KNOCK YOURSELF OUT

Overreaction to a shattered windshield led to loss of consciousness and control.

BY MARK LACAGNINA

The Raytheon King Air B200 was cruising at 27,000 ft when the pilots heard a loud snap and saw a web of cracks appear in the left windshield. Procedures for dealing with a shattered windshield were not on the one-page collection of truncated checklists aboard the airplane. Fearing groundlessly that the windshield might blow out, the pilot depressurized the cabin. Both pilots then donned their oxygen masks — but failed to notice that the oxygen system shutoff valve was closed.

With the cabin depressurized and no oxygen flowing into their masks, the pilots momentarily lost consciousness. The King Air descended out of control for about five minutes, losing 17,600 ft of altitude. The windshield held, but the tail was shredded as aerodynamic loads reached at least 4 g — that is, four times standard gravitational acceleration — during the uncontrolled descent and the pilots' eventual recovery from the dive. Damage was substantial, but the pilots escaped injury and were able to land the airplane without further incident.

In its final report, the U.S. National Transportation Safety Board (NTSB) said that the probable cause of the accident was the "pilot's poor judgment before and during the flight, including turning the oxygen system ready switch

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The King Air's tail was extensively damaged during the uncontrolled descent and the pilots' recovery from the upset.

[i.e., the shutoff valve] to the 'OFF' position after he conducted the preflight inspection and using an unapproved checklist, which did not provide guidance for a fractured windshield and resulted in his depressurizing the airplane."

This statement of probable cause, however, did not result from consensus among the NTSB's five members. A dissenting statement was filed by one member who contended that the shattering of the windshield resulted from a design defect and should have been cited as a contributing cause of the accident. Another safety board member concurred.

Positioning Flight

The accident occurred on Feb. 2, 2007, during a positioning flight from Rogers, Arkansas, to Staunton, Virginia, in visual meteorological conditions. The report said that the King Air was operated by the Assembly of God.

The pilot, 31, was employed as a company pilot. He held an airline transport pilot certificate and had 4,048 flight hours, including 110 hours in type. "The pilot completed a flight review during B200 training at SimCom International on Aug. 24, 2006," the report said.

"A noncompany pilot, who had not attended or completed a training course or received a checkout for Raytheon … King Air 200 airplanes, was asked by the company pilot to accompany him on the flight so that the noncompany pilot could accumulate flight time."

The copilot, 28, had commercial pilot and flight instructor certificates with multiengine airplane ratings. He had 2,806 flight hours, including 557 hours in multiengine airplanes and 28 hours in the King Air.

The airplane was manufactured in 1998 and had accumulated 1,835 service hours. "The pilot's windshield … was installed at the time of the airplane manufacture and subsequently had not been overhauled or repaired prior to the accident," the report said. "There were no previous reports of delamination or cracking."

'Don't Tear It Up'

The King Air departed from Rogers Municipal Airport at 0839 local time. The report said that cockpit voice recorder (CVR) data indicated that the pilot left the cockpit shortly after the airplane was established in cruise flight at 27,000 ft at about 0900. The pilot said that he was going to "fetch the trash can" and told the copilot, "Don't tear it up while I'm gone."

About four minutes later, the CVR recorded the sound of a very loud snap and the copilot calling the pilot's name. "[This] indicated that the company pilot was not in the cockpit when the windshield fractured because he was emptying trash in the cabin," the report said. "This action showed poor judgment, considering the noncompany pilot was not qualified in the airplane."

After the copilot called his name, the pilot said, "What did you break?"

The inner ply of the left windshield had shattered. According to the B200 airplane flight manual (AFM), this is an abnormality, not an emergency: Although small particles may separate from a shattered inner ply, the windshield is designed to remain in place.

The "Abnormal Procedures" section of the AFM includes a checklist titled "Cracked or Shattered Windshield." A note at the top of the checklist says, "The following procedure

The shattering of the inner ply of the left windshield was traced to a fracture within the glass.

Raytheon King Air 200B

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Beech Aircraft began deliveries of the Super King Air 200 in 1974. The airplane shares the same basic fuselage with the King Air 100 but has a longer wing, a T-tail and more powerful engines — 850-shp (634-kW) Pratt & Whitney PT6A-41s. Raytheon acquired Beech in 1980 and shortly thereafter introduced the B model with PT6A-42 engines, which provide improved cruise performance and a higher — 6.5-psi — maximum cabin-pressurization differential.

The prefix "Super" was deleted from the names of the 200-, 300- and 350-series King Airs in 1996.

In standard configuration, the King Air B200 accommodates a pilot and seven passengers, and has a maximum takeoff/landing weight of 12,500 lb (5,670 kg), a maximum cruise speed of 289 kt, a service ceiling of 35,000 ft or 21,735 ft with one engine inoperative, and a range of 1,461 nm (2,706 km) at 25,000 ft.

Hawker Beechcraft, formed in 2007, currently produces the King Air 200GT and 350 models.

Source: *Jane's All the World's Aircraft*

should be used when one or more cracks occur in the inner or outer ply of the windshield. The procedure is also applicable if the windshield shatters. This usually occurs in the inner ply and is characterized by a multitude of cracks which will likely obstruct the crewmember's vision and may produce small particles or flakes of glass that can break free of the windshield."

The checklist procedure comprises the following actions:

- Maintain an altitude of 25,000 ft or lower "if possible."
- Maintain a cabin differential pressure of 2.0 psi to 4.6 psi during cruise and descent.[1]
- Depressurize the cabin before landing.

The checklist also includes the following "in-flight considerations":

- "Visibility through a shattered windshield may be sufficiently reduced to dictate flying the airplane from the opposite side of the cockpit;
- "Precautions should be taken to prevent particles or flakes of glass from a shattered inner ply of the windshield from interfering with the crew's vision;
- "A cracked outer windshield ply may damage operating windshield wipers;
- "Windshield heat may be inoperative in the area of the crack(s); [and,]
- "The structural integrity of the windshield will be maintained."

The checklist refers the user to the "Limitations" section of the AFM for postflight considerations. Basically, the airplane can be flown for up to 25 hours after cracks appear in either the inner ply or the outer ply of the windshield. However, if both plies are cracked or if an inner ply has shattered, the windshield must be replaced before further flight.[2]

Homemade Checklist

The pilots did not consult the AFM after the windshield shattered. "An unapproved document, not derived from the AFM, that contained several checklists was found on the airplane," the report said. "The company pilot stated that he used this document and that it 'came with the airplane.' The document did not include a checklist addressing a cracked or shattered windshield."

The pilot told investigators that he depressurized the cabin because he did not know what had caused the windshield to shatter and whether it would remain in place. This indicates that the pilot did not know that the shattered windshield did not present an in-flight emergency and that there was no need to depressurize the cabin, the report said.

After the pilot selected the pressurization "DUMP" switch, the copilot said, "We need to go on oxygen." The pilot replied, "Yeah." They donned their oxygen masks but found that oxygen was not flowing into the masks. "Can't get no oxygen," the pilot said. "I ain't getting no oxygen. … You got oxygen?"

That was the last statement recorded by the CVR. "After this time, the only crew noise was the sound of the copilot breathing erratically," the report said.

Shutoff Valve Shut

The pilot told investigators that he pulled the oxygen-system control knob on the left side of the center console to open the shutoff valve on the oxygen cylinder, which places the oxygen system in the ready mode, but "it was hard to pull and did not seem to engage properly."

The oxygen cylinder is located behind the aft cabin firewall. The oxygen system shutoff valve on the cylinder is connected to the cockpit control knob by a cable (Figure 1). Opening the shutoff valve is among the actions specified by the "Before Start" checklist — as well as by several emergency checklists — in the AFM, but it was not included in the truncated "Before Start" checklist that the pilots were using.

"Oxygen will flow to each mask only if the oxygen tank shutoff valve is in the 'OPEN' position," the report said.

The pilot told investigators that he opened the shutoff valve during preflight preparation to check that the oxygen system was functional but then closed the valve because he was concerned that the oxygen would be depleted if the valve remained open.

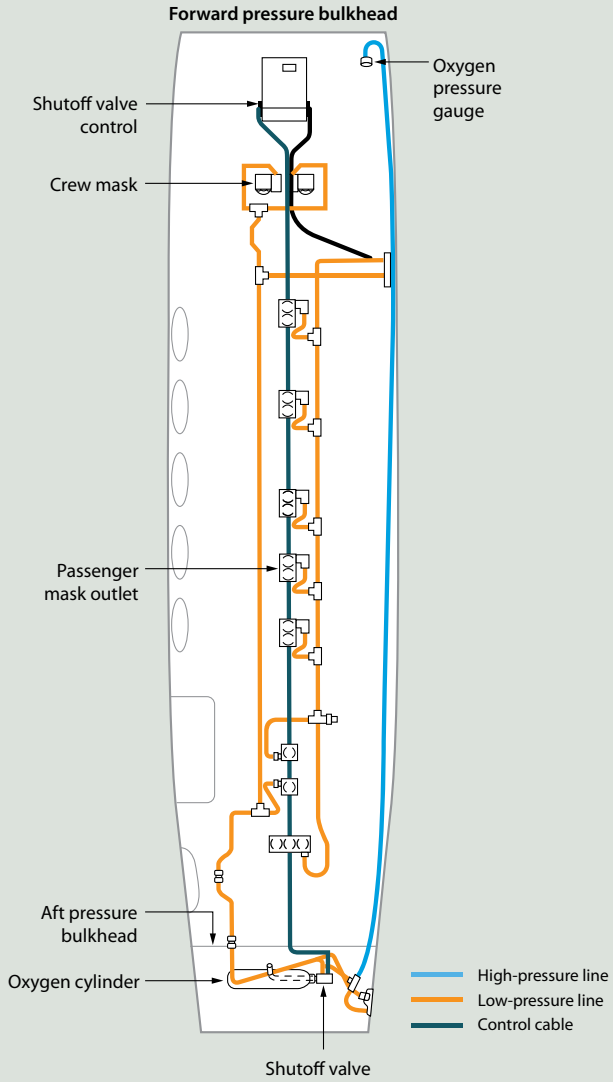
After the accident, the oxygen shutoff valve control knob was found in the "OFF" position. "Functional testing of the oxygen system revealed normal operation," the report said. "The unapproved-checklists document did not include the instruction to leave the oxygen system on. Regardless, the pilot stated that he knew the approved checklist stated to leave the oxygen system on but that he still chose to turn it off. The pilot exhibited poor judgment by using an unapproved, incomplete checklists document and by knowingly deviating from approved preflight procedures."

The report said that the pilots likely either forgot to open the oxygen system shutoff valve after depressurizing the cabin or lost consciousness before they could do so.

'Not Thinking Clearly'

The pilot said that soon after he depressurized the cabin, he developed tunnel vision and

King Air B200 Oxygen System



Source: U.S. National Transportation Safety Board/Susan Reed

Figure 1

had trouble thinking clearly.[3] He told investigators, "The last thing I remember, although not clearly, at this phase of flight was beginning an emergency descent. I disengaged the autopilot and pitched down but never made it to reducing power to idle or extending the landing gear."

Only two air traffic control (ATC) radar data points were recorded during the uncontrolled descent. The first showed the King Air at 25,400 ft at 0917:45; the second showed the airplane at 7,800 ft at 0922:59.

The pilot told investigators that he did not remember clearly what happened when he regained consciousness. "I remember the airspeed pegged, so I immediately reduced power to idle and began pitching toward a level attitude slowly," he said. "Due to very limited vision from oxygen deprivation, a shattered windshield and a failed attitude indicator, overcoming disorientation was very difficult. After an unknown amount of oscillations, satisfactory control of the aircraft under present conditions was obtained at approximately 7,000 ft."

He declared an emergency with ATC and requested, and received, vectors to the nearest suitable landing site, Cape Girardeau (Missouri) Regional Airport. "Although the aircraft was difficult to control, a successful landing was made with no injuries sustained," the pilot said.

The fact that the airplane had been subjected to aerodynamic loads of at least 4 g was established by the position of the CVR impact switch. The switch, which was found open, is designed to open automatically — and deactivate the CVR so that data are preserved — if the airplane is subjected to an acceleration force of 4 g.

"On-scene examination of the airplane noted that approximately two-thirds of the left horizontal stabilizer and elevator were separated from the airplane, and two-thirds of the right elevator was separated but attached at the inboard hinge," the report said. "The left and right wing [skins] were wrinkled. The left pilot windshield outer and inner plies were intact. The inner ply exhibited a shattered appearance with a crack at the lower right-hand corner of the windshield." In addition, the rear fuselage was buckled.

'Possible Anomaly'

The windshield, which consists of thermally tempered glass plies with a vinyl layer between them, was examined by the Research Laboratory Materials Integrity Branch at Wright-Patterson Air Force Base in Ohio. "There was no evidence of fractures or any other damage on the windshield's outboard surface or within the outer glass ply," the report said.

The shattering of the inner pane was traced to a "peel chip fracture" at the bottom center of the pane. "Scanning electron microscope examinations conducted of the glass fracture at the peel chip initiation revealed evidence of the initiation at a possible anomaly in the glass," the report said.

The windshields installed in King Airs were redesigned in 2001 to incorporate a urethane layer between the vinyl interlayer and the inner glass ply that relieves stresses on the glass ply. "No known similar fractures have occurred in the newly designed windshield," the report said. "The manufacturer chose not to issue a service bulletin for a retrofit of the new windshield design in airplanes manufactured before 2001 because the fracture of one pane of glass is not a safety-of-flight issue."

'Not an Aberration'

NTSB member Deborah Hersman did not agree with the probable-cause statement approved by the majority of the board members. Board member Robert Sumwalt concurred with the dissenting statement that she included in the public docket for the investigation.

Hersman pointed to 160 service difficulty reports (SDRs) of King Air windshield fractures that were submitted to the U.S. Federal Aviation Administration (FAA) between 1995 and 2007. "In a number of the cases cited in the SDR data, the crew failed to take the appropriate action," she said. "So, while this crew's reaction to their fractured windshield was poor, it was not necessarily an aberration.

"The fracturing of the windshield on this aircraft, which was due to a design defect, set in motion the crew's reaction that led to the accident. If the windshield had not failed, the crew would not have had the occasion to take any responsive action, appropriate or otherwise, and this accident would not have occurred. For that reason, I believe the fracturing of the windshield should be cited as a contributing cause of this incident."

The report was based on a limited investigation of the accident, and no recommendations were issued by NTSB.

This article is based on NTSB accident report no. CHI07LA063, issued on Nov. 20, 2008, and on public docket no. 65268.

Notes

1. The checklist notes that with a cabin differential pressure of 4.6 psi at 25,000 ft, cabin altitude is approximately 10,500 ft. Maximum differential pressure is 6.5 psi.
2. A special permit can be requested from the FAA to conduct a ferry flight to a repair station.
3. According to the FAA, loss of peripheral vision and impaired decision-making ability are symptoms of hypoxia, or oxygen deficiency; time of useful consciousness at 27,000 ft is about 90 seconds.