June 30, 2017

Chairman of the National Transportation Safety Board
NTSB Headquarters
490 L'Enfant Plaza
Washington D.C. 20594

Cc: Federal Aviation Administration, Crane Aerospace, Hartzell Propeller Inc.

Re: Crash of Pilatus PC-12/45 N128CM Report No. NTSB/AAR-11/05 PB2011-910405

Enclosed with this letter is a Petition for Reconsideration and Modification of the National Transportation Safety Board's Findings and Determination of the Probable Cause for the Crash of Pilatus PC-12/45 N128CM.

We look forward to your consideration of its contents and to your response. If you have any questions, please do not hesitate to contact Anthony Tarricone at [redacted] or Stuart Fraenkel and Nicole Andersen at [redacted].

Sincerely,

[redacted]

Irving Feldkamp III
Pamela Feldkamp
on behalf of the Feldkamp Family

[redacted]

Robert Ching
Phyllis Ching
on behalf of the Ching Family

[redacted]

John Jacobson
Judy Jacobson
on behalf of the Jacobson Family

[redacted]

Louis Pullen
Noellene Pullen
on behalf of the Pullen Family

[redacted]

Richard Mautz
Cheryl Mautz
on behalf of the Mautz Family

June 30, 2017

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Re: Crash of Pilatus PC-12/45 N128CM Report No. NTSB/AAR-11/05 PB2011-910405

Enclosed with this letter is a copy of a Petition for Reconsideration and Modification of the National Transportation Safety Board's Findings and Determination of the Probable Cause for the Crash of Pilatus PC-12/45 N128CM. The Petition is being filed by the parents and grandparents of the 13 passengers who were killed in the crash on March 22, 2009.

Pursuant to 49 C.F.R. 845.41(b), Petitioners are serving a copy of the Petition on all parties to the NTSB investigation as identified on page 92 of the NTSB Final Report, which is attached as Appendix 1 to the Petition.

49 C.F.R. 845.41(b) also provides that a copy of the supporting documentation shall be served on all parties to the investigation. A copy of the Affidavit of Richard McSwain and accompanying exhibits are attached as Appendix 3 to the Petition.

The Petition is also supported by documents previously produced by Pilatus Aircraft in litigation under claims of confidentiality which are subject to a stipulated protective order. Petitioners challenged the validity of Pilatus' confidentiality claims, and Pilatus has continued to insist upon their confidentiality and protection. Pilatus agreed to allow Petitioner Dr. Irving Feldkamp III the use of these documents only as attachments in support of the Petition, as a basis for the arguments made in the Petition, and for no other purpose.

In consideration of the agreement, Petitioners have omitted Appendix 2 – which contains the Pilatus Documents – from the copies served upon the parties to the investigation. If any party wishes to review the Pilatus Documents, Petitioners advise them to contact counsel for Pilatus Aircraft, Bruce Berman at Carlton Fields Jordan Burt P.A., [redacted] / [redacted].

If you have any other questions concerning the Petition, please do not hesitate to contact Anthony Tarricone at [redacted] or Stuart Fraenkel and Nicole Andersen at [redacted].

Sincerely,

[redacted]

Irving Feldkamp III, D.D.S.

Petition for Reconsideration and Modification of the National Transportation Safety Board's Findings and Determination of the Probable Cause for the Crash of Pilatus PC-12/45 N128CM

And Appendices:

1. Final NTSB Report
2. Exhibits A through AD
3. Affidavit of Richard McSwain, Ph.D., P.E.
4. Letter from Carlton Fields

NTSB Report No. NTSB/AAR-11/05 PB2011-910405

Submitted June 21, 2017 by:

Irving Feldkamp III
Pamela Feldkamp
on behalf of the Feldkamp Family

John Jacobson
Judy Jacobson
on behalf of the Jacobson Family

Richard Mautz
Cheryl Mautz
on behalf of the Mautz Family

Robert Ching
Phyllis Ching
on behalf of the Ching Family

Louis Pullen
Noellene Pullen
on behalf of the Pullen Family

Table of Contents

Abbreviations:

ABS	Automatic Fuel Balancing System
AFM	Aircraft Flight Manual
CAWS	PC-12 Central Advisory and Warning System
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FBP	Fuel Boost Pump
LFP	Low Fuel Pressure
the Report	subject NTSB Report
QRH	Quick Reference Handbook

Petition for Reconsideration and Modification of the National Transportation Safety Board's Findings and Determination of the Probable Cause for the Crash of Pilatus PC-12/45 N128CM - Report No. NTSB/AAR-11/05 PB2011-910405

I. INTRODUCTION

A. Overview

A Pilatus PC-12/45 aircraft, registered as N128CM ("the Aircraft") crashed near Butte, MT on March 22, 2009, killing all thirteen passengers and the pilot. The National Transportation Safety Board ("NTSB") investigated the accident with the assistance of the aircraft manufacturer, Pilatus Aircraft Ltd, *inter alia.*

On July 12, 2011, the NTSB adopted a Report of Findings and Determination of the Probable Cause for the Crash of Pilatus PC-12/45 N128CM Report No. NTSB/AAR-11/05 PB2011-910405 ("the Report").

Petitioners Dr. Irving and Pamela Feldkamp III are the parents of two of the crash victims, and the grandparents of five of the crash victims. Dr. Feldkamp was also the President of Eagle Cap Leasing Inc., the operator of the subject aircraft. Petitioners Robert and Phyllis Ching are the parents of one of the crash victims and the grandparents of two of the crash victims. Petitioners John and Judy Jacobson are the parents of one of the crash victims and the grandparents of three of the crash victims. Petitioners Richard and Cheryl Mautz are the parents of one of the crash victims and the grandparents of two of the crash victims. Petitioners Louis and Noellene Pullen are the parents of one of the crash victims and the grandparents of two of the crash victims.

The petition is also supported by documents, deposition testimony and an affidavit from a concerned engineer, Richard McSwain, Ph.D. The supporting documents are listed and contained in Appendix A. Many of the documents are claimed "confidential" by Pilatus Aircraft and subject to a confidentiality agreement between Pilatus and Petitioner Dr. Irving Feldkamp III.

Petitioners hereby request reconsideration and modification of the Report[1]. This petition is based upon both 1) new material evidence, and 2) identification of erroneous findings that do not support the Report's conclusions and determination of probable cause. It is submitted in accordance with 49 C.F.R. §845.32 et seq.

49 C.F.R. §845.32(a)(3) provides:

Petitions must be based on the discovery of new evidence or on a showing the Board's findings are erroneous. (i) Petitions based on the discovery of new evidence shall: Identify the new matter; contain affidavits of prospective witnesses, authenticated documents, or both, or an explanation of why such substantiation is unavailable; and state why the new

[1] Counsel for the Petitioners, Stuart Fraenkel and Nicole Andersen at Nelson & Fraenkel LLP and Anthony Tariccone at Kreindler & Kreindler, LLP prepared this petition for and at the direction of the Petitioners because of their familiarity with the evidence and involvement in the lawsuit concerning the subject accident. The private litigation related to this is over; there is no pending lawsuit or even the possibility of future legal proceedings. This appeal is entirely unrelated to private litigation and intended only to prevent another tragedy from occurring.

matter was not available prior to Board's adoption of its findings. (ii) Petitions based on a claim of erroneous findings shall set forth in detail the grounds relied upon.

NTSB investigations are meant to "ascertain measures that would best tend to prevent similar accidents or incidents in the future." (49 CFR 831.4) The reconsideration procedure allows the NTSB to review new evidence and enables the development of safety recommendations based on the most complete record possible. The new and previously unanalyzed evidence contained herein is presented with these goals in mind. Petitioners believe that the new evidence relates directly to the safety of flight of the PC-12/45 aircraft still in operation. The lives of PC-12 pilots and occupants, and those individuals on the ground in the zone of danger, are at risk of serious injury and death if certain design flaws and other issues with the PC-12 are not rectified by the FAA and Pilatus.

Subsequent to the NTSB Investigation, Petitioners and their representatives conducted extensive inspections and analyses of the aircraft wreckage and documentary evidence produced by Pilatus Aircraft Ltd. This investigation bore new evidence and insight that contradicts and challenges the accuracy of premises upon which the Report's findings and conclusions are based. The new evidence necessitates that the Report's findings and conclusions be reevaluated, reconsidered and modified accordingly.

B. New Evidence

The most significant new discovery consists of material components of the aircraft's left Fuel Boost Pump ("FBP") not recovered or analyzed during the NTSB wreckage investigation. Petitioners' representatives tested and analyzed these components, which confirmed that the left FBP had failed completely and revealed mechanical defects that led to its failure.

Other new key evidence comes from documents and testimony uncovered during the discovery phase of litigation in the Los Angeles Superior Court cases consolidated as *Jacobson v. Pilatus Aircraft Ltd. et al*, case no. [redacted]. This evidence reveals new information related to the development, history and operation of the PC-12 aircraft and its systems.

Below, Petitioners outline the new evidence he presents and its relevance to the reconsideration or modification of findings and conclusions in the Report.

NEW EVIDENCE	THIS EVDIENCE PROVES OR EXPLAINS THAT:	Sec X
1. Documents concerning the history of the PC-12 fuel system from before certification through the present.	• Pilatus knew, prior to certification of the PC-12 aircraft, that the fuel system was prone to icing, and that human error in ensuring the Prist requirement could lead to deadly consequences. • Pilatus knew, for over a decade before the fatal accident, that the PC-12 fuel system was prone to icing.	A
2. Testing and analysis of the	• The left FBP was mechanically defective which led to its failure on the flight, contributing to the cause of the crash.	B

NEW EVIDENCE	THIS EVDIENCE PROVES OR EXPLAINS THAT:	Sec X
left Fuel Boost Pump ("FBP")	• The PC-12 FBPs were not incorporated into the original PC-12 design and were never properly certified/tested by or on behalf of the FAA or any other authority for use on the PC-12.	
3. Documents and testimony concerning the PC-12 Fuel System	• The PC-12 FBPs were designed and intended to provide backup fuel pressure in the event of a blocked fuel filter caused by icing. • The PC-12 FBPs were not original design FBPs and were never properly certified/tested by or on behalf of the FAA or any other authority for use on the PC-12. • There is no redundancy in the event of a PC-12 FBP failure. • If an FBP fails when its function is required (i.e. a foreseeable fuel icing event), the system design will cause an increasing fuel imbalance in the opposite wing which is uncorrectable, resulting in a dangerous asymmetric fuel imbalance that is beyond the design characteristics of the airplane.	B, C
4. Documents and testimony concerning the PC-12 Central Advisory and Warning System ("CAWS")	• The CAWS system was defectively designed and programmed so that it suppresses the Low Fuel Pressure ("LFP") caution/warning that the system is required to provide. • Due to the logic programmed into the CAWS, a pilot will never receive a LFP warning during a fuel icing event. • The design of the aircraft and its CAWS are in violation of the Federal Aviation Regulations ("FARs"). • The FUEL PRESS caution light was never displayed during the hundreds of low pressure events on the fatal flight, nor on any of the previous flights when the aircraft experienced low fuel pressure events, because of the faulty CAWS programming. • A single LFP warning to the pilot, which should consist of a LFP light, an aural warning and a Master Caution warning, would have given the pilot of the accident PC-12 valuable information which would have saved the lives of the pilot and those on board. • If the CAWS system had operated as required, the pilot would have received LFP warnings\ well before a fuel imbalance occurred, increasing the likelihood of a successful landing.	C
5. Documents and testimony concerning the	• The subject aircraft's AFM and QRH contained inaccurate descriptions of the fuel system and warnings.	C

NEW EVIDENCE	THIS EVDIENCE PROVES OR EXPLAINS THAT:	Sec X
PC-12 Aircraft Flight Manual ("AFM") and Quick Reference Handbook ("QRH")	• The AFM and QRH contain defective language concerning: o The indication for operation of the FBPs; o The indication of an FBP failure; o The indication for a LFP condition; o Emergency Procedures for an Auto Fuel Balance ("AFB") system failure; o Emergency Procedures for a LFP condition. • Pilatus was aware of the inaccuracies in the AFM and QRH for years before the accident flight. • Pilatus corrected inaccurate language in the AFM before the fatal flight for other PC-12 aircraft iterations (i.e. the NG iterations, starting with serial no. 1001), but not for the accident aircraft (i.e. "Legacy" iterations ending in serial no. 888). • The design of the aircraft and its CAWS are in violation of the FARs. • There were no applicable emergency procedures or instructions for the situation that occurred on the accident flight.	
6. Correspondence between Pilatus and the Federal Aviation Administration ("FAA")	• Six years before the crash, the FAA expressed specific concerns with icing issues in the PC-12 fuel system and forewarned of the failure scenario that occurred during the flight. • If the PC-12 operates as designed and intended, the FBPs should provide equal fuel delivery to the engine in the event of a LFP situation caused by fuel system icing. • Pilatus gave false representations to the FAA that the failure scenario that occurred on the accident flight was not a safety concern. • Pilatus was aware of the PC-12's propensity for fuel icing since prior to certification of the PC-12 and prior to the production of the most recent PC-12 iteration, the "NG".	A

C. Erroneous Findings

Based on a critical analysis of the above-outlined new evidence, the following findings of the NTSB Report will be shown to be erroneous:

Finding No. 2

The NTSB Finding No. 2 states:

The investigation found that the airplane was properly certified, equipped, and maintained in accordance with Federal regulations and that the recovered components showed no evidence of any pre-impact structural, engine, or system failures.

Finding #2 in the Report is erroneous because the aircraft was *not* properly equipped in accordance with Federal regulations. New evidence (documents and testimony) shows that the aircraft's Central Advisory and Warning System ("CAWS") was designed in direct violation of the FARs concerning cockpit cautions and warnings.

The FARs require aircraft cockpits to be equipped with a **red** warning light to indicate a Low Fuel Pressure ("LFP") condition[2]. Per the FARs, red warning lights are meant to prompt immediate corrective action by a pilot. But the PC-12 instead uses a yellow caution light, which the FARs treat as much less serious an indication. Consequently, a PC-12 pilot is not warned of the seriousness of a LFP condition as the FARs intended.

But new evidence reveals something even more egregious – the PC-12's improper yellow LFP warning does not even function under most intended circumstances. A pilot will never get a LFP warning during a foreseeable fuel icing event. This is due to an inexplicable one-second time delay, programmed into the system, that suppresses the caution light, aural gong and Master Caution light for a LFP condition. Therefore, despite hundreds of recorded occurrences of LFP on the accident aircraft, including many occurrences prior to the accident flight, the pilot never received a single indication of a LFP condition.

The CAWS system that incorporates this defective design was introduced in 2001, many years after certification of the PC-12. (See CAWS 2001 Engineering Report, Ex. R). The new system was never tested or certified under FAA regulations. The subject aircraft's warning system was not only designed in violation of the FAR requirements, but the LFP indication was completely ineffective on the accident aircraft. Even to this day, PC-12 aircraft manufactured between 2001 and 2007 are equipped with this faulty CAWS system violating federal regulations and threatening the lives of pilots, passengers and those on the ground in the zone of danger.

Finding No. 3

The NTSB Finding No. 3 states:

The low fuel pressure state <u>and the restricted fuel supply from the left tank during the accident flight</u> were the result of an accumulation of ice in the fuel system with an initial concentrated amount of ice at the airframe fuel filter.

Finding #3 erroneously identifies icing as the cause of the *restricted fuel supply* from the left tank, even though there is no evidence to support such a theory. The cause of the limited left-hand fuel supply (and resulting imbalance) is essential to a probable cause determination. Therefore, this fallacy is critically important. Within new evidence, Pilatus itself represents that a LFP condition should not have caused the crash, because the fuel system was designed to prevent such complications. Pilatus designed the fuel system such that when the airframe fuel filter encounters icing, the FBPs in both wings, together or singularly, can provide sufficient pressure to send fuel through a fuel filter by-pass, and ensure that the engine always receives sufficient fuel.

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[2] A condition of low fuel pressure in the PC-12 fuel system is considered to be fuel pressure below 2psi (hereinafter "Low Fuel Pressure Condition"). (Report at p. 15 "low fuel pressure occurs when fuel system pressure is less than 2 psi.")

The above determination that an ice accumulation could or did cause a "restriction" of the left side of the fuel system is contrary to the design of the PC-12 fuel system itself, contradicted by the evidence, and fundamentally impossible. The only "icing" restriction that could have occurred on the subject flight would have been a temporary and passable icing restriction at the airframe fuel filter. There was not, and cannot be, an icing restriction in one wing only.

Pilatus was aware of the PC-12 fuel system's icing propensity since at least the early 1990s, before the aircraft was certified. Pilatus knew that airframe fuel filter was prone to icing before the first aircraft S/N 101 came off of the production line. Pilatus knew, prior to certification of the PC-12 aircraft, that human error in carrying out the Prist requirement could lead to deadly consequences. Both PC-12 prototype aircraft experienced fuel system during the design and certification testing. The very first PC-12 in service, S/N 101, experienced fuel system icing during its ferry flight to the U.S. after being fueled at the Pilatus factory and while being piloted by Pilatus test pilots. For years following production, Pilatus' customers and even its own engineers encountered fuel system icing on the PC-12 due to an insufficient concentration of Prist in the fuel.

In 2003, the FAA became aware of the PC-12's vulnerability to fuel system icing and confronted Pilatus through detailed correspondence concerning specific fuel system icing incidents. The FAA correspondence forewarned of the exact scenario that occurred on the accident flight. Yet despite these grave concerns, Pilatus withheld critical information from the FAA and intentionally provided the FAA with misleading information in its response to the FAA.

Further new evidence allowed Petitioners and their consultants to explain the *true* cause of the limited left-hand fuel supply and progressive left-side heavy imbalance. Subsequent to the NTSB investigation, components of the left FBP were discovered among the recovered wreckage and preserved following the accident. Forensic testing, coupled with extensive documentary analysis, confirmed that the left FBP had a mechanical defect that caused its failure during the flight. This failure, coupled with the fuel system design—not a "restriction" due to icing—was the direct cause of lack of fuel delivery from the left tank, the severe fuel imbalance and the subsequent crash.

Finding No. 4

The NTSB Finding No. 4 states:

If the pilot had added a fuel system icing inhibitor to the fuel for the flights on the day of the accident, as required, the ice accumulation in the fuel system would have been avoided, and <u>a left-wing heavy fuel imbalance would not have developed.</u>

The above finding is premised on the same mistaken analysis as Finding No. 3. New evidence proves that the decreased left-side fuel flow and resultant imbalance were not caused by ice accumulation but by a mechanically failed left FBP. If both FBPs were operating properly, the lack of a fuel system icing inhibitor would not have caused an imbalance or resulted in any fuel starvation event. The FBPs, coupled with the fuel filter bypass, are designed to handle any fuel icing event. It is only when a FBP fails that an imbalance will be created as a result of the fuel system design.

New documentary evidence reveals additional defects with the PC-12 fuel system, warning system and AFM that directly contributed to the irreversible emergency situation on the flight, none of which were related to the lack of FSII in the fuel. Most notable among the defects is the blatant lack of redundancy with the PC-12 FBPs which are responsible for running the LFP system and the Auto Fuel Balance System ("ABS"). Because there is no redundancy, if either FBP fails, an uncorrectable imbalance will develop. This is precisely what occurred on the accident flight.

Internal Pilatus company documents show that before the PC-12 was even on the market, Pilatus foresaw the exact failure sequence that occurred with N128CM—that a failed FBP would disable the ABS and instead transfer fuel from one side to the other, while the crew is deceived by the lack of any warning. The lack of an LFP warning is another unanalyzed defect that was a direct cause of the imbalance on the subject flight. Had the CAWS system operated *as required*, the pilot would have received many red warnings on the first flight of the day and would have landed the plane immediately, without ever having taken on a single passenger.

The language of the Report also strongly suggests that the NTSB was not provided with the full gamut of information concerning the PC-12 manual and warnings. The Report does not fully acknowledge that the operative PC-12 AFM contained defective language concerning the CAWS advisory lights for FBPs. The manuals advise the pilot that green lights indicate whether each FBP is operating. But this is very deceiving because the green lights only indicate whether an FBP has been *signaled* to operate. In fact, these lights will be displayed in the cockpit even if one or both FBPs have failed. Had the pilot received a CAWS warning for LFP, he would have diverted in accordance with the instructions in the AFM & QRH, thereby minimizing the possibility of a fuel imbalance if a FBP were to fail.

Pilatus was aware of this erroneous language but seemingly never informed the FAA, pilots, or the NTSB during the investigation. As with the LFP warning defect, the erroneous language is still contained in the AFM to this day. The potential impact of these omissions on a pilot's decision-making is unquestionable and such analysis is crucial not only to the completeness of the Report, but to the safety of pilots and passengers daily.

Finding Nos. 9, 11 & 13

The NTSB Finding No. 9 states:

Although the <u>pilot should have diverted to a nearby airport once the maximum allowable fuel imbalance had been exceeded</u>, the pilot eventually diverted to Bert Mooney Airport likely because he recognized the magnitude of the situation and his attempts to resolve the increasing left-wing-heavy fuel imbalance had been unsuccessful.

The NTSB Finding No. 11 states:

The large left rolling moment induced by the left-wing-heavy fuel imbalance could have been minimized or even avoided <u>if the pilot had followed Pilatus Aircraft's required procedures for flight operations with a fuel imbalance</u>.

The NTSB Finding No. 13 states:

The pilot underestimated the seriousness of the initial fuel imbalance warnings because he had not experienced any adverse outcomes from ignoring similar previous warnings.

The entire Report heavily criticizes the pilot for the timing of his emergency diversion to his pre-chosen alternate airport. The above Finding Nos. 9, 11 & 13 illustrate how heavily the Report and its conclusions rely on the PC-12's "maximum allowable fuel imbalance", and criticize the pilot's behavior when such imbalance was supposedly exceeded. But new and unanalyzed evidence shows that this criticism was based on a number of assumptions originating from Pilatus during the investigation. Such input was both biased and underdeveloped, creating the precarious speculations and flaws in the Report's analysis.

In reality, PC-12 pilots are not equipped with any knowledge of the "maximum allowable fuel imbalance" or any specific emergency procedure to be performed when the fictional limitation is exceeded. New evidence shows that there are no warnings, cautions, or even emergency procedures specifically outlined for a fuel imbalance exceedance. Indirectly acknowledging the lack of any tangible "imbalance warnings", the Report's only reference to such a warning is the visual differential on the fuel gauges. The Report incorrectly categorizes this visual as an emergency indication, but it is far from it. During its final flight, the accident aircraft was afflicted with both a recurring LFP condition and a failed FBP, yet there were *no* cautions or warnings displayed throughout the entirety of the accident flight until the "Fuel Level Low" light 6 minutes before the crash.

The Report suggests that the pilot should have immediately followed the emergency procedure for an ABS failure even though the indication for this procedure was not present. Even if the pilot, in extreme foresight, had followed that emergency procedure, the Report takes great liberties in suggesting what he should have done. The Report concludes that the pilot should have diverted and landed immediately when the maximum imbalance was reached, but this is not instructed by the AFM. What is instructed by the AFM is to first troubleshoot – this is what the pilot did, and the Report (see Finding #9) specifically criticizes him for doing.

Finding Nos. 9, 11 and 13 are therefore erroneous because they do not accurately reflect the facts known about the situation with which the pilot was faced, nor do they account for the content of the emergency instructions available to the pilot.

Finally, even if the pilot had diverted earlier, as the Report suggests was expected, the diversion would have accomplished little to nothing. Considering factors such as the aircraft altitude at the time of imbalance, the aircraft performance specifications, and the distance to any "suitable airport" identified by the NTSB, a landing at *any* alternate airport would still have been wrought with a fuel imbalance far greater than the most severe imbalance ever tested by Pilatus – a 9-bar gauge differential. There is no evidence to suggest that the pilot could have safely landed over this amount. The aircraft likely would have been uncontrollable and would have crashed.

II. ANALYSIS OF NEW EVIDENCE AND ERRONEOUS CONCLUSIONS

A. An Essential Warning for Low Fuel Pressure Failed to Activate on the Accident Flight.

The NTSB report acknowledged that a recurring Low Fuel Pressure ("LFP") condition existed on all legs of the accident flight. (Report at p. 49.) In fact, it is discernable from the cockpit data that a LFP condition occurred hundreds of times on the day of the crash– even on the first flight in which there were no passengers. The Report also unequivocally acknowledges that the LFP condition led to the crash. What the Report did *not* highlight – due to a lack of pertinent information – was that the PC-12 is supposed to provide a series of warnings in the event of a LFP condition. These warnings failed to activate on the accident flight. This is due to an inherent problem with the system design – a problem that still afflicts dozens of PC-12 aircraft in service today.

The operative AFM provides an emergency procedure for Low Fuel Pressure. As shown below, the "INDICATION" for such an emergency is the amber FUEL PRESS caution light illuminating on the CAWS panel:

PILATUS PC12

SECTION 3
EMERGENCY PROCEDURES

3.17 FUEL SYSTEM

3.17.1 LOW FUEL PRESSURE

Indication: **FUEL PRESS CAWS CAUTION**

It is beyond discussion that this LFP condition should have triggered illumination of the amber FUEL PRESS and Master CAUTION lights, and the aural gong should have sounded — literally hundreds of times. Regardless of the reason for the LFP condition—the one system required and intended to inform the pilot of the emergent situation repeatedly failed to function, and the flight continued without a single illumination of the FUEL PRESS annunciator. Had the CAWS functioned properly, it would have alerted the pilot to the imminent emergency before it was too late to safely divert. Had it functioned as required, the applicable AFM provision would have instructed the pilot to "*land as soon as possible*". The display of the amber FUEL PRESS was the only condition in the AFM's Emergency Fuel section that instructed the pilot to land as soon as possible. While the FARs required a red warning for LFP, the amber caution was still the only emergency condition relating to fuel that the AFM treated as significant enough to instruct immediate landing[3]. The NTSB must assume that the pilot of the accident aircraft would have observed the FUEL PRESS indication—as well as the Master Caution and aural warning—and followed the AFM instruction to *land as soon as possible*. This would have occurred during the first flight of the day and the accident flight would never have departed.

Unfortunately, there were no LFP warnings or cautions on the accident flight due to the flawed logic programmed in the CAWS system, which still exists today despite the capability to be remedied with a simple modification. Further discussion of this issue is discussed in detail in section "D".

[3] The AFM for the NG series PC-12 (S/N 1001 and up) issued a full year before the subject accident contains five commands to "land as soon as possible" in the Fuel System Emergency Procedures, in contrast to the AFM that remained in effect for the accident aircraft. A year after the subject accident, Pilatus finally revised the latter to include the same five commands to "land as soon as possible."

B. The True Story of Pilatus' Prior Knowledge

The Pilatus-assisted NTSB investigation, documented in the Report, concluded that fuel system icing caused a LFP condition, and *also* caused a degradation of the left FBP, leading to the crash. For this they laid blame solely on the pilot, for not ensuring that enough anti-icing additive or FSII (sometimes referred to by the brand name "Prist") was added to the fuel. The outcome of their investigation bore no evidence of any inherent mechanical or system failure – only those allegedly caused by a lack of Prist.

However, Petitioners have since located new evidence – namely components of the left fuel boost pump ("FBP") – that shows the degradation of the left FBP was actually caused by a mechanical failure of the pump itself. The mechanical failure was caused not by a single incident of inadequate Prist, but by an inherent manufacturing defect coupled with a fatally flawed fuel system design. The mechanical failure is discussed in detail in section B of this Petition.

While it may be understandable that the NTSB was hard-pressed to identify a mechanical failure without access to the physical pump (the pump was located after publication of the Report), new evidence shows that Pilatus withheld from the NTSB documents that establish Pilatus' extensive prior knowledge of the PC-12's poor fuel system performance in cold temperatures and prediction of the very failure sequence that occurred here. This knowledge is documented in new evidence that was unavailable during the NTSB investigation.

Petitioners uncovered documents that tell a very troubling story. After several years of intense opposition by Pilatus, the court overseeing the litigation arising from this accident ordered Pilatus to produce documents that exposed an alarming account of the history and development of the PC-12 fuel system. From day one, the PC-12 fuel system was plagued with problems in freezing temperatures – problems that Pilatus attempted to resolve for years, eventually abandoning such efforts to save costs.

But the story grew even more disturbing. Through a Freedom of Information Act ("FOIA") request derived from the aforementioned Pilatus records, Petitioners obtained 2003 correspondence between the FAA and Pilatus that relating to concerns over PC-12 fuel system icing and FBP failure[4] (Exhibit ("Ex.") A [FAA FOIA Response 4/14/2014].) Parts of this letter were heavily redacted, and it was not until two years into related litigation and after repeated discovery demands that Pilatus finally produced the un-redacted version of this correspondence.

1. Pilatus' Long-Term Knowledge of PC-12 Fuel System Icing

For over thirty years, Pilatus has been aware that the PC-12 fuel system is prone to icing and that the aircraft cannot safely fly in cold temperatures without an adequate concentration of Prist. The fuel system of the PC-12 was based on 1970s technology of the PC-7 and PC-9, developed in the late 1970s and first produced in the early 1980s. Certification testing of the fuel system for the PC-7 and 9 showed that in cold temperatures, icing would accumulate on the fuel filter and block the filter, causing a low fuel pressure condition resulting in activation of the filter bypass. The PC-7 and PC-9 therefore required the use of Prist, even for these military trainer "tandem"-seat aircraft that rarely operated at altitudes where icing would be a problem.

Unlike the PC-7 and PC-9, however, the PC-12 was developed as a pressurized, general aviation aircraft for corporate, charter and similar operations, designed to regularly fly at altitude.

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[4] The correspondence produced in response to the FOIA request is attached as Exhibit A.

FAR 23.951(c) requires that aircraft fuel systems demonstrate ability to sustain operation using fuel cooled to critical icing conditions. Certification cold-testing of the PC-12 fuel system revealed that the boost pumps were unable to restore adequate pressure at -20C, and the test was prematurely terminated when the fuel filter became a block of ice. (Ex. J.) This spawned the PC-12 requirement to always use Prist when operating below 0 degrees.

In 1993, before the aircraft was certified, the PC-12 experienced fuel system icing when the prototype aircraft did not have an adequate concentration of Prist during a test flight to Beja, Portugal. (Ex. F, p. 1.) Then again, in 1994, the very first production PC-12 (S/N 101) experienced fuel system icing on its very first flight from the factory to the U.S., which is commonly known as a "ferry flight". (Ex. F, p. 1) Both flights were flown by Pilatus' own professional pilots who certainly knew that Prist was required to prevent fuel icing at altitude. The fuel icing on both flights was necessarily caused by either (1) the Pilatus-employed pilots or other Pilatus employees not adding FSII to the fuel, or (2) their inability to ensure that the concentration of FSII was sufficient to prevent fuel icing.

Due to these fuel icing incidents, within weeks of the PC-12 ferry flight of S/N 101, Pilatus embarked on a project to develop an oil-to-fuel heater, which would prevent fuel system icing and eliminate the need for Prist. (Ex. I "Feasibility Study for Fuel Heating Requirements, 9/2/1994", and Ex. F "Summary and development plan for a fuel heater system" 11/10/1994.) This project was in development for years, and progressed to the point where Pilatus actually put the heat exchanger out to bid and received bids from several vendors experienced in designing and building oil-to-fuel heat exchangers using this very technology in aviation applications. However, around 1998, Pilatus shelved this program due to "budgetary restrictions", i.e., Pilatus did not want to spend the money. (Ex. G) Consequently, to this day, all PC-12 model aircraft, from the original model to the New Generation ("NG") model, require the use of FSII when flying in temperatures below 0 degrees Celsius.

2. <u>Pilatus' Knowledge of PC-12 Fuel System Failures</u>

Pre-certification tests showed that the PC-12 FBPs were incapable of operating in freezing temperatures if Prist was not added to the fuel. But despite its knowledge that a simple mistake could lead to fuel icing and uncontrollable fuel imbalance, Pilatus overlooked the potential for drastic consequences and rolled the PC-12 into production.

In accordance with certification requirements, in 1993 Pilatus generated an assessment of hazards in the PC-12 fuel system. (Ex. K, "Aircraft Fuel System Hazard Assessment.") The predictable errors repeatedly refer to the PC-12 problems with fuel system icing. And the failure of an FBP in such a scenario is both blatantly predicted and egregiously ignored.

The assessment lists a series of potential maintenance and operator errors that are considered both *possible* and *significant.* Among these errors are the failure to drain the fuel tanks of water, failure to ensure that Prist is added to the fuel, failure to examine the fuel filter for ice blockage, and failure of the FBPs to activate. (Ex. K.) The assessment also addresses failures of the ABS and the FBPs, specifying an imbalance level that it determined was a major failure. The assessment recognized that this failure scenario could occur if the ABS failed to correct an increasing imbalance. *And*, it recognized that the situation could not be corrected if an FBP malfunctioned.

The assessment lists a series of "potential for maintenance errors" that are considered both "possible and of significant effect":

1*) Failure to drain wing tanks may result in accumulation of large quantities of water in the fuel tanks which may cause icing problems;*

2) Failure to ensure that fuel includes anti-icing additives which may cause icing problems;

3) Failure to examine the fuel filter for indication of blockage [i.e. icing] which may result in catastrophic failure;

4) Faulty LFP switch, will result in boost pumps not automatically activating when required." [i.e. when the filter is blocked with ice]. (Ex. K at sheet 18-19.)

An addendum to the assessment specifically addressed the ABS and classified as a "Major failure" an imbalance more than 25%.

> *It is considered that a Major failure condition will occur if the out-of-balance between the two wing tanks exceeds 25% of the full tank load. At this point the resulting rolling moment cannot be corrected by trimming alone and the control column must be used. This increases the pilot workload and decreases the aircraft safety margin in the event of a manoeuvre requiring higher than usual levels of piloting skill (i.e. approach and landing in turbulent weather conditions) being called for.*
>
> *The failure condition will arise in the event of a loss of flow from one of the wing tanks, followed by a failure of the AutoFBS to recognise or correct the resulting difference in wing tank levels. Following this,* ***the failure condition may be prevented if the out-of-balance is appreciated by the aircrew, who then manually select the required booster pump. This will not occur if*** *the aircrew are inattentive or deceived by an incorrect FQMS display (in both cases assuming that the increasing rolling moment is due to a failure of the flying controls) or if* ***there is a malfunction of the relevant booster pump.***
>
> (Ex. K at p. 40 – Addendum A, Sheet 1.)

The hazard assessment further identifies the following failure scenarios:

2.4.15c: <u>LH booster pump selector fails OFF</u>.
This failure condition would of course result in the booster pump being inoperable and is classified as ***Major****. Its occurrence must also be considered in combination with other system failures.* (Ex. K at p. 13, sheet 9.)

2.7.4: <u>Booster pump selector switch fail in off position</u>.
The above malfunction will obviously result in the affected booster pump not being able to operate if required. As in 2.7.2 and -.3 above the normal operation of the fuel supply system is not affected by this failure condition is considered to be minor unless it coincides with another system malfunction, when a major failure condition will result.
(Ex. K at sheet 16.)

Pilatus determined that the likelihood of both the ABS and the FBP failing concurrently was improbable. But it failed to consider that the same condition – icing – could initiate both failures (which is what the Report, under Pilatus' analysis, determined occurred on the accident flight.) Before the inception of the PC-12, Pilatus predicted both the potential for icing complications along with the consequences of FBP failure, but never considered the two in tandem, which would (and did) have catastrophic consequences.

Lastly, the hazard assessment further conceptualizes the following "major" hazard condition:

2.7.6: <u>Excessive difference in wing fuel tank levels</u>:

This failure condition is caused by a combination of faults in the following sequence:

-significant mis-match in fuel flow from left and right wing tank

-inability to select booster pump in "full" wing to restore imbalance

(Ex. K at sheet 16-17.)

The above sequence of events is summarized in the hazard assessment and it is determined that the likelihood of the failure condition occurring is improbable. However, the assessment again fails to recognize that the same component failure (a single FBP) would result in both these faults. Assuming, as the Report determined, that icing can cause the failure of a FBP, that would (and per the Report, *did*) necessarily cause *both* the above faults. In this scenario, the likelihood of both faults occurring coincidentally is not only probable, but absolute.

3. <u>The Action Letter re. Proposed FAA Safety Recommendations</u>

While Pilatus may have brushed aside the strong potential for danger, the FAA grew wary in the early 2000s. Plaintiffs discovered through a FOIA request, that the FAA submitted a letter in July 2003 from its "Recommendation and Analysis Division" addressed to the Small Airplane Directorate and forwarded it to Pilatus (Exhibit B "the Action Letter") The Action Letter addressed a number of critical issues including a 2002 incident with an imbalance caused by fuel icing, concerns with the PC-12 requirement of Prist (anti-icing additive) instead of using a fuel heater, and several other incidents of fuel icing on the PC-12. One such incident references cycling boost pumps with **no low fuel pressure light and a 6-bar fuel imbalance that caused "serious difficulty in landing."** (Ex. B, 2003 [Correspondence between FAA and Pilatus], at p. 5 [PAL-MT 159702].) If this sounds familiar, it is because it screams the exact failure scenario that occurred on the accident flight.

In the Action Letter, the FAA also made the following harrowing remarks:

> "*My investigation has indicated that a strong potential exists for fuel icing and possible engine failure under certain conditions.*"
>
> "*A review of "SPAS" records shows at least two other incidents that point to fuel icing in the Pilatus in addition to this instance, to date with no injury to property or persons but with* ***<u>tremendous potential for a vastly different outcome</u>***." (Ex. B at p. 2 [PAL-MT 159699].) (emphasis added.)

The FAA, "in the interests of safety", proposed several recommendations for the PC-12 including incorporation of a fuel heating device and new restrictions on the use of Prist. (Ex. B at

p. 3 [PAL-MT 159700].) But the FAA's voice was quickly silenced by a number of misleading representations and inaccuracies from Pilatus.

As produced per the FOIA request, the response letter (Ex. A, at pp. 15-18) is ostensibly written by the FAA Small Airplane Directorate to the manager of the Recommendation and Analysis Division[5]. But during litigation, Petitioners discovered that the content of this letter was actually written by Pilatus' head engineer for Research and Development, John Senior. (See Ex. C[6] [Letter from Pilatus to FAA 9/23/2003].) The content of this letter (the "Response Letter"), prepared by Pilatus, is unambiguously designed to assuage the FAA's grave concerns over PC-12 fuel system icing, FBP failures, and fuel imbalance – the exact issues involved in this accident. In the Response Letter, Pilatus make the following representations:

> "*In the event the fuel filter becomes clogged by fuel icing (i.e. no additive in the fuel) fuel pressure would drop, the boost pumps would automatically come on line and the fuel filter by-pass valve would open and supply the engine with (unfiltered) sufficient fuel flow. Therefore, even if the AFM/POH limitation for the addition of Prist is not followed, fuel delivery to the engine will be continued via the by-pass valve.*
>
> ...
>
> *Additionally, the system is highly tolerant and can cope with fuel mixed incorrectly by the use of the bypass, which is the main element that may be blocked by fuel containing super cooled water or ice crystals.*
>
> ...
>
> *We are confident that the information supplied in this letter shows that the two Safety Recommendations are based on false assumptions and should therefore be withdrawn. PILATUS is of the opinion that the design of the PC-12 series aircraft is excellent, extremely safe and superior to the standards of today.*" (Ex. C at pp. 2-3.)

In sum, Pilatus assured the FAA that, in the event of a LFP condition caused by icing due to a lack of Prist- *the exact scenario that that the Report attributed to the accident flight*- the fuel system "is highly tolerant and can cope" through operation of the FBPs. But these representations are directly contrary to the conclusions in the NTSB Report which were based on Pilatus' guidance during the investigation.

The Report instead concluded that the LFP condition and the restricted fuel supply from the left tank during the accident flight were the result of an ice accumulation in the fuel system originating at the fuel filter (Report at p. 76.) It surmised that the left FBP was ON but could not maintain the required fuel system pressure, leading to an imbalance that caused the crash (Report at p. 52.) This scenario certainly does not depict a "highly tolerant" system that can easily cope. This new correspondence is incredibly unnerving in relation to the safety of this aircraft.

Furthermore, the Response Letter contained a number of misleading representations and inaccuracies. Additional new documents show that Pilatus was well aware of the PC-12 difficulties

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[5] The Response Letter is contained in Exhibit A pages 15-18. It was redacted by the FAA.

[6] Ex. C was produced in discovery and consists of a letter with the identical language as the Response Letter, written by Pilatus Engineer John Senior and Othmar Ziorjen to Mr. Rudolph, manager of the Small Airplane Directorate. The Small Airplane Directorate used the identical language in responding to the FAA's Action Letter, in Ex. A.

with icing at the time the FAA Action Letter was reviewed in 2003, but Pilatus' Response did not inform the FAA of the history of fuel icing that dated back to the design and certification testing phase of the PC-12 . In effort to divert attention from icing, the Response Letter instead asserted that the FBP cycling phenomena (as referenced in the Action Letter) were caused by a "faulty batch" of Low Fuel Pressure Switches rather than poor FBP performance in cold weather (Ex. C at p. 2.)

Pilatus documents not disclosed to the NTSB show that as early as 1994, immediately after the initial production of the PC-12, Pilatus identified problems with fuel icing in the PC-12. This previously unseen evidence reveals that the *very first flight of the very first PC-12*, serial number 101, experienced fuel system icing due to issues with Prist. (Ex. F at p. 1.) Pilatus failed to disclose this fact, or the resultant study that was undertaken to redesign the fuel system to incorporate a fuel heater, which was one of the recommendations suggested by the FAA. (Exs. I, F and H.) Pilatus also failed to disclose that the engineer who designed the fuel system determined that the proposed fuel heater was feasible and important for flight safety. Or that the project was eventually abandoned due to cost. (Ex. G.) Emails circulated amongst the head Pilatus engineers contain language implying that they were well aware of the problems that could occur if no Prist was added to the fuel. the following language:

> August 2000: "*We know that a potential problem exists if the Prist requirement guidelines in the AFM are not followed.*" (Ex. G.)

> November 2000: "*URGENT, concerning the failure of the subject pump to operate at low temperatures, and expressed our concern over the safety aspects of such a failure... This problem is deadly serious. Please ensure that it receives the highest priority and respond with your findings*." (Ex. D, emphasis in original.)

And yet another email sent to Pilatus engineers from one of Pilatus' corporate customers just months before the FAA Action Letter was received, states:

> March 2003: "*It is found that the fuel freezes in the Airframe fuel filter after prolonged flights at high altitudes at low temperatures. Both boost pumps will come on giving an indication of fuel filter blockage.*" (Ex. E.)

Despite the known history of the precise issues raised in the Action Letter, Pilatus intentionally diverted the FAA's attention away from icing and FBP failures towards a supposed "pressure switch" problem. In its Response Letter, Pilatus implied that cycling FBPs—for whatever reason—are *not a safety concern* requiring emergency action by a pilot. The Response Letter states:

> "*Cycling boost pumps caused by a pressure switch with the described problem, does not require any pilot action, as it does not, in any way, adversely affect the delivery of fuel to the engine.*" (Ex. C at p. 2.)

Inexplicably, Pilatus informed the FAA that a condition of cycling FPBs "does not require any pilot action." Regardless of whether a faulty Low Pressure Switch would present a safety issue, there is no way for a pilot in the cockpit to differentiate between cycling boost pumps caused by a faulty switch and cycling boost pumps caused by an LFP condition. In fact, because the warning indicator for LFP does not work on the PC-12 (this issue is discussed later in section C3), cycling FBP lights are the *only* way to identify a LFP condition. In the revised version of the PC-12 AFM, published a year after this accident, the emergency indicator for a LFP condition instructs the pilot to look not for the LFP warning light, but for the following:

"Indication: CAWS Advisory FUEL PUMP cycling on and off every 10s."

(Ex. P-3, p. 3-48, sec. 3.17.1)

Disturbingly, a nearly identical indication for low fuel pressure was published a year before the crash in the AFM for new PC-12 purchasers (but not the accident aircraft) that read:

"Indication: MFD Fuel Window – Both fuel pumps cycling on and off every 10s."

(Ex. P-2, p. 3-48, sec. 3.16)

Pilatus' assurances in the Response Letter that cycling FBPs are not a cause for concern is fundamentally at odds with the NTSB's Probable Cause determination, which criticizes the pilot for his failure to heed the *only* indication during the accident flight – cycling FBPs. Therefore, these new documents are critically important to understanding what caused this crash and Pilatus' decades-long knowledge of the problem and failure to fix it. Pilatus' assurances likely thwarted further investigation by the FAA, which may have led a safety recommendation that would have prevented this accident.

Another false representation contained in Pilatus' Response Letter is:

"*Cycling boost pumps, which are set to AUTO will not create an imbalance situation. Furthermore, if the pumps are switched to ON for whatever reason and a fuel imbalance develops, the AFM/POH gives an emergency procedure to correct the situation.*" (Ex. C at p. 2.)

The statement that cycling boost pumps will not create an imbalance is plainly false and contrary to Pilatus' long-held knowledge. The statement also ignores the possibility of a FBP failure. Further, if the boost pumps are set to AUTO, and one pump fails, an imbalance situation will not only be created, but it will be uncorrectable. Yet seven years after submitting the Response Letter, Pilatus assisted the NTSB in determining that a boost pump *did* fail on the subject aircraft due to a lack of FSII. The central focus of the 2003 Action and Response letters is fuel icing in the PC-12 due to a lack of FSII, yet Pilatus resolutely assured the FAA that concerns regarding icing and potential imbalance situations was unjustified.

C. The Severe Fuel Imbalance Was Caused by a Mechanical Failure of the Left-Hand Fuel Boost Pump.

Page 62 of the NTSB Accident Report states in section 2.2.4 that:
In addition to the low fuel pressure state that existed during the accident flight, the left-side fuel system was not delivering fuel to the engine during much of the flight. ***The NTSB attempted to determine a possible reason for the restricted fuel supply from the left tank. Although the exact source of the restriction could not be identified,*** *the post-accident*

testing clearly showed that ice accumulation in the fuel system (as a result of not adding a FSII) could degrade the performance of many fuel system components, including the fuel boost pumps and valves.

The NTSB concludes that the low fuel pressure state and the restricted fuel supply from the left tank during the accident flight were the result of an accumulation of ice in the fuel system with an initial concentrated amount of ice in the airframe fuel filter. The NSTB further concludes that, if the pilot had added a FSII to the fuel for the flights on the day of the accident, as required, the ice accumulation in the fuel system would have been avoided, and a left-wing-heavy fuel imbalance would not have developed.

While the NTSB struggled to determine the cause of the limited fuel supply from the left hand tank, it nonetheless concluded that it was the result of icing in the fuel system. But previously undisclosed documentary evidence unequivocally proves that the PC-12 fuel system was designed and intended to operate during a LFP situation caused by icing. And, subsequent to the NTSB investigation, Petitioners and their consultants uncovered new material evidence including key components of the left FBP. Forensic testing and analysis pinpointed a definitive cause of the limited left hand fuel flow–the left FBP was afflicted with manufacturing defects that led to its complete failure.

1. <u>Background</u>
    a. *Indications of a boost pump failure were present.*

Even without tangible evidence of a boost pump failure, it is surprising that such was not at the forefront of the NTSB analysis considering the evidence that was available during the investigation. During the flight, a recurring LFP condition caused both FBPs to cycle. (Airworthiness Report p. 25.) Just prior to impact, the left and right fuel tanks were in an unbalanced fuel state with the left fuel tank heavy and the right fuel tank nearly empty. The Report acknowledged that the left FBP ceased fuel circulation while the right FBP transferred fuel from the right tank to the left tank, thereby creating the increasing fuel differential.

The above accident scenario alone indicates a likely left FBP failure. Internal company documents written before the PC-12 was even in production show that the manufacturer foresaw this exact failure scenario. Moreover, internal Pilatus documents written during the post-crash investigation reveal that the manufacturer considered this very failure sequence early in the investigation of this crash, but did not share that analysis with the NTSB.

While the FBPs are designed to correct a fuel imbalance, the left FBP clearly did not perform this function. Why is that so? If the cause was anything extrinsic to the pump, such as contaminants or ice in the fuel, it is inexplicable why the source would only affect the left side while the same fuel was circulating and being transferred from side-to-side. The only explanation is a problem intrinsic to the left FBP itself.

b. *The left-hand boost pump was discovered and examined subsequent to the NTSB investigation.*

During the NTSB investigation, the only component recovered from the left FBP was the impeller housing (Report at p. 28). However, subsequent to the Pilatus-assisted NTSB investigation, Petitioners conducted a wreckage inspection (also attended by Pilatus representatives). The inspection took place in December 2012 in Pearblossom, California, where the aircraft wreckage was stored after transport from Montana. Petitioners' representatives combed through the wreckage and located several key components of the fuel system, including the armature assembly (or pump motor) of the left FBP, depicted below.

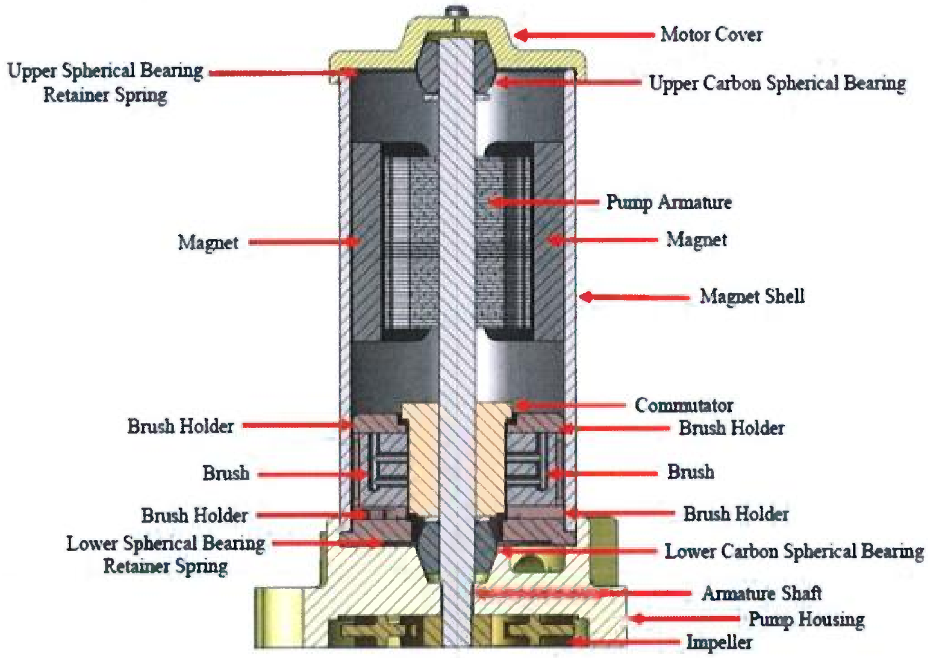
An analysis of these components provided significant new evidence which necessarily alters the NTSB findings by providing a tangible explanation for the limited left-hand fuel flow and resulting imbalance.

The left FBP armature was analyzed at a lab in Pensacola, Florida. Forensic analysis revealed manufacturing defects that created an out-of-round condition, in violation of the manufacturer's specifications. This defective condition caused the left FBP to operate in an unbalanced manner and eventually fail completely.

c. *Description of the Boost Pumps*

i. The RR53710K Boost Pump

The subject right and left FBPs were installed on the aircraft as new when the aircraft was built by Pilatus in 2001. (Declaration of Richard McSwain ("McSwain Decl.") at ¶¶8-9.) They were manufactured by Crane Co. and were model number RR53710K ("K pump"). (Id.) The K pump is a centrifugal pump powered by a D.C. electric motor. (Id.) The motor in the K pump consists of a rotating armature, which is affixed to an armature shaft oriented vertically in the pump. The armature shaft in the K pump is held in position at the top and just below the commutator by self-aligning bearings, which are made of carbon graphite. If the armature shaft in the K pump is rotating, the floating impeller, located just below the lower bearing, will also rotate. The image below is a drawing of the K pump[7].



The pump's carbon brushes are constant-force-spring-loaded, meaning they have constant contact force with the rotating commutator. The commutator in the pump is made of copper, is cylindrical in shape, and is pressed on the armature shaft. The commutator is concentric to, and rotates with, the shaft. As rotation occurs, the constant-force springs maintain brush contact pressure against the commutator. When electrical current is supplied to the pump, the brush assembly provides electricity to the commutator, resulting in rotational torque that causes the armature shaft and floating impeller to rotate. As fuel enters the pump through the inlet, impeller rotation creates fuel flow, thereby providing the fuel flow in the overall system to the aircraft engine.

Confidential internal correspondence between Crane Co. and Pilatus shows that the RR53710K model boost pump ("K pump") was designed to replace the predecessor Crane RR53710B centrifugal boost pump ("B pump") at the request of Pilatus for a "less expensive", *lower quality* pump. (Ex. Y.) The "K" pump was introduced several years after certification of the PC-12 and was not part of the fuel system at the time the plane was first certified by the FAA or for the first seven years of aircraft production. The new "K" pump was redesigned with different balancing properties, different carbon bearings, and a different brush system. Despite these significant changes, the new model K pump never underwent the extensive testing and certification normally performed on Crane pumps.

[7] This image was created by Dr. Richard McSwain; Petitioners were advised that Crane Co. would not allow use of the original Crane Co. drawing based on confidentiality concerns.

The PC-12 Fuel System Hazard Assessment indicates that the PC-12 fuel system was developed from the predecessor PC-7 / PC-9 aircraft: "all the PC-12 fuel system components are used in the PC-7 and PC-9 systems." (Ex. K, p. 37, Annex A, sheet 1 [PAL-MT 01634].) This is how Pilatus justified its use of the PC-7/9 system failure rates for the PC-12. (*Id.* and p. 52 [PAL-MT 01649].) However, because the K pump was not a component on the PC-7 and PC-9, the K pump rendered that justification unreliable. Most importantly, Pilatus did not conduct any endurance cold testing on the model K pump, even after a 2001 fleet-wide boost pump problem rendered dozens of K pumps inoperable on Pilatus PC-12 aircraft in cold conditions. Pilatus should have *ensured* that the new model pump was tested and certified with the PC-12 fuel system, particularly considering Pilatus' knowledge that the fuel system was highly prone to icing.

ii. <u>Intended Purpose of the Boost Pumps</u>

As designed, the PC-12 fuel system draws fuel from both wing tanks to supply the engine and also redistributes excess fuel back to the wing tanks through "motive flow" lines that operate the jet transfer and delivery pumps. The delivery pumps—one in each wing—together with the Engine Driven Pump, supply fuel to the engine and provide motive flow unless the fuel filter becomes obstructed, such as by ice.

When the fuel filter becomes blocked, the delivery pumps and engine driven pump are unable to maintain sufficient fuel pressure to supply fuel to the engine. To overcome low fuel pressure, and to avoid creating an imbalance, the aircraft requires that the two FBPs function properly. One FBP is located in each wing's collector tank. The aircraft's FBPs provide fuel system pressure when a LFP condition exists. (NTSB Report at 2, and Sec 1.6.2 and 1.16.2) (NTSB Docket #2 "Operations" p. 19-20.) A blocked filter will provoke a persistent LFP condition which will cause the pumps to cycle on and off as they repeatedly attempt to overcome the LFP condition.

The FBPs also balance the fuel load between the left and the right wing fuel tanks when needed. A fuel imbalance could occur when the fuel tanks are unevenly filled, over time if the two FBPs have slightly different capacities, or if only one pump is turned on.

At some point during the accident flight, the left FBP failed and was unable to perform the above-outlined functions.

d. *Inspections and Results*

i. <u>Laboratory Setting</u>

Subsequent to the NTSB investigation, the recovered components of the right and left FBPs underwent optical microscopic and SEM inspection at McSwain Engineering, Inc. in Pensacola FL. There were additional inspections at other facilities, including measurements using specialized equipment at Anamet Inc. in Hayward, CA. Dr. Richard McSwain was then asked to perform a materials failure analysis and engineering investigation of certain components from the accident aircraft, including, most significantly, the previously undiscovered components of the left hand FBP. The Declaration of Dr. McSwain is attached to this Petition. ("McSwain Decl.")

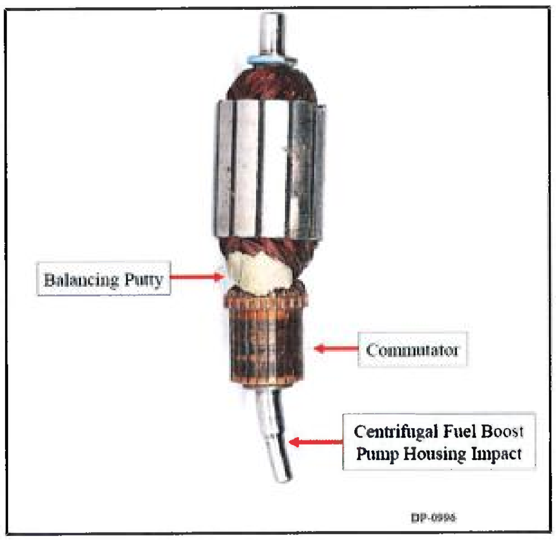
McSwain Engineering is a consulting firm with capabilities in materials engineering, mechanical engineering, and forensic chemistry, and has state-of-the-art equipment particularly suited to the science of failure analysis and engineering investigation. These capabilities specifically include optical and scanning electron microscopy (SEM), physical, dimensional, chemical and mechanical property evaluation; and comprehensive photographic documentation capability. McSwain Engineering, Inc. utilizes standard methodology and generally accepted techniques in performing failure analysis and incorporates internal peer review throughout the failure analysis process.

The laboratory inspections were conducted in a neutral setting, attended by representatives of all parties to the litigation, including several for Pilatus. After the inspections, Petitioners asked Dr. Richard McSwain to document his analysis of the facts and findings in a scientific report, which is attached to this petition, and the contents of which are discussed below.

ii. Nonoperation of left-hand boost pump at impact

Examination of the recently recovered armature assembly revealed that the right FBP motor was rotating at the time of impact, but the left FBP motor was not. (McSwain Decl. at ¶13.)

The subject left hand pump armature assembly shown below was bent on the end that passes through the pump housing and into the impeller. The left pump exhibited static impact signatures where the impeller contacted the pump housing on impact in a non-rotating manner, with resulting fractures of only three impeller vanes. (McSwain Decl. at ¶13.)

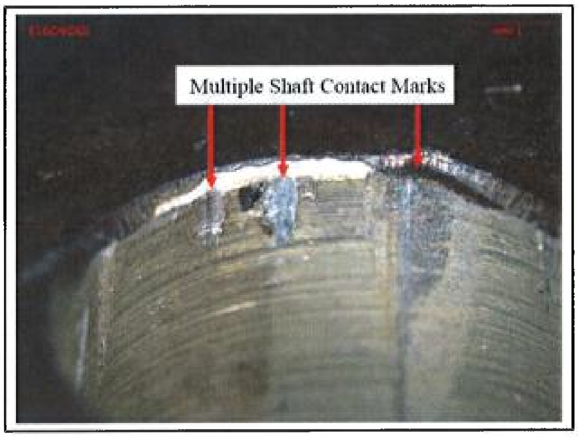


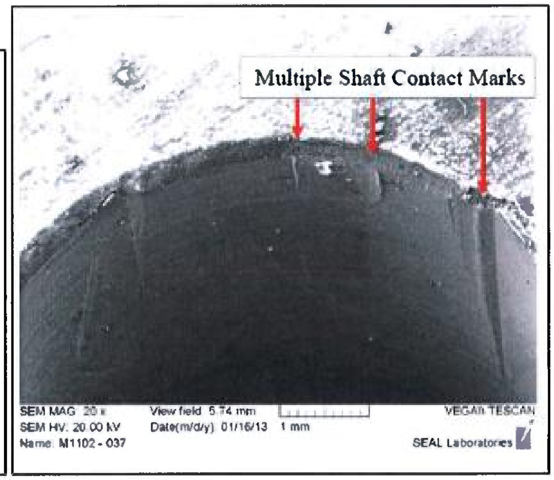
Laboratory examination of the pump housing revealed non-rotational contact damage in the armature shaft bore from the armature shaft. (McSwain Decl. at 25-28.) The damage was caused by impact of one of the armature shaft flats with the bore of the pump housing. The stationary impact marks can be clearly seen in the optical stereo micrographs below (*Id.*, Attachment 3.)

The marks were also examined with the SEM, which further confirmed that there was no evidence of significant rotation of the armature at the time of impact, as shown below (*Id.*, Att. 4.)

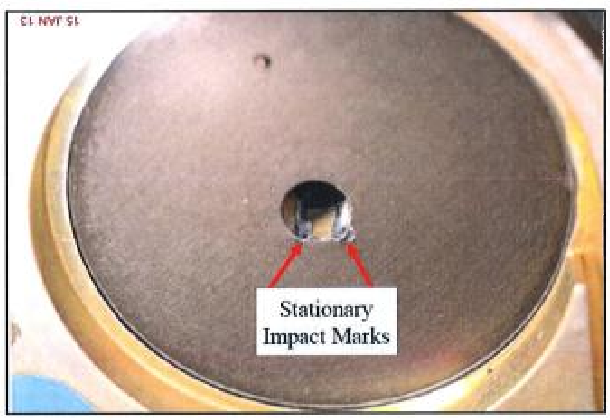
The left FBP motor *should* have been rotating at impact because logs from the plane's onboard computer show that the left FBP was activated about one hour into the flight and continuously activated after that until the crash. When the pump is in an active state, the motor should be rotating at approximately 7800 rpm. The lack of rotation establishes that the left FBP had failed.

In contrast, the right FBP exhibited clear evidence of rotation / operation at impact. (McSwain Decl. at ¶29.) Stereomicroscopic examination of the edge of the bore revealed multiple pump armature impact marks, consistent with "chatter" caused by the armature rotating at impact, as shown below on the left (*Id.* at ¶17, Att. 19.). The same marks were observed using the SEM, shown below on the right (*Id.*, Att. 20.). The pump armature shaft contact-induced marks in the right boost FBP shaft bore were significantly different than those in the subject left FBP. The left did not exhibit the characteristic chatter marks indicative of armature rotation.



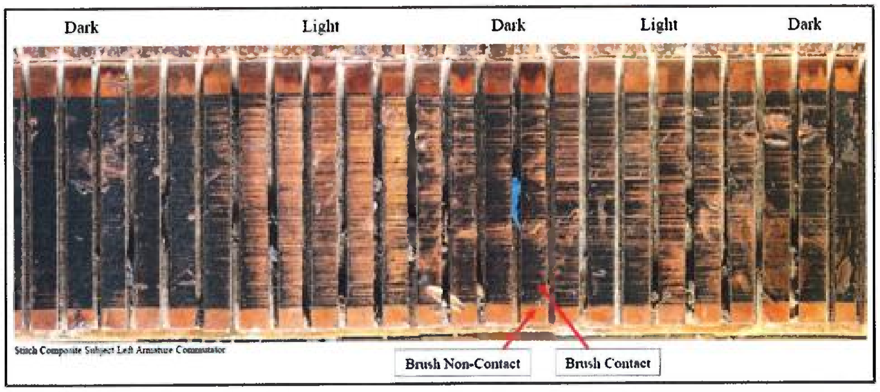


Examination of the impeller side of the FBP housing reveals that the stationary impact marks extended into the fuel boost pump impeller cavity as shown below (*Id.* at ¶13, Att. 5.) There were no indications of left FBP operation at the armature shaft bore exit point in the pump housing impeller cavity at impact. (*Id.* at ¶13.)

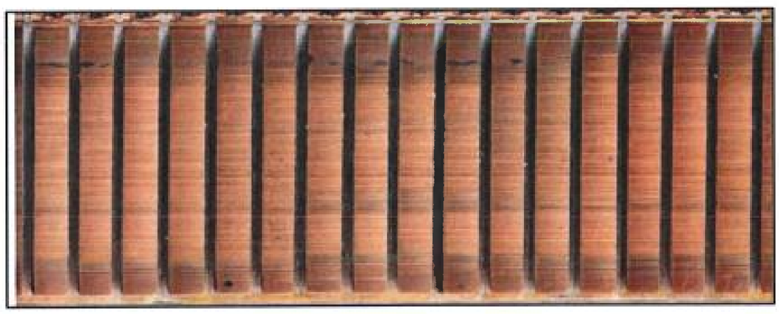


iii. <u>Commutator imbalance</u>

A combined photo of commutator bars of the left-hand boost pump commutator is shown below. (*Id.*, Att. 6.) The commutator bars are darkened at the brush contact sites. The circumference of the commutator reveals a banding of both dark and light surface conditions. This banding is indicative of an out-of-balance commutator condition and non-uniform contact between the brushes and the commutator. (McSwain Decl. at ¶¶14 and 27.) This condition resulted in alternating contact pressures between the commutator and the brush assembly. (McSwain Decl. at ¶¶14, 15, 35.)



In a properly operating pump, the patina on the commutator bars should be a reflexive sheen with a predominately copper color. An out-of-balance commutator causes the brush to glide over one area and then come down hard on others, causing the patina to scrape away. The result is seen in the varying light and dark patterns. The photo below is what normal wear on the patina of the commutator should look like. This shows homogenous wear, color and banding.



iv. Total Indicated Runout

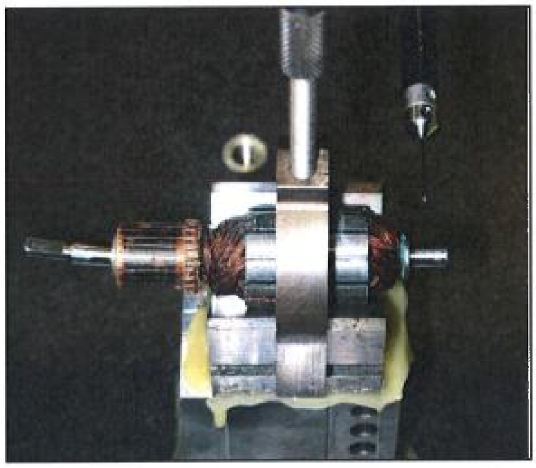
One specification for FBP commutators is Total Indicated Runout ("TIR"). TIR is the dimensional characterization of roundness. If the TIR of a rotating part exceeds the tolerance specified in the technical documents, it is considered "out-of-round". Every Crane K pump manufactured and certified for use in aircraft must be built to a certain TIR specification[8], otherwise it is unairworthy. An out-of-round condition will be indicated by a higher TIR number.

The commutator for the left FBP was measured at Anamet, Inc. in Hayward, CA using a special electronic instrument capable of measuring tolerances in the thousandths called a Coordinate Measuring Machine ("CMM")[9]. The CMM was used to reconstruct the TIR of the left boost pump commutator. The instrument's scanning touch probe was swept down the commutator bar length and over the surface of the commutator. (McSwain Decl. at ¶15.) The measurements

[8] The documents that specify the TIR for the K pump are confidential pursuant to a protective order.

[9] TIR is typically measured by centering an armature shaft and rotating the shaft while measuring the perpendicular position of the commutator bar surfaces. This measurement was not possible for the left-hand pump commutator because the shaft was bent from the impact of the accident. (McS Decl. at ¶15.)

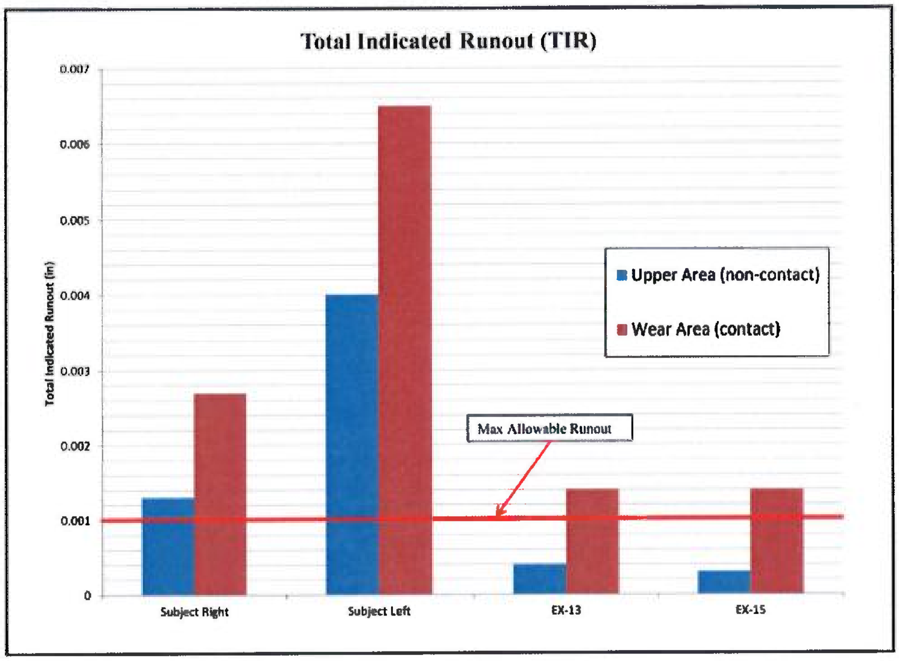
were made in both the non-contact and contact areas of the commutator bars, as shown below (*Id.*, Att. 8.)



The CMM scanning touch probe data was used to construct the roundness condition of the commutator. (McSwain Decl. at ¶15.) Areas of impact-induced surfaces were removed from the CMM data to ensure representative pre-accident surface data for the non-contact areas of the commutator. (*Id.*) The results—which are purely objective—showed that the LH boost pump commutator TIR was *four times* the accepted limit. (*Id.*) This is the discrepancy measured on the non-contact surfaces (surfaces not subject to wear through use) and correlates directly with the runout measurement when the part left the factory. (*Id.*) The derived TIR measurement for the left-hand pump commutator is shown on the graph below. (*Id.*, Att. 23.)

The out-of-round condition of the as-manufactured left FBP commutator was a manufacturing defect and would not have changed after the pump was in service. (McSwain Decl. at ¶15.) The dynamic imbalance of the commutator, as evidenced by the alternating dark and light bands on the commutator, combined with the dimensional stack-up condition between the commutator and the brush holder, led to the in-service commutator-to-brush holder contact. (*Id.*)

In contrast, examination of exemplar FBPs were shown to exhibit roundness within the Crane specification limits. (McSwain Decl. at ¶33.) The right FBP commutator measured a TIR that only slightly exceeded the Crane specification, as shown below (*Id.* at ¶¶19 and 30, Att. 23.) Laboratory investigation revealed, however, that the right FBP commutator had not been running in an out-of-balance condition. (McSwain Decl. at ¶19.)



When building the boost pumps and armatures, Crane technicians use what is called a Manufacturing Outline ("M.O.") which contains step-by-step procedures that the technician is required to follow. The technician assembling the pump is required to follow the detailed assembly instructions delineated in the M.O. Significantly, the M.O. for the RR53710K pump and armature failed to specify that the TIR should be verified during assembly. This is a fundamental omission that is the direct cause of the left FBP having left the factory in a defective condition.

Federal regulations require that the parts certified for use in an aircraft must conform to specifications. The left FBP's out-of-specification TIR was a manufacturing defect. Accordingly, the left FBP should not have been released from the factory for use on the subject aircraft.

e. *Result of the Faulty Manufacturing*

i. The left-hand boost pump left the Crane factory with a manufacturing defect.

Forensic analysis revealed that the left FBP was defectively manufactured in an out-of-round condition, over 400% out of specification. Examination also revealed light and dark bands caused by uneven repeating brush contact pattern on the commutator surface. This indicates that the pump had been operating in an out-of-balance condition with non-uniform brush-to-commutator contact. Because this condition would not have changed after the pump left the Crane factory, this condition was the result of a manufacturing defect. Moreover, documents show that Crane did not have a manufacturing process step for checking TIR at the time the left FBP was manufactured. The left FBP was dimensionally uncentered and dynamically unbalanced when the pump left Crane's possession after manufacture. It should never have been placed into service in its defective condition.

ii. <u>The manufacturing defect in the left-hand boost pump led to its failure.</u>

During manufacture of the K pump armature, there is a balancing requirement. An imbalanced armature occurs when the armature's center of mass is different from its center of rotation. The root cause of the left FBP failure was the combination of a dimensionally uncentered and a dynamically imbalanced condition caused by a defective manufacturing-induced out-of-specification condition. Such led to the degradation of the pump by commutator-to-brush/brush holder contact.

The effect of an out-of-round condition on the pump is decreased performance life of the motor. Icing conditions, especially without Prist, will cause fuel to become more viscous. The more viscous the fuel, the harder the pump must work and the more amperage it must pull. The more the pump must work, the more current must pass through the brushes to the armature. The more current that passes, the greater the wear on the commutator and brushes. If the commutator is out-of-round, it is already a weak motor. When this weakness is combined with high current density, pitting and scoring of will appear on the commutator, and the brushes will wear at a much greater rate than normal.

The mechanical defects in the left FBP weakened its performance. As a pump motor weakens, the pressure and volume of fluid will decrease. The carbon buildup from the brushes on the left-hand commutator pad was built up so much in spots that it could not efficiently transfer electrical energy between the brush and the commutator to the windings. Due to this carbon buildup, the left FBP progressively weakened throughout the accident flight, from operating at about 50% capacity to eventually operating very poorly, or perhaps not at all. At the time of the crash, the left-hand pump was significantly diminished in performance and was totally ineffective to meet the system requirements including restoration of fuel pressure and balancing of fuel.

f. *The left-hand Boost Pump failure led to the severe imbalance.*

The aircraft's FBPs are critical components of the computer-controlled fuel system (McSwain Decl. at ¶36.) Each pump can only draw fuel from its respective wing tank (right or left). When they are called upon to provide backup fuel pressure, both pumps must operate so that fuel is drawn from both sides of the plane. During the accident flight, the left FBP was in such a degraded condition that when it was activated in tandem with the right FBP, it could not "compete", and the right pump became the only one providing fuel pressure.

While one FBP can maintain enough fuel pressure to avoid starving the engine during a fuel filter icing condition, if only one pump is operable, fuel will be transferred from one wing to the other at approximately 11 lbs. per minute. Consequently, when the left FBP failed, the right FBP drew fuel from the right tank and transferred it to the left tank until the left tank was full and the right tank was nearly empty, causing a severe fuel imbalance.

For situations of fuel imbalance, the PC-12 is equipped with a balancing system. This system *also* depends on properly functioning FBPs; the pump on the heavy side is supposed to correct the imbalance by drawing fuel from the heavy side and transferring it to the lighter side. But again, because the left FBP had failed, it could not redistribute fuel, rendering the balancing system inoperative. The PC-12 has no back-up pump or means to transfer fuel from the heavy side to the lighter side in the event of a failed or degraded pump. The fuel system was therefore incapable of correcting the fuel imbalance.

When the low fuel pressure condition arose, it initially took approximately 14 minutes to create an imbalance of 60lbs (by taking 30 lbs from one side and transferring it to the other). (*Id.*) This calculates to about 2 lbs per minute more fuel from the right side than from the left.

g. *Conclusions*

The heart of the electrical motor of the FBPs is where the brushes meet the commutator because this is where the electrical energy is converted into mechanical energy. The most prominent area that wears in an electric motor is the commutator and the brushes.

The left FBP contained a manufacturing defect that caused uneven contact between the brushes and the commutator. This created an un-centered and unbalanced operating condition and resulting in deterioration of the pump armature assembly, which ultimately caused the left FPB to fail.

One of the primary purposes of the boost pumps is to provide fuel to the engine in the event of low fuel pressure, such as when the filter becomes blocked with ice. (Ex. AD [Pilatus Depo. of J. Senior] at 465:11-466:3.) Even assuming the lack of FSII caused the blocked filter, the normal system operation is to activate the FBPs. The FBPs are supposed to work properly in this situation, and correct the condition caused by icing. But here, unfortunately, the left boost pump failed for a reason completely unrelated to the lack of FSII. Therefore, it stands to reason that the lack of FSII bears no relation to the failure of the boost pump which caused the crash.

As further support of the remoteness of FSII, the accident could have occurred even if the fuel had FSII. There are several reasons the FBPs may activate: if there is an imbalance of fuel between the two tanks, if the Engine Driven Pump fails, or if there is a blockage of the fuel filter. There are a number of contaminants that could block the filter, other than icing. (Ex. AD at 465:11-466:3.) The boost pumps could have been activated due to a filter clogged with another contaminant, even if FSII had been added. In such a situation, the left FBP would still have failed and the accident would still have occurred, whether or not FSII had been added.

h. *Relationship of New Evidence to Probable Cause Determination*

The NTSB investigation centered heavily on efforts to determine the cause of the severe left-wing heavy fuel imbalance. The Report dedicated significant analysis in effort to provide an understanding of how the fuel system operated during the accident flight. But because the NTSB did not have access to critical components of the left FBP, and because Pilatus did not provide the NTSB with critical information, its efforts were necessarily incomplete and resulted in what might be described as a speculative explanation for the fuel imbalance. The Report surmised that,

> "This imbalance was likely created because the right fuel boost pump had delivered more fuel to the engine than the left fuel boost pump had delivered (likely because of a restricted flow of fuel from the left-wing tank) during the time that both fuel boost pumps were simultaneously cycling." (Report at p. 52.)

The Report further observed that, even with the left FBP on continuously, the fuel pressure output of the left-side fuel system had degraded to less than 2 psi, and the left FBP could not maintain the required fuel system pressure. (Report at p. 52.) In contrast, it recognized that the right FBP could take over the duty of providing pressure and ensure a continuous one-way flow of fuel to the engine with relatively high output pressure. (Report at p. 52.) Thus, the NTSB concluded that, about 1 hr. 21 mins into the flight, the entire fuel supply was being provided by the right FBP, causing the left-wing heavy imbalance to increase. (Report at p. 53.)

As the Report acknowledges, the continuous operation of the left FBP indicates that the ABS commanded the pump to operate to correct an imbalance and to maintain adequate fuel pressure. (Report at p. 52) But a gaping omission in the report is the failure to address *why* the left FBP was unable to function despite Pilatus' recognition that "**a single fuel boost pump operating continuously could simultaneously correct a fuel imbalance and a low fuel pressure state.**" (Report at p. 50; Airworthiness Report at p. 25.)

The initial obvious inaccuracy here is that a single FBP can *only* correct an imbalance condition if that FBP is in the wing that happens to have the greater level/quantity of fuel. Each of the two FBPs can *only* push fuel to the opposite side of the plane. So, one FBP acting alone (for example, the left FBP) can only correct an imbalance when the fuel level is greater / heavier on its own (left) side, but is completely unable to correct an imbalance when the fuel is greater on the *opposite* (right) tank. This is why *both* FBPs must operate when there is a LFP condition. One pump operating alone will transfer fuel from one side to the other.

Here, the continued functioning of the right FBP after the left FBP failed created an ever-increasing fuel imbalance condition. At the same time, the balancing system commanded the left FBP to correct the imbalance, which was impossible because the left FBP was inoperative with no back up. This is the exact failure scenario described in the 1993 Fuel System Hazard Assessment required for certification of the PC-12.

Secondly, the Report concluded that "the low fuel pressure state and the restricted fuel supply from the left tank during the accident flight were the result of an accumulation of ice in the fuel system with an initial concentrated amount of ice at the airframe fuel filter." (Report Finding #3.) But again, this explanation ignores the fact that these pumps were specifically designed to restore fuel pressure during an LFP condition, whether caused by icing in the filter or for some other reason.

The NTSB relies on post-accident testing of other boost pumps of the same model to show that icing could have caused the LFP condition on the accident flight. One of their "test" pumps allegedly had problems operating in cold temperatures. However, there is no evidence to explain why, in real conditions on the accident flight, icing only caused a LFP condition on the left-hand side of the aircraft, while the right-hand system remained perfectly functional. The same fuel was being circulated through both sides of the plane in the same environment. The Report completely ignores this critical fact that cannot be explained by icing. After considering all of the above, the NTSB's below analysis and conclusion draw significant questions:

> The NTSB attempted to determine a possible reason for the restricted fuel supply from the left tank. Although the exact source of the restriction could not be identified, the post-accident testing clearly showed that ice accumulation in the fuel (because of not adding a FSII) could degrade performance of many fuel system components, including the fuel boost pumps and valves. The NTSB concludes that the low fuel pressure state and the restricted fuel supply from the left tank during the accident flight were the result of an accumulation of ice in the fuel system with an initial concentrated amount of ice at the airframe fuel filter. (Report at p. 62.)

The Report first admits that the exact source of the restriction could not be identified, but then conversely concludes that the restriction was caused by an accumulation of ice. The NTSB acknowledged a gaping hole in its theory. Now, with the discovery of the left FBP components and subsequent testing and analysis, examined against the back-drop of the PC-12 fuel system's history, which was not shared with the NTSB, the reason for the fuel and balancing systems failures is understandable. The new evidence of FBP failure is inextricably linked to the cause of this accident, and renders the theory of ice accumulation implausible. Petitioners implore the NTSB to review the new forensic and documentary evidence in support of the identified failure in effort to revise the probable cause determination.

D. Defects in the PC-12 Instructions, Cautions and Warnings Disguised the Seriousness of the Emergency and Prevented the Pilot from Acting.

Due to defects in the PC-12 internal computer system and AFM, there were no cautions or warnings to indicate an emergency during the flight. Unsurprisingly, there were also no applicable emergency procedures or instructions delineated in the operative manuals for the situation faced by the pilot.

The PC-12 Aircraft Flight Manual ("AFM") and Quick Reference Handbook ("QRH") contain emergency procedures, each beginning with an "Indication" directing the pilot to the respective procedure, two examples as shown below:

PILATUS PC12 — SECTION 3 EMERGENCY PROCEDURES

3.17 FUEL SYSTEM

3.17.1 LOW FUEL PRESSURE

Indication: FUEL PRESS CAWS CAUTION

3.17.2 FUEL PUMP FAILURE

Indication: No FUEL PUMP advisorywhen fuel pump(s) ON.

The PC-12 Central Advisory & Warning System ("CAWS") incorporates a panel in the cockpit which illuminates lights and activates "gongs" during certain situations. Some of the Indications in the emergency procedures are the illumination of lights on the CAWS panel. An image of the panel is shown below, taken from page 15 of the NTSB Report.

Each light displayed on this panel can be classified as an "advisory", "caution" or "warning." The federal regulations are very specific about what constitutes a "warning" light as differentiated from a "caution" or an "advisory" light. FAR 23.1332 requires that "warning" lights, which are meant to prompt immediate corrective action by the pilot, shall be red in color. As described in the Accident Report, illumination of a red warning light indicates a condition that requires an immediate corrective action by the pilot and it is accompanied by an additional red master WARNING light[10] and an audio message. An amber caution light indicates a condition that requires the pilot's attention but not an immediate corrective action; it is accompanied by an amber master CAUTION light and an aural gong. And a green advisory light indicates that a system is safely operational. (Report at p. 14-15).

§ 23.1322 Warning, caution, and advisory lights.

If warning, caution, or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights;

On the accident flight, there were no caution or warning lights illuminated, no master cautions or warnings, and no aural warnings. Nor were any of the emergency procedure Indications present. Despite the undisputed left FBP failure, as well as an increasing fuel imbalance, neither the indication for a FBP failure or Auto Fuel Balancing failure was present. Instead, the green FUEL PUMP lights were illuminated to indicate safe operation. And despite the hundreds of

[10] Pushing the master WARNING or CAUTION light will extinguish it, but the CAWS warning or caution light will remain illuminated in red or amber until the situation is resolved.

recurring instances of Low Fuel Pressure, the indication for an LFP condition was never illuminated and no master caution/warning was displayed or sounded. Instead, the revised AFM replaced a cautionary warning with a *green* light, indicating proper operation, which is direct violation of the FARs.

1. <u>There Were No Cautions or Warnings of a Low Fuel Pressure Condition.</u>

   a. *The Federal Regulations require a red warning light for Low Fuel Pressure.*

Federal Aviation Regulation ("FAR") 23.1305 requires certain indicators for emergency conditions involving aircraft powerplants. It requires turbine engines to be equipped with a *warning* means for Low Fuel Pressure – fuel pressure below 2psi. (Report at p. 15)

As previously discussed, FAR 23.1332 requires that "warning" lights are supposed to be red, "caution" lights are to be amber, and green lights are only to be used to indicate "safe operation" *Id.* Similar descriptions are included in the PC-12 AFM. (See Ex. P-1, sec. 3-1.) On the PC-12, warning and caution lights are also accompanied by an aural gong and Master light.

Accordingly, the PC-12 should be equipped with a red-colored light to warn the pilot of Low Fuel Pressure. However, as acknowledged in the NTSB Report, the PC-12 indication of low fuel pressure is an *amber* caution light displaying "FUEL PRESS" on the CAWS panel when the fuel pressure is less than 2 psi. (Report at p. 15) This intended function is also stressed in the operative AFM. (See Ex. P-1, secs. 7-59, 7-109.) Contrary to the NTSB conclusion that the plane was properly in accordance with the Federal regulations, the amber coloring of the light is in direct violation of the FARs. (Report at p. 76.) Also contrary to the FARs and even common sense, the current version of the AFM states that the green pump advisories, when cycling, are a warning of low fuel pressure. While this is an improvement over the version of the AFM that existed at the time of the subject accident, it is a poor substitute for a caution or warning compliant with the applicable FAR.

As for the other related NTSB findings, it will be assumed for the sake of argument, that an amber light would have been sufficient for a pilot to react sooner on the accident flight. But, as shown below, the amber light did not even display, despite hundreds of instances of LFP.

   b. *Despite the alleged, intended safeguards for a Low Fuel Pressure Condition, the pilot on the accident flight received no caution or warning of Low Fuel Pressure.*

The NTSB investigation assumed (understandably) that all the warnings would have been present during the accident flights. The Report only goes as far as to acknowledge that the FUEL PRESS Caution did not *log* in the CAWS data. (Report at p. 60.) But it never admits, let alone emphasizes the fact that the FUEL PRESS Caution light never *illuminated* in the cockpit during the accident flight – a fact which we now know to be true. Petitioners must assume that Pilatus did not provide the NTSB with the specifications for the CAWS on the accident aircraft. Pilatus seemingly did not even understand how the CAWS delays worked until Petitioners' representatives raised questions on the system during litigation. In its analysis provided to the NTSB, and in initial depositions during litigation, Pilatus incorrectly explained that the FUEL PRESS light may have been "flashing" or "blinking" on the accident flight, even if it hadn't fully illuminated. But an understanding of the logic disproves this "flashing" theory.

The specifications reveal that the CAWS system is programmable with delays in 100 millisecond increments up to a full second. In fact, the programmed delays—3 milliseconds for illumination of the FUEL PRESS annunciator and one full second for displayed and aural Master caution—guaranteed that the FUEL PRESS caution would never display, because one functioning pump restores fuel pressure in less than 300 milliseconds.

When the PC-12/45 was first developed, and as explained in the 1993 PC-12 Hazard Assessment, the amber FUEL PRESS Caution was intended to illuminate in the event of a Low Fuel Pressure Condition. (See Ex. K, p. 54, PAL-MT 01651.) And at that time, the aircraft were outfitted with the pre-2001 CAWS systems which did not implement the 0.3 sec delay for the FUEL PRESS Caution. So, at the time of certification it was true that the FUEL PRESS Caution would illuminate in the event of a LFP Condition, without limitation.

Documents acquired since the NTSB investigation, and presumably never provided to the NTSB, explain how the pertinent CAWS caution operated after the system was revamped in 2001, for all series-10 PC-12 aircraft (and was retrofitted on all existing PC-12). This evidence provides a thorough explanation of how the system on the accident aircraft was programmed to work and leaves no question that none of the warnings for Low Fuel Pressure ever activated on the accident flights.

The CAWS system installed on the accident aircraft was implemented on all PC-12 aircraft starting in 2001, many years after certification, and the PC-12 was not recertified. The new CAWS system implemented timed delays that affect when certain caution and warning signals will occur. (See Ex. T [Memo from CAWS manufacturer, AEE, to Pilatus], "The CAWS warning mechanism allows a certain delay time after [which] a sensed event will be displayed or played aural. The programmed delay times vary between 0.1 second and 10 minutes.") The below chart provided to Pilatus but the CAWS manufacturer shows that the FUEL PRESS caution is programmed with a delay of 0.3 sec for the light and 1.0 sec for the aural gong:

Message	Delay in Sec.	
	Display	Audio
AP Trim (Warn)	0.3	1.0
AP Trim (Adv)	0.3	No Audio
Fuel Low(Caut)	10.0	10.0
Fuel Pressure (Caut)	0.3	1.0
Pusher (Caut)	0.3	1.0
Pusher Safe Mode (Caut)	0.3	1.0

Table 1: Delays for Audio and Display

(See Exs. R, S and T.) The effect of this delay was that a LFP condition must persist for more than 0.3 sec before the FUEL PRESS light will illuminate, and 1 second before the gong will sound; if the LFP condition is corrected before 0.3 sec, the pilot will not receive any warnings of LFP. Importantly, the testimony of Pilatus representatives established that a single FBP will correct an LFP condition in less than 0.3 sec. (See Ex. AB, [Pilatus Depo. K. Oetiker] at 100:1-13; 203:15-204:1; 858:10-859:1.) Therefore, the recurring LFP condition on the accident flights was repeatedly, but briefly, "corrected" quicker than the FUEL PRESS light is programmed to react.

(See Ex. AB at 100:1-13 and 203:15-204:1.) Therefore, the FUEL PRESS Caution did not illuminate at any time during the accident flights. And an additional delay of one second prevented the aural gong and Master Caution light from initiating. The accident aircraft (S/N 403) was one of the first to be fitted with the new CAWS system in 2001 which implemented the 0.3 sec delay for the FUEL PRESS caution and full second for the Master caution.

Arguably the most significant inaccuracy in the Report is the following statement, in bold below:

> *According to the PC-12 AFM, the fuel boost pumps operate automatically if a low fuel pressure state exists—which occurs when fuel system pressure drops below 2 psi—and the pump's switch is set to the AUTO position. Similarly,* ***the PC-12 AFM also states that*** *the CAWS annunciates a low fuel pressure caution when fuel system pressure drops below 2 psi for* ***more than 0.3 second.*** (Report at p. 50, emphasis added.)

This statement is plainly wrong. There is no caveat anywhere in the operative AFM or any other materials accessible to pilots, indicating that FUEL PRESS will only activate after a 0.3 second delay. Similarly, there is nothing in the AFM that explains that the CAWS, by design, will not display in certain LFP conditions. The AFM and other materials available to the pilot all instruct that FUEL PRESS will illuminate when the fuel pressure drops below 2psi – period. The above misstatement is not superficial. Such information would have been indispensable to the pilot in understanding what was happening to the fuel system. More importantly, the delay programmed into the CAWS beginning with S/N 401 was not necessary and could easily be modified.

Technical documents disprove any argument that the FUEL PRESS light might have "flickered". The CAWS logs events either as "activated" (on) or "cleared" (off). (Report at p. 2, ft. 7.) The specifications are unambiguous that if the light illuminates, even momentarily, there will be a "CLEARED" log entry for Low Fuel Pressure[11]. (Exs. R, S and T.) This is also stated in Pilatus' draft submission to the NTSB: "As soon as the caption is displayed, "activated" is entered in the CAWS log. When the caption goes away, "cleared" is entered." (See Ex. U, p. 9.) This mechanism was discussed between the NTSB and Pilatus during the investigation in connection with the PUSHER caution analysis, which prompted an errata to the Factual Report. (Report at p. 32; NTSB Docket Entry 03 Errata to Operations.) Because the CAWS data does not show FUEL PRESS logs (activated *or* cleared), it is certain that the pilot of the accident aircraft never saw a FUEL PRESS Caution, despite hundreds of occurrences of Low Fuel Pressure[12]. Importantly, Pilatus' hazard assessment for the CAWS system describes the failure of the FUEL PRESS caution as "Low Fuel Pressure, but No Caution Indication", which is classified as a "major failure."

[11] Note, Pilatus provided inaccurate information to the NTSB on this matter, failing to differentiate between a CLEARED and ACTIVATED log. (See Ex. U, "A 'fuel low pressure' log is entered when the fuel pressure senses by the fuel pressure switch drops below 2 psi for more than 1 second.")

[12] New documentary evidence, consisting of Pilatus' draft Reports to the NTSB re. its analysis of the accident scenario, show that Pilatus had initially included language advising the NTSB that no Low Fuel Pressure CAWS annunciations were displayed during the accident flight. (Ex. V, p. 9, "No low fuel PX annunciation was displayed.") This language never made it to the analysis received by the NTSB and therefore was absent from the final Report.

Because the system is *programmed* to suppress the FUEL PRESS caution in the scenario that occurred on the accident flight, this was a "major failure" that occurred many times on the day of the crash. (See Ex. R, p. 24, PAL-MT 000496 and Ex. Q [AEE CAWS 4800 Equipment Specification].)

The NTSB compares this incident and the pilot's actions to that of another incident with Aircraft N666M. (Report at p. 44-45.) However, the CAWS data log for the N666M incident shows a FUEL PRESS data entry, which necessarily means that the pilot of N666M *did* receive a FUEL PRESS Caution light in the cockpit, however briefly. This is not addressed in the Report even though the Report criticizes the accident pilot by emphasizing that the N666M pilot made a precautionary landing under similar conditions. But it is now very significant to note that, without the amber FUEL PRESS light and Master Caution indicating the need for corrective action, the accident pilot's sense of urgency was greatly diminished.

Despite hundreds of instances of LFP on the accident flight, the CAWS *never* displayed the FUEL PRESS caution. Had the system operated as expected, without the programmed delays, the CAWS would have displayed FUEL PRESS dozens of time on the first flight on the day of the crash, requiring immediate landing of the aircraft and the likelihood that the accident flight never would have departed. The PC-12/45 aircraft warning system is missing a crucial emergency warning – a void which ended in disaster on the day of the accident.

c. *Pilatus was aware of the defect in the Low Fuel Pressure warning system for years before the crash, but did not inform pilots.*

It appears that Pilatus did not acknowledge or understand the effect of the 0.3 sec delay when it was implemented into the updated CAWS system in 2001. At that time, Pilatus' updated CAWS Engineering Report detailed the failure modes of the CAWS system. (See Ex. R.) The FBP failure mode for a failed FBP – "Green advisory even though fuel pump is not operating correctly" – is considered a **Major** failure. (Ex. R, p. 29, PAL-MT 000501.) And the written "justification" for this failure mode is "Fuel pressure caution will be illuminated." However, we now know that this justification is categorically incorrect; when the FBP failed on the accident flight and the fuel pressure dropped, the LFP cautions did *not* activate due to an intentional 0.3 sec delay in the CAWS. It is telling that the Pilatus CAWS Engineering Report describes the failure of the FUEL PRESS light as "No Caution Indication when Fuel Pressure Low." (See Ex. R at p. 24, PAL-MT 000496.) Therefore, according to the Engineering Report, the repeated incident that occurred on the accident flight was a failure condition – but at the same time, the system was operating as designed.

As stated above – the operative AFM specifies that the "Indication" for an LFP condition is a FUEL PRESS Caution light. (Ex. P-1 at sec. 3-47.) But if the light does not illuminate during an LFP condition, the emergency procedure becomes moot. As acknowledged in the Report, the downloaded CAWS data showed hundreds of occurrences where the boost pumps "cycled" on and off in attempt to restore fuel pressure. (NTSB Docket #45 "Airworthiness", p. 5.) On the first leg of the accident flight alone, there were approximately 88 recurring LFP conditions, and on the second leg there were approximately 168 occurrences. But the FUEL PRESS caution never once illuminated.

Further documentary evidence reveals that, well before the crash, Pilatus became attuned to the fact that the FUEL PRESS Caution would rarely, if ever, illuminate despite the fuel pressure falling below 2psi. As early as 2006, Pilatus was aware of this inadequacy and began revising the AFM. (See internal Pilatus communications re. revisions to the AFM at Ex. O.) The revisions deliberately amended the "Indication" for the Low Fuel Pressure emergency procedure. They added a new, alternative "Indication" – "Both fuel pumps cycling on and off every 10 s" – with no reference to the FUEL PRESS Caution. The FUEL PRESS Caution is only listed as an Indication *after* the entire procedure for the former Indication; and even then, it is listed in conjunction with the green PUMP advisories.

2007 AFM Emergency Procedures for the PC-12/45 (in effect in 2009):

PILATUS PC12 — SECTION 3 EMERGENCY PROCEDURES

3.17 FUEL SYSTEM

3.17.1 LOW FUEL PRESSURE

Indication: FUEL PRESS CAWS CAUTION

2008 Revised AFM Emergency Procedures for the PC-12/47E:

SECTION 3 EMERGENCY PROCEDURES — PILATUS PC-12/47E

3.16 FUEL SYSTEM

3.16.1 FUEL PRESSURE LOW

Indication: MFD Fuel Window – Both fuel pumps cycling on and off every 10 s.

2010 Revised AFM Emergency Procedures for the PC-12/45:

SECTION 3 EMERGENCY PROCEDURES — PILATUS PC12

3.17 FUEL SYSTEM

3.17.1 LOW FUEL PRESSURE

Indication: - FUEL PRESS CAWS CAUTION, and or
- CAWS Advisory FUEL PUMP cycling on and off every 10 seconds

When Pilatus became aware that the LFP Caution light failed to operate, it made a half-hearted attempt to conceive an alternative means for a pilot to recognize an LFP condition. Instead of implementing changes to the CAWS system to fix the obvious defect[13], Pilatus chose to have pilots rely on the green FUEL PUMP lights as an Indication of an LFP condition, which is an egregious violation of the FARs. It began using "cycling green PUMP lights" as a warning for an LFP condition. As stated in the Report, this "cycling" condition was present for approximately 15 minutes during the accident flight, before the left-hand boost pump switched on constantly. (Report at p. 32.) These considerations are crucial because they show that Pilatus not only recognized the defective nature of the FUEL PRESS caution, but also the seriousness of a situation in which the Caution failed to activate.

Pilatus amended and published these new emergency procedures in 2008, a full year before the crash, with the advent of its PC-12/47E or "NG" aircraft. (Ex. P-2.) Unfortunately, however, Pilatus only revised the AFM for purchasers of these newer model PC-12, but did not provide this information to existing owners or operators of PC-12 aircraft, such as the accident owner and pilot.

This critical information was not incorporated into operative AFM until 2010, after the crash. (Ex. P-3.) Therefore, the pilot of the accident aircraft had no knowledge of these revised procedures which very likely would have saved the lives of all on the accident flight. This immense oversight in updating the AFM deprived the pilot of the means to determine the critical unfolding events during the accident flight.

d. *The revised emergency procedures would have prevented the accident.*

As stated above, Pilatus amended the emergency procedures in the operative AFM in 2010 to include cycling green boost pumps as an indication of an LFP condition. Taking note of this, the NTSB made the following opinion:

> *In June 2010, Pilatus revised its emergency procedure for low fuel pressure. The revised procedure stated that both the FUEL PRESS caution and the cycling of a FUEL PUMP advisory on and off every 10 seconds were indications of low fuel pressure.* ***The NTSB believes that, even if the revised procedure for low fuel pressure had been in place at the time of the accident, the outcome of the accident would still have been the same*** *because the pilot did not (1) add a FSII to the fuel, (2) descend to warmer air when the fuel boost pumps were cycling, and (3) divert to a suitable airport when the maximum allowable fuel imbalance had been exceeded.* (Report at p. 61)

But the NTSB's three delineated reasons are based on faulty logic and are invalidated by new evidence. It implies that, since the NTSB determined the pilot did not follow other specific instructions and procedures, he would not have followed this new one. Such a bold assumption cannot relieve Pilatus of its duties regarding safety or its fault in failing to provide the pilot with the best available information.

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[13] In 2007, a series of updates were made to the CAWS system, at which point Pilatus could have easily implemented modifications to the CAWS logic to correct the flawed logic for a Low Fuel Pressure Caution. Similarly, in 2007 a series of revisions were made to the PC-12/45 AFM, when Pilatus could have easily implemented the corrected language into the emergency procedures section.

First, whether the pilot added FSII to the fuel is entirely unrelated to how he would have reacted had he believed he was presented with an LFP condition. Based on the NTSB's conclusion that FSII would have prevented the entire emergency, there would have been no need for the LFP emergency procedure, which would make the content of those procedures irrelevant. The fact that the fuel lacked FSII does not affect how the pilot reacted to differing emergency procedures, when he in fact was faced with such a situation.

Next, the NTSB points out that the pilot did not descend to warmer air when the fuel boost pumps were cycling. But what they mean is that he didn't descend soon enough, a criticism which is based on numerous assumptions, discussed earlier. The biggest assumption is that the pilot was expected to know he was having an icing problem and should descend to warmer air. The NTSB glosses over the fact that the instruction "descend to warmer air" is buried in a note[14] within the emergency procedure for an LFP condition, and we now know that the pilot did not have the Indication for LFP – a FUEL PRESS caution light. An expectation that the pilot should have continued reading the emergency steps of a procedure for which he had no Indication is irrational and unfounded.

Lastly, the NTSB reiterates that the pilot did not divert to a suitable airport when the maximum allowable fuel imbalance had been exceeded. As detailed in section C(2)(b), the pilot was not given any warnings that the maximum imbalance had been reached. Furthermore, the heart of the ABS–the left FBP–had failed, so the imbalance was uncorrectable, but the pilot received no indication of FBP failure. And, even if the pilot had realized at some point in time that there was an uncorrectable fuel imbalance, the emergency procedure for an ABS failure was, at best confusing and at worst, useless.

The Indication for such a procedure necessitates that the Auto Fuel Balance System did not activate ("without automatic activation"). But the only signal to a pilot that balancing is activated are the two green FUEL PUMP lights, which were illuminated during the flight, alerting that the system *was* activated. Additionally, the Indication for the relevant procedure *begins* with an imbalance of 3 or more bars on the indicator, and then leads into troubleshooting. So even assuming the pilot disregarded the signs he was receiving that balancing had been activated, to expect the pilot to have already diverted the aircraft when he reached an imbalance of 3 bars is entirely unreasonable.

The first step in the procedure requires the pilot to turn the pump to ON. Next, it directs the pilot to "monitor", but does not give any length of time as to how long he should monitor, or how long it would take a pump to correct an imbalance. Only after this unspecified length of time does it direct the pilot to "land as soon as practical", which per the AFM means that "Landing airport and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest suitable airport is not recommended." (Ex. P-1, sec. 3-1.) This instruction is not nearly as severe as "Land as soon as possible" which necessitates landing "without delay at the nearest airport

[14] p. 60-61 of the Report discusses this note at length only because it includes language that an LFP condition can cause the FBPs to cycle and that a possible cause may be ice crystals blocking the filter. But the expectation that the pilot should have immediately (or even quickly) located that note within the procedure is wildly presumptive because it necessitates that the pilot not only overlooked the lack of FUEL PRESS caution but also troubleshot the entire problem, including an instruction to "land as soon as possible."

where a safe approach and landing is reasonably assured." (Ex. P-1, sec. 3-1) Approximating the time frame between when the pilot absolutely should have noticed a problem and the time he diverted, a finding that he acted unreasonably is unwarranted.

On the contrary, if the pilot had been presented with the *revised* Indication, there is no doubt he should have heeded it. If, at the moment of peril, the pilot's AFM had included "cycling FUEL PUMP lights" as the primary Indication of Low Fuel Pressure, there would be no question that he should have "Landed as Soon as Possible." Under the NTSB's theory that a diversion to an alternate airport would have prevented the accident, the revised emergency procedure indeed would have prevented the accident.

e. *The revised emergency procedures remain defective and in violation of the FARs.*

Starting with revisions to the PC-12/47E AFM in 2008, Pilatus began using the "cycling green PUMP advisories" as a warning for low fuel pressure. (Ex. P-2 an P-3.) It implemented similar[15] amendments to the PC-12/45 AFM in 2010, after the accident.

3.17.1 LOW FUEL PRESSURE		
	Indication:	**- FUEL PRESS CAWS CAUTION, and or**
		- CAWS Advisory FUEL PUMP cycling on and off every 10 seconds

This above revised "Indication", while more useful to a pilot that the original, is inherently improper and violates the FARs even more egregiously than the original indication. The cycling PUMP lights are *green*, a color reserved for non-emergency situations, and in fact are supposed to indicate safe, proper system operation. (See NTSB Report p. 14 "Illumination of a green advisory light indicated that a system was operational"; FAR 23.1332.) But the FARs require a *warning* means for Low Fuel Pressure, and warnings are supposed to be red. Moreover, it does not take Federal regulations to understand that a red indicator is more crucial than a green one.

These defects in the PC-12 warning system and AFM are critically important to the safe operation of aircraft. There are hundreds of PC-12 aircraft and accompanying manuals currently in use, and all are in violation of FAR 23.1305. Therefore, Petitioners urge the NTSB to review the evidence presented and not only amend the erroneous findings, but also initiate remedial measures to bring the PC-12 and its components into compliance with the Federal Regulations.

2. <u>There Were No Cautions or Warnings of a Fuel Pump Failure.</u>

Because it can now be confirmed that the left FBP failed on the flight, it is also important to consider the warnings (or lack thereof) for a failed FBP when evaluating the pilot's decision making on the accident flight. Per the operative AFM, the indication of a failed boost pump is "No FUEL PUMP advisory when fuel pump(s) ON." (Ex. P-1.) This is reiterated in other sections of the AFM that instruct that the green FUEL PUMP lights indicate proper operation. But even

[15] The 47E/NG aircraft had an updated Cautions and Warnings System, so the instructions are slightly different.

though the left FBP failed, the green lights were displayed throughout the accident flight. Therefore, the pilot was deceived into believing that both boost pumps were operating properly, and he was not directed to the emergency procedure for a fuel pump failure.

Moreover, newly uncovered documentary evidence shows that for years prior to the crash, Pilatus was aware of the inaccuracies in the operative AFM. In fact, a year prior to the crash, Pilatus amended the emergency procedures in the PC-12 AFM (again, only for their *new* PC-12 aircraft) to include an accurate indication of a failed boost pump – "both fuel pump(s) on for more than 10s with 2 or more segments difference between the left and right and no Fuel Pressure Low caution." This indication is exactly what occurred on the accident flight, but the pilot was not provided with the revised emergency procedures to follow.

3. There Were False Indications of Fuel Boost Pump Operation

a. *The misleading green FUEL PUMP advisories*

The PC-12 CAWS panel contains two green advisory FUEL PUMP lights, one for each pump: "L FUEL PUMP" and "R FUEL PUMP". Again, it must be noted that the FARs and AFM state that green cockpit lights indicate safe operation of a functioning system. (F.A.R. 23.1332; Ex. P-1, AFM secs. 3-1 and 7-105) The Pilatus engineering report for the CAWS system notes "Green advisory annunciation to indicate safe system operation." (See Ex. R, [Pilatus Engineering Report CAWS 4800] at p. 38, PAL-MT 000510.) The AFM specifically instructs that the green FUEL PUMP lights "indicate that the applicable fuel boost pump is operating." (See Ex. P-1, PC-12/45 2007 POH Sec 7-58, 7-59, 7-110).[16]

However, the green FUEL PUMP lights do not actually indicate that the pumps are operating. They only indicate that an FBP has been *activated,* or, in other words, that it *should* be operating. This is confirmed in Pilatus' own documents: "The indication system is not able to determine whether the fuel boost pump is actually providing fuel flow or building up pressure." at Ex. U, p. 2. Pilatus fuel system engineer Thomas Friedli stated: "*There is a condition where the green light will be shown and the pump cannot provide appropriate flow.*" (Ex. AC at 239:1-3.)

In fact, an FBP could be completely non-operational, but if it has been commanded to operate, as in the case of a LFP condition, the green lights will illuminate even in the event of complete failure. In the PC-12 as designed, there is no way to know whether the pump is working based on the green annunciator.

This fact is critical for several reasons. First it violates the FAR requirement that green lights are to be used to indicate safe operation. These FUEL PUMP lights will illuminate even if a pump has failed, in which case the system is clearly not operating safely. Not only is the indicating system deficient; it also erroneously misinforms the pilot that the system is functioning when it is not. This deficiency is compounded by the AFM's erroneous statement that the PUMP lights indicate "safe operation", with potentially deadly consequences. In fact, in 2010 after the crash, the language of the AFM was amended to advise that the green FUEL PUMP lights "do not confirm correct pump operation." (Ex. P-3 and Ex. AD at 247:2-248:2.)

[16] In fact, the most current PC-12/45 AFM, published in 2010, still contains this erroneous language. (See Ex. P-3, 2010 POH sec 7-58, 7-110)

b. *The NTSB's misunderstanding of the misleading FUEL PUMP advisories*

The NTSB's understanding of this aspect of the system and the related AFM defect appears to be limited and partially incorrect. Contradictory "facts" and conclusions contained in the Report indicate that the NTSB did not fully recognize this deficiency in the PUMP indication lights, or the implications that it had on the accident flight. The Report contains many contrary assertions as to the meaning of the lights, including the following inaccurate observations:

- "Fuel **boost pump operation** and low fuel pressure conditions are indicated on the CAWS." (Report at p. 12)
- "Illumination of a green advisory light indicated that a system was **operational**." (Report at p. 14.)
- "Among the CAWS indications were...green advisories for fuel **boost pump operation** ("L FUEL PUMP and R FUEL PUMP")." (Report at p. 15.)
- "When set to ON, the boost pump will operate continuously and a green LFUEL PUMP or RFUEL PUMP caption on the CAWS is illuminated. This indicates that the applicable fuel **boost pumps are operating**." (NTSB Docket #2 "Operations", p. 20.)
- "A green advisory light would have indicated that a **system was in operation**." (NTSB Docket #41 "Airworthiness Factual Report", p. 17.)

In only one place does the Report accurately express the function of the green FUEL PUMP lights, where it acknowledges that the CAWS is not equipped with a direct indication of FBP operation because the green FUEL PUMP advisories only show that power is being relayed to the respective pump. (Report at p. 15.) Nowhere does the Report acknowledge that the AFM (which the pilot would have heeded) repeatedly instructs that these green advisory lights indicate proper and safe operation. These factors are critical oversights that affect the entire analysis of the Probable Cause, which stressed that the pilot's failure to take appropriate remedial actions contributed to the accident. The above information highlights a critical reason why the pilot was not alerted to an emergency sooner.

c. *Boost Pump non-operation and non-indication on the accident flight*

As noted by the NTSB on pages 1 and 3 of the Report, the pumps were activated in a cyclical manner throughout the flights on the day of the accident:

> *Data downloaded from the airplane's central advisory and warning system (CAWS) showed that, for the flight from REI to VCB, the left and right fuel boost pumps began cycling (that is, turning on for about 10 seconds and then off for about 1 second) about 1 hour 30 minutes into the flight. About 15 minutes later, the left fuel boost pump was on continuously, and the right fuel boost pump was of. The left fuel boost pump remained on continuously for the rest of the flight.*
>
> ...
>
> *CAWS data revealed that the left and right fuel boost pumps began cycling about 1323 (1 hour 13 minutes into the flight). For about 3 minutes starting about 1328, the left fuel boost pump was on continuously, and the right fuel boost pump was off. After that time, the right fuel boost*

pump was cycling or was on continuously, and the left fuel boost pump was on continuously or was off.

Significant inaccuracies pervade the above description, which makes repeated conclusions as to the operational status of the pump ("on" or "off"). The only determination that can be made from the CAWS data is whether the pump was activated—**not** whether it was operating. The CAWS data also shows that in each situation where a pump was commanded "on" or "off", the respective green FUEL PUMP light was displayed in the cockpit—regardless of the operational status of the pump. Every time the left FBP was signaled to activate, the L FUEL PUMP light illuminated in the cockpit even though the left boost pump stopped working during the accident flight (Report at p. 50.) The green "L FUEL PUMP" light was illuminated for most of the critical time during the flight, even though the pump had failed. So, despite the AFM's instruction that the L FUEL PUMP light indicates boost pump operation, this was not true on the accident flight. This inaccuracy grossly misled the pilot into believing that he had operational boost pumps when in fact the left pump had failed.

d. *Conclusion*

The green PUMP "safe operation" advisories were the *only* fuel-related CAWS lights illuminated during the critical period of the accident flight. The seriousness of the pilot's worsening situation is undisputed; yet as this emergency progressed behind the scenes, there were no cautions or warnings displayed to the pilot. That the pilot should have nonetheless been expected to assume that the system was not operating as intended is patently unreasonable. ***This crash was not the result of the pilot's failure to heed emergency indications, but the result of a lack of any such indications to begin with.***

4. There Was No Indication of an Auto Balancing System Failure.

a. *The manufacturer's instructions do not treat a fuel imbalance as an emergency.*

NTSB Finding Nos. 9, 11, 12 and 13 make many misleading implications regarding the aircraft's warning system. They unduly emphasize the "maximum allowable fuel imbalance" and nonexistent "fuel imbalance warnings".

First, the "maximum allowable fuel imbalance" is not nearly as well-delineated as the Report implies. In truth, the PC-12 AFM contains a single line that lists the maximum fuel imbalance of 178 lb, or 3 "bars"[17] on the fuel gauge. Even though this information is stated in the Limitations section, *not* the Emergency Procedures section, the NTSB Report continually treats the scenario as an emergency requiring immediate and specific pilot reaction.

The NTSB Report analysis in sec. 2.2.1 similarly states that Pilatus' AFM procedures require a pilot to "land the airplane as soon as practical if the maximum allowable fuel imbalance [is] exceeded." (Report at pp. 49 & 62). Finding # 9 criticizes the pilot for not diverting immediately, *before* performing any troubleshooting, while in so criticizing, acknowledges that

[17] The Report regularly references the maximum as a "three bar", difference between the gauges. But it fails to acknowledge the uncertainty in this limitation, as a "three bar" difference could range dramatically among a 100-pound range.

the pilot troubleshot the aircraft systems before diverting. Such analysis is unfounded because there are no emergency procedures concerning an exceedance of the "maximum imbalance," partially because there are not even any CAWS cautions or warnings indicating that an excessive imbalance has occurred![18] Only the newer model PC-12 47E or NG iteration is so equipped.

Nonetheless, the NTSB explicitly states that there *were* "fuel imbalance warnings" (Report, Finding No.13) during the accident flight, as well as on previous flights. Once again, the FARs clearly state that "warnings" are to be indicated by red lights in the cockpit. The PC-12 (before S/N 1001) has no such warning, or even "caution" (amber colored) lights in the cockpit to indicate a fuel imbalance. Instead, throughout the entire critical situation, the only indications given to the pilot were green FUEL PUMP advisories that falsely indicated normal operation.

b. *The indication for an ABS failure was not present.*

The emergency procedure for an ABS failure is depicted below.

3.17.3 AUTO FUEL BALANCING FAILURE

Indication: **EIS analogue fuel gauges indicate 3 segments or more difference between left and right without automatic activation. Possibly aileron deflection required for wings level flight, especially at low speed.**

1.	Fuel Pump (fuller side)	ON
2.	Fuel state	Monitor. If difference cannot be balanced, land as soon as practical
3.	When fuel balanced	Fuel Pump AUTO

The Indication for an ABS failure is a 3-bar imbalance (on the fuel gauges) with "no automatic activation". (See Ex. P-1, Sec. 3-48) The only way a pilot can identify "automatic activation" is by the green FUEL PUMP lights. Because these lights were ON, the pilot would believe and expect that the ABS was operational. It is therefore misplaced to assume that he would or should have immediately followed the respective instructions.

c. *Following the ABS procedure would not have prevented the crash.*

The second misleading implication is that the emergency procedure for the failure of the ABS would have avoided the rolling moment caused by a left-wing heavy imbalance. (Report Finding No. 11) But even if the pilot had followed the procedure, it would have been completely ineffective because the left FBP, the mechanism for correcting the left-wing heavy imbalance, had failed. The problem was not that the ABS itself had failed, but the actual component required by the system to correct the imbalance had failed. The ABS *was* operating and did in fact signal the left fuel boost pump to activate. But, because of a manufacturing defect, the left FBP had failed

[18] The only way the pilot could have appreciated the severity of the imbalance scenario was based on the fuel gauges which are segmented by "bars". These gauges are not part of the CAWS cautions and warnings system.

and could not transfer fuel through the system. The pilot could have troubleshot to no end, and at best would have reached a vague instruction to "monitor" the fuel state.

The Report repeatedly emphasizes that the pilot should have effected a more "immediate" diversion. But there is no evidence to support the conclusion that any diversion would have avoided the crash. Pilatus deposition testimony notes that the pilot would not be expected to have diverted until a 6-8 bar imbalance was present. Accepting Pilatus' estimated fuel transfer rate, if the pilot had diverted at 6-8 bars, and descended at approximately 2000 fpm (a rather significant descent rate), the imbalance would increase to about a 15-bar differential by the time the aircraft was setting up for a landing at an alternate airport. The most severe imbalance that was ever tested in a landing situation by Pilatus was approximately an 8-bar differential. There is no evidence to support an argument that the aircraft would have safely landed with a 15 bar, rather than a 27 bar, differential. With the "dangerous wing design," the significant asymmetric imbalance, no warnings, instructions or training to the pilot to keep his speed up, the accident was inevitable. Therefore, the Report's finding that the pilot should have diverted sooner has no causal relevance to the outcome of this crash.[19].

It is noteworthy that the only instruction to "land as soon as possible" in the operative AFM Fuel Emergency Procedures is when a FUEL PRESS caution is displayed. As discussed in detail below, the CAWS was programmed with a one-second time delay that suppressed the warning. (See Ex. AB at 858:10-859:11, Oetiker states that Pilatus was aware of the 1-sec delay at the time of manufacture, but does not recall anyone asking to change it.) Considering this deficiency in the CAWS—which was known to the manufacturer for years before the accident and was and remains easily correctible—an NTSB finding that the ABS failure should have been observed and acted on is not warranted.

d. *Criticism of the pilot's timing is unwarranted.*

There is also no evidence that that the pilot was *not* following the ABS emergency procedure. The CAWS data demonstrates that from about one hour and 45 minutes into the flight, the left FBP stayed ON continuously. At this point, the pilot may have turned the pump to ON and begun to monitor the imbalance, as instructed. However, because there is no instruction on how to monitor, how quickly an imbalance will be corrected, or how quickly an imbalance will progress if the system has failed, it is impossible to say that the pilot was not following the ABS procedure.

These findings also assume the amount of time the pilot should have spent choosing and diverting to an alternate airport. After all, the ABS emergency procedure ultimately instructs the pilot to "land as soon as practical." This phrase is defined in the AFM as: "Landing airport and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest suitable airport is not recommended."[20] (See Ex. P-1, POH Sec. 3-1.) Even if the pilot had followed the

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[19] The pilot was faced with a situation where he had a full left wing and little to no fuel in the right wing. When he needed to make a left hand turn to re-enter the pattern, the P-factor of the engine, coupled with the dangerous wing design, resulted in a roll moment that the pilot could not arrest. The PC-12 failed its certification testing and was required to implement a stick shaker system for this very reason, instability in a low airspeed, high thrust scenario – an issue that Pilatus was aware of prior to the creation of the first prototype.

[20] Compare this with "land as soon as *possible*" which necessitates landing "without delay at the nearest airport where a safe approach and landing is reasonably assured.

ABS procedure and proceeded to the final step, the AFM affords him *discretion* in how long to continue his flight and where to land. It doesn't inform him how critical the situation is. Considering the undisputed immanency of the situation presented, any argument that the pilot should have followed the emergency procedure for an ABS failure necessarily must acknowledge that the procedure was critically lacking such urgent language.

e. *The significance of the 2007 CAWS Data*

Lastly, the NTSB's references to "previous similar warnings" are misleading and inaccurate. (Report Finding No. 13.) The Report analysis states:

> *The pilot had likely downplayed the seriousness of the initial advisories because no adverse outcomes resulted from ignoring the advisories during the flight from REI to VCB and during an October 2007 flight, when a low fuel pressure state existed that also necessitated the automatic operation of the left and right fuel boost pumps to provide the required fuel pressure to the engine (see section 1.16.2).* (Report at pp. 49 & 67.)

The CAWS data show that the FBPs underwent a similar "cycling" phenomenon in 2007. But the evidence equally shows that the only fuel system indications on that flight were green PUMP advisories. As already explained, the PC-12 aircraft (before S/N 1001) does not display any caution or warning related to fuel imbalance.

But there is another significant aspect of the previous phenomenon that was overlooked. The CAWS data revealing the FBP phenomenon was only available after the crash. Despite maintenance work performed on the aircraft after the 2007 phenomenon, the maintenance facility never had access to the CAWS data. Access to this data would have been critical in preventing the situation that occurred.

Of course, it is easy to say this in hindsight; why would the maintenance facilities have thought to look at this data? But, in fact, new internal documents show that maintenance facilities *did* seek the ability to access the CAWS data on PC-12 aircraft years prior to the crash. But, for purely financial reasons, Pilatus denied them the opportunity. (Ex. Z.) There is no excuse for this problem not having been discovered in 2007, which would have prevented this crash.

5. **There Is No Evidence That the Pilot Was Presented with Any Indication of a Severe and Uncorrectable Fuel Imbalance Prior to the Point of Diversion.**

The Report heavily emphasizes nonexistent "fuel imbalance warnings". The main criticism of the pilot is that he didn't notice these warnings soon enough.

The report makes the following observations in support of its rationale. (Report at p. 53.)

- The AFM instructs pilots to monitor the fuel quantity indicator for fuel symmetry during each flight.
- About 1 hr 32mins into the flight, the fuel quantity indicator would have displayed a six-bar differential between the left and the right fuel tanks.
- The AFM states that the maximum fuel imbalance for the PC-12 was 178 pounds with a maximum three-bar differential displayed on the fuel quantity indicator.

- The pilot elected to continue to BZN, even though the maximum three-bar differential had been exceeded.

The above "facts" upon which the NTSB bases its findings are a series of assumptions used to reach determinations that could have gone several ways. It is important to note that, despite a dispute over cause, the Report clearly acknowledges that the fuel system was malfunctioning during the accident flight. This alone demonstrates that its calculations concerning the effects of such malfunction are indefinite. Section 2.2.3.1 of the Report chronicles its interpretation of how the fuel system operated and the resulting amount of imbalance at critical points during the flight. This section repeatedly uses language such as "likely" and "assuming," or references to what "would have" or "should have" happened if the system had been operating properly.[21]

The fuel gauges in the PC-12 (shown on the right) are highly indefinite and never actually state the fuel differential in pounds. Instead, a small 2-inch gauge with 28 segments is used to illustrate the fuel in each tank. Because each segment could represent a variance of up to 50lbs of fuel in either direction, a three-bar differential may represent any amount across a 100 lb range. This observation is merely meant to demonstrate the angle taken by the Report which "assumed the worst" and blatantly excluded equally viable predictions. Such is directly related to the Report's criticism of the pilot's actions and ultimate Probable Cause determination. This evidence strongly indicates that Pilatus' and the Report's conclusions as to what the pilot was seeing during the accident flight are based on pure speculation.

III. NEW FINDINGS

Based on the critical new evidence presented, key conclusions can be drawn that support findings which were not, or could not, have been drawn by the NTSB at the time of its investigation. Petitioners urge the NTSB to review the totality of the new evidence and consider the resultant findings below which have a fundamental impact on the determination of probable cause.

New Finding No. 1: Investigation and forensic testing found that the left Fuel Boost Pump contained mechanical defects that prevented it from operating as designed and intended.

New Finding No. 2: If the left Fuel Boost Pump had operated as designed and intended, it would have maintained sufficient fuel pressure while balancing the fuel between the tanks, and a left-wing heavy fuel imbalance would not have developed.

New Finding No. 3: The recurring Low Fuel Pressure condition, the lack of fuel supply from the left fuel tank, the uncorrectable increasing imbalance, and the inability for the system to correct the imbalance were the result of a mechanical defect in the left Fuel Boost Pump.

[21] The report identifies two more assumptions in footnote 101.

New Finding No. 4: Despite the fact that the left Fuel Boost Pump was not operating properly on the accident flight, the cockpit was displaying green PUMP advisories to the pilot throughout the flight, which, according to the AFM, indicated that the left Fuel Boost Pump was operational.

New Finding No. 5: If the Fuel Boost Pump advisories had been properly described in the AFM, the pilot would have had an immediate indication that the left Fuel Boost Pump had failed, at which point he would have troubleshot and diverted the plane and had a better chance of safely executing an emergency landing.

New Finding No. 6: The CAWS system was defectively programmed with a timed delay that suppressed visual and audible indications for Low Fuel Pressure, including hundreds of occurrences of Low Fuel Pressure during the flights on the day of the accident.

New Finding No. 7: The CAWS system incorporated a design that violates FARs 23.1305 and 23.1332 because it does not use a red warning means to indicate Low Fuel Pressure.

New Finding No. 8: If the warning for Low Fuel Pressure had operated in compliance with the FARs, the pilot would have received visual and audible Low Fuel Pressure warnings on the first flight of the day, indicating an emergency requiring immediate pilot action, and the pilot would have safely grounded the plane before any of the decedent passengers even boarded the plane.

New Finding No. 9: The <u>only</u> caution or warning the pilot received during the flight was a "Fuel Level Low" warning for the right tank six minutes before the crash.

New Finding No. 10: An updated version of the PC-12 AFM was published a year before the crash with revised fuel system emergency procedures which may have prevented the crash, but the AFM was only distributed to owners and operators of the new PC-12 47E or "NG" aircraft.

New Finding No. 11: If the pilot had the revised fuel system emergency procedures contained in the PC-12 NG AFM, he would have been advised to land "as soon as possible" shortly after the green PUMP lights began cycling.

IV. CONCLUSION

Petitioners also urge the NTSB consider the calamitous effect of the inoperable warning for Low Fuel Pressure on the PC-12 Legacy aircraft. A review of the specifications for the CAWS system that was introduced in 2001 along with testimony of Pilatus witnesses will aid in understanding why the CAWS never provided the FUEL PRESS warning, with the result that the pilot was never informed of the progressing emergency situation. While components can and do fail, such as the fuel boost pump, the CAWS is supposed to inform the pilot of the failure so that he can take appropriate action to avoid disaster. The subject CAWS system was programmed to defeat the FUEL PRESS caution in violation of the FARs and should be modified to prevent another disaster.

During this review, Petitioners also urge the NTSB to isolate and study Dr. McSwain's declaration concerning metallurgical analysis of the left fuel boost pump components. This analysis is critical because the NTSB did not have access to the left fuel boost pump during its investigation. The manufacturing defect documented in Dr. McSwain's analysis identifies the cause of the aircraft's fuel system failure during the accident flight distinct from the presence of icing in the fuel system.

Documents previously undisclosed by Pilatus reveal numerous other defects and failures of the PC-12 fuel system, warning system and Aircraft Flight Manual. These have been summarized herein and provide a complete picture of the circumstances surrounding this tragedy.

Petitioners believe that, after review and analysis of this newly submitted evidence—including both physical evidence and documents previously not disclosed by Pilatus—the NTSB will agree that its original findings were erroneous due to the unavailability of critical evidence during its initial investigation. Petitioners therefore urge the NTSB to revise its published findings and conclusions based on its fresh review of all relevant evidence, including the evidence previously unavailable to the Board.

The substance of this Petition has a direct impact on the safety of flight of existing PC-12/45 aircraft. Petitioners' hope is that this Petition will broaden the NTSB's understanding of this accident, allowing it to ascertain the best means for preventing future similar accidents which have the strong potential to take the lives of more innocent pilots and passengers and devastate the lives of more families.

[redacted]

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