



Joshua Gang
General Counsel & Corp. Secretary

August 7, 2023

National Transportation Safety Board
Attn: NTSB Chairman
490 L'Enfant Plaza, SW
Washington, DC 20594

RE: Petition for Reconsideration NTSB Accident Number CEN22LA153

Dear NTSB Chairman:

Enclosed please find the Petition for Reconsideration and Modification of Findings for NTSB Accident Number CEN22LA153 including the confirmation of delivery to the FAA of the same.

Should you have any questions concerning this letter, please contact me at the address or phone number listed.

Regards,


Joshua Gang, Esq.
General Counsel & Corp. Secretary



August 07, 2023

Dear Customer,

The following is the proof-of-delivery for tracking number: 664139111982

Delivery Information:

Status:	Delivered	Delivered To:	Receptionist/Front Desk
Signed for by:	V.BROOKS	Delivery Location:	100 W CROSS ST
Service type:	FedEx First Overnight		
Special Handling:	Deliver Weekday		JACKSON, MS, 39208
		Delivery date:	Aug 7, 2023 07:51

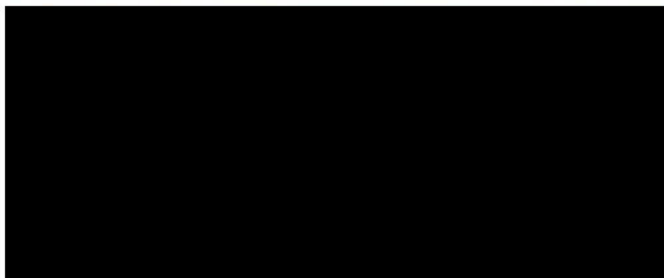
Shipping Information:

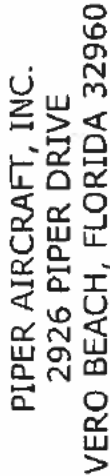
Tracking number:	664139111982	Ship Date:	Aug 4, 2023
		Weight:	0.5 LB/0.23 KG

Recipient:
BEROOKS R.VAUGHAN, AIRWORTHINESS INSPECTOR
100 WEST CROSS STREET SUITE C
JACKSON FLIGHT STANDARDS DISTRICT
JACKSON, MS, US, 39208

Shipper:
SUSAN GROENWALDT, PIPER AIRCRAFT INC
2926 PIPER DR
VERO BEACH, FL, US, 32960

Purchase Order 8925
Department Number EXECUTIVE





SHIP TO: Jackson Flight Standards District Office
100 West Cross Street, Suite C
Jackson, Mississippi 39208

TO BE COMPLETED BY SENDER

PLEASE SHIP VIA: **FED-X Overnight**

Recipient Phone Number Required for International Shipments

ATTENTION: Brooks R. Vaughan

Telephone:

SENDER & PH. EXTENSION
Marisa Hayden -

DEPARTMENT NAME
Executive

DEPT. NO.
1111

DATE 08/04/20

TIME

PT. OF ORIGIN
VRB**DESCRIPTION**

Letter

QTY SHIPPED

TO BE COMPLETED BY SHIPPING DEPARTMENT

SHIPPED VIA:

DATE SHIPPED:

TO BE COMPLETED BY SHIPPING:

CLOCK NO.

---: EXECUTIVE

DEPT. OF THE ARMY
REQUESTOR: 5005

CL_CLK# = 0000

SHIPPING CHARGE

AIRWAY BILL:

WEIGHT & DIMS:

Shipping:	Special:	Equipment:	Total:
100	100	100	300

Date : 04Aug23
Weight : 0.55 LBS

COO ! ATB WORTHINESS INSPRE

LEONARD

Avco: FIMB1 01LUN
TRML: 6641 3911 1982

AIRWAY BILL:

WEIGHT & DIMS:

Monday 8/7 by 8:30 AM

Domestic shipments must be delivered to the Shipping Department no later than **3:00 pm Eastern**
International shipments must be delivered to the Parts Admin Office no later than **2:00 pm Eastern**



Joshua Gang
General Counsel & Corp. Secretary

August 4, 2023

Brooks R. Vaughan
Airworthiness Inspector
Jackson Flight Standards District Office
100 West Cross Street, Suite C
Jackson, Mississippi 39208

RE: Petition for Reconsideration NTSB Accident Number CEN22LA153

Dear Mr. Vaughan:

Enclosed please find the Petition for Reconsideration and Modification of Findings for NTSB Accident Number CEN22LA153.

Should you have any questions concerning this letter, please contact me at the address or phone number listed.

Regards,



Joshua Gang, Esq.
General Counsel & Corp. Secretary



Date: August 1, 2023
Sent via E-Mail
Correspondence@NTSB.gov

Attn: NTSB Chairman
National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, DC 20594

Re: Piper Aircraft, Inc. Petition for Reconsideration and Modification of Findings, Analysis and Determination of Probable Cause, and Request for Oral Presentation: Accident Number CEN22LA153, Olive Branch, Mississippi, March 23, 2022, Aviation Investigation Final Report with Probable Cause and Findings, (the "NTSB Report").

Dear Sir or Madam:

Piper Aircraft, Inc. ("Piper") hereby petitions the National Transportation Safety Board ("NTSB"), pursuant to 49 CFR §845.32, to reconsider and modify its findings and determination of probable cause in the above-referenced matter.

The basis of this petition is that the NTSB Final Report includes erroneous findings and analysis that are unsupported and/or contradicted by the factual record and inconsistent with engineering principles. Simply stated, the NTSB Report is replete with speculation and incorrect conclusions. These mistakes and errors are so fundamental that the NTSB should reconsider and modify its findings and determination of probable cause related to this accident.

Because of the nature of the issues discussed herein, should the NTSB not grant Piper's request for reconsideration and modification of the findings, analysis and determination of probable cause, Piper respectfully requests the opportunity to make an oral presentation to the Board and for the presentation to be made available in the public docket.

Attachment A to this petition and incorporated herein by reference is a report prepared by Dr. Snorri Gudmundsson, a recognized expert in the design of general aviation aircraft, who

among other things, is the author of the work cited in the NTSB Report. Attachment B is the curriculum vitae of Dr. Gudmundsson. As will be demonstrated throughout this petition Dr. Gudmundsson's report disagrees with the NTSB Report and provides clear and convincing proof that the findings, analysis and probable cause determination is incorrect.

For ease of reference, this petition is organized as follows:

- I. Overview and Summary of Petition**
- II. Factual Errors in the Accident Investigation NTSB Final Report**
 - A. There is no factual evidence of an "uncommanded" right turn after touchdown.**
 - B. The incontrovertible evidence clearly establishes the absence of a dynamic instability.**
 - C. The NTSB Report has no analysis or discussion of pilot performance other than relying upon the pilot's statements of what happened, which are inconsistent with the objective evidence.**
 - D. The NTSB Report misrepresents the work cited in the report (Dr. Gudmundsson's book General Aviation Aircraft Design: Applied Methods and Procedures, First Edition, Elsevier, Inc., 2014) upon which the NTSB relies to support its engineering analysis, findings and conclusions.**
 - E. Communications with the pilot indicates confirmation bias played a role in the investigation leading to erroneous findings, analysis and probable cause.**
- III. Conclusion and Proposed Probable Cause/Contributing Factor**
 - A. Proposed Probable Cause:** The pilot's loss of directional control on landing in crosswind conditions.
 - B. Proposed Contributing Factor:** Contributing to the accident was the pilot's failure to utilize appropriate techniques required for landing a steerable nose-wheel aircraft in crosswind conditions.

I. Overview and Summary of Petition

The factual evidence demonstrates that immediately following touchdown, the pilot (who had previously stated that the PA-46 aircraft “steering and responsiveness was “quite different from other airplanes he had experience operating (the T240 airplane’s nose-wheel is free-castering.))” provided improper control inputs during touchdown in crosswind conditions. Indeed, there is a complete absence of any objective factual information supporting proper crosswind landing technique utilized by the pilot following touchdown.

The only “evidence” that exists supporting the conclusion that this accident was anything other than pilot error are the statements of the pilot himself, who by his own admission was aware that the steering and responsiveness of the aircraft was “different” from what he was accustomed to. Attached to this Petition is a report from Dr. Snorri Gudmundsson, whose book, *General Aviation Design: Applied Methods and Procedures*, is cited and relied upon in the NTSB Report. Dr. Snorri’s report (hereinafter the “Gudmundsson Report”) clearly demonstrates that the available photographic evidence and Garmin data indicates the pilot used improper crosswind landing technique and, after touching down, utilized incorrect braking and steering technique, essentially “driving” the aircraft off the runway.¹

As noted, consistent with the foregoing, the Gudmundsson Report establishes that the analysis, conclusions, and probable cause in the NTSB Report are erroneous and incorrect, and that there is no evidence of inherent “dynamic instability” in the design of the PA-46 landing

¹ In his report Dr. Gudmundsson notes that “the accident appears to be an incipient ground loop, perhaps preceded by partial incipient Wheelbarrowing.” Further noting that “Excessive wheelbarrowing may result in the airplane rolling on the nose gear, making it highly susceptible to side-rotation (ground-looping) in crosswind.” Citing Chapman Flying, Wheelbarrowing - Bad Landings Ep1, available online (YouTube) at <https://www.youtube.com/watch?v=QOVduBGPqtw>, and the FAA Flying Handbook (FAA-H-8083-3C), available here: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/airplane_handbook.

gear system or that it was in anyway causative of the incident. Moreover, the Gudmundsson Report makes it clear that the photographic evidence demonstrates the absence of any dynamic instability in the PA-46 landing gear design.

II. Factual Errors in the Accident Investigation Final Report

A. There is no factual evidence of an “uncommanded” right turn after touchdown.

As pointed out in the Gudmundsson Report, the use of the word ‘uncommanded’ in the Probable Cause indicates that the aircraft did something independent of the pilot’s actions (p.2) (all page references herein are to the Gudmundsson Report). However, the only evidence of an uncommanded turn is from the subjective statements of the pilot. Since the photographic evidence conclusively contradicts such subjective statements from the pilot, the use of the term “uncommanded” is based on inference, not direct evidence, and is unsupported speculation (p.2). Moreover, it is illogical to assume that a pilot landing in a right crosswind, and touching down well left of the runway centerline was not attempting to “command” or steer the aircraft back toward the center of the runway (i.e. “the pilot was correcting back to the centerline of the runway with rudder input” as noted in the NTSB Report on page 2). The term “uncommanded” should be removed from the NTSB Report because there is no support to draw such a conclusion based on the physical evidence.

B. The incontrovertible evidence clearly establishes the absence of a dynamic instability.

As is discussed in the Gudmundsson Report, (pp 5-6), the tire marks contradict the conclusion that any dynamic instability was causative of this accident. The Gudmundsson Report establishes the following:

- using the Garmin data conclusively establishes that where one would expect evidence of dynamic instability, none exists (p.6).
- the continuous nature of NLG tire marks is factual evidence of the absence of a dynamic instability (p.5).
- the tire marks that would/should be evident if there was a dynamic instability in a NLG, whether lateral or vertical, are absent (p.10).

Simply stated, there is no objective evidence to support a finding of dynamic instability in this instance or that it was causative - other than the pilot's own statements. In fact, Dr. Gudmundsson's Report suggests that the most likely cause of the accident was, as is the cause of most aviation accidents, pilot error.

C. The NTSB Report has no analysis or discussion of pilot performance other than relying upon the pilot's statements of what happened, which are inconsistent with the objective evidence.

The factual evidence establishes that the pilot touched down left of centerline by a large amount, and then utilized braking techniques in opposition to proper crosswind landing technique. It was this improper piloting technique that resulted in a loss of directional control, and not any alleged dynamic instability or "uncommanded" actions by the aircraft. However, the NTSB report has no credible analysis or discussion of pilot's performance and landing technique other than relying on the pilot's own statements.

In fact, as noted on page 6 of the NTSB Report, section 4.5p of the Pilot Operating Handbook (POH) outlines the aircraft's normal landing procedures for crosswind conditions, which cautions the pilot about centering the rudder as the nosewheel touches down to prevent the aircraft from swerving in the direction of the nosewheel is offset (see below):

4.5p LANDING

CAUTION

In crosswind conditions, the nosewheel may not be aligned with the runway as the wheel touches down because of opposite rudder input. To prevent swerving in the direction the nosewheel is offset, the rudder must be promptly centered just as the nosewheel touches down.

CAUTION

Abrupt or aggressive application of reverse thrust during landing rollout, especially during crosswind landings, may reduce directional control.

NORMAL TECHNIQUE

POWER Lever.....IDLE
Brakes.....MODERATE (or as required)
POWER Lever..... BETA (or REVERSE as required)

However, other than citing the POH and noting the proper technique, the NTSB Report does not analyze the pilot's technique or engage in any analysis or review of whether the pilot in fact used proper crosswind technique and rudder control (by promptly centering the nose-wheel) at the point of touchdown, or at any other point during the landing. It is far more probable and perhaps understandable that the pilot, when landing in the crosswind, resorted to his past experience with a castering nose gear and failed to operate this aircraft properly.

As noted in the Gudmundsson Report the photographic evidence demonstrates that the pilot used improper technique for landing a steerable nose-wheel aircraft in crosswind conditions, and after touching down applied incorrect braking and steering technique, essentially "driving" the aircraft off the runway.

D. The NTSB Report misrepresents the work cited in the report (Dr. Gudmundsson's book *General Aviation Aircraft Design: Applied Methods and Procedures*) upon which the NTSB report relies to support the engineering analysis, findings and probable cause conclusions.

In the NTSB Report the author states "Negative trail (see figure 6, Item B except angle is aft) occurs when the steering axis intersects the ground left of the vertical axis and results in a torque about the steering axis that acts to increase the turn angle (negative dynamic stability) and is typically not used for NLG (p.14)." The entire discussion on NLG design in the NTSB report appears to be flawed. Not only does it misrepresent Dr. Gudmundsson's text it used images from the book related to castering nose-wheel design to support the incorrect assumptions of "dynamic instability" in the actively steered nose gear design on the PA-46.

- The conclusion finds no support in the reference upon which it relies. It does not speak of negative dynamic stability or inherent dynamic instability as described in the NTSB Report.
- The illustration from Dr. Gudmundsson's book was edited by the NTSB to remove the clear label noting that it represented **a castered steering system and not an actively steered system** like the nose landing gear system on the PA-46.
- The illustration in the book actually says that Item A is dynamically stable and requires steering.
- The report misrepresents that illustration in order to support the NTSB Report's narrative. Moreover, Pazmany, Landing Gear Design for Light Aircraft – Volume 1, Pazmany Aircraft Company, 1986, as cited in the Gudmundsson Report, establishes that the configuration of the NLG on the PA-46 aircraft is dynamically stable and simply requires positive steering.

As far back as 2008, both the FAA (in the Airplane Flying Handbook, FAA-H-8083) and Piper (in a Customer Information Letter) cautioned pilots that steerable nose-wheel aircraft required special techniques.

Pilot Technique

The FAA has published document FAA-H-8083-3 “Airplane Flying Handbook”, which is designed as a technical manual to introduce basic pilot skills and knowledge that are essential for piloting airplanes. The document may be downloaded for free at the following website:

https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/airplane_handbook

Like all steerable nose-wheel aircraft with interconnected rudder, special technique is required during a cross wind landing as explained in Chapter 8. Specifically, page 8-15 includes the following text:

In those airplanes having nose-wheel steering interconnected with the rudder, the nose-wheel may not be aligned with runway as the wheels touch down because opposite rudder is being held in the crosswind correction. To prevent swerving in the direction the nose-wheel is offset, the corrective rudder pressure must be promptly relaxed just as the nose-wheel touches down.

Piper designs and builds products to the highest standards for safety and reliability. Following these guidelines will help ensure that your aircraft continues to meet these standards throughout the service life of the aircraft.

It is evident, from the foregoing discussion that the pilot of the accident aircraft recognized that the steering and responsiveness of a steerable nose-wheel design were different from that of a castering nose-wheel aircraft, and that it would require different piloting technique. However, the facts and evidence related to this accident demonstrate that he failed to utilize the techniques required for a steerable nose-wheel design when landing in a crosswind as required.

E. Communications with the pilot indicates confirmation bias played a role in the investigation leading to erroneous findings, analysis and probable cause.

Confirmation bias is the tendency to seek out, interpret and rely on evidence that favors an existing belief or hypothesis, while discounting evidence that may disagree with or disprove that belief.² It is clear from the email communications between Mr. Clinton Crookshanks, NTSB Aerospace Engineer (Structures), and the pilot less than two months into the investigation, that Mr. Crookshanks had already determined that there was no pilot error. It is unclear whether Mr. Crookshanks was aware at the time that the pilot's previous flight experience was in aircraft with a free-castering nose-wheel.

Attachment C is a copy of an email exchange between the pilot and Mr. Crookshanks, in which the pilot thanked Mr. Crookshanks for calling to let him know that his "landing was good and the incident was not [the pilot's] fault." In fact, in that same series of emails on May 17, 2022, Mr. Crookshanks appears to admit as much in an email to the pilot's insurance adjuster. In that email, although he acknowledged that the investigation was incomplete and he had not yet completed his engineering report, Mr. Crookshanks noted that the NTSB had "found nothing abnormal during the preliminary review" and "The runway markings show the airplane tracking straight with the nosewheel rolling before it suddenly departs to the right." (Attachment C). From this series of emails it is clear that Mr. Crookshanks had already determined the probable cause of the accident, and was focused solely on the design of the PA-46 nose landing gear while discounting or ignoring any evidence of pilot error. These communications suggest

² See Gilbey, A. and Hill, S. (2012), *Confirmation Bias in General Aviation Lost Procedures*. Appl. Cognit. Psychol., 26: 785-795. <https://doi.org/10.1002/acp.2860> (citing Nickerson, R. S. (1998), *Confirmation bias: A ubiquitous phenomenon in many guises*, Review of General Psychology, 2, 175– 220.1998).

that the investigation was flawed from the beginning, and that Mr. Crookshanks made a determination as to the probable cause and contributing factors well before the investigation was complete, and before could have reviewed all of the facts and evidence available at the time. In fact, it is unclear whether all of the evidence had actually been gathered and thoroughly reviewed at that time.

Not only is it improper for a member of the NTSB investigation team to communicate the findings and probable cause at that early stage of the investigation, but the email exchange suggests that Mr. Crookshanks was focused on evidence that supported his conclusion and the probable cause finding he intended for the investigation, rather than engaging in a proper engineering review and analysis of the facts and evidence on the record, again demonstrating confirmation bias played a role in the investigation, analysis and probable cause findings. Mr. Crookshanks conduct was improper, unprofessional and demonstrates bias in the investigation – and this conduct in and of itself, demonstrates why this petition for reconsideration is not only warranted but must be granted.

F. Conclusion and Proposed Probable/Contributing Factor

As the foregoing demonstrates, the NTSB Report is fundamentally flawed. It includes erroneous findings and incorrect analysis that is unsupported and/or contradicted by the factual record. Moreover, the report's findings are incorrect and inconsistent with engineering principles. The NTSB Report includes improper speculation and draws conclusions that are inconsistent with the evidence in the record. Finally, there is evidence of bias, further suggesting that the investigation was flawed. These mistakes and errors are so fundamental that the NTSB must reconsider and modify the findings, analysis and determination of probable

cause related to this accident. As such, pursuant to 49 CFR §845.32, petitioner respectfully requests that the NTSB reconsiders the facts and evidence in the record, and modifies the findings, analysis and probable cause/contributing factors related to the accident.

A. Proposed Probable Cause: The pilot's failure to maintain directional control of the airplane during landing in crosswind conditions.

B. Proposed Contributing Factor: Contributing to the accident was the pilot's failure to utilize appropriate techniques required for a crosswind landing in a steerable nose-wheel aircraft.

Date: 08/01/2023

Respectfully Submitted on
behalf of Piper Aircraft, Inc.



John Calcagno
President & CEO



Josh Gang, Esq.
General Counsel & Corp. Secretary

ATTACHMENT A



MEMORANDUM

Title :	REVIEW OF NTSB REPORT CEN22LA153	
Project:	SGCE053	
Date:	06/20/2023	
Document Number:	SGCE053-MEMO01	
Revision:	A	
Assembly:	N/A	
Part Number:	N/A	
Material:	N/A	
Engineer:	S. Gudmundsson	
Checked:	S. Gudmundsson	
Pages:	19	
Contact:	Snorri Gudmundsson [REDACTED] Daytona Beach, FL 32124 U.S.A.	Phone: [REDACTED] Email: [REDACTED]

REVISION HISTORY:

Revision	Description	Date
A	Initial release	06/20/2023

INVESTIGATOR CREDENTIALS:

2021-Present	Xwing, Inc. Chief Engineer. Adjunct Professor of Aerospace Engineering, Embry-Riddle Aeronautical University (ERAU)
2010-2021	Associate Professor of Aerospace Engineering, ERAU
2016	Ph.D. in Mechanical Engineering, ERAU
2014 and 2022	Author of textbook "General Aviation Aircraft Design: Applied Methods and Procedures"
2005-2010	Consulting DER appointment from the FAA as a Structural Analyst.
2000-2010	Company and consulting DER appointment from the FAA as a Flight Analyst.
2000-2010	Received company Material Review Board (MRB) appointment from Cirrus Aircraft.
1995-2010	Cirrus Aircraft. Aerodynamics and Structural Analysis expert, one of the designers of the SR20, SR22, and SF50 aircraft. Chief Aerodynamicist from 2005.
1994-1995	Propulsion Engineer with Icelandair.
1994	M.Sc. in Aerospace Engineering, ERAU
1991	B.Sc. in Aerospace Engineering, ERAU

REVIEW OF NTSB REPORT CEN22LA153

Piper PA-46-600T (M600) – N627PR

SUMMARY:

This memorandum reviews NTSB accident report titled "Aviation Investigation Final Report" [1] identified by NTSB Accident Number: CEN22LA153. The review includes associated documents provided on the NTSB docket per the link: <https://data.nts.gov/Docket?ProjectID=104834>.

The report and supporting documents detail the accident investigation involving a Piper PA-46-600TP (M600) aircraft with tail number N627PR. On March 23rd, 2022, the aircraft was subjected to substantial damage during a landing in crosswind at Olive Branch Airport, MS, when it experienced an alleged "uncommanded" hard right turn that caused it to depart the runway.

In a section titled "Probable Cause and Findings," reference [1] concludes as follows:

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The airplane's uncommanded hard right turn and loss of directional control during landing in crosswind conditions. Contributing to the accident were the dynamic instability of the nose landing gear and the crosswind conditions.

After extensive analysis, this report disagrees with this conclusion on the following grounds:

- (1) The term "uncommanded" in the first sentence implies the aircraft did something independent of pilot action. In this context, the term "uncommanded" can be taken to mean: (1) Pilot does A, but airplane does B (example: crossed aileron cables), or (2) pilot does nothing, but airplane does something (example: electrical short-circuiting), or (3) pilot does something, but airplane does nothing (example: disconnected pushrod). In each case, the action (or inaction) of the airplane should leave physical evidence to support it actually took place. Granted, this may be easier said than done in many accidents, but this does not hold here. Besides the damaged NLG, the airplane is largely unscathed. In absence of such evidence an alleged action becomes an unsupported hypothesis. A speculation. The offending term is just that. The only evidence provided is anecdotal per reference [2]¹. It is contradicted by the post-accident examination of the aircraft (pg. 11-12 of reference [1]), which did not expose any anomalies with the aircraft. It states

No anomalies were noted during the dimensional check of the components that would have precluded normal operation.

In light of this conclusion, it is suggested that the term "uncommanded" be removed as it is not supported by physical evidence. A more plausible explanation would be "Contributing to the accident was the pilot's loss of directional control during landing" (pilot did A, airplane did A, but A was an erroneous action).

- (2) The first part of the 2nd sentence² of the conclusion is based on inference rather than direct evidence. Unfortunately, this presentation misleads the reader by inferring a causal mechanism where none may exist. It reads like a textbook example of *false cause fallacy*³: Just because a dynamic instability of a nose landing gear may be factual does not mean it is causal. It is analogous to stating "the engine was

¹ See NARRATIVE HISTORY OF FLIGHT and RECOMMENDATION blocks.

² "Contributing to the accident were the dynamic instability of the nose landing gear..."

³ The false cause fallacy occurs when a presumed real (or perceived) relationship between things leads one to believe that one causes the other. A popular example of this says: "Pointing to a chart, Tim shows how global temperatures have risen over the past few centuries while, simultaneously, the number of pirates has fallen drastically. This shows that pirates keep the world cooler."

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running at the time of the accident, therefore, it contributed to the accident.” This is discussed further below.

Similar Accidents

The frequency of the kind of accident of reference [1] specific to the PA-46 aircraft was investigated. This was accomplished using the NTSB database portal, where selected CAROL searches were made. In particular, terms found in the “Probable cause” section of reference [1] were searched. The search entries used and resulting hits are shown in the screen captures in Appendix B. The search terms were the specific “directional control during landing” and the more general “landing.” A total of 12 NTSB numbers were returned (one outside the search terms), of which 7 were considered relevant⁴. These are listed in Table 1. Only one of the 12 documents uses the term “uncommanded:” the focus of this review, CEN22LA153.

Table 1: Results from a CAROL Search Involving Piper PA-46 Aircraft.

NTSB No	AC	Date	Probable Cause
CEN22LA153	PA-46-600TP	3/23/2022	The airplane's uncommanded hard right turn and loss of directional control during landing in crosswind conditions. Contributing to the accident were the dynamic instability of the nose landing gear and the crosswind conditions.
LAX05LA116	PA-46-500TP	3/15/2005	the loss of directional control during landing for undetermined reasons.
CEN09IA153	PA-46-500T	02/04/2009	The pilot's inability to maintain directional control of the airplane during landing for undetermined reasons.
ATL04LA114	PA-46-350P	3/2/2004	The pilot's inadequate compensation for wind and his failure to maintain directional control during landing roll that resulted in the collapse of the nose gear. The crosswind was a contributing factor.
IAD03LA028	PA-46-350P	1/18/2003	The pilot's loss of directional control during landing, which resulted in an impact with a snowbank, and overstress fracture of the nose gear actuator and engine mount foot attachment. A factor in the accident was the icy runway conditions.
ATL99LA052	PA-46-350P	3/14/1999	The pilot's disregard for current wind conditions and his failure to maintain directional control during landing. Factors were the tailwind and wet runway surface.
ATL95LA154	PA-46 Malibu	8/12/1995	The pilot's failure to maintain control of the aircraft during landing.

Review of Evidence – Tire Marks

The evidence provided is primarily of two types: (1) Photographic, in form of tire marks on the runway, and (2) electronic, based on recordings by the onboard Garmin G3000 Integrated Avionics system (pg. 12 of [1] and pg. 15. of [3]). Photographic evidence allowed accident investigators to determine the sequence of landing gear ground contact through visible tire marks. The sequence of events is illustrated in Figure 1 (indicated airspeed) and Figure 2 (ground speed). It shows where landing gear speed sensors were triggered, and where and when tire marks became visible.

⁴ The author acknowledges there may exist a combination of search terms that would result in more hits, just does not know which.

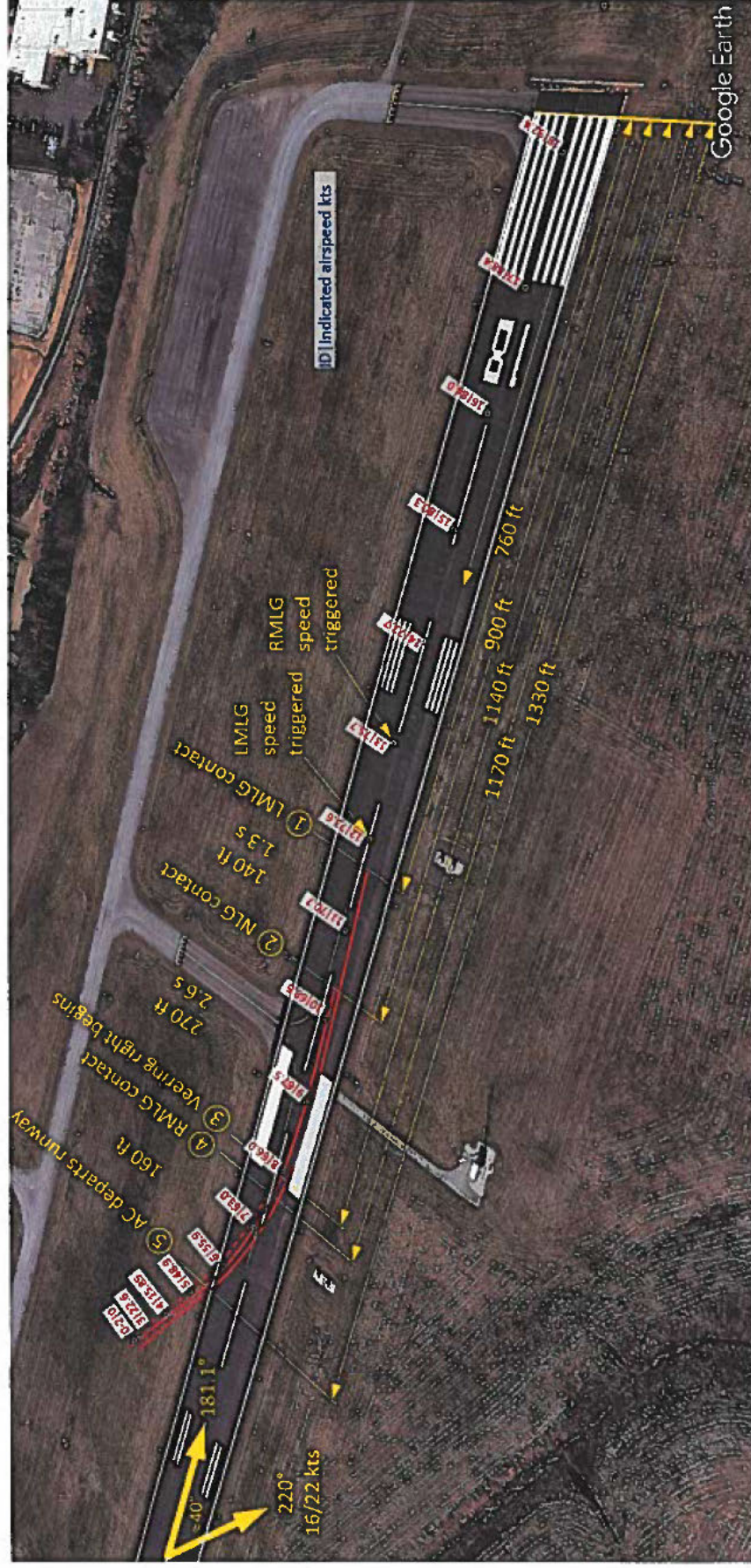


Figure 1: A "Google Earth" screen capture showing event-markers based on the photographic and electronic evidence superimposed on the accident scene. The labels along the position markers show the Indicated airspeed in knots. Each is spaced 1-second apart. Timestep (or ID) 18 means 18-sec before airplane came to complete stop, and so forth.

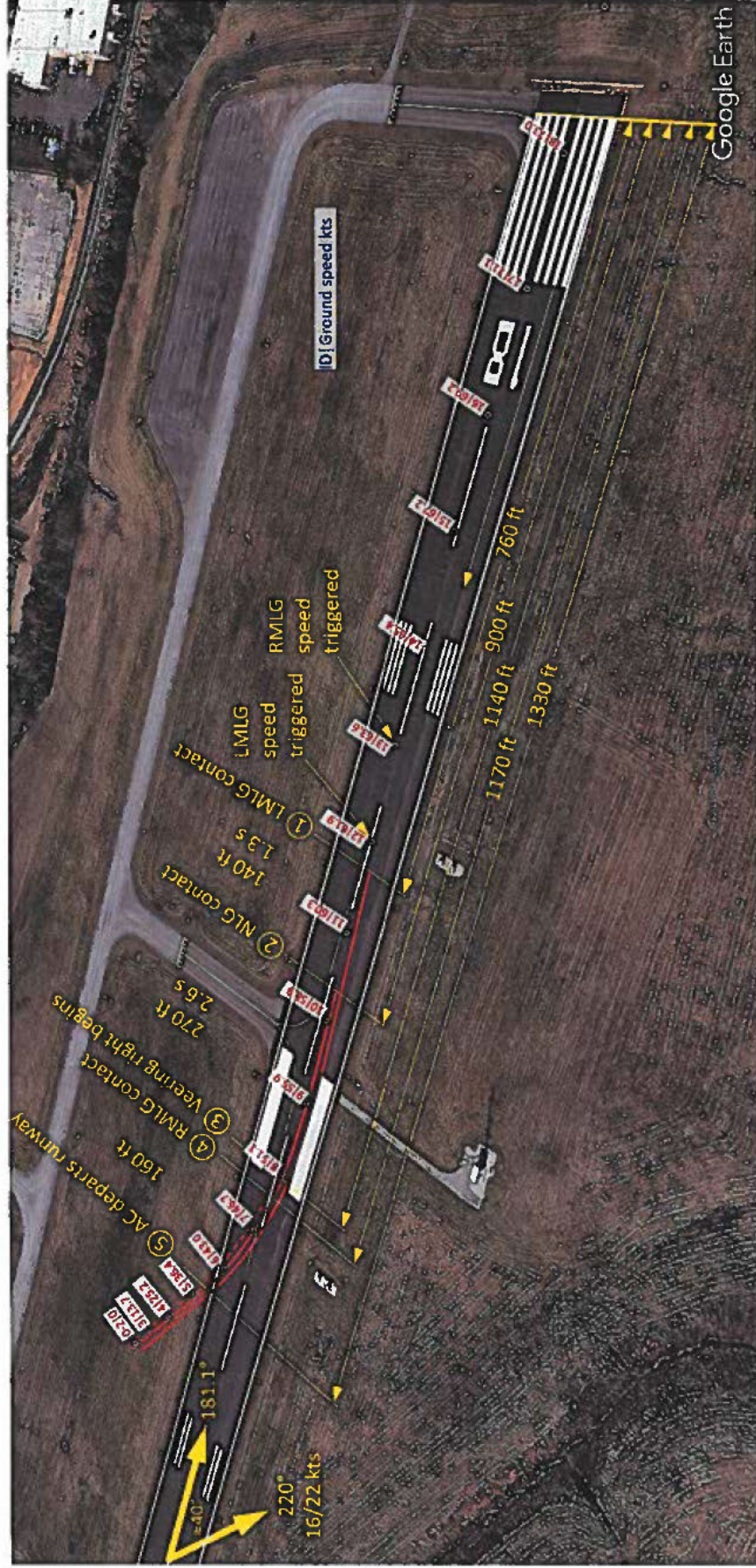


Figure 2: A "Google Earth" screen capture showing event-markers based on the photographic and electronic evidence superimposed on the accident scene. The labels along the position markers show the ground speed in knots. Each is spaced 1-second apart. Timstep (or ID) 18 means 18-sec before airplane came to a complete stop, and so forth.

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Phone :	Email :	

Tire marks form due to the abrasion of a tire during braking, skidding, or due to spin-up acceleration of the tire. They may even form during normal rolling when a high vertical force is reacted. They have forensic evidentiary potential. Here, they provide insight into how things developed during the accident and indicate when a specific tire had a firm enough ground contact for abrasion to take place. The red lines in Figure 1 and Figure 2 indicate where each tire left marks, either due to rolling, skidding, braking, or a combination of the three. Note that speed markers (in knots) have also been superimposed in the figures. These were extracted from the G3000 system per reference [4]. The events shown in Figure 1 and Figure 2 are detailed in Table 2.

Table 2: Event Listing (view with Figure 1 and Figure 2).

Timestep sec	Event Marker	Indicated /ground speed, knots	Distance to threshold, ft	Event Description
14		77.7/65.4		Flare in progress.
13		75.7/63.6		RMLG speed sensor is triggered. Right-wing slightly high. 3.5° difference between HDG and TRK.
12		73.6/61.9		LMLG speed sensor is triggered. Right-wing high. 0° difference between HDG and TRK.
	①		760 ft	LMLG begins abrading, producing tire marks.
11		70.7/60.3		LMLG abrading continues. Wings close to level. -0.9° difference between HDG and TRK.
	②		900 ft	NLG begins abrading. Here, LMLG+NLG are producing tire marks. Any impact load that would have produced dynamic instability of the NLG, would have started here, or even earlier. However, its duration would be less than 1 sec.
10		68.6/58.9		LMLG+NLG are producing tire marks. Right-wing slightly high. 14.2° difference between HDG and TRK.
9		67.5/55.9		LMLG+NLG are producing tire marks. Right-wing slightly high. 27.1° difference between HDG and TRK.
8		66.0/51.1		LMLG+NLG are producing tire marks. Right-wing slightly high. 28.3° difference between HDG and TRK. Note that airspeed has dropped 2.6 KIAS since time stamp 10.
	③		1140 ft	LMLG+NLG are producing tire marks. Veering right begins.
	④		1170 ft	RMLG begins abrading, producing intermittent tire marks. Starting here LMLG+NLG+RMLG are producing the tire marks.
7		63.0/46.7		LMLG+NLG+RMLG are producing the tire marks. 11.6° difference between HDG and TRK.
6		55.9/43.0		LMLG+NLG+RMLG are producing the tire marks. Last position recorded on the runway. -7.8° difference between HDG and TRK.
	⑤		1330 ft	Airplane departs the runway.
5		48.9/36.4		First position recorded off the runway. -12.2° difference between HDG and TRK.
4		15.9/25.2		Second position recorded off the runway. Airspeed reading may be tainted by uneven terrain.
3		22.6/13.7		Second position recorded off the runway. Airspeed reading may be tainted by uneven terrain.
0-2		0/0		GPS coordinates hold still – airplane becomes to rest. 28.7° difference between HDG and TRK.

Selected data collected by the G3000 in the final 50 seconds before the airplane came to rest was plotted (see Figure 3, Figure 4, and Figure 5). Figure 3 shows a time history of the roll and pitch angles of the aircraft, the final 50 seconds before it came to rest. It also co-plots the time history of the barometric altitude to help the reader further putting things in context. The barometric altitude uses the left vertical scale. The roll and pitch angle curves use the right vertical scale. Also, they feature circular markers; each is separated by 1 second and represents a specific timestep. Among other things, the graph shows flare taking place

just before touchdown of the main landing gear. It shows the airplane being about 3° right-wing high some 3-seconds before the RMLG touches down, and remaining so (albeit diminishing) until veering right begins. It also shows where the NLG may have collapsed and the final fuselage pitch-down angle of -15°.

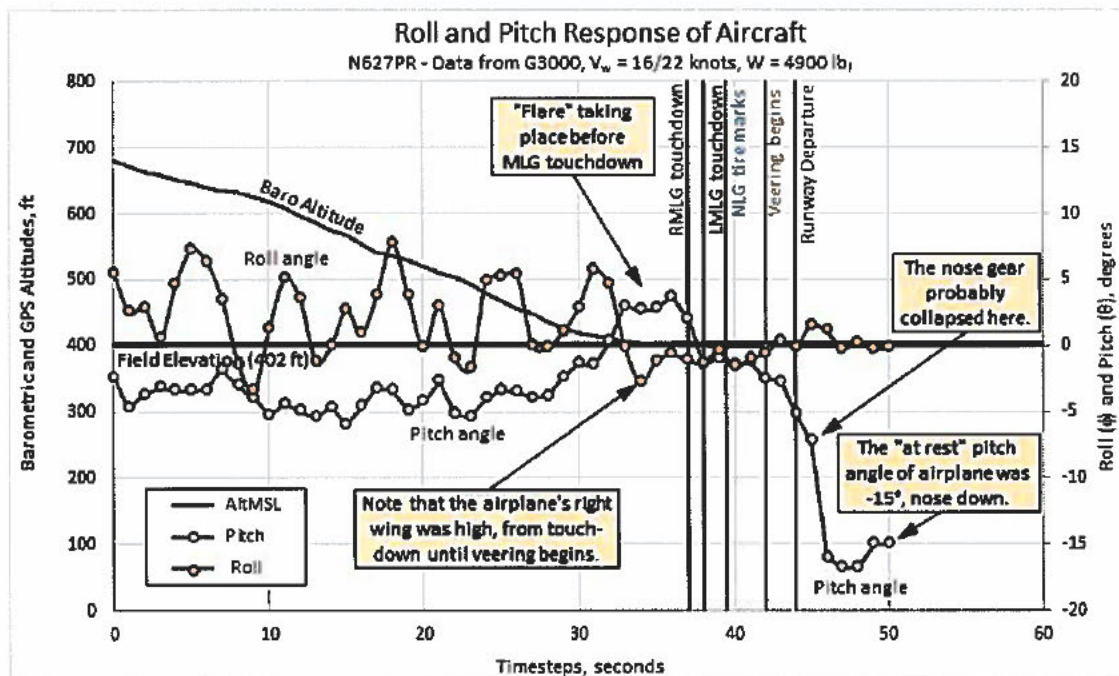


Figure 3: A 50-sec time history of accident per G3000. The altitude curve uses the left vertical scale, and the roll and pitch angles use the right vertical scale.

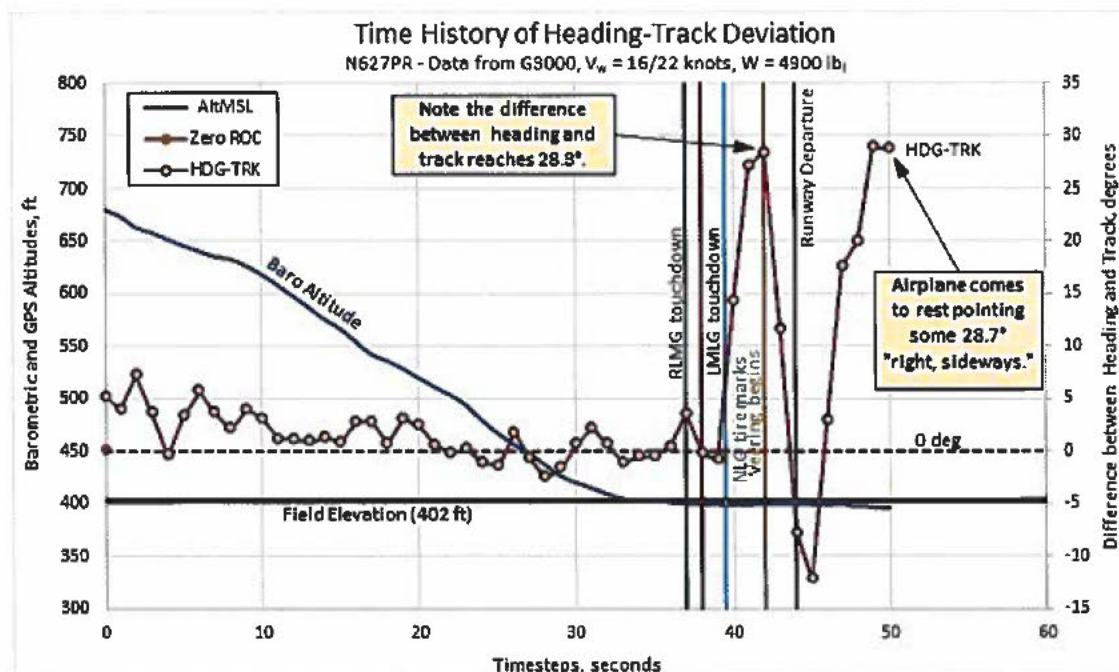


Figure 4: A 50-sec time history of accident per G3000. The altitude curve uses the left vertical scale, and the HDG-TRK curve (in degrees) uses the right vertical scale.

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Figure 4 reveals a time history of the *heading* (HDG: direction in which the nose points) and *ground track* (TRK: direction in which the CG moves). Ideally, these should be one and the same. By plotting the difference between the two, a large deviation is visible during the accident. At the time when veering right begins its magnitude reaches 28.3°. This shows an airplane responding to the combination of challenging crosswind conditions and improper control inputs. This is so because the demonstrated crosswind limit for the aircraft is 17 knots [8], but max crosswind component on scene was 14 knots.

Figure 5 shows a time history of the indicated airspeed (in KIAS) and ground speed (in KTAS, knots true airspeed⁵). The graph shows the airplane approaching at indicated airspeed greater than 97 KIAS, up until some 20 seconds before the airplane came to rest. The airspeed labelled " V_{so} " (see the bottom horizontal red line) represents the *stalling speed* of the airplane in the landing configuration. This has the landing gear extended and flaps deflected 41°.

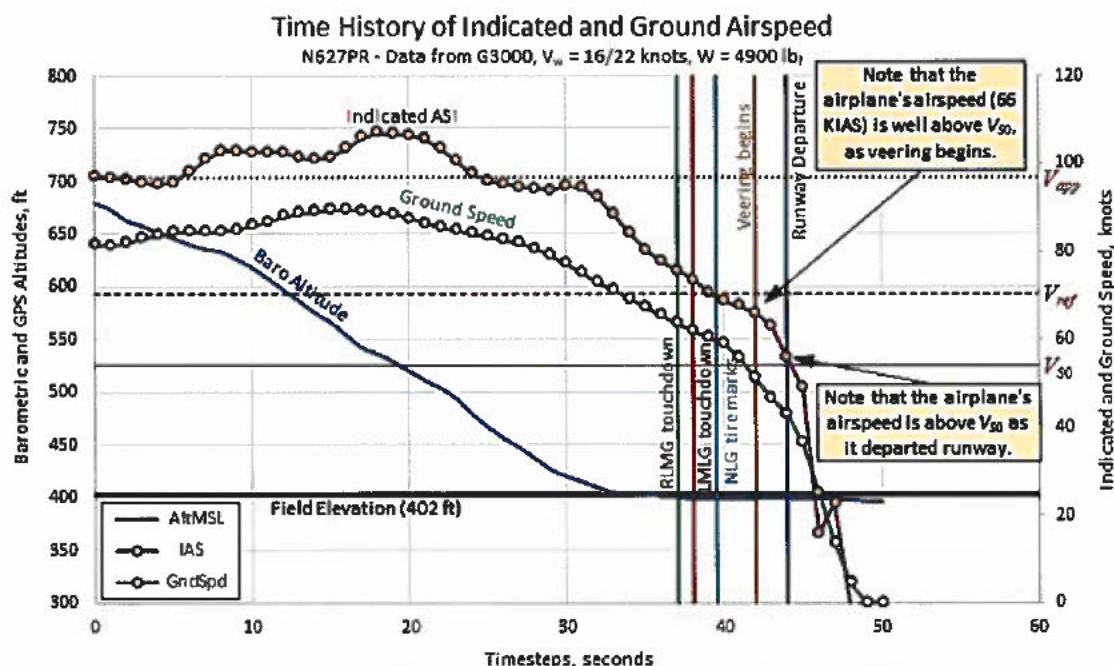


Figure 5: A 50-sec time history of accident per G3000. The altitude curve uses the left vertical scale, and the airspeeds use the right vertical scale.

The aircraft's Pilot's Operating Handbook (POH) states the stalling speed in the landing configuration (V_{so}) is 60 KCAS at the airplane's maximum gross weight of 6000 lb_f. However, "Aircraft Information" of reference [2] states the weight of the airplane at the time of the accident was approximately 4900 lb_f. This means that the value of V_{so} reduces to about 54 KCAS (see calculations elsewhere in this memorandum). This, in turn, means that the airspeed labelled " V_{ref} " (reference speed) in Figure 5, is $1.3V_{so}$ or about 71 KCAS. This value represents an airspeed the pilot should maintain during approach to landing – in low wind conditions. Pilots normally increase this airspeed further when the windspeed is strong or gusty. Depending on the operator, the increase specific to the prevailing wind conditions at the time of the accident could range between 6 to 26 knots (see calculations later). This increase of V_{ref} is referred to as V_{app} (approach speed). It appears from the pilot's statement of "Narrative History of Flight" of reference [2] that the pilot may have selected to increase airspeed closer to the 26-knot value. If accurate, it may have impacted events as the airplane

⁵ Ground speed is a type of airspeed called *true airspeed*. It is specified using units of KTAS (knots, true airspeed). This is so because, in aircraft navigation theory, the speed of the aircraft along the ground (*ground speed*) is the difference between the true airspeed vector and wind velocity vector (also a true airspeed). Thus, unit consistency requires the ground speed to be a true airspeed as well. At low airspeed and altitude, as prevailing at the time of this accident, the resulting differences this introduces can be neglected as it amounts to ± 0.5 knots, or so, at best.

would have been at higher speed at time of touchdown than otherwise. Therefore, the kinetic and rotational energy would have been higher than otherwise and, thus, made it harder to suppress the skidding once it began.

Review of Evidence – Dynamic Instability

The final report, reference [1], brings up the term *instability* on page 2 to describe how landing gear impact loads (spin-up and inertial) can cause *damped oscillation*. It states:

On NLG touchdown, the NLG strut will deflect aft due to spin-up loads, increasing the negative rake that could cause instability, and will undergo a damped oscillation. – pg. 2, parag 2

It brings up this term again in the last paragraph on pg. 7, where it states:

Examination of the structural response of a landing gear at wheel touchdown showed that the gear will deflect aft initially due to wheel spin-up loads and then undergo a damped oscillation about its equilibrium point. – pg. 7, parag 4

The presence of *dynamic trail* must be noted. It stabilizes the NLG by shifting the tire's center of ground-contact slightly aft due to tire deformation [5, 6]. That said, the above statement is general and applies to all landing gear. In fact, it applies to all structures: All structures undergo damped oscillation upon being subject to time dependent forces. This may lead some to think this principle of nature applies to the landing gear only and, thus, makes it seem causally important.

The term *dynamic instability* is mentioned three times in the same document, all on pg. 2. This is done to describe the possibility of damped oscillation contributing to the accident. However, even if dynamic instability was evident during the accident, references [1] and [3] present no evidence to support it was causal. For instance, reference [1] states:

The NLG transfer mark began about 900 ft from the threshold and about 10 ft left of the centerline, with light intensity and its tread pattern evident, consistent with a rolling, non-skidding tire. The rolling tire marking continued until the right veering began, at which point it was of moderate intensity with tread pattern evident and transitioned to heavy intensity and no tread pattern, consistent with a skidding tire. – pg. 1, parag. 2

No conclusive evidence of dynamic instability here either. The visible tread pattern transitioning to heavy intensity without tread pattern is evidence of skidding, not dynamic instability. Then, on page 10, parag. 1, reference [1] states:

A light rubber transfer mark with the tread pattern evident, consistent with the NLG, began about 900 ft from the threshold and about 10 ft left of the centerline. The mark was mostly continuous until it departed the right side of the runway and varied in intensity. – pg. 10, parag. 1

Again, no conclusive evidence of signs of dynamic instability is mentioned. If the dynamic instability of the NLG is significant enough to cause the airplane to veer off course, this should be reflected in the tire marks. There should be evidence of sudden change in the direction of the tire's center line, ideally accompanied by lateral or vertical oscillation. After all, the instability is *dynamic*. As a consequence of the spin-up loading, the resulting tire marks should have appeared close to event marker ②. Per reference [1], the NLG of the accident aircraft began showing continuous tire marks at event marker ②. At that point its ground speed was close to 60 knots. The veering right began at event marker ③, some 270 ft and 2.6 sec later, with continuous tire marks. Evidence of skidding occurs between event markers ④ and ⑤.

Examples of tire marks showing sudden directional changes are shown in Figure 6 and Figure 7. For the NLG's dynamic instability to be significant enough to change the aircraft's direction requires: (1) the NLG must be in ground contact. (2) The tire marks must show sudden directional change preceding any

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significant heading change. No such evidence is visible in the photographs presented in reference [1]. Therefore, the claim that dynamic instability contributed to the accident is not supported.

Figure 7 shows signs of vertical oscillation (bouncing) of an aircraft after landing. The asymmetric contact pattern indicates it landed slightly skidded, perhaps due to crosswind. Per paragraph 2.4.5 of reference [7], the length of the centerline stripe should be 120 ft. The instability is seen to last between 90 to 120 ft. In aircraft, the damped oscillation is usually highly transient, lasting less than a second. If it is not, it is called *shimmy*. Shimmy is not alleged in reference [1] and, thus, beyond the scope of this report. The main point is that reference [1] does not state how the tire marks confirm dynamic instability.



Figure 6: Examples of tire marks showing rapid lateral change of the tire direction (close to bottom of photo). (NOT the accident scene.)



Figure 7: Example of tire marks showing rapid vertical oscillation of a tire (just left of runway centerline). (NOT the accident scene.)

Relevant Calculations

This section presents a few calculations pertinent to the discussion here. A listing of all calculations conducted are presented in Appendix C. The initial focus is the impact of the airplane's reduced weight at the time of landing. The pilot states in his "Narrative History of Flight" of reference [2]:

I was about 95 knots entering the approach end of the run way [sic]. Power was reduced and I was about 85 knots I flared and touched down about 300 feet passed th [sic] threshold...

Inspection of the electronic data shows that this is close to position marker "18" in Figure 1 and Figure 2. Per the G3000 data, the indicated airspeed at that point is 92.4 KIAS (the groundspeed is 73.0 KGS). This supports the pilot's narration. Corrected per reference [8], this airspeed corresponds to 90.4 KCAS.

"Aircraft Information" of reference [2] states the weight of the airplane at the time of the accident was approximately 4900 lb_r. Using information from the airplane's POH [8], the stalling speed (V_{S0}) of the aircraft in the landing configuration at its 6000 lb_r maximum takeoff weight is 60 KCAS (62 KIAS⁶). With its wing area (S) of 209 ft² and standard day air density at sea-level of 0.002378 slugs/ft³, this can be used to extract the airplane's maximum lift coefficient, C_{Lmax0} , in the landing configuration:

$$C_{Lmax0} = \frac{2W}{\rho V_{S0}^2 S} = \frac{2(6000)}{(0.002378)(60 \times 1.688)^2 (209)} = 2.354$$

This, in turn, can be used to estimate the stalling speed of the aircraft at 4900 lb_r weight, yielding:

$$V_{S0} = \sqrt{\frac{2W}{\rho S C_{Lmax0}}} = \frac{1}{1.688} \sqrt{\frac{2(4900)}{(0.002378)(209)(2.354)}} = 54.2 \text{ KCAS}$$

Call it 54 KCAS. Note the factor 1/1.688 is used to convert the result under the radical from ft/s to KCAS. This allows us to estimate $V_{ref} = 1.3 V_{S0} = 70.5$ KCAS (call it 71 KCAS). A common wind correction holds that one adds half of the headwind component to V_{ref} to form what pilots call *approach speed*, V_{app} (e.g. see reference [9]). Using the reported 16 knot windspeed ($=V_w$) at 220° ($=\theta_w$) (runway is 181.1°, but let's call it 180°). The headwind component is given by $V_w \cos(\Delta\theta)$, or

$$V_{wx} = V_w \cos(\Delta\theta) = (16) \cos(220^\circ - 180^\circ) = 12.3 \text{ knots}$$

Using 12 knots, the resulting headwind correction leads to: $V_{app} = V_{ref} + \frac{1}{2} V_{wx} = 71 + 6 = 77$ KCAS. Some operators increase this further and add the full gust speed (up to 20 knots max). In that case, the approach speed becomes 97 KCAS. This supports that the being "...about 95 knots entering the approach end..." may be reasonable per the "Narrative History of Flight" of reference [2]. However, it is a rule-of-thumb and not a regulatory requirement. Here, it results in a "safety factor" of $97/54 \approx 1.8$ or 80% above V_{S0} . It may lead to the airplane coming in "hot," requiring extra distance for slowing down. For some aircraft it may lead to Pilot Induced Oscillation (PIO)⁷.

Another consideration of crosswind is the angle-of-yaw that develops on the vertical tail due to the crabbed angle of the airplane. While the pilot cancels it using rudder deflection, it can be used to give insight into the aircraft response if the rudder deflection is neutralized. Using information in the POH, assuming neutral rudder deflection and condition at timestep 11 in Table 2, the side force of the vertical tail amounts to 117 lb_r, and yawing moment is about 1698 ft·lb_r. The potential yaw-acceleration of 13°/s² is not expected to pose a control challenge.

⁶ Note that the correction is $V_{cas} = V_{ias} - 2$, or -2 knots for 60-70 KIAS, -2.5 knots for 70-80 KIAS, and -3 knots for 80-100 KIAS, per Figure 5-5 (Sheet 2 of 2) in POH.

⁷ It is not alleged this happened here.

Conclusion

Figure 1 and Figure 2 tell a different story than reference [1]. The tire marks indicate that, between event-markers ① and ②, only the LMLG had a firm enough ground contact for tire abrasion to occur. It indicates the right-wing was slightly high (banked left 1-2°), with the airplane drifting left, likely due to the right crosswind component of 10-14 knots⁸. This is supported by the readout from the G3000 as shown in Figure 3. At event-marker ②, the NLG begins abrading. It is here that one would expect evidence of dynamic instability. But reference [1] reports none. Instead, the NLG produces continuous tire marks, void of expected tell-tale signs of dynamic instability. Between event-markers ② and ③, the LMLG+NLG both have ground contact, abrading the tires, with the airplane remaining slightly right-wing high. This space is separated by 270 ft and 2.6 seconds. Again, there is no evidence of dynamic instability of the NLG in this segment of events. Instead, it produces continuous tire marks until the last. Veering right begins at event-marker ③. At this point, the airplane's airspeed is 66 KIAS (51.1 KGS - see Figure 5). Then, at event-marker ④, the RMLG eventually achieves intermittent ground contact that results in its abrasion. However, the aircraft is now rapidly changing its heading and track. It is skidding. At ⑤, the airplane departs the runway at airspeed just above its stalling speed (V_{SO}) at the reported landing weight. In the view of this author, the accident appears to be an incipient ground loop, perhaps preceded by partial incipient wheelbarrowing⁹ [10], as described on pages pg. 8-33 and pg. 8-34 of reference [11].

Respectfully,

Snorri Gudmundsson, Ph.D.
Consulting Engineer

ABBREVIATIONS:

ASI	AirSpeed Indicator
CAROL	Case Analysis and Reporting Online (NTSB Search Engine)
CG	Center of Gravity
HDG	Aircraft heading (the direction the nose points in)
KCAS	Knots, Calibrated AirSpeed
KGS	Knots, Ground Speed
KIAS	Knots, Indicated AirSpeed
KTAS	Knots, True AirSpeed
LMLG	Left Main Landing Gear
MLG	Main Landing Gear
NLG	Nose Landing Gear
NTSB	National Transportation Safety Board
PIO	Pilot Induced Oscillation
POH	Pilot's Operating Handbook
RMLG	Right Main Landing Gear
T-O	Take-Off
TRK	Aircraft track (the direction of the aircraft's motion)
VT	Vertical Tail

⁸ Reported gust was 22 knots at 220°. With runway at 181.1°, this results in a 14-knot crosswind component.

⁹ Wheelbarrowing is the reduced vertical force on the main landing gear struts when pilot pushes elevator down during landing. On tricycle landing gear aircraft, it off-loads the main gear and loads up the nose gear. Excessive wheelbarrowing may result in the airplane rolling on the nose gear, making it highly susceptible to side-rotation (ground-looping) in crosswind. See example in reference [10].

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APPENDIX A: Airport Diagram

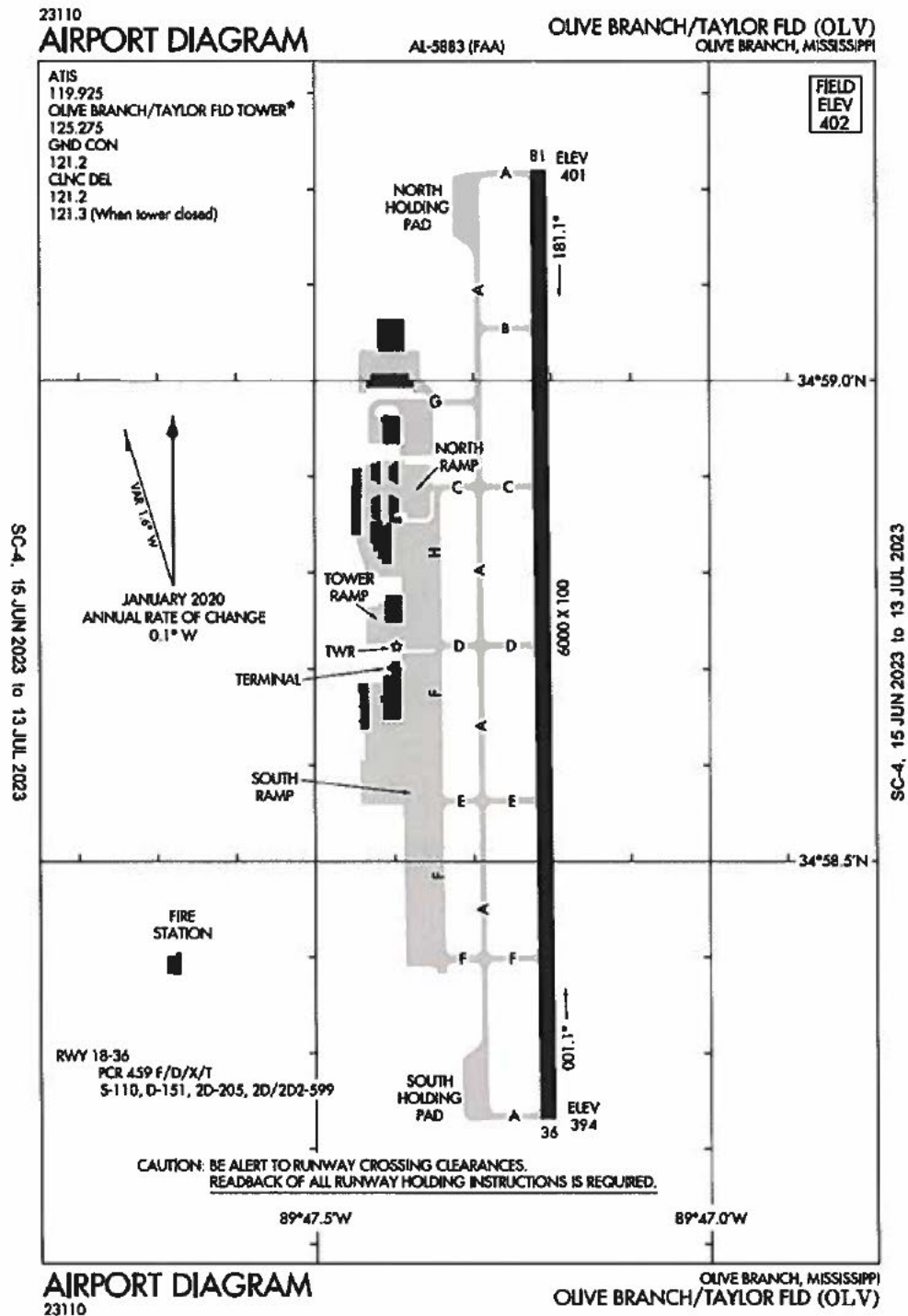


Figure A.1. Airport Information (Reference [12])

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APPENDIX B: Search for Similar Accidents on NTSB CAROL

SGudmundsson Consulting Engineering

NTSB Home CAROL Query

Search for: ☒ Investigations ☐ Recommendations

Find results that match ALL ☒ of the following rules:

Field	Condition	Query value
Investigation mode	Is	Aviation
Probable cause	contains	directional control during landing
Aircraft make	contains	Piper
Aircraft model	contains	PA-46

Buttons:

Buttons:

Buttons:

Buttons:

Buttons:

Search Results: 6

NTSB#	PUBLIC DOCKET	EVENT DATE	LOCATION	REPORT	ORIGINAL PUBLISHED DATE	EVENT TYPE	HIGHEST BLURRY	AIRCRAFT DETAILS	STATUS	HAS SAFETY REC
CEN22LA133	Docket	03/23/2002	Olive Branch, Mississippi	Final	03/23/2003	Accident	None	N627PR Piper Aircraft BAC / PA-46-600TP	Completed	☒
CEN22LA060	Docket	12/01/2001	Cassville, Missouri	Final	04/09/2002	Accident	None	N444BT Piper / PA-46-510P	Completed	☒
LAX03LA114		03/15/2005	Flagstaff, Arizona	Final	08/29/2006	Accident	None	N304SR Piper / PA-46-500TP	Completed	☒
ATL04LA114		03/02/2004	Montgomery, Alabama	Final	02/24/2005	Accident	Minor	N61734 Piper / PA-46-350P	Completed	☒
LA803LAC28	Docket	01/18/2003	Liscomb, New Hampshire	Final	03/02/2004	Accident	None	N917BC Piper / PA-46-350P	Completed	☒
ATL99LA052		03/14/1999	LAURENS, South Carolina	Final	04/25/2001	Accident	None	N343RP Piper / PA-46-350P	Completed	☒

Show 30 results per page 1

Buttons:

Figure B.1. CAROL search for “directional control during landing.”

SEARCH RESULTS

Find results that match ALL of the following rules:

Field	Condition	Value	Action
Investigation mode	is	Autodon	Delete Rule / Add Rule
Probable cause	contains	landing	Delete Rule / Add Rule
Aircraft make	contains	Piper	Delete Rule / Add Rule
Aircraft model	is	PA-46	Delete Rule / Add Rule

Search Results: 5

NTSB#	PUBLIC DOCKET	EVENT DATE	LOCATION	REPORT	ORIGINAL PUBLISHED DATE	EVENT TYPE	HIGHEST INJURY	AIRCRAFT DETAILS	STATUS	HAS SAFETY REC
✚ WPR12CA310	Docket	07/17/2012	Delano, California	✚ Email	11/26/2012	Accident	None	M358PW Piper / PA-46	Completed	✕
✚ C4407LA080		12/19/1996	RED OAK, Iowa	✚ Email	05/23/1997	Accident	None	M446SD Piper / PA-46	Completed	✕
✚ AT19SLA134		08/12/1995	DAYTON, Tennessee	✚ Email	01/10/1996	Accident	Minor	M620DS Piper / PA-46	Completed	✕
✚ NYCB4A039		12/15/1993	WILKES-BARRE, Pennsylvania	✚ Email	10/29/1994	Accident	None	M920P Piper / PA-46	Completed	✕
✚ LAX88FA060		11/29/1987	LONG BEACH, California	✚ Email	11/02/1989	Accident	Fatal	M436PW Piper / PA-46	Completed	✕

Show 50 results per page

Download Data (JSON) Download Summary (CSV)

Figure B.2. CAROL search for "landing."

APPENDIX C: Pertinent Calculations

```

*****
'
'          BACK-OF-ENVELOPE CALCULATIONS
'
'REPORT:          SGCE053-MEMO01DOCX
'DATE:           06/27/2023
'AIRCRAFT:       piper PA=46-600TP (M600)
*****

'=====
'1. ASI CALIBRATION (based on POH, Figure 5-5 (Sheet 2 of 2))
'=====
'For IAS to CAS conversion use data from Figure 5-5 (Sheet 2 of 2)
KIAS1:=60
KCAS1:=58

KIAS2:=70
KCAS2:=68

'Stalling speed at 6000 lbf in landing configuration per Figure 5-6
Vs0_ias:=62

'Convert Vias to Vcas
CALC_YOFX[KIAS1,KCAS1,KIAS2,KCAS2,Vs0_ias]=60

'=====
'2. AIRCRAFT DATA
'=====
Wo:=6000          'lbf - Gross weight
w:=28.71          'lbf/ft² - Wing loading

'Extract wing area (since it doesn't appear in POH)
S:=Wo/w=209.0 ft²

'=====
'3. MAXIMUM LIFT COEFFICIENT
'=====
'Atmospherics
rho0:=0.002378    'slugs/ft³ - Density at S-L

'Clean configuration (gear+flaps retracted)
Vs:=71            'KCAS (73 KIAS per POH)
CLmax:=2*Wo/(rho0*(1.688*Vs)^2*S)=1.681

'Landing configuration (gear+flaps 35°)
Vs0:=60           'KCAS (62 KIAS per POH)
CLmax0:=2*Wo/(rho0*(1.688*Vs0)^2*S)=2.354

'=====
'4. AT CONDITION PARAMETERS
'=====
W:=4900           'lbf - Data per NTSB Incident report
W/S=23.4 lbf/ft²
Vw:=16
Vgust:=22
deltaGust:=Vgust-Vw=6

'Flap setting during incident was 41°, per pilot.

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'Stalling speed in the landing configuration
Vs0a:=sqr(2*W/(rho*S*CLmax0))/1.688=54.2 KCAS

'Calculate Vref, Vapp, wind components (sustained and max)
Vref:=1.3*Vs0a=70.5 KCAS
Vapp:=Vref+0.5*Vw+Vgust=100.5 KCAS
Vwx:=Vw*dcos(220-180)=12.3 KTAS
Vwy:=Vw*dsin(220-180)=10.3 KTAS
Vwx_max:=Vgust*dcos(220-181.1)=17.1 KTAS
Vwy_max:=Vgust*dsin(220-181.1)=13.8 KTAS

'=====
'5. SIDE-FORCE AND YAW ACCELERATION
'=====
'Olive Branch airport elevation above MSL in ft
Href:=402 'ft

'Outside air temperature from G3000 in degrees C
OAT_C:=8 '°C

'Convert to degrees Rankine
OAT:=1.8*(273.15+OAT_C)=506.1 °R

'Standard day temperature at Href is
atmostemp(Href)=517.2 °R

'NOTE 1: Actual temperature (506.1 °R) is LOWER than standard
'         temperature (517.2 °R) at Href. Therefore, air is
'         DENSER than otherwise.
'

'Pressure (baro setting was 29.72, versus 29.92 inHg standard)
'Convert absolute pressure to lbf/ft² at airport
p:=29.72*2116/29.92=2102 psf

'For comparison, standard day pressure at Href in inHg
29.92/2116*atmospress(Href)=29.49 inHg

'NOTE 2: Actual pressure at Href (29.72 inHg) is HIGHER than
'         standard day pressure (29.49). Therefore, air is
'         DENSER than otherwise.
'

'Air density at time of accident per ideal gas law
rho:=p/(1716*OAT)=0.002420

'Density ratio
sigma:=rho/0.002378=1.0178

'NOTE 3: Actual density at Href is HIGHER than standard day
'         density at sea-level. This means, density altitude
'         is BELOW sea-level. (Common reality in winter time.)
'

'Density altitude
Hr:=145442*(1-sigma^0.234957)=-604 ft

'-----
'Example airspeed to check
'-----
'Just before NLG begins abrading, airspeed is 70.7 KIAS (timestep 11)
Vias:=70.7 'This includes the effect of Vwx

'Vcas=Vias-3 knots per POH
Vcas:=Vias-3=67.7
```

```
'Convert Vcas directly to Vtas (skip Veas step because M is low)
Vtas:=Vcas/sqr(sigma)=67.1 KTAS

'Mach number
M:=1.688*Vtas/atmosspeed(Href)=0.1016

'Components of Vtas, considering presence of crosswind
Vtasx:=Vtas=67.1 KTAS
Vtasy:=Vwy=10.3 KTAS

'Effective yaw angle "seen" by VT
beta_vt:=atan(Vtasy/Vtasx)=8.7°

'Vertical tail geometry scaled using 3-view in POH
Crvt:=5.52      'ft - VT root chord
Ctvt:=2.65      'ft - VT tip chord
bvt:=6.08       'ft - VT span
Glevt:=42.3     'deg - VT LE sweepback
Gc2vt:=34       'deg - VT midchord sweepback

'Wing area
Svt:=0.5*(Crvt+Ctvt)*bvt=24.84 ft²

'Wing Aspect Ratio
ARvt:=bvt²/Svt=1.488

'Prandtl-Glauert compressibility parameter
beta:=sqr(1-M²)=0.9948

'Ratio of 2-dimensional airfoil lift curve slope to 2*pi
kappa:=1        'Symmetrical NACA airfoil

'Lift curve slope for VT
CLvt:=2*pi*ARvt/(2+sqr((ARvt*beta/kappa)²*(1+(dtan(Gc2vt))²/beta²)+4))
CLvt=1.997

'Lift coefficient generated by VT
CLvt:=beta_vt*CLvt*(pi/180)=0.3037

'Lift force generated by VT
Lvt:=0.5*rho*(1.688*Vtas)²*Svt*CLvt=117 lbf

'Yawing moment generated by Lvt about MGC quarterchord
lvt:=14.5        'ft - tail arm from VT Cmgc/4 to wing MGC Cmgc/4 (approximate)
Mz:=Lvt*lvt=1698 ft·lbf

'*****
'INPUT VALUES
'*****
'Geometry
b:=43.16          'Wingspan in ft
d:=29.7           'Overall length in ft
e:=(b+d)/2=36.43

'Inertia related parameters
g:=32.174         'Acceleration due to gravity in ft/s²
m:=W/g=152.3 slugs 'Mass in slugs

'COMMENT:
'Roskam's method, while convenient, is only intended for early
'conceptual design. Here, if the radii of gyration are based
'on the C-210, since data for the PA-46 does not exist.
Rx:=0.222
```

Ry:=0.356
Rz:=0.379

```
*****
'OUTPUT VALUES IN UK-SYSTEM
*****
'Moments of inertia per Roskam's method
Ixx:=m*(Rx*b/2)^2=3495 slugs*ft^2
Iyy:=m*(Ry*d/2)^2=4256 slugs*ft^2
Izz:=m*(Rz*e/2)^2=7258 slugs*ft^2

'Yaw acceleration for the PA-46
Psi_dotdot:=Mz/Izz=0.233 rad/s^2

'In degrees per second-squared, this becomes:
Psi_dotdot*180/pi=13.4 deg/s^2
```

References

- [1] Anonymous, *Aviation Investigation Final Report*, Accident Number CEN22LA153, NTSB, 2022.
- [2] Anonymous, *NTSB Pilot/Operator Aircraft Accident/Incident Report*, 6120_Redacted-Rel.pdf, 03/23/2022.
- [3] Anonymous, *Airworthiness – Group Chair's Factual Report*, Accident Number CEN22LA153, NTSB, 2022.
- [4] Anonymous, *log_220323_074801_KCRG-Rel.csv*, System generated CSV file, 3/23/2022.
- [5] Pazmany, L., *Landing Gear Design for Light Aircraft – Volume I*, Pazmany Aircraft Company, 1986.
- [6] Currey, N.S., *Aircraft Landing Gear Design: Principles and Practices*, AIAA Education Series, 1988.
- [7] Anonymous, *Standards for Airport Markings*, AC 150/5340-1M, FAA, 2019.
- [8] Anonymous, *M600, PA-46-600TP, Pilot's Operating Handbook*, Piper Aircraft, Inc., July 3., 2018.
- [9] Anonymous, *FSF ALAR Briefin Note 8.2 – The Final Approach Speed*, Flight Safety Foundation. Online reference: https://flightsafety.org/files/alar_bn8-2-apprspeed.pdf. Accessed 06/30/2023.
- [10] Chapman Flying, *Wheelbarrowing - Bad Landings Ep1*, Online reference (YouTube): <https://www.youtube.com/watch?v=QOVduBGPqtw>. Accessed 06/20/2023.
- [11] Anonymous, *Airplane Flying Handbook*, FAA-8083-3B, FAA, 2016.
- [12] Online reference: <https://aeronav.faa.gov/d-tpp/2306/05883AD.PDF>. Accessed 06/22/2023.

ATTACHMENT B

Snorri GUDMUNDSSON, Ph.D., BSAE, MSAE, FAA DER (ret.)

Current Address:

Daytona Beach, FL 32124
USA

Phone:**E-mail:****Current position:**

Chief Engineer, Advanced Aircraft Design, Xwing Inc.

Adjunct Professor of Aerospace Engineering at Embry-Riddle Aeronautical University, Daytona Beach, FL.

Career Objectives:

Design, research, and development of aircraft for both industry and academia.

EDUCATION

Ph.D. in Mechanical Engineering – 2016

Embry-Riddle Aeronautical University (ERAU)

Master of Science in Aerospace Engineering – 1994

Embry-Riddle Aeronautical University (ERAU)

Bachelor of Science in Aerospace Engineering – 1991

Embry-Riddle Aeronautical University (ERAU)

Additional Education and Appointments

2009 – Cirrus Experimental Flight Test monitor.

2006 – TetrUSS Training Seminar, Vigyan Inc, Newport News, VA.

2005 – Appointed FAA DER as Structural Analyst (consulting), focus on composite structures.

2004 – Principles of Aeroelasticity University of Kansas, Hampton VA.

2002 – Pro/ENGINEER Wildfire Software Training, Duluth, MN.

2000 – Appointed FAA DER as Flight Analyst (company and consulting).

2000 – Material Review Board appointment at Cirrus Aircraft.

1999 – LEWICE 2.00 Training Seminar, NASA Lewis Research Center, Cleveland OH.

WORK EXPERIENCE

2021-Current Xwing, Inc - Chief Engineer working on aircraft design and development (remote).

2017-2021 ERAU - Associate Professor of Aerospace Engineering (Daytona Beach, FL).

2010-2017 ERAU - Assistant Professor of Aerospace Engineering (Daytona Beach, FL).

2005-2010 Cirrus Aircraft - Chief Aerodynamicist (Duluth, MN).

1995-2005 Cirrus Aircraft - Flight Test Engineer, Structural Analyst, Aerodynamicist (Duluth, MN).

ENGINEERING TEACHING EXPERIENCE

2021-Current Adjunct Professor of Aerospace Engineering at ERAU.

2018-2021 Associate Professor of Aerospace Engineering at ERAU.

2010-2018 Assistant Professor of Aerospace Engineering at ERAU.

Classes taught: *Unconventional Aircraft Design* (AE595BB), *Aircraft Airworthiness Capstone Design* (AWE-520), *Aircraft Preliminary Design* (AE420), *Aircraft Detail Design* (AE421), *Aerospace Flight Vehicles* (AE201), *Incompressible Aerodynamics* (AE307), and *Statics* (ES201).

EXPERIENCE IN SPECIFIC DEVELOPMENT PROGRAMS*

- Cirrus VK30 (1995) – Kitplane
- Cirrus ST50 (1995) – Prototype intended for 14 CFR Part 23 certification
- TUAV (1997-1998) – Unmanned aircraft development
- Cirrus SR20 and SR20A (1995-2005) – Certified 14 CFR Part 23 (1999)
- Cirrus SR22 (1998-2005) – Certified 14 CFR Part 23 (2001)
- Cirrus SF50 Vision (2005-2010) – Certified 14 CFR Part 23 (2016) – 2017 COLLIER TROPHY RECIPIENT
- Cirrus SRS (2007) – Prototype intended for 14 CFR Part 1.1 certification (LSA)
- Piquero (2011) – Unmanned aircraft development
- SG-10 Long Ranger (2017) – Unmanned aircraft development

* This list only includes development projects that resulted in airworthy aircraft.

PATENTS AND PUBLICATIONS

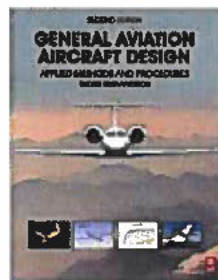
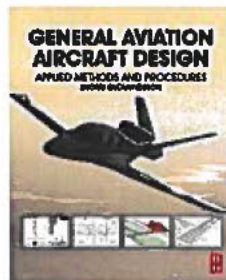
Patent

Electric Autonomous Aircraft (XW-0009-1-US-PRV Attorney Docket – Pending)

Books

General Aviation Aircraft Design – Applied Methods and Procedures, Butterworth-Heinemann (a subsidiary of Elsevier), 2013.

General Aviation Aircraft Design – Applied Methods and Procedures, 2nd Edition. Publication October 2021. 1143 pages. Butterworth-Heinemann (a subsidiary of Elsevier), 2021.



Journal Papers

(1) Bio-Inspired Methodologies for Energy Conservation and Harvesting Flight-Path Modeling for Unmanned Aerial System (2019 Journal of Aerospace Information Systems – AIAA) (2) Feasibility Study of a Multi-Purpose Aircraft Concept with a Leading-Edge Embedded Cross-Flow Fan (2020)

Conference Papers

(1) Towards Development of a Dynamic Soaring Capable UAV using Reinforcement Learning (2023 AIAA) (2) Towards Development of a Dynamic-Soaring, Morphing-Wing UAV: Flight Simulations (2021 AIAA) (3) Towards Development of a Dynamic Soaring, Morphing Wing UAV (2020 AIAA) (4) Parametric Study of Aerodynamic Performance of an Airfoil with Active Circulation Control using Leading Edge Embedded Cross-Flow Fan (2019 AIAA) (5) Adaptation of General Aviation Techniques for the Design of a Supersonic Leading-Edge Business Jet (2019 AIAA) (6) Preliminary Feasibility Study of a Multi-Purpose Aircraft Concept with a Leading-Edge Embedded Cross-Flow Fan (2018 AIAA) (7) A Biomimetic Energy-Conserving/Harvesting Trajectory Planning for a sUAV (2017 AIAA) (8) Effect of Slot Span on Wing Performance (2017 AIAA) (8) Biomimetic Opportunistic Approaches in Energy-Conserving/Harvesting Flight-Path Modeling for UAS (2016)

AIAA) (9) Towards Experimental Validation of Robust Control of Gust-induced Airfoil Limit Cycle Oscillations Using Synthetic Jet Actuators (2016 AIAA) (10) Transient Dynamic Analysis and Control of a Morphing UAV (2016 AIAA) (11) Dynamic Analysis of a Variable-Span, Variable-Sweep Morphing UAV (2015 IEEE) (12) Acoustic Emission Monitoring of Fatigue Crack Growth in a Beechcraft Bonanza Aircraft (2011). (13) Fatigue Crack Monitoring of a Beechcraft Bonanza Wing Spar Carry Through Structure (2011) (14) Computer Simulation of a Whole-Aircraft Parachute Recovery System (2009 AIAA) (15) Nonlinear Analysis of a Simply-Supported Composite Beam under Random Excitations (1996).

Technical Papers

(1) Cirrus SR20 and SR22 Tail Section Load Analysis (2015). (2) Evaluation of Residual Strength of Beechcraft Bonanza Spar Carry-Through with Fatigue Crack (2011). (3) Evaluation of Residual Strength of Beechcraft Bonanza Spar Carry-Through with Fatigue Crack (2010).

EXPERIENCE MATRIX

Involvement in Specific Aircraft Design and Development Activities by Aircraft Model

MODEL	CLASS	PISTON PROP	TURBOPROP	ELECTROPROP	JET	ASRODYNAMICS	STRUCTURES	MECHANICAL DESIGN	LOADS	AEROELASTICITY	PERFORMANCE	STABILITY AND CONTROL	FLIGHT TESTING	DE-ICE	FLIGHT CONTROLS	WIND TUNNEL TESTING	SUBSCALE TESTING	PARACHUTE RECOVERY	CFD	CERTIFICATION PROGRAM
VC30	5-PERSON KITPLANE	✓	✓			✓		✓				✓								
SP40	6-PERSON PRT 23 PROTOTYPE		✓							✓	✓							✓		
UAV OUTRIDER	UAS PROTOTYPE	✓				✓	✓	✓					✓							
SR20	4-PERSON PRT 23 CERTIFIED	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	
SR22	4-PERSON PRT 23 CERTIFIED	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	
SP40	5-7 PERSON PRT 23 CERTIFIED			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
SBS	2-PERSON LSA PROTOTYPE	✓				✓				✓	✓							✓		
PIQUERO	UAS PROTOTYPE	✓				✓	✓	✓					✓					✓		
TORNADO	6-PERSON KITPLANE		✓			✓				✓	✓		✓					✓		
LONG RANGER	UAS COMMERCIAL			✓		✓				✓	✓		✓					✓		
ELAN	4-PERSON PRT 23 PROTOTYPE			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

CAPS = Cirrus Airframe Parachute System, CFD = Computation Fluid Dynamics.

ATTACHMENT C

Subject: FW: 75084 220512 Fwd: Cg as requested - N627PR

From: Rob Rowe [REDACTED]
Sent: Tuesday, May 17, 2022 11:21 AM
To: Mac Langston [REDACTED]
Subject: FW: 75084 220512 Fwd: Cg as requested - N627PR

Mac,

Here is the note from Mr. Crookshanks with the NTSB to my insurance adjuster. It is obvious the final report will take a while to come out, but to me and many others it is very clear that this incident was caused by a design flaw with the NWLG.

This information could be and I am pretty sure would be debated by many who want to defend a position. No difference than a murderer on death row going to the electric chair screaming that they are innocent and justifying their position. But in the end reality sets in and they meet their maker. In this case there is a flaw in the design, it is factual and logical why they have recently changed the NWLG on the M600. I am extremely happy they did change it, but I am not happy because I was number 190 and not 198. Had I know about the design change prior purchasing the plane I would have not taken delivery without the new gear. This excursion happened to me because of a design flaw that was changed 8 planes after mine. That says something to me!

There is a bright side to all of this, Mr. Crookshanks did tell me that he believed that the new gear would solve the dynamic instability and he more than once told me to be sure that when the plane is repaired to get the new gear. Without putting words in his mouth, this means he believes the old gear is not stable or at least as stable as the new gear and I should avoid the old gear.

All of this being said, I respectfully request you work with Piper to handle the repairs under warranty at their expense. Anyone under the same circumstances would expect the manufacture to step up and correct the problem and ask the dealer to represent them. I think your representation would be better than others. With your persistence I would expect a positive reaction from them real soon.

Thanks for your help

Rob Rowe

From: Rob Rowe
Sent: Tuesday, May 17, 2022 9:00 AM
To: Jeff Krell [REDACTED]
Subject: Fwd: 75084 220512 Fwd: Cg as requested - N627PR

Sent from my Verizon, Samsung Galaxy smartphone Get Outlook for
Android<[From: Crookshanks Clinton \[REDACTED\]
Sent: Tuesday, May 17, 2022 8:52:19 AM
To: J.B. Sherrill \[REDACTED\]
Cc: File \[REDACTED\]; Amy Jamieson
\[REDACTED\]; Rob Rowe
\[REDACTED\]; Crookshanks Clinton
\[REDACTED\]; Link Samantha
\[REDACTED\]
Subject: RE: 75084 220512 Fwd: Cg as requested - N627PR](https://urldefense.com/v3/__https://aka.ms/AAb9ysg__;!!CKHWCaM!2xssYsy6BDB_LATs1ifvp2NwtC1RfDSbIRmUtpltGg3tWR0DZSZn8VWnHBKe8Fj0n4gprKqHGwWvf0PQU2$></p></div><div data-bbox=)

Mr. Sherrill,

I cannot tell you when the final report will be complete for this case. It could be several months. I have to first complete my engineering report and then Ms. Samatha Link, the investigator-in-charge for this case, will have to write the final report. As you know the Board will determine probable cause based on the facts and circumstances that we as the staff document in our reports.

In my conversation with Mr. Rowe last week, I informed him that we had mostly completed the tear down inspection of the NLG from the incident airplane. The right trunnion was fractured, and the steering horn was deformed during the gear collapse. We disassembled and measured all the NLG components. All the measured dimensions were within spec with the exception of one that is not related to the nose wheel steering. The steering horn and torque links are undergoing further measurements. The tire pressure was measured to be 84 psi after the event and was still holding 77 psi during the inspection. The NLG rake angle could not be measured due to the damage. We also examined the data downloaded from the PFD. It showed a nominal landing with the RMLG touching down before the LMLG during the crosswind landing. There was nothing abnormal noted during the preliminary review. The runway markings show the airplane tracking straight with the nosewheel rolling before it suddenly departs to the right.

The PA-46-600TP has a NLG that is set at a rake angle of 90 degrees (+0.5/-0) from the factory and outlined in SL 1286D which means that the NLG leg is vertical so that the steering axis is coincident with the center of the tire contact patch at rest. As the rake angle is increased the steering axis moves forward of the center of the contact patch. If the rake angle is decreased the steering axis moves aft of the center of the contact patch. The location of these in relation to one another is directly related to the static and dynamic stability of the steering. The stability will be described in detail in my factual report.

Regards,

Clint Crookshanks

Aerospace Engineer (Structures)

National Transportation Safety Board

From: Mr. Jordan B. Sherrill [REDACTED]

Sent: Thursday, May 12, 2022 5:40 PM

To: Crookshanks Clinton [REDACTED]

Cc: File [REDACTED]; Amy Jamieson

Subject: Re: 75084 220512 Fwd: Cg as requested - N627PR

[CAUTION] This email originated from outside of the organization. Do not click any links or open attachments unless you recognize the sender and know the content is safe.

Good day Mr. Crookshanks,

We are an independent claims adjustment company and have been assigned this subject matter the Underwriters of N627PR, 2022 Piper PA-46-600TP.

We were advised by the Insured today further regarding his below email to you. Do you know when the NTSB's official report will be made available on this matter? Are the circumstances outlined in the Insured's email below accurate as they relate to the cause of loss?

Contact me with any questions or concerns, sir.

Best regards,

[cid:image001.png@01D869B7.70C6AD70]

Jordan B. Sherrill, Adjuster/Surveyor/P.I.

Phoenix, Arizona Operating Location

Direct line [REDACTED]

eComm [REDACTED]

Arnold and Arnold, Inc.

2329 India Street

San Diego, CA 92101

Telephone (800) 207-9301 (24 hour)

Facsimile (619) 233-1607

website

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On May 12, 2022, at 4:25 PM, Mr. Jordan B. Sherrill

[REDACTED] wrote:

Begin forwarded message:

From: Rob Rowe [REDACTED]

Subject: FW: Cg as requested

Date: May 12, 2022 at 4:24:48 PM MST

To: "Mr. Jordan B. Sherrill" [REDACTED]

As info.

From: Rob Rowe

Sent: Thursday, May 12, 2022 7:21 PM

To: Crookshanks Clinton [REDACTED]

Subject: Cg as requested

I took a picture from my I pad. Thanks again for calling me. I cannot tell you how much it meant to me for you to call me. I was thrilled this the good news part and you told me my landing was good and the incident was not my fault. I knew that my landing was good and that it was not my fault, but waiting for the call was an enternity. The dynamic instability makes sense as you described it, i call it the shopping cart wheel vut same diffence to me. I love the plane, so I am extremely excited to hear the new nose gear with the different rake angle and such will solve the problem. I was really doubtful to fly it again but now super excited to get her back on the air. My plane is going to get flown back to the shop sometime next week. They are in process of getting parts to fly it back. I hope by end of next week. So if all goes well 7 to 8 weeks it will be fixed.

I REALLY hope that an FAA comes out with an AD to replace the NWLG gear for the fleet, awsome plane and needs to be fixed. I always ask my self what good can come from a bad experience. To me the GOOD that comes from all of this would A mandate to replace the 197 planes in the fleets nose wheel gear.. if that happens, then i would say it was well wrth the pain. I am thankfull no one was hurt in my incident and to my knowledge no one has been injured to date. So solving this will undoubtedly save a life. Thanks again, I really appreciate you and the efforts of every one and respect the work you all do to keep us as safe as possible. Thanks again. Rob

Sent from my Verizon, Samsung Galaxy smartphone Get Outlook for
Android<[https://urldefense.com/v3/__https://aka.ms/AAb9ysg__;!!CKHWCaM!2xssYsy6BDB_LATs1ifvp2NwtC1RfDSbIRmUtpltGg3tWR0DZSZJn8VWnHBKe8Fj0n4gprKqHGwWvf0PQUs2\\$>](https://urldefense.com/v3/__https://aka.ms/AAb9ysg__;!!CKHWCaM!2xssYsy6BDB_LATs1ifvp2NwtC1RfDSbIRmUtpltGg3tWR0DZSZJn8VWnHBKe8Fj0n4gprKqHGwWvf0PQUs2$>)>

<20220512_185121.jpg>

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