AIRCRAFT SERIOUS INCIDENT SHORT REPORT

CA18/3/2/1224: ZS-PHX, cabin decompression while cruising at FL200

Date and time	**:**	22 October 2018, 1150Z
Occurrence type	**:**	Serious incident
Aircraft registration	**:**	ZS-PHX
Aircraft manufacturer and model	**:**	Beechcraft (Textron) B1900D
Last Point of departure	**:**	Londolozi Aerodrome (FALD), Mpumalanga
Next point of intended landing	**:**	OR Tambo International Airport (FAOR), Gauteng
Location of incident site with reference to easily defined geographical points (GPS readings if possible)	**:**	40 nm east of Witbank town, approximate GPS coordinates: S25°44'54.75" E029°54'8.11"
Meteorological Information	**:**	FL200 at 1133Z: temperature: –15°C, wind: 208°/16 kt, light turbulence possible
Type of operation	**:**	Air transport operations – carriage of less than 20 passengers or cargo (Part 135)
Persons on board	**:**	2 + 11
Injuries	**:**	None
Damage to aircraft	**:**	Minor

All times given in this report are Coordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011), this report was compiled in the interests of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

Disclaimer:

This report is produced without prejudice to the rights of the CAA, which are reserved.

1. SYNOPSIS

1.1 On 22 October 2018, at 1059Z, a Federal Airlines flight (FDR123) with 2 crew members and 11 passengers on-board, departed from Londolozi Aerodrome (FALD) near Sabi in Mpumalanga on a scheduled flight to OR Tambo International Airport (FAOR) in Gauteng.

1.2 While in a stable cruise at flight level (FL) 200, approximately 40 nm east of WIV VOR (very-high frequency omni-directional range) navigational beacon, the aircraft experienced an explosive decompression. The crew immediately carried out an emergency descent to FL120 and declared a mayday emergency.

Figure 1: The aircraft during a previous operation (source: S Sowa)

1.3 The aircraft was routed directly to FAOR by air traffic control (ATC) and the remainder of the flight and landing on runway 03R was uneventful.

1.4 The investigation revealed that the cause of the decompression was due to failure of the third cabin window on the right-hand side of the fuselage during flight.

2. HISTORY OF FLIGHT

2.1 On 22 October 2018, at 1059Z, a Federal Airlines flight (FDR123) with 2 crew members and 11 passengers on-board, departed from FALD near Sabi in Mpumalanga on a scheduled flight to FAOR in Gauteng. The aircraft in use was a B1900D. The flight was operated in accordance with South African Civil Aviation Regulations, 2011, Part 135 (air transport operations – carriage of less than 20 passengers or cargo).

2.2 After 15 minutes of cruise at FL200, approximately 40 nm east of WIV VOR, the aircraft experienced an explosive decompression followed by a “CABIN ALT HI” annunciated in the fight deck. The crew immediately carried out an emergency descent to FL120 and declared a mayday emergency. All oxygen masks deployed and operated as required.

2.3 Once the aircraft stabilised at FL120, the first officer inspected the cabin and found that the cause of the decompression was due to the failure of the third cabin window on the right-hand side of the fuselage. The standard terminal arrival for the aircraft was cancelled and the aircraft was routed directly to FAOR. The remainder of the flight was uneventful. The aircraft landed on runway 03R, 57 minutes after departing FALD.

2.4 None of the occupants on-board sustained any injuries. Damage to the aircraft was limited to the cabin window, cabin side wall panel and one insulation blanket.

2.5 The flight was carried out in daylight hours in VMC. Due to the nature of the operation being carried out, the aircraft was under radar control and therefore the flight was conducted under IFR.

Figure 2: Internal (left) and external (right) view of the failed window

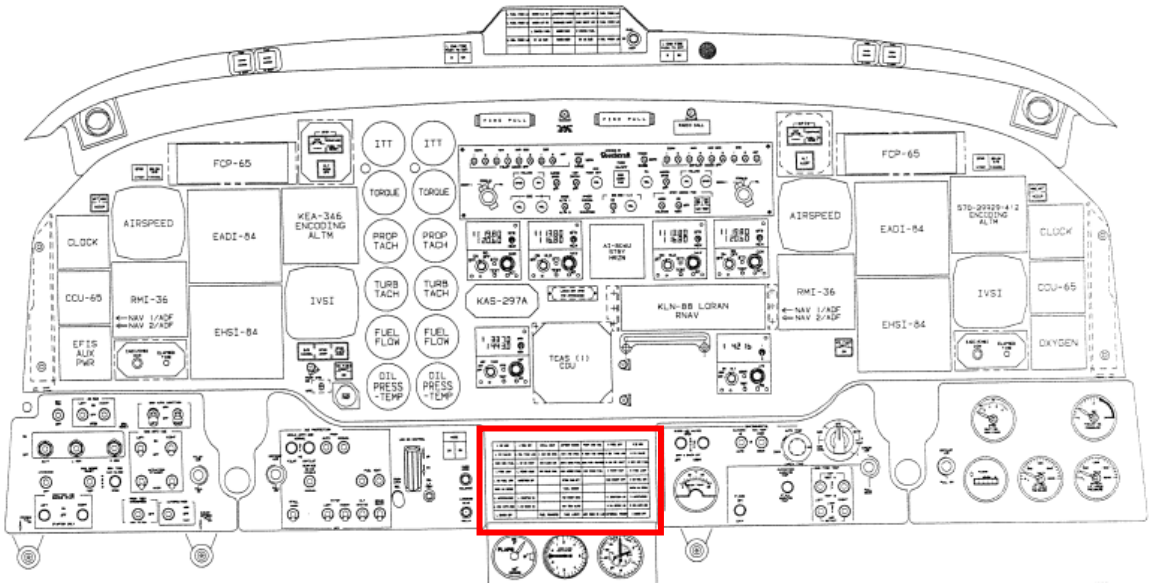


Figure 3: The location of the annunciator panel on the flight deck of a B1900D airliner (B1900D systems description, section 3)

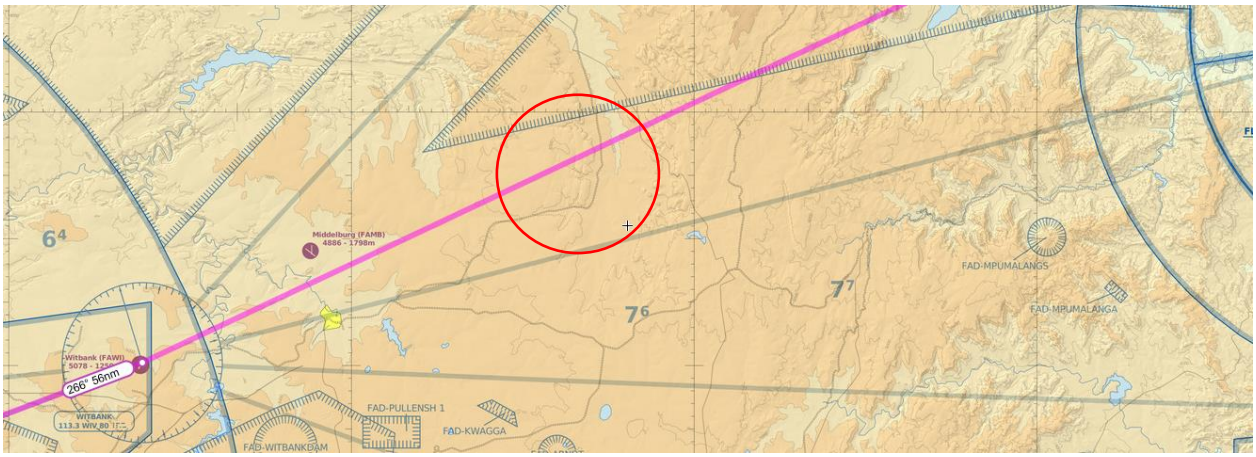


Figure 4: The approximate location of the incident (Source: SkyVector)

3. FACTUAL INFORMATION

Aircrew

3.1 The flight was used to carry out internal line sector training. The pilot occupying the left seat was in the process of upgrading to captain, and was acting as the pilot-in-command (PIC) for this flight. The pilot occupying the right seat was a training captain and was acting as first officer (FO).

3.2 The PIC, a 27-year-old male, held a valid commercial pilot's licence (CPL). The last competency check for the CPL licence and instrument rating had been carried out on 13 November 2017 and was due to expire on 31 December 2018. The PIC also held the necessary aircraft type rating to operate the aircraft.

3.3 The PIC had flown a total of 341.5 hours on the B1900, of which 45 hours had been flown in 90[DM1] days.

3.4 The PIC had been issued a Class 1 aviation medical certificate on 17 January 2018, which was due to expire on 31 January 2019.

3.5 The FO, a 39-year-old male, held a valid airline transport pilot's licence (ATPL). The last competency check for his ATPL licence and instrument rating had been carried out on 16 February 2018 and was due to expire on 28 February 2019. The FO also held the necessary aircraft type rating to operate the aircraft.

3.6 The FO had flown a total of 2 132 hours on the B1900, of which 60 hours had been flown in the last 90 days.

3.7 The FO had been issued a Class 1 aviation medical certificate on 13 September 2018, which was due to expire on 30 September 2019.

Note: No cabin crew were on-board the aircraft for this flight, nor was this a requirement for the operation according to the South African Civil Aviation Technical Standards, 2011: "*91.02.1 CREW COMPOSITION AND QUALIFICATIONS: 2. Cabin crew member complement (1) The cabin crew complement shall be based on the originally certified maximum passenger seating capacity for the aircraft and, subject to paragraph (2), shall consist of – (a) one cabin crew member for an aircraft certified for 20 to 50 passenger seats, inclusive.*"

Aircraft

3.8 The aircraft had been issued with a Certificate of Release (CoR) to service on 14 June 2018, which was due to expire on 13 June 2019 or at 26 521.3 hours of flight time (whichever occurs first).

3.9 The last maintenance check carried out was a phase 6: 50-hour routine check. This check did not require inspection of the cabin windows. According to the B1900 maintenance manual (5-30-00, paragraph 13a), cabin windows need to be inspected at 4 500-hour intervals for evidence of crazing, cracks and deterioration. The last detailed inspection on the cabin windows had been carried out on 26 January 2014 (at 24 336.83 airframe hours). The next inspection was due at 28 836.83 airframe hours.

3.10 The last documented date for window replacement was 15 January 2007, at 20 484 airframe hours. The window had been in operation for approximately 6 025 hours since installation. The last phase 3 inspection, which would have required that a window inspection be accomplished, had been carried out on 3 January 2017.

3.11 Inspection of the cabin window frames is required to be carried out annually. The last inspection of the window frames occurred on 5 December 2017.

3.12 The B1900D has two types of cabin windows fitted: numbers 1 and 2 are two-pane windows, while the remainder of the cabin windows are single pane.

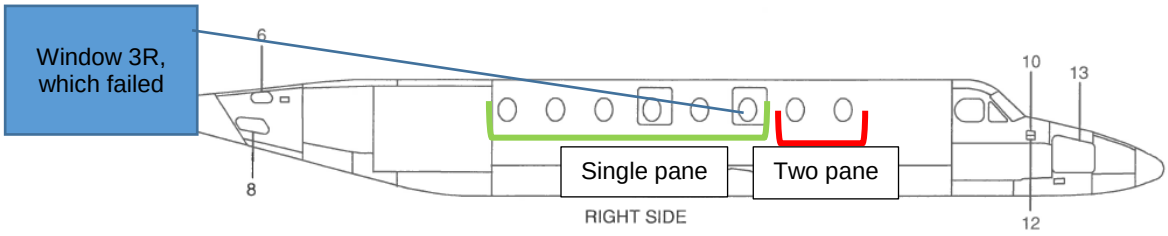


Figure 5: View of the right side of the fuselage
(source: B1900D MM, 06-20-00-001, Figure 2 (Rev Nov 1/09))

3.13 The B1900D single-pane cabin windows have a life span of 43 600 flight hours or 61 700 pressure cycles. The life span is designed to ensure the windows are in a serviceable condition during the previously mentioned inspections. At the time of the window failure, the aircraft had flown a total of 26 508.6 airframe hours and completed 32 884 cycles.

3.14 The B1900D is a twin turboprop aircraft, powered by two Pratt & Whitney PT6A-67D power plants. Each power plant has two exhausts on either side. When the propeller is in the feathered position, the exhaust gases are blown directly onto the cabin windows and fuselage. The B1900D Aircraft Flight Manual section on power plant limitations, engine exhaust heating of cabin windows and airframe states: "*do not operate the engines with the propellers feathered except during external power starts and propeller feather checks, except that the propellers may be operated in feather at temperatures not to exceed +5°C for a maximum of 3 minutes for the purpose of airframe de-icing*."

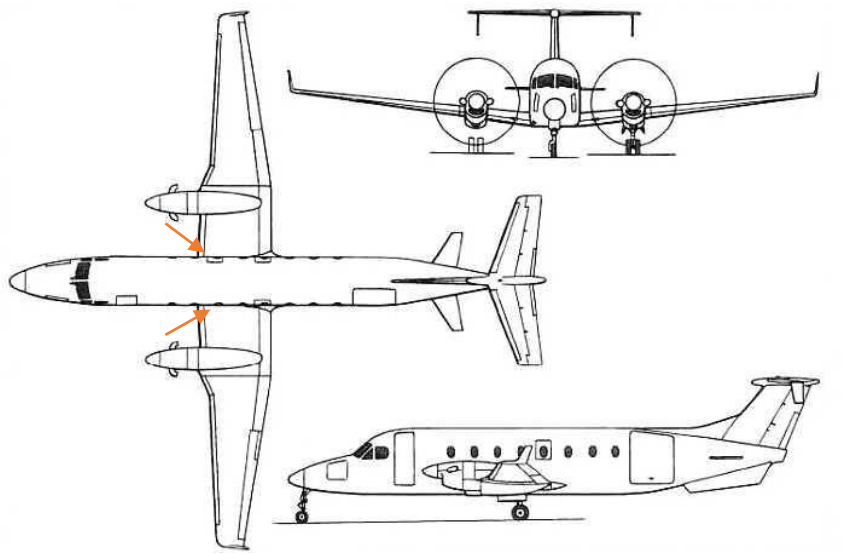


Figure 6: View of the power plant exhaust ducts and the direction of exhaust gas flow with the propellers feathered (Skybrary)

3.15 The aircraft held a Certificate of Airworthiness, which had been issued on 29 June 2004 and which was due to expire on 30 June 2019. This permitted the aircraft to operate in the standard commuter category.

3.16 Prior to the incident, the aircraft did not have any defects relating to the pressurisation system. After the cabin decompression, all oxygen systems operated as required.

3.17 The investigation revealed that the cause of the decompression was due to failure of the third cabin window on the right-hand side of the fuselage during flight.

Environment

3.17 The METAR for FAOR at the time of the incident was FAOR 221130Z 06010KT 020V100 CAVOK 20/M03 Q1032 NOSIG. The METAR for Witbank Aerodrome (FAWI) at the time of the incident was FAWI 221200Z AUTO 10005KT //// // ////// 22/M00 Q1031=.

3.18 Upper air conditions at the time of the incident at FL200 were temperature –15°C, wind 208° at 16 kts, and cirrus clouds with some cumulus development in the area.

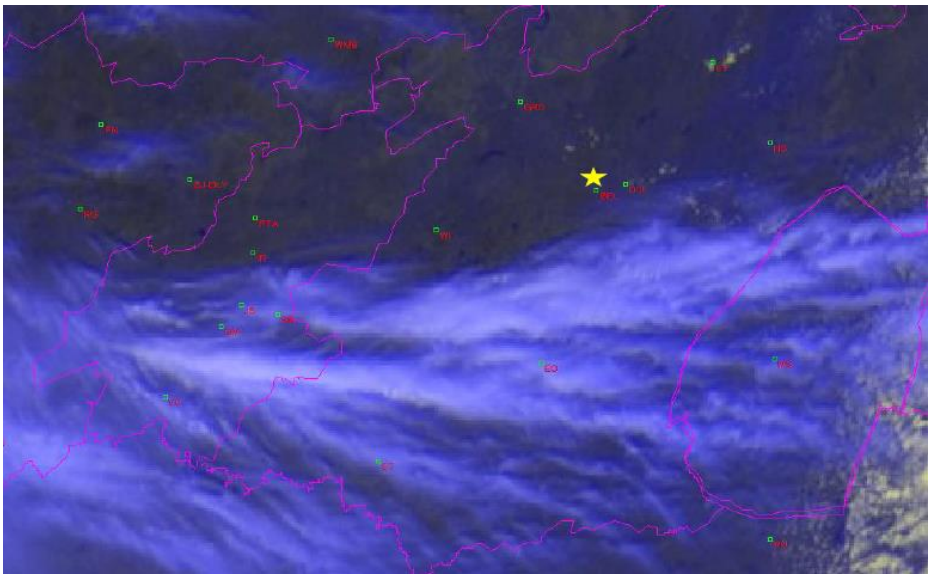


Figure 7: Satellite image showing atomspheric conditions over the incident site. The star demarcates the incindent location. (source: South African Weather Service)

3.19 The 11 passengers on-board comprised United States, Dutch and British citizens.

3.20 The flight was conducted in VMC during daylight hours. Due to being under radar control, the flight was conducted under IFR.

4. PROBABLE CAUSE

4.1 The aircraft experienced the decompression due to failure of the third cabin window on the right-hand side of the fuselage during flight.

5. CONTRIBUTING FACTORS

5.1 None.

6. REFERENCES USED IN THE REPORT

6.1 B1900 Airliner communiqué no. 30

6.2 Crash lab window analysis report

6.3 Air Traffic and Navigation Services flight plan

6.4 South African Weather Service report

6.5 Raytheon Aircraft Company B1900D Pilot Operating Manual

6.6 Raytheon Aircraft Company B1900D Maintenance Manual

6.7 Raytheon Aircraft Company B1900D Illustrated Parts Catalogue

7. SAFETY RECOMMENDATION

7.1 It is recommended to the Director of Civil Aviation to issue maintenance notice to all operators of the B1900D aircraft type to carry out inspection on all cabin windows regardless of the remaining hrs and cycles for the next inspection, this follows the failure of the third cabin window on the right-hand side of the fuselage during flight and subsequent cabin window inspection carried by the operator where by eight (8) cabin windows were replaced due to manufacturer's limits.

7.2 **Safety Action taken by the operator**

7.2.1 The operator has carried out a special inspection on all the cabin windows on both B1900D aircraft in its fleet. On completion of this inspection, eight cabin windows were replaced due to being close to the manufacturer's specified limits.

8. ORGANISATION

8.1 None.

9. SAFETY MESSAGE

9.1 It is imperative that operators abide by the B1900 communiqué no. 30 during ground operations to avoid excessively heating the cabin windows.

10. APPENDICES

10.1 Appendix A (Failure Analysis Report)

10.2 Appendix B (extract from B1900 communiqué no. 30)

This report is issued by:

Accident and Incident Investigation Division
South African Civil Aviation Authority
Republic of South Africa

Appendix A

COMPILED BY	F.A.&I.L.	PAGE 1 OF 9
COMPILED FOR: Federal Airlines (Pty) Ltd	FAILURE ANALYSIS REPORT: CABIN WINDOW, BEECHCRAFT 1900D, ZS-PHX	DOCUMENT NUMBER FA-006-11-18
		DATE 2018-11-19 / ISSUE 1

ITEM: **RIGHT-HAND FORWARD EMERGENCY EXIT CABIN WINDOW, PART No 129-430041-1, BEECHCRAFT 1900D, SERIAL No UE-145, No ZS-PHX**

1. BACKGROUND INFORMATION

1.1. The remainder of a failed cabin window (Photo's 2 and 3; Part no 129-430041-1) originating from the forward right-hand (pilot's view) emergency exit position from a Beechcraft 1900D, No ZS-PHX (Photo1), was submitted to determine the most probable root- and contributory causes towards failure during operation.

1.2. The relevant cabin window failed during flight at approximately 20000' MSL (FL020) while the aircraft was under pressurization (Photo 2).

1.3. The cabin window base material conforms to Polymethyl Methacrylate (PMMA) of the Transparent Thermoplastic - Amorphous Polymer type.

Photo 1: ZS-PHX File Photo[1]

Photo 2: Cabin window failure, as found[2]

[1] Courtesy Planespotters.net
[2] Courtesy Federal Airlines

Photo 3: Failed cabin window, as received (digital)

1.4. This report is divided into the following sections:

2. APPLICABLE DOCUMENTS

(a) Photographic evidence, supplied.
(b) Raytheon Aircraft AFM extract.
(c) Beechcraft General Maintenance Practices Chapter 56.
(d) ASM International Document no 06987G.

3. DEFINITIONS

(a)	OEM	Original Equipment Manufacturer
(b)	AMO	Aircraft Maintenance Organization
(c)	assy.	Assembly
(d)	ASM	American Society for Metals
(e)	PMMA	Polymethyl Methacrylate

4. PERSONNEL

(a) The investigative member and compiler of this report is Mr C.J.C. Snyman, ID number 6406105057080. Mr Snyman is a qualified Physical Metallurgist (Professional Engineering Technologist: Metallurgy; ECSA Registration No 201670194), Radiation Protection Officer (RPO, NNR, No 281) and Aircraft Accident Investigator (SCSI).

5. APPARATUS AND METHODOLOGY

(a) The methodology included visual inspection of the supplied parts and aircraft.

(b) Microscope analysis.
(c) Administrative examination of the supplied documentation.

6. INVESTIGATION RESULTS

6.1. Visual Inspection Results.

The visual inspection revealed of the supplied remains of the fracture single-ply cabin window (Extract 1, yellow arrow) revealed extensive multi-directional scoring marks (Photo 4, blue arrows).

An isolated outside surface scoring mark revealed indications of extension beyond the fracture surface edge (Photo 8, red arrow; Photo 5, red arrow and dashed circle) suggesting existence pre-failure of the component.

Extensive surface crazing was evident (Photo 6, red dashed square) indicating exposure to exceedingly high strain exposure during operation.

Comparative tests between new and used units revealed extensive inward (towards inner cabin) contouring of the failed window (Photo 8).

Inspection of the relevant aircraft showed the inboard right-hand engine exhaust duct facing upward while angled towards the fuselage side in proximity of the failed cabin window. The aft cabin emergency door window revealed slight indications of inward contouring (Photo 9).

6.2. Fracture Analysis.

The fracture surface analysis revealed clear indications of fast fracture propagation in both the long-transverse (Photo 7, red arrow; Mode III; Diagram 1) and the short-transverse (Photo 8, yellow arrows; Mode I) directions. Although only selected remains were recovered, it can be derived that the fracture initiated from the central region and not from the window edge/s.

The fracture surface geometry in the short-transverse direction revealed three areas with A corresponding with the Mirror-, B with the Mist- and C with Fast Final Fracture-Zones associated with the brittle behaviour of PMMA at low temperatures. The direction of propagation (yellow arrows) confirm initiation on the outside while progressing towards the inside (cabin).

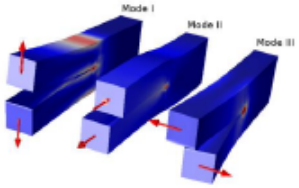
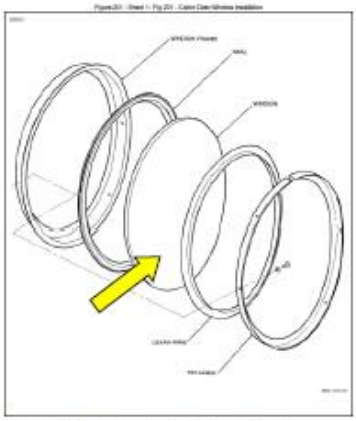


Diagram 1: Fracture Modes[3]

[3] Courtesy Modus



Extract 1: Single-ply Cabin Window assembly[4]

Photo 4: Reminder of cabin window showing multi-direction score marks (digital)

Photo 5: Pre-failure score mark (digital)

[4] Beechcraft GMP Ch 56

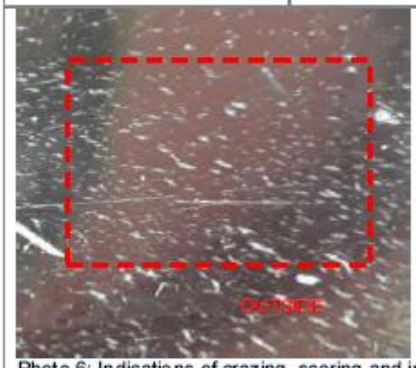


Photo 6: Indications of crazing, scoring and impact marks, outside surface (digital)

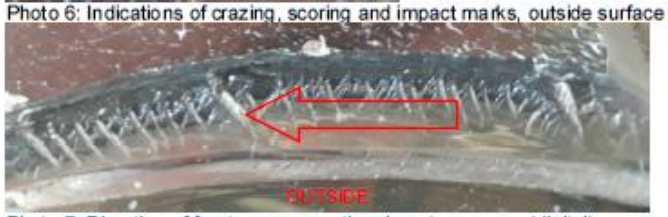


Photo 7: Direction of fracture propagation, long transverse (digital)

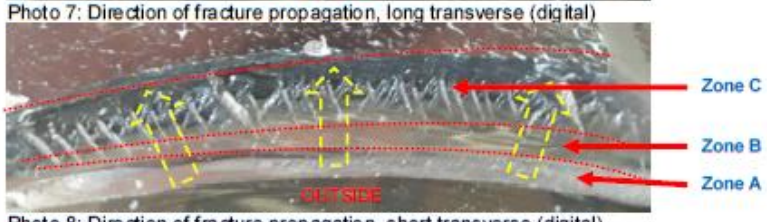


Photo 8: Direction of fracture propagation, short transverse (digital)

Photo 8: Comparative contouring between new (top) and used (bottom) cabin windows (digital)

Table 202
Single-ply Window Damage

Damage Type	Probable Cause	Recommended Action
Scratches, abrasions, gouges and chips with a maximum depth of 0.015 inch.	Improper maintenance cleaning procedures or object impact.	Damage may be worked out (Ref. ACRYLIC WINDOW REFURBISHING PROCEDURE).
		CAUTION Repair may cause optical distortion.
Scratches, gouges and chips with a maximum depth in excess of 0.015 inch.	Improper maintenance cleaning procedures or object impact.	Airplane MUST be operated unpressurized until the window is replaced.
Crazing with a maximum depth of 0.015 inch.	Contact with unapproved cleaners, solvents or chemical compounds; stress fatigue.	Damage may be worked out (Ref. ACRYLIC WINDOW REFURBISHING PROCEDURE).
Crazing with a maximum depth in excess of 0.015 inch.	Contact with unapproved cleaners, solvents or chemical compounds; stress fatigue.	Immediate replacement of the window is mandatory before further flight.
Haziness and cloudiness	Improper maintenance cleaning procedures; contact with unapproved cleaners, solvents or chemical compounds; stress fatigue.	Properly clean the window. Reinspect and check for scratches, abrasion or crazing; if present, follow above action. If the damage is the result of chemical exposure, the airplane MUST be operated unpressurized until the window is replaced.
Out of contour	Excessive heat or pressurization, high humidity, water absorption, chemical or solvent absorption.	If window is out of contour beyond limits specified by detail A-A or detail B-B of Figure 202, remove the window and ensure that it measures 18.05 inches minimum along the curvature of the vertical axis and 11.80 inches minimum along the horizontal axis. If the window does not meet this criteria, immediate replacement is mandatory before further flight.
Distortion (Flight Compartment)	Improper restoration methods. Chemical or solvent damage.	Immediate replacement of the window is mandatory before further flight.

Extract 3: Single-ply Window Damage chart[6]

Table 1 Glass transition temperatures for selected plastics

Material	Glass transition temperature °C	°F
PS	101	215
PMMA	107	225
PVC	78	170
PC	150	300

PS, polystyrene; PMMA, polymethyl methacrylate; PVC, polyvinyl chloride; PC, polycarbonate

Extract 4: Glass Transition Temperatures[7]

[6] Beechcraft GMP Ch 56
[7] ASM International Document no 06987G

POWER PLANT LIMITATIONS

ENGINE EXHAUST HEATING OF CABIN WINDOWS AND AIRFRAME

1. Do not operate the engines with the propellers feathered except during external power starts and propeller feather checks, except that the propellers may be operated in feather at temperatures not to exceed +5°C for a maximum of 3 minutes for purposes of airframe deicing.
2. Do not conduct static operations in ground fine when the OAT exceeds 38°C.
3. Do not back the airplane using reverse thrust for periods longer than 10 seconds.

Extract 5: Powerplant limitations[8]

9. RECOMMENDATIONS

9.1. Considering the detrimental effects on Aviation Safety, it is always strongly recommended that the Operator/AMO ensure the correspondence to OEM set limits and Flight Manual/s.

10. DECLARATION

10.1. All digital images have been acquired by the author and displayed in an un-tampered manner.

[8] Raytheon Aircraft AFM

Appendix B

1900 Airliner Communique No. 30 December 1993

FLIGHT DATA RECORDER WILL NOT TEST ATA 31

We have reports from the field of the Loral/Fairchild Solid State Flight Data Recorders P/N S703-1000-00 (SSFDR) not testing during the preflight test. Replacing the solid state flight data recorder corrects the condition. Loral/Fairchild has investigated this condition and has found in some cases it is caused by delamination in the flash memory devices in the memory module. Loral/Fairchild has altered its manufacturing processes to correct this condition. Current production units have this change incorporated and as units are returned to the factory for repair, they are inspected for the condition.

If you have a system exhibiting this condition, it is suggested you contact Mr. Carl Palkovich with Loral/Fairchild product support. His phone number is 813-377-5568 and his fax number is 813-378-6996.

POWER SOURCE FOR THE ALTITUDE PRESELECTOR/ALERTER ATA 34-10

In the past, it has been our policy to connect the altitude preselector/alerter to a generator bus. Due to customer and vendor comments, current production 1900D Airliners have the altitude preselector/alerter circuit breaker connected to the avionics master bus. This was done in an effort to increase MTBR (Mean Time Between Removal) of this unit. Since this change has been accomplished on current 1900D Airliner production aircraft, we have no objection with operators altering their installation in 99, 1900 and 1900C aircraft to match this configuration and thus gaining these benefits. If a local FAA approval is required, it is the responsibility of the installation agency making the changes to acquire this approval.

FERRY FLIGHT OF MODEL 1900C AND 1900D WITH DAMAGED STABILON ATA 55

The Model 1900 Operators experience has shown the need for data to support ferry flights of damaged aircraft.

The attached letter (Attachment "A") will provide criteria we feel will assist you in obtaining a ferry permit when you have a damaged stabilon on your aircraft. In the future this information be inserted in our Model 1900 Structural Repair Manual. We will endeavor to expand upon these type needs and increase information available to the Operators.

PASSENGER COMPARTMENT - CABIN OUTER WINDOWS ATA 56-20

Some 1900 airline operators have reported a condition of no. 3 and 4 cabin side window distortion or dishing and in a few severe cases, shrinkage of the window. We are evaluating this situation in an effort to determine what action, if any, may be necessary to prevent such occurrences.

Tests have demonstrated that window distortion is caused by "hot" engine exhaust gasses impinging upon the cabin side windows. To date, our research has found that the possibilities of window distortion can be minimized or avoided by simply modifying ground operating procedures listed below.

1. Refrain from "backing" of the aircraft.

2. Avoid static ground operation of the aircraft with the propellers in the feather position.

3. Limit operation with the propellers in ground fine to a minimum.

4. Awareness of quartering tail winds and jet blast - these external forces could redirect hot engine exhaust gasses onto the windows. Such exposure should be minimized whenever possible.

Additionally, we recommend that all personnel review the fuselage side window inspection criteria listed in Maintenance Manual ATA 56-20. Beech has received one report of a cabin side window blowout and two reports of severe distortion. The side window blowout may be a totally unrelated case, but based on these occurrences, extra vigilance is in order.

We would hope that by following the steps listed above and monitoring the condition of the cabin side windows, possibly you may prevent any reoccurrence of side window heat related distortion.