

1987

Crashworthiness Claims in Aviation Accidents

Steven R. Baggett

Recommended Citation

Steven R. Baggett, *Crashworthiness Claims in Aviation Accidents*, 53 J. AIR L. & COM. 219 (1987)
<https://scholar.smu.edu/jalc/vol53/iss1/6>

This Comment is brought to you for free and open access by the Law Journals at SMU Scholar. It has been accepted for inclusion in Journal of Air Law and Commerce by an authorized administrator of SMU Scholar. For more information, please visit <http://digitalrepository.smu.edu>.

CRASHWORTHINESS CLAIMS IN AVIATION ACCIDENTS

STEVEN R. BAGGETT

I. INTRODUCTION

“WHAT GOES UP must also come down.” While modern space technology has proven that there are exceptions to this old adage, it remains true with respect to modern air travel. Any aircraft en route to its intended destination will eventually return to earth. However, there is always the very real possibility that the manner of its return will result in the tragic consequence of injury or death to its passengers.

To be sure, the odds are great that any given flight will reach its destination safely.¹ As technology has improved over the years, aircraft manufacturers have made substantial progress in improving the “airworthiness” of their products.² Through such improvements, the overall accident rate in both general aviation³ and commercial aviation⁴ aircraft has gradually dropped.⁵ However, man has yet to design and manufacture an aircraft which is crash-

¹ See Nolan, *Airline Safety: The Shocking Truth*, DISCOVER, Oct. 1986, at 30. According to the author, “[i]f 374 people in New York board a 747 for California, the chances are 99.99995 percent they’ll all arrive alive”. *Id.* at 32.

² See Saba, *Aircraft Crashworthiness in the United States: Some Legal and Technical Parameters*, 48 J. AIR L. & COM. 287 (1983).

³ “General aviation aircraft may be defined as aircraft certified under 14 CFR 23 and predecessor regulations, having a gross weight of 12,500 pounds or less.” NATIONAL TRANSPORTATION SAFETY BOARD, SAFETY REPORT: THE STATUS OF GENERAL AVIATION AIRCRAFT CRASHWORTHINESS 1 n.1 (1980) [hereinafter SAFETY REPORT].

⁴ “Commercial aviation” aircraft may be defined as aircraft which the Federal Aviation Administration (FAA) designates as transport category aircraft under 14

proof. Consequently, aviation accidents still occur at unacceptable rates.⁶ When these accidents do occur, they are responsible for an inordinate number of injuries and deaths. For instance, one commentator notes that deaths per passenger mile of flight in general aviation aircraft are eight times as great as deaths per passenger mile of travel in automobiles.⁷ While one may not find these figures to be particularly surprising given the speed and altitude of modern air travel, recent studies of aviation disasters show that most accidents occur during the takeoff, approach, and landing phases of the flight, when the aircraft is traveling at a relatively slow speed and low altitude.⁸ Under these circumstances, the aircraft cabin and its occupants may well remain intact upon initial impact.⁹ Yet, in many instances, the passengers of these aircraft fall victim to any number of subsequent injury-causing events¹⁰ which may be attributed to the manufacturer's failure to design the aircraft so that it could withstand such a collision.¹¹ When this is the case, the injured parties may attempt to seek recovery against the manufacturer or operator of the aircraft under the doctrine of "crashworthiness."¹²

C.F.R. §§ 25.1-1587 (1986). Note, *The Crashworthiness Doctrine and the Allocation of Risks in Commercial Aviation*, 52 S. CAL. L. REV. 1581 n.1 (1979).

⁵ Saba, *supra* note 2, at 287-88.

⁶ In the period of 1970-1980 over 100,000 passengers in general aviation aircraft were involved in 39,458 accidents. SAFETY REPORT, *supra* note 3, at 1. Studies have shown that

each general aviation aircraft manufactured will statistically be involved in 1.5 accidents sometime during its existence, or giving consideration to the fact that a given aircraft may be involved in more than one accident, it can be said that more than a 70 percent chance exists of an aircraft being in an accident.

Schaden, *Aircraft Crashworthiness*, TRIAL, Jan. 1978, at 40-41.

⁷ Schaden, *supra* note 6, at 40. As between general aviation and commercial aviation aircraft, passengers in the former suffer fifty times as many deaths per passenger mile as passengers in the latter. *Id.*

⁸ Saba, *supra* note 2, at 288.

⁹ *Id.*

¹⁰ For a discussion of these hazards, see *infra* notes 118-200 and accompanying text.

¹¹ Saba, *supra* note 2, at 290.

¹² In some cases, the *passenger* may bring a suit against the manufacturer for

Put simply, crashworthiness concerns the degree to which an aircraft is "fit to crash."¹³ More specifically, crashworthiness may be defined as "the ability of the aircraft to protect its occupants from injury during the crash sequence and to provide for safe egress from the wreckage."¹⁴ Despite the continuous development and implementation of technology to improve airworthiness, aircraft manufacturers have done little to improve the crashworthiness of their products.¹⁵ Understandably, the best way to avoid crash-related injuries and deaths is to avoid crashes altogether; nonetheless, neglect in the area of crashworthiness is often responsible for needless injuries and deaths in "survivable crashes."¹⁶

Often, the failure to design and build an aircraft to protect its passengers in the event of an accident is the result of a conscious design choice by the manufacturer.¹⁷ Unfortunately, aircraft safety must compete with other factors which motivate manufacturing and business decisions, such as the desire to maximize profits.¹⁸ Many design features that would greatly enhance safety are simply too expensive in the eyes of aircraft manufacturers

injuries sustained in the crash. See, e.g., *McGee v. Cessna Aircraft Co.*, 82 Cal. App. 3d 1005, 147 Cal. Rptr. 694 (1978). Often, however, the relatives of those passengers killed in such accidents are the "injured parties" who seek recovery from the manufacturer. See, e.g., *Patillo v. Cessna Aircraft Co.*, 379 So. 2d 1225 (Miss. 1980). The doctrine of "crashworthiness" is often referred to in these cases as the doctrine of "second collision" or "enhanced injury." Harris, *Enhanced Injury Theory: An Analytic Framework*, 62 N.C.L. REV. 643, 647 (1984).

¹³ Saba, *supra* note 2, at 290.

¹⁴ D. CATHCART, *AIRCRAFT LITIGATION TECHNIQUES* 269 (1985).

¹⁵ See *infra* notes 230-266 and accompanying text.

¹⁶ A "survivable crash" is one in which the deceleration forces upon impact do not exceed human tolerance. Donnelly, *Aircraft Crashworthiness-Plaintiff's Viewpoint*, 42 J. AIR L. & COM. 57, 65 (1976). A particularly tragic example of needless death and destruction in a survivable crash occurred when two 747's collided on the ground in Tenerife in 1977. Experts estimated that most of the 583 deaths in that accident did not result from the impact, and, therefore, could have been avoided if the planes had been "designed and equipped with crashworthiness in mind." Nolan, *supra* note 1, at 31. See CATHCART, *supra* note 14, at 276 for other instances of survivable accidents which tragically resulted in injury and death.

¹⁷ See Nolan, *supra* note 1, at 50.

¹⁸ *Id.*

and operators.¹⁹ Indeed, since deregulation of the commercial airline industry, fierce competition among the airlines virtually dictates that each accord top priority to profit maximizing, as opposed to safety-enhancing, aircraft design.²⁰

All of this does not mean that enhanced aircraft safety does not have its allies. Potentially, the greatest of those allies is the American judicial system. In the last twenty years, American courts have armed themselves with the doctrine of strict liability in tort.²¹ Under this doctrine, the manufacturer of a defective product that is unreasonably dangerous is liable for any injuries suffered by the ultimate user or consumer as a result of the defect, even if the manufacturer exercised all possible care in preparing and selling the product.²² In easing the plaintiff's burden of proof in a personal injury action, the doctrine serves to shift the risk of loss due to defective products from the injured consumer to the manufacturer, and, ultimately, to other consumers of the products.²³ Aside from shifting the risk of loss resulting from defect-related injuries, another important justification for the doctrine is its tendency to provide an incentive for manufacturers to produce safer products.²⁴ A tort liability scheme that imposes liability on the manufacturer for every injury caused by a defect in one of its products could potentially induce manufacturers to go to great lengths to ensure that their products do not present a danger to consumers, thus

¹⁹ *Id.* For example, seats and upholstery which better protect passengers from the force of a crash and the spread of a post-crash fire may well cost as much as \$22 million for a fleet of 100 commercial aircraft, not to mention that the added weight of these features may increase fuel costs by as much as \$500,000 per year. *Id.* at 51.

²⁰ *Id.*

²¹ The first case to apply the doctrine of strict liability was *Greenman v. Yuba Power Prods.*, 59 Cal. 2d 57, 377 P.2d 897, 27 Cal. Rptr. 697 (1963).

²² RESTATEMENT (SECOND) OF TORTS § 402A (1965).

²³ *Greenman*, 377 P.2d at 901.

²⁴ See *Escola v. Coca Cola Bottling Co.*, 24 Cal. 2d 453, 150 P.2d 436, 441 (1944) (Traynor, J., concurring). The influential concurring opinion of Justice Traynor provides an excellent discussion of the justifications for imposing strict tort liability upon manufacturers of defective products. See *id.* at 440-44.

serving to "discourage the marketing of products having defects that are a menace to the public."²⁵

Despite the "safety-insurance" potential of strict liability, the courts have not utilized the theory to significantly alter the current cost-benefit analysis which often leads aircraft manufacturers to conclude that it is less expensive to compensate consumers for their injuries than to take steps to avoid these injuries.²⁶ While a few courts have permitted recovery to aircraft passengers injured as a result of design features which have enhanced crash-related injuries, application of the doctrine of crashworthiness in aviation accident litigation has been far from prevalent.²⁷ In fact, the doctrine, as it is presently applied, may be ill-equipped to serve as a serious deterrent to the manufacture and operation of unsafe aircraft.²⁸

A court cannot invoke the doctrine of crashworthiness to allow recovery to a victim of an aviation accident unless the victim's injuries may be attributed to a defect in the design, manufacture, or operation of the aircraft. This comment will discuss the manner in which the courts have addressed the difficult question of what constitutes a defect, exploring and criticizing alternative standards which the courts may employ. It will also discuss the extent to which the current state of aircraft design, manufacture, and operation has failed to keep pace with existing technology which could make air travel safer. Finally, it will propose a means by which the tort system could prevent avoidable injuries in aviation accidents by utilization of the doctrine of crashworthiness in the aviation context.

II. THE DOCTRINE OF CRASHWORTHINESS IN AVIATION ACCIDENT LITIGATION

The judicial doctrine of crashworthiness has its origin

²⁵ *Id.* at 441.

²⁶ See *infra* note 274 and accompanying text.

²⁷ See *infra* notes 29-36 and accompanying text.

²⁸ See *infra* note 274 and accompanying text.

in cases involving defective automobile design.²⁹ Since 1968, almost every jurisdiction in the United States has recognized the doctrine in the context of automobile injury actions.³⁰ However, there is little recorded precedent for extension of the doctrine to aviation accident litigation,³¹ despite the fact that there is virtually no basis under the doctrine for distinguishing aviation litigation from automobile litigation.³² The paucity of reported

²⁹ See, e.g., *Larsen v. General Motors Corp.*, 391 F.2d 495 (8th Cir. 1968). In that case, the plaintiff suffered severe injuries in a head-on collision when the impact of the collision thrust the steering wheel into his head. *Id.* at 497. He subsequently sued the automobile manufacturer, claiming that the manufacturer's design of the steering wheel was responsible for enhancing the injuries he suffered as a result of the accident. *Id.* The manufacturer maintained that it did not have a duty to design and manufacture automobiles which are safe to occupy in the event of a collision, and that it therefore should not suffer liability for the plaintiff's injuries. *Id.* The court, holding in favor of the plaintiff, stated that a manufacturer has a duty to produce a product "that is reasonably fit for its intended use and free of hidden defects that could render it unsafe for such use." *Id.* at 501. Although collisions are not "intended uses" of vehicles, they are "a frequent and inevitable contingency of normal automobile use." *Id.* at 502. As such, the court held that automobile manufacturers are subject to a duty to design products which minimize the injurious effects of such collisions, at least as much as is possible "under the present state of the art." *Id.* Other cases have reached a similar result with respect to automobiles. *Perez v. Ford Motor Co.*, 497 F.2d 82 (5th Cir. 1974); *Dryson v. General Motors Corp.*, 298 F. Supp. 1064 (E.D. Pa. 1969); *Bolm v. Triumph Corp.*, 41 A.D.2d 54, 341 N.Y.S.2d 846, *aff'd*, 33 N.Y.2d 151, 305 N.E.2d 769, 350 N.Y.S.2d 644 (1973); *Turner v. General Motors Corp.*, 514 S.W.2d 497 (Tex. Civ. App. — Houston [14th Dist] 1974, writ ref'd n.r.e.). *But see McClung v. Ford Motor Co.*, 333 F. Supp. 17 (S.D.W. Va. 1971), *aff'd*, 472 F.2d 240 (5th Cir.), *cert. denied*, 412 U.S. 940 (1973); *Walton v. Chrysler Motor Corp.* 229 So. 2d 568 (Miss. 1969).

³⁰ Comment, *Uncrashworthy Aircraft and the Manufacturer's Liability*, 13 AKRON L. REV. 553, 557 (1980).

³¹ Note, *Aircraft Crashworthiness: Should the Courts Set the Standards?*, 27 WM. & MARY L. REV. 371 (1986) [hereinafter Note]. For example, in 1982 there were 3000 aviation accidents resulting in 574 deaths, but only one reported decision involving aircraft crashworthiness. *Id.* at 372 n.6. In this regard, the reader should note, as well, that three of the four cases discussed in the section immediately following are unreported.

³² Perhaps the two most important justifications for imposition of strict tort liability are its cost-spreading characteristics and its tendency to create an incentive for manufacturers to produce safe products. See *supra* notes 23-25 and accompanying text. It is difficult to imagine how imposition of strict tort liability under the doctrine of crashworthiness would serve these purposes to any greater extent in the automobile context than in the aviation context. Certainly, imposition of strict liability for enhanced injuries in aviation accidents would effectively shift the losses due to these injuries to the parties in the best position to spread such

cases in the area of aircraft crashworthiness is primarily due to the fact that most of these cases are eventually settled out of court.³³ Further, those cases that actually reach judgment at trial are seldom appealed.³⁴ Nonetheless, there are a few aviation cases which have allowed recovery under the crashworthiness doctrine,³⁵ and still others which have at least hinted that the doctrine would be available in certain situations.³⁶

A. *Cases in Which Courts Have Allowed Recovery Under the Doctrine*

Although crashworthiness claims in aviation accident litigation do not appear to be particularly prevalent, a few of the plaintiffs asserting these claims have achieved recovery. Often, however, these cases are not reported and there is little discussion regarding the propriety of imposing the doctrine of crashworthiness in the aviation context.³⁷

Some commentators believe that *Smith v. Cessna Aircraft Co.*³⁸ is the first case to apply the doctrine of crashworthiness to an airplane crash.³⁹ In that case, James Smith, David French, and their two sons were on board a single-engine Cessna airplane which, during take-off, left the end of the runway, rolled down a slope, and struck a barbed

losses. Further, such liability could serve as a strong incentive to aircraft manufacturers and operators to improve the safety of air travel, provided the liability imposed is costly enough. See *supra* notes 23-25 and accompanying text.

³³ Comment, *supra* note 30, at 558.

³⁴ *Id.*

³⁵ See *infra* notes 38-70 and accompanying text.

³⁶ See *infra* notes 74-105 and accompanying text. Mississippi is the only state which has adamantly *opposed* application of the doctrine of crashworthiness to aviation accidents. See *Williams v. Cessna Aircraft Corp.*, 376 F. Supp. 603 (N.D. Miss. 1974). However, this opposition does not differentiate aviation as a class, because Mississippi also refuses to recognize the doctrine of crashworthiness in automobile cases. See *Walton*, 229 So. 2d at 568.

³⁷ See *supra* note 31.

³⁸ No. 70-9255-L, slip op. (Tex. Dist. Ct. Oct. 6, 1972) (cited in Comment, *supra* note 30, at 561 n.57).

³⁹ See, e.g., *Saba*, *supra* note 2, at 310; Comment, *supra* note 30, at 561.

wire fence.⁴⁰ The "crash" itself did not result in any substantial damage to the airplane or injury to the passengers.⁴¹ However, a post-crash fire in the cabin killed Smith and the two sons, and seriously injured French.⁴² Subsequently, French and Smith's wife (as representative of Smith's estate) brought suit against Cessna, seeking recovery under warranty, negligence, and strict liability theories.⁴³ For the most part, plaintiffs' claims centered around the features of the airplane that aggravated the passengers' injuries in such a minor accident.⁴⁴ The court ultimately allowed recovery to plaintiffs under these claims.⁴⁵

In *Fuller v. Capitol Sky Park*,⁴⁶ the court awarded damages for injuries suffered when plaintiff's airplane crashed as he was crop dusting a field.⁴⁷ Upon impact, the seat belt he was wearing failed and he was violently thrust from the plane.⁴⁸ The force of the thrust and his subsequent impact with the ground resulted in plaintiff's permanent paraplegia.⁴⁹ Plaintiff brought suit against the defendant manufacturer, claiming that the defective seat belt was responsible for his injuries.⁵⁰ Despite the fact that plaintiff's own negligence caused the accident, the court found that the defective seat belt was the proximate cause of the injuries.⁵¹ Accordingly, the court awarded judgment for plaintiff.⁵²

⁴⁰ Comment, *supra* note 30, at 561. In fact, the plane never left the ground. *Id.*

⁴¹ *Id.*

⁴² *Id.* Initially, Smith and French managed to escape the aircraft, but their sons could not be freed. *Id.* Both sons burned to death in the plane, but Smith lived for a period of five days before he died. *Id.*

⁴³ *Id.*

⁴⁴ *Id.* Specifically, plaintiffs argued that the fuel line system was unreasonably dangerous. *Id.* n.58.

⁴⁵ Saba, *supra* note 2, at 310.

⁴⁶ No. 203674, slip op. (Cal. Super. Ct. Feb. 1973) (cited in Saba, *supra* note 2, at 311 n.125).

⁴⁷ Comment, *supra* note 30, at 562.

⁴⁸ *Id.*

⁴⁹ *Id.*

⁵⁰ *Id.*

⁵¹ *Id.*

⁵² *Id.* Judgment for plaintiff was in the sum of \$432,000. *Id.*

Four years after *Fuller*, a Nevada court allowed recovery to a plaintiff in a similar case. In *Eichstedt v. Cessna Aircraft Co.*,⁵³ decedent was a passenger in a Cessna airplane which crashed into the wall of a canyon.⁵⁴ Upon impact, decedent's seat broke loose from the floor of the plane and, as a result, he suffered serious injuries.⁵⁵ Although he managed to escape from the wreckage under his own power, these injuries subsequently resulted in his death.⁵⁶ Decedent's survivors brought suit against Cessna, claiming that improper installation of the seatbelts in the plane, the absence of shoulder harnesses, and inadequate anchorage of the seats resulted in decedent's death.⁵⁷ On the basis of these claims, the jury found in favor of the plaintiffs and awarded a substantial recovery.⁵⁸

*McGee v. Cessna Aircraft Co.*⁵⁹ presented the California courts with an opportunity to apply the doctrine of crashworthiness to allow recovery for injuries suffered in a fire which broke out in a small plane after a crash. In *McGee*, the plaintiff was among four passengers in a Cessna airplane that crashed in hilly terrain shortly after take off from the San Diego County airport.⁶⁰ She and another passenger were thrown forward and rendered unconscious by the impact of the crash,⁶¹ but suffered only minor injuries as a result of the impact itself.⁶² However, the force of the impact caused the nose wheel strut, located in the nose of the airplane, to collapse.⁶³ This col-

⁵³ No. 282029, slip op. (Nev. Dist. Ct., Aug. 1977) (cited in Saba, *supra* note 2, at 311 n.128).

⁵⁴ Comment, *supra* note 30 at 562.

⁵⁵ *Id.*

⁵⁶ *Id.*

⁵⁷ *Id.* The claims sought recovery under warranty, negligence, and strict liability theories. *Id.*

⁵⁸ *Id.* The jury awarded plaintiffs the sum of \$900,000. *Id.* Again, as in the previous cases, the court's opinion was not reported.

⁵⁹ 82 Cal. App. 3d 1005, 147 Cal. Rptr. 694 (1978).

⁶⁰ 147 Cal. Rptr. at 695.

⁶¹ *Id.* Each of the occupants was wearing a seatbelt, but there were no shoulder harnesses to provide further protection. *Id.*

⁶² *Id.*

⁶³ *Id.*

lapse ruptured a fuel tank which was located in the nose, and caused fuel to escape into a combustible area.⁶⁴ The resulting fire reached the cabin almost immediately.⁶⁵ The two conscious passengers managed to escape the aircraft and pull the unconscious passengers to safety, but plaintiff suffered severe burns on her legs as a result of the fire.⁶⁶ She brought suit against Cessna, asserting strict liability and negligence claims.⁶⁷ At trial, the jury found in favor of Cessna on these claims and refused to grant recovery.⁶⁸ On appeal, the court of appeals rejected Cessna's contention that the crashworthiness doctrine should not apply to aircraft manufacturers,⁶⁹ and held that the design of the airplane's fuel system could be evaluated under principles of strict liability in tort.⁷⁰

In assessing Cessna's potential liability in this case, the court applied the concept of crashworthiness, which it had previously accepted in the context of automobile crash litigation.⁷¹ It ruled, as it had in previous automobile cases, that a manufacturer has a duty to foresee some misuse of its products, and to take reasonable precautions to enhance the safety of any person who might be endangered

⁶⁴ *Id.* Cessna had designed the airplane to contain an "accumulator tank" in the nose, near the cockpit. *Id.* This tank essentially "intercepted" the flow of gasoline from the fuel tanks in the wings to the engine and carburetor in the nose of the airplane. *Id.*

⁶⁵ *Id.*

⁶⁶ *Id.* The plaintiff suffered extensive third-degree burns on both her legs which required amputation of her right leg just below the knee and of her left leg just below the hip joint. *Id.*

⁶⁷ *Id.* Specifically, the plaintiff asserted that the fuel system's design caused the plane to be inherently unsafe, and that the defendant manufacturer knew, or should have known, that the nosewheel strut could collapse in a minor crash landing, thus puncturing any fuel tank which might be located in the area. *Id.*

⁶⁸ *Id.*

⁶⁹ *Id.* at 702. Cessna argued that the matter of providing standards for the crashworthiness of aircraft is best left to the legislature. *Id.*

⁷⁰ *Id.* Ultimately, the plaintiff lost on remand. Comment, *supra* note 30, at 563.

⁷¹ See *supra* note 29 for a brief discussion of the doctrine of crashworthiness in automobile accident litigation. California adopted the concept of crashworthiness in the case of *Cronin v. J.B.E. Olson Corp.*, 8 Cal. 3d 121, 501 P.2d 1153, 104 Cal. Rptr. 433 (1972). The *Cronin* court also held that the courts may award damages in such cases under the doctrine of strict liability in tort. See *Cronin*, 501 P.2d at 1162.

by such misuse.⁷² When a manufacturer breaches this duty by designing a product in such a manner that the product's misuse results in injuries which could have been avoided or minimized by a feasible alternative design, the manufacturer may appropriately be subject to liability for these injuries.⁷³

B. *Cases in Which Courts Have Approached the Doctrine of Crashworthiness*

In addition to those courts that have allowed recovery to aviation accident victims under the doctrine of crashworthiness, other courts have explicitly or implicitly recognized that the doctrine is applicable in the aviation context without allowing recovery under the doctrine. The opinions in these cases may supply authority for recovery under the doctrine, provided the plaintiff can establish that the injuries he or she suffered resulted from defective design of the aircraft.

In *Trust Corp. v. Piper Aircraft Corp.*,⁷⁴ an aircraft struck a telephone wire shortly after take off and crashed.⁷⁵ As a result of this crash, all of the passengers on board the aircraft were severely injured or killed.⁷⁶ Plaintiff, as personal representative of one of the deceased passengers, brought suit against the defendant manufacturer based upon strict tort liability.⁷⁷ Specifically, plaintiff claimed that the passenger restraint system, which was not equipped with shoulder harnesses, was a dangerous defect which enhanced the decedent's injuries.⁷⁸ The defendant manufacturer asserted that the restraint system

⁷² *McGee*, 147 Cal. Rptr. at 698. Specifically, "[t]he manufacturer must evaluate the crashworthiness of his product and take such steps as may be reasonable and practicable to forestall particular crash injuries and mitigate the seriousness of others." *Id.*

⁷³ *See id.* at 698-702. In this particular case, the trial court, upon remand, ultimately denied recovery to the plaintiff. Comment, *supra* note 30, at 563.

⁷⁴ 506 F. Supp. 1093 (D. Mont. 1981).

⁷⁵ *Id.* at 1094.

⁷⁶ *Id.*

⁷⁷ *Id.*

⁷⁸ *Id.*

was not defective and that the concept of contributory negligence barred plaintiff's motion to strike the defendant manufacturer's defenses which were based upon contributory negligence.⁷⁹

In its opinion, the district court stated that an injured plaintiff may maintain an action to recover for injuries enhanced by a defective aircraft design, even though the defect did not cause the accident which resulted in the plaintiff's injuries.⁸⁰ Under the court's approach, a plaintiff may recover if he or she can prove that the defect is at least "a substantial cause of [his or her] injuries," regardless of whether it was a factor contributing to the occurrence of the accident itself.⁸¹ The court noted that the plaintiff in this case could recover if it could prove that the crash which killed the decedent was survivable, that the absence of a shoulder harness system constituted an unreasonably dangerous defect, and that the defect actually caused the decedent's injuries.⁸² While the court recognized the propriety of recovery in the event that these facts could be established, it further recognized that the

⁷⁹ *Id.* at 1095. The defendant manufacturer asserted, *inter alia*, that: (1) the decedent's injuries were due to his own negligence (decedent was the pilot), (2) the decedent assumed the risk of such injuries, and (3) the decedent misused the aircraft. *Id.*

⁸⁰ *Id.* at 1094. The court stated:

A second collision action is viable even though the cause of the accident was not the defective condition alleged to have enhanced the injuries. In a crashworthiness case such as this, plaintiff must prove that the defect, though not necessarily the proximate cause of the accident, was, at least, a substantial cause of injuries.

Id. (citations omitted). The court ruled that the Montana Supreme Court, if deciding the case, would apply comparative negligence principles and, thus, would reduce plaintiff's recovery based upon the decedent's percentage of fault. *Id.* at 1095. For a discussion of contributory negligence and comparative negligence, see W. PROSSER & P. KEETON, PROSSER AND KEETON ON TORTS §§ 65, 67 (5th ed. 1984).

⁸¹ See *Trust Corp.*, 506 F. Supp. at 1094. The court cited the case of *Brandenburger v. Toyota Motor Sales*, 162 Mont. 506, 513 P.2d 268 (1973), which established the crashworthiness doctrine in Montana. See *Trust Corp.*, 506 F. Supp. at 1094. Although that case involved an automobile accident rather than an airplane crash, the court did not appear to have any difficulty in applying its principles to the case at hand. See *id.*

⁸² *Trust Corp.*, 506 F. Supp. at 1094.

defendant should not be subject to liability for all of plaintiff's injuries.⁸³ Instead, it stated that recovery should be limited to the extent that the actual injuries exceed the injuries which would have resulted from the accident in the absence of the defect.⁸⁴

*Bruce v. Martin-Marietta Corp.*⁸⁵ involved the crash of an airplane chartered to carry the Wichita State University football team to a game in Utah.⁸⁶ Upon impact, a number of the seats in the cabin broke loose from their supports.⁸⁷ These broken seats piled up in the front of the cabin and blocked the exits.⁸⁸ Subsequently, a post-crash fire swept through the cabin where the forty passengers were trapped, burning thirty-two passengers to death.⁸⁹ The surviving passengers, and representatives of the deceased, brought a products liability action against the defendant manufacturer, claiming that the seat fastenings were inadequate to withstand a crash, and that the defendant manufacturer did not take proper design measures to minimize the risk that a post-crash fire would occur.⁹⁰ While the Tenth Circuit affirmed a judgment in favor of the manufacturer, it did not reject the application of the doctrine of crashworthiness to aircraft accident cases.⁹¹ Instead, the court based its decision upon its finding that plaintiffs failed to meet their burden of proof

⁸³ *Id.*

⁸⁴ *Id.* The court stated:

Any design defect not causing the accident would not subject the manufacturer to liability for the entire damage, but the manufacturer should be liable for that portion of the damage or injury caused by the defective design over and above the damage or injury that probably would have occurred as a result of the impact or collision absent the defective design.

Id. (quoting *Larsen*, 391 F.2d at 503); see *supra* note 29 for a discussion of *Larsen*.

⁸⁵ 544 F.2d 442 (10th Cir. 1976).

⁸⁶ *Id.* at 444. The airplane was manufactured in 1952, some 18 years before the crash occurred. *Id.*

⁸⁷ *Id.*

⁸⁸ *Id.*

⁸⁹ *Id.*

⁹⁰ *Id.* The plaintiffs proceeded under warranty, negligence, and strict liability theories. *Id.*

⁹¹ See *id.* at 446-49.

in establishing the fact that the airplane was, in fact, defective.⁹²

Unlike the court in *Trust Corp.*,⁹³ the *Bruce* court drew a firm distinction between design defect cases grounded upon a theory of negligence, and those grounded upon strict liability.⁹⁴ Although the plaintiff in *Bruce* ultimately failed to prove to the satisfaction of the court that the airplane's lack of certain safety features constituted a defect, the court never questioned the fact that, upon a proper showing, the plaintiff in a case such as this could recover under a negligence theory.⁹⁵ However, the court stated that, under the applicable law, the plaintiff in an aircraft design defect case could *not* recover in strict liability.⁹⁶

The *Bruce* court's dichotomy between negligence and strict liability with respect to the availability of recovery under the doctrine of crashworthiness was not peculiar to aviation accident cases. In fact, the court did not distinguish aviation cases from automobile crashworthiness cases (which are now well established),⁹⁷ but, instead, stated that the same principles apply in both types of cases.⁹⁸ Thus, the *Bruce* opinion is quite favorable for the proposition that automobile crashworthiness concepts, to

⁹² *Id.* at 449. The 10th Circuit stated, "[T]o prove liability under § 402A [of the Restatement (Second) of Torts] the plaintiff must show that the product was dangerous beyond the expectation of the ordinary consumer." *Id.* at 447. In making this determination, the court may consider evidence which tends to show that the product was within the state of the art at the time it was designed and manufactured, because such evidence "helps to determine the expectation of the ordinary consumer." *Id.* The plaintiffs did not succeed in this case because they failed to show that an ordinary consumer would expect a 1952 airplane to contain the safety features of a 1970 airplane. *Id.* For a discussion of the "consumer expectation" standard for liability, see *infra* notes 201-214 and accompanying text.

⁹³ 506 F. Supp. at 1093; see *supra* notes 74-83 for a discussion of this case.

⁹⁴ See *Bruce*, 544 F.2d at 448-49.

⁹⁵ See *id.* at 445-47.

⁹⁶ See *id.* at 448. The court, in holding as it did, stated, "Regardless of whether the theory of § 402A of the Restatement should be accepted in other contexts, we are convinced that it has no proper application to liability for design defects in motor vehicles." *Id.* (quoting *Volkswagen of America v. Young*, 272 Md. 201, 321 A.2d 737 (1974)).

⁹⁷ See *supra* text accompanying note 30.

⁹⁸ See *Bruce*, 544 F.2d at 448. Maryland does not recognize the doctrine of strict liability in automobile design defect cases. See *supra* note 95. The court stated

the extent they are recognized, should be extended to cover aircraft crashworthiness litigation.⁹⁹

The Supreme Court of Oregon had occasion to consider the doctrine of crashworthiness as applied to aviation accident litigation in *Wilson v. Piper Aircraft Corp.*¹⁰⁰ In *Wilson*, the decedents were among four passengers in a general aviation aircraft which crashed in the Cascade Mountains near Oakridge, Oregon.¹⁰¹ All four passengers survived the initial impact of the crash, but three of the four died before rescue workers could arrive at the crash site.¹⁰² Personal representatives of two of the decedents filed wrongful death actions against the defendant manufacturer of the aircraft, alleging, *inter alia*, that the defendant's failure to provide crashworthy shoulder harnesses and seat belt attachments contributed to the decedent's injuries.¹⁰³ The trial court found in favor of the plaintiffs on these and other claims.¹⁰⁴ The Oregon Supreme Court reversed the decision of the trial court, but did not reject the doctrine of crashworthiness in denying recovery.¹⁰⁵ Thus, it appears that the court would have allowed the crashworthiness claim had the plaintiff's evidence been more persuasive.¹⁰⁶

that "[this] principle is applicable to a § 402A case involving design defects in airplanes." *Bruce*, 544 F.2d at 448.

⁹⁹ See *Bruce*, 544 F.2d at 448.

¹⁰⁰ 282 Or. 61, 577 P.2d 1322 (1977).

¹⁰¹ *Id.* at 1324.

¹⁰² *Id.*

¹⁰³ *Id.* at 1329. The two front seats of the aircraft were equipped with shoulder harnesses, but the two back seats, in which plaintiff's decedents were sitting, were not so equipped. *Id.* The plaintiff alleged that the failure to provide shoulder harnesses was an "unreasonably dangerous" design defect. *Id.*

¹⁰⁴ *Id.* at 1322.

¹⁰⁵ The court's reversal as to crashworthiness rested largely upon its exclusion from evidence of two films which had been admitted at trial to demonstrate the necessity of shoulder harnesses for safety in the event of a crash. See *id.* at 1329-31. The court excluded one film on hearsay grounds and the other on the ground that its prejudicial effect substantially outweighed its probative value. See *id.*

¹⁰⁶ Comment, *supra* note 30, at 561. The court stated that "[o]ne of the important issues in the case was whether the airplane was dangerously defective because of the type of lap belt assembly used and because of the failure to provide shoulder harnesses." *Wilson*, 577 P.2d at 1329. The fact that the court identified

The cases in this section serve to illustrate the fact that the courts have typically not drawn a distinction between crashworthiness claims in automobile cases and similar claims in aviation cases.¹⁰⁷ Still, the fact remains that few courts have actually addressed the issue of crashworthiness as it pertains to general and commercial aviation accidents.¹⁰⁸ As a result, there has been little opportunity to develop a satisfactory means of determining how the doctrine should operate in the technical and complex area of aviation. The next section will address the important and difficult problem of determining whether a particular aircraft design is defective for the purpose of imposing liability under the doctrine of crashworthiness.¹⁰⁹

III. STANDARDS FOR DEFINING "DEFECT" IN AIRCRAFT DESIGN

If the tort system is to determine whether failure to provide certain crashworthiness features constitutes a "defect" for purposes of strict liability actions in aviation accidents, the courts must develop a suitable standard with which to make this determination. Unfortunately, this is much easier said than done. There are many standards from which the courts may choose, but each has its limitations.¹¹⁰ Accordingly, the courts have failed to reach a uniform consensus as to which standard to apply.¹¹¹

crashworthiness as an issue and took evidence on the point is indicative of the court's willingness to allow the claim. *See id.* at 1329-31.

¹⁰⁷ *See supra* note 32 for several arguments in favor of allowing crashworthiness claims in aviation cases.

¹⁰⁸ Although most of the cases in this section involve general aviation aircraft, there is no real reason for distinguishing availability of the doctrine of crashworthiness on the basis of the type of aircraft in question, and the author knows of no court which has ever done so.

¹⁰⁹ While the doctrine of crashworthiness should be available in aviation accidents as it is in automobile accidents, the technical complexity of modern aircraft may well justify application of a separate standard for determining what constitutes a defect under the two types of cases. *See infra* notes 275-278 and accompanying text.

¹¹⁰ *See infra* notes 111-228 and accompanying text.

¹¹¹ Saba, *supra* note 2, at 319. For an excellent discussion of the various stan-

This section will identify the possible standards, and point out the relative strengths and weakness of each.

A. *Federal Regulations Regarding Crash Safety Measures*

Over sixty years ago, the United States Congress realized the need to promulgate standards regulating aviation operations.¹¹² It originally assigned this task to the Department of Commerce, which enacted the first federal standards for aircraft in 1926.¹¹³ In 1938, Congress substantially broadened federal authority in the area of aviation safety, and reassigned the task of administering aviation safety programs to the Civil Aeronautics Board (CAB).¹¹⁴ Twenty years later, Congress passed the Federal Aviation Act of 1958, which established the Federal Aviation Administration (FAA) and made it responsible for aviation safety.¹¹⁵ Today, the FAA continues to administer aviation safety programs and to issue Federal Aviation Regulations (FARs), which provide minimum standards for the aviation industry.¹¹⁶

Despite the comprehensive nature of the FAR's, very few regulations specifically provide for standards which would enhance the crashworthiness of aircraft. In fact, *no* FAR contains the term "crashworthiness."¹¹⁷ Many commentators note that those regulations which are *related* to crashworthiness fail miserably to provide adequate safety standards because they are outdated.¹¹⁸ This sec-

dards by which the courts have defined "defect," see *id.* at 319-38. A great deal of the following discussion is based upon this analysis.

¹¹² SAFETY REPORT, *supra* note 3, at 12.

¹¹³ *Id.*

¹¹⁴ *Id.*

¹¹⁵ *Id.* at 13.

¹¹⁶ The FAA, among other powers, has the power to promulgate "[such] minimum standards governing the design, materials, workmanship, construction, and performance of aircraft, aircraft engines, and propellers as may be required in the interest of safety." 49 U.S.C.A. § 1421(a)(1) (West 1976). FARs issued by the FAA are contained in 14 C.F.R. §§ 1-1262 (1987).

¹¹⁷ D.CATHCART, *supra* note 14, at 269.

¹¹⁸ See, D.CATHCART, *supra* note 14, at 277; Dillingham, *Crashworthiness FARs and the Effect of Compliance in Products Liability Actions Involving Airplanes*, 33 FED'N INS. COUNS. Q. 55 (1982); Comment, *supra* note 30, at 563; Galerstein, *Aircraft*

tion will discuss the standards embodied in these regulations as they apply to important problem areas of crashworthiness.

1. *Structural Integrity of the Airframe*

In order for the occupants of an aircraft cabin to remain safe in the event of a crash, the cabin itself must remain intact.¹¹⁹ If the force of a crash results in mutilation of the frame of the aircraft, its passengers face the danger of being thrown from the aircraft or of being crushed.¹²⁰ Ideally, the airframe structure of the aircraft should be sufficiently sturdy to form a "protective shell" around the passengers in the event of a crash, thus avoiding these dangers.¹²¹

FAR 23.561 provides a minimum federal standard regarding the ability of a general aviation aircraft to withstand the forces of an emergency landing.¹²² Under this provision, the structure of the aircraft must be designed to "give each occupant every reasonable chance of escaping serious injury in a minor crash landing" when the occupant experiences an ultimate inertial force of nine "g's" in the forward direction.¹²³

The minimum force requirements of FAR 23.561 are, quite simply, unrealistic. One commentator notes that, historically, the inertia force requirements in the section date back to 1946.¹²⁵ While the section requires protec-

Crashworthiness: Who Sets the Standard?, 28 FED'N INS. COUNS. Q. 258, 264 (1978). One of these commentators states that the standards promulgated by the FAA are "approximately forty years behind the state of the art." D.CATHCART, *supra* note 14, at 277.

¹¹⁹ Saba, *supra* note 2, at 292.

¹²⁰ *Id.*; see Thompson & Clark, *General Aviation Crashworthiness*, in AIRCRAFT CRASHWORTHINESS 45 (K. Saczalski ed. 1975).

¹²¹ Saba, *supra* note 2, at 292.

¹²² 14 C.F.R. § 23.561 (1986). For commercial aviation aircraft standards, see 14 C.F.R. § 25.561 (1986).

¹²³ The term "g" refers to the gravitational attraction upon objects at sea level. SAFETY REPORT, *supra* note 3, at 5 n.5. This may be expressed as 32.2 ft./sec.² *Id.*

¹²⁴ *Id.* FAR 23.561 also requires that the structure be able to withstand forces on the occupant of three "g's" vertically and 1.5 "g's" horizontally. *Id.*

¹²⁵ See D.CATHCART, *supra* note 14, at 278. The author states that these stan-

tion for the passengers up to the ultimate inertia force of nine "g's" in the forward direction, studies have shown that the human body can withstand forty "g's" without suffering broken bones and other internal injuries.¹²⁶ Clearly, aircraft structures which provide only the minimum safety features required by FAR 23.561 will fail to protect passengers in crashes which should, in fact, be survivable.¹²⁷

Aside from the fact that FAR 23.561 does not adequately reflect the ability of the human body to withstand "g" forces, it does not recognize the modern state-of-the-art in aircraft design. Experts have known for quite some time that harder metals in the nose of the aircraft will decrease the likelihood that the fuselage will collapse in the event of a crash, and will reduce the likelihood that the nose will dig in upon impact.¹²⁸ However, the FAA has failed to officially recognize these developments, and the regulation remains as it was forty years ago.¹²⁹

2. *Passenger Restraint Systems*

Aside from structural concerns, which focus essentially upon the aircraft's exterior, manufacturers must also concern themselves with providing adequate passenger restraint systems in the interior of the aircraft. Without these restraints, passengers and seats may become "missiles," which create very real hazards during a crash sequence.¹³⁰

FAR 23.785 recognizes these dangers by requiring that each passenger in a commercial aviation aircraft be protected by a safety belt and shoulder harness.¹³¹ FAR

dards "did not represent the state of the art at that time, and certainly do not represent the state of the art decades later." *Id.* at 279.

¹²⁶ Saba, *supra* note 2, at 292.

¹²⁷ See *supra* note 16.

¹²⁸ Saba, *supra* note 2, at 292.

¹²⁹ See *supra* text accompanying note 30.

¹³⁰ Saba, *supra* note 2, at 293.

¹³¹ 14 C.F.R. § 23.785(g) (1986). Specifically, subsection (g) provides as follows:

Each occupant must be protected from serious head injury when

25.785 imposes a similar regulation for general aviation aircraft.¹³² The provision requiring a shoulder harness is relatively new, but is a very important addition to the safety requirements issued by the FAA.¹³³ Without these shoulder harnesses, simple lap belts would provide little protection for passengers. In a crash, lap belts provide restraint only for the passenger's pelvis, allowing his or her head, torso, and appendages to fly freely about, possibly being struck by flying objects.¹³⁴ Shoulder harnesses allow the passenger's head, torso, and appendages to remain intact despite the force of a crash, reducing the potential for injuries and fatalities.¹³⁵

Despite the potential effect of the shoulder harness requirement in FAR 23.785(g), another provision in the same subsection severely minimizes the positive impact of this requirement. While each passenger is to be protected by a safety belt and shoulder harness, these devices need only be durable enough to withstand the ultimate inertia forces specified in FAR 23.561(b)(2).¹³⁶ As mentioned earlier, the standards in 23.561(b)(2) are inadequate to provide even a reasonable degree of safety to passengers in the event of a survivable crash.¹³⁷ Thus, FAR 23.785 suffers from the same flaw as FAR 23.561: the human body is far better able to withstand the deceleration force

subjected to the inertia forces prescribed in § 23.561(b)(2) [see note 29 and accompanying text] for normal, utility, and acrobatic category airplanes, by a safety belt and shoulder harness that is designed to prevent the head from contacting any injurious object for each forward-and aft-facing seat.

Id.

¹³² See 14 C.F.R. § 25.785(c) (1986).

¹³³ In his article in 1983, Saba noted that there was no such requirement in the FARs. See Saba, *supra* note 2, at 294-95.

¹³⁴ *Id.* at 294. In 1964, the CAB studied 25 general aviation aircraft accidents involving 826 fatalities. After the study, the CAB concluded that 200 of these fatalities could have been avoided if the aircraft involved had been equipped with shoulder harnesses for their passengers. SAFETY REPORT, *supra* note 3, at 2.

¹³⁵ See SAFETY REPORT, *supra* note 3, at 2-6.

¹³⁶ 14 C.F.R. § 23.785(b)(1986); see also *supra* notes 121-126 and accompanying text.

¹³⁷ See *supra* note 125 and accompanying text.

of a crash than the equipment designed to protect it.¹³⁸ When this is the case, otherwise survivable accidents will result in avoidable injuries and deaths.¹³⁹

It should be noted that many of the same dangers giving rise to passenger restraint systems also require that the seats themselves be properly anchored to avoid being broken loose from the floor by deceleration forces. Clearly, safety belts and shoulder harnesses will be much less effective (if effective at all) when the seats to which they are attached break loose.¹⁴⁰ Once again, however, the regulations provide that the seats be anchored to withstand only those forces specified in FAR 23.561(b)(2).¹⁴¹

3. *Post-Crash Hazards*

The previous two sections dealt with FARs related to the dynamic phase of the crash.¹⁴² This section will deal with FARs related to the "static" phase. The static phase of an accident occurs after the crash itself, when the passengers are engaged in an emergency evacuation of the aircraft.¹⁴³ During this time, any number of events may result in injury and death to the passengers.¹⁴⁴ Of course, a manufacturer may not be able to avoid a number of these hazards, as they may result from such factors as "the passengers' behavior, the exterior environment, the weather, and the time of day or night of the crash."¹⁴⁵

¹³⁸ See *supra* text accompanying note 126.

¹³⁹ See *supra* note 126 and accompanying text.

¹⁴⁰ See D.CATHCART, *supra* note 14, at 284.

¹⁴¹ 14 C.F.R. § 23.785(a)(1986). This subsection states that [e]ach seat, berth, and its supporting structure, must be designed for occupants weighing at least 170 pounds . . . , and for the maximum load factors corresponding to the specified flight and ground load conditions, including the emergency landing conditions prescribed in § 23.561.

Id.

¹⁴² See *supra* notes 119-140 and accompanying text. The dynamic phase of the crash is the period of initial impact. Saba, *supra* note 2, at 296.

¹⁴³ Saba, *supra* note 2, at 296.

¹⁴⁴ See *infra* notes 146-197 and accompanying text.

¹⁴⁵ Saba, *supra* note 2, at 297.

However, a number of factors affecting survivability during this phase of a crash are well within the control of aircraft manufacturers.¹⁴⁶ Two of the most important factors are control of post-crash fires and design of the aircraft to allow safe, rapid egress by the passengers.

a. *Control of Post-Crash Fires*

"Fire is the four-letter word of airline safety."¹⁴⁷ In fact, post-crash fires are quite likely, and may spread rapidly when large quantities of uncontained fuel are ignited.¹⁴⁸ Such fires are often responsible for a majority of deaths in survivable crashes.¹⁴⁹ Aside from the heat of the fire itself, many injuries and deaths may result from toxic gases emitted by the flames, and from black smoke which fills the cabin and so impairs visibility that passengers cannot find their way to the emergency exits.¹⁵⁰

FAR 23.1191 addresses these hazards by requiring that each engine on a general aviation aircraft be isolated from the rest of the aircraft by a firewall.¹⁵¹ These firewalls must be fireproof,¹⁵² and must be constructed so that "no hazardous quantity of liquid, gas, or flame can pass from the engine compartment to other parts of the airplane".¹⁵³ In order to comply with FAR 23.1191, a firewall must be able to resist flame penetration for at least

¹⁴⁶ *Id.*

¹⁴⁷ Nolan, *supra* note 1, at 38.

¹⁴⁸ Saba, *supra* note 2, at 299.

¹⁴⁹ See Bullock, *Survivability in Aircraft Fires: New Standards are Needed*, 34 INTERAVIA 557 (1979). The author notes that 95 percent of air crash fatalities occur when a post-crash fire is involved and that, of these fatalities, 40 percent may be attributed to the fire itself. *Id.* For specific instances in which fires have resulted in literally hundreds of deaths in survivable crashes, see Nolan, *supra* note 1, at 38.

¹⁵⁰ Nolan, *supra* note 1, at 38-41; see also D.CATHCART, *supra* note 14, at 29.

¹⁵¹ 14 C.F.R. § 23.1191 (1986). Subsection (a) states that "[e]ach engine, auxiliary power unit, fuel burning heater, and other combustion equipment intended for operation in flight, must be isolated from the rest of the airplane by firewalls, shrouds, or equivalent means." *Id.* § 23.1191(a). 14 C.F.R. § 25.1181 (1986) contains a similar provision for commercial aviation aircraft.

¹⁵² *Id.* § 23.1191(e).

¹⁵³ *Id.* § 23.1191(b).

fifteen minutes¹⁵⁴ at a temperature of 1950 degrees to 2050 degrees Fahrenheit.¹⁵⁵ If these firewalls work as they should, any fire in the engine or fuel tank will not spread into the occupied parts of the aircraft before the passengers exit safely. The safety features required by FAR 23.1191 appear to be adequate,¹⁵⁶ but they have, in fact, failed to achieve the level of safety for which they were designed.¹⁵⁷

While FAR 23.1191 regulates the ability of the aircraft to isolate any engine fire from the cabin, another provision, FAR 23.853, addresses the ability of the cabin's interior to withstand any fire which originates in or reaches the area.¹⁵⁸ The provision simply states that the materials for each compartment used by the crew or passengers must be flame-resistant.¹⁵⁹ In addition, FAR 23.853 specifies means to avoid cigarette fires by dictating that no lines, tanks, or equipment containing flammable fluids may be installed in passenger compartments unless they are installed in such a manner that their failure would not create a fire hazard.¹⁶⁰ The regulation further states that any materials on the cabin side of a firewall must be either self-extinguishing or located at such a distance from the firewall that they will not ignite when the firewall is subjected to a flame temperature of "not less than 2000 degrees F for 15 minutes".¹⁶¹

The provisions of FAR 23.853 are primarily prophylactic, and in fact, may fail to provide adequate protection to passengers once a fire has started in the cabin, or has pen-

¹⁵⁴ *Id.* § 23.1191(g).

¹⁵⁵ *Id.* § 23.1191(f)(1).

¹⁵⁶ For instance the 2000 degree Fahrenheit requirement may, in fact, be sufficient to contain most fuel fires, because fuel fires usually burn at a temperature somewhere between 1700 degrees and 2000 degrees Fahrenheit. See D.CATHCART, *supra* note 14, at 290.

¹⁵⁷ *See id.*

¹⁵⁸ 14 C.F.R. § 23.853 (1986).

¹⁵⁹ *Id.* § 23.853(a).

¹⁶⁰ *Id.* § 23.853(d).

¹⁶¹ *Id.* § 23.853(e). This should serve to protect the cabin for as long as the firewall itself will hold up. *See id.* § 23.1191(g).

etrated the cabin from without.¹⁶² When exposed to heat, many nonmetallic cabin materials, such as curtains, carpets, and seat cushions, emit toxic gases.¹⁶³ These gases may asphyxiate the passengers, or rise and collect along the ceiling where they may ignite, engulfing the entire cabin in flames.¹⁶⁴ Despite these dangers, the FAA has not issued a single rule regarding toxic gas emissions in well over a decade.¹⁶⁵

b. *Design Factors Allowing Safe Egress*

Clearly, safe exit from the crashed aircraft must be the ultimate objective of those who are concerned with crash-worthy design. Construction of firewalls and other safety mechanisms is of little worth if the passengers aboard a crashed aircraft cannot exit within the extra time these devices will afford. Therefore, as a necessary complement to the safety concerns already discussed, aircraft manufacturers must design their products to allow hasty exit by the passengers in the event of an emergency.¹⁶⁶

One of the primary concerns in providing for the safe exit of passengers after a crash is designing and constructing a sufficient number of operable emergency exits.¹⁶⁷ The key word here is "operable." Often, the force of a crash will deform the exterior of the aircraft, causing emergency exit doors to jam.¹⁶⁸ When this occurs, passengers have no quick means of escape, and may fall victim to post-crash fires or other hazards.¹⁶⁹ Even if the doors are operable after the crash, they may be too small or the procedure to open them may be too complex.¹⁷⁰

¹⁶² D.CATHCART, *supra* note 14, at 290-91.

¹⁶³ *Id.* at 296.

¹⁶⁴ *Id.*

¹⁶⁵ See Saba, *supra* note 2, at 300.

¹⁶⁶ See D.CATHCART, *supra* note 14, at 285.

¹⁶⁷ Bullock, *supra* note 148, at 558.

¹⁶⁸ D.CATHCART, *supra* note 14, at 286.

¹⁶⁹ See Nolan, *supra* note 1, at 44. "When a Pan Am 707 crash-landed and burned in Pago Pago in January 1974, only four passengers survived. The bodies of the rest were found piled up behind a forward door that never opened." *Id.*

¹⁷⁰ Saba, *supra* note 2, at 298-99. To add to the confusion, emergency door

To deal with these concerns, the FAA promulgated FAR 23.807.¹⁷¹ This regulation provides that each aircraft must have a sufficient number of emergency exits which are "located to allow escape without crowding in any probable crash attitude."¹⁷² These exits must be large enough to provide an unobstructed opening through which an object measuring nineteen-by-twenty-six inches could pass.¹⁷³ In addition, the exits must be readily accessible,¹⁷⁴ simple to open,¹⁷⁵ easy to locate,¹⁷⁶ and reasonably difficult to jam.¹⁷⁷

FAR 23.807, though it provides necessary standards for emergency exits, contains no objective criteria by which to judge compliance with these standards.¹⁷⁸ When is a method of opening "simple and obvious?"¹⁷⁹ What are "reasonable provisions against jamming by fuselage deformation?"¹⁸⁰ The regulation is silent as to these questions, simply stating that operators must periodically conduct "tests" to determine the proper functioning of each emergency exit.¹⁸¹ However, there is no provision specifying the manner of criteria to be used on these "tests."¹⁸² As a result of their enigmatic nature, the provisions of FAR 23.807 provide little guidance.

While FAR 23.807 is of little guidance in providing objective criteria concerning safe evacuation of a crashed aircraft, FAR 25.803, which deals with emergency evacua-

handles in aircraft may look like "levers or switches" rather than handles, and may be located at some distance from the door itself. D.CATHCART, *supra* note 14, at 286.

¹⁷¹ 14 C.F.R. § 23.807 (1986).

¹⁷² *Id.* § 23.807(a).

¹⁷³ *Id.* § 23.807(b).

¹⁷⁴ *Id.* § 23.807(b)(1).

¹⁷⁵ *Id.* § 23.807(b)(2).

¹⁷⁶ *Id.* § 23.807(b)(3).

¹⁷⁷ *Id.* § 23.807(b)(4).

¹⁷⁸ D.CATHCART, *supra* note 14, at 285.

¹⁷⁹ See 14 C.F.R. § 23.807(b)(2) (1986).

¹⁸⁰ See *id.* § 23.807(b)(4).

¹⁸¹ *Id.* § 23.807(c).

¹⁸² D.CATHCART, *supra* note 14, at 285.

tion, contains much more detailed requirements.¹⁸³ This regulation specifies that an aircraft with a seating capacity of at least forty-four passengers must undergo a demonstration to show that all passengers on board may evacuate from the aircraft to the ground within ninety seconds.¹⁸⁴ FAR 25.803 imposes a number of requirements so that these demonstrations may best simulate real life conditions in the event of a crash.¹⁸⁵ For instance, these demonstrations must be conducted "in the dark of the night" or in simulated darkness conditions during daylight hours.¹⁸⁶ In addition, the demonstration "passenger" group must contain a specified percentage of female,¹⁸⁷ juvenile,¹⁸⁸ and elderly¹⁸⁹ "passengers."¹⁹⁰ Finally, the "passengers" in the demonstration must have access to no more than fifty percent of the emergency exits in the aircraft,¹⁹¹ with no prior information as to which exits will and will not be available for use.¹⁹²

On its face, FAR 25.803 appears to provide reasonable assurance that manufacturers who comply with its provisions will produce airplanes that *can* be evacuated before

¹⁸³ See 14 C.F.R. § 25.803 (1986).

¹⁸⁴ See *id.* § 25.803(c)(1)-(20).

¹⁸⁵ *Id.* § 25.803(c).

¹⁸⁶ *Id.* § 25.803(c)(1).

¹⁸⁷ *Id.* § 25.803(c)(8)(i). At least 30 percent of the "passengers" must be female. *Id.*

¹⁸⁸ *Id.* § 25.803(c)(8)(iii). Between five and ten percent of the "passengers" must be under the age of 12. *Id.*

¹⁸⁹ *Id.* § 25.803(c)(8)(ii). At least five percent of the "passengers" must be over 60 years of age. *Id.*

¹⁹⁰ It is important to note that "crewmembers, mechanics, and training personnel who maintain or operate the airplane in the normal course of their duties" are not eligible to serve as "passengers" for these demonstrations. *Id.* § 25.803(c)(8)(v).

¹⁹¹ *Id.* § 25.803(c)(17). This subsection further states,

Exits that are not to be used in the demonstration must have the exit handle deactivated or must be indicated by red lights, red tapes, or other acceptable means, placed outside the exits to indicate fire or other reason why they are unusable. The exits to be used must be representative of all the emergency exits on the airplane and must be designated by the applicant, subject to approval by the Administrator. At least one floor level exit must be used.

Id.

¹⁹² See Nolan, *supra* note 1, at 44.

post-crash hazards result in injury or death to the passengers.¹⁹³ This is not to say, however, that these airplanes *will* be evacuated before disaster strikes in the event of a real crash. In a sense, safe evacuation in a real crash is largely conditioned upon the extent to which all of the other crashworthiness features¹⁹⁴ of the aircraft are effective,¹⁹⁵ and the extent to which the passengers are able to remain calm and follow emergency directions.¹⁹⁶ It is impossible to simulate either of these conditions in a staged demonstration.¹⁹⁷

4. *Final Observations*

Crashworthiness FAR's issued by the FAA provide nothing more than minimum safety standards.¹⁹⁸ Many of these standards are either so low or so vague that they fail to provide any type of adequate protection for aircraft passengers who are unfortunate enough to become involved in aviation accidents.¹⁹⁹ As a result, these regulations, as they exist presently, are simply not suited to serve as standards for liability in tort actions based upon injuries or deaths in crashes. To build an aircraft which meets FAA crashworthiness standards is not necessarily to build a crashworthy aircraft. Fortunately, many courts

¹⁹³ See 14 C.F.R. § 25.803(c)(13) (1986).

¹⁹⁴ See *supra* notes 118-182 and accompanying text.

¹⁹⁵ See D.CATHCART, *supra* note 14, at 296. For instance, the burn-through time for an exterior fuel fire may be as little as thirty to forty seconds. *Id.* When fire penetrates the cabin so quickly, it will be virtually impossible for all the passengers to evacuate safely, regardless of any ability to evacuate within ninety seconds. *Id.*

¹⁹⁶ These demonstrations "assume" that the passengers of a crashed aircraft will have ninety seconds in which to evacuate safely. See 14 C.F.R. § 25.803(c)(1986). In a real crash, the passengers may not have ninety seconds. In addition, the passengers in a real crash may be fighting for their lives. Because their situation is so serious, fear and panic may overcome rationality, and the evacuation process may be chaotic and confused. See Nolan, *supra* note 1, at 43-44. On the other hand, the passengers in a demonstration evacuation do not fear for their lives, and, therefore, do not allow panic to slow their progress to the nearest means of exit. See *id.*

¹⁹⁷ See *supra* notes 195-196 and accompanying text.

¹⁹⁸ See *supra* note 115 and accompanying text.

¹⁹⁹ See *supra* notes 116-197 and accompanying text.

have recognized this, and have not accorded FAR's the status of absolute standards in litigation based upon the doctrine of crashworthiness.²⁰⁰

B. The "Consumer Expectations" Standard

Section 402A of the Restatement (Second) of Torts states that a product is defective, for purposes of that section, when it is dangerous beyond what a consumer with "ordinary knowledge common to the community" would contemplate.²⁰¹ This standard is quite vague, lending itself to inconsistent application.²⁰² In addition, this standard has a number of limitations which may make it difficult to apply.²⁰³ First, application of this standard in design defect cases would "short-circuit the analytic process" by failing to consider what risk-utility factors²⁰⁴ resulted in the manufacturer's design choice.²⁰⁵ Because the standard focuses upon the ordinary consumer's knowledge, rather than the reasonableness of the manufacturer's design choice, disposition of a case is a rather routine matter once the court determines what an ordinary consumer's expectations are.²⁰⁶

²⁰⁰ See, e.g., *Bruce v. Martin-Marietta Corp.*, 544 F.2d 442, 446 (1976).

²⁰¹ RESTATEMENT (SECOND) OF TORTS § 402A comment i (1965). This section states, by way of example, that "[g]ood whiskey is not unreasonably dangerous [and therefore defective] merely because it will make some people drunk, and is especially dangerous to alcoholics; but bad whiskey, containing a dangerous amount of fusel oil, is unreasonably dangerous." *Id.*

²⁰² Birnbaum, *Unmasking the Test for Design Defect: From Negligence [to Warranty] to Strict Liability to Negligence*, 33 VAND. L. REV. 593, 611 (1980). The author points out that one of the points upon which courts, in applying the consumer expectations test, differ is that of whether the term "ordinary consumer" is "a hypothetical construct . . . or whether it is the actual plaintiff in the action at bar." *Id.* at 611. Compare *Vincer v. Esther Williams All-Aluminum Swimming Pool Co.*, 69 Wis. 2d 326, 230 N.W.2d 794 (1975) (objective test) with *Young v. Tide Craft*, 270 S.C. 453, 242 S.E.2d 671 (1978) (subjective test).

²⁰³ *Saba*, *supra* note 2, at 322; see also Birnbaum, *supra* note 202, at 613.

²⁰⁴ For a discussion of risk-utility factors, see *infra* notes 215-228 and accompanying text.

²⁰⁵ Birnbaum, *supra* note 202, at 613.

²⁰⁶ *Id.* This standard also creates the risk that consumers or users may not recover where the court finds that the dangers inherent in the product are patently obvious. *Id.* In such instances, there would be no mechanism by which to provide an incentive to the manufacturer to produce a safer product. *Id.*

Secondly, it is often difficult for a judge or jury to ascertain the reasonable expectations of a consumer, especially where "the defect is latent and the product complicated in design,"²⁰⁷ as is the case with today's general and commercial aviation aircraft.²⁰⁸ Indeed, this standard assumes that consumers will *have* expectations as to the safety of certain products, which, in fact they may *not* have.²⁰⁹ Thus, in the case of aircraft design, passengers may not have any idea as to how safely the aircraft could, or should, have been made,²¹⁰ and a jury may simply be forced to "guess."²¹¹

Finally, use of this standard could conceivably result in a situation in which a court would refuse to find a product defective even though it had not met specific minimum safety requirements specified by a legislative or administrative body.²¹² Thus, a court, in applying this standard, would refuse to consider even the minimal requirements of aircraft crashworthiness FAR's if it found that "ordinary expectations" of aircraft passengers fell below the standards embodied therein.²¹³ On the other hand, the expectations of consumers may reach far beyond available technical expertise, in which case strict adherence to this standard would penalize the manufacturer for its failure to do the impossible.²¹⁴

C. *The Risk-Utility Balancing Standard*

According to this approach, all products have certain

²⁰⁷ *Id.* at 614.

²⁰⁸ Saba, *supra* note 2, at 323.

²⁰⁹ Birnbaum, *supra* note 202, at 614.

²¹⁰ Saba, *supra* note 2, at 323.

²¹¹ Birnbaum, *supra* note 202, at 614; *see also* Montgomery & Owen, *Reflections on the Theory and Administration of Strict Tort Liability for Defective Products*, 27 S.C.L. REV. 803, 823 (1976).

²¹² Saba, *supra* note 2, at 323-24.

²¹³ *See id.* Where the manufacturer violated FAR's, it would normally be considered negligent per se. *Id.*

²¹⁴ *See id.*

risks and benefits.²¹⁵ In order to determine whether a given product is defective, a court would weigh the danger-in-fact, or risk, of the product against its utility.²¹⁶ If the former tips heavier on the scale than the latter, the product will be considered defective.²¹⁷

The most widespread approach to this standard, known as the "reasonably prudent manufacturer" approach, is similar (indeed, almost identical) to a traditional negligence approach.²¹⁸ In fact, the only real difference between the two is the requirement of scienter (knowledge of the dangerous nature of the product) in the former.²¹⁹ The scienter requirement under the "reasonably prudent manufacturer" approach is easily satisfied, however, because scienter is automatically imputed to the manufacturer.²²⁰ Once this requirement is met, the court must then engage in the risk-utility balance to determine whether the product is defective.²²¹ If the court determines, on balance, that a reasonable person would find that the inherent risk of the product in its present condition outweighs its utility, the product will be deemed un-

²¹⁵ Keeton, *The Meaning of Defect in Products Liability Law — A Review of Basic Principles*, 45 Mo. L. REV. 579, 592 (1980).

²¹⁶ *Id.* Dean Keeton noted that there are three important factors affecting utility of design: (1) "an evaluation of the needs, wants, or desires that are served by the product," (2) "the technological and economic feasibility, and practicability, of serving the need with alternative products," and (3) "the technological and economic feasibility of serving society's needs with a safer product." *Id.* at 592-93.

²¹⁷ *Id.* at 592.

²¹⁸ See Wade, *Strict Tort Liability of Manufacturers*, 19 Sw. L.J. 5, 15 (1965).

²¹⁹ *Id.*; see also Birnbaum, *supra* note 202, at 619.

²²⁰ See Saba, *supra* note 2, at 327. There is a difference of opinion between the two leading proponents of this approach as to when scienter will be imputed to the manufacturer. Dean Wade would impute scienter to the manufacturer at the time the product is manufactured. See Wade, *On the Nature of Strict Tort Liability for Products*, 44 Miss. L.J. 825, 834-40 (1973) [hereinafter Wade II]. Dean Keeton, on the other hand, would impute scienter to the manufacturer at the time of trial. See Keeton, *Manufacturer's Liability: The Meaning of "Defect" in the Manufacture and Design of Products*, 20 SYRACUSE L. REV. 559, 568 (1969) [hereinafter Keeton II]. Thus, under Dean Keeton's approach, a product will be considered unreasonably dangerous, and therefore defective, if, at the time of the trial, a reasonable manufacturer would recognize the risk it presents, even if the risk of danger could not have been known at the time of manufacture. See *id.* at 568.

²²¹ Saba, *supra* note 2, at 325.

reasonably dangerous and, therefore, defective.²²²

Despite certain advantages to the application of this approach,²²³ there are several limitations.²²⁴ First of all, application of this standard would not provide an incentive for manufacturers to improve the safety of their products.²²⁵ If, under this approach, the manufacturer can escape liability where, on balance, the risk of danger from the product does not exceed its utility, then manufacturers will not be encouraged to improve safety in situations where injuries might not be as numerous.²²⁶

Secondly, manufacturers may well perceive that the presumption of scienter against them is unfair, and that they are being forced to absorb too much of the costs resulting from accidents.²²⁷ Finally, given the extremely technical nature of modern aircraft, it may be virtually impossible for a jury to make a truly informed decision as to the reasonability of a conscious design choice on the part of an aircraft manufacturer.²²⁸

D. *Preliminary Conclusions*

As this section shows, there are *no* universally acceptable standards for the courts to use when deciding aircraft crashworthiness cases. Each of the alternatives discussed above has, along with its advantages, substantial limitations upon its effectiveness in the context of such litigation. In the absence of acceptable standards the courts have looked to all three of the above standards, and have failed to provide a definitive standard with which to mea-

²²² *Id.*

²²³ This approach *does* have the advantage of encouraging "a relatively scientific and objective examination of the design of the product by focusing the court's attention toward the product itself in the context of certain given criteria." *Id.* at 326. Also, the presumption of scienter serves to ease the plaintiff's burden of proof. *Id.*

²²⁴ *Id.*

²²⁵ Holford, *The Limits of Strict Liability for Product Design and Manufacture*, 52 TEX. L. REV. 81, 93 (1973).

²²⁶ *See id.*

²²⁷ Saba, *supra* note 2, at 326-27.

²²⁸ *See* Note, *supra* note 31, at 401.

sure the efforts of aircraft manufacturers in the area of safety.²²⁹

IV. STATE OF THE ART AND MANUFACTURERS' RESPONSE

While FAA regulations have remained unchanged²³⁰ and the courts have remained reluctant to pursue the matter of crashworthiness in aviation cases,²³¹ technology in the area of crashworthy design has progressed tremendously.²³² However, aircraft manufacturers have yet to incorporate much of the new technology into their products, primarily due to cost.²³³

A. Passenger Restraint Systems

As mentioned earlier, a primary cause of injury and death in aircraft crashes is the failure of seats and seat belts to restrain the passengers during deceleration.²³⁴ In fact, seat design has progressed far beyond the minimum "g's" requirement embodied in FAR 23.785.²³⁵ Many years ago, NASA tested an airplane seat which was designed to hold up to forty-five "g's."²³⁶ More recently, Simula, Inc., a firm which builds high-tech seats for military helicopters, has developed a seat which is flexible enough to absorb eighteen "g's" without breaking, and which may be sturdily attached to the cabin floor by a ductile, load-limiting tract fitting.²³⁷ Crashworthy seats and seatbelts are not novel items. In fact, the Department of Transportation *requires* that automobile safety belts be

²²⁹ See *Bruce v. Martin-Marietta Corp.*, 544 F.2d 442, 446-47 (applied the "consumer expectations" test, but held that FAR's were persuasive evidence of the level of safety that consumers could reasonably expect); *Wilson v. Piper Aircraft Corp.*, 577 P.2d 1322 (applied the "risk-utility balance" approach).

²³⁰ See, e.g., *supra* note 124 and accompanying text.

²³¹ See *supra* note 31 and accompanying text.

²³² See *infra* notes 234-266 and accompanying text.

²³³ See *supra* notes 17-20 and accompanying text.

²³⁴ See *supra* note 129 and accompanying text.

²³⁵ See *supra* note 135 and accompanying text.

²³⁶ Nolan, *supra* note 1, at 37.

²³⁷ *Id.*

able to withstand twenty-nine "g's."²³⁸ In addition to improving seat strength, research has shown that aft-facing seats²³⁹ and double strap shoulder harnesses²⁴⁰ tend to protect passengers more than forward-facing seats and single strap harnesses.

Despite continued testing and research, most airplane seats in use today are designed to withstand no more than the minimum "g's" requirement.²⁴¹ Manufacturers and operators have rejected the sturdier models largely because they tend to weigh more than the traditional models.²⁴² In commercial aviation especially, extra weight results in extra fuel costs.²⁴³

B. *Post-Crash Fires*

One of the primary dangers in a plane crash is the possibility of fire.²⁴⁴ Post-crash fires are usually due to a fuel leak.²⁴⁵ Today most Army helicopters use rupture-resistant fuel tanks made of a tough, rubber-like material.²⁴⁶ These tanks are designed to remain intact upon impact in a crash. During their use, the number of post-crash fires dropped by seventy-five percent and, of 2500 army helicopter crashes, only two people were killed by fire.²⁴⁷ In addition to puncture-resistant tanks, the FAA and NASA have tested fuel additives which appear to be a promising means of reducing the likelihood that leaked fuel will ignite.²⁴⁸

While the above devices may lessen the odds of a post-

²³⁸ Schaden, *supra* note 6, at 43. The U.S. Navy standard is 40 "g's" for its aircraft. *Id.*

²³⁹ See Nolan, *supra* note 1, at 37.

²⁴⁰ See D.CATHCART, *supra* note 14, at 280.

²⁴¹ Nolan, *supra* note 1, at 33.

²⁴² See *id.* at 37.

²⁴³ *Id.* Commercial airline operators are highly concerned about extra weight, because "each excess ounce costs about a gallon of extra fuel a year." *Id.*

²⁴⁴ See *supra* note 146 and accompanying text.

²⁴⁵ See Saba, *supra* note 2, at 299.

²⁴⁶ Nolan, *supra* note 1, at 39.

²⁴⁷ *Id.*

²⁴⁸ *Id.* One of the latest tests of a new fuel additive known as FM-9 was not successful, however. *Id.* at 40.

crash fire occurring, other devices may minimize the harmful effects of smoke in the event that a fire develops. Fire-resistant upholstery materials, such as a Du Pont neoprene foam called Vonar, have long been available.²⁴⁹ In addition, there are devices known as smoke hoods, which may give a passenger breathing time of fifteen to twenty minutes in the event that the cabin is filled with toxic gases.²⁵⁰

Despite the existence of the above safety features, few manufacturers or operators use them. Most modern aircraft are designed with aluminum fuel tanks, which rupture upon even the most minor impact.²⁵¹ In addition, most airplane seats are upholstered with urethane foam, which gives off thick smoke and lethal gasses when heated.²⁵² Manufacturers and operators tend to prefer the urethane to the neoprene because the former is much lighter.²⁵³ Finally, the airline industry has ardently opposed use of smoke hoods, and, consequently, they are not standard equipment on any aircraft.²⁵⁴

C. *Factors Allowing Safe Egress*

Again, it is important that passengers safely exit an aircraft as soon as possible after a crash in order to avoid injury in post-crash fires and other hazards.²⁵⁵ One of the most important safety considerations in this regard is seat spacing.²⁵⁶ If the aisles are too narrow, evacuating passengers may clog them creating serious and costly delays in the evacuation process.²⁵⁷ Unfortunately, however, commercial aircraft manufacturers and operators have in-

²⁴⁹ *Id.* at 41.

²⁵⁰ *Id.* at 41-43.

²⁵¹ *Id.* at 38.

²⁵² *Id.* at 40.

²⁵³ *Id.* at 40-41.

²⁵⁴ *Id.* at 43. In 1969, the FAA proposed mandatory smoke hoods, but the airlines successfully protested that such smoke hoods would impede evacuation. *Id.*

²⁵⁵ See *supra* note 168 and accompanying text.

²⁵⁶ Saba, *supra* note 2, at 298.

²⁵⁷ *Id.* For example, a study of a 1961 airplane crash found that some of the deaths were attributable to the narrow aisles, which made it impossible for attend-

creased the seating capacities of most of their airplanes in order to fit more passengers.²⁵⁸ This has resulted in aisle space shrinking from an average of about thirty-four inches a few years ago to twenty-nine inches today.²⁵⁹

Aside from seat spacing concerns, there is evidence that aircraft manufacturers and operators do not fully comply with the evacuation demonstration prescribed by FAR 25.803.²⁶⁰ A flight attendant who participated in an evacuation demonstration testified at congressional hearings on airline safety that the "passengers" in the demonstration were mostly airline employees, whose jobs depended upon the aircraft passing the ninety second test.²⁶¹ Further, although no one told these "passengers" which exits would be operable, they easily guessed that the operable exits were those with the video cameras above.²⁶² Consequently, they easily carried out the evacuation within the required ninety seconds.²⁶³ This testimony led one Congressman to characterize the evacuation test as a "farce" and a "charade."²⁶⁴

D. *Evaluation of Manufacturers' and Operators' Efforts Concerning Crashworthiness*

Overall, aircraft manufacturers have failed to adequately incorporate existing technology into their products to make them more crashworthy. "Today's aircraft, both private and commercial, contain numerous crashworthiness defects."²⁶⁵ Despite the existence and availability of technological improvements in the area of air safety, aircraft manufacturers and operators have not been encouraged to exceed the insufficient and outdated

ants to go forward and move passengers back to an emergency exit located in the rear. *Id.*

²⁵⁸ Nolan, *supra* note 1, at 43.

²⁵⁹ *Id.*

²⁶⁰ See *supra* notes 183-197 and accompanying text.

²⁶¹ Nolan, *supra* note 1, at 44.

²⁶² *Id.*

²⁶³ *Id.*

²⁶⁴ *Id.*

²⁶⁵ D.CATHCART, *supra* note 14, at 269.

requirements contained in the various FARs which deal with crashworthiness.²⁶⁶ Of course, failure to incorporate existing technology into today's commercial and general aviation aircraft is not the result of a desire on the part of these manufacturers to produce dangerous products. Rather, it is the end result of a process in which a number of competing considerations go into the decision of how to build the aircraft. Unfortunately, it seems that crashworthiness features are all too often cast aside to the detriment of those who may find themselves in dire need of these safety features in a future crash.

V. CONCLUSION

Having determined that certain aspects of modern aircraft design and operation often needlessly endanger passengers in the event of an accident, we must decide upon a course of conduct that takes this determination into account. In this regard, there are a number of alternatives available.

Perhaps one alternative would be to simply ignore the numerous injuries and deaths that occur each year and reject the doctrine of crashworthiness as it would pertain to general and commercial aviation aircraft. No doubt, this approach would save aircraft manufacturers and operators a considerable amount of money by freeing them from liability for these injuries and deaths. This, in turn, would greatly economize air travel as manufacturers and operators could pass these savings on to passengers through lower fares. However, despite the economic "benefits" which could be derived from this approach, the social "costs" could be quite substantial.²⁶⁷ Virtually every jurisdiction in the United States has recognized the need to impose liability upon automobile manufacturers where automobile design features result in foreseeable in-

²⁶⁶ For a discussion of the requirements contained in the FARs, see *supra* notes 111-200 and accompanying text.

²⁶⁷ The social "costs" are the injuries and deaths resulting from aviation accidents. See *supra* note 7 and accompanying text.

juries during accidents.²⁶⁸ Presumably, the imposition of liability in such instances serves to provide economic incentives for automobile manufacturers to produce safer automobiles and to compensate specific victims whose injuries resulted from a defective automobile design.²⁶⁹ As noted earlier, it is virtually impossible to distinguish aircraft from automobiles for the purpose of furthering these policy considerations.²⁷⁰ To attempt to do so could create precisely the results in the aviation context that courts applying the doctrine of crashworthiness to automobile claims have sought to avoid in the automobile context: uncompensated victims and fewer safety features. As a result, this alternative is not acceptable.

Another alternative would be to apply the doctrine of crashworthiness in the aviation context through the judicial system.²⁷¹ This approach would certainly further an important policy consideration underlying the doctrine of strict liability by providing compensation to accident victims and spreading the costs of their injuries to other consumers.²⁷² However, it would do little to further the goal of providing an incentive for manufacturers to produce safer products.²⁷³ In a sense, the "safety incentive" effect of aviation crashworthiness litigation on the manufacturer has an inverse relationship with the airworthiness of the manufacturer's aircraft. As the airworthiness of a manufacturer's airplane increases (which has been the rule in the last few years), the manufacturer's incentive to enhance crashworthiness *decreases*, because the manufacturer will be subject to fewer crashworthiness claims. When the manufacturer weighs the cost of avoiding liability through added crashworthiness safety features with the costs of ac-

²⁶⁸ See *supra* note 30 and accompanying text.

²⁶⁹ See *supra* notes 23-24 and accompanying text.

²⁷⁰ See *supra* note 32.

²⁷¹ See *supra* notes 29-108 for a discussion of judicial decisions regarding the doctrine of crashworthiness in the aviation context.

²⁷² See *supra* note 23 and accompanying text.

²⁷³ See *supra* note 24 and accompanying text for a discussion of the "safety-incentive" policy of strict liability.

tual liability in crashworthiness actions when they occur, it may well find that the former outweigh the latter. In this instance it would be less expensive simply to pay for deaths and injuries than to prevent them.²⁷⁴ Perhaps the only way to avoid this result would be to develop a means by which a manufacturer could be immediately sanctioned for building, selling, or operating an uncrashworthy aircraft, regardless of whether the short-coming actually resulted in loss of life or health to passengers.

In addition to its failure to provide a sufficient incentive for manufacturers to incorporate safety features, another problem with judicial disposition of crashworthiness claims is that technical design choices may be matters best left to those with expertise in the area. Often, crashworthiness features are rejected due to a number of factors (including airworthiness considerations) which a judge or jury focusing on the single factor of crashworthiness could not appreciate.²⁷⁵

Finally, another alternative would be to create an adjudicative body "composed of existing governmental agencies and aircraft manufacturers" in order to determine whether a manufacturer should be subject to liability under the doctrine of crashworthiness in a given case.²⁷⁶ This body would include representatives from NASA, the FAA, and the NTSB, as well as the aircraft industry itself.²⁷⁷ It would establish "clear," "precise," and "up to date" minimum requirements as to crashworthiness and use those requirements as absolute standards in determining the liability of aircraft manufacturers in crashworthiness cases.²⁷⁸ All in all, this alternative is very

²⁷⁴ See Nolan, *supra* note 1, at 51. The author discusses a scenario in which an airline executive concludes that crashworthiness liability would reach about one million dollars per year, while expenses to install crashworthiness features could run as much as five million dollars per year. See *id.*

²⁷⁵ Note, *supra* note 31, at 402.

²⁷⁶ *Id.* at 404.

²⁷⁷ *Id.* at 404-05.

²⁷⁸ *Id.* at 405. "A finding of compliance with these standards would be conclusive evidence that the aircraft was crashworthy. A finding that the manufacturer

attractive. It would provide an efficient means of dealing with disputes, while providing relatively clear guidelines which the manufacturers could follow. However, it does have its own problems. First, it does not address the "safety insurance" problem identified earlier,²⁷⁹ because it would operate to sanction a manufacturer only when an injured party brings suit.²⁸⁰ Perhaps this could be remedied if the panel had the power to issue fines for failure to comply with the crashworthiness regulations independently of any accident adjudication. Secondly, it seems a bit optimistic to believe that the FAA and the aircraft industry will suddenly be moved to promulgate up-to-date standards when they have virtually refused to budge from the standards they promulgated over thirty years ago, despite repeated criticism regarding their inadequacy.²⁸¹ Finally, leaving the matter of adjudicating crashworthiness disputes up to the industry and its federal regulators may, in fact, be "letting the fox guard the chicken coop." Over the years, the industry and the FAA have developed a close working relationship through which the former has wielded a great deal of influence over the latter.²⁸² Doubtless, the industry has been outspoken in its desire to avoid crashworthiness standards which are more stringent than those which currently exist. Adjudication by a judicial court would provide an independent player in the field of crashworthiness which could approach the problem from a different perspective. However, creation of this proposed administrative body would not necessarily deprive the courts of review, because a court of appeals could presumably have jurisdiction to review its decisions as it does those of other administrative tribunals.²⁸³ De-

failed to comply with these standards, however, would subject the manufacturer to liability under a negligence per se doctrine." *Id.*

²⁷⁹ See *supra* note 268 and accompanying text.

²⁸⁰ *Id.*

²⁸¹ See, e.g., D.CATHCART, *supra* note 14, at 269-98; Saba, *supra* note 2, at 291-300.

²⁸² See, e.g., Nolan, *supra* note 1, at 43.

²⁸³ Also, presumably, the question of damages would be left to a judicial court after the panel had determined liability. Note, *supra* note 31, at 405.

spite its problems, this approach is, perhaps, the most attractive alternative available.

Casenotes and Statute Notes

