Factual Report – Addendum 1

METEOROLOGY

CEN19FA072

A. ACCIDENT

Location: Zaleski, Ohio
Date: January 29, 2019
Time: 0651 eastern standard time
1151 Coordinated Universal Time (UTC)
Aircraft: Bell 407; Registration: N191SF

B. METEOROLOGIST

Paul Suffern
Group Chairman
Operational Factors Division (AS-30)
National Transportation Safety Board

C. WEATHER INFORMATION

RECORD OF CONVERSATION
FAA Icing Weather Tools Meetings
In person
Paul Suffern and Sathya Silva (NTSB)
On 10/16/2019 and 10/17/2019 at 0900 MDT

The FAA held their annual FAA Icing Weather Tools meetings on October 16 through October 18, 2019. During the meetings on October 16 and 17 discussions were held with several individuals regarding clarification and historical context for wet and dry snow with regards to potential icing conditions therein. It was discussed with individuals at the FAA Icing Weather Tools meeting, that there is no definition for wet or dry snow conditions in FAA Advisory Circular (AC) 91-74B[1]. However, in Section 4-1, titled "Preflight Planning Information," of AC 91-74B, paragraph j states the following:

> *In flight, dry snow is unlikely to pose a hazard with respect to icing; however, wet snow may begin to adhere to aircraft surfaces. If wet snow does begin to stick, it should then be treated as an icing encounter because ice may begin to form under this accumulation of snow…Be aware that freezing drizzle can coexist with snow. If you are flying into or over areas reporting snow, it is important to understand that the presence of snow does not necessarily mean that icing conditions are not present.*

[1] https://www.faa.gov/documenTLibrary/media/Advisory_Circular/AC_91-74B.pdf

Document 14 *Code of Federal* Regulations (CFR) Part 139[2] (attachment 1) was provided as the only FAA document wherein wet and dry snow are defined but this document pertains to airport operators, and FAA AC 25-31[3] where wet and dry snow are also defined pertains to contaminated runways. No other advisory circulars provide definitions or guidance for pilots or operators on wet and dry snow conditions (attachment 2).

Afterwards discussion was had with National Oceanic and Atmospheric Administration (NOAA) National Severe Storms Laboratory (NSSL) with regards to radars and the definition of wet snow within the NWS radar data and categories. In the NWS radar data definition of wet snow, including HC[4] categories, wet snow pertains to the melting of snow near the 0°C isotherm, and not the forms of snow with aggregates attached (mainly between 0°C and -20°C), or mixed-phased icing conditions with snow and freezing drizzle occurring at the same time (attachments 3 and 4).

In discussions with an Associate Scientist with National Center for Atmospheric Research (NCAR) with regards to CIP and FIP[5] and CIP and FIP's ability to forecast aggregate or mixed-phased icing conditions with temperature between 0°C and -20°C, he stated the CIP is based on the RAP model and transitioning to the HRRR model over the coming year. The next generation CIP will incorporate upgraded NWS radar data. This radar data includes a delineation between dry and wet snow, but does not include explicit mixed-phase condition information. However there is current research underway on ways to use dual-polarization radar data to detect mixed-phase conditions at NCAR that may become part of the next generation CIP. The timeline for the next generation CIP deployment was 2022-2023. The FIP would not include this radar data, since it is a forecast product and is based off of model data only. The CIP and FIP performance is validated using reported weather conditions and pilot reports. It is possible that if wet snow is incorporated into the products, but aren't being reported by pilots that the performance validation of the product could suffer. In later discussion with the Associate Scientist at NCAR, he suggested CIP and FIP are concerned with areas where supercooled liquid water (SLW) could exist. If this happens to be in a place where there is also ice/snow, then CIP and FIP could potentially identify these areas of SLW. In the next version of CIP using the High-Resolution Rapid Refresh (HRRR), part of the radar work includes a category for mixed-phase conditions (attachment 4). Generally the CIP and FIP would be less interested in these areas for icing since crystal growth typically comes at the expense of scouring supercooled liquid water and thus reducing the icing threat, however the CIP

[2] https://www.faa.gov/airports/central/airport_safety/part139/
[3] https://www.faa.gov/documentlibrary/media/advisory_circular/ac_25-31.pdf
[4] Definitions for Zdr, CC, KDP, and HC adapted from training material from the NWS WDTD. Hydrometeor Classification (HC) is a product produced by the hydrometeor classification algorithm and the HC attempts to discriminate between 10 classes of radar echoes at every 250 m range bin. HC ingests reflectivity, Zdr, CC, Kdp, and velocity, along with radially averaged and smoothed fields of reflectivity and differential phase. HC then uses the height of the melting layer along with the previous data and assigns a radar class to each bin with a weighted value. The HC then applies a set of hard thresholds to reduce the number of clearly wrong class designations, and given the weight and likelihood of each of the 10 classes at each bin, the HC assigns the radar classification with the highest likelihood value to that particular bin.
[5] B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cunning, Current Icing Potential: Algorithm Description and Comparison with Aircraft Observations (Journal of Applied Meteorology, 2005), pp. 969-986.
C.A. Wolff, F. McDonough, M. K. Politovich, B.C. Bernstein, and G. Cunning, FIP Severity Technical Document (Prepared for the Aviation Weather Technology Transfer Technical Review Board), pp. 1-44.
https://arc.aiaa.org/doi/abs/10.2514/6.2009-3531

and FIP could still indicate some icing in these situations. It would not be identified any differently than classic SLW icing in the product, so there would be no distinction to a user based on current displays. . In addition, it was discussed in certain scenarios that liquid water equivalent (LWE) in snow conditions could be a proxy for mixed-phase icing conditions as well (attachment 5).

Given the above discussion, "wet and dry snow" mentioned in AC-91-74B and potential icing conditions does differ from the NWS radar definition of "wet snow". In the DOT/FAA/AR-98/76 document on "Mixed-Phase Icing Conditions: A Review" from 1998, it specifies that most mixed-phase icing conditions while could occur as low as -40°C, most frequent would be between 0°C and -20°C (attachment 4).

Therefore it was discussed with the Associate Scientist at NCAR and a second Associate Scientist at NCAR that the mixed-phase icing conditions with snow, aggregation, and slightly rimed dendrites (attachments 6 and 7) more likely pertain to the "wet and dry snow" mentioned in AC 91-74B. It was further discussed that snow ratio or the LWE system of the falling snow rather than the NWS radar term of "wet snow" would likely capture the potential mixed-phased icing and snow aggregation scenario, especially between 0°C and -20°C. The Associate Scientist at NCAR said that CIP and FIP would not necessarily take into account the icing scenario of snow aggregation and slightly rimed dendrites between 0°C and -20°C.

A snow ratio forecast in real-time can be found at:
http://sanders.math.uwm.edu/cgi-bin-snowratio/sr_intro.pl
From Prof. Paul Roebber at roebber@uwm.edu and the University of Wisconsin.
For more information please see attachments.

D. LIST OF ATTACHMENTS

Attachment 1 – 14 CFR Part 139 wet and dry snow definition

Attachment 2 – FAA Correspondence

Attachment 3 – NSSL Correspondence

Attachment 4 – Mixed-Phase Icing Conditions: A Review

Attachment 5 – NCAR Correspondence

Attachment 6 – Verification of the Cobb Snowfall Forecasting Algorithm

Attachment 7 – From mm to cm… Study of snow/liquid water ratios in Quebec

Submitted by:

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Paul Suffern
Senior Meteorologist