

APPENDIX

APPENDIX**TABLE OF CONTENTS**

Appendix A	Opinion in the United States Court of Appeals for the Fifth Circuit (February 5, 2018)	App. 1
Appendix B	Memorandum Opinion and Final Judgment in the United States District Court for the Southern District of Texas, Houston Division (September 29, 2016)	App. 13
Appendix C	Order in the United States District Court for the Southern District of Texas, Houston Division (December 12, 2016)	App. 42
Appendix D	Plaintiffs' Memorandum in Opposition to Motion for Summary Judgment by Fairchild Controls Corporation in the United States District Court for the Southern District of Texas, Houston Division (April 4, 2016)	App. 44
Appendix E	PAI-9, Foil Air/Gas Bearing Technology ~An Overview and Excerpt of Expert Report/Review of In-Flight Cabin Fume-Air Incident (page 5) Fold-Out Exhibit	App. 84

App. 1

APPENDIX A

**IN THE UNITED STATES COURT OF APPEALS
FOR THE FIFTH CIRCUIT**

No. 17-20018

[Filed February 5, 2018]

JANA DAVIDSON, Individually and on behalf)
of their minor children J.C.D. and K.S.D.;)
THOMAS FARMER; KENNETH DAVIDSON,)
Individually and on behalf of their minor)
children J.C.D. and K.S.D.,)

Plaintiffs - Appellants)

v.)

FAIRCHILD CONTROLS CORPORATION,)

Defendant - Appellee)

Appeal from the United States District Court
for the Southern District of Texas

Before WIENER, ELROD, and SOUTHWICK, Circuit
Judges.

LESLIE H. SOUTHWICK, Circuit Judge:

Two of the plaintiffs were injured when oil from an
airplane's air cycle machine leaked into the cabin,
causing smoke and fumes to fill the cockpit during

their flight. The plaintiffs brought suit against several defendants. The district court granted summary judgment to defendant Fairchild Controls Corporation on a design-defect claim due to a lack of adequate expert testimony that a feasible alternate design existed. It also dismissed the failure-to-warn claim because the plaintiffs were knowledgeable users. We AFFIRM.

FACTUAL AND PROCEDURAL BACKGROUND

On May 31, 2011, two employees of an aerospace and defense technology company embarked on a mission to determine the cause of fumes and smoke in one of the company's airplanes, a Twin Commander 690A. Prior to that flight, another pilot at the company, William O'Connor, complained that fumes and smoke had filled the cockpit when the Twin Commander 690A reached a cruising altitude. The company wanted the two employees, a pilot and a sensor operator, to fly the aircraft to determine if the fumes and smoke problem had been resolved.

This problem with the Twin Commander 690A was already known by the plaintiffs,¹ who were the pilot, Thomas Farmer, and the sensor operator, Kenneth Davidson. Farmer had observed fumes and smoke on 50 prior flights and had repeatedly complained to the company about his concerns. He knew that the problem

¹ Kenneth Davidson's wife, Jana Davidson, is also a plaintiff and is suing for loss of consortium, society, and service. Kenneth and Jana Davidson are also suing on behalf of their minor children, J.C.D. and K.S.D., for loss of consortium, society, and service. Jana Davidson, J.C.D. and K.S.D.'s claims are derivative of Kenneth Davidson's claims. *See Hassanein v. Avianca Airlines*, 872 F. Supp. 1183, 1190 (E.D.N.Y. 1995).

App. 3

was because of an old air cycle machine (“ACM”), which was contaminating the air from leakage of oil. Farmer stated in his deposition that he had “recommended that the cause of the smoke and fumes, the air cycle machine unit, be replaced.” Farmer was also aware of the negative health effects of the fumes and smoke, which released a chemical neurotoxin known as tricresyl phosphate. Farmer had visited several doctors concerning the damage to his health from experiencing smoke and fumes on prior flights.

The second plaintiff, Davidson, also knew about the fumes and smoke problem in the Twin Commander 690A. He was warned about the risk of smoke and fumes in the cockpit by another pilot, who had experienced the smoke and fumes in the cockpit. Davidson also researched these risks on the Internet and emailed management with his concerns.

Shortly after take-off on the relevant flight, the plaintiffs could smell the fumes and see the smoke, but they continued their mission. By the time they reached an altitude of 28,000 feet, the smoke and fumes from the oil leakage were sufficiently severe that both plaintiffs experienced burning eyes, coughing, and difficulty breathing. They put on oxygen masks, began descending, depressurized the cabin upon reaching a lower altitude, and landed shortly thereafter. From take-off to landing, their flight was between 60 and 90 minutes. An inspection of the airplane after this flight revealed that oil was leaking from the oil bearings in the ACM and then escaping into the aircraft’s cabin, creating smoke and fumes in the cockpit.

The ACM in the Twin Commander 690A was made by Fairchild Controls Corporation. Although Fairchild

App. 4

had ceased manufacturing ACMs in the 1980s, it had retrofitted the ACM in the Twin Commander 690A in 2007. The ACM, a part of the aircraft's environmental control system, uses hot air produced by the aircraft's engines and recycles the air into the cabin after a cooling and pressurization process. This process was approved and certified by the Federal Aviation Administration ("FAA") to be used in the Twin Commander 690A.

On May 30, 2014, the plaintiffs filed suit in the United States District Court for the Southern District of New York based on diversity jurisdiction. The initial complaint was filed against many defendants, including Fairchild. By March 2015, all of the defendants were dismissed from the case except Fairchild. The New York district court held that it lacked personal jurisdiction over Fairchild and transferred the case to the United States District Court for the Southern District of Texas instead of dismissing the action. In September 2016, the Texas district court granted Fairchild's motion for summary judgment.

The district court rejected the design-defect claim because the plaintiffs failed to prove that an alternative design was technologically and economically feasible. The district court found no merit to the failure-to-warn claim because the plaintiffs were knowledgeable users, which barred their recovery on a failure-to-warn theory. The plaintiffs timely appealed. It is uncontested that New York law applies to the resolution of the issues presented on appeal.

DISCUSSION

The standard of review on summary judgment is *de novo*. *United States v. Lawrence*, 276 F.3d 193, 195 (5th Cir. 2001). The court should grant summary judgment when “there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law.” FED R. CIV. P. 56(a).

I. The design-defect claim

To succeed on a design-defect claim, a plaintiff must provide expert testimony that a feasible, alternative design would have prevented the injury. *See Voss v. Black & Decker Mfg. Co.*, 450 N.E.2d 204, 208 (N.Y. 1983). There are two methods for satisfying this requirement: (1) the plaintiff’s expert can show through testing and construction of a prototype that an alternative design is technologically and economically feasible; or (2) the plaintiff’s expert can identify an alternative design that is already available and being used. *Kosmyinka v. Polaris Indus., Inc.*, 462 F.3d 74, 80 (2d Cir. 2006).

We agree with another court that expert testimony provided by the plaintiff in a complex design case must be competent and non-conclusory. *Guarascio v. Drake Assocs. Inc.*, 582 F. Supp. 2d 459, 463 (S.D.N.Y. 2008). Further, the designs offered as alternatives by the plaintiff’s expert must be more than theoretically or hypothetically possible. *See Adams v. Genie Indus., Inc.*, 929 N.E.2d 380, 385 (N.Y. 2010). As one court stated, “the history of engineering and science is filled with finely conceived ideas that are unworkable in practice.” *Stanczyk v. Black & Decker Inc.*, 836 F. Supp. 565, 567 (N.D. Ill. 1993). We also agree with another

App. 6

court that if the plaintiff fails to present evidence from which a reasonable jury could infer that an alternative design is technologically feasible and commercially practicable, then the district court should grant summary judgment to the defendant on a design-defect claim. *Guarascio*, 582 F. Supp. 2d at 463.

The parties agree that the district court used the correct legal standard but disagree about its application. The plaintiffs argue that their expert, Don Hansen, provided the necessary expert testimony on alternative designs to avoid summary judgment. Throughout the litigation proceedings, however, the plaintiffs have changed the evidence they rely on to support their alternative-design theory. In their opening summary judgment brief, the plaintiffs argued that Hansen's testimony supported that the ACM could have been designed with oil-less bearings, common in the industry, which would have prevented the oil-leakage and subsequent exposure to the smoke and fumes. Later, in a motion for reconsideration of the adverse summary judgment decision, the plaintiffs argued that a viable alternative design existed based on a 1997 article on "foil air/gas bearing technology" cited by Hansen. On appeal, the plaintiffs argue that the foil air theory from the 1997 "article provides examples of the prevalence and economic feasibility of oil-less bearing technology" because at least six companies have used this technology in air cycle machines.

In response, Fairchild argues that the initial theories for alternative designs identified by Hansen were conclusory and hypothetical designs without proof of actual feasibility. Fairchild argues that the air

App. 7

bearing design mentioned in the 1997 article should be disregarded for two reasons: (1) the plaintiffs waived the argument by not raising it until their motion for reconsideration; and (2) on the merits, the 1997 article and Hansen's testimony fail to show that using air foil technology was technically or economically feasible in the Twin Commander 690A or an airplane similar to it.

The plaintiffs' initial theories were that Fairchild could have used oil-less bearings, fume sensors, filters, and diverters. Yet, in his deposition, Hansen admitted that he had not designed or tested a prototype based on the alternatives he suggested. He also acknowledged that he was not aware of anyone else who had designed or tested a prototype using the alternative design theories he proposed. By not offering any testimony about the use of such alternatives in the industry, the plaintiffs failed to provide expert testimony showing that these alternative designs for a safer ACM were technically or economically feasible.

Perhaps the best argument raised by the plaintiffs is that the foil-air bearing theory mentioned in the 1997 article that Hansen cited satisfies the requirement for adequate expert testimony. The plaintiffs waived this argument, however, because they failed to argue or brief it to the district court. We find a single line in plaintiffs' opposition to the summary judgment motion stating that "competitors have developed, tested, obtained FAA approval, and sold alternative designs which are in flight today." This statement is written at such a high level of generality that it cannot be said to preserve the air-foil bearing theory from the 1997 article. "When evidence exists in the summary judgment record but the nonmovant fails

App. 8

even to refer to it in the response to the motion for summary judgment, that evidence is not properly before the district court.” *Malacara v. Garber*, 353 F.3d 393, 405 (5th Cir. 2003).

Furthermore, we generally do “not consider an issue or a new argument raised for the first time in a motion for reconsideration in the district court.” *U.S. Bank Nat. Ass’n v. Verizon Commc’ns, Inc.*, 761 F.3d 409, 425 (5th Cir. 2014), *as revised* (Sept. 2, 2014) (citation omitted). In response, the plaintiffs cite an opinion where we allegedly did consider such a late-made argument, as we stated that “even if we were to consider the evidentiary material designated for the first time in the reply brief, we would still affirm summary judgment[.]” *Forsyth v. Barr*, 19 F.3d 1527, 1537 (5th Cir. 1994). This argument misapprehends *Forsyth*. We will not consider new evidence or arguments raised for the first time in a motion for reconsideration, and by saying in addition such an argument had no merit anyway, we did not change the general rule.

Accordingly, the plaintiffs waived the air-foil bearing theory. As did the *Forsyth* court, we too will add suspenders to the belt we just used. Were we to consider the merits of the argument from the 1997 article, the plaintiffs still failed to provide adequate expert testimony. Hansen himself testified that the technology in the 1997 article would provide a starting point, but he had no opinion on whether it was “feasible economically and technically to refit the Environmental Control System of a 690A aircraft with an air bearing ACM[.]” Further, Hansen testified that he had not evaluated whether the ACM in the Twin Commander

690A could be altered to use an air bearing. He further testified that he had not performed any analysis on the economic feasibility of using an air bearing ACM in the Twin Commander 690A. He did not testify that he was aware of anyone else who had studied the economic feasibility of using an air bearing ACM in an airplane similar to the Twin Commander 690A. The limited expert testimony about the air-foil bearing technology does not prove that a safer design was feasible.

II. The failure-to-warn claim

There are two defenses under New York law to a failure-to-warn claim: (1) the hazard presented an open and obvious risk; or (2) the plaintiff was a knowledgeable user. *Liriano v. Hobart Corp.*, 700 N.E.2d 303, 308 (N.Y. 1998). In those situations, the lack of warning was not a proximate cause of the plaintiff's injuries, which precludes a finding of liability. *See id.*

The plaintiffs alleged in their complaint that Fairchild was liable for its "failure to warn complainants of unreasonably dangerous condition[s] of the subject engine and/or its components." Yet, as admitted in later depositions, the plaintiffs had actual knowledge of the specific hazard and potential medical consequences resulting from the faulty ACM. The following exchange occurred during plaintiff Farmer's deposition:

Q. Do you know what was causing the fumes on that flight?

A. Yeah. It -- I'd been flying that airplane for almost three years previous to that, and we

constantly complained about the smoke and the fumes.

....

Of course, after high temperature and pressure and -- breaks down -- that oil back down into organophosphates, tricresyl phosphates, which are highly toxic. And that air goes into the air cycle machine, which if it's malfunctioning, further contaminates the air with fumes and smoke.

Plaintiff Davidson testified in his deposition that he had been informed of prior fume events in the Twin Commander 690A and that he had researched the problem on the Internet. In an email to his co-workers and submitted as part of the record, Davidson wrote that "[t]he severity of these fumes was reported by a pilot on [M]ay 26 and then he refused to fly until resolved." As the district court wrote, "[b]oth were aware of possible harm, Farmer from personal experience and Davidson from personal research."

The parties agree that the knowledgeable user defense applies when the plaintiff has actual knowledge of the specific hazard causing the injury but disagree about the degree of knowledge required. See *Liriano*, 700 N.E.2d at 308. The plaintiffs cite an unpublished federal district court opinion to argue that "the user must not only know of the particular risk he or she faces, but must also be aware of the severity of the potential harm." *Ferracane v. United States*, No. 02-CV-1037 SLT, 2007 WL 316570, at *7 (E.D.N.Y. Jan. 30, 2007). In response, Fairchild cites *Liriano*, which is the leading New York case on defenses to failure-to-warn claims, to argue that a warning is not

required when a plaintiff “was fully aware of the hazard through general knowledge, observation or common sense.” 700 N.E.2d at 308.

Based on the *Liriano* standard, New York intermediate appellate courts have affirmed summary judgments for defendants when plaintiffs were aware of the specific hazards that might cause injury. *See, e.g., Heimbuch v. Grumman Corp.*, 858 N.Y.S.2d 378, 380 (N.Y. App. Div. 2008); *Wesp v. Carl Zeiss Inc.*, 783 N.Y.S.2d 439, 442 (N.Y. App. Div. 2004). In *Wesp*, the plaintiff was injured when she tried to move a 600-pound surgical microscope; the trial court granted summary judgment to the defendant because the plaintiff had previously attempted to move the microscope and was aware of the specific hazard involved. 783 N.Y.S.2d at 442. In *Heimbuch*, the plaintiff had knowingly been using a defective product for six months prior to her injury, and the trial court granted summary judgment to the defendant on the failure-to-warn claim because a warning would have been superfluous. 858 N.Y.S.2d at 380. Both of these decisions were affirmed on appeal. *Id.* at 381; *Wesp*, 783 N.Y.S.2d at 442.

In a decision prior to *Liriano*, a New York intermediate appellate court acknowledged that “[t]he degree of danger is a crucial factor in determining the specificity required in a warning” but reiterated that “there is no necessity to warn a consumer already aware through common knowledge or learning of a specific hazard.” *Lancaster Silo & Block Co. v. N. Propane Gas Co.*, 427 N.Y.S.2d 1009, 1015 (N.Y. App. Div. 1980).

Without deciding if the plaintiff must have specific knowledge about the severity of the potential injury, we conclude that the district court correctly granted summary judgment on the failure-to-warn claim because the undisputed evidence shows that both plaintiffs were aware of the potential injuries that could result from flying the Twin Commander 690A. Further, the plane was taken to a higher altitude even as the plaintiffs experienced discomfort from the smoke and fumes filling the airplane, with neither plaintiff saying either urged the other to end the mission. This supports that the plaintiffs would have flown the mission regardless of whether Fairchild provided a warning.

As Farmer testified, he and Davidson were asked to fly the Twin Commander 690A “to verify th[e] smoke and fumes which they knew the airplane was making. We really didn’t want to do it, but, you know, it’s your -- when it’s your job [A]s soon as you get in the plane, you smell the smoke and fumes, but we went ahead and flew[.]” The plaintiffs were knowledgeable users, and a warning would have been superfluous.

AFFIRMED.

APPENDIX B

**IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION**

CIVIL ACTION NO. H-15-0827

[Filed September 29, 2016]

KENNETH DAVIDSON, et al.,	)
	)
Plaintiffs,	)
	)
v.	)
	)
FAIRCHILD CONTROLS CORPORATION,	)
Defendant.	)

MEMORANDUM OPINION

Pending before the court¹ are Defendant Fairchild Controls Corporation's ("Fairchild") Motion for Summary Judgment (Doc. 227), Fairchild's Motion to Exclude the Report, Testimony, and Opinions of Don Hansen ("Hansen")(Doc. 254), and Fairchild's Motion to Exclude the Report, Testimony, and Opinions of C. Van Netten (Doc. 255). The court has considered the

¹ The parties consented to proceed before the undersigned magistrate judge for all proceedings, including trial and final judgment, pursuant to 28 U.S.C. § 636(c) and Federal Rule of Civil Procedure 73. See Docs. 245, 246, Consents; Doc. 247, Ord. Dated May 5, 2016.

motions, Plaintiffs Kenneth Davidson (“Davidson”), his wife (“Jana”), their children, and Thomas Farmer’s (“Farmer”) (collectively, “Plaintiffs”) responses, Fairchild’s replies, the parties’ supplemental briefs and exhibits, the competent summary judgment evidence, and the applicable law. For the reasons set forth below, the court **GRANTS** Fairchild’s motion for summary judgment. As that disposes of the case, the court **DENIES AS MOOT** Fairchild’s motions to exclude.

I. Case Background

Plaintiffs originally filed this products liability action in the United States District Court for the Southern District of New York, alleging that Davidson and Farmer were exposed to toxic fumes while operating an airplane on a work assignment.

A. Factual Background

At the time relevant to this action, Fairchild manufactured air cycle machines (“ACM”) and other components for commercial and military aircraft.² Additionally, Fairchild repaired and overhauled components that it or one of its predecessors had manufactured.³ Fairchild ceased manufacturing ACMs in approximately 1980 but continued to repair and overhaul ACMs.⁴

In 2007, Fairchild repaired and overhauled the ACM that was installed in the Twin Commander 690A

² Doc. 227-2, Ex. 1 to Fairchild’s Mot. for Summ. J., Decl. of Paul Dziorny ¶¶ 4-5.

³ Id. ¶ 4.

⁴ Id. ¶ 6.

turboprop aircraft, which was owned by Northrop Grumman Corporation and/or Northrop Grumman Systems Corporation (“NGC”) and used in aerial surveying.⁵ The Twin Commander 690A and certain other types of aircraft utilize an ACM as part of the environmental control system, which delivers pressurized, temperature-conditioned air to the cockpit and cabin.⁶ An ACM is comprised of a compressor, a turbine, a bearing cartridge, and an oil compartment.⁷ A wick-fed oil lubrication system provides ball bearings of an ACM with the necessary oil to perform properly.⁸

“[U]nfiltered high pressure hot turbine engine compressor ‘bleed air’” is throttled and cooled with “ram air” from outside the aircraft’s airframe by a heat exchanger.⁹ The ACM compressor raises the air pressure to a higher level and sends the air to a

⁵ See id. ¶ 26; Doc. 1, Pls.’ Compl. p. 8 of 16; cf. Doc. 227-4, Ex. 3 to Fairchild’s Mot. for Summ. J., Dep. of Thomas Farmer pp. 19-21, 23 (indicating generally that he piloted for aerial surveying missions at several employers including NGC and that he flew the Twin Commander 690A for NGC).

⁶ Doc. 227-2, Ex. 1 to Fairchild’s Mot. for Summ. J., Decl. of Paul Dziorny ¶ 5; see also id. ¶¶ 8, 9.

⁷ Id. ¶ 13.

⁸ See id. ¶¶ 13-15.

⁹ Doc. 236-6, Ex. 3 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., Hansen’s Expert Report/Review of In-Flight Cabin Fume-Air Incident (“Hansen’s Report”) p. 3; see also Doc. 227-2, Ex. 1 to Fairchild’s Mot. for Summ. J., Decl. of Paul Dziorny ¶ 12.

App. 16

secondary heat exchanger where it is cooled by ram air and then enters the ACM's turbine.¹⁰

In the turbine, the high pressure air powers the compressor and, in the process, is further cooled.¹¹ The air and any condensate produced exits the ACM to the water separator, which dehumidifies the air.¹² From there, the air passes through a mixing chamber that conditions the air to the selected temperature by adding the appropriate amount of bleed air directly from the compressors of the aircraft.¹³ The air is then distributed throughout the cockpit and cabin.¹⁴

In late May 2011, Bill O'Connor, a pilot for NGC, flew the Twin Commander 690A on a work assignment.¹⁵ Afterwards, he complained of fumes and smoke in the cockpit.¹⁶ On May 31, 2011, NGC, Farmer and Davidson's employer, instructed the two men to fly

¹⁰ Doc. 227-2, Ex. 1 to Fairchild's Mot. for Summ. J., Decl. of Paul Dziorny ¶ 12.

¹¹ See id.

¹² See id.

¹³ See id.

¹⁴ Id.

¹⁵ See Doc. 227-7, Ex. 6 to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Davidson p. 16; Doc. 236-10, Ex. 7 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Farmer pp. 5-6; Doc. 236-5, Ex. 2 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Davidson p. 69.

¹⁶ See Doc. 236-10, Ex. 7 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Farmer pp. 5-6; Doc. 236-5, Ex. 2 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Davidson p. 69.

App. 17

the airplane “to verify those smoke and fumes” reported by the other pilot.¹⁷

Farmer, the pilot on May 31, 2011, testified that he did not want to fly the airplane, but his managers pressured him to make the flight, even though Farmer and the managers were aware of prior smoke and fumes incidents.¹⁸ Farmer admitted that he was aware of the problems on the Twin Commander 690A prior to the May 31, 2011 flight.¹⁹ Farmer testified that smoke and fumes entered the cockpit on “[e]very flight . . . mildly at lower altitudes, but at higher altitudes and a higher temperature selection for the cabin heat . . . significant smoke and oil mist” formed.²⁰ By May 2011, Farmer had experienced smoke and fumes at least fifty times while flying the Twin Commander 690A.²¹ “There

¹⁷ Doc. 236-10, Ex. 7 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer pp. 5, 6; see also Doc. 227-7, Ex. 6 to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Davidson p. 17.

¹⁸ Doc. 236-10, Ex. 7 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer pp. 5, 6; Doc. 227-6, Ex. 5 to Fairchild’s Mot. for Summ. J., Ga. Workers’ Comp. Dep. of Farmer p. 53.

¹⁹ Doc. 227-6, Ex. 5 to Fairchild’s Mot. for Summ. J., Ga. Workers’ Comp. Dep. of Farmer p. 53.

²⁰ Doc. 227-6, Ex. 5 to Fairchild’s Mot. for Summ. J., Ga. Workers’ Comp. Dep. of Farmer p. 47; see also Doc. 236-4, Ex. 1 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., Dep. of Farmer p. 52.

²¹ Doc. 227-6, Ex. 5 to Fairchild’s Mot. for Summ. J., Ga. Workers’ Comp. Dep. of Farmer p. 47. The court acknowledges that, at his deposition in this action, Farmer contradicted his prior testimony, stating that the only time he was exposed to chemicals in the Twin Commander 690A was on May 31, 2011. Doc. 236-4, Ex. 1 to Pls.’

was always fumes and an oily mist in the cabin. But at a higher altitude, above 10,000 feet, say, up to 28 or 30,000 feet, you're at a higher temperature selection for cabin heat, the aircraft had a 90 percent probability of excessive smoke and fumes."²²

Farmer reported the problem "[v]erbally, probably 100 times" and wrote notes on forms to be placed in the logbooks.²³ Farmer also knew that other NGC pilots had experienced smoke and fumes in the cockpit during flights and that Bill O'Connor had suffered respiratory irritation, confusion, and disorientation as a result.²⁴ After flying the Twin Commander 690A on multiple missions, Farmer "felt sick all the time" with respiratory stress, more headaches, and dizziness.²⁵ On one flight in June 2010, Farmer was overcome by the

Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Farmer p. 48. When asked at his deposition in this action if he was changing his prior testimony, Farmer replied, "Yes." Id. Plaintiffs failed to explain the contradiction in Farmer's sworn testimony. Therefore, the court deems his prior testimony to include admissions against interest. Even in Plaintiffs' brief in opposition to Fairchild's motion for summary judgment, Plaintiffs admit that Farmer had experienced smoke and fumes in the Twin Commander 690A before the May 31, 2011 flight. Doc. 236-2, Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J. p. 1 ("The plane had a history of smoke and fumes in the cabin, including on previous occasions when Thomas Farmer had flown it.").

²² Id. p. 48.

²³ Id. pp. 48-49; see also Doc. 227-9, Ex. 8 to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Farmer p. 10.

²⁴ Doc. 227-6, Ex. 5 to Fairchild's Mot. for Summ. J., Ga. Workers' Comp. Dep. of Farmer pp. 50-51.

²⁵ Doc. 227-10, Ex. 9 to Fairchild's Mot. for Summ. J., Unsworn Statement of Farmer p. B.

smoke and fumes was unable to exercise good judgment or accurate fuel calculations when the gauge malfunctioned.²⁶ The airplane ran out of fuel, which led to Farmer's conducting a "flamed out" approach and glider landing.²⁷

Davidson, a sensor operator, became aware of the problems with the Twin Commander 690A about a week before his May 31, 2011 flight, having heard that occupants, including Bill O'Connor, had experienced odors in the cockpit during flights.²⁸ Davidson was prompted by the information to search the internet on "this type of fume event" to find out what they could be and what problems could be associated with them.²⁹ Based on his research, Davidson sent an email to management to express his concerns.³⁰ When questioned about the results of his research, Davidson reported that he could not recall anything at all.³¹ When it came to the May 31, 2011 flight, Davidson

²⁶ Id.

²⁷ Id.

²⁸ See Doc. 227-5, Ex. 4 to Fairchild's Mot. for Summ. J., Dep. of Davidson pp. 69-70; Doc. 227-7, Ex. 6 to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Davidson p. 17; Doc. 236-5, Ex. 2 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Davidson pp. 68, 69.

²⁹ Doc. 227-7, Ex. 6 to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Davidson pp. 17-18.

³⁰ Id. p. 17.

³¹ See id. p. 18.

stated that he was not concerned and viewed it simply as part of the job.³²

As soon as Davidson and Farmer got into the airplane, they could smell the smoke and fumes but began to fly the mission anyway.³³ By the time they reached an altitude of about 28,000 feet, “the smoke and fumes were so bad that [Farmer experienced] burning eyes, coughing, and more difficulty breathing.”³⁴ Farmer thought Davidson appeared to be “halfway intoxicated.”³⁵ Davidson reported that he tasted oil and metal and started feeling groggy and dizzy.³⁶ He said he felt as if he were moving in slow motion.³⁷

The two men donned oxygen masks.³⁸ Farmer contacted the air traffic controller to report the fume event.³⁹ Air traffic control gave permission for an

³² Doc. 236-5, Ex. 2 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., Dep. of Davidson p. 68.

³³ Doc. 236-10, Ex. 7 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer p. 6.

³⁴ Id.

³⁵ Id.

³⁶ Doc. 236-5, Ex. 2 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., Dep. of Davidson p. 69.

³⁷ Id.

³⁸ See Doc. 227-7, Ex. 6 to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Davidson p. 18; Doc. 227-9, Ex. 8 to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer p. 7.

³⁹ Doc. 227-9, Ex. 8 to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer p. 7.

immediate descent, and, after reaching a low enough altitude, Davidson and Farmer depressurized the cabin and flushed the air.⁴⁰ They returned to the airport and landed, but neither one can remember how they made it back to the hotel.⁴¹ From the time the men entered the airplane to the time they landed, sixty to ninety minutes had elapsed.⁴²

According to Plaintiffs' complaint, Farmer suffered "permanent damage to his eyes and lungs, decreased mental acuity, neurological deficits, severe headaches, weakness, irritability, and injuries to other parts of his body."⁴³ The complaint stated that Davidson suffered "toxic encephalopathy with persistent cognitive sequela, industrial asthma, fatigue, difficulty with balance, memory loss, eye and throat irritation, and injuries to other parts of his body."⁴⁴

On June 1, 2011, Farmer and Davidson flew the Twin Commander 690A, at low altitude and unpressurized, to the repair location.⁴⁵ He flew the airplane several other times after being told that the problem was fixed, experiencing approximately six

⁴⁰ Id.

⁴¹ See id.

⁴² See Doc. 236-4, Ex. 1 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Farmer p. 47.

⁴³ Doc. 1, Pls.' Compl. p. 15 of 16.

⁴⁴ Id.

⁴⁵ See Doc. 227-9, Ex. 8 to Fairchild's Mot. for Summ. J., La. Workers' Comp. Dep. of Farmer p. 17; Doc. 236-5, Ex. 2 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Dep. of Davidson p. 68.

more incidents of smoke and fumes.⁴⁶ The ACM was returned to Fairchild on October 17, 2011, for an evaluation.⁴⁷ The Fairchild report stated, “As a result of the oil starvation, heat caused expansion of the shaft, bearing, and cartridge assembly thus causing damage to the turbine and impeller as well as the diffuser.”⁴⁸ The report indicated that the ACM was to be overhauled.⁴⁹

B. Procedural Background

On May 30, 2014, Plaintiffs filed this diversity action in the U.S. District Court for the Southern District of New York pursuant to New York common law.⁵⁰ The original complaint named as defendants fifteen business entities that Plaintiffs believed to be involved “in the design, construction, and maintenance of the subject aircraft and its component parts.”⁵¹ Against Fairchild, Plaintiffs averred that the ACM was “defective in its design and/or manufacture and/or assembly, allowing drops of oil leaking from the engine

⁴⁶ See Doc. 227-9, Ex. 8 to Fairchild’s Mot. for Summ. J., La. Workers’ Comp. Dep. of Farmer p. 17.

⁴⁷ Doc. 227-2, Ex. 1 to Fairchild’s Mot. for Summ. J., Decl. of Paul Dziorny ¶ 27.

⁴⁸ Doc. 236-9, Ex. 6 to Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J., Shop Visit Report.

⁴⁹ See id.

⁵⁰ See Doc. 1, Pls.’ Compl.

⁵¹ Doc. 236-2, Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J. p. v; see also Doc. 1, Pls.’ Compl. pp. 2-8 of 16. Farmer did not join in the naming of Northrop Grumman Corporation and/or Northrop Grumman Systems Corporation as a defendant. See id. pp. 5-8 of 16.

to access the aircraft's bleed air-ducting system and into the cabin."⁵² Plaintiffs' claims against Fairchild were based on defective product theories: defective design, failure to warn, and breach of express or implied warranty.⁵³ Jana and the children sought damages for loss of consortium.⁵⁴

The case proceeded in the New York district court for ten months, during which time, the parties engaged in preliminary litigation matters, including the filing of waivers of service, notices of appearance, disclosures, pleadings, motions to dismiss, and stipulations of dismissal.⁵⁵ On March 26, 2016, the New York court entered an opinion on a motion to dismiss filed by Fairchild, which, by that time, was the only remaining defendant.⁵⁶ The court determined that it lacked personal jurisdiction but, in lieu of dismissal and by agreement of the parties, transferred the case to this court pursuant to 28 U.S.C. § 1404(a).⁵⁷

On April 10, 2015, Fairchild filed its answer, asserting twenty-nine defenses.⁵⁸ On May 1, 2015, the court held a scheduling conference and entered a

⁵² Doc. 1, Pls.' Compl. p. 12 of 16.

⁵³ See id. pp. 12-13 of 16.

⁵⁴ See id. pp. 15-16 of 16.

⁵⁵ See, e.g., Doc. 6, Notice of Appearance; Doc. 7, Corp. Disclosure Statement; Doc. 13, Waiver of Serv.; Doc. 20, Ans.; Doc. 30, Mot. to Dismiss; Doc. 100, Stipulation & Ord. Dated Sept. 4, 2014; Doc. 132, Pls.' 1st Am. Suppl. Compl.

⁵⁶ See Doc. 201, Op. & Ord. Dated Mar. 26, 2015.

⁵⁷ See id.

⁵⁸ See Doc. 204, Fairchild's Ans.

App. 24

docket control order.⁵⁹ On May 8, 2015, Plaintiffs amended their complaint to delete portions not applicable to Fairchild.⁶⁰ The parties engaged in discovery and called upon the court to resolve several discovery issues.⁶¹

On January 25, 2016, the parties unsuccessfully attempted mediation.⁶² On February 12, 2016, Fairchild timely filed the pending motion for summary judgment.⁶³ In Plaintiffs' response, which was filed with leave of court on April 4, 2016, Plaintiffs explained that discovery was ongoing and that they expected to discover additional information and documents in support of specific material facts.⁶⁴ On April 21, 2016, Fairchild replied to Plaintiffs' response, and discovery ended on April 29, 2016.⁶⁵ The summary

⁵⁹ See Doc. 209, Min. Entry Ord. Dated May 1, 2015; Doc. 210, Docket Control Ord. Dated May 1, 2015.

⁶⁰ See Doc. 213, Pls.' 2^d Am. Compl.

⁶¹ See, e.g., Doc. 218, Jt. Mot. for Protective Ord.; Doc. 219, Protective Ord. Dated July 21, 2015; Doc. 220, Fairchild's Mot. to Compel Disc. Resps.; Doc. 222, Pls.' Resp. in Opp. to Mot. to Compel Disc. Resps.; Doc. 223, Fairchild's Reply in Support of its Mot. to Compel; Doc. 224, Ord. Dated Jan. 6, 2016.

⁶² See Doc. 226, Ord. Dated Jan. 8, 2016; Doc. 236-2, Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J. p. v.

⁶³ See Doc. 210, Docket Control Ord. Dated May 1, 2015; Doc. 227, Fairchild's Mot. for Summ. J.

⁶⁴ Doc. 236-2, Pls.' Opp'n to Fairchild's Mot. for Summ. J. pp. 3-5; see also Doc. 228, Pls.' Mot. to Extend Docket Date for Fairchild's Mot. for Summ. J.; Doc. 230, Ord. Dated Mar. 3, 2016.

⁶⁵ See Doc. 210, Docket Control Ord. Dated May 1, 2015; Doc. 239, Fairchild's Reply in Support of Mot. for Summ. J.

judgment briefing, however, continued over the course of nearly two additional months, during which Fairchild supplemented exhibits twice and filed a supplemental brief in support of summary judgment and Plaintiffs filed a supplemental brief in opposition to summary judgment.⁶⁶

While the briefing was ongoing, the court referred the case to the undersigned.⁶⁷ The court extended the deadlines for expert depositions and non-dispositive motions and removed the case from docket call.⁶⁸ At a discovery hearing in late April 2016, the court resolved disputes and extended discovery.⁶⁹ On May 3, 2016, the parties consented in writing to proceed before the undersigned, and the case was transferred on May 5, 2016.⁷⁰

On May 12, 2016, Fairchild filed an amended answer to conform with Plaintiffs' live pleading.⁷¹ On July 8, 2016, Fairchild filed motions to exclude the

⁶⁶ See Doc. 244, Fairchild's Notice of Filing Suppl. to Ex. 1 of its Mot. for Summ. J.; Doc. 251, Fairchild's Notice of Filing Exs. to the Suppl. Decl. of Paul Dziorny; Doc. 252, Pls.' Suppl Mem. in Opp'n to Fairchild's Mot. for Summ. J.; Doc. 253, Fairchild's Suppl. in Support of Summ. J.

⁶⁷ See Doc. 238, Ord. Dated Apr. 13, 2016.

⁶⁸ See Doc. 241, Ord. Dated Apr. 22, 2016.

⁶⁹ See Doc. 243, Min. Entry Dated Apr. 26, 2016.

⁷⁰ See Docs. 245, 246, Consents; Doc. 247, Ord. Dated May 5, 2015.

⁷¹ See Doc. 250, Am. Ans.

expert testimony of Hansen and C. Van Netten.⁷² Plaintiffs responded to both motions on August 26, 2016, after requesting and receiving an extension of time to respond, and Fairchild filed a reply on September 7, 2016.⁷³

In light of the passage of time since the filing of Fairchild's dispositive motion, the intervening close of discovery, and the parties' supplemental filings, the court finds that the briefing is complete on the motion for summary judgment.

II. Summary Judgment Standard

Summary judgment is warranted when the evidence reveals that no genuine dispute exists on any material fact and the moving party is entitled to judgment as a matter of law. Fed. R. Civ. P. 56(a); Celotex Corp. v. Catrett, 477 U.S. 317, 322 (1986); Stauffer v. Gearhart, 741 F.3d 574, 581 (5th Cir. 2014). A material fact is a fact that is identified by applicable substantive law as critical to the outcome of the suit. Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 248 (1986); Ameristar Jet Charter, Inc. v. Signal Composites, Inc., 271 F.3d 624, 626 (5th Cir. 2001). To be genuine, the dispute regarding a material fact must be supported by

⁷² See Doc. 254, Fairchild's Mot. to Exclude Expert Report, Test., & Ops. of Hansen; Doc. 255, Fairchild's Mot. to Exclude Expert Report, Test., & Ops. of C. Van Netten.

⁷³ See Doc. 256, Pls.' Mot. to Extend Docket Date for Fairchild's Mot. to Exclude Reports, Test., & Ops. of Experts Hansen & C. Van Netten; Doc. 257, Ord. Dated July 27, 2016; Doc. 258, Pls.' Resp. in Opp'n to Fairchild's Mot. to Exclude Expert Report, Test., & Ops. of Hansen; Doc. 259, Pls.' Resp. in Opp'n to Fairchild's Mot. to Exclude Expert Report, Test., & Ops. of C. Van Netten.

evidence such that a reasonable jury could resolve the issue in favor of either party. See Royal v. CCC & R Tres Arboles, L.L.C., 736 F.3d 396, 400 (5th Cir. 2013)(quoting Anderson, 477 U.S. at 248).

The movant must inform the court of the basis for the summary judgment motion and must point to relevant excerpts from pleadings, depositions, answers to interrogatories, admissions, or affidavits that demonstrate the absence of genuine factual issues. Celotex Corp., 477 U.S. at 323; Topalian v. Ehrman, 954 F.2d 1125, 1131 (1992). If the moving party carries its burden, the nonmovant may not rest on the allegations or denials in his pleading but must respond with evidence showing a genuine factual dispute. Stauffer, 741 F.3d at 581 (citing Hathaway v. Bazany, 507 F.3d 312, 319 (5th Cir. 2007)).

III. Analysis

Fairchild argues that all of Plaintiffs' claims are preempted by federal law and cannot survive under the applicable federal law.⁷⁴ Alternatively addressing Plaintiffs' claims individually, Fairchild argues that none survive under New York products liability law. Plaintiffs respond that their claims are not preempted and that they have produced sufficient evidence to

⁷⁴ Without conceding that Plaintiffs' state-law claims are not preempted by federal law, Fairchild now urges the court to disregard the issue and analyze Plaintiffs' claims under New York products liability law. Fairchild raised the issue of federal preemption, thus prompting the court to address whether federal or state law applies before addressing the merits of Plaintiffs' claims. The court cannot leave that question unanswered simply because Fairchild wavers on its commitment to the preemption argument.

raise fact issues on their claims of defective design and failure to warn. Plaintiffs did not respond to Fairchild's arguments in favor of summary judgment on Plaintiffs' claims of breach of express and implied warranties, and, therefore, the court deems that claim abandoned.⁷⁵

A. Federal Preemption

Federal preemption "ultimately turns on congressional intent" and may be express or implied. Witty v. Delta Air Lines, Inc., 366 F.3d 380, 384 (5th Cir. 2004). When a statute does not expressly state congressional intent

⁷⁵ Paul Dziorny of Fairchild initially declared that Fairchild made no warranties relevant to the ACM but later amended his declaration to introduce a letter dated April 14, 2005, and a standard warranty policy. See Doc. 227-2, Ex. 1 to Fairchild's Mot. for Summ. J., Decl. of Paul Dziorny ¶ 26; Doc. 244, Suppl. Decl. of Paul Dziorny ¶¶ 3-5; Doc. 251-1, Ex. 1 to Suppl. Decl. of Paul Dziorny, Letter from Fairchild to Global Aviation Servs. Dated Apr. 14, 2005; Doc. 251-2, Ex. 2 to Suppl. Decl. of Paul Dziorny, Standard Warranty Policy.

In a supplemental brief, Plaintiffs accuse Paul Dziorny of misrepresenting the facts in his original declaration and call into question his credibility. See Doc. 252, Pls.' Suppl. Mem. in Opp. to Mot. for Summ. J. pp. 7-8. However, Plaintiffs offer no substantive response to Fairchild's arguments in favor of summary judgment on the warranty claims. See id.

The court finds that, not only does Plaintiffs' failure to respond to these arguments represent an abandonment of the claims, but Fairchild's statute of limitations argument is meritorious. See N.Y. U.C.C. Law § 2-725 (stating that the statute of limitations for breach of contract for sale is four years from accrual, which occurs in the context of breach of warranty when tender of delivery is made). Fairchild shipped the ACM on February 13, 2007, more than seven years prior to Plaintiffs' filing suit. See Doc. 1, Pls.' Compl.; Doc. 227-2, Ex. 1 to Fairchild's Mot. for Summ. J., Decl. of Paul Dziorny ¶ 27. Thus, the statute of limitations bars Plaintiffs' warranty claims.

to preempt state law, as here, the implied preemption doctrines of field preemption and conflict preemption come into play. See id. “[A] state claim is preempted where ‘Congressional intent to preempt is inferred from the existence of a pervasive regulatory scheme’ or where ‘state law conflicts with federal law or interferes with the achievement of federal objectives.’” Id. (quoting Hodges v. Delta Airlines, Inc., 44 F.3d 334, 335 n.1 (5th Cir. 1995)).

The Third Circuit is the most recent federal circuit court to consider whether federal aviation law preempts the field of state tort law covering products liability claims. See Sikkelee v. Precision Airmotive Corp., 822 F.3d 680, 683 (3^d Cir. 2016), pet. for cert. filed, ___ U.S.L.W. ___ (Sept. 6, 2016)(No. 16-323). The plaintiff in Sikkelee alleged that the aircraft accident, which led to her husband’s death was caused by a malfunction or defect in the engine’s carburetor, and she brought claims under Pennsylvania law for strict liability and breach of warranty, among others. See id. at 685. The opinion found that Abdullah v. American Airlines, Inc., 181 F.3d 363 (3^d Cir. 1999), a prior Third Circuit opinion that held federal law preempts the field of aviation safety, did not govern products liability claims. See id. at 683, 688-90.

The court then turned to its preemption analysis, beginning with the question whether “the presumption that Congress does not preempt areas of law traditionally occupied by the states unless that is its clear and manifest intent” applies to products liability claims. Id. at 690; see also id. at 691-92. Deciding that products liability is an area of law traditionally occupied by states, the court examined the Federal

Aviation Act (“FAA”), subsequent relevant congressional action, and federal aviation regulations in search of Congress’s “clear and manifest intent to preempt aviation products liability claims.” Id. at 692; see also id. at 689-90, 692-99.

Finding “the indicia of congressional intent . . . point overwhelmingly the other way,” the court continued its thorough discussion by analyzing field preemption in analogous statutory regimes and by way of the FAA’s certification regulations. Id. at 698-99; see also id. at 700-05. The court also considered the aviation preemption precedent of federal appellate courts. See id. at 705-07. After also considering the policy arguments offered by the parties in that case, the court determined that field preemption did not apply to products liability claims. See id. at 708-09. Product liability claims remain “subject to traditional conflict preemption principles.” Id. at 709.

The U.S. District Court for the Northern District of Texas addressed the issue in 2011. See Morris v. Cessna Aircraft Co., 833 F. Supp.2d 622 (N.D. Tex. 2011). That court also found that the presumption against preemption applied “because state tort law has long been concerned with securing compensation for its citizens who sustain injuries caused by defective products.” Id. at 630 (citing Sprietsma v. Mercury Marine, 537 U.S. 51, 69 (2002)). The court noted that neither the Supreme Court nor the Fifth Circuit had found the entire field of aviation preempted, although both had found specific areas of aviation preempted. Id. at 630 (discussing City of Burbank v. Lockheed Air Terminal Inc., 411 U.S. 624 (1973), and Witty, 366 F.3d at 380). The court concluded that field preemption did

not apply to aircraft design and manufacture. See id. at 637; cf. McLennan v. Am. Eurocopter Corp., 245 F.3d 403, 425-26 (5th Cir. 2001)(applying state tort law to products liability claims arising out of a helicopter crash); Monroe v. Cessna Aircraft Co., 417 F. Supp.2d 824 (E.D. Tex. 2006)(providing a thorough discussion and concluding that neither the entire field of aviation safety nor products liability claims are impliedly preempted).

Implied preemption via the doctrine of conflict preemption applies only “where it is impossible for a private party to comply with both state and federal requirements, or where state law ‘stands as an obstacle to the accomplishment and execution of the full purposes and objectives of Congress.’” English v. Gen. Elec. Co., 496 U.S. 72, 79 (1990)(citations omitted). The FAA sets out a system for the issuance of certificates, which includes a type certificate for a new design for an aircraft or aircraft part, a production certificate for a duplicate part produced for a particular aircraft, and an airworthiness certificate for a new aircraft prior to being put into operation. See 49 U.S.C. § 44704. The FAA authorizes the Federal Aviation Administration to promulgate “regulations and minimum standards in the interest of safety.” 49 U.S.C. § 44701.

The court finds the rationale of the well-considered opinions in Sikkelee and Morris to be convincing. The court concurs that the federal statutory and regulatory scheme on aviation does not preempt the field of products liability. Those opinions also acknowledge, in the discussions of field preemption, that the certification system effectuates “baseline requirement[s]” that “speak to a floor of regulatory

compliance.” Sikkelee, 822 F.3d at 694 (noting “that the regulations are framed in terms of standards to acquire FAA approvals and certificates—and not as standards governing manufacture generally” in support of its conclusion that they are merely “baseline requirement[s]”); Morris, 833 F. Supp.2d at 635 (noting that, “in the area of aircraft design and manufacture requirements,” are empowered “to create only ‘minimum standards’”).

This court finds that products liability law is not preempted as a field. This court also concludes that the minimum standards of the federal aviation regulations do not prohibit the design and manufacture of safer aircraft and component parts. Therefore, conflict preemption also does not apply.

B. Defective Design

The federal preemption disagreement aside, the parties’ citation to New York law demonstrates their agreement that, if any state law applies, it is that of New York, the location of the air space in which the incident occurred.⁷⁶

In 2010, the Court of Appeals of New York reaffirmed what the court previously stated was required to prove a design defect:

In order to establish a prima facie case in strict products liability for design defects, the plaintiff must show that the manufacturer breached its duty to market safe products when it marketed

⁷⁶ Plaintiffs explicitly stated their agreement to the application of New York law. Doc. 236-2, Pls.’ Mem. in Opp. to Fairchild’s Mot. for Summ. J. p. 16 n.4.

a product designed so that it was not reasonably safe and that the defective design was a substantial factor in causing plaintiff's injury.

Adams v. Genie Indus., 929 N.E.2d 380, 383-84 (N.Y. 2010)(quoting Voss v. Black & Decker Mfg. Co., 450 N.E.2d 204, 208 (N.Y. 1983)). A product is “not reasonably safe” when, “if the design defect were known at the time of manufacture, a reasonable person would conclude that the utility of the product did not outweigh the risk inherent in marketing a product designed in that manner.” Id. at 384 (quoting Voss, 450 N.E.2d at 208). The court explained that the plaintiff's burden is “to present evidence that the product, as designed, was not reasonably safe because there was a substantial likelihood of harm and it was feasible to design the product in a safer manner.” Id. (quoting Voss, 450 N.E.2d at 208).

Based on that language, New York courts require a strict liability plaintiff to prove that: “(1) the product as designed posed a substantial likelihood of harm; (2) it was feasible to design the product in a safer manner; and (3) the defective design was a substantial factor in causing the plaintiff's injury.”⁷⁷ Ferracane v. United States, No. 02-CV-1037 (SLT), 2007 WL 316570, at *5 (E.D.N.Y. Jan. 30, 2007)(applying New York law and citing cases). The Voss decision led to the use of a “factor-based risk/utility analysis.” Ferracane, 2007 WL 316570, at *5. To meet his burden under that analysis, a plaintiff must offer more than “unsupported, conclusory evidence on the technological and economic feasibility of a safer design.” Id. (quoting G.E. Capital

⁷⁷ The standards are the same whether the allegation is negligent or strict liability design defects. Adams, 929 N.E.2d at 384.

Corp. v. A.O. Smith Corp., No. 01 Civ.1849 LAP, 2003 WL 21498901, at *4 (S.D.N.Y. July 1, 2003)); see also Guarascio v. Drake Assocs. Inc., 582 F. Supp.2d 459, 463 (S.D.N.Y. 2008)(applying New York law and calling for admissible evidence on the technological and economic feasibility of an alternative design); Adams, 929 N.E.2d at 385 (favorably acknowledging the argument that “merely . . . showing that a safer product was theoretically possible at the time” is not enough).

Two means are available to satisfy the plaintiff's burden:

1. Plaintiff's expert can show, through testing and construction of a prototype, that such an alternative design is within the realm of practical engineering feasibility, thereby demonstrating the utility, cost, safety, sanitation and other characteristics of the proposed alternative; and/or

2. Plaintiff's expert can identify makers of similar equipment who have already put into use the alternative design that has been proposed.

Rypkema v. Time Mfg. Co., 263 F. Supp.2d 687, 692 (S.D.N.Y. 2003)(applying New York law). The Rypkema court excluded the expert's testimony produced by the plaintiff because the expert had not reconstructed the accident, proposed an alternative design, evaluated the feasibility of an alternative design, explained how an alternative design would have prevented injury, or pointed to use of an alternative design in the marketplace. See id. The court then granted summary

judgment in favor of the defendant because the plaintiff lacked evidence of product liability. See id. at 694.

In Adams, the court considered whether the plaintiff had produced enough evidence for the jury to find likelihood of harm and feasibility of an alternative, safer design. Adams, 929 N.E.2d at 384. The court found that the plaintiff had produced sufficient evidence where, in addition to the testimony of a former employee of the manufacturer regarding consideration of an alternative design at the time of manufacture, the plaintiff's experts explained how the alternative design would have made the product safer, illustrated feasibility with a model of the product with the design changes, demonstrated how the alternative product worked, and testified that the concept was not new at the time of manufacture and that the alterations were not expensive at that time. See id. at 384-85.

In Ferracane, the court found the expert's opinion to be insufficient to establish that feasible, safer alternatives existed at the time of manufacture because he proposed hypothetical designs without details about the proposed alternatives, had not tested the alternative designs, had not illustrated the proposed designs with a drawing, mock-up, or prototype, was unable to identify a manufacturer who had ever used the alternative designs proposed in the product, and did not testify to the cost or feasibility of the alternative designs. Ferracane, 2007 WL 316570, at *6. The court cited other cases in which the evidence was insufficient: (1) Gonzalez by Gonzalez v. Morflo Industries, 931 F. Supp. 159, 166 (E.D.N.Y. 1996), in which the court found insufficient the expert's

testimony on hypothetical designs that had never been tested coupled with no cost or feasibility analysis and no identification of a manufacturer that had used the proposed designs; (2) Sita v. Danek Medical, Inc., 43 F. Supp.2d 245 (E.D.N.Y. 1999), in which the court found insufficient the expert's testimony that a device with "hooks instead of screws" or "no system at all" would be safer but failed to point to any evidence to support these conclusory statements. Ferracane, 2007 WL 316570, at *5.

In this case, Hansen provided a report⁷⁸ in which he stated, "It is most likely that damage-causing dangerous fumes, generated from aerosolized and/or vaporized turbine engine oils, were allowed to enter the cabin through the use of the ACM at issue."⁷⁹ He noted that the ACM did not include "safety features such as oil-less bearings, fume absorbers, filters, or early warning sensors that could have operated to avoid damage to cabin occupants."⁸⁰ He repeated these suggested features several times in his report but provided no indication of how they could be retrofitted into the ACM or how an entirely new system

⁷⁸ The court need not determine whether Hansen's report is admissible under the Federal Rules of Civil Procedure because, even assuming it is, the court finds that his opinions are insufficient to meet New York standards for a plaintiff's burden on an alternative, safer design.

⁷⁹ Doc. 236-6, Ex. 3 to Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J., Hansen's Report p. 4. Hansen also postulated that, in addition to oil from the turbine engines, the oil bearings within the ACM could leak oil into the airflow. See id. pp. 6-8.

⁸⁰ Id. p. 4.

incorporating those features would work in place of the ACM.⁸¹

Regarding alternative, feasible, safer design options, the most Hansen offered was the following:

Alternative systems capable of preventing the claimant's damage (which would not be unduly burdensome on anyone) were/are available — Modern design practices for ACM equipment avoids the use of turbine engine oil lubrication systems entirely, instead using “air bearings” and “ceramic hybrid bearings.” Additionally, high efficiency particulate (HEPA) filters combined with activated charcoal or similar filters could have been installed to remove both particles and chemical from the cabin air. In the interest of safety, Fairchild could and should have produced some FAA Supplemental Type Certificate (STC) to at least install some fume sensors, filters, absorbers, and/or suggested diverters to adequately warn cabin occupants such as the plaintiffs. Also, Fairchild could have used oil-less bearings as suggested above.⁸²

Without offering more detail as to any alternative design, Hansen concluded that the fume event “could have been avoided if [Fairchild] had used common oil-less air bearings, filters, fume absorbers, sensors, or other easily available design features.”⁸³

⁸¹ See *id.* pp. 4, 5, 7, 8.

⁸² *Id.* p. 5 (emphasis in original)(internal citations omitted).

⁸³ *Id.* p. 8.

When Hansen's report is compared with the expert opinions considered by the courts in the cases cited above, it belongs in the group of those that were found to be insufficient to carry the plaintiffs' claims to trial. His efforts fall woefully short of the evidence in Adams, which the Court of Appeals of New York found sufficient for jury consideration. As with the cases in which the expert opinions were found to be insufficient, Hansen suggested hypothetical changes without any details. His ideas were not developed at all, much less committed to paper, made into models, or tested. Hansen did not point to any manufacturer who used a design that incorporated any or all of the design features he mentioned.⁸⁴ Significantly, Hansen offered nothing more than conclusory assertions about economic feasibility, stating only that the design features were easily available and not unduly burdensome rather than analyzing the risk/utility of each or all of his suggestions.

New York law directs this court to grant Fairchild summary judgment on Plaintiffs' design defect claims.

C. Failure to Warn

A manufacturer may be held liable for failure to warn of latent dangers that it knew or should have

⁸⁴ Although not mentioned in Hansen's report, Plaintiffs point, in their response brief, to a design of an air pressurization system that they allege was on the market in 2006. See Doc. 236-2, Pls.' Mem. in Opp. to Fairchild's Mot. for Summ. J. p. 22. Even if Plaintiffs could produce evidence of the design's existence in the market at the relevant time, it would not carry Plaintiffs' burden to show that it would have been safer, that it could have functioned in the place of the Fairchild ACM, or that it would have been feasible for use in place of the Fairchild ACM.

known existed from foreseeable usage of a product. Hall v. Husky Farm Equip., Ltd., 939 N.Y.S.2d 604, 608 (N.Y. App. Div. 2012)(citing Liriano v. Hobart Corp., 700 N.E.2d 303, 305 (N.Y. 1998)). However, New York courts recognize a “knowledgeable user” exception, which allows courts to find as a matter of law either that the manufacturer had no duty or that the duty was discharged. See Steuhl v. Home Therapy Equip., Inc., 857 N.Y.S.2d 335, 337 (N.Y. App. Div. 2008)(citing Travelers Ins. Co. v. Fed. Pac. Elec. Co., 625 N.Y.S.2d 121, 123 (N.Y. App. Div. 1995)); Bigness v. Powell Elecs., Inc., 619 N.Y.S.2d 905, 906 (N.Y. App. Div. 1994)(citing cases)). “Where the person who would benefit from a warning is already aware of the specific hazard, the manufacturer cannot be held liable for failing to warn of that known hazard.” Steuhl, 857 N.Y.S.2d at 337 (citing Lombard v. Centrico, Inc., 557 N.Y.S.2d 627, 628 (N.Y. App. Div. 1990)).

In this case, Farmer and Davidson were aware of the occurrence of smoke and fumes in the cabin and cockpit of the Twin Commander 690A prior to taking the May 31, 2011 flight. The very purpose of the mission, as explained to them, was to confirm the presence of smoke and fumes that had been reported by Bill O’Connor a few days earlier. Both Farmer and Davidson knew that others had experienced odors, smoke, and/or fumes during flights. Farmer had experienced such events many times while flying the Twin Commander 690A prior to May 31, 2011. Both Farmer and Davidson had reported concerns to management. Both were aware of possible harm, Farmer from personal experience and Davidson from personal research. As soon as they boarded the airplane, they could smell the smoke and fumes. Yet,

they continued the mission. In light of that evidence, it appears that a warning would not have dissuaded Farmer and Davidson from taking the flight. Plaintiffs presented no evidence to the contrary.

Thus, the “knowledgeable user” exception applies. New York law directs this court to grant Fairchild summary judgment on Plaintiffs’ claim of failure to warn.

IV. Conclusion

Based on the foregoing, the court **GRANTS** Fairchild’s motion for summary judgment. Jana and the children may not maintain their derivative claims for loss of consortium in the absence of any substantive claim. See Griffin v. Garratt-Callahan Co., 74 F.3d 36, 40 (2^d Cir. 1996)(applying New York law and dismissing claims for loss of consortium because none of the spouse’s claims survived). As that disposes of the case, the court **DENIES AS MOOT** Fairchild’s motions to exclude.

SIGNED in Houston, Texas, this 29th day of September, 2016.

s/_____
U.S. MAGISTRATE JUDGE

**IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION**

CIVIL ACTION NO. H-15-0827

[Filed September 29, 2016]

KENNETH DAVIDSON, et al.,	)
	)
Plaintiffs,	)
	)
v.	)
	)
FAIRCHILD CONTROLS CORPORATION,	)
Defendant.	)
	)

FINAL JUDGMENT

In conformity with the Memorandum Opinion signed on this day, it is hereby **ADJUDGED** that Plaintiffs take nothing against Defendant.

All relief not granted herein is **DENIED**. Defendant is awarded its costs.

THIS IS A FINAL JUDGMENT.

The Clerk will provide a copy of this judgment to all counsel.

SIGNED this 29th day of September, 2016, in Houston, Texas.

s/_____
U.S. MAGISTRATE JUDGE

APPENDIX C

**IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION**

CIVIL ACTION NO. H-15-0827

[Filed December 12, 2016]

KENNETH DAVIDSON, et al.,	)
	)
Plaintiffs,	)
	)
v.	)
	)
FAIRCHILD CONTROLS CORPORATION,	)
Defendant.	)

ORDER

Pending before the court¹ is Plaintiffs Kenneth Davidson and Jana Davidson, individually and on behalf of their minor Children, and Thomas Farmer's Rule 59(e) Motion to Alter or Amend Judgment. Having considered the motion and Defendant Fairchild Controls Corporation's response, the court **DENIES** Plaintiffs' motion.

¹ The parties consented to proceed before the undersigned magistrate judge for all proceedings, including trial and final judgment, pursuant to 28 U.S.C. § 636(c) and Federal Rule of Civil Procedure 73. See Docs. 245, 246, Consents; Doc. 247, Ord. Dated May 5, 2016.

App. 43

SIGNED in Houston, Texas, this 12th day of
December, 2016.

s/_____

Nancy K. Johnson
United States Magistrate Judge

APPENDIX D

**UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION**

CIVIL ACTION NO. 4:15-cv-00827

JUDGE: SIM LAKE

[Filed April 4, 2016]

KENNETH DAVIDSON AND JANA DAVIDSON,)
INDIVIDUALLY AND ON BEHALF OF THEIR)
MINOR CHILDREN JCD AND KSD,)
AND THOMAS FARMER)
)
VERSUS)
)
ROCKWELL INTERNATIONAL CORPORATION,)
ET AL)
)

**PLAINTIFFS' MEMORANDUM IN
OPPOSITION TO MOTION FOR SUMMARY
JUDGMENT BY FAIRCHILD CONTROLS
CORPORATION**

NOW INTO COURT, through undersigned counsel, come Plaintiffs, Kenneth Davidson, et al, who file this memorandum in opposition to the Motion for Summary Judgment filed by Defendant Fairchild Controls Corporation ("Fairchild").

* * *

[Tables omitted in this appendix]

NATURE AND STAGE OF PROCEEDINGS

This is a personal injury matter arising out of Plaintiffs Kenneth Davidson and Thomas Farmer's exposure to a cloud of toxic fumes and smoke aboard a Twin Commander 690A aircraft. The source of the toxic fumes was an Air Cycle Machine manufactured and subsequently overhauled and repaired by Fairchild Controls Corporation ("FCC") which is a critical piece of the aircraft's environmental controls system and is responsible for pressurizing the aircraft's cabin during flight. Mr. Davidson and Mr. Farmer, the only two occupants of the plane, filed this products liability in the United States District Court for the Southern District of New York against FCC and multiple other Defendants believed to be involved in the design, construction, and maintenance of the subject aircraft and its component parts.

The preliminary stages of this litigation were occupied by initial disclosures and a large volume of dispositive motions from the numerous Defendants seeking dismissal on various grounds. (ECF Nos. 23, 39, 43, 64, 116). These dismissals took place beginning in February of 2015 and continued through the end of March of 2015 (ECF Nos. 169, 186-194, 196-197) and resulted in a single remaining Defendant, FCC. By agreement between Plaintiffs and FCC, the matter was transferred by order of the New York court on March 26, 2015. (ECF No. 201)

After the litigation of multiple discovery issues (ECF Nos. 218-224), the parties jointly moved to extend

the court-ordered mediation deadline. (ECF No. 225) On January 25, 2016 Plaintiffs' counsel traveled to Houston to attend the mediation. The Parties were unable to come to a resolution, and on February 12, 2016 Fairchild filed its Motion for Summary Judgment. (ECF No. 227) In addition to that motion, two other Motions are pending before the Court: Plaintiffs' Motion for Extension of Docket Control Order Deadlines (ECF No. 232) and the now-uncontested Plaintiffs' Motion for Leave to Expand the Number of Interrogatories by Seven Interrogatories. (ECF No. 231)¹

STATEMENT OF ISSUES

1. Whether current jurisprudence in the Fifth Circuit holding that products liability claims against the manufacturers of aircraft and their component parts are neither subject to field preemption nor conflict preemption protects Plaintiffs' claims and prevents the summary judgment dismissal requested by FCC.
2. Whether the testimony of Plaintiffs' expert showing that the Air Cycle Machine manufactured by FCC was defective and could have been designed differently to avoid Plaintiffs' injuries is sufficient to defeat FCC's suggestion that Plaintiffs cannot prove their design defect claim.

¹ Although FCC initially objected to Plaintiffs' motion for leave to propound additional interrogatories, FCC has since communicated its consent to be served with additional interrogatories. Plaintiffs have submitted a supplemental memorandum informing the Court of FCC's agreement and supplying an order for the Court's signature. (ECF. No. 235)

3. Whether Plaintiffs' expert testimony on the issue of a design defect also prevents summary judgment on the issue of failure to warn.
4. Whether Plaintiffs' knowledge that the aircraft had experienced prior fume events is sufficient to completely bar their failure to warn claim or whether this is just a matter of comparative fault which is not properly the subject of summary judgment.

SUMMARY OF THE ARGUMENT

FCC's attacks on Plaintiffs' lawsuit ask the Court to disregard the typical presumption against preemption and follow the lead of a limited number of opinions from the Third Circuit which have merely decided issues on the periphery of federal preemption in the context of products liability. Even if FCC could overcome the presumption against preemption, the well-reasoned decisions of *Morris v. Cessna Aircraft Co.*, *Monroe v. Cessna Aircraft Co.*, among others, show that Congress has consistently demonstrated an aversion to applying preemption in this field through its savings clauses in the Federal Aviation Act and subsequent congressional acts in the field of aviation.

The attacks on Plaintiffs' design defect and failure to warn cases can be quickly dispatched as well. Plaintiffs have provided the Court with the Affidavit of a Professional Engineer with extensive experience in aviation who opines not only that the FCC ACM created a dangerous condition through its use of oil-lubricated bearings, but that alternative designs were available which employed the use of oil-less bearings and relied upon outside air rather than engine

bleed air to ventilate an aircraft's cabin. The evidence also shows that FCC was involved as a manufacturer of the subject part as late as 2007 when it performed an overhaul of the ACM at issue.

Plaintiffs certainly did not understand or appreciate the significant danger of neurological damage which they could be facing as a result of their exposure to the fumes created by the ACM. There is simply nothing to suggest that their knowledge of previous cabin air fume events was thorough enough to place the blame on them for this incident. At any rate, that is not an issue appropriate for summary judgment.

The leaking of this bearing lubrication oil, its vaporization by the ACM, and the release of these vapors into the aircraft cabin – which caused the injuries to Plaintiffs – were defects which could have been avoided if FCC had elected to design its ACM differently. Plaintiffs' non-preempted claims related to these defects are fully supported by the evidence, and FCC's motion for summary judgment should be denied.

MEMORANDUM

I. FACTS AND PROCEDURAL HISTORY

In this product liability action, Plaintiffs Thomas Farmer and Kenneth Davidson were a pilot and sensor operator, respectively, for Northrop Grumman on May 31, 2011, when they were injured by exposure to toxic fumes that entered the cabin of the Twin Commander 690A aircraft that they were flying. The plane had a history of smoke and fumes in the cabin, including on previous occasions when Thomas Farmer had flown it. On this particular occasion, Farmer and

Davidson were asked in connection with the mission that they were flying to verify complaints of smoke and fumes that another pilot had made. (Ex. 1, Farmer Depo. pp. 58, (Oct. 13, 2015); Ex. 7, Farmer Depo. pp. 5-6 (Jun. 7, 2012)) When they reached their project altitude, Mr. Farmer and Mr. Davidson began to smell fumes. (Ex. 2, Davidson Depo. pp. 68-69, October 13, 2015)

Sure enough, by the time the plane reached an altitude of approximately 28,000 feet, the smoke and fumes became so bad that Plaintiffs eyes were burning, they were coughing, having difficulty breathing, and Kenneth Davidson appeared to Farmer to be intoxicated. (Ex. 2, at 68) They used oxygen as much as they could and initiated an immediate descent. Their total exposure on that day was approximately an hour and a half. (Ex. 1, pp. 47-48) As a result, Plaintiffs suffered severe and permanent injuries, including permanent damage to their brains, lungs, eyes, and nervous system-- symptoms collectively known as "aerotoxic syndrome." (See Pls.' Complaint, 23-26, ECF. No. 1)

Plaintiffs subsequently learned that defects in the aircraft's Environmental Control System (ECS) allowed toxic fumes containing TCP (tricresyl phosphate) to enter the cabin; specifically, defects in the "air cycle machine" (ACM) that was designed and manufactured by defendant Fairchild Controls Corporation ("FCC"). The ACM is the component of the plane responsible for ventilating and pressurizing the cabin. TCP is a dangerous neurotoxin emitted from jet engine oil when the oil is heated to high temperatures.

The design of ACM uses extremely hot “bleed air” coming off the engine rather than outside air to ventilate and pressurize the cabin. (Ex. 3, Hansen Aff., Ex. A, p. 3) The ACM is a relatively small component that was designed specifically for the Twin Commander 690A. The ACM consists of many smaller parts and two primary sections--a compressor side and a turbine side. “Bleed air” enters a heat exchanger, then enters the compressor side of the ACM, then exits and goes into a secondary heat exchanger, then goes back into the ACM on the turbine side, before finally being sent into the cabin. The turbine of the ACM is supported by two metallic ball bearings that are lubricated with jet engine oil. (Ex. 3, Hansen Aff., Ex. A, p. 3) The oil is held in a reservoir inside the ACM and “wicked” up to the bearings by a wick. (Ex. 3, Hansen Aff., Ex. A, p. 6-7) During operation, the bearings spin extremely fast to process and cool the hot “bleed air.” (Ex. 3, Ex. A, p. 3; Dziorny Declaration, p. 12, ECF No. 227-2)

As demonstrated by the Hansen report, the ACM is defective in that the oil-lubricated bearing system unnecessarily added toxic engine oil into a situation of high temperature, friction, and pressure, contributing fumes and toxins into the ECS which fumes were then pumped into the cabin of the aircraft. Leakage of as few as 0.214 and 0.642 drops of oil per minute would continuously and thoroughly pollute the aircraft’s cabin with enough TCP to cause adverse health effects to the aircraft’s occupants. (Ex. 3, Ex. A, p.12). In addition, the ACM failed to integrate sensors, filters, switches, warnings, or other easily available design features to protect aircraft occupants from toxic TCP. As will be detailed below, findings after the incident support Plaintiffs’ claims, revealing that oil from the ACM

reservoir had burned or leaked out, requiring a complete overhaul of the ACM. (Ex. 3, Ex. A, p.5).

FCC overhauls and sells rebuilt ACMs pursuant to a Parts Manufacturer Approval (PMA) issued by the FAA.¹ Original equipment ACMs for the Twin Commander 690A bear FAA Part Number 977018-1. Rebuilt ACMs bear FAA Part Number 977000-2. A rebuilt ACM receives a new part number because it is essentially a new product. FAA approval to produce and sell rebuilt parts requires a manufacturer to submit drawings and specifications; information on dimensions, materials, and processes; test reports and computations; material specifications; and certification of the fabrication inspection system. *See* 14 C.F.R. § 21.303.

The ACM that was involved in the major fuming incident of May 31, 2011, was Model BUR-20-1D, Serial Number 353. The subject plane had been manufactured in 1975, but ACM component Serial Number 353 probably was not its original ACM. Plaintiffs have outstanding interrogatories seeking information about the origins and history of this particular ACM. Documents produced so far indicate that it was completely overhauled by FCC in 2007, sold, and installed into the subject aircraft. (Dziorny Declaration, p. 13, ¶ 26 & Ex. E, ECF No. 227-1) Among other things, Plaintiffs are pursuing discovery about the maintenance and repair history of the ACM between its overhaul in 2007 and the major fuming

¹ The current version of the PMA, dated March 14, 2000, is Supplement Number 05-F to at least one earlier version, Supplement Number 01-F, dated November 10, 1993. (Dziorny affidavit, Exhibit A)

incident in 2011. However, Plaintiffs have already been able to obtain ample factual support for their claims against FCC, and its motion should be denied.

II. RULES GOVERNING MOTIONS FOR SUMMARY JUDGMENT AND THEIR APPLICATION TO DEFENDANT'S MOTION

Given the nature and stage of discovery in this litigation, FCC's Motion for Summary Judgment is premature. The parties are currently operating under a Docket Control Order issued by the Court on May1, 2015 (ECF No. 210) which required the parties to file dispositive motions after Plaintiffs were required to tender their experts' reports but well before the close of discovery and before FCC was required to produce its experts' reports. Plaintiffs have moved for an extension of these deadlines to accommodate the time it will take to depose the various out-of-state experts and perform other necessary discovery in this matter. (See ECF No. 232) The parties are in the process of arranging these depositions, and two will occur this week.²

The evidence Plaintiffs have developed so far is more than adequate to overcome summary judgment, but Plaintiffs expect to obtain additional evidence during the remainder of discovery that will further support their opposition. Among other things, Plaintiffs need to depose the defendant FCC, Plaintiffs have propounded interrogatories and requests for production of documents that remain outstanding, Plaintiffs will

² The parties will fly to San Francisco to take the depositions of Drs. Harrison and Bowler, Plaintiffs' medical experts over two days, Wednesday, April 6 -7, 2016.

be propounding subpoenas to various entities where the subject aircraft is believed to have been serviced, and both sides are in the process of taking expert witness depositions. Most notably, the deposition of Plaintiffs expert, Don Hansen, was taken on March 22, 2016. The parties have yet to receive a copy of the transcript of this deposition, which will contain additional supporting information for this memorandum. Plaintiffs believe that the following material facts will be further supported through Plaintiffs' current discovery efforts:

- a. In and around the time the ACM Model BUR-20-1D was originally designed (approximately the 1960s-1970s), there were designs available and in use for ventilating and pressurizing aircraft cabins that did not involve the use of engine "bleed air."
- b. In and around the time the ACM Model BUR-20-1D was originally designed (approximately the 1960s-1970s), there were designs available and in use for ventilating and pressurizing aircraft cabins that did not involve the use of oil-lubricated bearings.
- c. From the time the ACM Model BUR-20-1D was originally designed (approximately the 1960s-1970s) until the time the ACM component Serial Number 353 was overhauled, sold, and installed on the subject aircraft, the ACM Model BUR-20-1D underwent several design revisions. At least one of these revisions included modifications to the oil-lubricated bearings.
- d. From the time the ACM Model BUR-20-1D was originally designed (approximately the 1960s-1970s)

until the time the ACM component Serial Number 353 was overhauled, sold, and installed on the subject aircraft, the Environmental Control System of the Twin Commander 690A underwent several design revisions. At least one of these revisions included the addition of a secondary emergency shut-off valve.

- e. From the time the ACM Model BUR-20-1D was originally designed (approximately the 1960s-1970s) until the time the ACM component Serial Number 353 was overhauled, sold, and installed on the subject aircraft, technology had been developed and implemented that eliminated the use of engine “bleed air” to ventilate and pressurize the cabin of the Twin Commander 690A.
- f. Defendant FCC substantially participated in the design of the Environmental Control System of the Twin Commander 690A.
- g. The ACM component Serial Number 353 underwent at least one complete overhaul from the time of its original manufacture until the time of its sale and installation in the subject aircraft.
- h. Defendant FCC maintains an inventory of used ACMs that it overhauls and sells as replacement parts.

Summary judgment is authorized if the movant establishes that there is no genuine dispute about any material fact and the law entitles it to judgment. Fed.R.Civ.P. 56(c). Disputes about material facts are “genuine” if the evidence is such that a reasonable jury could return a verdict for the nonmoving party. *J.D. Fields & Co. v. United States Steel Int’, Inc.*, 690 F.

Supp.2d 487 (S.D. Tex., 2/17/10) citing *Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 106 S.Ct. 2505 2511, 91 L.Ed.2d 202 (1986). The Supreme Court has interpreted the plain language of Rule 56(c) to mandate the entry of summary judgment “after adequate time for discovery and upon motion, against a party who fails to make a showing sufficient to establish the existence of an element essential to that party’s case, and on which that party will bear the burden of proof at trial.” *Humana Health Plan, Inc. v. Nguyen*, 17 F.Supp.3d 638 (S.D. Tex., 5/2/14) citing *Celotex Corp. v. Catrett*, 477 U.S. 317, 106 S.Ct. 2548 2552, 91 L.Ed.2d 265 (1986). A party moving for summary judgment “must ‘demonstrate the absence of a genuine issue of material fact,’ but need not negate the elements of the nonmovant’s case.” *Little v. Liquid Air Corp.*, 37 F.3d 1069, 1075 (5th Cir.1994) (en banc) (quoting *Celotex*, 106 S.Ct. at 2553-2554). If the moving party meets this burden, Rule 56(c) requires the nonmovant to go beyond the pleadings and show by affidavits, depositions, answers to interrogatories, admissions on file, or other admissible evidence that specific facts exist over which there is a genuine issue for trial. *Id.* (citing *Celotex*, 106 S.Ct. at 2553-2554). In reviewing the evidence “the court must draw all reasonable inferences in favor of the nonmoving party, and it may not make credibility determinations or weigh the evidence.” *Reeves v. Sanderson Plumbing Products, Inc.*, 530 U.S. 133, 120 S.Ct. 2097 2110, 147 L.Ed.2d 105 (2000).

A summary judgment is only appropriate when, viewing the evidence in the light most favorable to the nonmoving party, no genuine issue of material fact exists, and the moving party is entitled to judgment as

a matter of law. *Flock v. Scripto-Tokai Corp.*, 319 F.3d 231, 236 (5th Cir. 2003), *citing Canova v. Shell Pipeline Co.*, 290 F.3d 753, 755 (5th Cir.2002). In determining whether there is a dispute as to any material fact, the court must consider all of the evidence in the record, but is not permitted to make credibility determinations or weigh evidence. *Flock*, 319 F.3d at 236 *citing Ramirez v. City of San Antonio*, 312 F.3d 178, 181 (5th Cir.2002). Instead, all reasonable inferences must be drawn in favor of the nonmoving party.

This maxim of summary judgment law is particularly applicable here. FCC's primary focus in its memorandum is a criticism of the merits of the opinions of Don Hansen rather than on the existence or non-existence of disputed facts. For example, rather than make what would be an incorrect suggestion to the Court that Plaintiffs have no evidence of an alternative design FCC instead acknowledges that Plaintiffs' expert advances alternative designs for the ACM but criticizes his "failure to settle on a specific alternative design." (Def.'s Mot. Summ. J. 14, ECF No. 227). However, to prevail on its Motion, FCC must show an absence of factual support. Drawing all reasonable inferences in favor of Plaintiffs, FCC's allegations regarding Plaintiffs' design defect claims must fail.

Plaintiffs will show below through the use of proper summary judgment evidence both that (1) as a matter of law, plaintiffs' products liability claims are not preempted under controlling precedent and (2) as a matter of fact, Plaintiffs have support in the form of expert testimony for each of their products liability claims. Accordingly, FCC's Motion should be denied.

III. PLAINTIFFS' CLAIMS ARE NOT PREEMPTED BY FEDERAL LAW.

A. The Court must Begin its Analysis of Preemption with a Presumption That Plaintiffs' Claims Are Not Preempted

The “ultimate touchstone” in any preemption case is Congressional intent. *Wyeth v. Levine*, 555 U.S. 555, 129 S. Ct. 1187, 1194, 173 L. Ed. 2d 51 (2009). Congressional intent to preempt state law may be either express or implied. *Witty v. Delta Air Lines, Inc.*, 366 F.3d 380, 384 (5th Cir. 2004). Implied preemption can take two forms: field preemption and/or conflict preemption. *English v. Gen. Elec. Co.*, 496 U.S. 72, 78-79, 110 S. Ct. 2270, 110 L. Ed. 2d 65 (1990). Although Congress has the power to preempt other laws, our system of Federalism commands that in absence of clearly-expressed Congressional intent, there must be a presumption against preemption. See *Morris v. Cessna Aircraft Co.*, 833 F. Supp. 2d 622, 629-630 (N.D. TX 2011) citing *Wyeth*, 129 S.Ct. at 1193 n. 3 (quoting *Medtronic, Inc. v. Lohr*, 518 U.S. 470, 485, 116 S.Ct. 2240, 135 L.Ed.2d 700 (1996)). As a result, in beginning any preemption analysis the court must start with a presumption against preemption. See *Morris*, 833 F. Supp. 2d 629-630; see also *Cf. Cipollone v. Liggett Group, Inc.*, 505 U.S. 504, 517 (1992)

B. Field Preemption Does Not Apply

“Just as the federal government’s long history of regulating pharmaceutical drugs did not dictate preemption in *Wyeth*, the history of federal regulation over air transportation does not detract from the states’ long-standing role in ensuring product safety.” *Morris*,

833 F. Supp. at 630. Here, FCC contends that the Federal Aviation Act (FAA), 49 U.S.C. § 40101, et seq., and its regulatory scheme, 14 C.F.R. Pt. 21, impliedly preempt plaintiffs' claims under both field and conflict preemption theories. Yet, congress expressly indicated in the FAA that it did not intend to preempt state law when it included in the original FAA a savings clause that provided: "Nothing contained in the Act shall in anyway a bridge or alter the remedies now existing at common law or by statute, but the provisions of this Act are in addition to such remedies." Federal Aviation Act of 1958, Pub. L. No. 85-726, § 1106, 72 Stat. 731, 798; *Morris*, 833 F. Supp. 2d at 627. The current version was simplified to read: "A remedy under this part is in addition to any other remedies provided by law." 49 U.S.C. § 40120(c); see *Id.* While the court in *Morris* acknowledged that subsequent acts of Congress have provided exceptions to the general rule against preemption, these exceptions apply only in limited circumstances and for limited purposes.

For example, the Airline Deregulation Act (ADA) of 1978 added a provision that expressly preempts state and local laws related to a price, route, or service of an air carrier (49 U.S.C. § 41713(b)(1)) and the General Aviation Revitalization Act (GARA) of 1994 added an eighteen-year statute of repose preempting applicable state law statutes of repose for certain civil actions against certain aircraft manufacturers (49 U.S.C. § 40101 Note § 2(a)(1)). *Id.* at 628, see also *Lyon v. Agusta S.P.A.*, 252 F.3d 1078, 1084 (9th Cir. 2001). Both of these acts implicitly suggest that state-law claims in the field of aviation safety remain viable. See *Monroe v. Cessna Aircraft Co.*, 417 F.Supp.2d 824

(E.D. Tex. 2006)(citing legislature history of GARA which shows “strong support of Congress’s intent not to preempt” at H.R.Rep. No. 103-525(II), at 6-7 (1994), as reprinted in 1994 U.S.C.C.A.N. 1644, 1648); *Public Health Trust of Dade Cnty., Fla. v. Lake Aircraft, Inc.*, 992 F.2d 291, 295 (11th Cir. 1993).

FCC acknowledges that federal courts, including the United States District Court for the Eastern District of Texas, have rejected federal preemption for design defect and failure to warn claims against aircraft and aircraft component manufacturers. See *Monroe*, 417 F.Supp.2d 824-826 (holding that claims that an aircraft manufacturer was negligent for “not providing sufficient warnings with regard to bird strikes and in flight structural damage, for failing to design and manufacture the aircraft to reduce potential structural damage resulting from a bird strike, and for failing to design and manufacture the aircraft to mitigate the risk of landing with structural damage” were not preempted.); *Cleveland ex rel. Cleveland v. Piper Aircraft Corp.*, 985 F.2d 1438, 1444 (10th Cir. 1993). In *Monroe*, the Eastern District explicitly rejected field preemption under the FAA, noting that the Supreme Court has opined that field preemption is “itself suspect,” in the absence of an express “congressional command that a particular field be pre-empted.” *Monroe*, 417 F.Supp. 2d at 828, citing *Camps Newfound/Owatonna, Inc. v. Town of Harrison, Maine*, 520 U.S. 564, 614-15, 117 S.Ct. 1590, 137 L.Ed.2d 852 (1997) (stating that recent Supreme Court decisions have rejected field preemption in the absence of statutory language expressly requiring it). *Cleveland ex rel. Cleveland v. Piper Aircraft Corp.*, supra, also rejected the application of field preemption in the

Tenth Circuit along with *Public Health Trust of Dade Cnty., Fla. v. Lake Aircraft, Inc.*, 992 F.2d 291, 295, in the Eleventh Circuit. Further, the Court in *Monroe* reinforced the limited nature of other preemption holdings such as the *Witty* decision, noting that the Fifth Circuit in *Witty* expressly limited its holding to the narrow issue before it (“*Witty* is a narrow opinion that only applies to warnings given to passengers on commercial airliners...*Witty* neither stands for the proposition that the field of aviation safety is preempted nor suggests that any of *Monroe*’s state law claims are precluded.”). *Monroe*, 417 F. Supp. 2d at 829.

FCC’s argument that the type certificate and Federal Aviation Regulations provisions result in field preemption was also rejected in the *Monroe* decision. While the FAA employs a type certification program through which it applies certain design regulations, these regulations do not specifically dictate how certain components are to be designed; they merely provide minimum requirements applicable to aircraft parts and components. *Monroe*, 417 F. Supp. 2d at 833. The certification process does not meet the requirements of a pervasive regulatory scheme intended to preempt state-law claims. *Id.* The same conclusion was reached in *Cleveland*, supra at 1446 (noting that an FAA design certification “is, by its very nature, a minimum check on safety.”)

The opinions cited by FCC in support of its position are neither binding, nor applicable due to factual dissimilarities. Moreover, courts in the Fifth Circuit have already rejected the *Abdullah* decision from the Third Circuit upon which FCC relies and would likely

also reject the recent holding of the United States District Court for the Middle District of Pennsylvania, *Sikkelee v. Precision Airmotive Corp.*, 45 F. Supp. 3d 431 (M.D. Pa. Sept. 10, 2014).³ See *Morris*, 833 F. Supp. 2d at 633-634 (in which the Northern District of Texas noted that it was “not persuaded” by *Abdullah* and lodged several criticisms of the underpinnings of that decision). Fifth Circuit cases on the issue of preemption, when combined with its disapproval of *Abdullah*, show that the law in the Fifth Circuit is that preemption will not apply where there is not a clear regulatory scheme affecting the product at issue. See, e.g., *Peace v. Am. Gen. Life Ins. Co.*, 462 F.3d 437, 441 (5th Cir. 2006)

Outside of being expressly disapproved by courts in this circuit, *Abdullah* is distinguishable on its face. In *Abdullah*, the plaintiffs’ claims were for injury resulting from a commercial airliner’s alleged failure to avoid turbulence and failure to warn the passengers of turbulence. 181 F.3d at 365. The district court held that the FAA impliedly preempted state laws which

³ The *Sikkelee* decision is presently under review by the Third Circuit. Even among the district courts of the third circuit, there is significant conflict over the scope of the preemption intended by the Federal Aviation Act. See, e.g., *Landis v. US Airways, Inc.*, No. 07-1216, 2008 WL 728369 (W.D. Pa. Mar. 18, 2008); *Duwall v. Avco Corp.*, No. 4:cv-05-1786, 2006 WL 1410794 (M.D. Pa. May 19, 2006); *Pease v. Lycoming Engines*, No. 4:10-CV-00843, 2011 WL 6339833, at *23 (M.D. Pa. Dec. 19, 2011). In connection with the proceedings in *Sikkelee*, the American Association for Justice submitted a Brief as Amici Curiae for Plaintiffs noting the confusion in the Third Circuit and arguing against the application of preemption. See Exhibit 4, Cause No. 14-4193, *Sikkelee v. Precision Airmotive Corp.*, In the U.S. Court of Appeals for the Third Circuit (Jan. 4, 2015), 2015 WL 309174

intruded on the “standards of care for pilots, flight attendants, and passengers.” *Id.* at 366. This case does not involve allegations of pilot or flight attendant error, so the *Abdullah* decision cannot be used to apply preemption here. *Abdullah* was intended only to cause federal preemption to apply to standards of care when operating an aircraft, and not to the safe design of manufacture of aircraft and aircraft components occurring long before an aircraft is placed into operation.

Similarly, *Sikkelee*, which was based on the *Abdullah* rationale, will not apply here. The defendant in that case was not the manufacturer or designer of the allegedly defective part as FCC is here. 45 F.Supp.3d 439. The defendant in *Sikkelee* was the type certificate holder of an engine design within which was incorporated a carburetor manufactured by another company. *Id.* That carburetor was the allegedly defective part. Even though some of the plaintiff’s claims were dismissed on rationale which conflicts with the jurisprudence here, it is important to note that the plaintiff was actually permitted to move forward on her claims that the defendant failed to report engine defects to the FAA. *Id.* at 456-460.

Other cases cited by FCC similarly fail to support the application of preemption in this case. For instance, in *U.S. Airways, Inc. v. Odonnell*, 627 F.3d 1318 (10th Cir. 2010), U.S. Airways sought to enjoin the state of New Mexico from regulating alcoholic beverage sales. This was after the state of New Mexico issued a citation and a cease and desist to U.S. Airways under the New Mexico Liquor Control Act (“NMLCA”) when a passenger allegedly purchased and consumed

alcoholic beverages on a flight then caused a deadly automobile accident. *Id.* The Tenth Circuit found that the field of alcoholic beverage service provided on airplanes, was already regulated by 14 C.F.R. § 121.575, so field preemption applied to prevent New Mexico's actions under the NMLCA. Similarly, the other cases cited by Fairchild fail to discuss the issue of preemption as it relates to design defect claims under state products liability laws. *See Montalvo v. Spirit Airlines*, 508 F.3d 464 (9th Cir. 2007)(claims of failure to warn of the risk of deep vein thrombosis allegedly due to an inappropriate seating configuration which would affect airline prices was preempted); *Witty v. Delta Airlines*, 366 F.3d 380 (5th Cir. 2004)(no claim for failure to warn against deep vein thrombosis); *Greene v. B.F. Goodrich Avionics Sys., Inc.*, 409 F.3d 784 (6th Cir. 2005) (On appeal after a jury verdict, the Sixth Circuit found that the plaintiff failed to produce sufficient evidence to create an issue of fact for the jury that there was a manufacturing defect. The court did not find that the manufacturing defect claim would have been preempted.).

It is unlikely that the district courts of the Fifth Circuit would follow the *Sikkelee* decision, especially considering its heavy reliance on *Abdullah* and the criticisms lodged against *Abdullah* by the Courts in this circuit. See *Morris*, 833 F. Supp. 2d at 631-336. Instead, the precedent established in this jurisdiction through *Morris* and *Monroe* shows that Congress did not intend field preemption to apply to Plaintiffs' claims here. Applying the preemption suggested by FCC would in effect leave anyone injured on an aircraft due to the failure of its parts without any legal recourse for injury. Holding in FCC's favor would strongly

conflict with the presumption against preemption and with other acts of Congress such as GARA and the ADA (which includes an express savings clause) in addition to the jurisprudence.

C. Conflict Preemption Does Not Apply Because the FAR's Governing Ventilation, Heating, and Pressurization Do Not Dictate Any Specific Design.

The doctrine of conflict preemption only applies where there is a conflict with specific federal standards for manufacturers which renders it “impossible for a private party to comply with both state and federal requirements, or where state law ‘stands as an obstacle to the accomplishment and execution of the full purposes and objectives of Congress.’” *Monroe*, 417 F. Supp. 2d at 836 (internal citations omitted). Plaintiffs claims here that FCC improperly designed, re-manufactured, and refurbished the ACM do not place FCC in a position of being unable to comply with the broad minimum standards set out by relevant federal regulations governing the ventilation, heating, and pressurization systems aboard aircraft. Therefore, there is no basis for the imposition of conflict preemption.

The federal regulations governing ventilation, heating and pressurization for “transport category airplanes” are found at 14 C.F.R. §§ 25.831-25.843, not at § 25.819 as erroneously cited by FCC. These regulations specify general performance standards for all types of aircraft within that category; they do not dictate design details for the ACM or the Twin Commander 690A. With regard to air quality features, the FARs simply state:

Under normal operating conditions and in the event of any probable failure conditions of any system which would adversely affect the ventilating air, the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crew members to perform their duties . . .

Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapors.

14 C.F.R. § 25.831 (a) and (b). These performance standards apply to all transport category airplanes; there are not individual FARs for different type of planes. Neither are there FARs specific to different component parts like the ACM. Different aircraft necessarily use different parts and employ different designs that may all comply with the FARs. Nothing in the FARs suggest that the design features suggested by plaintiffs' expert Mr. Hansen "would create an irreconcilable conflict with federal law," as asserted by FCC. (Def.'s Mot. Summ. J. 12) The FARs say nothing whatsoever about alternative types of bearings, specifications for oil seals, filters, diverters, absorbers, or indicators proposed by plaintiffs' expert. Proposing an alternative, safer design that would conform to FARs ventilation standards does not trigger conflict preemption.

FCC also relies upon the type certificate, the airworthiness certificate, and the absence of airworthiness directives for the Twin Commander 690A in support of its preemption argument. Again, however, these oversights do not address anything specific about the design or manufacturing features of

the plane. Just because an aircraft receives certification does not mean that it is free from defect. The FARs themselves acknowledge that defects are still possible: they require the holder of a type certificate to “report any failure, malfunction, or defect in any product,” including “the accumulation or circulation of toxic or noxious gases in the crew compartment or passenger cabin.” 14 C.F.R. § 21.3(b).

Numerous courts have recognized that although compliance with federal statute or regulation may provide some evidence that a product is not defective, it does not preclude liability for failure to provide a safer design or additional warnings. See *Alami v. Volkswagen of America, Inc.*, 10 A.D.3d 344, 780 N.Y.S.2d 638 (N.Y. App. Div. 2004) (finding compliance with National Traffic and Motor Vehicle Safety Act of 1966 (49 USC § 30101, et seq.) or relevant provisions of Federal Motor Vehicle Safety Standard 208 does not preclude liability); *Mercogliano v. Sears, Roebuck and Co.*, 303 A.D.2d 566, 756 N.Y.S.2d 472 (N.Y. App. Div. 2d Dep’t 2003) (stating compliance with the Federal Flammable Fabrics Act (15 USC § 1191 et seq.) and its accompanying regulations (16 CFR part 1610.1 et seq.) is merely some evidence of due care and does not preclude a finding of negligence).

According to FCC, the type certificate for the Twin Commander 690A was issued in 1973. FCC’s witness Mr. Paul Dziorny explains that FCC manufactured ACMs only between approximately 1950 and 1980. (Def.’s Mot. Summ. J. Exhibit 1 at 6) After FCC discontinued manufacturing new ACMs, it would repair and overhaul old ones to supply replacement parts to older model aircraft. (Def.’s Mot. Summ. J.

Exhibit 1 at 6-7) FCC does this under authority of the FAA. It is possible for FCC to both comply with Federal law and to have made the changes to its design which Plaintiffs will show were necessary to protect aircraft occupants.

FCC made repeated repairs and overhauls to the subject ACM after its original manufacture, both before and after the 2011 flight in question. There is substantial evidence that plaintiffs and other pilots who flew this plane repeatedly complained of misting and fumes in the passenger compartment. FCC cannot shield itself and these events from scrutiny by hiding behind federal conflict preemption.

IV. GENUINE ISSUES OF MATERIAL FACT REGARDING PLAINTIFFS' PRODUCT LIABILITY CLAIMS

A. Genuine Issues of Material Fact Regarding Design Defect Claims

FCC's seeks summary judgment on Plaintiffs' design defect claim in Sections VI.B.1.a-c and Section VI.B.2 of its motion; these all basically address a single element-whether or not Plaintiffs can prove the existence of a feasible alternative design. New York law generally follows the strict liability principles outlined in the Restatement (2d) of Torts, Section 402A, and adopted by many other states. See *Codling v. Paglia Eyeglasses*, 298 N.E.2d 622, 345 N.Y.S.2d 461 (N.Y. 1973); *Voss v. Black & Decker Mfg. Co.*, 59 N.Y. 2d 102, 106, 450 N.E. 2d 204 (1983).⁴“A manufacturer may

⁴ Neither party has requested that the Court address the choice of laws issue. However, it is submitted that New York Law will

be liable under strict products liability for defective products based on a manufacturing flaw, improper design or failure to warn.” *Monell v. Scooter Store, Ltd.*, 895 F. Supp. 2d 398, 412 (N.D.N.Y. 2012) (quoting *Sukljian v. Charles Ross & Son Co., Inc.*, 69 N.Y. 2d 89, 94, 503 N.E. 2d 1358 (1986)). Manufacturers may also be liable on the basis of contract (express or implied) and negligence, in addition to strict liability. *Monell*, 895 F. Supp. at 410-11.

In order to establish a claim for design defect, Plaintiffs must establish that (1) the product as designed posed a substantial likelihood of harm; (2) it was feasible to design the product in a safer manner; and (3) the defective design was a substantial factor in causing their injuries. See *Monell*, 895 F. Supp. 2d at 412. Plaintiffs can easily meet this threshold; material issues of fact preclude summary judgment on design defect.

As to the first and third elements, Plaintiffs will show that the Fairchild ACM as designed posed a substantial likelihood of harm, and that the fumes that injured Plaintiffs came from the ACM. (Ex. 3, Ex. A, p.12) The basic technology of the Fairchild ACM uses

apply to this dispute, so Plaintiffs’ claims will be discussed based on the presumption that New York law applies. Texas has adopted the Restatement (Second) on Conflict of Laws and the “most significant relationship” test outlined in §§ 6 and 145 of the Restatement. See *Cates v. Creamer*, 431 F.3d 456, 463 (5th Cir. 2005)(internal citations omitted). The flight on which Plaintiffs were injured took off in, flew over, and landed in New York. The FCC part installed aboard the aircraft caused a significant fume event in the aircraft’s cabin during this New York flight. The only significant confluence between the injury, the injury-causing event, the parties, and product at issue came in New York.

extremely hot “bleed air” coming off the engine to pressurize and ventilate the cabin. On its journey through the ACM, the “engine bleed air” passes through the ACM’s turbine, which contains a rotating assembly supported by two ball bearings that are lubricated with jet engine oil. Lubrication of the bearings is accomplished by means of a wick that draws oil up from an oil reservoir. The bearings, wick, and oil reservoir are all part of the ACM. (Ex. 3, Ex. A, pp. 3-4; ECF No. 227-1, p.13-15)

The jet engine oil which is used to lubricate the ACM’s bearings contains TCP, a dangerous neurotoxin that vaporizes at high temperatures and can pass into the cabin, reaching toxic levels even when only very small amounts are released. Plaintiffs’ expert Don Hansen explains that “the ACM leaking less than one drop of oil per minute would continuously and thoroughly pollute the aircraft’s cabin.” (Ex. 3, Ex. A, p. 5) Hansen calculates that approximately 1.085 drops of aerosolized turbine oil dispersed throughout the cabin of the Twin Commander 690A would surpass the OSHA long-term 8-hour permissible exposure limit, and that 3.2415 drops would surpass the short-term 15-minute exposure limit. Further, toleration of pollutants is reduced at higher altitudes. (Ex. 3, Ex. A, pp. 4-5)

The ACM is the only component of the aircraft responsible for air conditioning, pressurizing, and ventilating the cabin. Because the ACM is so critical to the health and safety of the pilot and other occupants, its design must be scrutinized closely under a risk-utility analysis. As the only source of breathable air, the ACM must take care to minimize the use of

engine oil and any creation or transference of engine oil vapors.

Hansen opines that designing the system to rely on such oil by using oil-lubricated bearings in the ACM turbine constitutes a design defect. In addition, the ACM's absence of filters, the "hidden" nature of its oil seals, which prevented inspection for leaks or wear, and the use of pressurized, hot "engine bleed air" further confounded the danger to aircraft occupants. (Ex. 3, Ex. A, p.5) As is detailed below, feasible alternative designs were readily available that would have minimized or eliminated the use of engine oil in the ACM.

Substantial evidence demonstrates that the ACM was in fact the source of the fumes that poisoned the plaintiffs. Prior to the major fume event in issue, Plaintiff Thomas Farmer's complaints of smoke and fumes in the Twin Commander aircraft illustrate they only occurred when the ACM was activated. Farmer testified in his deposition as follows:

Q: What caused you to believe there was an issue with the air cycle machine?

A: That's the only source of air in the plane and there's smoke and fumes.

Q: When was there smoke and fumes?

A: Every flight. The - mildly at lower altitudes, but at higher altitudes and a higher temperature selection for the cabin heat, you can develop significant smoke and oil mist.

Thomas specifically testified that fuming did not occur whenever the aircraft was flown unpressurized. (Ex. 1, p. 52)

After the major fuming incident, Northrop Grumman sent the aircraft to Eagle Creek Aviation for repairs. Documents produced by Eagle Creek note that Northrop Grumman described “smoke seen in cabin when the cabin is pressurized.” (Ex. 5, EC 000266) At that time, the ACM was removed and was sent back to FCC for another overhaul. John Probst, Northrop Grumman’s Director of Maintenance, told FCC, “My aircraft is grounded until I can get a replacement (ACM) unit. . . .” (Ex. 6, FAIRCHILD_00000033) The fact that an overhaul was required, in itself, is evidence that it was malfunctioning.

Records from the post-incident overhaul show that the oil reservoir had been leaking. FCC’s Shop Visit Report records the following:

CAUSE OF FAILURE: Oil starvation caused excessive damage internally.

FINDINGS AT DISASSEMBLY: As a result of the oil starvation, heat caused expansion of the shaft, bearing, and cartridge assembly thus causing damage to the turbine and impeller as well as the diffuser.

(FAIRCHILD_0000021) “Oil starvation” in the reservoir means that the oil was leaking out of the ACM. Hansen describes “evidence of oil leakage from the turbine side and the impeller side of the rotor, thus indicating ACM oil seal leakage.” (Ex. 3, Ex. A, p. 5)

The fact that fuming only occurred when the cabin was pressurized and the fact that the ACM was the only component responsible for pressurization point positively to the ACM as the source of the toxic fumes. As noted, discovery is ongoing and additional evidence is expected to be generated. Plaintiffs intend to depose FCC about the history, maintenance, and prior overhauls of this particular ACM. Plaintiffs will also shortly serve subpoenas to aviation service centers where discovery has revealed that the subject aircraft was serviced. Plaintiffs have propounded additional interrogatories and document requests to FCC which have not yet been answered.

Regardless, plaintiffs are not required to prove specifically how the ACM malfunctioned; it is sufficient for Plaintiffs to establish that the ACM was the source of the toxic fumes. Circumstantial evidence maybe sufficient and expert testimony is not required. See *Sipes v. General Motors Corp.*, 946 S.W. 2d 143, 155 (Tex. App.-Texarkana 1997) (“Strict liability does not require a specific showing of how the product became defective.”); *McDevitt v. Standard Oil Co.*, 391 F.2d 364 (5th Cir. 1968). “Proof of malfunction is circumstantial evidence of a defect in a product since a product will not ordinarily malfunction within the reasonable contemplation of a consumer in the absence of a defect.” *Farmer International Harvester Co.*, 553 P.2d 1306, 1312 (Id. 1976). See also *Wernimont v. International Harvester Corp.*, 309 N.W.2d 137 (Iowa Ct. App. 1981) (“proof of such defect need not, however, necessarily rest upon direct evidence. It can be and is usually established by circumstantial evidence.”); *Garrett v. Nobles*, 630 P. 2d 656, 658-59 (Idaho 1981) (“a prima facie case of product liability may be proved

by direct or circumstantial evidence of a malfunction of the product and the absence of evidence of abnormal use and reasonable secondary causes which would eliminate the defendant's liability") (citing *Farmer*, 553 P.2d at 1310-11 (1976)). See also *Garrett v. Nobles*, 630 P. 2d 656, 659-60 (Idaho 1981) (plaintiff's testimony that the "throttle stuck" was sufficient; trial court erred in requiring specific proof that the warranty seal impeded closure of the fuel pump throttle and the absence of direct linkage between the fuel pump and the accelerator pedal). See also *Sipes*, 946 S.W. 2d at 155 (expert testimony not required to establish defect when airbag failed to deploy-- "[t]he testimony of a product's user or operator about the circumstances of the event complained of has been held sufficient to establish the product's alleged malfunction."); *Hiser v. Bell Helicopter Textron Inc.*, 111 Cal. App. 4th 640, 654 (2003) (evidence pointed to a defect in the fuel flow switches, even without direct evidence of a malfunction, because "the fuel flow switches were the only components of the system having as their primary purpose the giving of such a warning.")

The evidence described above easily meets the Plaintiffs burden to establish the first and third elements of a design defect claim. FCC directly challenges only the third element-- feasible alternative design. The Fairchild ACM is based on very old technology developed in the 1960s, when "engine bleed air" was used for ventilation and pressurization, rather than outside air. Prior to that time, aircraft manufacturers used a supercharger to pressurize outside air, a method which prevented the introduction of toxic bleed air. According to FCC, this basic design of the 1960s remained state-of-the-art only through the

1980s, at which time oil-lubricated bearings were replaced with ceramic, “air bearings.” (ECF No. 227-2, at 15-16)

FCC asserts that economic feasibility “at the time the machine was made” refers to the time period decades ago when the ACM was originally designed. It does not matter what was economically feasible in the 1960s and 1970s, however, because FCC completely rebuilt the subject ACM in 2005 (and probably several times before that) before it was installed on the Twin Commander 690A that was flown by Plaintiffs. (Ex. 6, FAIRCHILD_00000004-7) That is the time period that must be examined. See *Brewer v. Dodson Aviation*, 2006 WL 3231974 (W.D. Wash. 2006) (when vacuum pump of airplane was overhauled in 1992 it became a new product for purposes of strict liability); *Anderson v. Olmstead Utility Equip., Inc.*, 573 N.E. 2d 626, 629 (Ohio 1991) (“[w]hen a product is totally remanufactured or rebuilt, it becomes, for all intent and purposes, a new product.”); *Caldwell v. Enstrom Helicopter*, 230 F.3d 1155 (9th Cir. 2000) (revised flight manual for a 1975 helicopter was a new “part” within the meaning of the General Aviation Revitalization Act (GARA)). In establishing a design defect under New York law, “the plaintiff must show that there was an economically and technically feasible alternative design available at the time the product was manufactured.” *Hilaire v. DeWalt Indus. Tool Co.*, 54 F. Supp. 3d 223, 252 (E.D. N.Y. 2014) (emphasis added).

The design of the ACM did not remain static from 1975 through 2005, and FCC cannot hide behind design standards of the 1960s. As FCC acknowledges, oil

bearings were replaced by “air bearings” in the 1980s. FCC’s own witness Paul Dziorny acknowledges that the wick-fed oil lubrication system for the ACM metallic bearings was replaced in the 1980s by ceramic “air bearings” that did not require the presence of engine oil inside the ACM. Dziorny argues that this change was made not for safety, but rather “to reduce maintenance and improve reliability.” (ECF No. 227-2, p. 15-16) That is a distinction without difference; the ACM is the only component capable of providing breathable air to the cabin. Any “maintenance” or “reliability” issues would necessarily affect the safety of aircraft occupants.

Other changes were made throughout the years. In 1986 the FAA issued a Supplemental Type Certificate authorizing installation of an auxiliary bleed air shut-off and fuselage temperature monitoring system in the subject aircraft. This and many other authorized modifications to the Twin Commander 690A can be found on the FAA website at http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSTC.nsf/

Plaintiffs will establish that multiple safer designs were not only feasible, but were actually available, at the time FCC overhauled and sold the subject ACM. In 2006 the FAA issued a Supplemental Type Certificate authorizing an entirely new type of air pressurization system to be installed on the Twin Commander 690A. This system, called the “Peter Schiff Aero’s Cabin Comfort Unit” uses outside air, not “bleed air” to pressurize and ventilate the cabin. The Schiff unit is a direct competitor to the Fairchild ACM; one can remove the ACM and replace it with the Schiff unit. This

design was actually on the market in 2006; its application had been pending since 2004.

FCC complains that eliminating the ACM's oil-lubricated bearings "would require a complete overhaul and redesign and manufacture of the ACM that would not be economically feasible given the small and shrinking market for these components," and would involve "high costs and impracticability." (Def.'s Mot. Summ. J. 20) Apparently the market disagrees, as competitors have developed, tested, obtained FAA approval, and sold alternative designs which are in flight today. Further, it is not sufficient for FCC to assert merely that the ACM functioned as designed, when a safer, feasible alternative design was available. See *Sipes*, 946 S.W. 2d at 156 (fact that airbag was not designed to deploy in side impact did not negate design defect claim). The issue is not whether various filters, bearings, or seals could have been retrofitted into an existing ACM; the issue is whether the entire ACM could/should have been redesigned. This is a question for the jury.

FCC further contends that, as a component part manufacturer, it cannot be held liable for engine oil fumes that may have entered the cabin from a source outside the ACM itself. This is known as the "component parts doctrine." See *Gray v. R.L. Best Co. Eyeglasses*, 78 A.D.3d 1346, 910 N.Y.S.2d 307 (N.Y. App. Div. 2010). Plaintiffs will submit evidence to show that the not only was the ACM the source of oil fumes, but also that the concentration of engine oil fumes coming from bleed air could not have caused the toxic build up in the cabin. So, the components part doctrine will not apply (and has not yet been alleged by FCC).

App. 77

However, even if FCC could argue that it did, the components part doctrine is not absolute; it has a couple of exceptions which come into play here. The Restatement (Third) of Torts: Products Liability, Section 5 (1998), provides:

One engaged in the business of selling or otherwise distributing product components who sells or distributes a component is subject to liability for harm to persons or property caused by a product into which the component is integrated if:

- (a) the component is defective in itself, as defined in this Chapter, and the defect causes the harm; or
- (b)
 - (1) the seller or distributor of the component substantially participates in the integration of the component into the design of the product; and
 - (2) the integration of the component causes the product to be defective, as defined in this Chapter; and
 - (3) the defect in the product causes the harm.

Thus, the manufacturer of a component may be held liable for damage caused by another component or raw material when the use of the subject component renders the other component or raw material harmful. An in-depth discussion of this exception is seen in *Olivares v. Morehouse-Cowles*, 2014 WL 1571766 (Cal. App. 2d 2014), where the defendant manufactured a commercial mixing machine designed to mix chemicals used to produce electrical insulation.

To summarize, the complaint alleges defendants' machines were "specifically designed" for the "sole purpose" of mixing chemical "ingredients [used] for the manufacture of [electrical insulation]." The complaint further alleges that although these "ingredients . . . , in and of themselves, were harmless," the "operation of defendant[s]' mixing machines: caused the chemical ingredients to emit respirable, toxic particles that substantially contributed to Olivares's lung cancer.

Id. at *7. The court reversed judgment on the pleadings, holding that the complaint adequately stated a claim for strict liability and negligence. *Id.*

Similarly, in *Tellez-Cordova v. Campbell-Hausfeld / ScottFetzer Co.*, 129 Cal. App. 4th 577, 28 Cal.Rptr.3d 744 (2004), the court reversed dismissal of the plaintiff's complaint against a tool manufacturer. The defendant manufactured a grinding tool designed to be used with abrasive wheels, discs, and belts; the defendant did not manufacture the accessory wheels, discs or belts themselves. The plaintiff allegedly contracted lung disease from inhaling "harmful respirable metallic dust" created from disintegration of the wheels, discs and belts used with the defendant's tools. *Id.* at 747. The court noted that "respondents' tools, when used as intended, caused toxic particles to be released from the otherwise harmless wheels and discs." *Id.* at 751. See also *Komanekin by Hausmann v. Inland Truck Parts*, 819 F. Supp. 802 (E.D. Wisc. 1993) (when a component is incorporated into a larger product, contributing to dangerousness of product, the seller of component is liable under Wisconsin law for

App. 79

injury caused by that danger unless the component was made dangerous through further processing or substantial change).

In addition, the manufacturer of a component part may be held liable for the product or system into which it was integrated if the component manufacturer “substantially participated” in the design of the integrated system. Comment (e) to the Restatement (Third) of Torts: Products Liability, Section 5 (1998), explains:

Substantial participation in the integration of the component into the design of another product. When the component seller is substantially involved in the integration of the component into the design of the integrated product, the component seller is subject to liability when the integration results in a defective product and the defect causes harm to the plaintiff. Substantial participation can take various forms. The manufacturer or assembler of the integrated product may invite the component seller to design a component that will perform specifically as part of the integrated product or to assist in modifying the design of the integrated product to accept the seller’s component. Or the component seller may play a substantial role in deciding which component best serves the requirements of the integrated product. When the component seller substantially participates in the design of the integrated product, it *916 is fair and reasonable to hold the component seller responsible for harm caused by the defective, integrated

product. A component seller who simply designs a component to its buyer's specifications, and does not substantially participate in the integration of the component into the design of the product, is not liable within the meaning of Subsection (b). Moreover, providing mechanical or technical services or advice concerning a component part does not, by itself, constitute substantial participation that would subject the component supplier to liability.

See also *Gudmundson v. Del Ozone*, 232 P.3d 1059 (Utah 2010).

Discovery is ongoing and Plaintiffs have not yet deposed FCC to examine its knowledge and participation in the design process. This has only arisen as an issue upon the filing of FCC's Motion for Summary Judgment. Plaintiffs are entitled to investigate the extent to which FCC participated in the design of the Environmental Control System of the subject aircraft. At this point in the litigation, FCC cannot avoid liability under the component parts doctrine. Summary judgment on Plaintiffs' design defect claim should be denied.

B. Genuine Issues of Material Fact Regarding Failure to Warn Claims

The only two issues FCC raises with respect to Plaintiffs' failure to warn claims are easily contradicted by the evidence available to the Court.

First, as Plaintiffs have established above, they have evidence from which it can be concluded that the ACM manufactured by FCC was defective. As will be further shown through discovery, FCC had knowledge

of this defect (Plaintiffs expert explained, both the original ACM and the ACM overhauled by Fairchild had evidence of oil leakage, Ex. 3, Ex. A) The genuine issues of material fact associated with this defect prevent summary judgment on Plaintiffs' failure to warn claims.

In addition, **there is no evidence that Plaintiffs were aware of the substantial danger associated with the fume events which they were experiencing or were in a position to fully understand and appreciate these risks** such that they had a duty to avoid them. (Ex. 1, 31:24-326; Ex. 2, 68). In order for this to be true, Plaintiffs must have not only known about the potential exposure to engine fumes, but must also have known that these fumes contained a chemical in sufficient amounts to cause them permanent harm. There is no evidence that either Mr. Farmer or Mr. Davidson possessed such knowledge of the amount of harmful chemicals they would be exposed to or the scope of the risk those chemicals presented. They were asked by their employer (who also believed the aircraft was safe) to fly the aircraft, and they did. (Ex. 7, 13:13-23) In fact, it was Mr. Davidson's first time in that particular aircraft. (Ex. 2, 68:1-5). He had heard that some pilots had smelled odors in the plane, but he did not know anything more and was not concerned about riding aboard the aircraft. (Ex. 2, 68:11-22)

At any rate, whether or not a plaintiff caused or contributed to his own injury is a question of comparative fault which is generally a question for the trier of fact. *Allen v. Echols*, 931 N.Y.S.2d 402, 403 (N.Y. App. Div. 2011). New York courts have described

decisions as to a lack of reasonable care and its nexus to a plaintiff's injury as "quintessential jury questions." *Lombard v. Booz-Allen & Hamilton, Inc.*, 280 F.3d 209, 215-16 (2d Cir. 2002). **The cases cited by FCC are distinguishable.** In the primary case it cites, the court's opinion was based on the fact that the plaintiff was using a product that was inherently dangerous (a saw without a blade guard), the product had labels which communicated its dangerous nature, and the product's instruction manual also communicated this hazard. *Banks v. Makita*, 641 N.Y.S.2d 875, 876-877. FCC also cited *Burke v. Spartanics, Ltd.*, 252 F.3d 131, 140 (2d Cir. 2001) which arose as an appeal after a verdict on the merits, not a motion for summary judgment.

FCC has merely raised another issue which is genuinely disputed by the facts that have been developed thus far in this litigation. These genuinely disputed facts are material to Plaintiffs' nonpreempted failure to warn claims, so summary judgment must be denied.

CONCLUSION

Considering the above and foregoing, FCC's Motion for Summary Judgment (ECF Nos. 227, et seq.). There are numerous statutory indications that Congress intended for state-based products liability claims to survive the FAA and subsequent enactments relative to aviation. So, Plaintiffs claims, which are properly supported by the evidence attached hereto, are not preempted by federal law.

App. 83

RESPECTFULLY SUBMITTED,

By: ***S/Michael C. Palmintier***

MICHAEL C. PALMINTIER (#10288)

JONATHAN E. MITCHELL (#33284)

deGravelles, Palmintier, Holthaus & Fruge, L.L.P.

618 Main Street

Baton Rouge, Louisiana 70801

Telephone: (225) 344-3735

Mpalmintier@dphf-law.com

Attorneys for Plaintiffs

App. 84

APPENDIX E

FOIL AIR/GAS BEARING TECHNOLOGY ~AN
OVERVIEW

EXCERPT OF EXPERT REPORT/REVIEW OF
IN-FLIGHT CABIN FUME-AIR INCIDENT

See Fold-Out Exhibit

The AMERICAN SOCIETY OF MECHANICAL ENGINEERS
345 E. 47th St., New York, NY 10017
Publication 97-GT-347

FOIL AIR/GAS BEARING TECHNOLOGY ~ AN OVERVIEW

Giri L. Agrawal
R&D Dynamics Corporation
Bloomfield, CT 06002

ABSTRACT

This paper summarizes the chronological progress of foil air bearings for turbomachinery during the last 25 years. Descriptions of various machines which are in production are provided. The foil bearing air cycle machine on the 747 aircraft has demonstrated an MTBF (mean time between failure) in excess of 100,000 hours. Many advantages of foil air bearings are noted. Various designs of foil air bearings presently in use and their relative merits are described. Analytical methods, their limitations, and their relationships with test results are noted. Descriptions of various machines built and tested in process fluids being gases, other than air, and cryogenic liquids are described. Conclusions are drawn that various high speed turbomachines including high temperature applications can be designed and developed using foil air bearings which will increase efficiency and reduce cost of these machines.

INTRODUCTION

Foil air bearings have made significant progress during the last 25 years. Reliability of many high speed turbomachines with foil bearings has increased over tenfold compared to those with rolling element bearings. A high speed rotating machine called Air Cycle Machine (ACM) is the heart of the Environmental Control System (ECS) used on aircraft to manage cooling, heating and pressurization of the aircraft. Today, ACM for almost every new ECS system on military and civil aircraft and on many ground vehicles use foil air bearings. Old ECS systems with rolling element bearings are being converted to foil air bearings. The F-16 aircraft ACM used rolling element bearings from 1974 to 1982, but all aircraft built since 1982 use foil air bearings. The 747 aircraft ACM used rolling element bearings from 1970 to 1988. All aircraft

built since 1988 have foil air bearings. ECS on the older model 737 aircraft have rolling element bearings, whereas ECS on new 737 use foil air bearings. Many machines with working fluids other than air, such as helium, xenon, refrigerants, liquid oxygen and liquid nitrogen, have been built and successfully tested.

WHY FOIL BEARINGS?

The use of foil bearings in turbomachinery has several advantages.

Higher Reliability - Foil bearing machines are more reliable because there are fewer parts necessary to support the rotative assembly and there is no lubrication needed to feed the system. When the machine is in operation, the air/gas film between the bearing and the shaft protects the bearing foils from wear. The bearing surface is in contact with the shaft only when the machine starts and stops. During this time, a coating on the foils limits the wear.

No Scheduled Maintenance - Since there is no oil lubrication system in machines that use foil bearings, there is never a need to check and replace the lubricant. This results in lower operating costs.

Soft Failure - Because of the low clearances and tolerances inherent in foil bearing design and assembly, if a bearing failure does occur, the bearing foils restrain the shaft assembly from excessive movement. As a result, the damage is most often confined to the bearings and shaft surfaces. The shaft may be used as is or can be repaired. Damage to the other hardware, if any, is minimal and repairable during overhaul.

Environmental Durability - Foil bearings can handle severe environmental conditions such as sand and dust ingestion. Larger

particles do not enter into the bearing flow path because of a reversed pitot design at the cooling flow inlet and smaller particles are continually flushed out of the bearings by the cooling flow. This ability to withstand contamination eliminates the need for filters in the airflow.

High Speed Operation - Compressor and turbine rotors have better aerodynamic efficiency at higher speeds. Foil bearings allow these machines to operate at the higher speeds without any limitation as with ball bearings. In fact, due to the hydrodynamic action, they have a higher load capacity as the speed increases.

Low and High Temperature Capabilities - Many oil lubricants cannot operate at very high temperatures without breaking down. At low temperature, oil lubricants can become too viscous to operate effectively. Foil bearings, however, operate efficiently at severely high temperatures, as well as at cryogenic temperatures.

Process Fluid Operations - Foil bearings have been operated in process fluids other than air such as helium, xenon, refrigerants, liquid oxygen and liquid nitrogen. For applications in vapor cycles, the refrigerant can be used to cool and support the foil bearings without the need for oil lubricants that can contaminate the system and reduce efficiency.

HISTORY

Garrett AiResearch (now Allied Signal) has done the pioneering work on foil air bearings. Several laboratory and prototype machines were built in the mid 60's. The first production ACM using foil air bearings was designed and developed for the DC-10 ECS system in 1969. Field experience proved that the unit was far more reliable than previous 727 ball bearing units. Further research and laboratory testing to increase load capacity and damping continued. In 1972, a 125 kw turbo-alternator-compressor (TAC) supported on foil bearings was built by AiResearch for NASA Lewis, which worked well. In 1974, under pressure from the Navy to increase the reliability of the A7E air cycle machine, AiResearch converted existing ball bearing machines to foil bearing machines on three A7E aircraft. These aircraft were flown by the Navy off the Coral Sea during the Vietnam War for evacuation of Americans from South Vietnam. These units worked extremely well and proved to be much more reliable than previous ball bearing units. As a result, after Vietnam was over, the Navy gave a contract to AiResearch to convert the entire fleet of A7E to foil bearing units. This program gave high confidence to AiResearch management in foil bearing technology even for a military aircraft. In 1976, when the F-18 program was launched by Northrop, AiResearch decided to proceed with foil air bearings from the start. The unit successfully passed vibration and shock load testing. This was the first military unit with foil air bearings to go into production.

In 1978, AiResearch developed a small foil air bearing supported ACM for the commuter plane Cessna-550. This unit since then is also used on other aircraft e.g. EMB-120, ATR-42, ATR-72 and others. In 1979, a new commercial aircraft 767/757 was launched by Boeing. By now the success of foil air bearings was well known; hence Boeing required that ECS on 767/757 use foil air bearings. AiResearch successfully developed a foil air bearing supported ACM for 767/757. Based on the successful testing, they won the contract and went into production. In 1979

AiResearch developed a foil air bearings supported ACM for Navy F-14 aircraft which was also flight tested on Air Force F-15 aircraft with some modifications. Later AiResearch, by making necessary modifications, used existing machines on various other ECS systems. They also developed a small foil air bearing supported machine for the M-1 tank.

While substantial advancement in foil air bearing technology was being made by AiResearch in the 70's, their competitor Hamilton Standard started lagging behind in ECS business. At the same time, Mechanical Technology Inc. (MTI), a research and development company, came up with their own concept of a foil bearing design called Hydresil. Hamilton signed a contract with MTI to use Hydresil bearings. Hydresil had comparable load capacity, but had low damping. Several ACM with Hydresil bearings were flight tested by Hamilton on 747 aircraft from 1975 to 1979. During flight testing those units lasted only four hours to fifty hours. In 1979, Hamilton launched their own program for foil bearing research. They came up with their own design concept and patented it. In 1982, Hamilton successfully flight tested a foil bearing ACM based on their own foil bearing design on F-16 aircraft. The same machine with minor changes went into production for B-1B aircraft and B-2 aircraft. Later the same machine was successfully flight tested on two F-18 aircraft. Based on successful flight test experience, the Navy qualified the machine for the F-18 without formal qualification testing. Hamilton also developed, qualified and produced a machine for L-1011 aircraft. Under pressure from various airlines, Boeing adopted the same machine with some changes for 747-400 aircraft which went into production in 1988. This machine has shown MTBF (mean time between failure) of over 100,000 hours. Between 1983 and 1988, Hamilton developed several other prototype machines supported on foil air bearings. In 1991, Hamilton developed, qualified and started producing a machine for SAAB 2000 aircraft. The same machine is being used for EMB-145 aircraft.

In 1993, Hamilton developed, qualified and started producing the world's first four-wheel ACM supported on foil air bearings for 777 aircraft. The unit passed 36,000 start-stop cycle to simulate a 30 year life.

Various other companies such as Sunstrand, British Aerospace, ABG-Semca (France) and Tupolev (Russia) have done limited work on foil air bearing technology.

FOIL BEARING TECHNOLOGY

The principle of an air or gas bearing is simple. As shown in Fig. 1, when two surfaces form a wedge, and one surface moves relative to the other surface, pressure is generated between the surfaces due to the hydrodynamic action of the fluid which carries load.

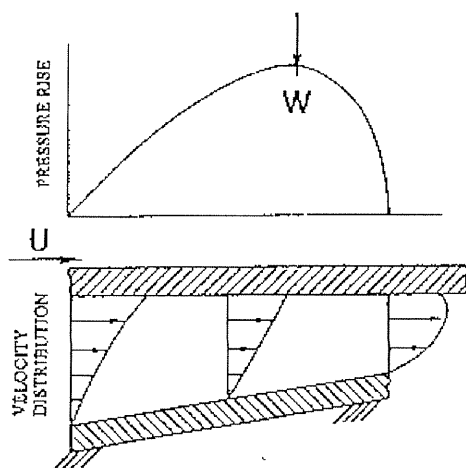


Fig. 1: Principle of an Air Bearing

Journal Bearing

In a journal bearing, the shaft deflects and a wedge is formed due to the eccentricity between the shaft center and the bearing center. The resulting hydrodynamic pressure generation is shown in Fig. 2. Even though, the principle of an air bearing is simple, application is complex. Usually running radial clearance between the shaft and the bearing is less than 0.0005 inch for a 2 inch diameter shaft running at 36,000 rpm. But the shaft growth due to temperature and centrifugal force could be 0.0020 in. Hence a bearing can not be made to work at various speeds and temperatures. In addition, damping is required to suppress any whirl instability, and there could be misalignment between various rotating parts and stationary parts. These problems are resolved by foil bearings. While stationary, there is a small amount of preload between the shaft and the bearing. As the shaft turns, a hydrodynamic pressure is generated, which pushes the foils away from the shaft and the shaft becomes completely airborne. This phenomenon occurs instantly during start-up at a very low speed. When the shaft is airborne, friction loss due to shaft rotation is very small. As the shaft grows, the foils get pushed further away keeping the film clearance relatively constant. In addition, foils provide coulomb damping due to relative sliding, which is essential for stability of the machine. Various concepts of foil bearings have been tested.

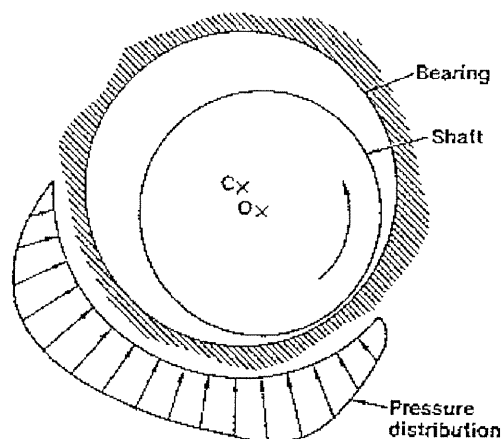


Fig. 2: Hydrodynamic Pressure Generation

The Multipad concept is shown in Fig. 3, which has been pursued by AiResearch since the days of the DC-10. Multiple pads form an iris and provide a preload when the shaft is not running. During starting, the iris expands and a cushion of air is formed between the bearing and the shaft. Later versions such as for 767/757 have a supportive spring behind each pad which increases the load capacity significantly. The top foil is coated with Teflon-S or a polyimide coating to provide lubricity during starts and stops.

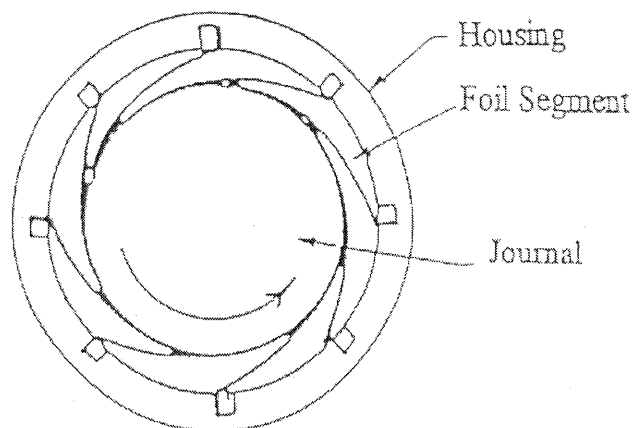


Fig. 3: Multipad Foil Journal Bearing Schematic

Figure 4 is a Reversed Multilayer journal bearing concept which has been pursued by Hamilton Standard in 747, B-1B, B-2, SAAB-2000, 777 and other aircraft. The single corrugated (bump) foil which has a bilinear spring characteristic is restrained in an axial keyway in the outer shell along one edge. The intermediate and top foils are attached to a key along one edge and are wound in opposite directions. The top foil has a thin coating which provides lubricity during startup and shutdown. As the shaft rotates, a wedge is formed due to the radial displacements of the shaft. Hydrodynamic action draws the working gas into the wedge where it is locally compressed. The corrugated foil acts as a spring which accommodates expansion, excursions and any misalignment. It also provides a flow path for the cooling air to remove parasitic heat from the bearing. In the Reversed Multilayer foil bearing, the adjacent foils move in opposite directions. The net result is that relative movement is additive, which in turn produces high coulomb damping.

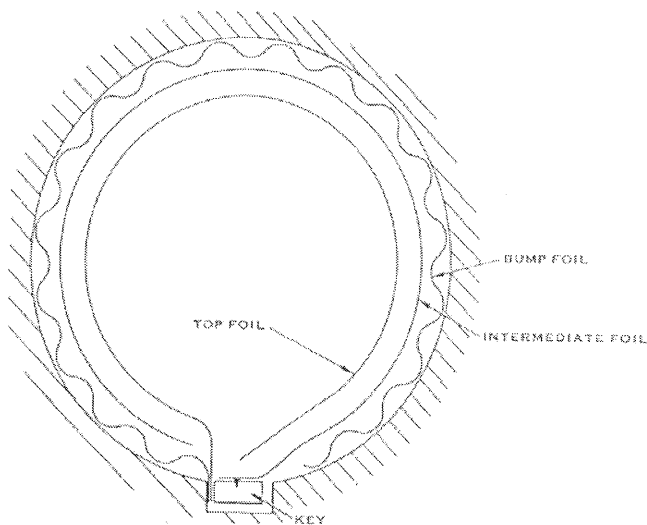


Fig. 4: Reversed Multilayer Foil Journal Bearing Schematic

Figure 5 is a Hydresil foil journal bearing. It has been pursued by Mechanical Technology Inc. (MTI). Both the bump foil and the foil are spot welded to the sleeve. Various versions have been patented. The load capacity of the Hydresil is comparable to the Multipad or Reversed Multilayer foil bearing, but it has low damping.

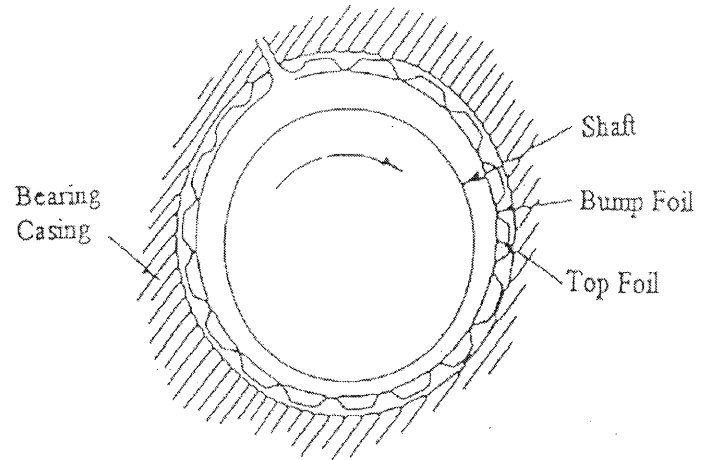


Fig. 5: Hydresil Foil Journal Bearing Schematic

The damping characteristic of three types of bearings is shown in Fig. 6, where orbits are shown when 27 lbs. of shock load is applied to a 2 inch diameter shaft rotating at 36,000 rpm. It is obvious that the Reversed Multilayer concept is the most stable and it is least affected by shock loads.

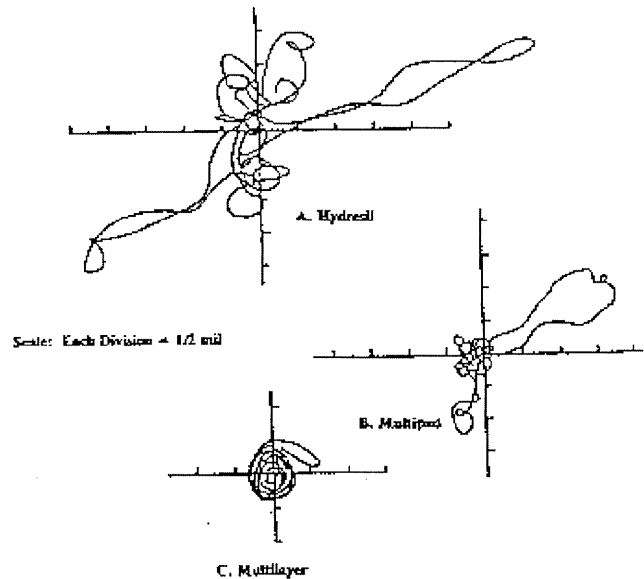


Fig. 6: Orbits of Various Foil Journal Bearings under 27 lbs. of Shock Load

Even though Reversed Multilayer concept has high damping, the foils have a tendency to protrude like a telescope during assembly. In addition, manufacturing is costly because all bends

near the keyway have tight tolerances. A new concept called Reversed Multipad shown in Fig. 7 has been patented by R&D Dynamics Corporation. It has benefits of both Multipad and Reversed Multilayer designs. It has high damping as well as it requires low preload. Lower preload makes the machine start at a lower torque. Due to multipad design, the tolerances are not tight.

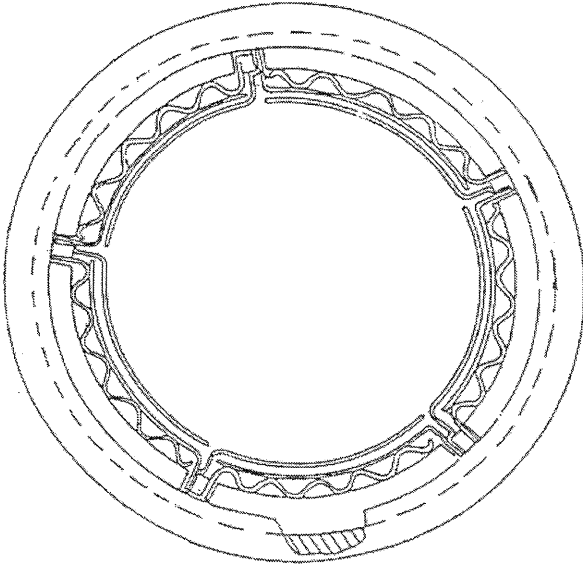


Fig. 7: Reversed Multipad Foil Journal Bearing Schematic

Thrust Bearings

Thrust bearings withstand axial loads in a rotating machinery. They work on the same hydrodynamic principle as journal bearings shown in Fig. 1. In a journal bearing the wedge action comes from eccentricity between the center of the rotating shaft and the center of the bearing itself, whereas in a thrust bearing the wedge is built in taking into account any deflection due the axial load.

A radial spring type thrust bearing is shown in Fig. 8. It was invented by AiResearch and has been followed since 1970 when first used for the DC-10. There are multiple radial springs which transfer the load to the housing. Foils between the springs deflect under pressure forming the wedge required for the hydrodynamic action. During the last 20 years many versions of the same design, usually for the manufacturing reasons mostly by AiResearch, have been used. In some designs instead of a separate spring being spot welded to the main bearing plate, it is formed by chemical etching out of the bearing plate. It reduces manufacturing cost, but somewhat compromises performance in some instances.

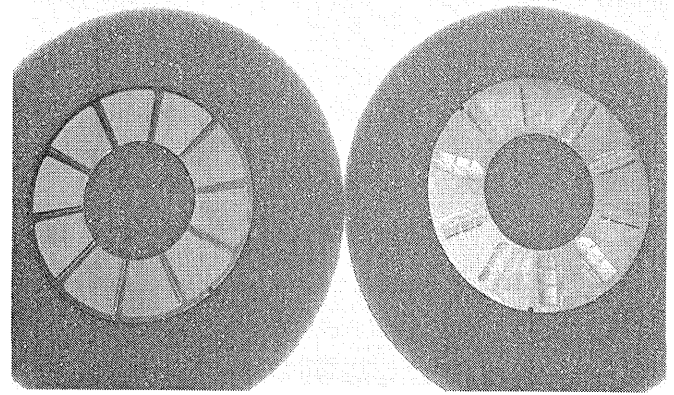


Fig. 8: Radial Spring Foil Thrust Bearing

A dual spring thrust bearing is shown in Fig. 9. It was invented by Hamilton Standard. In this concept the bearing consists of two washer shaped plates similar to radial spring bearings. The coated pads, welded to the top plate, are supported on stiff bump foil springs to optimize the wedge shape required for load capacity and lift-off. The bottom plate has several softer bump foil springs welded to it, required to optimize the overall spring rate and damping of the bearing. The dual spring rate thrust bearings have approximately 15% higher load capacity than the radial spring bearings, but they are more expensive to manufacture.

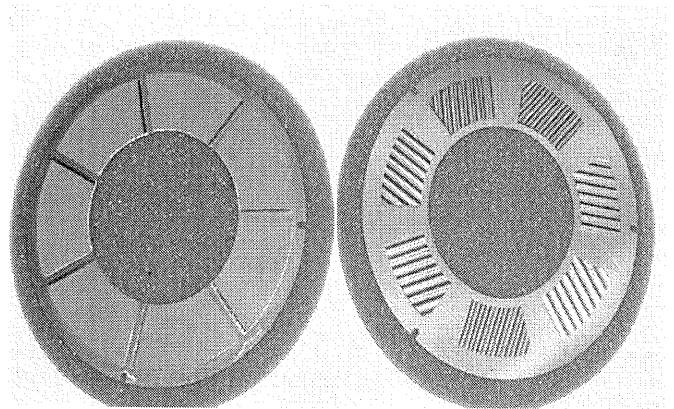


Fig. 9: Dual Spring Foil Thrust Bearing

Coatings

Both journal and thrust bearings apply a small amount of preload on the shaft when the machine is not running. The foil face which is touching the shaft is coated for lubricity during startup and shutdown. A typical DC-10, machine which runs at 48,000 rpm, is fully airborne at about 2,000 rpm. Several foil coatings are used. Most commercial aircraft use Teflon-S made by DuPont which is

good up to 475°F. Most military aircraft ACM use a polyimide coating, whose basic research was performed by NASA Lewis. Both AiResearch and Hamilton have modified the basic formula and the application process to suit their needs. The coating is good up to 700°F. Extensive high temperature coating research has been performed, mostly by NASA Lewis, Air Force Wright Laboratory, AiResearch (Phoenix Division) and Mechanical Technology Inc. A partial list of various coatings, which have been considered, is given below:

<u>Coating</u>	<u>Process</u>
FOIL:	
BN/Pt, BN/Pd	Electrophoretic Deposition
BN/Pt	Chemical Vapor Infiltration
BN/SiO ₂ , BN/ZrO ₂	Sol Gel
BN/Ni-Cr, ZrO ₂ /Ni-Cr	Mechanical Alloying
BN/Ni	Electroless Deposition
Cr ₂ O ₃	Sputtering
TiC	Sputtering
Al ₂ O ₃	Sputtering
TiN	Sputtering
Tribaloy-400	Sputtering
JOURNAL:	
NASA PS212	Plasma Spray
KAMAN DES	Chemically Adherent
TiAlN/TiAl	Sputtering
WC-9Co	D-Gun
Cr ₂ O ₃ -40Cr	D-Gun

Analysis and Testing

The analysis of foil air bearings requires simultaneous solutions or iteration methods to solve foil elasticity equations and fluid hydrodynamic equations. Foil elasticity equations are nonlinear and involves large deformation theory. A foil can deform as much as five times its own thickness. Hence most finite element or finite difference methods, do not provide satisfactory results. Hydrodynamic equations are nonlinear Reynolds' equations with continuously changing boundary conditions. Many papers analyzing foil bearings have been published. In some papers, predicted results vary as much as 500% from the actual test results. What seems to work and provide reasonable results are semi-empirical methods. Sufficient test data are collected by varying geometrical parameters and test parameters of the bearing. Results are correlated using a multiple regression method. Then a model is prepared using coefficients of the multiple regression analysis. Hydrodynamic equations are solved using the preferred final geometry. Then an inverse method is used to design the foil geometry in the unloaded position. In the above described procedure, the complex problem is decoupled into many simple problems using both analytical methods and the test results.

The above described approach has been used both by AiResearch (Los Angeles) and Hamilton Standard to design and develop successfully many foil air bearing machines which are flying today. Others have taken more conventional approach and have not succeeded. Design of the machine parameters such as static and dynamic loads, critical speed, thrust loads, rotor clearance, seals, cooling flow etc. must be correlated with the design of the foil air bearings.

A satisfactory design method requires reliable test data. Successful test rigs to test journal bearings, thrust bearings and coatings have been designed and developed. Typical rigs presently being used at R&D Dynamics Corporation are shown in Figs. 10, 11 and 12.

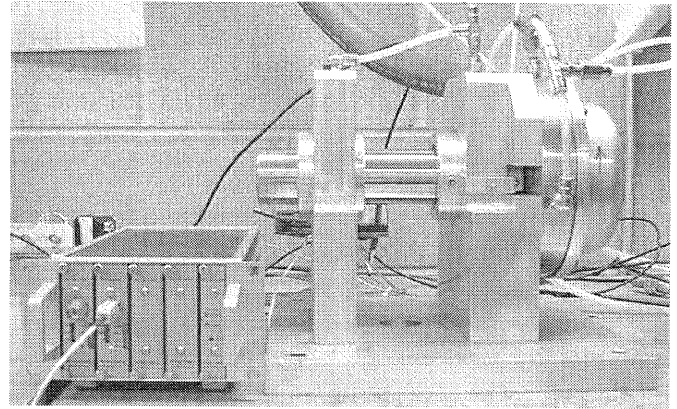


Fig. 10: Journal Bearing Test Rig
(R&D Dynamics Corp.)

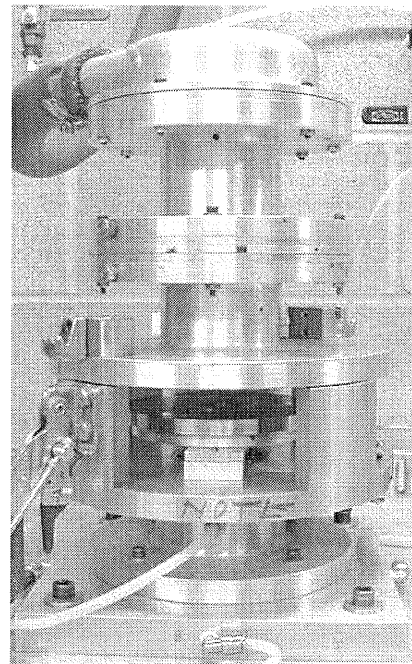


Fig. 11: Thrust Bearing Test Rig
(R&D Dynamics Corp.)

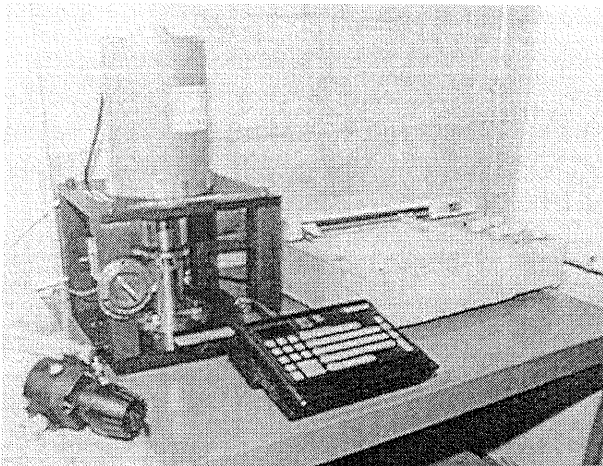


Fig. 12: Coating Wear Test Rig
(R&D Dynamics Corp.)

APPLICATIONS

DC-10 - The DC-10 was the first production foil air bearing machine. It was designed and developed by AiResearch and went into production in 1970. The same machine is also used for Airbus A-300. A photograph of the machine is shown in Fig. 13. The rotating assembly has three rotors: a turbine, a compressor and a fan. The machine runs at 48,000 rpm. To date, over 80 million hours have been accumulated on this machine.

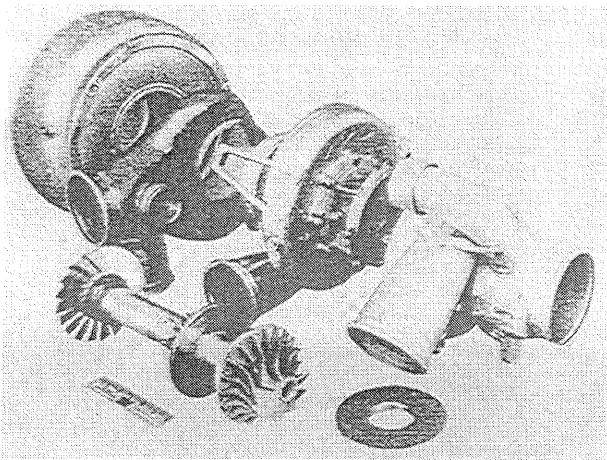


Fig. 13: DC-10 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

F-18 - The F-18 is the first military production machine after successful modifications of the A7E machine from ball bearings to air bearings. The F-18 machine was designed and developed by AiResearch in 1976. A cross section of the machine is shown in Fig. 14. It has two rotors: a turbine and a compressor. The machine runs at about 95,000 rpm.

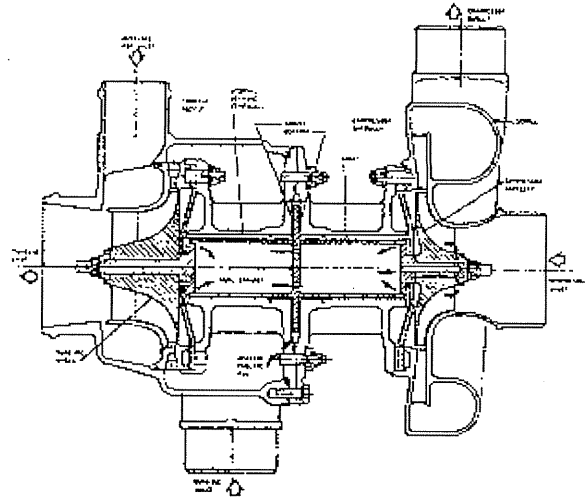


Fig. 14: F-18 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

Cessna-550 - In 1977 AiResearch developed a small two-wheel air cycle machine for commuter aircraft such as the Cessna-550. The machine is shown in Fig. 15. It runs at 105,000 rpm. The same machine is being used for EMB-120, ATR-42 and ATR-72 aircraft with minor modifications.

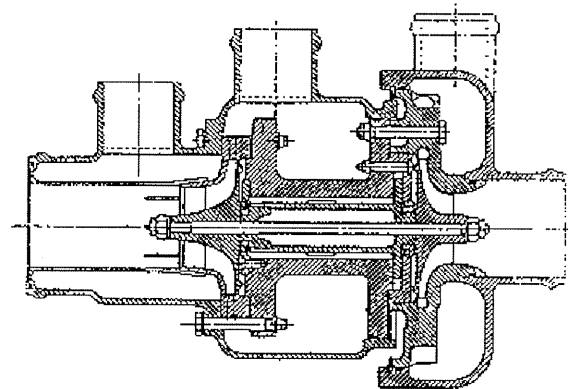


Fig. 15: Cessna-550 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

F-15/F-14 - Following success of the F-18, AiResearch developed a slightly larger two-wheel air cycle machine for F-15 aircraft in 1977. The same machine with slight modifications was used for F-14 aircraft in 1978. Photograph of F-14 machine is shown in Fig. 16.

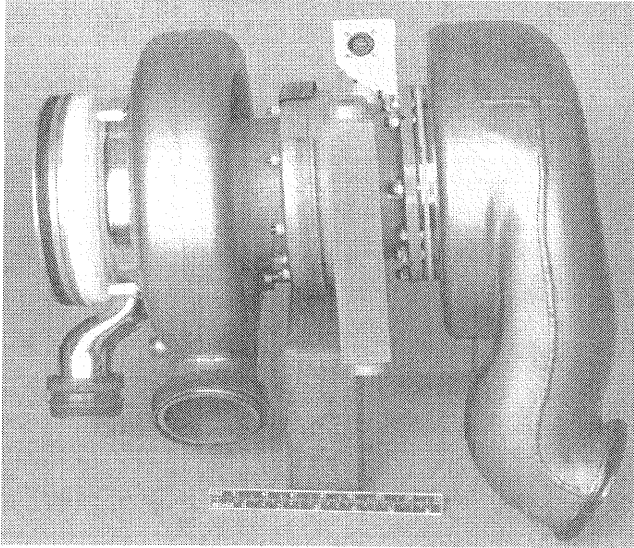


Fig. 16: F-14 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

767/757 - The 767/757 aircraft was launched by Boeing in 1979. Knowing the success of DC-10 ACM, Boeing required that 767/757 ACM must have foil air bearings. This was the first aircraft where the customer required a foil bearing ACM. Cross section of the machine developed by AiResearch is shown in Fig. 17. It is also a three-wheel machine like the DC-10, but the design is much simpler.

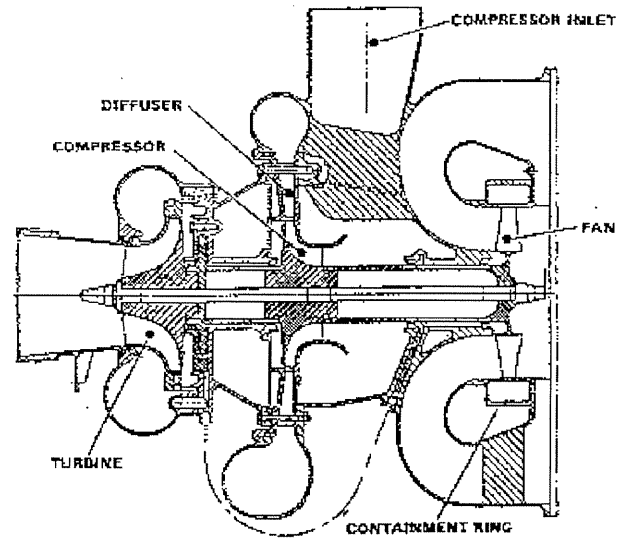


Fig. 17: 767/757 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

F-16 - The F-16 aircraft is built by General Dynamics. Its production was started in 1974. An air cycle machine with a ball bearing design was built by Hamilton Standard. In 1982, due to additional electronics on the aircraft, the Air Force required a new air cycle machine. AiResearch modified the existing F-18 machine and qualified for F-16 aircraft, which is now in production. A photo of the F-16 ACM is shown in Fig. 18.

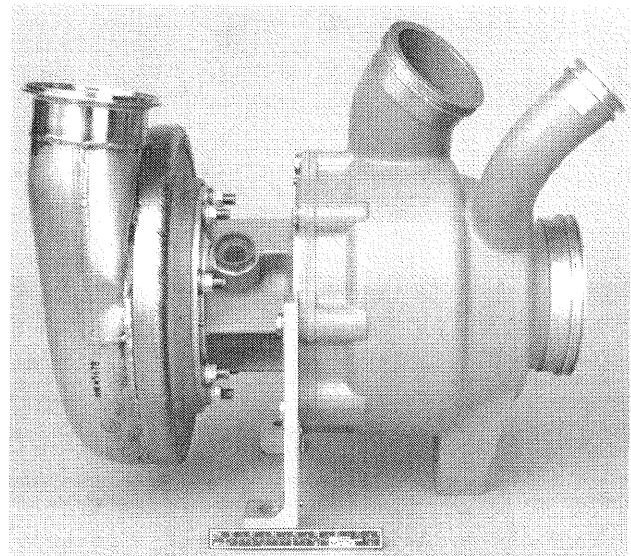


Fig. 18: F-16 Foil Bearing Air Cycle Machine
(Developed by AiResearch)

M1A1 - AiResearch also developed a foil air bearing air cycle machine for the M1A1 tank environmental control system. The machine has a turbine and a fan on a common shaft. The machine worked well during the last Gulf War in spite of heavy sand and dust in the desert. The machine is shown in Fig. 19.

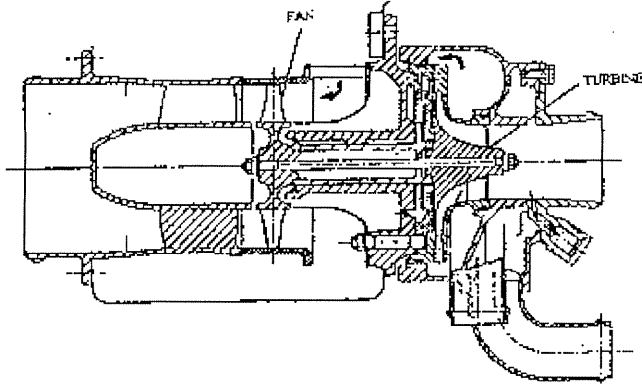


Fig. 19: M1A1 Tank Foil Bearing Air Cycle Machine
(Developed by AiResearch)

L-1011 - The L-1011 machine was the first production foil bearing machine produced by Hamilton Standard. As can be seen in Fig. 20, it is a three-wheel machine with fan, compressor and turbine rotors. These ACMs were placed on the last five production L-1011 aircraft and have been performing well. Figure 21 shows an L-1011 flight test unit that was returned for inspection after 13,000 hours of service at Saudia. The unit was in excellent working condition despite being heavily contaminated by sand, cement and oil. This shows the ability of the foil bearings to operate in severe environmental conditions.

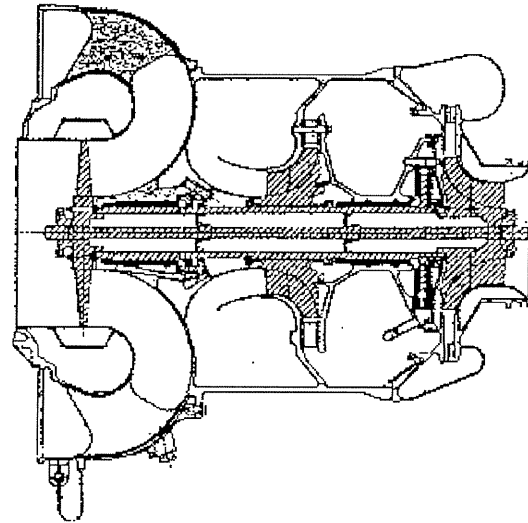


Fig. 20: L-1011 Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

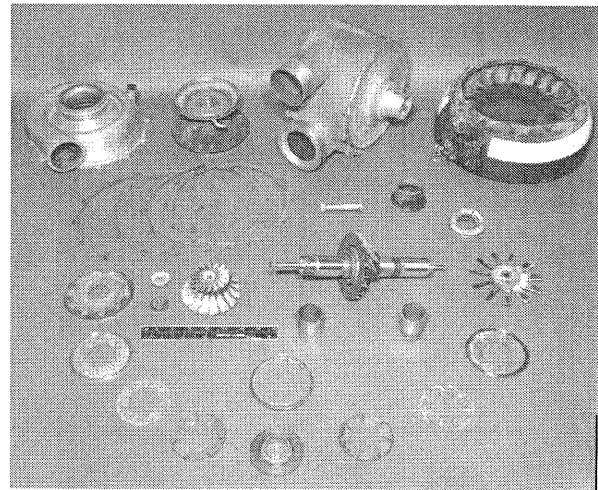


Fig. 21: L-1011 Foil Bearing Air Cycle Machine
After 13,000 Hours in Saudia Aircraft

747 - Hamilton Standard supplies the ECS on the 747 aircraft. Aircraft production started in 1970. Air cycle machines on all aircraft built until 1987 are ball bearing units. Under pressure from the airlines, Boeing and Hamilton Standard decided to change the ECS system to incorporate foil air bearing ACMs. All 747 aircraft built since 1988 have foil bearing ACMs. Over 1000 machines are flying successfully. These machines are performing well in the field, and to date, over 12 million flight hours have been accumulated. The machine has shown an MTBF (mean time between failure) of over 100,000 hours in the field. A photograph of the 747 machine is shown in Fig. 22.

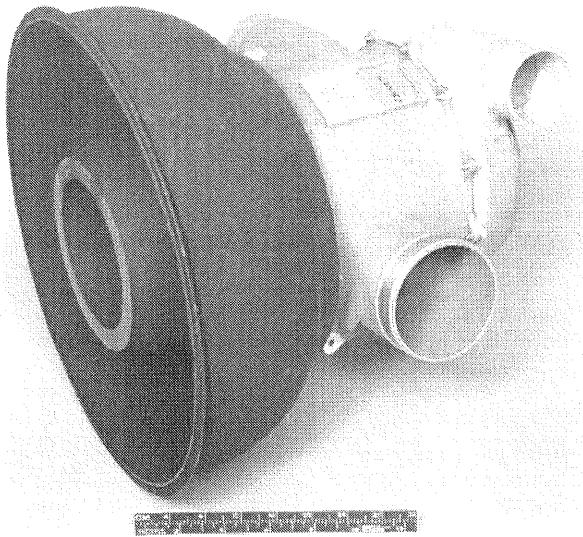


Fig. 22: 747 Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

B-1B - The foil bearing machine shown in Fig. 23 was developed for use on the B-1B aircraft by Hamilton Standard. The unit runs at 95,000 rpm. To date, this two-wheel foil bearing machine has logged over 120,000 flight hours. One hundred production units and thirty spares were delivered for use on this long range bomber.

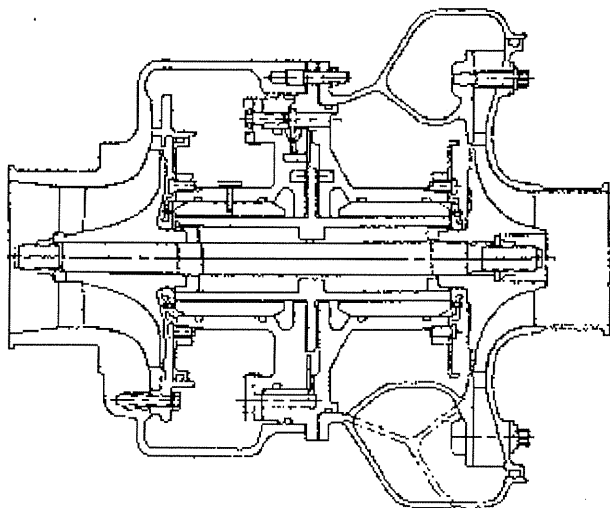


Fig. 23: B-1B Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

B-2 - Hamilton Standard builds the ECS system on the Air Force B-2 Stealth bomber. The system contains a high speed foil air bearing supported ACM. The B-2 ACM, shown in Fig. 24, completed a rigorous qualification program in 1989. After one test that included 7500 start/stop cycles, the bearings were inspected and found to be in like-new condition. The hardware for this machine is shown in Fig. 25. Another test included 1600 hours of endurance running. These tests show the durability of the foil bearings. Many B-2 aircraft are flying successfully using foil air bearing ACMs.

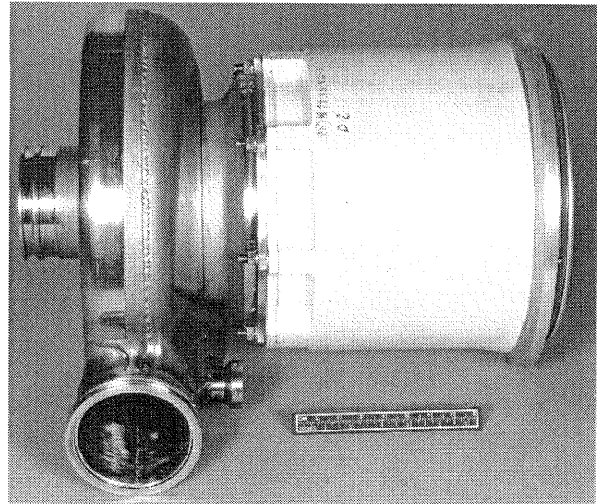


Fig. 24: B-2 Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

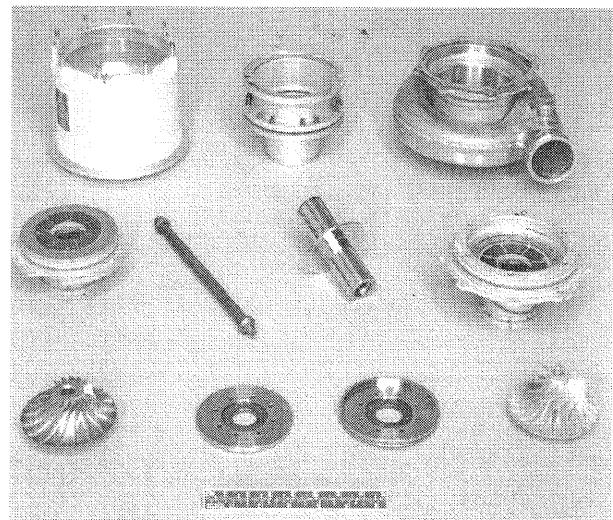


Fig. 25: B-2 Foil Bearing Air Cycle Machine After 7,500 Start-Stops

SAAB-2000 - Hamilton Standard has designed, developed and qualified a midsize foil air bearing ACM for use on SAAB-2000 commuter aircraft. Many aircraft with these units are flying successfully. Shown in Fig. 26, this three-wheel machine will also be used on other large commuter aircraft.

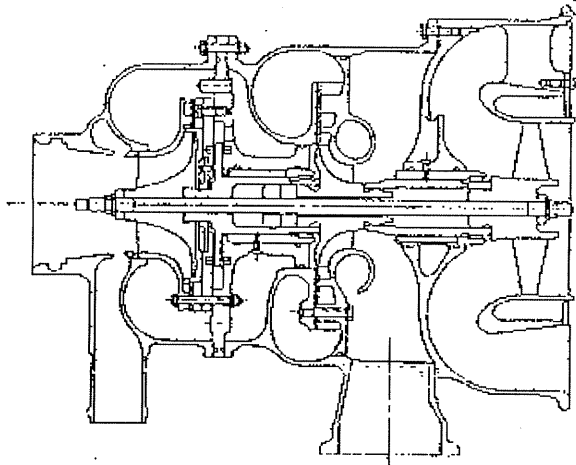


Fig. 26: SAAB-2000 Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

777 - Hamilton Standard has developed and qualified an ECS system on the latest Boeing aircraft 777. The system uses the world's first four-wheel air bearing ACM. All of the previous machines are either two-wheel or three-wheel machines. The unit has successfully passed 36,000 start-stop cycles, which is equivalent to 30 years life of the machines. Many 777 aircraft are flying with production ACMs. Approximately 300 aircraft have already been sold and will be delivered in the near future. A cross section of the ACM is shown in Fig. 27.

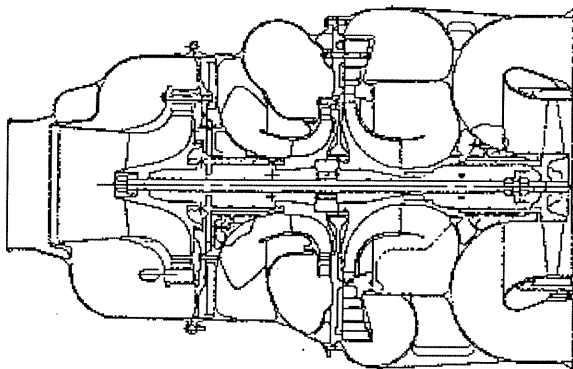


Fig. 27: 777 Foil Bearing Air Cycle Machine
(Developed by Hamilton Standard)

ADDITIONAL APPLICATIONS

Many applications of foil air/gas bearings other than air cycle machines have been built and successfully tested, but nothing appears to be in production at this time. AiResearch successfully tested a vapor cycle machine on Navy P-3 aircraft with Freon as the working fluid. A machine similar to this will be built for F-22 aircraft. A cryogenic foil bearing turbo pump working in liquid oxygen was built by AiResearch and successfully tested by NASA. Both AiResearch and Hamilton Standard have built foil bearing high speed fans for the Space Station. Several cryogenic foil bearing turboexpanders for air separation plants for the Navy have been built. AiResearch built a high temperature foil bearing APU (Auxiliary Power Unit) for B-2 aircraft in 1985. The unit ran successfully, but could not pass the endurance test. It was concluded that coating wear at high temperature was the cause. Since then much research has been done in the areas of foil coating and bearing design. Recently R&D Dynamics jointly with Allison Engine Company built a missile engine with a hot end foil bearing good up to 1000°F.

CONCLUSIONS

Foil bearings have been extremely successful for air cycle machines. They have increased the reliability of these machines up to tenfold. Even though several machines have been built for other applications, the work has not been pursued by the same vigor and commitment for various reasons. Foil bearings have strong potential for the following applications:

- A. A small general aviation gas turbine engine supported on foil bearings will be more reliable and cost less than existing engines.
- B. Oil free cryogenic turboexpanders supported on foil bearings will be more reliable and increase efficiency of gas separation plants.
- C. Highly reliable and less expensive APU's can be built for various aerospace and ground vehicles using foil bearings.
- D. Recent concept of foil bearings provide potential for low cost bearings using automated manufacturing methods for commercial applications; e.g. automobile gas turbine engines, vapor cycle centrifugal compressors and commercial air/gas compressors.

ACKNOWLEDGMENTS

The materials presented here have been compiled from various sources including those from airlines and military customers. Some cross sections and photos were reproduced or redrawn from previously published material or sales brochures. Some photos were retaken from hardware available with various customers.

Federal Air Regulation FAR-25 requires at least 0.55 lbm/minute/cabin occupant of outside make-up ventilation air (*ref. doc. PAI-10a*), which is the cabin air change rate to ensure 0.127 lbm/minute/occupant O₂. The primary reason for the large volume of make-up air at altitude is to maintain O₂ partial pressure for aviator/occupant lung function, not to account for the small volume taken in/out by an occupant's lungs at about 0.007 lbm/minute of O₂ (*ref. doc. PAI-7 & PAI-10a*). It appears that the N690EH environmental system is designed for one air change about every five minutes, and to maintain cabin pressure altitude at 8000 feet msl (measured from sea level) = 5.2 psi while flown at 23,900 feet msl (*Exhibit A, page 12*).

Air changes have little effect on removing infused pollutants from the aircraft's interior materials (*ref. doc. PAI-12b*). Making matters worse, the Personal Exposure Limit (PEL) for toleration of pollutants are reduced at higher cabin altitudes (*ref. doc. PAI-11*).

The aircraft maintenance manual, (*Bates # CD03505-CD04253*) provides no instruction for a pilot or aviation mechanic to see if excess turbine oil resides within the Fairchild ACM prior to any flight or intention of flight: The only ACM pre-flight check is to *"inspect the refrigeration unit oil filler and maintain oil level at top of filler neck"*, a process that only adds oil into the ACM (*ref. doc. PAI-7a*) without an easy way to check if too much oil resides inside the ACM. Fairchild drawings call for a filler / drain fitting (*Bates# Fairchild_00000040*). Ostensibly, this fitting should be able to empty the low point oil sump, but no drawings or representations are available to describe how to drain oil, to measure added oil, and thus render safe the exact quantity of oil in the ACM sump. There is no drawing to depict or exactly locate the *"oil filler valve assembly, installed on a bracket attached to the top left side of the refrigeration unit"*, a location that would provide an oil level higher than the top of the oil wick (*ref. doc. PAI-7b*) and thus over-oil the wick/shaft housing space.

For testing, Fairchild requires exactly 37cc (0.078 pint) of oil (*Bates # Fairchild_00000052 & 54*), implying that some exact small amount of oil is required for normal operations.

The maintenance manual offers a solution to eliminate and prevent noxious fumes from entering the cabin from the engine bleed air by isolating the problematic engines bleed air, but has no mechanism or instruction to divert or isolate contaminated air leaving the ACM (*ref. doc. PAI-7e*). The manual also fails to list a fume event warning in the three page Troubleshooting section Fig. 9-14 (*ref. doc. PAI-7c*), thus ignoring well known Aerotoxic Syndrome issues.

Additionally, there is no way for a pilot or aviation mechanic to determine the effectiveness or operating state of the hidden ACM's oil seals. The only way to determine the effectiveness of these important items is to send the ACM in for overhaul by Fairchild, a process that nearly guarantees a fume event: Both the original ACM and the overhauled ACM (*Serial #0335*) had evidence of oil leakage from the turbine side and the impeller side of the rotor (*ref. doc. PAI-8*) thus indicating ACM oil seal leakage.

An available safety solution would have been for Fairchild to retrofit the design to use industry common oil-less bearings within this Fairchild ACM to avoid the toxic fumes that entered the confined space of the aircraft as described in the paragraphs below.

Alternative systems capable of preventing the claimant's damage (which would not be unduly burdensome on anyone) were/are available – Modern design practices for ACM equipment avoids the use of turbine engine oil lubrication systems entirely, instead using "air bearings" (*ref. doc. PAI-9*) and "ceramic hybrid bearings". Additionally, high efficiency particulate (HEPA) filters combined with activated charcoal or similar filters could have been installed to remove both particles and chemicals from the cabin air (*ref. doc. PAI-10b*). In the interest of safety, Fairchild could and should have produced some FAA Supplemental Type Certificate (STC) to at least install some fume sensors, filters, absorbers, and/or suggested diverters to adequately warn cabin occupants such as the plaintiffs. Also, Fairchild could have used oil-less bearings as suggested above.