The Size of the Aircraft Doesn't Matter

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THE SIZE OF THE AIRCRAFT DOESN'T MATTER

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Abstract. There is much to learn from an accident investigation, no matter how large or small the accident aircraft may be. The U.S. National Transportation Safety Board recently investigated the crash of a Raytheon Beechcraft 1900D in Charlotte, North Carolina, that resulted in 22 safety recommendations to the Federal Aviation Administration (FAA). The recommendations mainly focused on maintenance and weight and balance issues and the oversight of those issues. The NTSB's investigations into two Beech Super King Air accidents are additional examples of small-aircraft investigations having a large impact on safety. A Beech Super King Air carrying the Oklahoma State University basketball team crashed on January 27, 2001, near Strasburg, Colorado, in IFR conditions. The NTSB made an unprecedented recommendation to the National Collegiate Athletic Association, the National Association of Intercollegiate Athletics, and the American Council on Education to improve collegiate air travel policies and procedures. The other Beech Super King Air accident occurred in Front Royal, Virginia, on October 26, 1993, while the aircraft was on an FAA repositioning flight. Seven of the eight recommendations to the FAA dealt with the structure of the FAA flight program. The Safety Board recommended that the FAA model its flight program after a civilian Federal Aviation Regulation (FAR) Part 135 operation. This paper will discuss the recommendations that resulted from these three accident investigations and some lessons learned by investigators during the investigations.

Investigate, Communicate, and Educate.

In keeping with this year's theme for the conference, this paper will cover three accident investigations that the Safety Board conducted involving small aircraft. The intent is to communicate to you the value that can be gained from small investigations, i.e. safety recommendations, and to educate you on the lessons learned by our investigators during these investigations.

Charlotte Investigation.

The Beech 1900D accident occurred on January 8, 2003, in Charlotte, North Carolina. The author of this paper was the Investigator in Charge (IIC) and followed the accident investigation from beginning to end. The final report was issued just a little over a year after the accident. The accident occurred just shortly after take-off, killing the two crew members and 19 passengers on board. The aircraft was destroyed by the ground impact and post-crash fire. Because this accident occurred just after takeoff, we naturally started looking at the flight control systems and how the aircraft was loaded. The first question was, "Did the crew members calculate the weight and balance correctly?" We found that they did. Given the weight and balance procedures that were in place at the time, the crew members actions were proper. However, we also found that the use of average passenger and baggage weights (as opposed to actual weights) resulted in a computed weight that differed greatly from the actual weight. In other words, if the weight and balance calculation had been based on the true weight of the passengers and baggage, it would have been apparent to the pilots that the flight was well outside the center of gravity (cg) envelope and over maximum takeoff gross weight. The important issue here is that the flight crew was erroneously led to believe that their cg was further forward than it actually was. This resulted in the flight taking off in a significantly tail-heavy condition.

While one group of investigators was looking into the weight and balance issues, the systems group was examining the flight control systems. In the airplane wreckage, the pitch control (or elevator) turnbuckles were found at an unusual setting. The maintenance records revealed that maintenance was performed on the accident aircraft's elevator system a few days earlier. In fact, the turnbuckles had been adjusted during that time. Interviews with maintenance personnel revealed that during the maintenance, a mechanic, who was receiving on-the-job training (OJT) at the time, found that the elevator cable tension was low and that he adjusted the cable tension using the elevator rigging procedure in the maintenance manual. But, with the approval of his OJT instructor, he selectively skipped some of the other steps in the rigging procedure. The result was that the newly rigged elevator now had limited travel in the airplane-nose-down direction. The combination of the limited elevator travel and the aft cg resulted in the airplane losing pitch control, which was what the Safety Board determined to be the probable cause of the accident.

As you can see, we had two major issues to contend with: the use of incorrect average weights and the maintenance training program for mechanics. Almost all of the recommendations issued to the FAA dealt

with these issues. A few of the recommendations will be highlighted. A full listing of the safety recommendations appears in the final report (Aircraft Accident Report NTSB/AAR-04/01), which is posted on the Safety Board's Web site at http://www.ntsb.gov.

Weight and Balance Recommendations. The use of assumed average passenger and baggage weights (in place of actual weights) for weight and balance calculations has long been an industry practice for carriers operating aircraft with more than nine passenger seats. However, using average weights has potential problems. The assumed average weights may not be an accurate representation of the general population and the actual passengers weights on a given flight may not represent the statistical norm of the general population. For example, a survey conducted after the accident found that the actual average weight of American adults was roughly 20 pounds higher than the average weights being used in many operators' average weight programs. Accordingly, the use of average weights carries a risk of being outside the weight and balance envelope, which was the case with the accident in Charlotte.

It is important to note that baggage weights are extremely important for small aircraft, such as the Beech 1900D, that have only one cargo hold or bin. This is because unlike a large aircraft within which you can move the baggage from one cargo hold to another to change the cg, in smaller aircraft there is only one cargo hold.

Clearly, if average passenger weights are not valid then the use of average weights does more harm than good. The Safety Board recommended that the FAA identify situations where actual weights were required versus average weights and recommended that it examine technology for using actual weights versus average weights. The Safety Board also recommended that the FAA require air carriers to periodically survey passenger and baggage weights, to retain the data from their survey, and to develop cg safety margins to account for variances in average weights of passengers and baggage.

Maintenance Program Recommendations. As a result of its findings regarding the maintenance of the accident aircraft's elevator cables, the Safety Board recommended that aircraft manufacturers establish appropriate procedures for a complete functional check of critical flight systems after maintenance work has been done on that system and that air carriers incorporate those checks in their maintenance procedures. This may sound like a common sense item, but, to our surprise, it wasn't being done, nor was it required. The Board also looked at how maintenance training was being accomplished, especially OJT, and recommended that maintenance training programs be approved by the FAA, just as the training programs for pilots and flight attendants are.

Many of the other maintenance-related recommendations focused on the need for improved maintenance oversight by both the operators and the FAA.

Lessons Learned from the Charlotte Investigation. An investigation safety lesson was learned the hard way when a systems investigator slipped and injured his back while working around the wreckage. The investigator was wearing the protective footwear covers (yellow booties) that are included with the PPE kit. These covers are required to be worn in areas where blood borne pathogens may be present. The investigator slipped because the footwear covers do not have good traction on slippery surfaces. They also have a tendency to get caught on objects or become torn from contact with sharp edges. After this incident, our OSHA representative researched other footwear options that would meet our blood borne pathogen program requirements and not add to the safety hazards presented by the work environment. The OSHA experts have offered several possible replacement boot types, but we still haven't found a suitable boot. The problem is, of course, finding a cost-effective boot that has good traction, that can meet the decontamination standards, and stand up to our rugged work environment. Many investigators have complained over the years about these boot covers, but it took someone getting hurt to cause us to examine alternatives.

Strasburg Investigation.

Another example of a less complex investigation that led to important increases in air safety concerned the loss of a Beech Super King Air on January 27, 2001, near Strasburg, Colorado. This accident investigation was closely followed by the American public because the aircraft was carrying members of the Oklahoma State University (OSU) basketball team. Unfortunately, all 10 people on the airplane were killed.

The immediate cause of the accident was reasonably straightforward. The aircraft lost a.c. electrical power and, thus, primary flight instrumentation, during a climb through instrument meteorological conditions. This probably occurred because of a failed electrical relay or inverter. The Safety Board determined that although standby flight instruments should have been available, the pilots became spatially disoriented and lost control of the airplane.

During the investigation, ancillary research revealed that Oklahoma State University did not provide any significant oversight of this flight, or any other school-sponsored flight carrying students to events away from the university. Furthermore, the Board determined that this may have been true at many other colleges and universities around the nation. To

its credit though, with the encouragement of the Safety Board, OSU formulated a comprehensive travel management system that now promotes safe university-sponsored travel and provides the necessary oversight to ensure that transportation services are carried out in accordance with the provisions of the revised policy. For example, in addition to the oversight provide by the university's athletic director, athletic staff and coaches, OSU now retains an aviation consultant with expertise in operations, safety and certification of aircraft.

Recommendation. The Safety Board thought that OSU's new safety-oriented travel policies were developed well enough to make a formal recommendation to encourage the National Collegiate Athletic Association, the National Association of Intercollegiate Athletics, and the American Council on Education to follow OSU's lead in these matters. Again, although this accident involved a small airplane, the results of the investigation and proactive participation by Oklahoma State University will undoubtedly save lives in the future.

Lessons Learned While On-Scene. This is one of the Board's first onscene investigations where a new onscene hazard "risk analysis" form was filled out before actually launching and every day while working on the wreckage. The IIC uses this form as a planning tool to make everyone more aware of the hazardous conditions that the investigators are working under. On the form, a numerical value is assigned to a variety of working conditions (weather, lighting, terrain, and the like). If the total value exceeds a certain number, then a mitigation plan has to be put in place. In this case, an identified risk was the very cold weather at the accident site. The IIC chose to combat the cold conditions by having several vehicles lined up along the debris field with the engines running and the heaters on. These vehicles acted as warming stations for the investigators and were heavily utilized.

Front Royal Investigation.

Another Beech Super King Air accident also illustrates the fact that the size of an accident often has little to do with the actual safety benefits of good recommendations. This accident involved an aircraft operated by the FAA that crashed into mountainous terrain during a repositioning flight near Front Royal, Virginia, in 1993. The Board determined that the probable cause of the accident was the failure of the pilot to stay in Visual Meteorological Conditions (VMC) while in mountainous terrain.

An important aspect of this rather straightforward case concerned discoveries during the investigation of the shortcomings within the entire, quite fragmented, FAA flight program. For instance, Board

investigators found that although each FAA flying unit had check airman; training captain; and safety officer slots, these positions were always considered extra duties, and decisions made by these pilots were often overridden by people not directly associated with the FAA flying program. In addition, due to scheduling biases, an unusual supervisory structure, and a lack of available flying time, FAA first officers were that in name only. They were rarely allowed to actually fly and land the airplanes and, for the most part, only served as radio operators on FAA flights.

Recommendations. Seven of the eight recommendations to the FAA that resulted from this investigation had to do with the structure of the FAA flight program, rather than the actions of the flight crew that crashed the airplane. In short, the Board recommended that the FAA flight program model itself after a civilian FAR Part 135 operation, with all the checks and balances, inspection requirements, and aircraft and pilot certifications standards that a small airline would be subject to. The FAA took these recommendations very seriously, and its flight program today is much safer than it was in 1993.

Lesson Learned. The accident occurred in daylight conditions but when one investigator, who lived close to the accident site, arrived on-scene, it was dark. The wreckage was in a mountainous area, and the terrain was rugged, but this investigator, anxious to do his job, began searching for the wreckage. When the IIC learned of this, he immediately told the investigator to stop his search effort to prevent him from possibly injuring himself. The following day the wreckage was located by aerial search. The lesson learned here is obvious. Any type of search effort, or any work on aircraft wreckage at all for that matter, is usually not advisable unless such actions can be done under very controlled, safe conditions.

In conclusion there is much to be gained from small aircraft accident investigations. As you can see from the three accidents discussed here, over two dozen recommendations were issued that undoubtedly have saved lives, and quite a few valuable lessons on how to investigate safely were learned.