

**IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA**

ELIZABETH C. SNIDER, Individually	:	
and as Executrix of the Estate of	:	CIVIL ACTION
DANIEL A. SNIDER, and	:	
LEE W. SNIDER, a minor, by his	:	
mother, ELIZABETH C. SNIDER	:	NO. 13-CV-2949
	:	
Plaintiffs	:	
	:	
vs.	:	
	:	
STERLING AIRWAYS, INC., and	:	
CONTINENTAL MOTORS, INC.,	:	
	:	
Defendants	:	

MEMORANDUM AND ORDER

JOYNER, J.

June 28, 2017

This case is again pending before this Court on Motion of the Defendant, Continental Motors, Inc. Presently, Continental renews its previous request for entry of judgment in its favor as a matter of law pursuant to Fed. R. Civ. P. 50(b). For the reasons which follow, the Renewed Motion shall be denied.

History of the Case

This is the remaining lawsuit of three¹ assigned to the undersigned, all of which arose out of the tragic crash of a Cessna T210L single engine aircraft in the early afternoon hours

¹ Those other matters, Lewis-Whiteman v. Continental Motors, Inc., et. al., Civ. A. No. 13-CV-2950, and Jessup v. Continental Motors, Inc., et. al., Civ. A. No. 12-CV-4439 have since been amicably resolved by the parties.

of June 21, 2010 as it neared the William T. Piper Memorial Airport in Lock Haven, Pennsylvania. As a result of the accident, which was caused by a total engine failure as the plane was preparing to land, the pilot, Patrick Jessup, and his two passengers, United States Forest Service employees Rodney Whiteman and Daniel Snider were killed. At the time of the accident, Messrs. Whiteman and Snider were in the process of conducting an aerial deforestation survey on behalf of the Forest Service. The plane was being operated pursuant to a charter plane and pilot contract between its owner, Defendant Sterling Airways, Inc. of Hornell, New York and the U.S. Forest Service, dated March 28, 2008. The accident airplane had been manufactured in 1973 and was equipped with a Continental Motors' TSIO-520-H engine that had last been overhauled in 2004.

The essence of the complaints in the actions filed by the estates of the three individuals killed as a result of the crash was that the accident resulted from the negligence, gross negligence, recklessness and/or strict liability on the part of the defendants in, *inter alia*, the manufacture, maintenance and operation of the Cessna, its engine and component parts. As noted, the lawsuits instituted on behalf of the Estates of Mr. Jessup and Mr. Whiteman were settled, but this action, filed on behalf of Mr. Snider and his Estate, was tried over a three-week period commencing on January 23, 2017. On February 16, 2017, the

jury returned a verdict in favor of the Plaintiff and against Continental Motors, Inc. only in the amount of \$2,753,048.49. Although Sterling Motors was found to have breached its contract with the U.S. Forest Service and to have been negligent, the jury found that Sterling's negligence and breach were not factual causes of the accident. By the motion which is now before us, Continental asserts that it is entitled to the entry of judgment as a matter of law for two reasons: "(1) there is no legally sufficient basis for a reasonable jury to find that CMI **'manufactured'** a new component or part that caused the accident under the rolling provision of GARA §2(a)(2); and/or (2) plaintiffs' claims fail under GARA and Pennsylvania tort law because plaintiffs failed to prove that the No. 2 exhaust valve guide's allegedly deficient material hardness **caused** the exhaust valve guide to fail." (Defendant Continental Motors, Inc.'s Renewed Motion for Judgment as a Matter of Law Pursuant to Fed. R. Civ. P. 50(b), at p.1).

Standards Governing Rule 50(b) Motions

"A court may grant a motion for judgment as a matter of law against a party when 'a party has been fully heard on an issue during a jury trial and the court finds that a reasonable jury would not have a legally sufficient evidentiary basis to find for the moving party on that issue.'" Shrey v. Kontz, 981 F. Supp. 2d 333, 337 (M.D. Pa. 2013) (quoting Fed. R. Civ. P. 50(a)). "After

trial, a party may renew their motion pursuant to Fed. R. Civ. P. 50(b).” Id. “A court may grant a renewed motion for judgment as a matter of law in favor of a party ‘if there is a legally sufficient evidentiary basis for a reasonable jury to find’ for the opposing party on a particular issue.” Graco Children’s Products, Inc. v. Century Products Company, Inc., Civ. A. No. 93-6710, 1996 U.S. Dist. LEXIS 10356 at *12 - *13 (E.D. Pa. July 23, 1996) (quoting Fed. R. Civ. P. 50(a)(1)(b)). Under well-established Third Circuit precedent, regardless of whether made under Rule 50(a) or 50(b):

Such a motion should be granted only if, viewing the evidence in the light most favorable to the nonmovant and giving it the advantage of every fair and reasonable inference, there is insufficient evidence from which a jury reasonably could find liability. In determining whether the evidence is sufficient to sustain liability, the court may not weigh the evidence, determine the credibility of witnesses, or substitute its version of the facts for the jury’s version.

McDaniels v. Flick, 59 F.3d 446, 453 (3d Cir. 1995); Lightning Lube, Inc. v. Witco Corp., 4 F.3d 1153, 1166 (3d Cir. 1993); Mancini v. Northampton County, 836 F.3d 308, 314 (3d Cir. 2016); Shrey, 981 F. Supp. 2d at 338. Stated otherwise, “a renewed motion for judgment as a matter of law ‘may be granted under Fed. R. Civ. P. 50(b) only if, as a matter of law, the record is critically deficient of that minimum quantity of evidence from which a jury might reasonably afford relief.’” Pollock v. Energy Corp. Of America, Nos. 15-2648, 15-2649, 665 Fed. Appx. 212, 216,

2016 U.S. Dist. LEXIS 19167 at *7 - *8 (3d Cir. Oct. 24, 2016) (quoting In re Lemington Home for the Aged, 777 F.3d 620, 626 (3d Cir. 2015)). And again, being mindful that credibility determinations, the weighing of the evidence, and the drawing of legitimate inferences from the facts are jury functions and not those of a judge, in its review of the record as a whole the court must disregard all evidence favorable to the moving party that the jury is not required to believe. Avaya Inc., RP v. Telecom Labs, Inc., 838 F.3d 354, 373 (3d Cir. 2016) (citing Reeves v. Sanderson Plumbing Products, Inc., 530 U.S. 133, 150-51, 120 S. Ct. 2097, 147 L. Ed.2d 105 (2000)).

Discussion

1. Applicability of GARA's "Rolling Provision"

We turn first to Continental's claim that there is no legally sufficient basis upon which the jury could find that it manufactured a new component or part which in fact caused the subject accident so as to fall within the scope of the "rolling provision" of GARA. Thus, Continental argues, because it manufactured the accident aircraft engine more than 18 years before the accident, Plaintiff's claims against it are barred and judgment should now be entered in its favor.

"GARA" is the abbreviated title for the General Aviation Revitalization Act of 1994 which is codified in the notes to 49 U.S.C. §40101. As "the legislative history makes clear, ...

Congress enacted GARA to ameliorate the impact of long-tail liability on a declining American aviation industry in furtherance of the national interest.” Prigden v. Parker Hannifin Corp., 591 Pa. 305, 309, 916 A.2d 619, 622 (2007). “A key assumption underlying GARA was the notion that any design defects in aircraft components generally will be discovered within the eighteen year period preceding repose. Id., (citing H.R. Rep. No. 103-525(I) at 3 (1994)). Section 2(a) of GARA reads as follows:

(a) In general. Except as provided in subsection (b), no civil action for damages for death or injury to persons or damage to property arising out of an accident involving a general aviation aircraft may be brought against the manufacturer of the aircraft or the manufacturer of any new component, system, subassembly, or other part of the aircraft, in its capacity as a manufacturer if the accident occurred -

(1) after the applicable limitation period beginning on-

(A) the date of delivery of the aircraft to its first purchaser or lessee, if delivered directly from the manufacturer; or

(B) the date of first delivery of the aircraft to a person engaged in the business of selling or leasing such aircraft; or

(2) with respect to any new component, system, subassembly, or other part which replaced another component, system, subassembly, or other part originally in, or which was added to, the aircraft, and which is alleged to have caused such death, injury, or damage, after the applicable limitation period beginning on the date of completion of the replacement or addition.

“[T]he term ‘limitation period’ means 18 years with respect to

general aviation aircraft and the components, systems, subassemblies and other parts of such aircraft.” GARA §3(3). GARA has therefore been said to be a statute of repose, not a statute of limitations. As our colleague Judge DuBois succinctly explained in Robinson v. Hartzell Propeller, Inc., 326 F. Supp. 2d 631 (E.D. Pa. 2004):

Statutes of limitations prohibit lawsuits if a period of time has elapsed after an accident occurs or is discovered. Statutes of repose bar suits brought more than a certain period of time after a product is manufactured and delivered to the purchaser.

Id., at 646(citing Burroughs v. Precision Airmotive Corp., 78 Ca. App. 4th 681, 93 Cal. Rptr. 2d 124, 130 (Cal. Ct. App. 2000)). This means that “[u]nder GARA §2(a)(2), a new eighteen year period begins when a new part is added to an aircraft if this part is alleged to have caused an accident.” Id., at 660. In other words, the new limitation period begins when a new system replaces an old system, a new component replaces an old component, etc. because “‘replacement’ requires two acts: removal of the old and substitution of the new.” Hiser v. Bell Helicopter Textron, Inc., 4 Cap. Rptr. 3d 249, 111 Cal. App. 4th 640, 650 (CA. App. 2003). However, as multiple courts have noted,

Congress’ intent to provide repose for aircraft manufacturers would be effectively nullified ... if plaintiffs could lump each new part into large systems for purposes of GARA’s rolling provision. If that were the case, parts that were manufactured at the time of the original sale and whose design had proven useful and safe

over the years could become the basis of a suit later, not because they were new or had been altered in the last 18 years, but because another part in the same system had been replaced.

Id.; Sheesley v. Cessna Aircraft Co., No. Civ. 02-4185, 2006 U.S. Dist. LEXIS 27133 at *25 (D.S.D. April 20, 2006); Hinkle v. Cessna Aircraft Co., No. 247099, 2004 Mich. App. LEXIS 2894 (Mich. Ct. App. Oct. 28, 2004); McCarthy v. Cessna Aircraft Co., No. 02-CV-1240, 2005 U.S. Dist. LEXIS 47672 at * 5 (S.D. Ill. July 14, 2005). See also, Crouch v. Honeywell International, Inc., 720 F.3d 333, 343 (6th Cir. 2013) ("Section 2(a)(2) cannot be reasonably construed as meaning that the 18-year period of repose for the entire engine is reset every time a single sub-part is replaced).

Moreover, because "manufacturer" is not defined in GARA, it is appropriate to consider the underlying Congressional policy and legislative history in construing the statute in this regard as well. Pridgen v. Parker Hannifin Corp., 588 Pa. 405, 905 A.2d 422, 435 (2006) (citing Patterson v. Shumate, 504 U.S. 753, 761, 112 S. Ct. 2242, 2248, 119 L. Ed.2d 519 (1992) and Mason v. Schweizer Aircraft Corp., 2002 Iowa Sup. LEXIS 228, 653 N.W. 2d 543, 548 (2002)). The meaning of "manufacturer" for purposes of the act is a question of law for the court, which should be mindful that the term is not uniform in scope throughout the text of GARA. Burton v. Twin Commander Aircraft, LLC, 171 Wn. 2d 204, 216, 254 P. 3d 778, 783 (2011) (citing Pridgen, 588 Pa. At 421-22

and Burroughs, 78 Cal. App. 4th at 688); Stewart v. Precision Airmotive Corp., 2010 PA Super 168, 7 A.3d 266, 275 (2010).

Indeed, while most of the courts to have considered the issue have held that type certificate² holders, like the holders of a parts manufacturer approval or "PMA", are "manufacturers" for purposes of GARA's statute of repose, GARA has also been held to apply to successors that purchase aircraft product lines from the original manufacturer and hold Type Certificates. Burton, 171 Wn. 2d at 217, 254 P. 3d at 784(citing *inter alia*, S. Side Trust & Sav. Bank of Peoria v. Mitsubishi Heavy Inds., Ltd., 401 Ill. App. 3d 424, 452-455, 927 N.E. 2d 179, 339 Ill. Dec. 638 (2010); Pridgen, 588 Pa. at 425; Mason v. Schweizer Aircraft Corp., 653 N.W. 2d 543, 548-549 (Iowa 2002)); Scott v. MD Helicopters, Inc., 834 F. Supp. 2d 1334, 1339 (M.D. Fla. 2011). See also, Hasler Aviation, L.L.C. v. Aircenter, Inc., No. 1:06-CV-180, 2007 U.S. Dist. LEXIS 56856 (E.D. Tenn. Aug. 3, 2007) (quoting Pridgen, 905 A.2d at 425 with approval for proposition that "a type certificate 'is an essential prerequisite to manufacture in the

² "A type certificate includes the type design, which outlines the detailed specifications, dimensions, and materials used for a given product; the product's operating limitations; a 'certificate data sheet,' which denotes the conditions and limitations necessary to meet airworthiness requirements; and any other conditions or limitations prescribed under FAA regulations." Sikkelee v. Precision Airmotive Corp., 822 F.3d 680, 684 (3d Cir. 2016). "The FAA issues type certificates for aircraft, aircraft engines, propellers and appliances to ensure that aircrafts and their parts are safe. ... To receive a type certificate, a manufacturer must demonstrate to the Administrator of the FAA that the products, design, specifications, and manufacturing process meet all applicable FAA regulations." Pease v. Lycoming Engines, Civ. A. No. 4:10-CV-843, 2011 U.S. Dist. LEXIS 145344 at *40 - *41 (M.D. Pa. Dec. 19, 2011) (citing 49 U.S.C. § 44704).

aviation industry'"). Under the reasoning of the Pennsylvania Supreme Court, however, the term "manufacturer," in the context of the rolling provision, is limited to the actual manufacturer of a replacement product, or one who supplies the replacement product as its own. Stewart, supra, (citing Pridgen, 905 A.2d at 437.

In reviewing the trial record of this case under the lens of the preceding authority, we find that Plaintiff produced sufficient documentary and testimonial evidence at trial that Continental manufactured a replacement part which was installed in the accident aircraft's engine some six years prior to the June, 2010 crash so as to fall within GARA's rolling provision. To be sure, the trial record evinces that in May 2004, Sterling Motors' Director of Maintenance performed the required total overhaul of the accident airplane's engine. At that time, all six of the engine's cylinder assemblies were removed and replaced with new cylinder assemblies which were manufactured in December, 2003 bearing Continental Motors' Part No. 65547083. (N.T. 1/25/17, pp. 94-99, 101; N.T. 2/3/17, pp. 82, 104; N.T. 2/8/17, pp. 19-20; Pl's Exhibits 239, 245, 253). Although the cylinder assemblies incorporated exhaust valve guides which were manufactured by Roderick Arms & Tool, the exhaust valve guides (which were assigned Continental Part No. 636242) were designed by Continental and manufactured specifically for Continental by

Roderick. As part of its routine manufacturing practices and as part of its quality assurance procedures, prior to its installation of the exhaust valve guides into its cylinder assemblies, Continental tests samples from each batch of valve guides which it receives from Roderick Arms & Tool to ensure that the components meet the necessary engineering and manufacturing criteria. (N.T. 1/25/17, pp. 108-123; N.T. 2/1/17, p. 54; N.T. 2/8/17, pp. 23-27, 33-34, 36-46; Pl's Exhibit 249). Unlike an after-market parts manufacturer which is required to undergo a similar FAA-certification process as does the holder of a Type Certificate, Roderick is an FAA-approved components supplier under Continental's Quality Control System. (N.T. 2/1/17, pp. 36-39; N.T. 2/8/17, 22-28).

Because a lot of movement between the valve and guide is harmful, the valve needs to fit fairly tightly in the valve guide. In order to make them fit, the valve guide has to be inserted into the cylinder head using a process by which the cylinder head is heated up and then the guide is pushed into the cylinder head using a press and reamed in place.³ (N.T. 1/25/17, pp. 103-104; 2/1/17, pp. 74-76). This process was followed by Continental in the process of completing the assembly of its cylinder and thereby essentially eliminating the guide. (N.T.

³ Reaming is an industrial term for inserting a reamer, which is essentially a drill bit or cutting tool, down into the guide and then taking off any excess material so that it's exactly the right dimension to fit over the valve system. (N.T. 1/25/17, p. 104; N.T. 1/26/17, pp. 20-21).

2/1/17, pp. 77-79). In 2007, Sterling became aware that there was a problem with the No. 3 and No. 5 cylinders in the accident engine and it accordingly sent out those two cylinders to have the parts replaced. (N.T. 2/2/17, 151-153). This is clear evidence that the exhaust valve guide manufactured and supplied by Roderick was incorporated into and made a part of the No. 2 cylinder/cylinder assembly manufactured by Continental Motors. It was that No. 2 cylinder which failed, thereby causing the Cessna's engine to fail and the subject accident to occur. We therefore find that inasmuch as Continental was the manufacturer of the cylinder which caused the accident, GARA's rolling provision is properly applied and Plaintiffs' claims against Continental are not barred.

2. Failure to Prove Hardness Deficiency Caused Accident

As previously stated, Continental's second argument in support of its Renewed Rule 50(b) motion is that Plaintiffs' claims fail under GARA and Pennsylvania tort law because plaintiffs failed to prove that the No. 2 exhaust valve guide's allegedly deficient material hardness caused the exhaust valve guide to fail. Following our review of the trial record, we find that this argument is also meritless.

In the course of the presentation of their case, Plaintiffs presented a number of expert witnesses with expertise in metallurgy, materials sciences and accident investigation and

reconstruction. Colin Sommer, an expert in the field of aircraft accident investigation, is a licensed mechanical engineer with a Bachelor of Science degree in civil and environmental engineering with an emphasis in structural design who has investigated some 400 aircraft accidents. Mr. Sommer testified that his examination of the accident aircraft's engine and the No. 2 cylinder in particular, revealed that the No. 2 piston had been destroyed by the failure of the valve system in the No. 2 cylinder. (N.T. 1/25/17, p. 127-128). The No. 2 valve head had become detached from the No. 2 valve system, and the metallurgical examination of the exhaust valve system showed that there was evidence of fatigue on the fracture surface of the exhaust valve system which meant that as the valve was riding up and down inside the cylinder, the valve became crooked because of wear that was found between the valve guide and the valve system. As a result, the valve started to bang up against the valve seat where it seals and eventually broke the head off of that valve. Once that happened, the valve was rolling around inside the cylinder while the piston was traveling up and down inside at 22 times per second. Eventually, the piston was destroyed, followed by the connecting rod, which was actually torn off of the crankshaft. In short, Mr. Sommer testified that the destruction of the No. 2 piston was the result of the failure of the No. 2 exhaust valve head, and the No. 2 exhaust valve head failure

resulted from the failure of the No. 2 exhaust valve and guide which then cascaded to the destruction of the rest of the engine. (N.T. 1/25/17, pp. 129-131).

According to this witness: "the purpose behind hardening something is generally wear resistance. It's the same reason that you wouldn't make an aircraft engine crank case out of plastic or wood. You have to make it out of something tough, something strong, something that is resistant to wear." (N.T. 1/26/17, p. 17-18). Typically, the exhaust valves are subject to much more heat and wear than are intake valves. (N.T. 1/26/17, p. 87). In an effort to determine why the valve guide wore in the foregoing manner, Mr. Sommer, as part of his accident investigation and in conjunction with the McSwain Engineering laboratory, performed the same type of test that Continental would perform⁴ on the valve to determine whether or not it met minimum hardness specifications. (N.T. 1/25/17, pp. 136-137).

That test is a "hardness test" utilizing a Brinell machine which operates by taking a small metal sphere and pressing it into the side of the metal of the object being tested. (N.T. 1/25/17, p. 137). Part of the design of the valve guide from

⁴ When Continental accepts shipments of valve guides from its supplier Roderick, they routinely inspect samples from the various lots received for hardness to ensure that the guides are in compliance with their specifications. When the sampling tests are completed, Continental's inspector completes a form called a Certificate of Compliance approving the batch if the lot's samples fell within the specified hardness rating of Rockwell B 75-90. (N.T. 1/26/17, pp. 26-33; Pl's Exhibits 294, 296, 297; CMI Exhibits 3345, 3346, 3347, 3348; N.T. 2/8/17, pp 24-28, 36-56).

Continental is that it must meet a certain hardness minimum requirement; for the exhaust valve guide at issue - Continental Part No. 636242 - that minimum hardness is 75 to 90 on the Rockwell B Scale.⁵ (N.T. 1/25/17, p. 138). Sommer testified that the guides on the first five cylinders on the accident aircraft's engine were tested for hardness using this methodology and scale which resulted in findings that the No. 1 guide had a score of 68, the No. 2 guide was 71.6, the No. 3 guide was 86.9, the No. 4 guide tested at 68.4, and the No. 5 guide was measured at 84.1. (N.T. 1/25/17, 139-140).⁶

Sommer further stated that the Continental exhaust valve guides are made from an alloy called Ni-Resist, which is designed for operating temperatures at a consistent basis typically between 1,000 to 1,300 degrees Fahrenheit. (N.T. 1/25/17, p.

⁵ Rockwell Hardness is a hardness-testing technique and a scale for measuring the hardness of materials. Under the American Society for Testing and Materials standards, specific equipment for Rockwell Hardness testing is required to be utilized and specific procedures for conducting the testing are to be followed. (N.T. 2/1/17, pp. 140-141). In addition to the Rockwell scale requiring the use of a Brinell apparatus, there are other scales for measuring the hardness of materials such as the HR15T and HR30T and which permit the use of other equipment and testing procedures. (N.T. 2/1/17, pp. 183-190). Continental Motors' designated inspection procedures for accepting materials, however, specified that the Rockwell B scale be followed. (N.T. 2/1/17, 188-190; Pl's Exhibits 291, 481).

⁶ Again, the guides in the No. 3 and No. 5 cylinders had been replaced in 2007 with guides manufactured not by Continental but by ECI, another company. (N.T. 1/25/17, p. 139). Those guides were pre-finished or pre-reamed, unlike the Continental Nos. 1, 2, 4 and 6 guides which were reamed or finish-in-place. (N.T. 1/26/17, pp. 18-20; N.T. 2/1/17, p. 54). Because they had to extract the guides from the cylinders, which is accomplished by either hammering or machining them out and is not easy, the Nos. 1, 2 and 4 guides were extracted because they were in close proximity to one another. The Nos. 3 and 5 guides were already loose and didn't have to be extracted. The No. 6 guide was left in place and was not tested. (N.T. 1/26/17, p. 162; N.T. 2/1/17, pp. 145-146).

141-142; Pl's Exhibit 49). Those higher temperatures notwithstanding, the TSIO-520-H engine (the model engine which was in the accident aircraft) was designed for a maximum (or "red-line") temperature of 460 degrees Fahrenheit and that temperature is measured in the cylinder head itself. (N.T. 1/25/17, 143-145; Pl's Exhibit 235). Mr. Sommer testified that his review of several pieces of evidence uncovered during the accident investigation reflected that in this case, the accident engine was not being operated at or above that red-line temperature⁷ (N.T. 1/25/17, 146). Mr. Sommer unequivocally stated that the evidence of the temperatures that were seen on the engine post-accident were nowhere near what would have been needed to cause Ni-Resist to soften. (N.T. 1/25/17, 149-150, 152). Thus, in Mr. Sommer's opinion, the No. 2 exhaust valve guide, which everyone agreed wore prematurely, did not suffer from premature wear because of excessive engine temperatures causing the alloy which it was made of to soften or because there was insufficient lubrication in the engine but rather because it did not possess the requisite hardness (Rockwell B 75-90) at the time that it was incorporated into the No. 2 cylinder assembly by Continental. (N.T. 1/26/17, 100, 126-128; 152-155, 160-162).

Plaintiffs also presented testimony from William Carden, the

⁷ For one, all of the cylinders exhibited normal combustion products on the cylinder bore, cylinder head and on the piston itself and there was no physical evidence of excessive heat or lack of lubrication. (N.T. 1/25/17, pp. 146-150; Pl's Exhibit 269).

Director of Materials Engineering at McSwain Engineering and an expert in materials engineering and materials failure analysis. (N.T. 2/1/17, pp. 104-107, 111). Mr. Carden testified that using a coordinated measuring machine and touch probe, he measured the exhaust valve guides in the accident aircraft's engine, in particular the inner diameters, and conducted a chemical analysis of the valves, guides and cylinders. (N.T. 2/1/17, 112-121). In doing so, Mr. Carden found that the inner diameter of the No. 2 exhaust valve guide was very large, especially at the opening into the barrel, but was much smaller at the top than it was at the bottom. Mr. Carden also found that the No. 2 valve guide was much larger than the rest of the guides in the other cylinders and that there was quite a bit of wear on the bottom parts of the valve guides. (N.T. 2/1/17, 121-123). In measuring the diameter of the valve systems with handheld blade and laser micrometers, Carden found that the clearance of the No. 2 guide was much larger than all of the others and in fact was some 10 times the maximum clearance of the return to service clearance limits of 7/1000 of an inch on the bottom of the guide. (N.T. 2/1/17, pp. 124-125).

Two cracks in the No. 2 exhaust valve guide from the top of the valve guide down into and along the right hand side of the guide were also observed using a scanning electron microscope. These cracks were found to be very flat, demonstrating that the

initial fracture occurred and separated the top of the valve guide such that the valve guide was then rubbing on top of itself or hammering itself flat. (N.T. 2/1/16, pp. 126-134).

Additionally, fatigue striations, which appear as ridges or lines and which are indicative of fatigue cracks⁸ were also seen in the course of Carden's examination of the No. 2 exhaust valve guide. (N.T. 2/1/17, 135-136).

The testing of the valve guide's chemical composition was undertaken using x-ray spectroscopy and revealed that the No. 2 guide was composed of the Ni-Resist Type 1 alloy (N.T. 2/1/17, 138-139). As discussed by Colin Sommer, Mr. Carden likewise testified as to the hardness testing which was done at McSwain Engineering in July of 2015, and his testimony mirrored that of Mr. Sommer as to how the tests were conducted, why they were conducted in the manner in which they were, and what the results were. (N.T. 2/1/17, pp. 139-154). Mr. Carden reiterated that the results of the hardness testing (which consisted of three tests per cylinder and the mean or average of the three being accepted as the overall reading) reflected that Cylinder No. 1 had a Rockwell B Hardness reading of 68.4, Cylinder No. 2 was

⁸ Carden explained that a fatigue crack is a crack that propagates incrementally over a period of time. Rather than something breaking all at one time in a sudden failure such as an overload event, at lower loads, a tiny crack can develop and that crack, as material is repeatedly loaded and unloaded, incrementally grows and moves forward generating the striations. A fatigue crack continues to grow over time until a break occurs, as in this case where the valve guide broke and then rubbed on top of itself producing the flat areas which were observed. (N.T. 2/1/17, 136-137).

71.6 , and Cylinder No. 4 was 68.37. The test results were between 75 and 90 on the Rockwell B scale for Cylinder Nos. 3 and 5 (manufactured by ECI). (N.T. 2/1/17, 155-158). And Mr. Carden agreed that the alloy carbide network in Ni-Resist remains stable at elevated temperatures up to 1,300 degrees Fahrenheit. (N.T. 2/1/17, 180-182; N.T. 2/2/17, pp. 9-10). He also testified regarding a test which he conducted on a #636242 Continental valve guide which had an as-manufactured hardness reading of 81.9 and which he placed in an oven at 600 degrees F for some 2,300 hours. (N.T. 2/2/17, 17-21). Despite exposure to these temperatures for such an extended period of time, the hardness reading on the valve guide at the conclusion of the test was 81.7. (N.T. 2/2/17, p. 21). Pointing to photographs of the accident engine and the cylinders, Mr. Carden also stated that there was no showing of any damage or burning to the plastic paint or rubber baffling on and around those areas or anything else showing heat damage. Since to soften the valve guides would require temperatures of upwards of 1,300 degrees, in Mr. Carden's opinion, the post-crash fire had no effect on the hardness of the exhaust valve guides and the No. 2 exhaust valve guide rather was not hardened. (N.T. 2/2/17, pp. 29-33, 61, 63-64).

Additional evidence regarding the sequence of events leading to the engine failure in the accident aircraft was provided by one of the defense witnesses, Dr. John Morris, an expert in

metallurgy, material science and failure analysis. Noting that everyone agreed on what the sequence of events leading to failure was, Dr. Morris explained that as the valve, which is situated in a cylinder, opens and closes, it passes through the valve guide and that as it moves back and forth, "there always is going to be some wear. In this case, the wear became very severe rather quickly. As it became severe, the valve became loose in the valve guide which created a much worse mechanical situation because then it was vibrating back and forth," creating a "cyclic load which tends to make materials fail in a phenomenon called fatigue." (N.T. 2/8/17, p. 151). Dr. Morris said that what typically happens is that "under cyclic loads the material will be damaged, the damage will accumulate, and finally a crack will form where the damage accumulates." (N.T. 2/8/17, p. 151). In this case, several cracks formed in the valve guide and the top of the valve guide broke off freeing the valve to move and break causing the cylinder to fail and parts of the engine to come apart. That was when the engine stopped operating. (N.T. 2/8/17, pp. 151-152).

Although Dr. Morris did not believe that the valve guide failed because of insufficient hardness but rather because of insufficient lubrication causing the engine to run too hot, he testified that he "is a metallurgist," ... "not an engine person," and that at the time of the first inspection at McSwain,

he and the "several people from Continental who were there at the same time [he] was... talked about what [they] could see and their main comment was that this thing obviously was pretty hot." He went on to explain that "[y]ou have a real wear problem when things get hot, because what's defeating wear is lubricant. You start heating up an engine, the lubricant becomes a real problem, the viscosity gets very low... [and] it's not producing a decent lubrication film anymore" resulting in "metal to metal contact" and "big wear." (N.T. 2/8/17, pp. 158-159, 167). Dr. Morris admitted that "[s]o we concluded very, very early that the probable cause of this was metal-to-metal contact due to an overheated operation of some kind." (N.T. 2/8/17, p. 159).

In applying the Rule 50 standards for adjudicating motions for entry of judgment as a matter of law and in viewing the evidence in the light most favorable to the Plaintiffs as non-movants and giving them the benefit of every fair and reasonable inference, we find that this evidence was more than sufficient to have enabled this jury to find that the No. 2 Continental valve guide that was in the No. 2 cylinder was not in compliance with its own hardness specifications and that it was because it did not meet the requisite hardness threshold that it wore prematurely and ultimately fractured and failed. In so holding, we observe that there was also adequate evidence to have permitted the jury to have adopted Continental's theory of the

case - that is, that the engine failure was caused by insufficient lubrication. The jury was free to believe or disbelieve any or all of the expert witnesses who testified in this action and was free to accept or reject the theories of failure advanced by any party. In determining whether the evidence is sufficient to sustain liability, the court may not weigh the evidence, determine the credibility of witnesses, or substitute its version of the facts for the jury's version. These principles are well-settled and we follow them now. Inasmuch as this record is **not** critically deficient of that minimum quantity of evidence from which a jury might reasonably afford relief, there is no basis upon which to grant Moving Defendant's Rule 50(b) motion. The motion is therefore denied pursuant to the attached order.