

October 27, 2019

Aircraft Performance Crash Site Factual

I. ACCIDENT

NTSB Number: DCA20MA002
Location: Thomas Madsen Airport (DUT), Unalaska, Alaska
Date: October 17, 2019
Time: 1740 Alaska Daylight Time
Aircraft: Saab 2000, N686PA
Operator: Peninsula Aviation Services, Incorporated d.b.a. PenAir

II. VEHICLE PERFORMANCE SPECIALIST AND ON-SCENE SUPPORT

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1.0 INTRODUCTION

On October 17, 2019, about 1740 Alaska Daylight Time, PenAir flight 3296, a Saab 2000, N686PA, overran the runway while landing at the Thomas Madsen Airport (DUT), Unalaska, Alaska.¹ The airplane was making its second landing approach when it touched down on runway 13 and overran the runway, passing through the airport perimeter fence, crossing a road, and then pitching down over shoreline rocks. The airplane came to rest with the main landing gear wheels at the top of the rocks and the nose wheels in the water. Of the 39 passengers and 3 flight crew on board, 1 passenger was fatally injured, 4 passengers sustained injuries, and 37 passengers and flight crew were uninjured. Visual meteorological conditions prevailed. The airplane was substantially damaged. The airplane was operating as a regularly scheduled passenger flight in accordance with the provisions of *14 Code of Federal Regulations Part 121* from Ted Stevens International Airport (ANC), Anchorage, Alaska to DUT.

The NTSB Office of Research and Engineering launched an aircraft performance investigator to support the NTSB Office of Aviation Safety investigation. The NTSB Team from Washington, DC arrived in Anchorage, Alaska on October 18, 2019. The NTSB team split into two teams on October 19, 2019 to support parallel investigative work in Anchorage and in Unalaska, AK. The NTSB aircraft performance investigator arrived in Unalaska on October 19, 2019 with the NTSB investigator-in-charge, the systems/structures specialist, and the powerplants specialist to join the NTSB regional investigator already working on scene.² Aircraft performance activities on scene were completed on October 24, 2019.

¹ The airplane was owned and operated by Peninsula Aviation Services, Incorporated d.b.a. PenAir.

² The NTSB regional investigator arrived on October 18th to stake down the accident site, begin to organize resources, and collect and document on-scene factual evidence.

2.0 FACTUAL EVIDENCE

2.1 Saab 2000 Drawing

A three-view drawing of the Saab 2000 is included in Attachment 1.

2.2 Airplane Final Rest Position

Aircraft performance evidence gathering began mid-day on October 19th with photographic documentation of the airplane in situ where it came to rest. Witness mark evidence from main gear wheels on improved runway surfaces indicated that the airplane had traveled off the departure end of runway 13, across the 300-ft declared distance runway safety area (RSA), and then on a curving path across the blast pad, to the right of the extended runway centerline. It then traversed a 15- to 30-foot section of grass and rolled over/through a 4-foot high, chain link, airport perimeter fence. Nonuniform curled and twisted wires were found along the top 8 inches of the perimeter fence in the travel path of the left engine propeller and left main landing gear. Each main landing gear wheel path was aligned with a vertical fence post support that was bent toward the ground in the direction of airplane travel, as documented by the photographs shown in Figures 1(a) and 1(b).



Figure 1(a): Left main gear wheel path exiting the blast pad surface, traveling across the grass, over the fence, across a ditch, and up on the roadway.



Figure 1(b): Airport perimeter fence, post and fence directional damage, displaced large rock and soil path across public roadway.

As the airplane entered and crossed a public road (with one travel lane in each direction), a large rock positioned between the airport perimeter fence and the road near the intersection of Ballyhoo Road and Airport Beach Road was displaced from the shoulder to the center of the roadway. The left wing or left engine propeller then struck a 4- to 6-foot vertical signal post on the opposite road shoulder. The left engine propeller subsequently struck a 6- to 8-foot high, yellow, diamond-shaped road sign (that displayed a warning regarding low flying aircraft) mounted on a metal post on the road shoulder. The yellow sign, metal post, and anchoring concrete monument were uprooted by the airplane. The Fuel Tank video image evidence documented in Section 2.4.1 indicates that the left engine shed propeller blade fragments and at least one propeller blade during this airplane/left engine propeller/road sign contact event.

The airplane then pivoted counterclockwise (with 12 o'clock viewed toward the departure end of runway 13) around the damaged left main landing gear and came to rest with the airplane pitched airplane nose down. At the airplane final rest position shown in Figures 2(a) and 2(b), the nose landing gear wheels came to rest in shallow water at the edge of Dutch Harbor, the left main landing gear was embedded in rocks just below the edge of the Ballyhoo Road shoulder, and the right main landing gear remained on the dirt/grass shoulder at the intersection of East Point Road and Ballyhoo Road.



Figure 2(a): View parallel to public road at the end of runway 13, airplane nose pointed toward the extended runway 13 centerline, nose wheels in the waters of Dutch Harbor.



Figure 2(b): View of East Point Road (left) intersection with Ballyhoo Road (right) and Airport Beach Road (beyond the stop sign on the left), looking generally toward the approach end of runway 13.

2.3 Runway Visual Survey

On the afternoon of October 19th, the NTSB aircraft performance investigator organized and led a group of 12 volunteers composed of Airport Operations (Alaska DOT), Ravn Air, PenAir, Unalaska Police Department, Unalaska Fire Department, and the local business community on a visual survey of runway 13/31 to identify airplane components, parts, or fluid leakage evidence that might be related to the airplane landing overrun. The volunteer group was divided into two laterally-staggered search lines. People on the leading search line were spaced equidistant laterally from the runway shoulder to the runway centerline. Trailing search line members were centered on the lateral gaps between the leading line of searchers. The two search lines maintained a longitudinal separation of about 30 feet.

The visual search progressed full length down the left side of runway 31 and then back full length down the left side of runway 13. Two 2- to 3-inch strips of tacky rubber were recovered, together with a small screw and a quarter-sized, polygonal piece of non-tacky rubber. This evidence was added to four 3- to 5-inch strips of tacky rubber that were previously recovered during vehicle-based surveys of the runway by Airport Operations staff and the NTSB regional investigator. Photos of the items recovered are shown in Figure 3.



View 1



View 2

Figure 3: Tacky rubber strips, rubber piece, and screw (3/4 inch) recovered during runway 13 visual surveys

2.4 Video Evidence

Events pertinent to aircraft performance, structures/systems, powerplants, operations, human performance, and/or airport survival factor specialists were summarized in the image sequence storyboards included in Attachments 2–7. The respective image content is subject to the following notes:

- For the most efficient image content access, change the view to show one complete page at a time
- Use the right/left arrow keys to advance/reverse the image sequence one page at a time (a la Walt Disney flip book style)
- The image sequence advances in time from left to right, top to bottom for a given page
- The time increment between images may not be constant
- Image frame rates can be estimated by counting the number of frames per second in the neighborhood of the image(s) of interest

2.4.1 OPH Fuel Tank and OPH Front Door Videos

On October 20, the Unalaska Chief of Police delivered copies of two surveillance camera videos having a partial view of the runway 13 blast pad area and the public road intersection at the end of runway 13. The video footage from both surveillance camera sources was reviewed.

The video footage labeled “OPH Fuel Tank” documented N686PA landing rollout events during roughly the last 10 seconds of airplane motion toward its final rest position. An exemplar uncropped image is shown in Figure 4. See Attachments 2–3 for the corresponding cropped image sequence. The “Fuel Tank” label in this video refers to a fixed structure as opposed to an airplane fuel tank.



Figure 4: Exemplar frame from OPH Fuel Tank video. N686PA is shown in upper left.

The video footage labeled “OPH Front Door” also recorded N686PA landing rollout events during roughly the last 10 seconds of airplane motion toward its final rest position. However, these images appear to be blurred due to wind-induced oscillation of the camera and/or the camera mounting system. An exemplar uncropped image is shown in Figure 5. Attachments 4–5 contain the corresponding cropped image sequences. The “Front Door” label in this video refers to a fixed structure as opposed to an airplane door.



Figure 5: Exemplar frame from OPH Front Door video. N686PA is shown in upper left.

2.4.2 First Passenger Video

A passenger video was made available to the investigation on October 20 and reviewed by the NTSB Team. The same storyboard construction technique used for the OPH Fuel Tank and OPH Front Door videos was applied to develop the image sequence summary for the first passenger video. The image contents show intermittent views of the left wing, left engine cowling, left main gear (LMG) strut, LMG inboard and out-board wheels, the left side of runway 13, and related runway paint markings during the N686PA short final approach, touchdown and initial landing rollout. A smoke event near the LMG is visible during the rollout. An exemplar cropped image is shown in Figure 6. See Attachment 6 for the corresponding cropped image sequence.



Figure 6: Exemplar frame from first passenger video

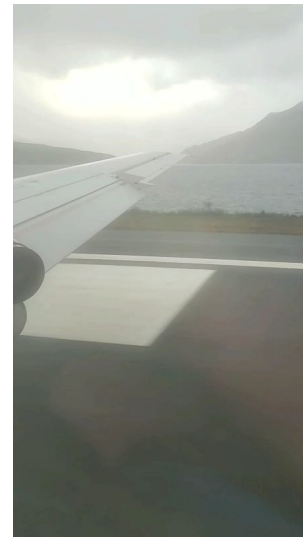


Figure 7: Exemplar frame, second passenger video

2.4.3 Second Passenger Video

A second passenger video was made available to the investigation and reviewed by the NTSB Team. The image contents show views of the right wing, right engine cowling, the right side of runway 13, and related runway paint markings during the N686PA short final approach, touchdown, and initial landing rollout. An exemplar cropped image is shown in Figure 7. Attachment 7 contains the corresponding cropped image sequence.

2.5 Runway 13/31 GPS Survey

During the late afternoon and early evening of October 19, the NTSB regional investigator and two Airport Operations staff members assisted with a Global Positioning System (GPS) survey of runway 13 to document witness mark evidence associated with the N686PA ground track. The surveyed airplane wheel path evidence was incorporated in a Google Earth model of the airplane path on runway 13, its departure from the blast pad, and its approach to the airport perimeter fence along Ballyhoo Road.

Excerpts of the Google Earth model are shown in Figures 8 and 9, which present planform views of surveyed N686PA witness marks during rollout, runway overrun, RSA overrun, and blast pad departure. Distance values in nautical miles uprange of the runway 13 threshold (the distance reference point) are annotated using orange text (negative values indicate distance uprange of the reference point). Distance values in feet downrange of the runway 13 threshold are shown in yellow, labeled every 100 feet for the first 1,000 feet and every 200 feet thereafter. The smallest distance increment shown on the scale along the right-hand side of runway 13 is 50 feet.

The calculated main gear touchdown point based on integrating FDR accelerometer data (see Section 2.8) is about 1,100 feet beyond the runway 13 threshold, as indicated by the green text label. Witness marks associated with the LMG outboard wheel path are depicted by the solid orange line, and begin about 1,835 feet downrange of the runway 13 threshold. The characteristics of the witness marks from the LMG outboard wheel vary from an initial, deep, dark, full width, contact patch to only thin inboard and outboard contact patch marks, to short, full-width patches of dark deposits, to long stretches of lighter deposits, to stretches free of discernible witness marks. The LMG outboard wheel path began on the left side of the runway centerline, crossed over to the right side of centerline, returned to the left side, and finally crossed over again to the right side before the airplane overran the blast pad surface (see Figures 9 and 10 for more detail).

The estimated position of a smoke event external to the airplane fuselage that was recorded in the first passenger video is identified by the blue text and corresponding camera orientation angle, at about 2,200 feet beyond the runway 13 threshold in Figures 8 and 9. Additional wheel path witness marks associated with the LMG inboard wheel and the right main gear (RMG) inboard and outboard wheels (beginning at about 4,030 feet downrange of the runway 13 threshold, near the midpoint of the 300-foot declared distance RSA) are shown by the respective solid orange lines in Figures 9 and 10.

On the afternoon of October 20, one Airport Operations staff member assisted the GPS survey of runway 13 markings to compare Trimble GPS geo 7x measurements to known reference points. The solid yellow lines in Figures 11–13 compare the resulting GPS survey data to available Google Earth satellite imagery data, dated July 27, 2019. In general, there is a nearly constant, longitudinal offset of 6–8 feet between the absolute position of runway paint markings defined by the GPS survey data and the reference Google Earth imagery data.

During the late morning and early afternoon of October 23, one investigator from SHK and one investigator from Saab joined the NTSB aircraft performance investigator to review the runway witness marks, collect additional wheel contact patch measurements, and take representative witness mark photographs. The team also reconstructed the probable airplane position at the time the first passenger video recorded a smoke event external to the airplane fuselage.

Early on the afternoon of October 24, the NTSB aircraft performance investigator gathered additional GPS survey data to document the roadway perimeters at the intersection between Ballyhoo Road, East Point Road, and Airport Beach Road.



Figure 8: Google Earth model showing N686PA calculated gear touchdown points and GPS survey of ground rollout path on DUT runway 13. Witness marks associated with the LMG outboard wheel are highlighted in orange (beginning about 1,835 feet on the distance scale). True North is toward the top of the page.



Figure 9: Google Earth model showing N686PA main gear wheel paths on DUT runway 13 based on GPS survey of witness mark evidence. Witness marks associated with the LMG inboard wheel and the RMG inboard and outboard wheels begin near the midpoint of the 300-foot declared distance RSA, as indicated by the respective solid orange lines. True North is toward the top of the page.



Figure 10: Google Earth model showing zoomed-in view of N686PA witness marks associated with the LMG inboard and outboard wheels and the RMG inboard and outboard wheels, as indicated by the respective solid orange lines. True North is toward the top of the page.



Figure 11: Google Earth model showing GPS survey of runway 13 arrival end markings (solid yellow lines) including arrows, threshold markings, runway number, centerline markings, and the touchdown zone target. True North is toward the top of the page.



Figure 12: Google Earth model showing GPS survey of runway 13/31 midsection (solid yellow lines) including centerlines and the touchdown zone targets. True North is toward the top of the page.



Figure 13: Google Earth model showing GPS survey of runway 13 departure end markings and public roadway edges (solid yellow lines). True North is toward the top of the page.

2.6 Photographic Survey of Runway 13/31

Photographs of witness mark and debris evidence associated with N686PA are presented in Attachment 8. These data were provided by Airport Operations (Alaska DOT), the NTSB Alaska regional investigator, the NTSB structures/systems investigator, and the aircraft performance investigative team (SHK, Saab, NTSB).

2.7 Preliminary Flight Data Recorder (FDR) Plots

Preliminary time history plots of the FDR parametric data are provided in Attachment 9.

2.8 Calculated Airplane Groundspeed and Ground Roll Distance

The FDR longitudinal acceleration data were integrated during the airplane ground roll between the nose wheel touchdown point and the point at which the nose wheel departed the improved runway surface. The integrated groundspeed result closely matches the FDR groundspeed data, as illustrated by the time history plot in Attachment 10. The corresponding nose wheel ground roll distance was about 2,880 feet. Due to FDR parameter sample rates, the calculated gear touchdown point is subject to an uncertainty on the order of ± 50 feet. Key FDR parameters for touchdown include vertical acceleration, longitudinal acceleration, bank angle, power lever angle, weight on wheels, pitch attitude, and for the Saab 2000, flap position.

According to the FDR data, the main gear touchdown point occurred about 1.5 seconds before nose gear touchdown. Given an FDR-based average groundspeed of about 235 feet per second between the main gear and nose gear touchdown points, main gear touchdown occurred about $2,880 + 350 = 3,230$ feet before the nose gear departed the improved surface. The corresponding main gear and nose gear touchdown points are annotated in Figures 8–9.

2.9 Stratus Data

The first officer recorded a GPS track file of the accident flight on his personal Appareo Stratus device. The device stores aircraft GPS position as well as attitude and heading reference system (AHRS) parameters including roll, pitch and yaw. The Stratus device was recovered from the N686PA flight deck by the NTSB systems and structures group chairman. The NTSB Alaska regional investigator downloaded the Stratus parametric data to a ForeFlight account and used CloudAhoy to construct a three-dimensional animation of the flight.³ Excerpts of the resulting aircraft flightpath visualization are shown in Figures 14(a) and 14(b). These factual data were used together with FDR, CVR, video, witness mark, aircraft, and witness statement evidence to reconstruct the airplane position on the runway.

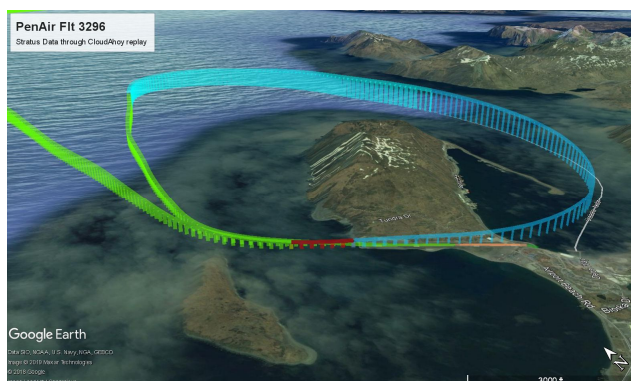


Figure 14(a): CloudAhoy reconstruction of N686PA flightpath during first approach, missed approach, second approach, landing, and rollout



Figure 14(b): CloudAhoy reconstruction of N686PA flightpath during missed approach and landing rollout

2.10 Airplane Recovery

During the airplane's roadway movement from the marine salvage operator's recovery and staging area to the airport revetment on the morning of October 21, 2019, the aircraft performance investigator assisted

³ ForeFlight provides flight planning, checklist, chart, weather, airport information, flight logging, document management, and hazard awareness products for personal aviators. CloudAhoy is a flight debriefing product for pilots.

the airplane recovery team by walking the airplane right wingtip path and affirming positive wingtip clearance from terrain and obstacles. Exemplar photographs of the recovered airplane configuration during transportation back to DUT are shown in Figures 15(a) and 15(b).



Figure 15(a): Recovered airplane voyage on salvage barge to staging area for truck transport



Figure 15(b): Airplane truck transport from salvage operator staging area back to airport

2.11 N686PA Weight and Balance Maintenance Record

PenAir provided the N686PA maintenance record that established the airplane operating empty weight and balance to the NTSB maintenance record specialist. A reproduction of this record is provided in Figure 16.

Aircraft: N686PA
 Serial No: 17
 Last Physical Weighing: 06/16/2019
 Date Computed: 06/16/2019
 Remarks: 45 pax seats use Whiz Wheel KS3R

ITEM	WEIGHT	ARM	MOMENT
Left Main	14022.0	623.2	8738510
Right Main	14065.0	623.2	8765308
Nose	2976.0	215	639840
Unusable fuel	66.0	598	39468
Flight Crew/Cockpit w/flt bag	406.0	193	78358
Flight Attendant w/flt bag	140.0	272	38080
Galley supplies	126.4	886	111990
Total as weighed	31801.4	579.0	18411555

Land OEW 31801.4 OI = -14.3
 C-1 max wt 1765 with C-2 at 880
 Total combined max wt 2645

Figure 16: Reproduction of N686PA maintenance record that established the airplane operating empty weight and balance (certification statement redacted)

2.12 Liaison for Airport Survival Factors Specialist Requests

The aircraft performance investigator relayed information requests from the NTSB airport and survival factors specialist to the DUT Airport Operations Manager on the morning of October 22 and to the Unalaska Police Chief and Unalaska Fire Chief on the morning of October 23.

Airport Survival Factors information requested from DUT Airport Operations (Alaska DOT)

- .pdf copy of the DUT Airport Certification Manual including the emergency response plan
- Computer Aided Dispatch (CAD) reports and audio recordings of communications around the time of the accident
- Signed statements from the (initial) first responders to the accident (airport personnel)
- After-action reports/summaries from airport first responders
- Photographs of the accident site taken by airport personnel
- Pre-accident photographs of road signage/lights involved in accident
- List of mutual aid responding vehicles and personnel
- Date of last airport triennial disaster drill and description of drill
- Description of traffic gate control procedures
- Description of RSA improvement project (2012-2014) and current compliance with RSA standards

Airport Survival Factors information requested from the Unalaska Police and Fire Departments

- Computer Aided Dispatch (CAD) reports and audio recordings of communications around the time of the accident (How and when was the alert reported and relayed between PD, FD, Airport, Good Samaritans?)
- Signed statements from the (initial) first responders to the accident (both PD and FD personnel on the scene and/or assisting passengers/crew in the airplane) regarding their activities, thoughts, and observations during the immediate response, rescue, triage, treatment, passenger egress, and transport to medical facility phases of the PD/FD response (Note: PD/FD activities after transition to securing the airplane and site pending arrival of investigators may be excluded)
- Applicable Life Flight/medical evacuation activities
- After-action reports/summaries from first responders
- Photographs of the accident site taken by police and fire personnel
- Pre-accident photographs of road signage/lights involved in accident
- List of mutual aid responding vehicles and personnel
- List of occupants transported to medical facilities
- Date of last airport triennial disaster drill and description of PD/FD participation, successes, challenges, and lessons learned during drill

2.13 Other Factual Evidence

The runway 13/31 surface was in good condition with respect to pavement wear, crown, grooving, and runway shoulder/infield drainage, as observed on-scene during both active rainfall and dry conditions.

The DUT Airport Layout Plan (ALP) is included as Attachment 11.

N686PA was reported to not be equipped with ADS-B.

If applicable, no Federal Aviation Administration (FAA) Air Traffic Control radar data were made available during the on-scene investigation.

3.0 ACKNOWLEDGEMENTS

The NTSB Alaska regional investigator on-scene, Noreen Price, captured the perishable evidence of the airplane main landing gear paths as N686PA approached and crossed Ballyhoo Road. She documented the large rock and main landing gear soil displacement evidence depicted in Figures 1(a) and 1(b) as well as the views of the airplane final rest position shown in Figures 2(a) and 2(b). The Alaska regional investigator also greatly assisted in identifying and documenting the airplane witness mark evidence included in the GPS survey of runway 13.

John O'Callaghan provided critical NTSB home team support by processing the runway 13 GPS survey data, incorporating the required base station differential signal corrections, and troubleshooting workarounds to access the required differential signal correction data, which allowed verification that the intended GPS survey data were captured and validated before the conclusion of on-scene investigative activities.

4.0 ATTACHMENTS

Attachment 1: Saab 2000 three-view drawing

Attachment 2: Image sequence from the OPH Fuel Tank video (cropped, 4 frames/page)

Attachment 3: Image sequence from the OPH Fuel Tank video (magnified, cropped, 1 frame/page)

Attachment 4: Image sequence from the OPH Front Door video (cropped, 4 frames/page)

Attachment 5: Image sequence from the OPH Front Door video (magnified, cropped, 1 frame/page)

Attachment 6: Image sequence from first passenger video (3 frames/page)

Attachment 7: Image sequence from second passenger video (3 frames/page)

Attachment 8: Runway witness mark and debris evidence

Attachment 9: Preliminary Flight Data Recorder (FDR) plots

Attachment 10: Calculated N686PA groundspeed (from integration of FDR longitudinal acceleration data)

Attachment 11: DUT Airport Layout Plan (ALP)