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January 3, 2022

VIA EMAIL
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National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, DC 20594

Re: Tamarack Aerospace Group's Petition for Reconsideration and Modification of Findings and Determination of Probable Cause and Request for Oral Presentation — Accident ID CEN19FA036, Memphis, IN – November 30, 2018, Aviation Accident; NTSB Aviation Accident Final Report Published on November 1, 2021

Dear Sir or Madam:

Tamarack Aerospace Group **(**Tamarack) 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 has made erroneous findings that are unsupported by the factual record, inconsistent with engineering principles, or proven to be physically impossible.

This petition also points out that significant factual information provided by Tamarack as a party of this accident investigation and included in the public docket for this accident (https://data.ntsb.gov/Docket?ProjctID=98710) was not analyzed or properly considered by the NTSB. The investigation and resulting NTSB Factual Reports (Systems, Aircraft Performance, Cockpit Voice Recorder, Computed Tomography) also failed to address additional issues raised by Tamarack in its Supplemental Submission (Docket Item # 25). These issues include the relationship of the Attitude Heading Reference System (AHRS) to the autopilot system and the Primary Flight Display (PFD), whether an AHRS anomaly or failure contributed or caused the autopilot to disconnect, the lack of specificity regarding the pilot's experience in the accident aircraft and training to obtain his type rating, and the possibility that the pilot was experiencing spatial disorientation during the accident sequence.

Overall, the errors and gaps in the factual record are so fundamental that the NTSB must reconsider and modify its determination of probable cause of the accident. As but one example of the NTSB's failure to properly consider key information provided by Tamarack, note that Tamarack, with the approval of the accident Investigator-in-Charge, provided a supplemental party submission to the NTSB on October 26, 2021. That supplemental submission provided important new information concerning a system anomaly or failure that could bear significantly on the accident's probable cause (see Docket Item # 25).

The NTSB published its Final Accident Report for this accident on November 1, 2021 – 4 business days after Tamarack submitted its supplemental party submission. There is nothing in the public docket or the Final Accident Report that addresses any information contained in the Tamarack supplemental submission. Given that the accident occurred 35 months prior to the date of publication of the Final Accident Report, it is difficult to comprehend why the NTSB published its Final Report a mere 4 business days after receiving the new information contained in Tamarack's supplemental party submission without even acknowledging the existence of that supplemental submission.[1]

Moreover, because of the complexity of some of the technical issues discussed herein, Tamarack requests the opportunity to make a verbal/oral presentation to the Board and for the presentation to be recorded and made available in the public docket.

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

I. Overview and Summary of Petition

II. Factual Errors in the Final Accident Report

  A. Introduction
  B. Autopilot Disconnect
  C. Pilot Training and Experience
  D. Witness Marks
  E. TACS Hinge Damage
  F. TCU Curled Pins
  G. Alleged Previous ATLAS Failures

III. Conclusions

IV. Appendix—TACS Deployment Hardware, TCU Hardware, and Actuator Hardware

I. Overview and Summary of Petition

The NTSB's Aviation Accident Final Report contains numerous substantive factual errors, gaps, and inconsistencies. These shortcomings lead to a series of erroneous conclusions which, in turn, resulted in a probable cause determination that cannot be

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[1] 49 CFR § 845.32(b), *Acceptance of Petitions*, states: "The Board will not consider petitions that are repetitious of … positions previously advanced." Given the exceedingly short timeframe between Tamarack's submission of its supplemental party submission and the NTSB's publication of its Final Accident Report, § 845.32(b) is not applicable.

supported by the evidence available to the NTSB. Given the gaps in the factual record and contradictory statements within the final report, it is apparent that the NTSB relies on mere possible scenarios and selective data, and misapplies scientific, engineering, and design criteria to back into a probable cause statement that is simply wrong.[2]

As this petition will make clear, the evidence available to the NTSB and the findings in the Final Accident Report demonstrate that Tamarack's "load alleviation system" (Active Technology Load Alleviation System, or "ATLAS) did not malfunction and did not cause the accident.[3]

The key erroneous findings contained in the Final Accident Report include the following:

- The report states that the autopilot prematurely disconnected at a 30° bank angle. The autopilot system disconnect threshold is 45°, which is 15° more than the bank angle at which the accident aircraft's autopilot actually disconnected. Therefore, the autopilot clearly did not disconnect because of excessive bank angle.

- The aircraft rolled at 5° per second, but the autopilot disconnect roll rate threshold is 10° per second. Therefore, the autopilot clearly did not disconnect due to excessive roll rate.

- ATLAS has no connection whatsoever to the autopilot, meaning the only way for an ATLAS failure to disconnect the autopilot is via bank angle or roll rate. If the autopilot did not disconnect due to bank angle or roll rate, ATLAS could not have caused the autopilot to disconnect. Critically, the Final Report does not identify a specific probable cause as to why the autopilot disconnected.

- The report refers to various witness marks to conclude that "the evidence indicates that the left TACS was in a position consistent with full trailing edge up position at the time of ground impact". The report fails to acknowledge that the referenced damage is consistent with the entire TACS control system being over-deflected. The report also fails to consider that because the TACS can be easily moved by hand when the system is not powered, it is extremely probable that the TACS moved significantly post impact, as violent forces acted on the various components. Physical limitation of the movement of

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[2] The NTSB determined "the probable cause[s] of this accident to be: The asymmetric deployment of the left-wing load alleviation system for undetermined reasons, which resulted in an in-flight upset from which the pilot was not able to recover." Final Accident Report at p. 4.

[3] ATLAS is a Tamarack-patented safety enhancing system designed to alleviate aerodynamic aircraft wing loads and increase range and efficiency.

components within ATLAS make it impossible for the witness marks relied on by the Board to conclude that a malfunction of ATLAS caused them. Rather, all of the referenced damage and witness marks were likely the result of the high impact forces over-extending the TACS control system just after the aircraft struck the ground.

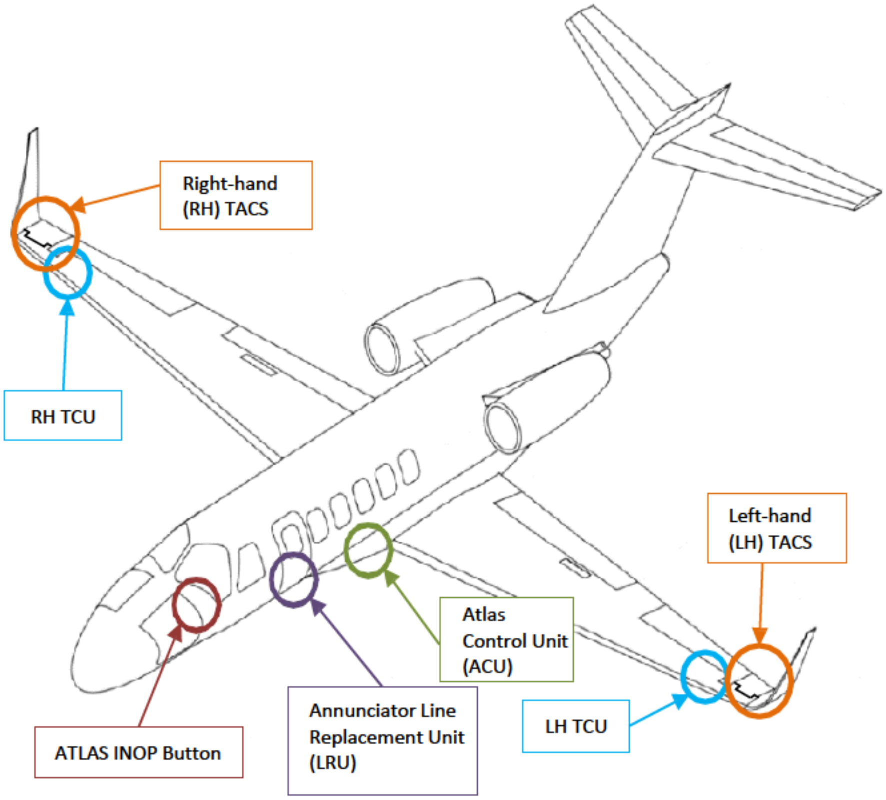
- The report clearly misinterprets at-impact witness marks found within the left and right actuators that could only have been caused by impact forces with the ground. These at-impact witness marks are evidence that the left and right actuators were at a symmetric deployment at an intermediate position consistent with a 2g flight condition, which matches the final flight condition reported in the NTSB Performance Study.

- The bending of six pins within an ATLAS electrical connector could not have existed for approximately 193 flight hours between the date when two key ATLAS components (both TACS Control Units, or TCUs) were removed and replaced for maintenance on July 13, 2018 and the time of the accident on November 30, 2018. This work was performed to comply with a Service Bulletin that changed the design of an internal screw assembly within the TCU. Note that the maintenance was performed without any anomaly in the accident aircraft's flight characteristics having presented itself. The cause of the bending was almost certainly impact forces.

- Reference to a roll event in the United Kingdom on April 13, 2019, involving another aircraft equipped with ATLAS, is completely misleading since the UK incident involved an ATLAS screw that had not been removed and replaced in accordance with the Service Bulletin, resulting in a failure. There was no evidence whatsoever of any such screw assembly issue in the accident aircraft.

This petition references specific ATLAS components, including components related to deployment of specialized Tamarack Active Camber Surfaces (TACS). The figure below (also appearing as Figure 1-2 in Tamarack's Party Submission of October 29, 2019 [hereinafter "Party Submission", Docket Item # 16) and its Party Submission with Errata (hereinafter "Party Submission with Errata", Docket Item # 20) provides an overview of ATLAS components on a Cessna model 525A aircraft, such as the accident aircraft. Additional details concerning the TACS deployment hardware, the TACS

Control Unit (TCU) hardware, and the actuator hardware are presented in the Appendix to this Petition.



ATLAS component locations, Cessna 525A

II. Factual Errors in the Final Accident Report

A. Introduction.

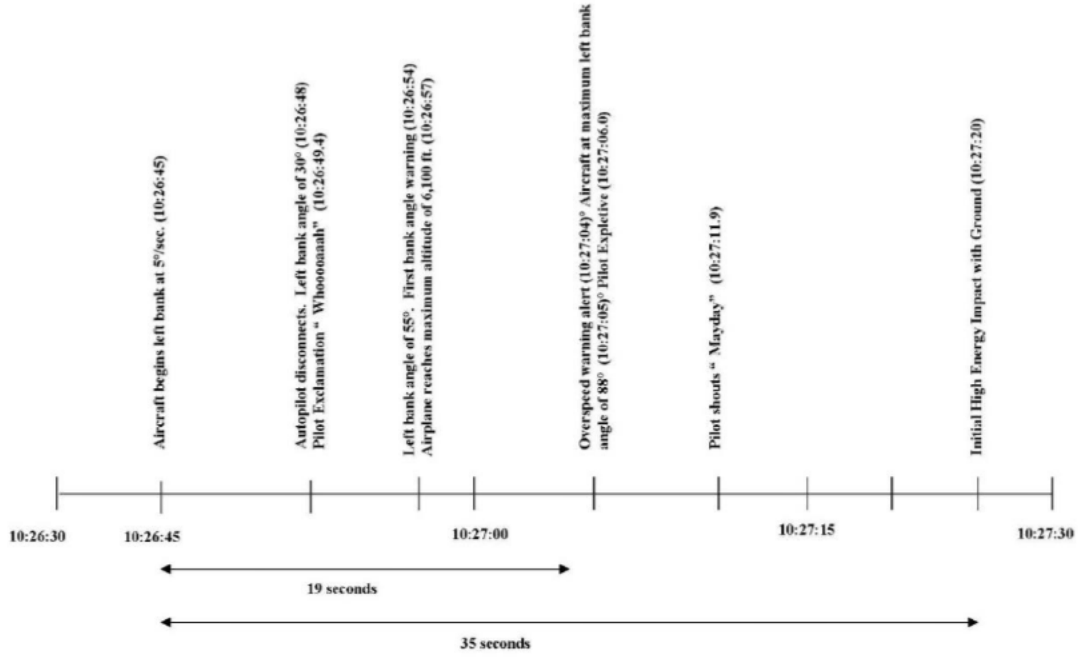
The Final Accident Report contains many statements that are contradicted by the facts in the public docket (or, in some cases, other statements in the Final Accident Report). These erroneous statements require correction, as well as reconsideration of the probable cause determination which they support. Each error is significant, and the cumulative effect of the errors is to clearly demonstrate that there is no evidence that Tamarack's ATLAS was in any way responsible for the November 30, 2018 accident. This section of the petition will sequentially address each set of factual errors summarized in Section I above.

B. Autopilot Disconnection.

For ease of reference, the following Timeline depicts key events in the accident sequence:

ACCIDENT TIMELINE

(SEE NTSB ERRATA TO PERFORMANCE STUDY AND COCKPIT VOICE RECORDER ERRATA)



The Final Accident Report states (at p. 1, ¶ 2, lines 1-2):

> When the airplane reached about 30° of left bank, about 3 seconds after the onset of the roll, the autopilot disconnected accompanied by an aural alert.[4]

This statement and its context in the Report implies that the autopilot disconnected because the airplane exceededthe maximum bank angle threshold and is therefore misleading. As stated elsewhere in the Report and in other information contained in the public docket, the bank angle threshold for the

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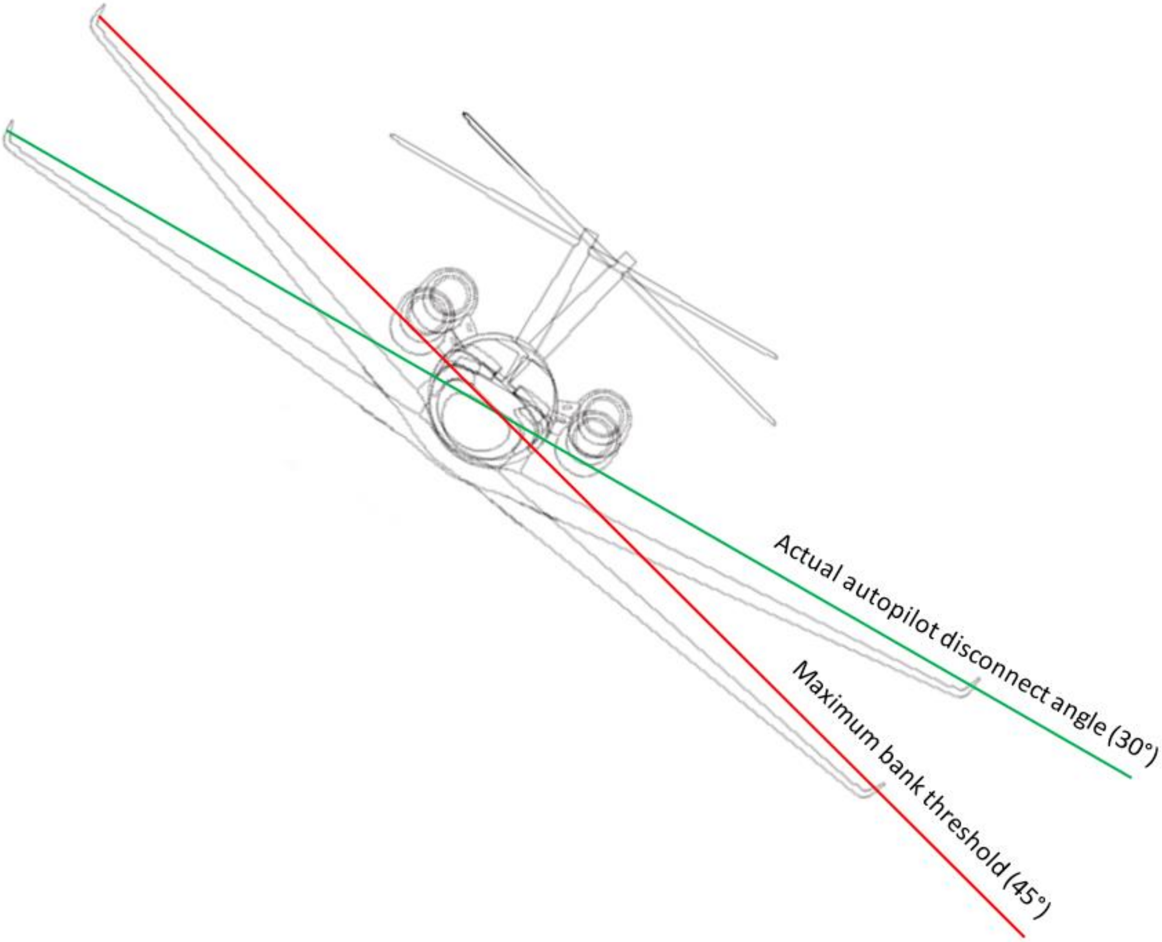
[4] The Errata to Performance Study [hereinafter "Performance Study"] (Docket Item # 9, at p. 4, ¶ 2, lines 2-3) includes a similar statement.

autopilot to disconnect is 45°.[5] The autopilot therefore did not disconnect due to excessive bank angle.

For additional ease of reference, the figure below provides a visual comparison of the accident aircraft's left bank angles of 30° and 45°.



Comparison of N525EG autopilot disconnect angle vs. maximum bank threshold

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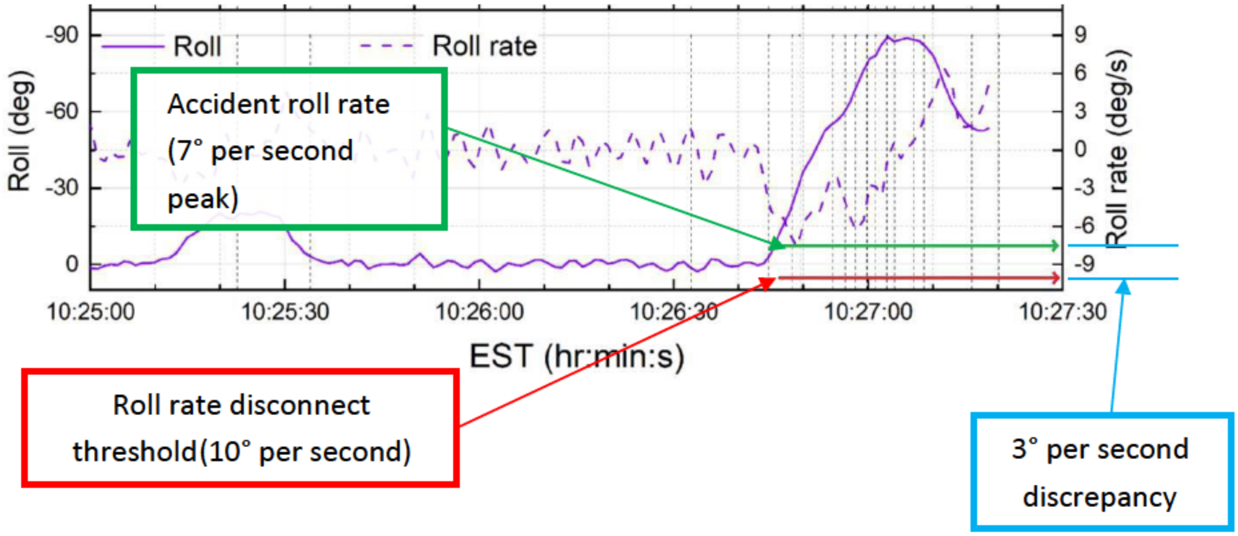
[5] A subsection of the Report, titled *Autopilot* (at p. 9, ¶ 1, lines 2-6), states:

> [T]he autopilot can also disengage during abnormal situations. Abnormal disconnects can occur if … excessive attitudes are reached ([including] … 45° left or right wing down).

This statement in the Report is ostensibly derived from a one-page document in the public docket (Docket Item # 18, entitled *Textron Provided Information Regarding Autopilot)*:

> The autopilot will disconnect itself for the following reason[ ]:
> - Excessive or unusual attitudes exist ([including] roll exceeds +- 45 degrees)

The Report also identifies a roll rate disconnect threshold of 10° per second.[6] However, the airplane was rolling at an average rate of 5° per second throughout the uncommanded roll event, with a peak roll rate of approximately 7° per second according to the NTSB's Performance Study.[7] The autopilot therefore did not disconnect because of excessive roll rate. The figure below provides a comparison of the peak roll rate determined by the NTSB for the accident aircraft with the autopilot disconnect threshold of 10° per second indicated in the Report. As the figure shows, the accident roll rate only reached 7° per second at the time the autopilot automatically turned off and the pilot resumed flying the aircraft. At no point during the accident sequence did the roll rate reach 10° per second. [8]



Accident roll rate (7° per second peak)

Roll rate disconnect threshold(10° per second)

3° per second discrepancy

Comparison of N525EG peak roll rate vs. roll rate disconnect threshold

Critically, ATLAS does not have any interface with any other system on the aircraft. The only connection that ATLAS makes to any aircraft systems is power, with all power connections conventionally protected with circuit breakers. As a result, ATLAS failures cannot cause the autopilot to disconnect except if the failure is an asymmetric deployment of the TACS resulting in excessive bank angle or roll rate. Thus, the only two ways for ATLAS to cause the autopilot to disconnect are by bank angle or roll rate. Because neither of those disconnect thresholds were met here, there must have

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[6] "Abnormal disconnects can occur if … there is a[n] … internal autopilot failure (such as an excessive autopilot roll rate of 10°/second into a bank … .)", at p. 9, ¶ 1, lines 2-4.

[7] See Performance Study, at p. 4, ¶ 1, line 1; p. 6, ¶ 1, line 2; and section titled *Conclusions*, p. 6., ¶ 1, line 2 and ¶ 2, line 1).

[8] This figure is excerpted from the Performance Study, Figure 3, at p. 5 and the Party Submission, at p. 34, Figure 3-3.

been some reason other than an externally induced roll exceeding the autopilot's attitude thresholds to cause disconnection of the autopilot.

The Report, however, fails to identify a specific reason why the autopilot disconnected. This information is critical to properly understand the cause of the uncommanded roll event. The missing information and data concern a key event in the accident sequence and clearly contributed to the erroneous probable cause statement presented in the Final Report.

1. Bank Angle Alerts

The Final Report states (at ¶ 1, lines 1-2) that "[f]or about 15 seconds, while the bank angle warning sounded and the overspeed warning began to annunciate, the pilot did not make any statements." Also, page 7 of the Report states (at ¶ 3, lines 3-4) that "[o]ver the next 8 seconds, the airplane's EGPWS annunciated six 'bank angle' alerts." The statement on page 1 of the Report and the CVR transcript regarding the eight warnings within 14 seconds raise important questions regarding the pilot's failure to react to these annunciations. As discussed further below in subsection C, Pilot Training and Experience, the Report fails entirely to address the pilot's failure to respond appropriately to these warnings in a timely manner.

Note that the accident pilot in his final communications with an air traffic controller mentioned a number of issues but did not mention that the ATLAS malfunction alert light had come on. It is reasonable to assume that if the warning light was malfunctioning, it would have been reported subsequent to Service Bulletin work and prior to the accident flight. As discussed further below in subsection F, TCU Curled Pins, the two TCUs were removed and replaced on July 13, 2018 – more than 4 months prior to the accident – to comply with a Service Bulletin and after that the accident aircraft had flown approximately 193 hours before the accident.

If the TCUs were malfunctioning during this period, the malfunction alert light would have alerted the pilot. As the Table on page 26 states (with reference to Pin 35, Servo Command):

> It is extremely improbable that the pilot(s) or owner would not have noticed the left-hand TCU intermittently malfunctioning for 193 flight hours.

Similarly, as this Table further states (with reference to Pin 39, Position Output);

> If this signal [provided by the TCU to the Atlas Control Unit] were intermittent, it is extremely probable that the system would have intermittently annunciated faults. It is improbable that the pilot(s) or owner would not have experienced these intermittent faults frequently enough to contact Tamarack technical support at some point during the 193 flight hours since the TCUs were removed and reinstalled for service bulletin work.

C. Pilot Training and Experience.

The Final Report and the public docket materials are notably deficient in addressing the pilot's experience and qualifications to fly a Cessna model 525A aircraft and whether his inability to control the aircraft was the result of lack of flight experience or training in operating type and the accident aircraft, his being distracted by performing routine operation tasks, or was due to spatial disorientation.[9] The Report indicates (at p. 8, ¶ 1, lines 1-5) that "[the pilot received his single-pilot Cessna 525 type rating to his airline transport] pilot certification February 28, 2018" [slightly more than 9 months prior to the accident] and had 453 hours of instrument experience. The Report further indicates (at p. 8, ¶ 1, lines 8-10) that "[l]ogbooks for the pilot were not located, and no online logbook was discovered during the investigation. The pilot's total hours and experience could not be verified."

- Further inquiry by the NTSB into the pilot's training experience, focusing on evaluations from training instructors and examiners involved in his Cessna 525 type rating could likely have provided important information concerning the types of emergency situations presented as part of training and the pilot's level of preparedness to address emergency situations. Similarly, obtaining additional information concerning the pilot's experience in type and the accident aircraft would offer important details concerning his flight proficiency.

- The Report also fails to adequately explain why the pilot was unable to roll the accident aircraft back to the right after the onset of the left roll. Assuming the pilot was not incapacitated or spatially disoriented, the approximately 19 seconds between the start of the roll event and the first indication of reversal of the roll was more than sufficient time for the pilot to have prevented the accident.

- As indicated previously, an ATLAS failure alone does not result in an unrecoverable flight condition. As the Report states (at p. 3, ¶ 2, lines 2-4 and ¶ 3, lines 1-2): "[t]he accident roll rate of 5° per second was significantly less than the [certification flight testing data provided to the NTSB for ATLAS, which involved an aircraft] speed of 240 kts, an initial bank angle of 30°, and a maximum unfavorable fuel imbalance (critical failure condition), a near full asymmetric deflection of the TACS resulted in a roll rate of greater than 20° per second."[10] This critical failure condition was proven by the FAA and EASA certification exercises to be recoverable by a pilot of average skill and

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[9] The NTSB has investigated several other Cessna 525 accidents where it determined that the probable cause of each accident was the pilot's spatial disorientation. See Accident Nos. WPR16FA054, MIA08MA051, CEN17FA072, and ERA19FA071. Note that none of these aircraft were equipped with Tamarack winglets.

[10] See also the Performance Study's comparison of the roll rates of the accident aircraft and the ATLAS certification flight test at pp. 5-6. Also, as the Final Accident Report indicates, the Flight Test Report, consisting of a flight test report prepared by Cranfield Aerospace Limited's Airborne Systems Group and a Tamarack flight test report, were given by the Tamarack party coordinator to the NTSB Investigator-in-Charge. Because this document consists of proprietary commercial information, it is not available in the NTSB public docket.

strength. As the Tamarack Flight Test Report points out, in recovering from a single TACS asymmetry, "[e]ven at high speed, recovery does not require exceptional pilot skill or strength." (See Annex D, TAG Memo, EASA Certification Flight Test Results, 4. Test Conditions, CS-23.1329, Automatic pilot system).

- The accident roll rate was significantly less than the roll rate for the ATLAS certification test flight. Despite this, the NTSB fails to analyze whether the accident pilot's actions, or lack of action, contributed to his inability to regain control of the aircraft. The NTSB does not provide even a cursory examination of what role spatial disorientation, inaccurate information displayed on the pilot's Primary Flight Display, or a combination of these possible factors may have played in the accident. In addition, as the Party Submission points out (at p. 39, ¶ 1), approximately 19 seconds elapsed between the onset of the roll and the first indication of the pilot's recovery actions.[11] There is no evidence that the pilot made any control inputs to roll the aircraft until it had reached approximately 90° left-wing down and was descending at a high rate of speed.

- Finally, the NTSB has failed to adequately address whether the pilot, who was operating in instrument meteorological conditions, was spatially disoriented during any of the phases of the flight. Although the Final Report points out (on p. 18, ¶ 1, lines 10-11) that "the pilot['s] inputs are unknown" because the "airplane was not equipped with a flight recorder," basic pilot skills certainly include the ability to recognize a roll condition and correct a roll when necessary. It is not at all unlikely that the pilot's performance in verbalizing the checklist diverted his attention away from monitoring the aircraft's movements until the autopilot disconnect, at which point the pilot first became aware of the uncommanded roll and increased bank attitude and then failed to property correct a developing flight condition which was clearly correctible.[12]

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[11] The Performance Study indicates (at p. 4, ¶ 1, lines 1-2) that at 10:26.45 the aircraft "began to bank to the left at a rate of about 5°/s." Nineteen seconds later [at 10:27.04], after the eight annunciations of the "bank angle" warnings, the "overspeed" warning was annunciated. See CVR transcript at p. 12). As the Party Submission points out (at p. 35, ¶ 1, lines 8-10): "for the time between 10:26:45 and 10:27:04, the pilot did not or could not provide control inputs to the airplane, including throttle reduction."

[12] The CitationJet Pilots Safety Foundation recently released an instructional video (*When All Else Fails)* that illustrates how pilots can easily recover from uncommanded rolls and loss of control. See https://youtu.be/ylsbbA_qmeI (at Scenario II, *When Instruments Lie*, at 5 min, 15 sec.) The Foundation's decision to produce this video also is a recognition that loss of control in a CitationJet is not limited to Tamarack modifications.

In summary, significant issues concerning the pilot's training, experience, and inability to correct the roll event raise doubts about the thoroughness of the NTSB's investigation into this topic, its findings, and probable cause statement.

D. Witness Marks.

The Final Report (at p. 2, ¶ 2, lines 6-8) states the following:

> Examination of the left TCU showed contact marks on the ram guide housing and on the extend hard stop plate, which were consistent with the actuator being at a **maximum extension position** at the time of ground impact. [Emphasis added.]

In contrast, the Report later includes the following factual statement (at p. 13, ¶ 4, lines 1-3:

> A set of witness marks was found on the upper ram guide housing, consistent with contact from the ball screw nut that positions the TACS, in an area consistent with **an intermediate extension position** (left TACS trailing edge up). [Emphasis added.]

Obviously, an intermediate extension position is not a maximum extension position.

The Systems Group Chairman's Factual Report (hereinafter "Systems Report", Docket Item # 5) includes the following figure (Figure 47 at p. 41):

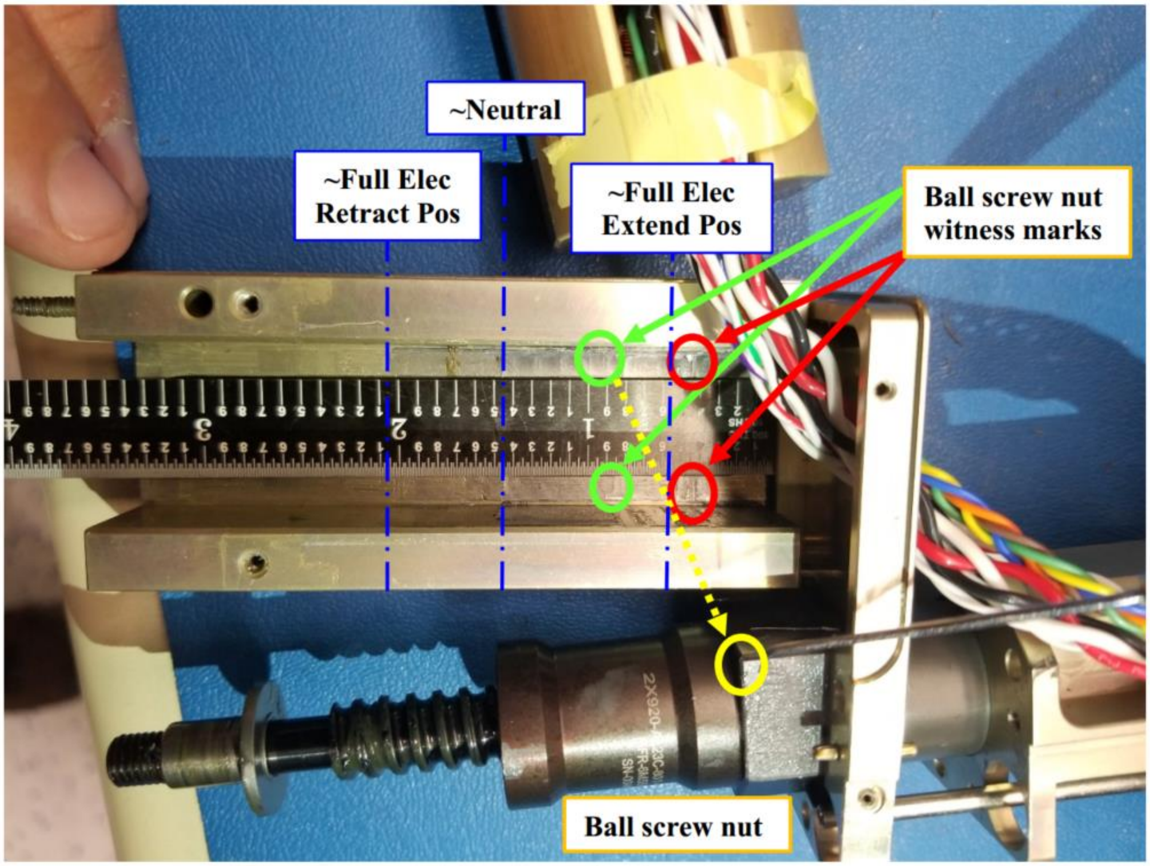


Figure 47 – Upper ram guide housing with witness marks highlighted and estimated travel positions

Immediately following Figure 47 in the Systems Report is the following description:

> The ball screw nut was lubricated and free to move by hand with no signs of binding. Two sets witness marks were observed on the ram guide housing, ref Figure 47. **One set of witness marks (green in picture) correspond to a position of intermediate extension**. **The location of the other set of witness marks (red in picture) corresponds to a position of full extension of the actuator.** [Emphasis added.]

The statements in the Final Report and the Systems Report are inconsistent. The Final Report must be revised to accurately reflect which set of witness marks were found in an intermediate position and which set of witness marks were found in a full extension position.

More fundamentally, the ram guide assembly only contacts the ball nut on two sides, to provide anti-rotation for the ball nut. It is impossible for the ball nut to leave contact marks on the upper or lower surface of the ram guide housing unless the actuator is subjected to a massive acceleration perpendicular to the line of action of the actuator. The acceleration would need to be sufficiently massive to deform the hardened steel ball screw and cause the ball nut to come into contact with the ram guide housing. The figure below provides an illustration of this scenario, in which the ball screw deforms to cause the ball nut to contact the ram guide housing.

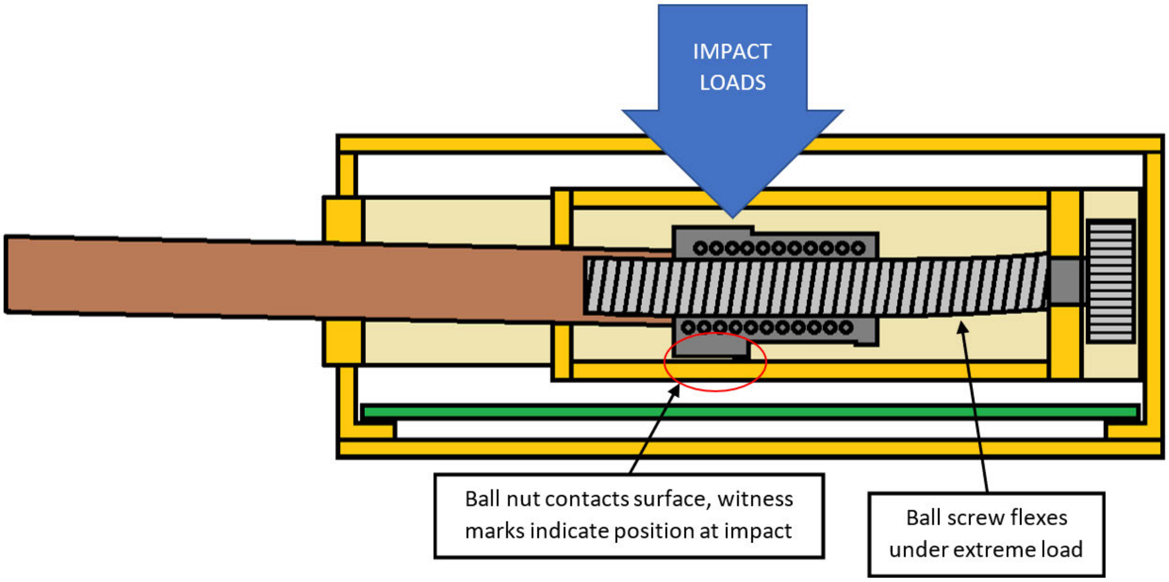
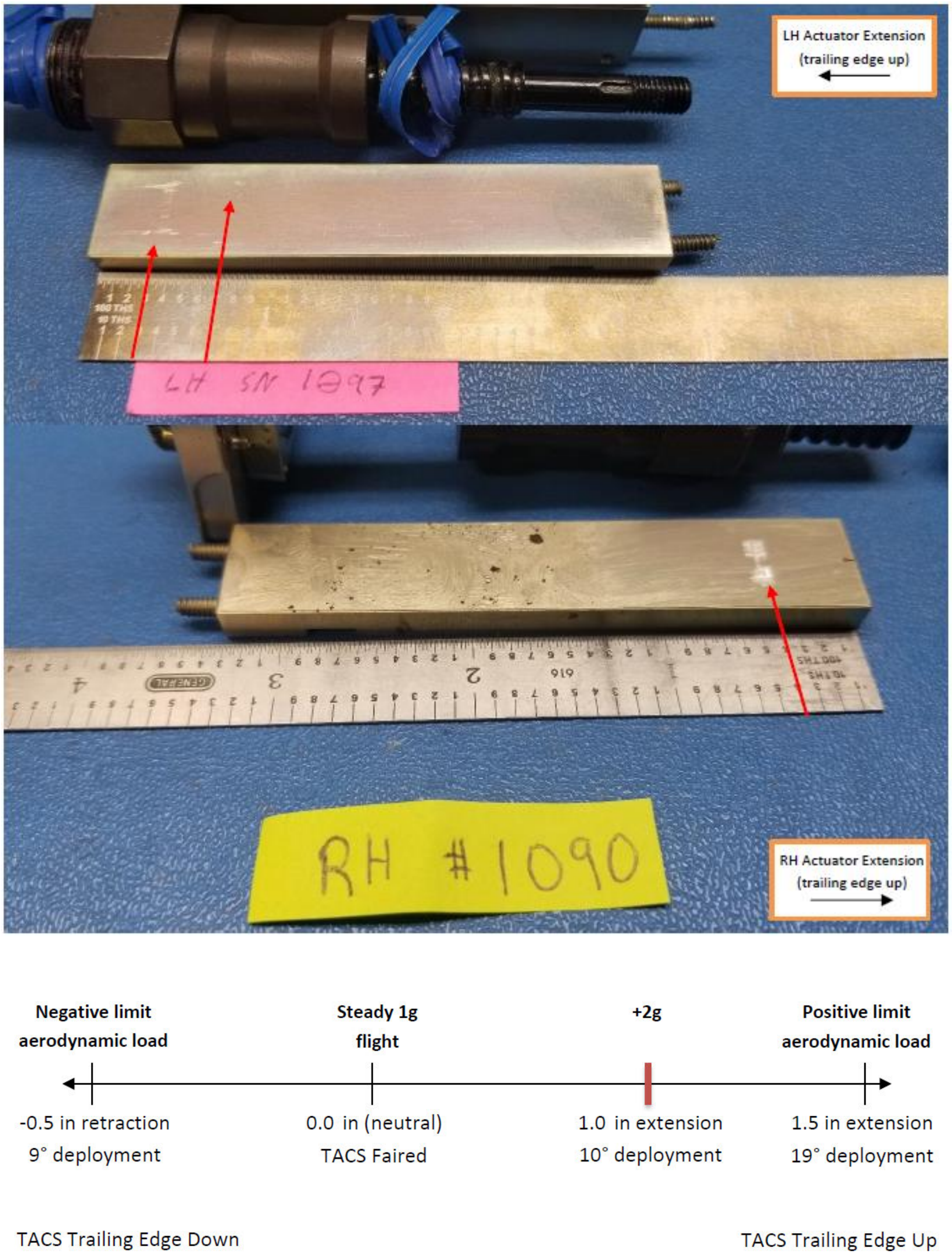


Illustration of ball screw deformation under impact loads

The only explanation for the presence of the contact marks on this part of the ram guide housing is a high velocity impact of the airplane with terrain. The ball nut guide attaches to an end plate within the actuator. The end plate functions as the extension hard stop within the actuator or the hard surface that the ball nut would contact if driven or externally forced past the electronic extension limit. The end of the ball nut guide is approximately 0.15” from the face of the extension hard stop.

The left-hand actuator has two sets of contact marks. One set is very faint and appears approximately 0.7” from the extension end of the ball nut guide, or 0.85” from the extension hard stop. The other set is more pronounced and appears at approximately 0.30” from the extension end of the ball nut guide, or 0.45” from the extension hard stop. See the Systems Report, at page 42, Figure 48, and the Party Submission, in Figure 2-22. See also Figure 2-23 in the Party Submission for an illustration of actuator position relative to various flight conditions. Both figures from the Party Submission are excerpted below.



Excerpts of Figures 2-22 and 2-23 from the Tamarack Party Submission

As discussed later, the TCUs are mounted in the aircraft asymmetrically– the right hand TCU is mounted upside down relative to the left hand TCU. The intermediate witness marks were found on the lower surface of the ram guide housing, which would be oriented differently on the left and right side relative to the airplane. This is expected, given that the shape of the ball nut makes the lower surface gap smaller.

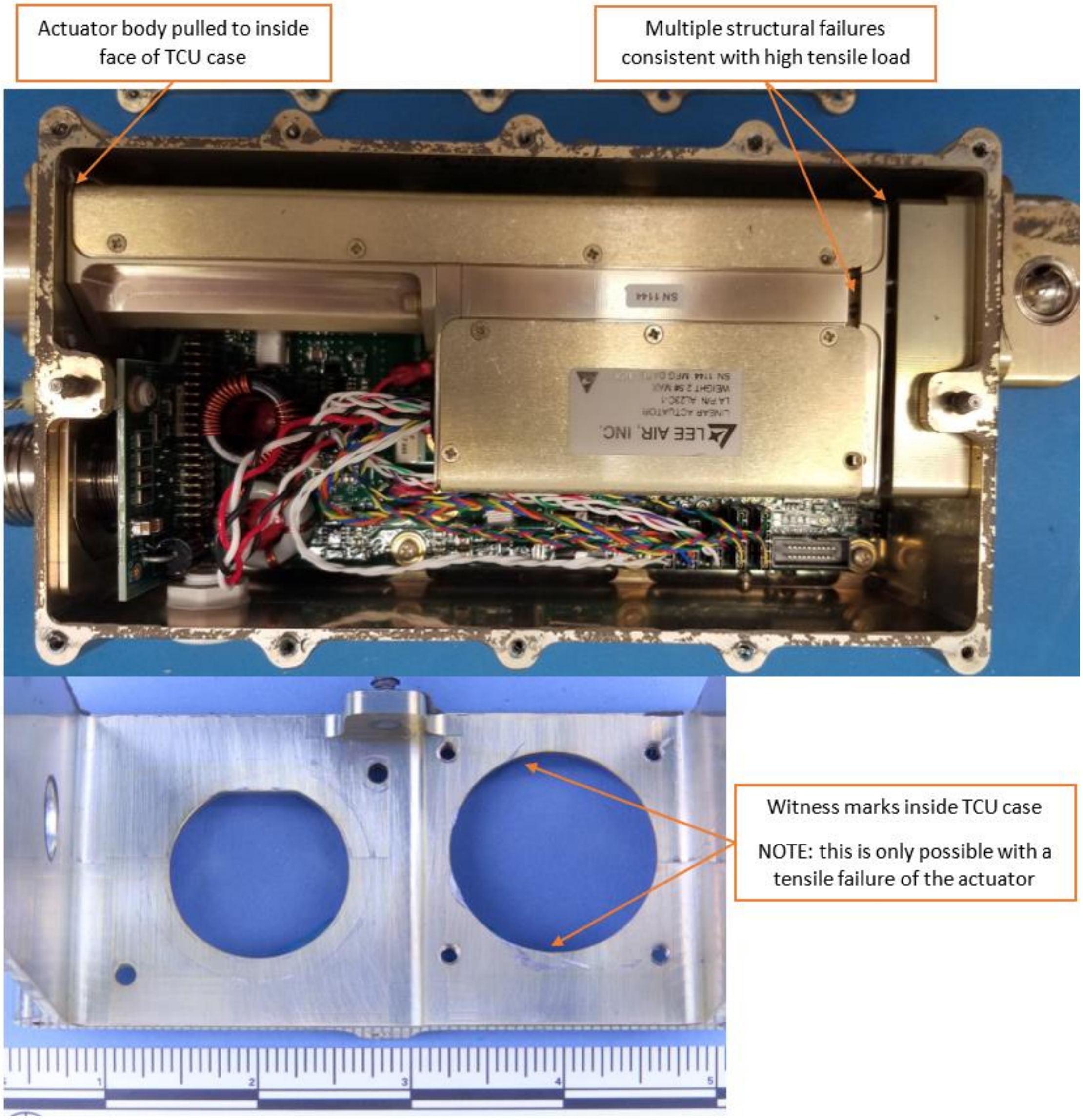
Note, however, that there still is a clear gap between the ball nut and the lower ram guide during normal operation.

A statement in the Systems Report calls attention to a contact mark on the extension hard stop itself, consistent with a high energy impact between the ball nut and the extension hard stop.

There is evidence in the TACS hinges that the left hand TACS was forced far past its designed travel, trailing edge up. This could have only happened in post impact settling because the actuator does not have the power to physically break or bend any external components of the TACS control system, and the actuator cannot physically extend far enough to do so in the first place.

Further, there is internal actuator damage at the TCU/Actuator mount consistent with the TACS being forced trailing edge up. This damage includes tensile failure at the attachment hardware. *If the TCU/Actuator had deployed to drive the TACS to a fully extended position, these fasteners would have been loaded in compression, not in tension.*

When the left-hand TCU was opened for examination by the party members after being recovered from the wreckage, the actuator was discovered with structural failures in the screws connecting the gear train to the rest of the actuator body. Examination of the inner face of the left-hand TCU case revealed a contact mark similar to the mark found inside the actuator on the extension hard stop. This is notable, because the actuator body is static and can only cause that type of mark in the event of a failure. The figure below illustrates the condition of the left-hand TCU as found, noting the relevant witness marks and structural failures.



Condition of left-hand TCU as found

There is one overwhelmingly probable explanation for the simultaneous existence of witness marks showing contact of the ball nut with the internal extension hard stop, witness marks showing contact of the unmoving actuator body with the interior of the TCU case, and structural failures in the fasteners holding the actuator body together. It is probable that a massive tensile force rapidly extended the ram tube of the actuator, causing the ball nut to impact the extension hard stops, then continued to pull the actuator until the fasteners failed and the entire actuator body was pulled forward to the interior wall of the TCU case. This scenario could only have been caused during the impact sequence.

The figure below provides an illustration of this sequence of events.

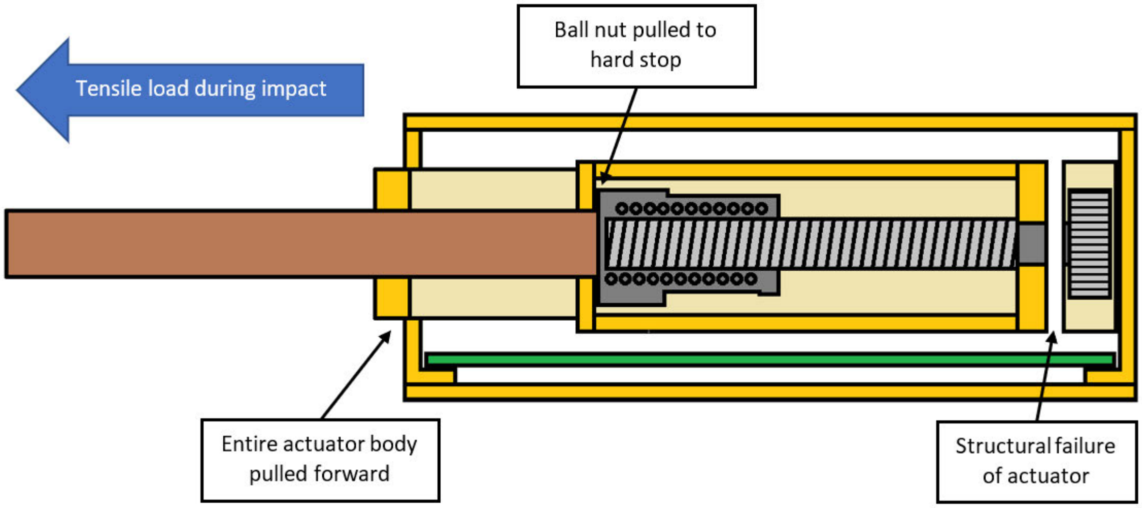
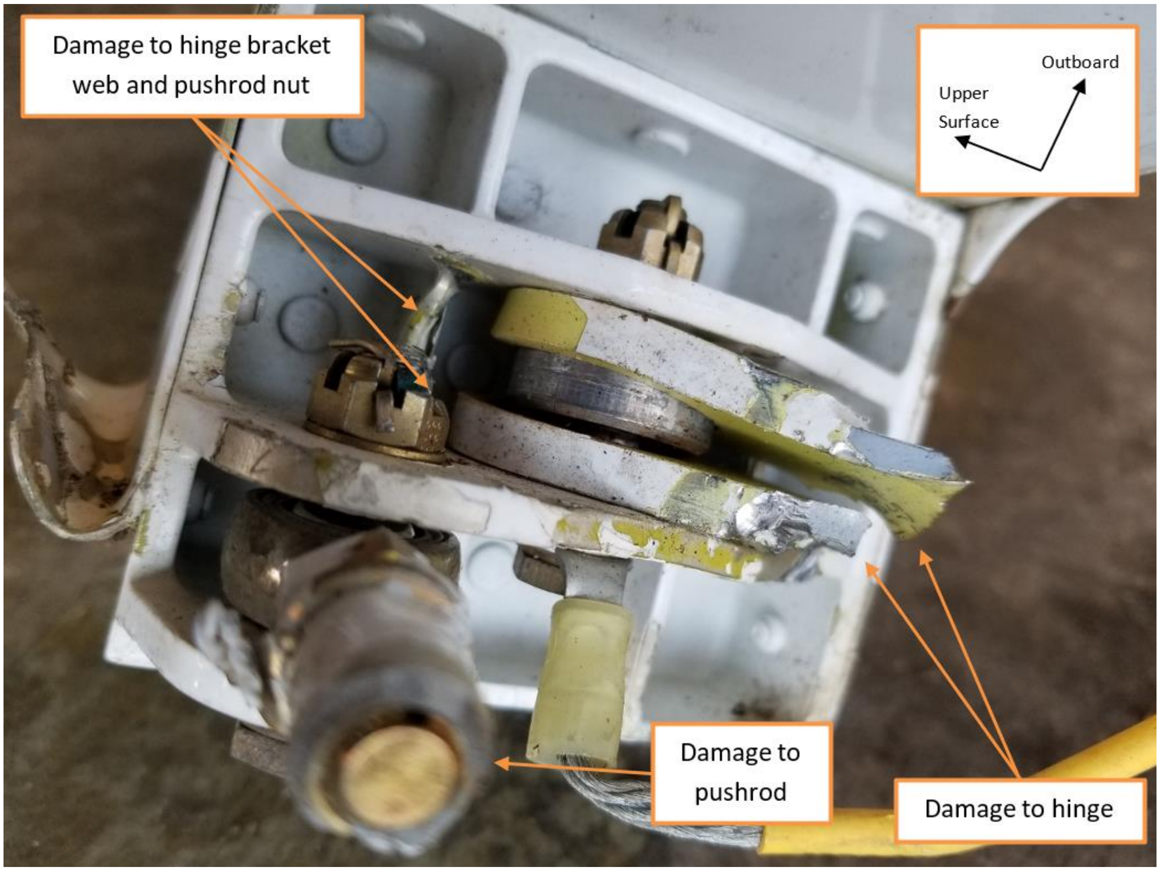


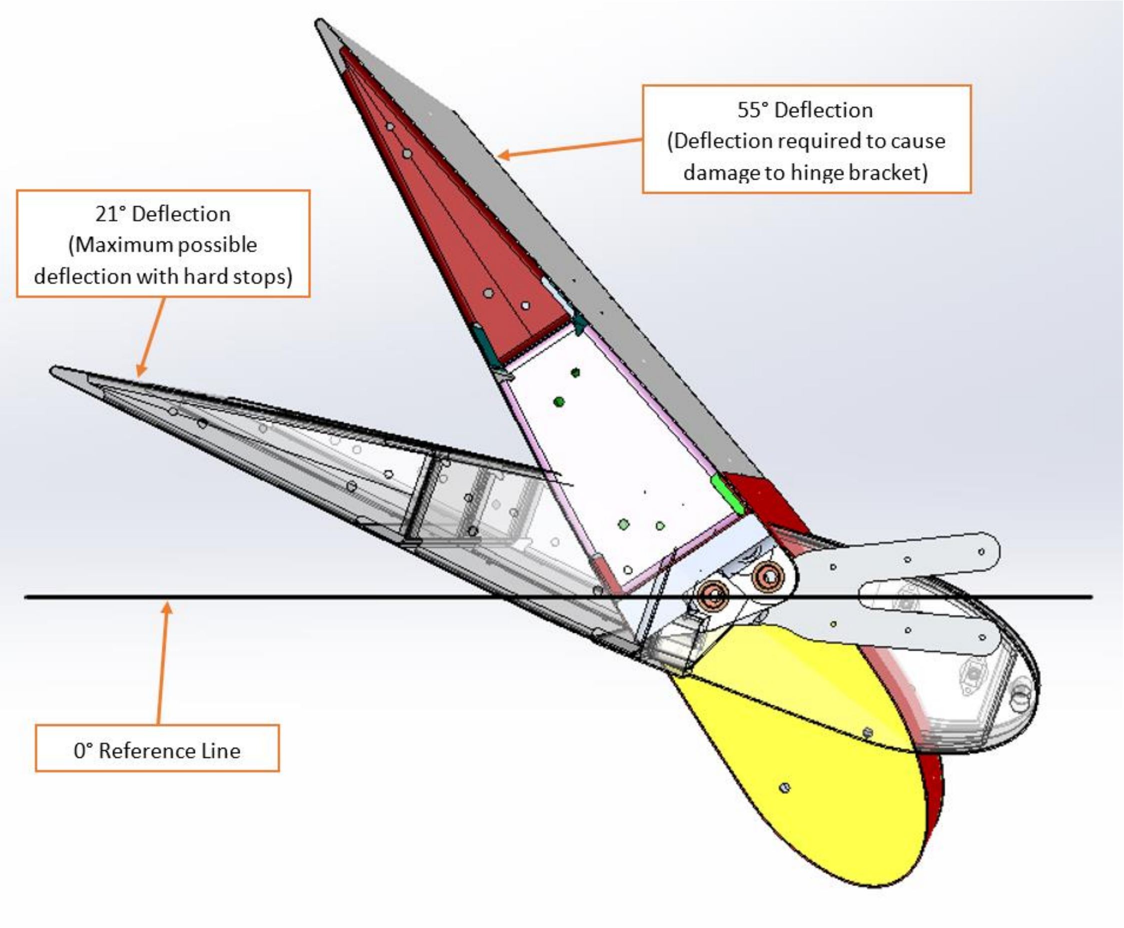
Illustration of impact tensile force and resulting damage to left-hand actuator

Physical evidence also shows that the TACS were forced to over-deflect beyond the physical limits of the actuator and deployment hardware post impact. During a meeting of the investigation parties to examine the wreckage of the accident aircraft, party members estimated that the damage to the left-hand TACS hinges was consistent with a TACS trailing edge up deflection of 55°, far exceeding the maximum possible deflection of 21°. See Party Submission at p. 22. The following figure from the Party Submission (Figure 2-16 at p. 22) presents the damage to the left hand TACS hinge caused by over-deflection of the TACS.

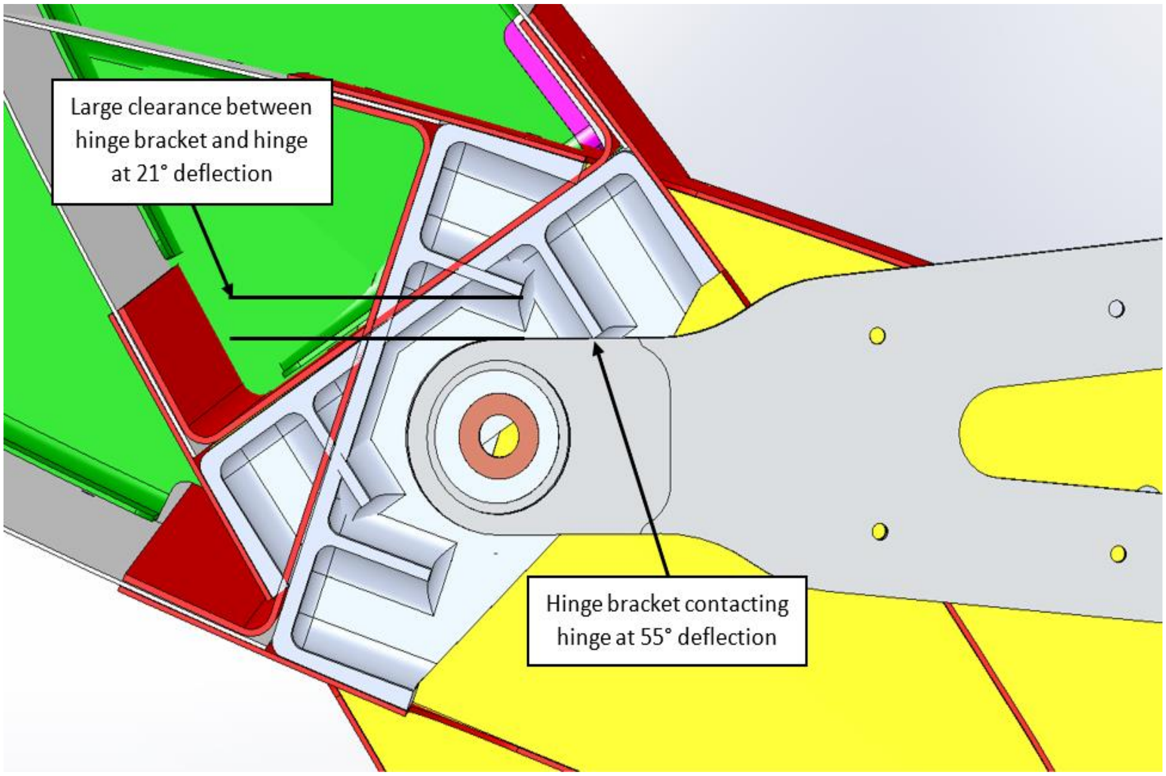


LH TACS hinge bracket damage

There are two sets of hard stops which limit the deflection of the TACS. One is the extension hard stop within the actuator. The other is a hard stop built into a bell crank connecting the actuator to the TACS. The maximum deflection allowed by either set of hard stops is 21°. The fact that the TACS hinges showed evidence of a TACS deflection to 250% of the maximum deflection indicates that the TACS were forced to an extreme trailing edge up deflection during the impact. The following two graphic depictions illustrate effects of 21° and 55° TACS deflections.



Comparison of LH TACS maximum deflection vs. over-deflection



LH TACS hinge bracket detail, maximum deflection vs. over-deflection

There is a walking beam installed between the actuator and the bell crank. The walking beam has three attachment points.[13] One end of the walking beam attaches to a bearing installed in a bracket mounted on the wing spar. The other end of the walking beam attaches to a bearing in the rod end of the actuator. The middle of the walking beam attaches to a bearing on a pushrod, which is connected to the bell crank that directly drives the TACS.

The walking beam was found fractured into two pieces. The fracture occurred at the point where the pushrod connects the walking beam to the bell crank. The damage to the walking beam was consistent with the middle bearing being torn out of the walking beam in the direction of the bell crank. This is consistent with the TACS being forced to an extreme trailing edge up deflection at high speed and clearly not a malfunction during flight operations.

It is probable that the contact marks on the ram guide housing were caused by initial impact forces, which deflected the ball screw within the actuator and caused the ball nut to contact the ram guide housing. It is therefore probable that the location of the contact marks on the ram guide housing indicate the position of the ball nut at the point of initial impact. It is probable that the left-hand actuator was subjected to more than one impact, as the left-hand wing was low on impact. This explains the

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[13] Please refer to the Figure *TACS deployment hardware overview* showing the location of the walking beam on the first page of the Appendix to of this Petition.

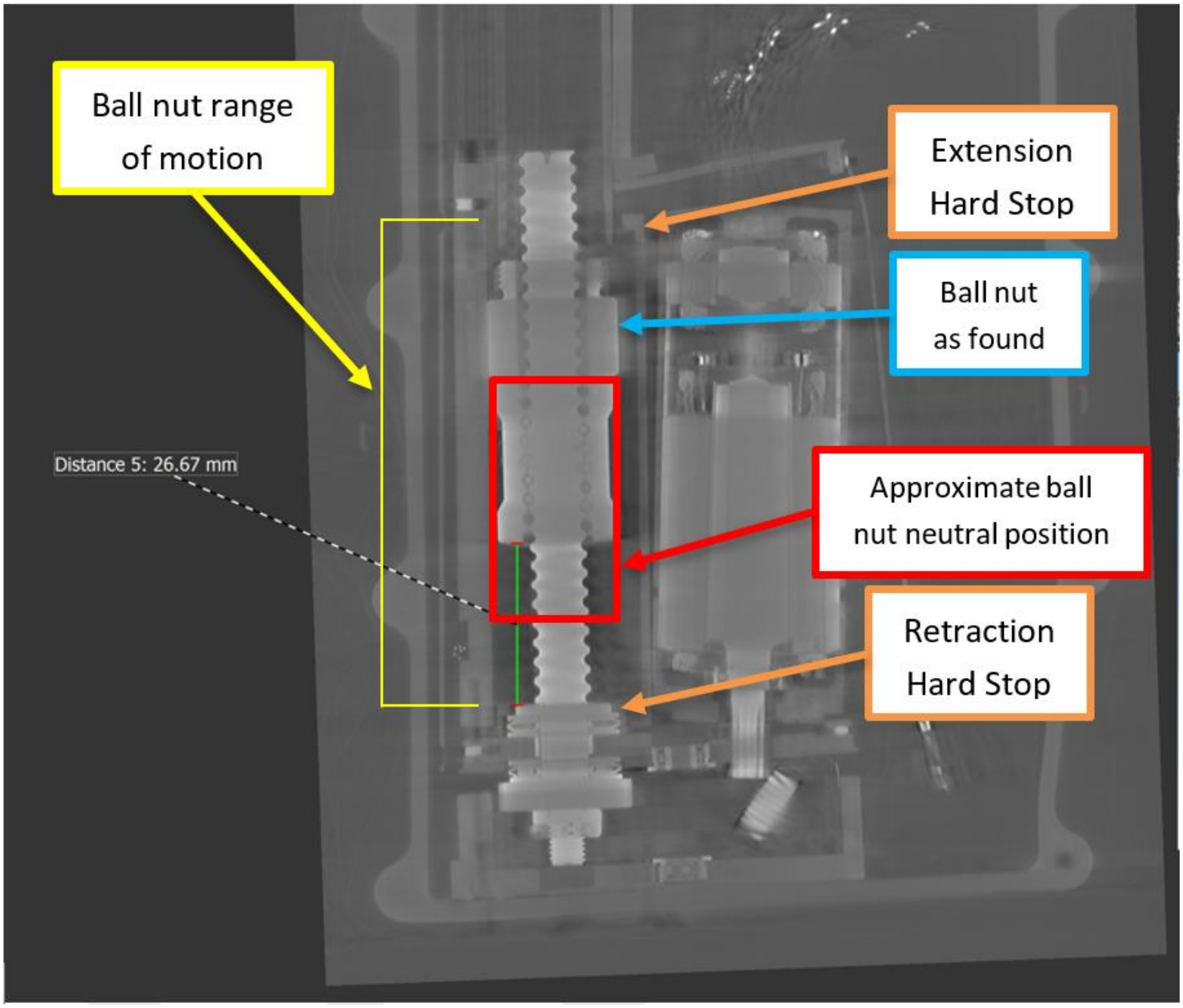
presence of multiple contact marks within the left-hand actuator, which appear to indicate movement of the actuator ball nut toward a more extended position.

It is also probable that the high energy contact marks on the extension hard stop within the left-hand actuator were caused during the impact, as the left-hand TACS was forced to an extreme trailing edge up deflection with sufficient force to cause multiple structural failures in multiple elements of the TACS installation.

The Final Report states the following, referring to the Right TCU:

> Additionally, marks on the ram guide housing were consistent with the actuator being in a midtravel position, or a **more neutral position** of the TACS. (at p. 2, ¶ 4, lines 3-4) [Emphasis added.]
>
> The location of the witness marks corresponded to a position of approximate midtravel of the actuator (**an intermediate extension position**). (at p. 14, first full ¶, lines 2-3) [Emphasis added.]

These two statements are inconsistent. An intermediate extension position is not the neutral position. The right-hand actuator contact marks appear approximately 0.40" from the extension end of the lower ball nut guide, or approximately 0.55" from the extension hard stop. This position is close to halfway between the neutral position and the maximum extension position. The right-hand TCU was found with the actuator ram tube broken off at the seal where the ram tube enters the actuator. CT scans of the right-hand actuator confirm that the ball nut was in this position when the right-hand TCU was recovered from the wreckage. See Systems Report, at Page 24, Figures 23 and 24; Party Submission, at page 28, Figure 2-22; and the figure below. As evidenced in the figure below (an image from the CT scan results of the right-hand TCU)[14], the location of the contact marks on the ram guide housing is direct evidence that the position of the ball nut was caused by the ground impact.



CT image of RH actuator in as-found condition

Damage to the right-hand TACS bell crank and right-hand TACS hinges indicate that the right-hand TACS was forced to an extreme trailing edge down position. This is not consistent with the contact marks within the right-hand actuator. The most probable explanation for the discrepancy is that the damage to the right-hand bell crank and right-hand TACS hinge occurred after the right-hand actuator ram tube was broken off.

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[14] This figure is derived from Figure 62 (on page 68) of the NTSB Computed Tomography Specialist’s Factual Report and the Party Submission, at page 14, Figure 2-6.

It is probable that the contact marks in the right-hand actuator were caused by impact forces. It is therefore also probable that the contact marks indicate the position of the ball nut at impact.

The bottom line of the foregoing discussion is that all of the damage and witness marks observed during the investigation were the result of the high impact forces when the aircraft struck the ground. None of these were caused by a pre-impact failure. Furthermore, evidence supports a finding that the actuators and TACS were in a symmetrical position at the time oftherefore do not support any hypothesis regarding actuator positions prior to impact, in a position consistent with the flight condition described in the NTSB's Performance Report.

E. Left-Hand TACS Hinge Damage.

The Final Report (at p. 2, ¶ 2, lines 4-7) states the following:

> Additional damage on the TACS inboard hinge fitting, consistent with overdeflection in the trailing-edge-up direction, was also consistent with the TACS being in a trailing- edge-up position at the time of ground impact.[15]

This statement is incorrect.

As discussed above in subsection D, the damage to the left-hand TACS hinge is only physically possible if the TACS are deflected to approximately 55°. See Party Submission at p. 22. A set of hard stops on the TACS bell crank limits the trailing edge up deployment of the TACS to a maximum of 21°, per the FAA-approved Installation Instructions and Aircraft Maintenance Manual Supplement. The actuator can only physically travel far enough to allow the TACS to deflect to 21° by design.

The damage that this statement describes can only have occurred post-impact and does not indicate the position of the actuator prior to impact.

When the TCU is unpowered, the entire control system is easily moved by hand. Therefore, it is expected that post-impact settling could have included forces that overextended the TACS and the TCU simultaneously, causing all of the damage observed in the TACS hinges, TACS pushrod, bellcrank assembly, walking beam assembly, the internal TCU witness marks at the fully extended position, and tensile failure at the attachment end of the actuator.

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[15] See Systems Report, Figure 55 (Left-hand TACS safety enhancements Inboard hinge fitting with signs of over-deflection damage highlighted), at p, 48).

F. TCU Curled Pins.

1. Lack of Intermittent Faults.

The Final Report (at p. 2, ¶ 6, lines 1-4) states the following:

> Post-accident examination revealed that the left TCU's 40-pin connector had 6 pins that were curled, with 2 of the pins not continuous, which could indicate an intermittent electrical connection in the left TACS that could interrupt power to the TACS, leading the left TACS to remain in a trailing-edge-up position while the right TACS floated to a neutral position.

This statement, at a minimum, is improbable and contains incorrect conclusions.

For context, there are two circuit boards within the TCU. The main circuit board is mounted on the bottom of the TCU enclosure. A smaller circuit board called the connector board is mounted vertically to the front face of the TCU enclosure. The function of the connector board is primarily to allow an environmentally sealed circular connector to be installed on the front face of the enclosure. The connector board also contains lightning protection components to protect the TCU circuitry from high energy transients. The connector board attaches to the main TCU circuit board via a 40 pin Mill-Max connector.

Curled pins were found on the left side of the 40 pin Mill-Max connector between the main TCU board and the connector board. Note that the left-hand TCU is mounted right-side up and the right-hand TCU is mounted upside-down. This is a result of the wing structure and installation needs. Note that this configuration causes the left and right TCUs to respond differently to impact forces, as discussed later in this petition.

The Final Report states (at p. 13, last **¶, and continuing on page 13):**

> The right TCU was found in the wreckage path, detached from its wing-mounted location. Its case was deformed and twisted, and the upper-case cover was found partially separated from the unit, **consistent with impact damage.** Internal components were found damaged. The ram tube assembly was fractured at the ball screw, and the remaining portion of the ram tube, internal to the assembly, was bent. [Emphasis added.]

Additional right-hand TCU components that were significantly damaged include the screws holding the PCB to the enclosure and the 40-pin connector.

According to the Final Report (at p. 13, first full ¶), the six pins which were found curled were pins 29, 31, 33, 35, 37, and 39. An explanation of each pin and its function is provided in the following Table:

Pin	Signal	Description
29	Ground	The main 16 AWG ground entering the TCU is split onto 16 of the smaller Mill-Max pins. 14 other common grounds remain.

31	Ground	The main 16 AWG ground entering the TCU is split onto 16 of the smaller Mill-Max pins. 14 other common grounds remain.
33	Servo Enable	The Atlas Control Unit (ACU) provides this signal to the TCU. When the enable signal is active, theTCU recognizes that the system is operational and will respond to ACU commands. If the signal were open, the TCU would move to its neutral position, then de-energize the actuator and “float.”
35	Servo Command	This signal is provided by the ACU. The signal is an analog voltage which varies between 1.0 and 10.0 VDC. If this signal were intermittent, the TCU would intermittently drive the actuator to the retraction hard stop and cause a high energy impact mark. It is extremely improbable that the pilot(s) or owner would not have noticed the left-hand TCU intermittently malfunctioning for 193 flight hours.
37	Servo Fault	This signal is provided by the TCU to the ACU as part of the system fault monitoring. If this signal were intermittent, it would not necessarily interrupt normal function of the system.
39	Position Output	This signal is provided by the TCU to the ACU. The signal is an analog voltage which varies between 1.0 and 10.0 VDC, nominally matching the command signal as the TCU responds to commands from the ACU. If this signal were open from one or both TCUs, the ACU would annunciate a fault to the pilot. If this signal were intermittent, it is extremely probable that the system would have intermittently annunciated faults. It is improbable that the pilot(s) or owner would not have experienced these intermittent faults frequently enough to contact Tamarack technical support at some point during the 193 flight hours since the TCUs were removed and reinstalled for service bulletin work.

Notably, the two signals which this statement in the Final Report describes as “not continuous” are the Servo Enable (Pin 33) and Servo Command (Pin 35). See also, Systems Report, § 4.4.2.1.3.3, *Additional Testing*, at p. 43. These are critical signals for the TCU. If these signals were open on the 40 pin Mill-Max connector between the connector board and the main TCU board, the TCU would simply not function. One of the other intermittent signals, the Position Output (Pin 39), is critical to normal ACU function and is redundantly monitored in the ACU. A Position Output signal failure will cause the ACU to latch a fault and annunciate to the pilot. When the system latches a fault, the fault can only be cleared by pilot action. As a result, it is improbable that a fault light warning would not be noticed by a pilot.

The airplane had flown for 193 flight hours since the TCUs were removed and replaced to implement a Service Bulletin issued by Cranfield Aerospace Solutions, with engineering support by Tamarack, (Service Bulletin CAS/SB1467[16]) on July 13, 2018. The fault monitoring implemented into ATLAS is specifically designed to detect and annunciate faults to alert the pilot to losses of load alleviation. There were no reports of faults from the accident aircraft between July and November of 2018. It is not possible that ATLAS would have functioned for 193 flight hours with three critical signals open or intermittent without annunciating intermittent faults to the pilot relatively frequently.

In addition to the TCUs replacements performed on July 13, 2018, to comply with Service Bulletin 1467, maintenance work was performed on 26 other airframe-related items, and 8 items related to both aircraft engines. As indicated in the Party Submission (at section 2.5, p. 30), the last maintenance on the accident aircraft occurred on November 20, 2018, ten days prior to the accident. Tamarack received no reports, and there is no evidence, of TCU faults or failures in time between the last maintenance on the TCU and the accident date. It is extremely improbable that multiple pilots and the owner would have ignored any faults that were annunciated, and not contacted Tamarack technical support to address the issue.

2. Cause(s) of Bent Pins.

The Final Report (at p. 3, ¶ 1, lines 1-3) states:

> However, it could not be determined how or when the pins had been curled, and the lack of fault recording capability in the ATLAS precluded the detection of any problems with the system.

This statement is misleading because it omits extensive follow-up investigation work to attempt to determine the cause of the bent pins in the TCU. Following discovery of the bent pins, Tamarack concluded that the extreme impact forces had caused the TCU circuit board to flex, partially disconnecting the 40 pin Mill-Max connector temporarily.[17] When the board flexed back, the pins were driven back into the sockets of the Mill-Max connector, but six pins did not seat properly and curled.

Further, as the Final Report states (at p. 13, last **¶, and continuing on page 13):**

> The right TCU was found in the wreckage path, detached from its wing-mounted location. Its case was deformed and twisted, and the upper-case cover was found partially separated from the unit, **consistent with impact damage.** Internal components were found damaged. The ram tube assembly

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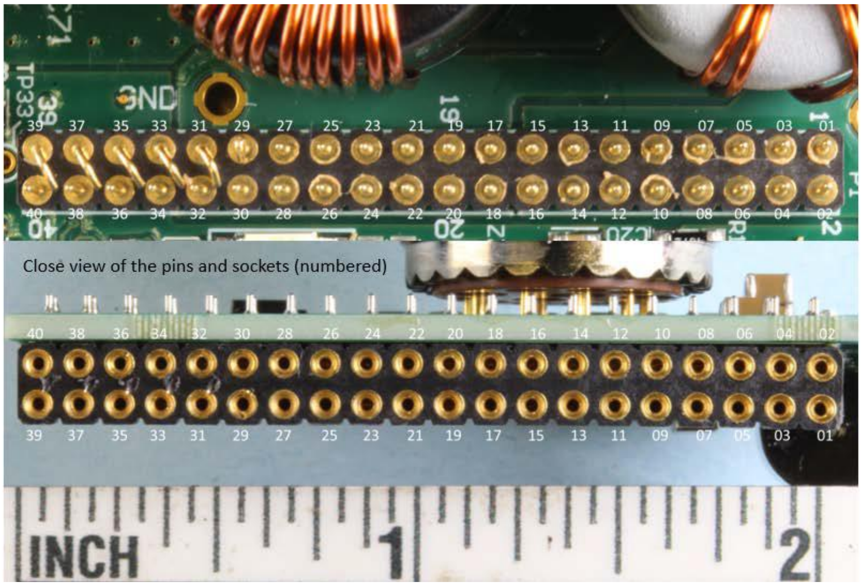
[16] Service Bulletin 1467 is available at https://app.box.com/s/rahh55nti1w94g7cgaol5q5.

[17] See the graphic depiction on page 28 of the Petition.

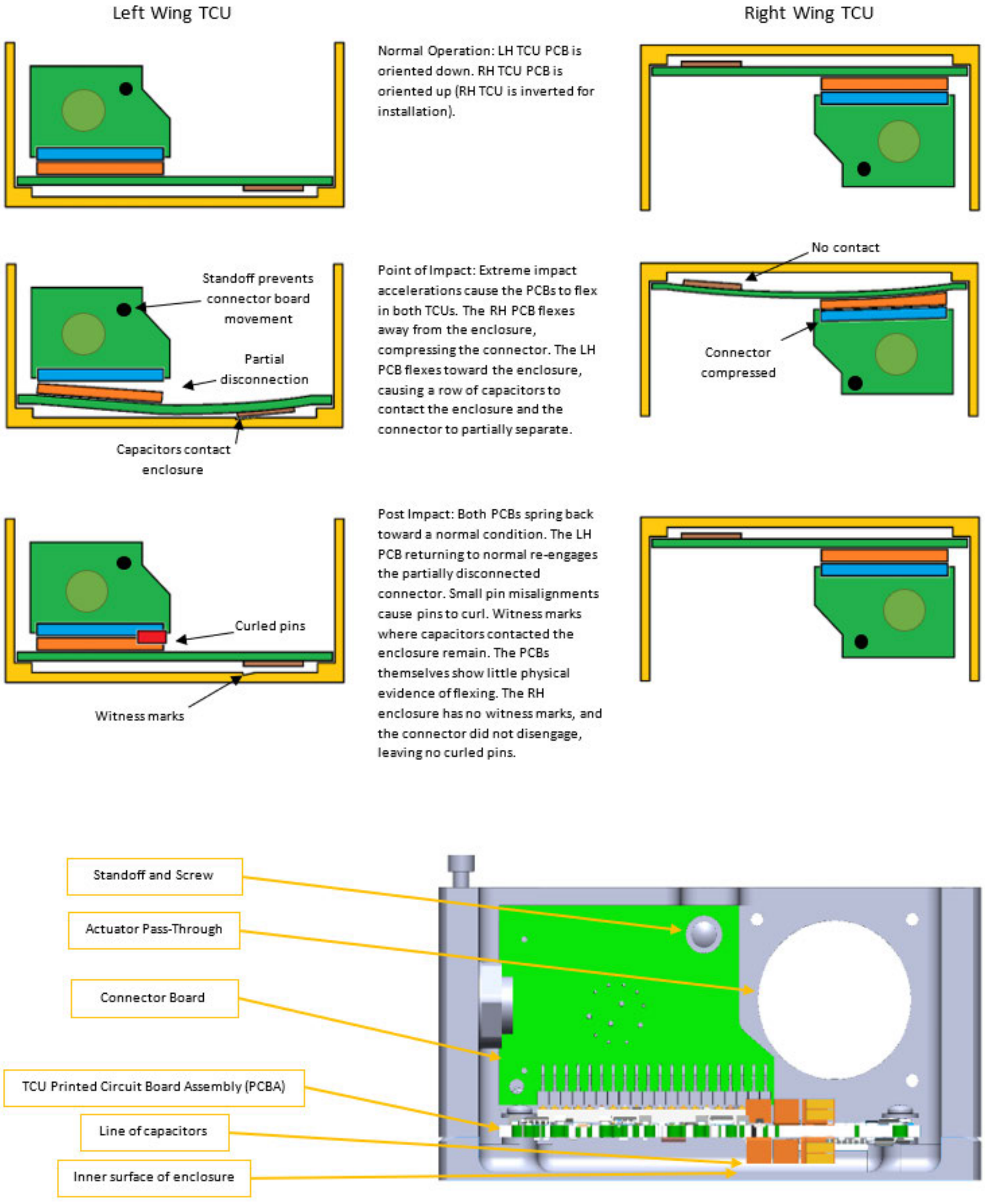
> was fractured at the ball screw, and the remaining portion of the ram tube, internal to the assembly, was bent. (emphasis added).

Additional right-hand TCU components that were significantly damaged include the screws holding the PCB to the enclosure and the 40-pin connector.

The location of the pins on the Mill-Max connector corroborates this theory. The six pins are located adjacent to each other, in one of the two lines of pins on the TCU main circuit board side of the connection. See the following figure from the Appendix A of the Systems Report, *Material Lab SEM Imagery of [Left-Hand] TCU* (Docket Item # 6, at p. A-2):



The pins are located on the line of pins farther from the front edge of the TCU housing, and on the far end of the connector from the TCU side wall. This is notable, because these pins are located under a less mechanically supported portion of the TCU board. In other words, if the TCU board were to flex, the pins are located in exactly the part of the connector which could be reasonably expected to move the most. The following graphic presents an illustration of how the left and right TCU would respond to impact forces, noting the difference in orientation between the left and right sides.



Normal Operation: LH TCU PCB is oriented down. RH TCU PCB is oriented up (RH TCU is inverted for installation).

Point of Impact: Extreme impact accelerations cause the PCBs to flex in both TCUs. The RH PCB flexes away from the enclosure, compressing the connector. The LH PCB flexes toward the enclosure, causing a row of capacitors to contact the enclosure and the connector to partially separate.

Post Impact: Both PCBs spring back toward a normal condition. The LH PCB returning to normal re-engages the partially disconnected connector. Small pin misalignments cause pins to curl. Witness marks where capacitors contacted the enclosure remain. The PCBs themselves show little physical evidence of flexing. The RH enclosure has no witness marks, and the connector did not disengage, leaving no curled pins.

TCU Section View (looking forward, some components hidden)

Illustration of TCU printed circuit board flex in response to impact forces

To test the theory, the NTSB sent the lower TCU cover to be imaged with a high magnification optical microscope. During this imaging, witness marks were discovered on the lower TCU cover. Notably, the marks on the lower cover approximately matched the shapes and locations of components on the lower side of the TCU circuit board. For example, a narrow rectangular mark was discovered below a pair of stacked capacitors with narrow, rectangular pieces of metal soldered to the ends to join the two capacitors. These witness marks are not addressed in the Final Report.

Images of the witness marks are available in Figures 40-42 of the Systems Report (at pp. 36-37), with the locations of the witness marks relative to components on the circuit board above them.

Scanning electron microscope (SEM) images were also captured, focusing on the interiors of the sockets on the connector board side of the Mill-Max connector. These images are included Appendix A of the Systems Report at pp. A-5 to A-12. Witness marks were found in the interiors of all sockets of the Mill-Max connector. This indicated that all of the sockets in the Mill-Max connector had made positive engagement with the mating pins at some point prior to being disconnected for imaging. Some sockets exhibited what appeared to be darker or more pronounced witness marks than others.

During the investigation, the NTSB SEM technician shared with the party an assessment that illuminating the interiors of such small sockets with an electron beam is difficult and that it is similarly difficult to ensure that each image is illuminated in exactly the same way. It is thus unclear whether some witness marks appear darker because of illumination or because of more positive engagement. It is also unclear whether a violent disconnection reconnection due to the circuit board flexing would cause the pins to rub within some sockets and therefore cause more pronounced witness marks. It is further unclear whether the process of disconnecting a damaged Mill-Max connector during post-accident investigation could cause some witness marks to be darker than others.

In summary, it is clear that the NTSB performed work that attempted to explain why certain pins were found curled in the left-hand TCU. The Final Report, however, does not describe any of that work or its results. Tamarack submits that inclusion of this information in the Final Report would significantly contribute to a better understanding of what caused the curled pins and demonstrate that it was the impact forces which did so.

G. Alleged Previous ATLAS Events

The Final Report (at p. 3, ¶ 5, lines 1-3) states the following:

> The investigation found that five uncommanded roll incidents have been reported to either the European Union Aviation Safety Agency or the Federal Aviation Administration involving airplanes equipped with ATLAS.

This statement is misleading and implies an incorrect correlation.

The statement refers to an investigation of an uncommanded roll event experienced by a Cessna Citation Jet 525 aircraft (N680KH) while departing Bournemouth, UK on April 13, 2019. Following an investigation, the United Kingdom Air Accident Investigation Branch issued its report on the incident (AAIB Bulletin: 1/2021, Docket

Item # 15).[18] The report included a summary of four other uncommanded roll events (see Table 2 of the AAIB report (at p. 31);

February 2018	Aircraft banked to the right in cruise achieving approximately 30° of bank as the pilot recovered. ATLAS would not reset in the air.
August 2018	Left Seat was being trained by Right Seat. "Right Seat" told "Left Seat" to recover and "Left Seat" did without "Right Seat" touching controls. "Left Seat" reported full aileron input for recovery. "Right Seat" reports that he "was never out of training mode".
January 2019	Pilot reported a violent roll input. Passenger didn't notice the event until landing.
March 2019	Pilot reported a roll input he assumed was autopilot hardover. Less than 45° bank during recovery, using 1/4 to 1/3 roll input.

Vital context is missing from the statement presented in the Final Report. The February 2018 event was the first known ATLAS asymmetric failure. Tamarack investigated that airplane following the event and determined that a screw connecting the vertical connector board to a standoff in the left-hand TCU had backed out. The subsequent Foreign Object Debris (FOD), *i.e.*, the screw, had interfered with electrical signals within the TCU. This interference caused the TCU to malfunction. Following the February 2018 event, CAS/SB1467 was issued. The Service Bulletin changed the design of the screw assembly to prevent the screw from becoming loose in the future.

Each of the reported uncommanded roll incidents summarized in the AAIB report clearly show that an aircraft with a malfunctioning TACS can be controlled with no resulting injury to the pilot or damage to the aircraft. Further, although the referenced uncommanded roll incidents involved known ATLAS failures, without exception, the aircraft recovered without injury to the pilot or damage to the aircraft. As mentioned earlier, these events corroborate extensive FAA and EASA flight test results, proving that an ATLAS failure does not present a pilot with an unrecoverable

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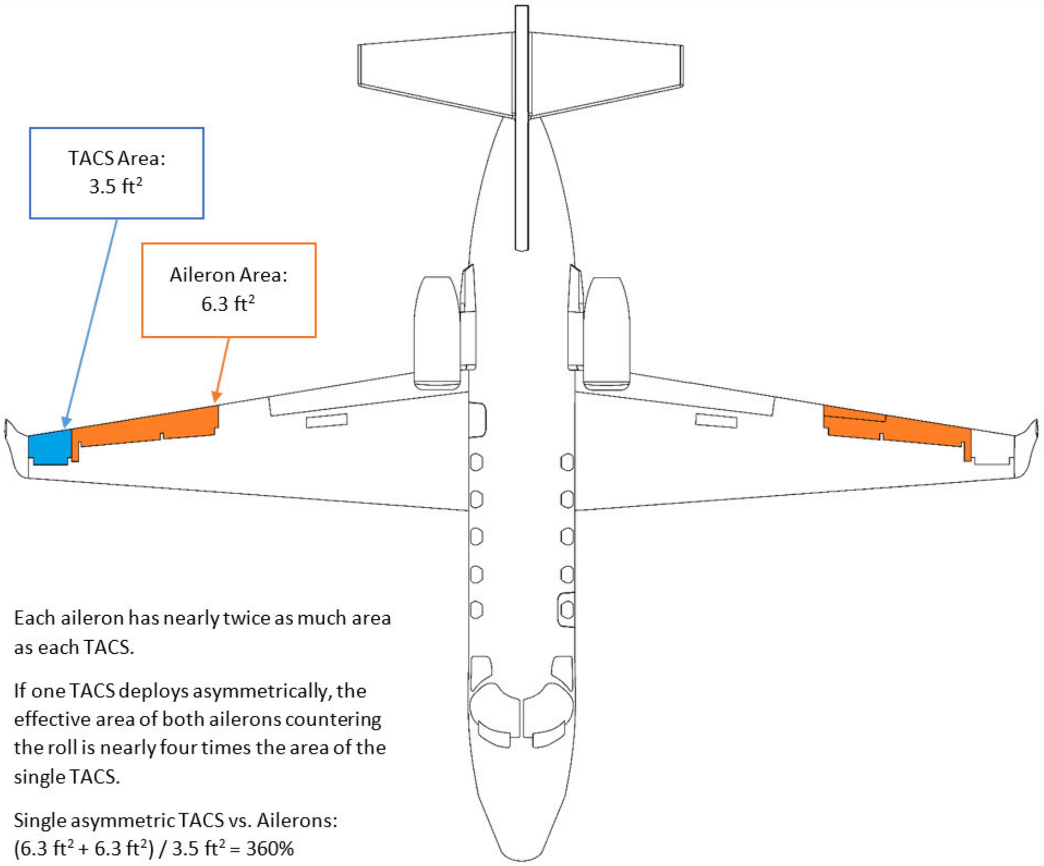
[18] The AAIB report's synopsis of the incident states:

> The aircraft had been modified with a system intended to enhance its performance, which included supplementary control surfaces designed to deflect symmetrically and automatically to alleviate gust loads. Shortly after takeoff, an electrical failure in this system caused one of these control surfaces to deploy separately, causing an uncommanded roll. The resulting aircraft upset caused the pilot significant surprise and difficulty in controlling the aircraft.

The NTSB Final Report also includes the AAIB synopsis (at p. 16).

flight condition. The following graphic depiction compares the area of the TACS vs. the ailerons and is offered to show the ability of the ailerons to counter uncommanded roll events. As the graphic description states, each aileron has nearly twice as much surface area as each TACS. If one TACS deployed asymmetrically, the effective surface area of both ailerons would clearly overcome the asymmetrical TACS deflection.



Each aileron has nearly twice as much area as each TACS.

If one TACS deploys asymmetrically, the effective area of both ailerons countering the roll is nearly four times the area of the single TACS.

Single asymmetric TACS vs. Ailerons:
$(6.3\ ft^2 + 6.3\ ft^2) / 3.5\ ft^2 = 360\%$

Comparison of aileron area to TACS area

Moreover, in each of the events, the airplane which experienced the event had not had the Service Bulletin applied. N525EG, the accident aircraft, did have CAS/SB1467 applied, as noted in the NTSB Final Report on page 11. In fact, the Service Bulletin had been applied 193 flight hours prior to the accident, with no faults reported to either Tamarack or the FAA.

Additionally, when the left-hand TCU was recovered from the wreckage and subsequently examined, the screw which had failed in each of the five above-described uncommanded roll events was found to be properly installed in its standoff. Thus, it is not physically possible that the accident aircraft experienced the same failure mode that the five uncommanded roll events experienced.

III. CONCLUSIONS.

This petition sets forth numerous instances where significant factual information included in the NTSB's Final Aviation Accident Report is either clearly erroneous or otherwise unsupportable. As a result, we specifically request that the NTSB carefully review this petition, make appropriate modifications to its Final Report, reevaluate its probable cause statement in light of the concerns we have raised, and prepare a revised probable cause statement.[19] Moreover, due to the technical nature of some of the issues, Tamarack requests the opportunity to make an oral presentation to the Board in accordance with 49 CFR § 845.32(d).

Sincerely,

[redacted]

Haldan Gates

Tamarack Aerospace Group, Inc.

cc: Dana Schulze (via email)
Kathleen Silbaugh (via email)
Timothy LeBaron (via email)

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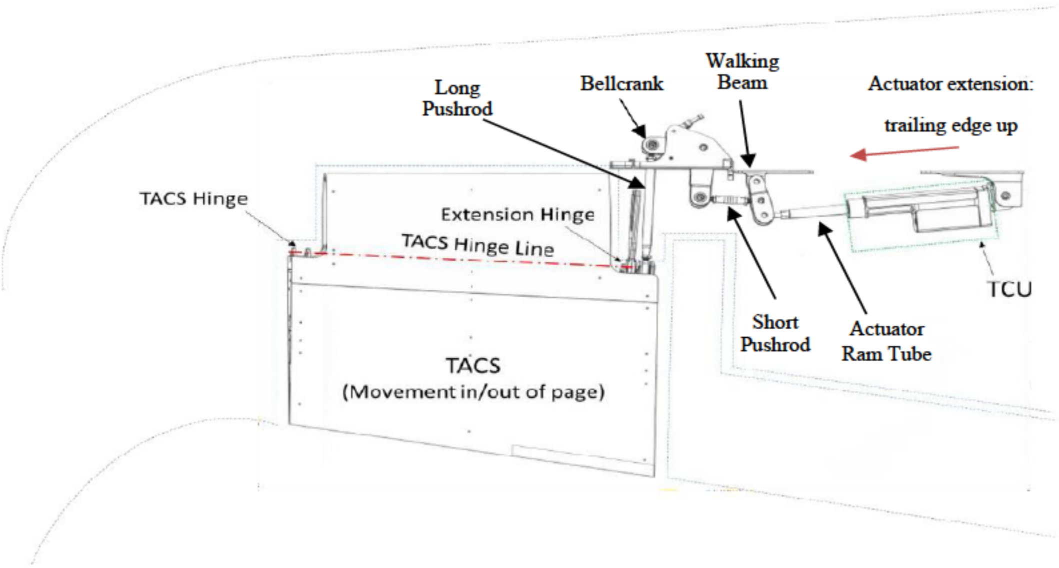
[19] We also respectfully request that a copy of this Petition for Reconsideration and the NTSB's ultimate response be placed in the public docket for this accident investigation.

IV. Appendix—TACS Deployment Hardware, TCU Hardware, and Actuator Hardware

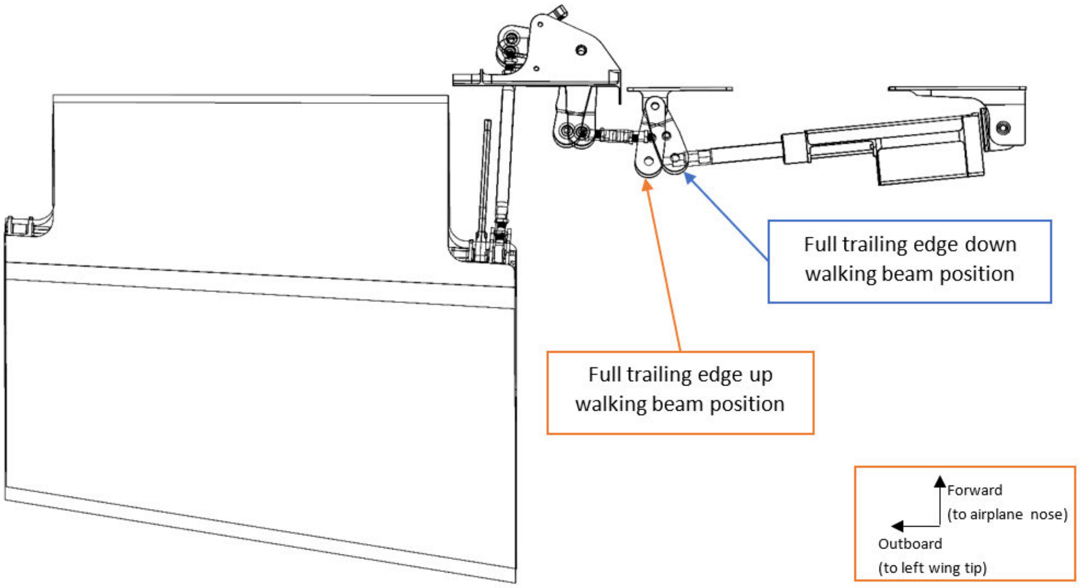
The following figure (also appearing as Figure 1-3 in Tamarack's Party Submission and its Party Submission with Errata) provides a diagram of components related to the deployment of the TACS on a Cessna 525A model. The figure below presents the system in a neutral position, with the TACS at 0°.



TACS deployment hardware overview

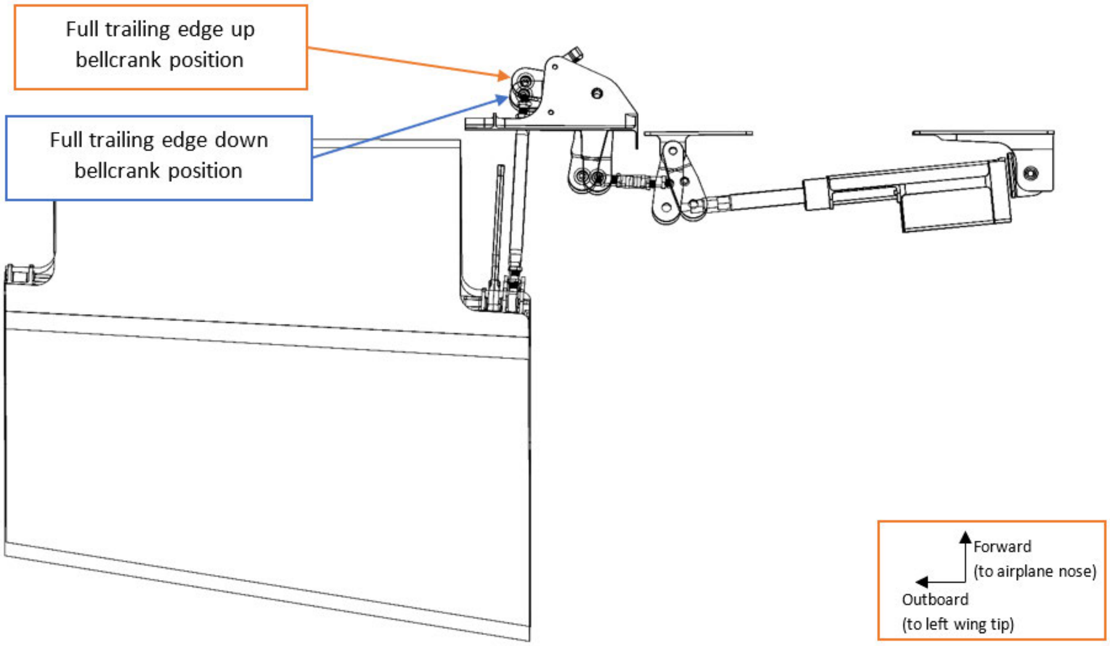
Each actuator is connected to a walking beam inside the wing near the end of the aileron. The actuator connects to the end of the walking beam. A short pushrod connects to the middle of the walking beam. The short pushrod connects to one arm of a bellcrank. The other arm of the bellcrank connects to a long pushrod. The long pushrod connects to the inboard hinge bracket of the TACS.

The actuator ram tube extends from its neutral position to deploy the TACS trailing edge up. The actuator ram tube retracts from its neutral position to deploy the TACS trailing edge down. The figure below provides an illustration of the position of the walking beam when the actuator is fully extended and when the actuator is fully retracted. Note that the images are superimposed to illustrate both limits of the system at once.



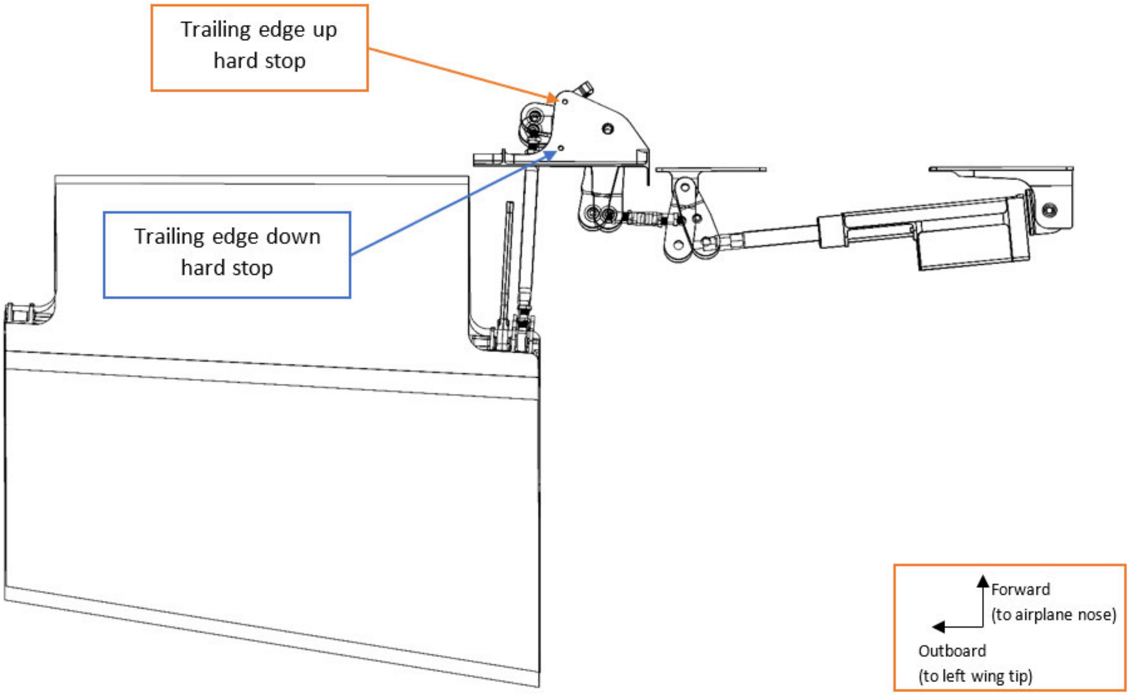
TACS deployment hardware, walking beam movement noted

As the actuator ram tube extends and retracts, the walking beam and short pushrod move inboard and outboard in response. This causes the bellcrank to rotate. The figure below provides the same image as the figure above, but with the position of the bellcrank at full trailing edge up and full trailing edge down deployment noted.



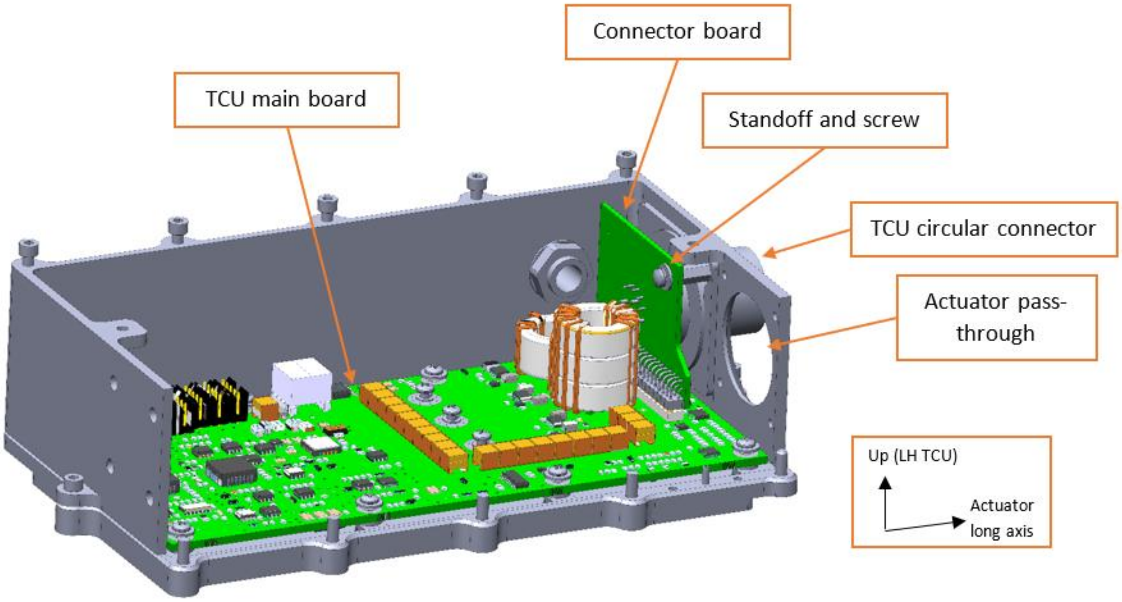
TACS deployment hardware, bellcrank movement noted

The bellcrank is installed in a bracket mounted inside the wing. Two bolts are installed in the bellcrank bracket on either side of one arm of the bellcrank. The bolts are oriented vertically, so that the bellcrank cannot rotate outside of a specific range of motion. These bolts are known as hard stops, and physically limit the movement of the TACS to a maximum of 21 degrees trailing edge up and 10 degrees trailing edge down. The figure below illustrates the positions of the hard stops.



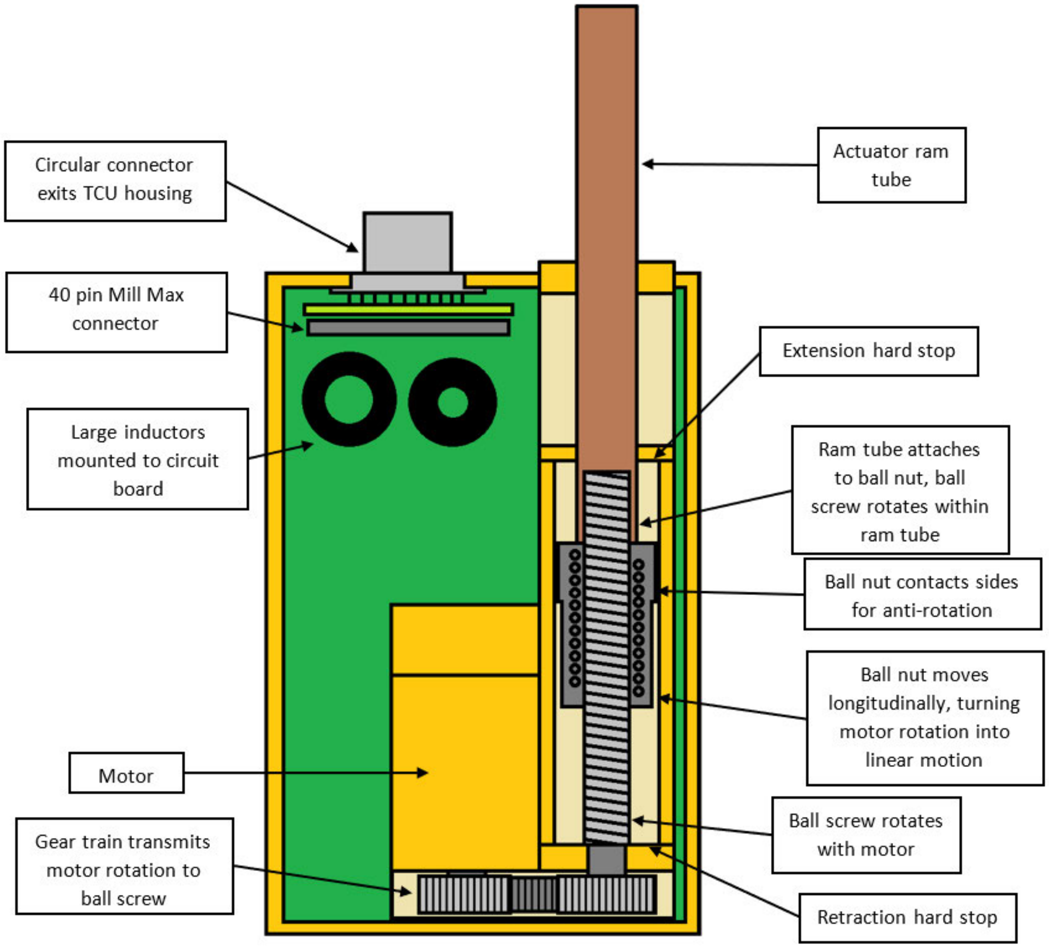
TACS deployment hardware, hard stops noted

The TACS are driven by linear electric actuators integrated with motor control circuitry inside a proprietary enclosure. The assembly of actuator and circuitry is known as the TACS Control Unit, or TCU. Each TCU contains two printed circuit board assemblies (PCBAs). The TCU main control board is the larger PCBA. This circuit board contains the motor control logic and monitoring circuitry. A smaller circuit board, known as the connector board, attaches to the main control board at a 90° angle via a 40 pin Mill Max connector. The connector board provides the interface between the TCU control board and the external circular connector that provides inputs and outputs to the TCU. The connector board is attached to the side of the TCU enclosure by the circular connector itself, and an additional standoff and screw assembly. The figure below illustrates the relationship of the TCU boards. Note that the actuator is hidden in the figure below, as well as the TCU enclosure top and assorted other assembly hardware. This is for clarity.



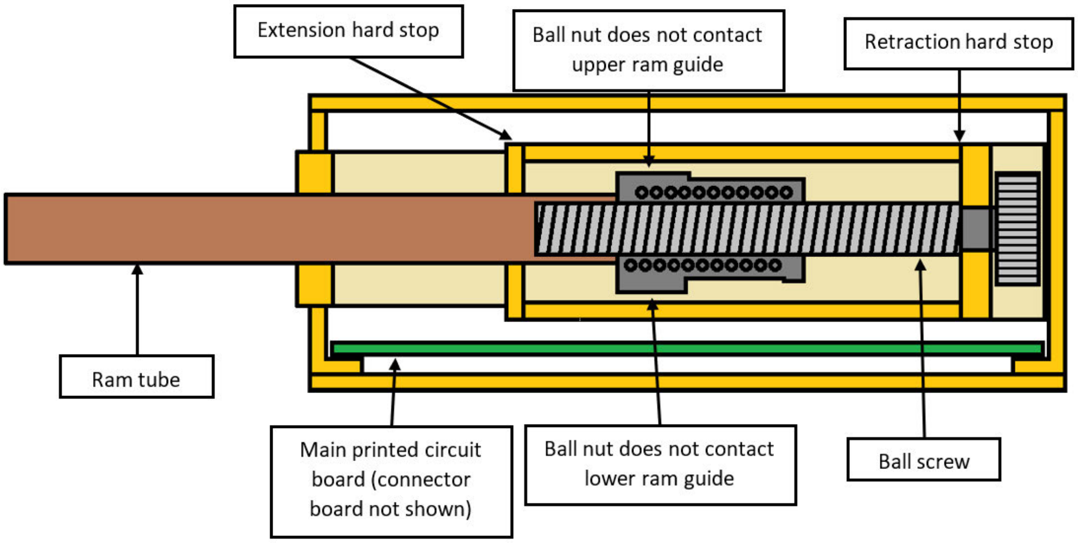
TCU interior detail

The actuator is a linear electric actuator. A high-speed electric motor is attached to a three-gear train to rotate a threaded shaft known as the ball screw. The ball screw rotates within a custom-designed assembly of ball bearings known as a ball nut. The combination of the ball screw and ball nut translates rotational motion into linear motion. The ball nut attaches directly to the ram tube of the actuator, so that the linear motion of the ball nut causes the ram tube to extend or retract. The figure below provides a highly simplified illustration of the internal components of the actuator relative to other TCU internal components. Note that the figure below is a top view, as a TCU would be oriented for the left-hand side of the airplane.



Actuator internal illustration (top view)

Note that the ball nut is designed to contact the interior of the actuator on the sides. This is to prevent rotation of the ball nut, which would hinder function. Crucially, the ball nut only contacts the interior of the actuator on the sides. The top and bottom of the ball nut do not come into contact with any face of the interior of the actuator normally. The figure below provides a similarly simplified illustration of the actuator from the side to demonstrate.



Actuator internal illustration (side view)

CERTIFICATE OF SERVICE

I hereby certify that on the 3rd day of January, 2022, a true and accurate copy of the foregoing Petition for Reconsideration filed with the National Transportation Safety Board was sent via U.S. certified mail, postage prepaid, return receipt requested, and via electronic mail message, to:

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To: [redacted]
Cc: [redacted]
Subject: Petition for Reconsideration, CEN19FA036
Date: Monday, January 3, 2022 10:55:10 AM
Attachments: Tamarack Aerospace - Petition for Reconsideration SIGNED.pdf

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Good morning-

Tamarack Aerospace Group is submitting a formal Petition for Reconsideration of investigation CEN19FA036, pursuant to 49 CFR 845.32. A PDF of the petition is attached, and a physical copy should arrive at the NTSB via certified mail within the next few days.

Copied on this email are the party members for the investigation as identified in the public docket for the investigation. They will also be provided with physical copies of the petition in addition to this PDF.

If there are any questions regarding our petition, please let me know.

Thank you,

HAL GATES
ENGINEER IV
[redacted]
w: www.tamarackaero.com

TAMARACK AEROSPACE
FAA-PMA PQ5231 NM CAGE Code: 6MQ60

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