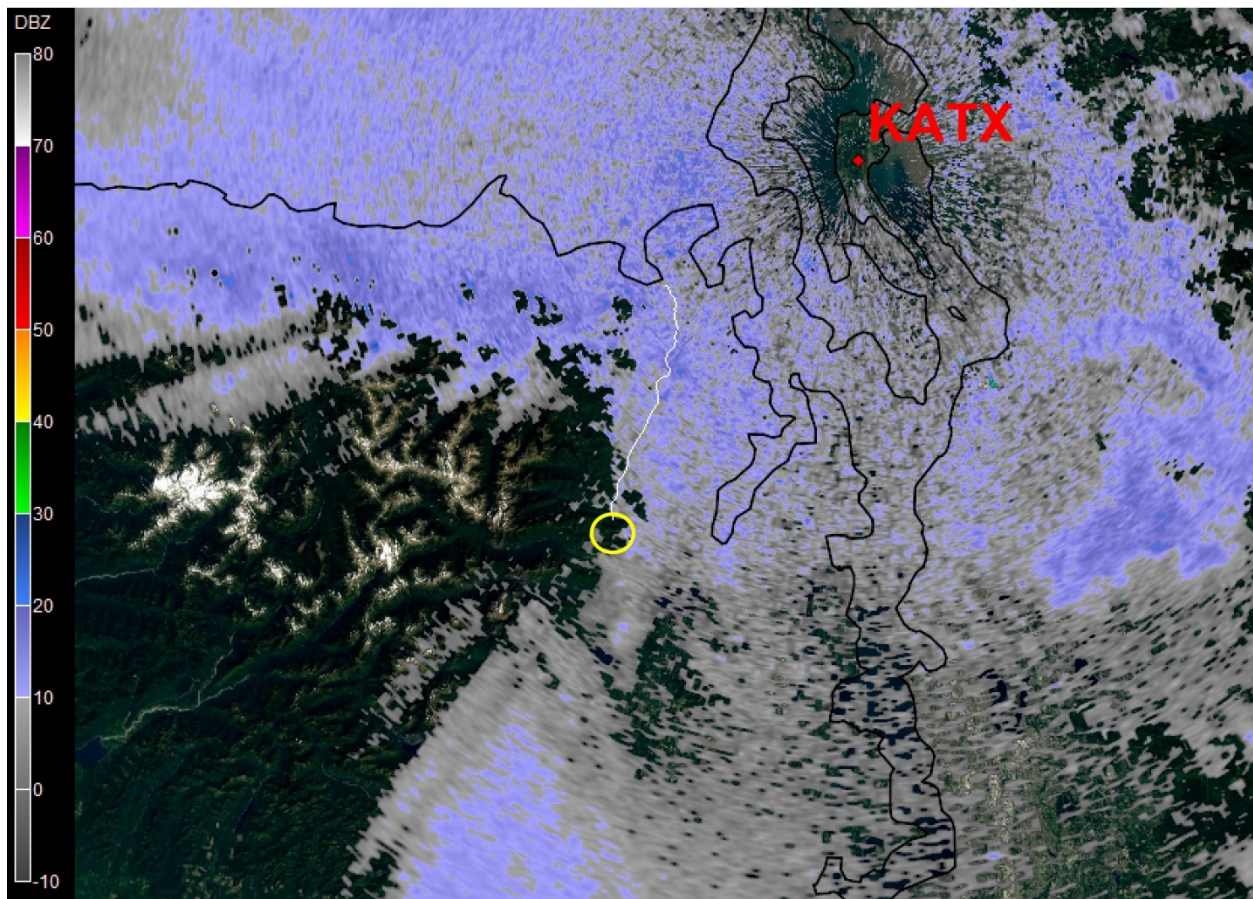


Figure 2 – KATX 0.5° Level-II reflectivity product from a sweep initiated at 2216:13 PDT. Accident flight path denoted by white line with accident aircraft location marked by yellow circle.

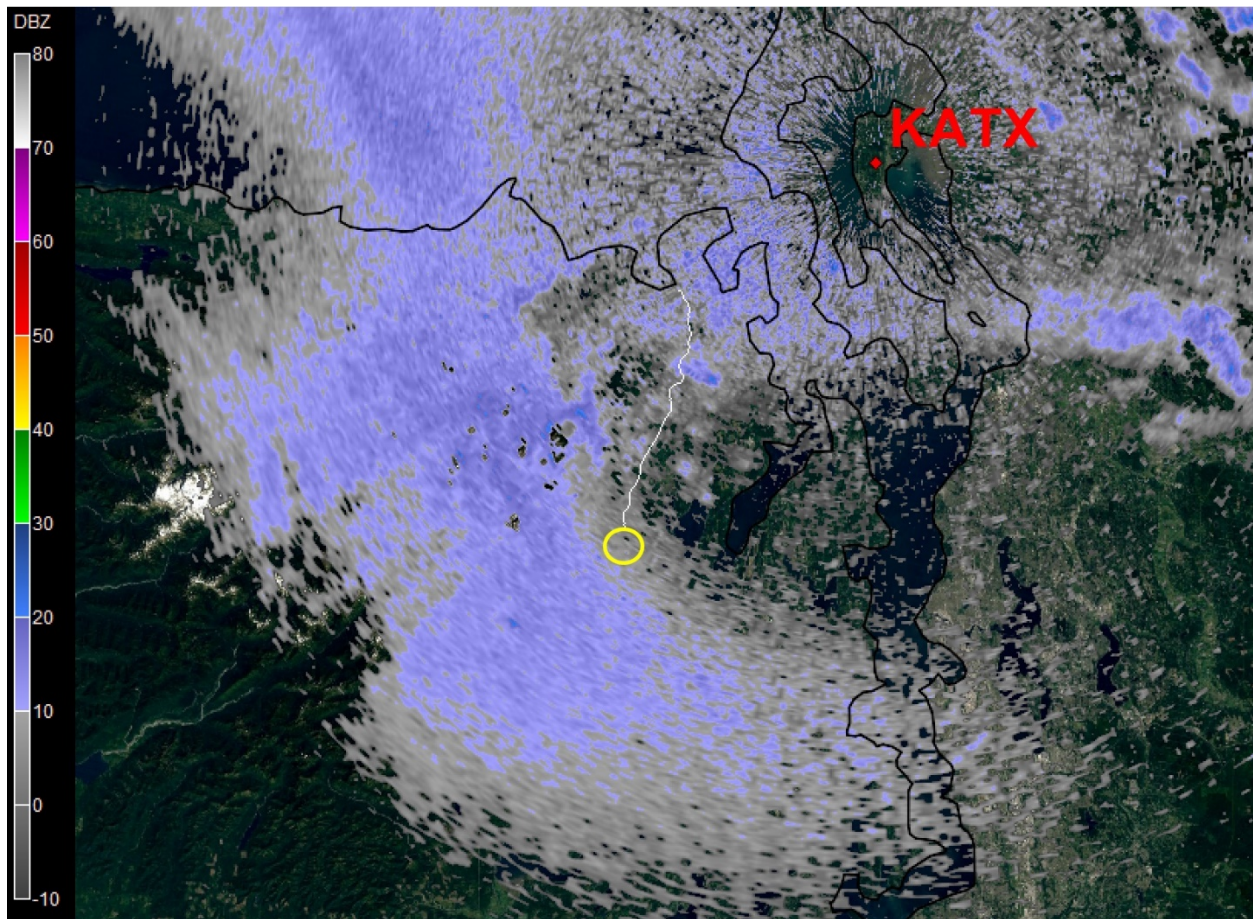


Figure 3 – KATX 1.5° Level-II reflectivity product from a sweep initiated at 2218:45 PDT. Accident flight path denoted by white line with accident aircraft location marked by yellow circle.

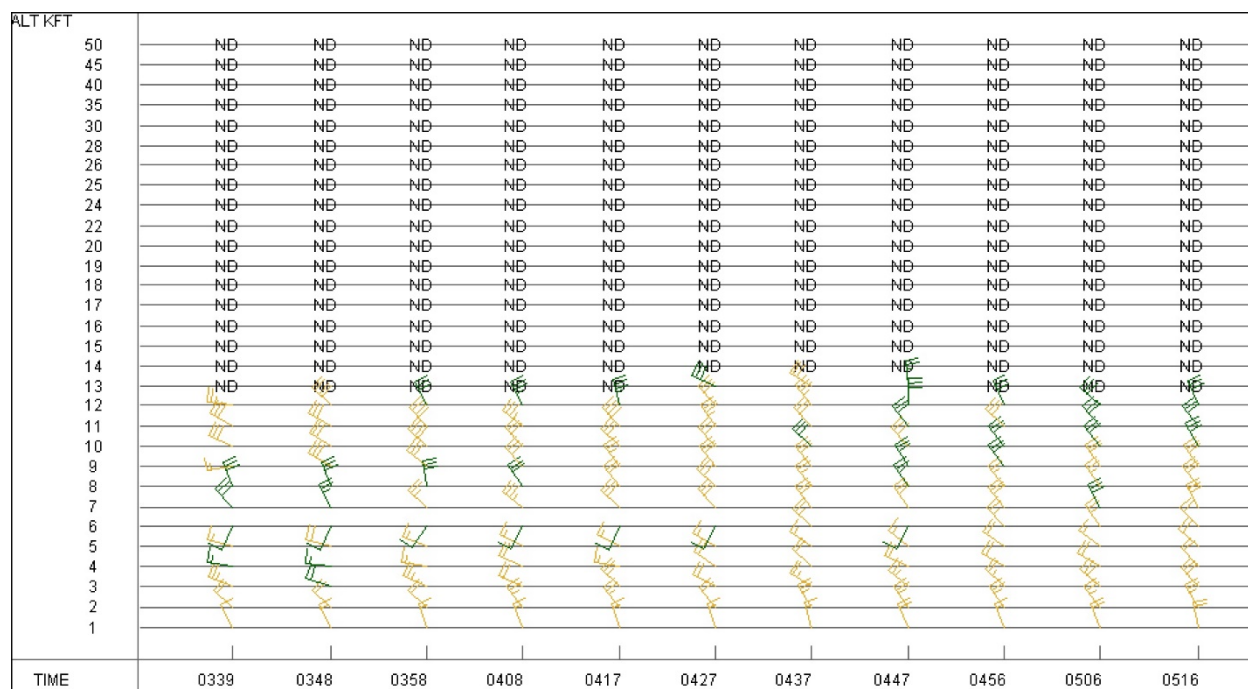


Figure 4 – KATX VAD wind profile for the times (in UTC) surrounding the accident time.

4.0 Pilot Reports

NTSB staff found no publicly disseminated pilot reports made within an hour of the accident time reported in the state of Washington.

5.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR) model⁶ sounding (figure 5) for the accident location at 2200 PDT was retrieved from the NOAA Air Resources Laboratory. The wind in the lowest 5,000 feet was light and variable, relative humidity was less than ninety percent. The freezing level (indicated by the blue horizontal line in figure 5) was at about 7,500 feet. Calculations made by the Rawinsonde OBservation Program did not yield any significant areas of non-convective turbulence for this atmosphere.

⁶ The HRRR is a National Oceanic and Atmospheric Administration (NOAA) real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

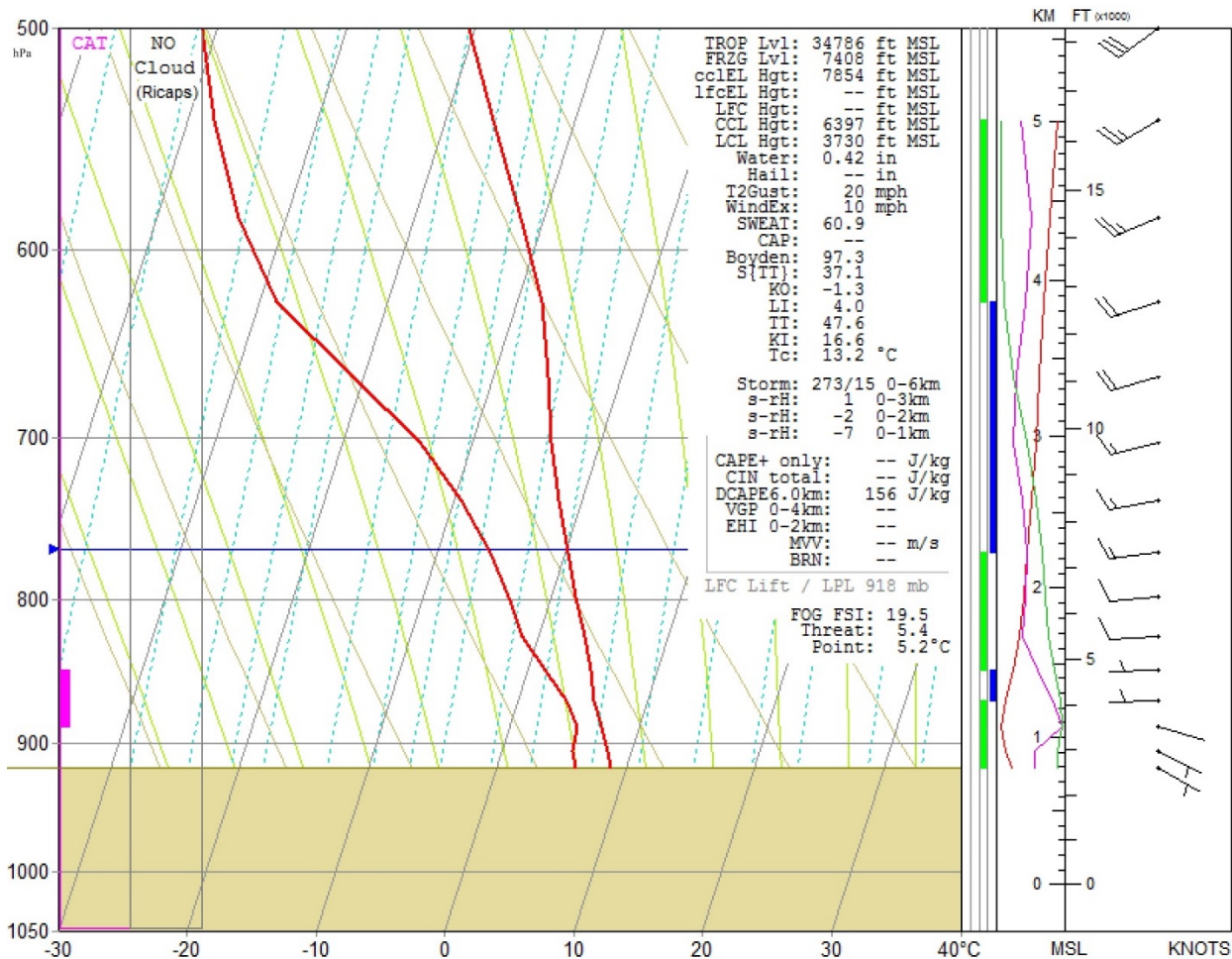


Figure 5 – HRRR model sounding data in SkewT/LogP format for 2200 PDT at the accident site, surface to 500 hectopascals.

6.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-15 infrared ($10.7\mu\text{m}$) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 2215 PDT is presented in figure 6. The GOES-15 infrared cloud-top temperatures in the area around the accident time were approximately 0°C , which, according to the HRRR model sounding, corresponded to cloud top heights of about 7,500 feet. It should be noted figure 6 has not been corrected for any parallax error.

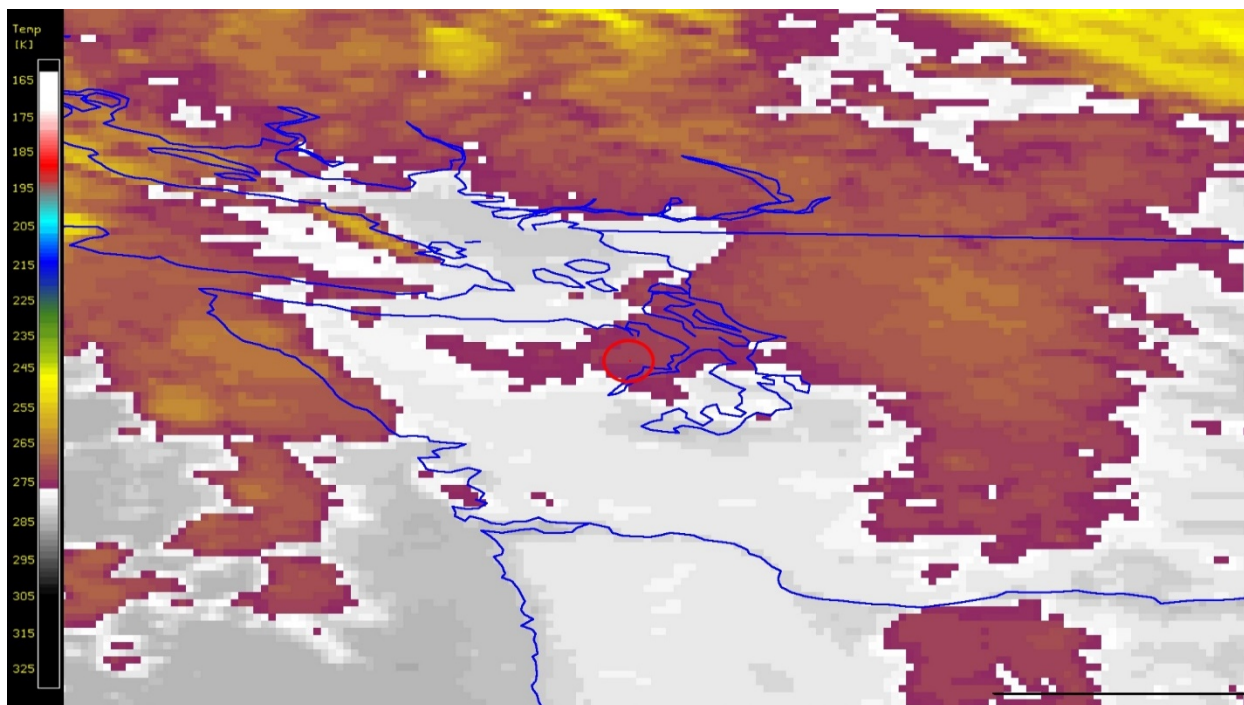


Figure 6 – GOES-15 infrared imagery from 2215 PDT. Accident location denoted by red circle.

7.0 Terminal Aerodrome Forecasts

The NWS issued Terminal Aerodrome Forecasts (TAFs)⁷ for PWT. The most recent PWT TAF issued prior to the accident time (at 1620 PDT) is presented here. The TAF forecasted for the accident time: wind from 220° at 8 knots, visibility greater than 6 statute miles, rain showers 5-10 miles⁸ away from PWT, ceiling broken at 4,000 feet agl.

[1620 PDT] TAF KPWT 292320Z 3000/3024 22015G25KT P6SM SCT040
FM300500 22008KT P6SM VCSH BKN040
 FM301000 18006KT P6SM BKN020
 FM301800 23006KT P6SM SCT025 BKN050=

8.0 Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 2145 PDT by the NWS Weather Forecast Office in Seattle, Washington. Portions of that AFD are presented here.

FXUS66 KSEW 300445
 AFDSEW
 Area Forecast Discussion
 National Weather Service Seattle WA

⁷ Conditions forecasted in the TAF are only official for 5 statute miles from the forecast site.

⁸ The METAR acronym “VC” (in the vicinity) means between 5 and 10 nautical miles from the reporting station.

945 PM PDT Fri Sep 29 2017

.SYNOPSIS...An upper level trough will remain over the area over through the weekend. An upper level ridge will begin to build offshore on Sunday night. Dry north northeasterly flow developing on Monday and continuing through next week.

.AVIATION...Westerly flow aloft will keep a chance of showers in the forecast tonight. A passing upper trough will enhance showers Saturday afternoon. Light surface onshore flow tonight will become moderate Saturday. The air mass is moist and slightly unstable. Areas of MVFR ceilings are likely to develop overnight and then scatter out again Saturday.

KSEA...VFR ceilings this evening will likely become MVFR late tonight and Saturday morning. SW wind 5-10 kt. CHB

9.0 Area Forecast

An Area Forecast that included the state of Washington was issued at 1945 PDT by the Aviation Weather Center (AWC) in Kansas City, Missouri. Cloud heights are above msl. The portion of the Area Forecast directed toward the Puget Sound/Interior Valley region of Washington forecasted for the accident time: broken clouds at 2,000-2,500 feet with tops to 8,000 feet, occasional visibility 3-5 statute miles, mist, isolated light rain showers.

FAUS46 KKCI 300245

FA6W

-SFOC FA 300245

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 302100

CLDS/WX VALID UNTIL 301500...OTLK VALID 301500-302100

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..BROAD UPR LVL TROF PACIFIC NW-SIERRAS-SRN CA WILL CONT EWD THRU PD APCHG ERN PTNS WA OR-WRN ROCKIES 18-21Z. CYCLONIC FLOW NRN PTN SPREADING EWD THRU PD. NW FLOW THRUT RMNDR.

SFC..CDFNT WRN ID-NW NV-NRN CA WILL CONT SEWD THRU PD APCHG WRN ROCKIES-NRN PTNS CNTRL CA/ADJACENT CSTL WTRS LATE DURG OTLK.

.

WA CASCDS WWD

CSTL SXNS...BKN020-025 TOPS 040. OCNL VIS 3-5SM BR. ISOL -SHRA.

BECMG 0609 BKN015-025 OVC040 TOPS 120. OCNL VIS 3-5SM BR. ISOL -SHRA.

OTLK...MVFR CIG BR.

**PUGET SOUND-INTR VLY...BKN020-025 BKN040 TOPS 080. OCNL VIS 3-5SM
BR. ISOL -SHRA. OTLK...MVFR CIG SHRA BR.
CASCDS...BKN070-080 TOPS 140. OCNL VIS 3-5SM BR. ISOL -SHRA.
OTLK...MVFR CIG BR.**

10.0 AIRMETs

There were no Airmen's Meteorological Information (AIRMET) advisories for turbulence active for the accident location at the accident time for altitudes below 10,000 feet. There were no AIRMETS active for icing in the accident region.

At 1945 PDT, an AIRMET SIERRA for mountain obscuration in clouds/precipitation/mist was issued by the AWC for a region that included the accident location at the accident time:

WAUS46 KPCI 300245
WA6S
-SFOS WA 300245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 300900

.
**AIRMET MTN OBSCN...WA OR CA
FROM 30SSE YDC TO 20WNW LKV TO 60SSW OED TO 70W OED TO 30SSE
HQM TO 20NNW TOU TO HUH TO 30SSE YDC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.**

11.0 SIGMETs

There were no convective or non-convective Significant Meteorological Information (SIGMET) advisories active for the accident location at the accident time.

12.0 CWSU Products

There were no Center Weather Advisories (CWA) or Meteorological Impact Statements issued by the Center Weather Service Unit (CWSU) at the Seattle Air Route Traffic Control Center (ZSE) that were active for the accident site at the accident time.

At 1704 PDT, the CWSU at ZSE issued a CWA for an area very close to the accident location and valid for two hours advising of occasional moderate turbulence between the surface and 1,500 feet and low-level wind shear up to 15 knots.

FAUS21 KZSE 300004
ZSE1 CWA 300003
ZSE CWA 101 VALID UNTIL 300203
FROM 45SSW HUH-50NNE SEA-15SE SEA-15SSW SEA-45SSW HUH
AREA OCNL MOD TURB. SFC-015. LLWS UP TO 15KT. RPRTD BY

P28A...C182...C510...LJ35. ZSE CWSU JV300003Z.

13.0 Astronomical

The astronomical data obtained from the United States Naval Observatory for 47° 46' north latitude and 122° 56' west longitude, for the accident location, indicated the following:

SUN

Sunset	1854 PDT
End Civil Twilight	1925 PDT

MOON

Moonrise	1558 PDT
Moonset	0126 PDT (September 30, 2017)

PHASE OF THE MOON

Waxing Gibbous with 66% of the Moon's visible disk illuminated



Submitted by:

Mike Richards
Senior Meteorologist

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