National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Guidance on the Issuance of Turbulence Products and Training for Low-Level Turbulence Identification and Forecasting for National Weather Service Forecasters

Accident Number:	CEN17FA168
Operator:	Rico Aviation LLC
Aircraft:	Pilatus PC-12, N933DC
Location:	Amarillo, Texas
Date:	April 28, 2017
Adopted:	August 2, 2018

The National Transportation Safety Board (NTSB) is providing the following information to urge the National Weather Service (NWS) to take action on the safety recommendations in this report. We identified these issues during our ongoing investigation of a fatal accident involving a Pilatus PC-12 airplane, N933DC, that impacted terrain near Rick Husband Amarillo International Airport (AMA), Amarillo, Texas. The NTSB is issuing two safety recommendations to the NWS.

Background and Analysis

On April 28, 2017, about 2348 central daylight time (CDT), a Pilatus PC-12 airplane impacted terrain near AMA shortly after takeoff.[1] The airline transport pilot and two flight crewmembers were fatally injured, and the airplane was destroyed. The airplane was registered to and operated by Rico Aviation LLC, under the provisions of Title 14 *Code of Federal Regulations* Part 135 as an air ambulance flight. The flight, which was operating on an instrument flight rules flight plan, was originating at the time of the accident and was en route to Clovis Municipal Airport, Clovis, New Mexico. The flight was cleared for takeoff about 2344, and the pilot reported to the AMA air traffic control (ATC) tower at 6,000 ft above mean sea level (msl) about 2347.[2] About 2348, the transponder signal was lost; shortly after, a fireball was observed south of the airport.[3]

[1] All times in this report are CDT.

[2] All heights in this report are above msl unless otherwise noted.

[3] Additional information regarding this investigation can be found in the public docket for this accident, NTSB case number CEN17FA168, at www.ntsb.gov. Specific information discussed in this report regarding the meteorological conditions relating to this accident can be found in the Meteorology Group Chairman's Factual Report (and attachments).

Although this investigation is ongoing, based on weather model, weather radar, and other data, the NTSB was concerned that low-level turbulence may have been present over Amarillo below 8,000 ft on the night of the accident.[4] Further, we noted that while the NWS Aviation Weather Center (AWC) issued several weather advisories around the time of the accident for areas near the accident location (see figure), there were no airmen's meteorological information (AIRMET) advisories active for turbulence below 10,000 ft at the accident location at the accident time.[5] In June 2017, the NTSB visited the NWS AWC in Kansas City, Missouri, to further examine the circumstances of the accident and document the AWC's operations regarding low-level turbulence identification and advisory issuance for turbulence.

During this visit and subsequent conversations with forecasters, the NTSB determined that (1) AWC forecasters may have varying professional criteria for issuing advisories for turbulence (like AIRMETs) when convective significant meteorological information (SIGMET) advisories are active in the same region and (2) low-level turbulence is not adequately covered in formal training for AWC or other NWS aviation forecasters.[6] Although the cause of this accident is still under investigation and the role of low-level turbulence has not been specifically identified as a factor or cause, the safety risks associated with significant turbulence encounters are well known and can include serious injuries to passengers and crew. Therefore, it is important that issuance of turbulence-related weather products directed to pilots be consistent and that these products address the turbulence potential at all operating altitudes.

Issuance of Products Advising of Turbulence When Convective SIGMETs Are Active

The NTSB obtained statements from two AWC forecasters responsible for the accident region and an AWC forecaster responsible for an adjacent region and noted that the forecasters expressed different criteria for the issuance of AIRMETs in the presence of active convective SIGMETs.[7]

[4] For the purposes of this report, *low-level turbulence* is turbulence not associated with the jet stream or convection and not terrain-induced (such as mountain wave turbulence). Generally, low-level turbulence is considered to occur below flight level 180. Low-level turbulence may exist below 2,000 ft above ground level with or without the presence of nonconvective low-level wind shear (low-level wind shear is defined in National Weather Service Instruction 10-813 at http://www.nws.noaa.gov/directives/sym/pd01008013curr.pdf).

[5] (a) According to the Federal Aviation Administration's (FAA) *Aeronautical Information Manual*, section 7-1-6, the four types of in-flight aviation weather advisories are AIRMETs, significant meteorological information (SIGMET) advisories, convective SIGMETs, and center weather advisories (CWAs). See https://www.faa.gov/air_traffic/publications/media/aim_basic_chg_1_dtd_3-29-18.pdf. (b) The NTSB has previously investigated accidents involving encounters with turbulence at lower altitudes where the turbulence hazard had not been identified in NWS products such as SIGMETs, AIRMETs, or Area Forecasts (see NTSB case numbers ERA16CA246 and ANC11LA027).

[6] According to the *Aeronautical Information Manual*, AIRMETs are "advisories of significant weather phenomena but describe conditions at intensities lower than those which require the issuance of SIGMETs." SIGMETs advise of weather that is potentially hazardous for all aircraft. Convective SIGMETs advise of severe thunderstorms due to certain conditions, embedded thunderstorms, a line of thunderstorms, and heavier precipitation and imply "severe or greater turbulence, severe icing, and low-level wind shear."

[7] All three forecasters indicated that the information available to them supported the AIRMETs that they issued (or supported not amending a previously issued AIRMET).

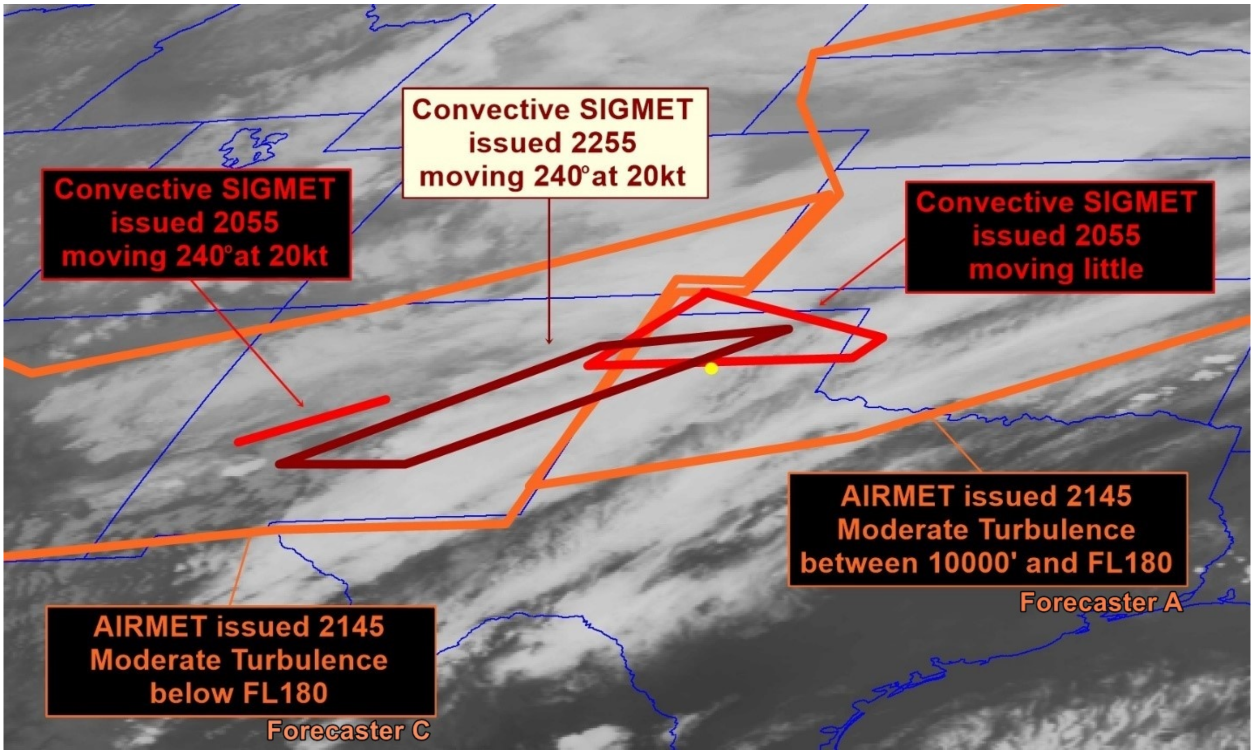

Figure. Map showing AIRMETs and convective SIGMETs issued the night of the accident.

Note: Background imagery was captured at 2145 by a geostationary weather satellite. Yellow dot indicates accident location.

Forecaster A. In a postaccident statement, the AWC forecaster who issued an AIRMET for moderate turbulence at 2145 over the accident location for 10,000 ft and above indicated that significant turbulence below 10,000 ft was not anticipated (until 0400 on April 29).[8] At the time of this AIRMET's issuance, a convective SIGMET was active over a large portion of the Texas Panhandle, and a convective SIGMET was issued at 2255 with boundaries close to the accident location at issuance time. The forecaster indicated that "[c]onvective SIGMETs in the region did not play a role in the issuance of the AIRMET for turbulence" but that, "[g]enerally speaking, once a convective SIGMET is warranted across a given area, the implied conditions within that product would preclude a necessity for a separate AIRMET for turbulence."

Forecaster B. At 2300, Forecaster B assumed the AWC responsibility for AIRMETs for the accident region after taking over for Forecaster A. In a postaccident statement, Forecaster B indicated that because there were active thunderstorms over the Texas Panhandle and a convective SIGMET was in effect, severe turbulence was implied, an AIRMET for low-level turbulence below 10,000 ft was not necessary (for the accident region), and no new data was available to justify amending the AIRMET for moderate turbulence that was issued at 2145.

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[8] In the "outlook" for the regional AIRMETs in the accident region, which advised on conditions between 0400 and 1000 on April 29, 2017, Forecaster A advised that moderate turbulence would be expected down to 8,000 ft for an area that included the accident site.

Forecaster C. Forecaster C, who was responsible for a region adjacent to the accident region, indicated that he issued an AIRMET at 2145 for moderate turbulence below flight level 180 that included almost the entire state of New Mexico due to strong wind magnitudes at 10,000 ft and 5,000 ft over portions of New Mexico approaching the north-central Texas Panhandle. The forecaster indicated that the AIRMET was extended to the surface to provide situational awareness and to avoid "gaps in altitude coverage between high and low turbulence due to the dynamic nature of [the] powerful weather system…changing atmospheric conditions and terrain features." At the time, several convective SIGMETs were active over portions of the area covered by the AIRMET.

National Weather Service Instruction (NWSI) 10-811 directs the issuance of various NWS products (such as those issued by the AWC) aimed at identifying turbulence (such as AIRMETs, nonconvective SIGMETs, and the Alaska Area Forecast) and establishes that AIRMETs will be issued for moderate turbulence and nonconvective SIGMETs will be issued for severe or greater turbulence, when these conditions "…are affecting or, in the judgment of the forecaster, are expected to affect an area of at least 3,000 square miles or an area judged to have a significant impact on the safety of aircraft operations."[9] While NWSI 10-811 indicates that convective SIGMETs should be issued for certain thunderstorm conditions (but does not specifically mention turbulence), it does not address issuance of an AIRMET (or other advisory) for moderate turbulence when a convective SIGMET (implying severe or greater turbulence) is in effect in the region.[10]

The NTSB is concerned that the AWC forecasters on the night of the accident had different ideas of when to issue AIRMETs in concert with active convective SIGMETs, and NWSI 10-811 does not address this issue.[11] Forecaster C identified atmospheric conditions conducive for turbulence generation and issued an AIRMET for low-level turbulence despite the issuance of a convective SIGMET in his region (adjacent to the accident region); however, Forecasters A and B (responsible for the accident region) believed that separate AIRMETs for turbulence would generally not be necessary when a convective SIGMET was active (since turbulence is implied). Of concern is a situation in which convection in an area prompts a convective SIGMET but moderate or greater turbulence generated by nonconvective phenomena may also exist over a greater area than where the convective hazard exists or an area close to where the convective hazard ends. In this case, NWS forecasters might not issue an AIRMET or other turbulence product for the larger area of nonconvective turbulence that covers or comes close to the convective SIGMET's boundaries, considering the region is already covered for significant turbulence by the convective SIGMET.[12] This also creates the potential for nonconvective turbulence to not be covered by an advisory if the convective hazard dissipates and the convective SIGMETs expire. A

[9] (a) See http://www.nws.noaa.gov/directives/sym/pd01008011curr.pdf. (b) The Alaska Area Forecast is issued by the Alaska Aviation Weather Unit in Anchorage, Alaska.

[10] According to NWSI 10-811, "International SIGMETs and SIGMETs issued by Alaska and Hawaii…are not separated into convective and non-convective products, as with AWC SIGMETs issued for CONUS areas." Criteria for issuance of these SIGMETs include "severe turbulence" as well as a "thunderstorm" if the "phenomena occur or are expected to occur in an area greater than 3,000 square miles or, in the judgment of the forecaster, an area having the potential to have a significant effect on the safety of aircraft operations."

[11] We note that NWSI 10-803, which details the procedures that NWS Center Weather Service Units should use to provide weather support to FAA ATC facilities, does not provide similar specific guidance about CWA issuance in concert with active convective SIGMETs. See http://www.nws.noaa.gov/directives/sym/pd01008003curr.pdf.

[12] Convective SIGMET boundaries move in time according to the motion vector included in the advisory.

related scenario is the case of the mesoscale convective system, which prompts convective SIGMETs throughout the event; however, as the convective phenomena decays below the 3,000-square mile threshold for convective SIGMET issuance, AIRMETs (and nonconvective SIGMETs) must then be considered for the larger turbulence hazard that may remain. Another AWC forecaster indicated in a conversation with the NTSB that turbulence coverage between convective SIGMETs and AIRMETs is a "huge gray area" and that "[t]here probably needs to be a better written definition on how to handle that." Although the presence of AIRMETs for low-level turbulence may not always prevent pilots from flying, it is important for turbulence products to be consistent. Thus, the NTSB concludes that the lack of clear guidance for forecasters on the issuance of products that advise of nonconvective turbulence hazards when convective SIGMETs have been issued in a region leads to nonstandardized criteria among forecasters and ultimately could limit the issuance of such products when they may be appropriate. Therefore, the NTSB recommends that the NWS revise NWSI 10-811 to include guidance on the issuance of AIRMETs and other products that advise of nonconvective turbulence hazards when convective SIGMETs are active, or may be issued, in the same region.

Low-Level Turbulence Training

Although this accident investigation is ongoing, the NTSB is concerned, as noted above, with the lack of clear guidance for forecasters on the issuance of products that advise of nonconvective turbulence hazards (such as low-level turbulence) when convective SIGMETs are issued in the same region and looked into training available for forecasters on low-level turbulence. Postaccident conversations with an AWC forecaster and NWS personnel and our examination of training for NWS aviation meteorologists indicate that formal training for the identification of low-level turbulence is lacking. Conversations with the AWC forecaster revealed that low-level turbulence is difficult for AWC forecasters to forecast and that a training module on low-level turbulence would be beneficial. An NWS aviation program lead confirmed that there is currently no formal low-level turbulence training available to NWS forecasters.

NWSI 10-815 provides specifications for the training of NWS aviation meteorologists (including training for both newly hired aviation meteorologists and recurring training for experienced meteorologists) and indicates that the NWS Aviation Professional Development Series (PDS) "provides a framework for training and identifying specific core skills and competencies for aviation forecasting."[13] NWSI 10-815 indicates that all NWS field offices that provide aviation forecasts and services should include the NWS Aviation PDS as part of their aviation weather training program. The NWS Aviation PDS is directed to NWS personnel (including those at the AWC required to issue turbulence products) who "provide aviation weather services in support of aviation customer decision-making." In the Aviation PDS, Professional Competency Unit 2, "Continuously Assess and Forecast the Aviation Weather Environment," one of the identified skills (skill 8.3) is "Analyze and interpret in situ and model data for the presence of low-level turbulence." For this skill, an employee training gap is clearly indicated in the online

[13] See NWSI 10-815 at http://www.nws.noaa.gov/directives/sym/pd01008015curr.pdf. According to the NWS training portal, "The basic idea behind the PDS concept is that individuals with a specific job responsibility…can, for each associated job duty…, easily find training resources…to help bring his/her performance of that job duty up to a sufficient level." See http://training.weather.gov/pds.php.

training portal: "Gap: No formal training identified."[14] According to the NWS, this training gap was identified in 2011; it is not known by the NWS aviation program lead why this gap has not been addressed.

As noted above, a concern in this accident investigation was the presence of low-level turbulence, which can be a safety hazard. NWSI 10-815 indicates that "[t]he NWS established the aviation PDS to promote the highest quality NWS aviation products and services…" The NTSB is concerned that no formal training on low-level turbulence has been developed in the NWS Aviation PDS despite the fact that the NWS clearly listed (in the PDS) the analysis and interpretation of low-level turbulence as a job skill for forecasters and identified this training gap years ago. Thus, the NTSB concludes that there is insufficient formal training for aviation weather forecasters on low-level turbulence. Therefore, the NTSB recommends that the NWS develop and provide formal training to its aviation weather forecasters on the analysis, interpretation, and forecasting of low-level turbulence.

Recommendations

To the National Weather Service:

Revise National Weather Service Instruction 10-811 to include guidance on the issuance of airmen's meteorological information advisories and other products that advise of nonconvective turbulence hazards when convective significant meteorological information advisories are active, or may be issued, in the same region. (A-18-21)

Develop and provide formal training to your aviation weather forecasters on the analysis, interpretation, and forecasting of low-level turbulence. (A-18-22)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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[14] See skill 8.3 at http://training.weather.gov/aviation_pcu2.php.