

WEATHER-RELATED AVIATION ACCIDENT INVESTIGATIONS
AT THE NATIONAL TRANSPORTATION SAFETY BOARD

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1. INTRODUCTION

The investigation of aircraft accidents in the United States began with the first fatal airplane accident in 1908 when Orville Wright was seriously injured and Lt. Thomas Selfridge was killed while conducting acceptance trials for the U.S. Army. The Aeronautical Board of the Signal Corps investigated the accident and attributed it to “the accidental breaking of a propeller blade and a consequent unavoidable loss of control” (Bruggink, 1992).

The complexity of aircraft accident investigations has increased exponentially from the early days of aviation. Today, a typical air carrier accident will involve hundreds of federal and company investigators and thousands of man-hours before the National Transportation Safety Board (NTSB) meets to determine the probable cause.

This paper focuses primarily on the role of the Safety Board meteorologist in aviation accident investigations. Responsibilities of the meteorologist, data acquisition and analysis methods, and external interactions with the scientific community are highlighted. In addition, weather-related safety recommendations issued by the Safety Board are discussed.

2. BACKGROUND

The Safety Board is an independent Federal agency charged by Congress with investigating all civil aviation accidents in the United States. In addition, the Safety Board investigates significant accidents in other modes of transportation: railroad, highway, marine, and pipeline. At the conclusion of the investigation, the Safety Board determines probable cause/s and issues safety recommendations aimed at preventing future accidents.

Since the inception of the modern-era Safety Board in 1967, the Safety Board has investigated more than 120,00 aviation accidents. More than 5,000 aviation-related safety recommendations have been issued, about 80 percent of which have either been adopted by the recipients or remain in an open status.

3. RESPONSIBILITIES AND DUTIES OF THE SAFETY BOARD METEOROLOGIST

A staff of four meteorologists serves as the primary meteorological resource for the Safety Board. In addition to aviation accident investigation activities, the staff supports Safety Board investigations into weather-related marine, highway, pipeline, and railroad accidents. The staff meteorologists assist in weather-related safety studies, represent the Safety Board in meteorological forums, and provide weather-related instruction and training to Safety Board staff and other accident investigators through the NTSB Academy.

A primary emphasis of the meteorologist is the investigation and analysis of weather-related aspects of major transportation accidents and incidents. As a member of the Go-Team, which is launched for any major civil transportation accident, a meteorologist is continuously on-call for immediate deployment to the scene of a transportation disaster. The meteorologist serves as the Meteorology Group chairman for the accident. In that role, the meteorologist supervises and directs a group of specialists assembled from the parties to the investigation. The group is responsible for the collection of all weather information and data pertinent to the accident. The Safety Board meteorologist with the assistance of the group prepares a comprehensive factual report of the environmental conditions pertinent to the accident. An in-house analysis report prepared by the meteorologist details findings and conclusions concerning the meteorological aspects of the investigation and is the basis for possible weather-related safety recommendations. Other duties associated with a major weather-related accident may include the meteorologist’s participation in public hearings and the Safety Board’s meeting to determine “the probable cause of the accident.”

Upon the request of foreign investigative agencies and under International Civil Aviation Organization (ICAO) agreements, the meteorologist may also assist in aviation accidents that occur outside of the United States. This involvement may range from traveling to the accident site as a member of the U.S. Investigative Team to providing technical and weather documentation support from Safety Board headquarters.

In addition to major accident investigation activities, the meteorologist expends a considerable amount of time investigating weather-related general aviation accidents. While the complexities of managing a major accident investigation are not present, weather-related general aviation accidents require similar in-depth analyses of the accident weather conditions, pre-flight weather briefings, and validity of forecasts and

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warnings. Factual and analysis reports are normally prepared for these investigations.

The meteorologist also supports investigations of accidents that occur in benign weather. Data, such as winds and temperatures aloft, are often required for aircraft performance studies or wake turbulence investigations. Weather documentation is needed for the official record for nearly all accidents. In all, the meteorology staff provides some level of support for more than 300 accident investigations a year.

The meteorologist participates in Safety Board safety studies as required. A safety study in 1995 concerning aviation safety in Alaska resulted in seven weather-related safety recommendations to the Federal Aviation Administration (FAA) and the National Weather Service (NWS). Currently, Safety Board meteorologists are assisting in a study of weather-related general aviation accidents. One aspect of the study is to identify decision-making factors that cause some pilots to attempt VFR flight into areas of adverse weather.

The NTSB Academy conducts an Aircraft Accident Investigation School once or twice a year to provide new Safety Board staff, transportation industry safety personnel, Federal and state safety personnel, and foreign investigative agencies with the skills to conduct accident investigations. As a part of the course, staff meteorologists teach a module on weather hazards and weather-related accident investigations.

4. DATA COLLECTION AND ANALYSIS

The primary task of the Safety Board meteorologist immediately after an accident is to collect a detailed package of weather data and information for use by the entire investigative team and to make a preliminary assessment of the impact of weather on the accident. If the meteorologist has been launched with the Go-Team, the individual will lead the Meteorology Group in on-scene data collection activities. Typical activities include gathering of weather data and forecasts from various sources and interviewing airport weather observers, NWS personnel, FAA Automated Flight Service Station specialists, airline dispatchers, and local witnesses.

Depending on the scope of the investigation, Safety Board meteorologists access many weather archives and use a variety of analysis tools.

The Man computer Interactive Data System (McIDAS), developed by the Space Science and Engineering Center (SSEC) at the University of Wisconsin, is the primary data retrieval, display, and analysis software used by Safety Board meteorologists. McIDAS is uniquely suited for Safety Board use since it offers sophisticated analysis and display software, along with real-time satellite and archived conventional data capabilities. It is particularly valuable in assisting foreign investigative agencies, because of its worldwide satellite and observational capabilities.

Archived Geostationary Operational Environmental Satellite (GOES) data in the McIDAS area format are obtained via the Internet through the National Oceanic and Atmospheric Administration's (NOAA)

Comprehensive Large Array-data Stewardship System (CLASS). Polar orbiting and international satellite data for high-altitude and foreign investigations are often obtained from the SSEC or from foreign meteorological services.

The National Climatic Data Center (NCDC) is the primary weather data source for the Safety Board. Currently, NCDC data access is primarily Internet-based. Automated weather observations and various NWS National Centers for Environmental Prediction (NCEP) weather charts are obtained through the NCDC on-line store. Weather Surveillance Radar-1988, Doppler (WSR-88D) Archive Level II and NWS Service Records Retention System (SRRS) products are accessed through the NCDC Hierarchical Data Storage System (HDSS). Also, NCDC expeditiously provides other data, such as the Automated Surface Observing System (ASOS) high-resolution data, upon request.

The Forecast System Laboratory's (FSL) on-line automated airline weather report and wind profiler archives often prove valuable in non-convective turbulence accidents and in wake turbulence investigations. The NCEP Eta Data Assimilation System (EDAS) and Global Data Assimilation System (GDAS) model data, which are available from the Air Resources Laboratory's (ARL) Internet site, have been found to be an asset for accident investigations that occur in data-sparse areas. Unidata's 15-day rolling archive of the NWS Level III products is accessed through McIDAS and is often very useful in limited weather investigations and in investigations when Archive Level II data are not available.

Safety Board meteorologists have found the Archive Level II base data to be indispensable in many accident investigations. While data availability and timeliness have occasionally been issues in the past, recent accident investigations have noted improvements in these areas. Currently, the Interactive Radar Analysis System (IRAS) (Priegnitz, 1995) and the WSR-88D Algorithm Testing and Display System (WATADS) (WATADS, 2000) software packages are used to display and analyze the Level II base data.

BUFKIT, a forecast profile visualization and analysis software package originally developed by the staff at the Buffalo NWS office, and Modsnd, a script developed at NCEP that converts BUFR sounding files to a format used by BUFKIT, are regularly used to help define winds and temperatures aloft. These software packages provide the meteorology staff with the capability to generate vertical atmospheric profiles for about 1,200 sites in the United States (Petty, 2003). In addition, RAWinsonde OBServation (RAOB), an interactive sounding analysis program developed by Environmental Research Services, is used in the analysis of upper air soundings.

Finally, the staff is evaluating the Integrated Data Viewer (IDV) developed by Unidata, the Grid Analysis and Display System (GrADS) originally developed by National Aeronautics and Space Administration (NASA), and the General Meteorological PackAge (GEMPAK) developed by NASA with supporting development by

Unidata to determine their applicability for Safety Board investigations (Petty, 2003).

5. SAFETY RECOMMENDATIONS

The safety recommendation is the most important product of the Safety Board. Safety recommendations are issued as soon as problems are identified without waiting for the completion of the investigation or the determination of probable cause. While safety recommendations are not mandatory and the Safety Board has no enforcement mechanism, the Board's reputation for thoroughness and impartiality has resulted in a large majority of its recommendations being adopted by the FAA or other targeted organizations.

The Safety Board's safety recommendation database from 1967 to 2004 was queried to determine the number of weather-related recommendations, the weather phenomena involved in the accident, and organizations expected to take action to resolve the recommendation.

Two hundred forty-nine safety recommendations or about 5% of the total aviation-related recommendations mentioned weather services or phenomena.

Figure 1 displays the distribution of safety recommendations by phenomena. As expected by the notable number of accidents over the years related to icing conditions, including Air Florida flight 90 (Washington, DC), Comair flight 3272 (Monroe, Michigan), and American Eagle flight 4184 (Roselawn, Indiana), icing recommendations more than doubled any other phenomena.

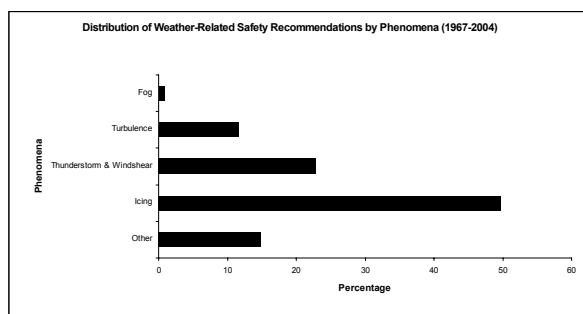


Figure 1. Percentage of safety recommendations by phenomena for 1967 to 2004.

A graph depicting the percentage of weather-related safety recommendations addressed to various organizations is provided in figure 2. Close to 90% of all recommendations were addressed to the FAA. Components of NOAA were addressed in about 8% of the recommendations.

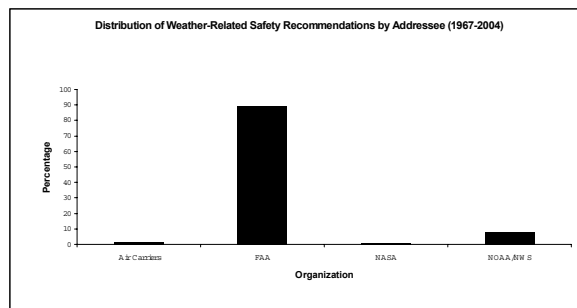


Figure 2. Percentage of weather-related safety recommendations addressed to various organizations.

6. SCIENTIFIC COMMUNITY

While the NTSB meteorologist has the ultimate responsibility in the oversight and direction of a meteorological investigation, various government agencies, research laboratories, and university researchers provide invaluable assistance to the NTSB during major accident investigations.

Scientists at the National Center for Atmospheric Research's (NCAR) Research Applications Program (RAP) have been very helpful assisting in many types of aviation weather accidents. In recent years, RAP's in-flight icing researchers have made important contributions to the Safety Board's understanding of the effects of supercooled large droplets (SLD) in icing accidents.

MIT Lincoln Laboratory's aviation weather program is another example of the positive collaborative relationship between the Safety Board and the research community. For example, in a recent accident investigation involving a Boeing MD-10 at the Memphis International Airport, Memphis, Tennessee, Lincoln Laboratory provided Safety Board investigators a detailed analysis of the Memphis Terminal Doppler Weather Radar (TDWR) data at the accident time.

In addition, NASA, FSL, NWS, and other government entities have been extremely cooperative in providing their expertise to many accident investigations over the years.

7. SUMMARY

The NTSB employs a staff of professional meteorologists, who provide comprehensive meteorological support for accident investigation and transportation safety-related activities. The meteorologists support all modes of transportation accident investigation on a worldwide basis. Depending on the circumstances of the accident and the meteorological phenomenon involved, the NTSB meteorologist may solicit assistance from various world-class meteorological research laboratories.

Safety recommendations related to icing comprise the majority of weather-related safety recommendations. Most weather-related safety recommendations are addressed to the FAA.

8. ACKNOWLEDGEMENTS

The views expressed are solely those of the authors and do not in any way represent the policy or position of the National Transportation Safety Board or the U. S. government.

9. REFERENCES

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