

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA23FA417

METEOROLOGY

Specialist's Factual Report

September 26, 2023

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A. ACCIDENT

Location: Santa Ana, California

Date: 20 August 2023

Time: 2315 Pacific daylight time (0615 UTC¹ on 21 August 2023)

Aircraft: Type - 737-890; Registration - N516AS

B. METEOROLOGY INVESTIGATOR

Mike Richards

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Office of Aviation Safety

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 for 20 August 2023 (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). The accident site was located at about: 33.675701° north latitude; 117.86799° west longitude at an elevation of about 40 feet.

This report provides information on near-surface weather conditions and forecasts applicable to the John Wayne/Orange County Airport (SNA²).

D. WEATHER INFORMATION

1.0 Surface Observations

An Automated Surface Observing Station (ASOS) was located at SNA, which was where the accident occurred. SNA had an elevation of about 40 feet and a magnetic variation

¹ UTC - abbreviation for Coordinated Universal Time

² This report uses the 3-digit International Air Transport Association format for airport identification, which does not use the geographic designating digit (e.g., "K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the 4-digit International Civil Aviation Organization (ICAO) identifier format. Weather observations from airports in this report are referenced by their reporting station's identifier (using ICAO format that includes the geographic designating digit), not by the airport at which the reporting station is located.

of about 12° east. Augmented and automated longline³ reports from the SNA ASOS during the times surrounding the accident time are presented here, and the observation closest in time to the accident time is highlighted with bold text.

[2201] KSNA 210501Z 17012G23KT 10SM FEW005 BKN018 OVC025 22/20
A2973 RMK AO2 PRESRR T02170200 PNO \$

[2253] KSNA 210553Z COR VRB03KT 2SM R20R/6000VP6000FT +RA BR
BKN009 OVC013 21/19 A2979 RMK AO2 RAB02 SLP087 LAST 60027
T02060189 10250 20206 51082 P0005 \$

**[2305] KSNA 210605Z AUTO 2SM +RA BR OVC011 21/19 A2981 RMK AO2
T02060189 PNO \$**

[2353] KSNA 210653Z AUTO 14014G26KT 2SM -RA BKN014 OVC022 20/17
A2984 RMK AO2 PK WND 13026/0647 SLP103 T02000172 PNO \$

At 2305, the SNA ASOS reported a visibility of 2 statute miles, heavy rain, mist, ceiling overcast at 1,100 feet above ground level (agl), temperature of 21°C and dew point temperature of 19°C, altimeter setting of 29.81 inches of mercury; Remarks: automated station with a precipitation discriminator, temperature of 20.6°C and dew point temperature of 18.9°C, precipitation amount not available, maintenance needed on the system.⁴

One minute observations (OMO) from the SNA ASOS that were retrieved every 5 minutes from the National Oceanic and Atmospheric Administration's (NOAA) Meteorological Assimilation Data Ingest System (MADIS) via Iowa State University are presented here.

[2300] KSNA 210600Z AUTO 11002KT 2SM +RA BR BKN011 OVC015 21/19
A2980 RMK T02100190 VRB03KT

[2305] KSNA 210605Z AUTO /////KT 2SM +RA BR OVC011 21/19 A2981 RMK
T02100190

³ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases (effectively, the whole world) and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline-dissemination of weather observations is the primary vehicle through which the general global public has access to surface weather observations, particularly outside of the aviation community.

⁴ A wind observation did not appear in this observation. According to the National Weather Service (NWS): *"The brief WIND SENSOR INOP would have most likely been due to an algorithm flag (i.e, wind direction/speed change > allowed in algorithm during allotted time frame), evident by the fact it came back on it's own 4 minutes later (3.5 minutes is the amount of time it will continue to exclude data after an algorithm flag)..."*

[2310] KSNA 210610Z AUTO 15011KT 2SM +RA BR OVC011 21/18 A2981 RMK T02100180

[2315] KSNA 210615Z AUTO 12008KT 2SM +RA BR OVC011 21/18 A2982 RMK T02100180 WND 08V16

[2320] KSNA 210620Z AUTO 14011KT 2SM RA BR BKN011 OVC019 20/18 A2982 RMK T02000180 WND 10V16

At 2315, the SNA ASOS OMO reported a wind from 120° at 8 knots, a visibility of 2 statute miles, heavy rain, mist, ceiling overcast at 1,100 feet agl, temperature of 21°C and dew point temperature of 18°C, altimeter setting of 29.82 inches of mercury; Remarks: temperature of 21.0°C and dew point temperature of 18.0°C, wind direction variable between 080° and 160°.

2.0 Weather Radar

WSR-88D⁵ Level-II base reflectivity and base velocity weather radar imagery from the Santa Ana Mountains, California, site (KSOX) is presented in Figures 1-2. KSOX was located approximately 14 miles northeast of the accident location with an antenna elevation of about 3,100 feet. Assuming standard refraction and considering the 0.95° beam width⁶ for the WSR-88D radar beam, the KSOX 0.44° tilt would have “seen” altitudes above the accident location of between about 3,200 and 4,600 feet. The imagery depicted light to heavy values of reflectivity across the accident region. A loop of these images suggested the reflectivity was moving to the north-northeast. The velocity imagery depicted velocity values immediately around the accident site in the direction toward the radar of about 10-15 knots.

A Vertical Azimuth Display (VAD) wind profile⁷ (not presented here) was retrieved for KSOX, but given the elevation of the radar, did not provide wind information for below 4,000 feet. At 2316 at 4,000 feet above KSOX, the VAD wind profile depicted a wind from the south at 30 knots.

⁵ Weather Surveillance Radar 88 Doppler (WSR-88D)

⁶ Here we define the angular width of the radar beam as the region of transmitted energy that is bounded by one-half the maximum power. The maximum power lies along the beam centerline and decreases outward from the radar antenna.

⁷ VAD wind profile - A plot of horizontal winds above a Doppler Radar as a function of height. The display is plotted with height as the vertical axis and time as the horizontal axis which then depicts the change in wind with time at various heights.

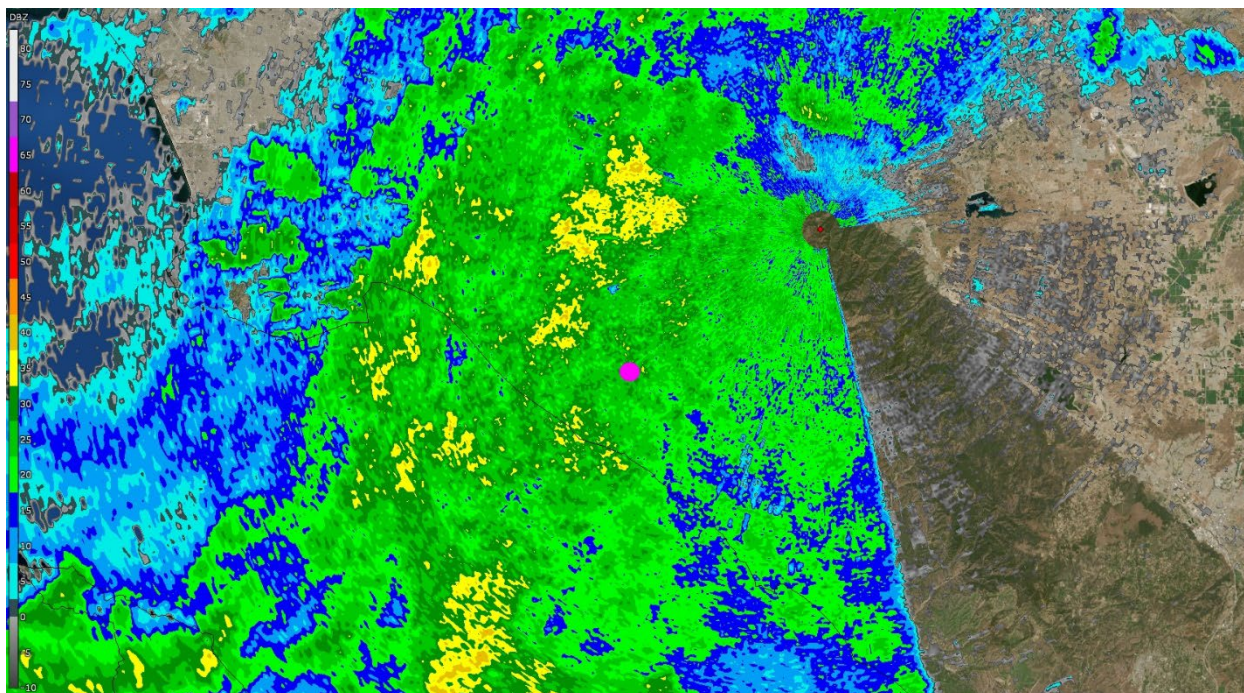


Figure 1 - KSOX 0.44° Level-II base reflectivity product from a sweep initiated at 2316:47. The accident location is denoted by the purple circle.

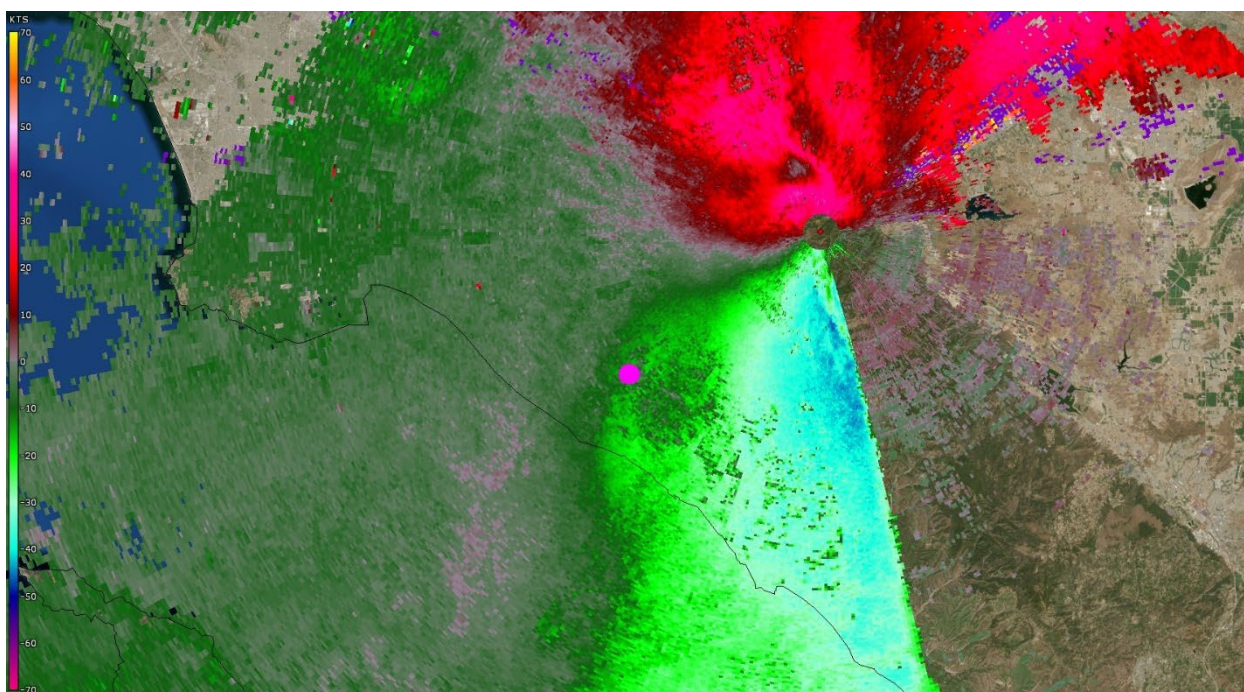


Figure 2 - KSOX 0.44° Level-II base velocity product from a sweep initiated at 2317:06. The accident location is denoted by the purple circle.

3.0 HRRR Model Sounding

A High-Resolution Rapid Refresh (HRRR) model⁸ sounding for near the accident site⁹ at 2300 was retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory. The sounding provided the following wind data for the lowest 4,000 feet.

<u>Height (feet)</u>	<u>Wind Dir (true)</u>	<u>Wind Mag (knots)</u>
52	154°	17
79	154°	16
164	156°	24
325	157°	29
590	158°	34
1000	159°	37
1512	162°	38
2158	165°	35
2877	168°	31
3660	173°	28

4.0 Pilot Reports

The following are the longline-disseminated pilot reports¹⁰ (PIREPs) reported between 2100 and 0100 (on 21 August 2023) within 150 miles of the accident location.

BUR UA /OV BUR/TM 0412/FL000/TP E135/SK BKN010/WX 3SM/TA 20/WV
OOOOOKTS/TB NA/IC NA/RM BRAKING ACTION REPORTED GOOD FOR
RWY 8 E135

LAX UUA /OV KBUR /TM 0437 /FL005 /TP B737 /RM LLWS -10KT ON FINAL
KBUR AWC-WEB

ONT UA /OV ONT/TM 0506/FL018/TP A321/TB LGT/RM DDCT 1 EAST ONT

ONT UA /OV ONT/TM 0639/FL015/TP BCS1/RM BASE 015 2 E ONT

⁸ The HRRR is a 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.

⁹ Coordinates used for the model were latitude: 33.68; longitude: -117.87.

¹⁰ These do not include pilot reports only broadcast via radio.

5.0 Terminal Aerodrome Forecasts

At 2220 a Terminal Aerodrome Forecasts (TAF) was issued for SNA that forecasted for the accident time: a wind from 180° at 13 knots with gusts to 20 knots, visibility of 5 statute miles, moderate rain, ceiling broken at 1,000 feet agl and overcast clouds at 2,000 feet. According to NWS Instruction 10-813: "A NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."¹¹

TAF KSNA 210520Z 2106/2206 **18013G20KT 5SM RA BKN010 OVC020**
FM210800 18010G20KT P6SM -SHRA OVC015
FM211400 16007KT P6SM OVC025
FM212000 22007KT P6SM SCT040
FM220200 VRB04KT P6SM SCT020=

6.0 Area Forecast Discussion

The NWS San Diego, California, Weather Forecast Office issued the following "Synopsis" and "Aviation" sections of an Area Forecast Discussion at 2133, applicable for a region that included the accident location.

FXUS66 KSGX 210433
AFDSGX
Area Forecast Discussion
National Weather Service San Diego CA
933 PM PDT Sun Aug 20 2023

.SYNOPSIS...

Tropical Storm Hilary will continue to move north across Southern California tonight. Strong and gusty winds will continue mainly across the mountains and foothills through tonight. Widespread moderate to heavy rainfall will continue through much of tonight. The heaviest rainfall will continue across the mountains into the deserts with catastrophic flash flooding possible. Light rain showers will gradually push out of the region on Monday with drier and warmer weather for Tuesday into next weekend. West of the mountains will be dry through the rest of the week, with a small chance for monsoonal thunderstorms in the mountains and deserts each afternoon and evening.

&&

.AVIATION...

¹¹ www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

210430Z...Coast/Valleys...RA will gradually decrease overnight, mostly ending by 12Z Mon in San Diego County and 14Z Mon in Orange County. Cigs will be quite variable, with BKN/OVC cloud bases 600-4000 ft MSL with layers extending to 20000+ ft MSL, with areas of vis 2-4 miles in RA/BR. South winds 15-30 kt will gradually lower overnight. SCT-BKN clouds with bases 3000-5000 ft MSL will prevail Mon with local vis 3-5 miles in -SHRA/BR through 17Z Mon.

Mountains/Deserts...RA/RA+ will gradually decrease overnight, mostly ending by 12Z-16Z Mon from south to north. Higher terrain will be obscured by clouds/RA/BR with cloud bases 2000-5000 ft MSL with layers extending to 20000+ ft MSL with areas of vis below 3 miles. South to southeast winds 15-40 kt with gusts to 50 kt will gradually lower overnight. SCT-BKN clouds with bases 4000-7000 ft MSL will prevail Mon with local vis 3-5 miles in -SHRA/BR through 18Z Mon.

7.0 SIGMETs

There were no non-convective Significant Meteorological Information (SIGMET) advisories active for the accident location at the accident time below FL180¹². There were no Convective SIGMETs active for the accident location at the accident time.

8.0 CWSU Products

There were no Center Weather Advisories or Meteorological Impact Statements issued by the Center Weather Service Unit (CWSU) at the Los Angeles Air Route Traffic Control Center that were active for the accident flight.

9.0 G-AIRMETs for Low Level Wind Shear

A Graphical-Airmen's Meteorological Information (G-AIRMET) is a graphical advisory of weather that may be hazardous to aircraft but can identify conditions that are less severe than what are addressed by SIGMETs. They are only valid at specific time "snapshots". G-AIRMETs are issued at 0300 UTC, 0900 UTC, 1500 UTC and 2100 UTC (with updates as necessary). At each issuance time, there are G-AIRMETs issued that

¹² Flight Level (FL) - a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the international standard pressure datum of 1013.25 hPa (29.92 inches of mercury), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above msl or agl.

are valid for the issuance time and for discrete times three hours apart for a period of up to 12 hours into the future (i.e., 03-, 06-, 09- and 12-hour forecasts). For example, at 1500 UTC, G-AIRMETs valid for 1500 UTC, 1800 UTC, 2100 UTC, 0000 UTC and 0300 UTC and issued.

There were no Graphical-Airmen's Meteorological Information (G-AIRMET) for low level wind shear active for the accident location at 2300.

Submitted by:

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