Some Comments on Aircraft Crashworthiness

G. I. Whitehead Jr.
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G. I. WHITEHEAD, JR.*

IT IS DIFFICULT to determine from the few available precedents the present posture of airplane manufacturers' responsibility under the "second accident" doctrine and its application to air crash cases. An obvious starting place for any attempt at analysis would be the leading cases where the issue was decided in automobile accidents, subject, nevertheless, to the caveat that for many legal purposes an airplane is not a motor vehicle. This article does not, however, include an analysis of the law and a forecast of future trends. Much has already been written on the subject. It appears unnecessary, for example, to revisit the material covered by Haskell in his manufacturers' liability paper prepared for and delivered at the 1975 Journal of Air Law and Commerce Symposium, perhaps with the one exception where the author pays welcome attention to and questions the validity of the compulsion

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1 Many of the principles of law applied to the fact situation in an "airplane case" have developed through the years in controversies wholly unrelated to aircraft. Legal principles and concepts which had their first application to horse-drawn vehicles have continued to be developed and expanded by the courts in keeping with industrial progress and are now in many instances capable of being applied to railroads, threshing machines, automobiles, airplanes, machine tools and appliances of every sort. Thus non-aviation cases have had an important influence on the development of air law. But in many areas the technology and economics of flight are distinctive, and this difference must be perceived when present and significant. Injustices may, and frequently do, result from tortured constructions.

2 See, e.g., McReynolds v. Municipal Court, 207 N.W.2d 792 (Iowa 1973), where the principal issue was the definition of "vehicle." "Although the result is always contingent on the particular wording involved, it has been almost invariably held, in the construction of statutes and regulations, that airplanes are not within the terms 'vehicles,' 'motor vehicles,' etc." Annot., 165 A.L.R. 916 (1946).

for “expansion of liability, without negligence, in the area of product design.” For one interested in a quick review, a recent opinion, William v. Cessna Aircraft Corporation\(^4\) contains a discussion of the important decisions and divergent views of authority e.g. a collision is not an intended use versus collisions are to be anticipated.

Who should get credit for coining the word “crashworthy?” It was probably derived as a word of opposite meaning to “airworthy” and may be literally translated as “fit to crash.” There is more to the difference between “fit to crash” and “fit to fly.” A critical point exists at which crashworthiness goals may, and probably do, frustrate airworthiness objectives. As pointed out in a report by Flight Safety Foundation:

> [W]hile much can be learned from automobile experience, great care must be exercised in applying these lessons to aircraft lest improving crash-worthiness reduce airworthiness, with an overall reduction in safety. The principal safety goal in aircraft must be to avoid accidents.\(^5\)

Surely, too, the principal aim of accident investigations is prevention.

For the pilot population, the rudiments of flying safety include: good equipment maintained to approved standards, good pilot maintenance in maintaining and improving proficiency and knowledge (a pilot’s license is, after all, a license to learn flying with knowledge of and respect for the airplane’s limitations), and the basic requirement automatically to comply with appropriate regulations. For manufacturers, the first obligation to flying safety is to design and manufacture airplanes that are “fit to fly.” This is not to suggest that manufacturers should not, and do not, take reasonable measures to design and manufacture airplanes to accident survival expectancy requirements. To quote federal standards, the

\(^4\) 376 F. Supp. 603 (N.D. Miss. 1974).

\(^5\) HOEKSTRA & HUANG, SAFETY IN GENERAL AVIATION 75 (1971); See also L. FRUMER & M. FRIEDMAN, PRODUCTS LIABILITY § 6.05(14) (1960), where it is stated that “the word [crashworthiness] was used originally in a report of the Aviation Medicine Branch of the Australian Department of Civil Aviation in 1949. . . .” A. Hasbrook is given credit for the expression “cockpit delethalization.”
manufacturer has a duty: "to give each occupant every reasonable chance of escaping serious injury in a minor crash landing . . .""

After more than three decades of experimentation with light airplanes, the terms "crashworthiness" and "survivable crash" are still shrouded in ambiguity. A definition of "crashworthiness" appears in a Glossary of Aeronautical Terms: "The ability of the aircraft structure to maintain living space for occupants." Neither "crash" nor "survivable accident" is defined elsewhere in the list of terms. The federal regulations do, however, measure crash performance in terms of "[m]inor crash landing" and "modest descent velocity." Researchers also use the expression "survivable crash" in their investigations, but are more specific in establishing parameters. For example, Hasbrook says:

It should be noted, however, that a few light plane accidents do involve major load vectors which parallel the aircraft's longitudinal axis, but these crashes usually are of a non-survivable type, involving cruising speed impacts against steep mountains or high velocity dives into ground or water. We are not concerned with this type of accident in this paper. Instead, we are interested in the run of the mill, slow speed accident in which the plane is inadvertently stalled—in a turn—just after take off or during an approach to a landing, and strikes the ground before the pilot regains control.9

Other authors have said, "so long as the fuselage remains intact (is) a good working definition of survivability."10 The rub is that the post crash condition of the fuselage may be misleading in classifying the accident survivable or non-survivable. Included in the complicated phenomena which have occurred in the accident sequence is spring-back. This is an engineering term which means

7 TRANSPORTATION SAFETY INSTITUTE (1973).
8 14 C.F.R. § 23.561(b), (c)(2) (1975).
9 A. Hasbrook, Crash Load Vectors in Severe but Survivable Light Plane Accidents, SAE 690336 (March 1969). See also TURNBOW, CARROLL, HALEY & ROBERTSON, CRASH SURVIVAL GUIDE DESIGN, U.S. ARMY AVIATION MATERIALS LABS TECHNICAL REP. 70-22 (1969), "An accident in which the forces transmitted to the occupant through his seat and restraint system do not exceed the limits of human tolerance to abrupt accelerations and in which the structure in the occupant's immediate environment remains substantially intact."
that the airplane structure has the ability to absorb and resist impact loads and after deformation tends to return to its original shape or condition. Spring-back from maximum deformation in the accident sequence may be as much as fifty percent. Things are almost never what they seem. In its textbook on *Aircraft Accident Investigation Procedures & Techniques,* the Department of Transportation makes the aviation accident investigator, with the assistance of a qualified doctor, and, where possible, specialists in aviation medicine and pathological assistance in the case of fatalities, responsible for classifying the accident as either survivable or non-survivable—pretty much a judgment decision somewhat short on scientific principles. Nevertheless, human tolerance is a prime factor in the classifying process.\(^\text{13}\)

In all events, the truth is that a scientifically prepared and complete definition of a survivable crash envelope is still in the future. To find such a definition is one of the three basic objectives of the extensive work under way with characteristic thoroughness by the NASA Langley Crash Safety Program.

A joint FAA/NASA program has been initiated that will lead to the development of a reliable technology for the design of crashworthy aircraft. This joint program includes three basic objectives: the development of analytical methods, the definition of a survivable crash envelope, and improved seat and restraint systems.\(^\text{14}\)

The conclusions should be helpful guidelines.

To comply with airworthiness and crashworthiness standards of the federal government, general aviation airplane manufacturers design and build their airplanes to CAR 3 or FAR 23 standards prescribed for small airplanes.\(^\text{14}\) In adversary proceedings an attempt is sometimes made to picture these standards as barely enough to meet needs. This probably stems from Sec. 601 of The Federal Aviation Act of 1958 in which the Administrator of the Federal Aviation Administration (FAA) is duty-bound, among other things, to prescribe "such minimum standards governing the


\(12\) See, e.g., A. Bloedel, Methods of Crashworthiness Testing for Aircraft Design, SAE 720323 (1972).

\(13\) Alfaro-Bell, Hayduk, Thompson & Vaughan, Simulation of Aircraft Crash and its Validation (NASA Crash Safety Program).

design, materials, workmanship, construction, and performance of aircraft, aircraft engines, and propellers as may be required in the interest of safety." An exact definition of "minimum standards" is elusive, but the intent to establish requirements of a higher degree than average or ordinary is explicit in the Act and in the Federal Aviation Regulations. The expressions "interest of safety" and "safety in air commerce" appear at many places in the Act. For example, Sec. 603 uses these terms in defining the terms under which type, production, and airworthiness certificates are granted and Sec. 609 speaks of the amendment, suspension, and revocation of these certificates. Also, violators are punished by the civil penalties provided in Sec. 901 providing for civil penalties. The federal interest in evolving the possibilities of improving civil aircraft in the United States is expressed in Sec. 312(b) which provides:

The Administrator is empowered to undertake or supervise such developmental work and service testing as tends to the creation of improved aircraft, aircraft engines, propellers, and appliances. For such purpose, the Administrator is empowered to make purchases (including exchange) by negotiation, or otherwise, of experimental aircraft, aircraft engines, propellers, and appliances, which seem to offer special advantages to aeronautics.

This is only a partial list of the Administrator's powers and duties in the public interest. The sections were included simply to make clear the Administrator's authority over general aviation airplane manufacturers from Type Certificate investigations through authorizing production and aircraft safety inspections to penalty proceedings for violations and a continuing responsibility and involvement into the future in research and development programs.

Clearly certification is a field of federal preemption and, indeed,
with some local and purely intrastate exceptions, the federal government regulates every aspect of aviation in the United States. Thus regulation is accomplished by a billion dollar agency with 57,279 full-time positions. This summary of federal involvement in the public interest and statement of federal resources in dollars and people is not to suggest that manufacturers can abdicate to the regulator their independent responsibility for the safety of their products. Nevertheless, charged with responsibility for "the promotion, encouragement and development of civil aeronautics," the FAA is by statute more than a regulator. To meet the requirements demanded by the Congress the FAA must, and has, established appropriate minimum standards to be met by manufacturers. "Minimum" cannot be equated with "marginal safe." In its 8th Annual Report, fiscal year 1974, the United States Department of Transportation refers to the Type Certificate as a "seal of approval" by stating:

One of the FAA's major safeguards against equipment failure is the type certification—a 'seal of approval' resulting from an examination of all new aircraft, accessories, and component parts to determine airworthiness. During 1974, 44 new aircraft models were type-certificated, and supplemental certificates—required when previously certificated equipment is modified—were issued for 1,584 others. The inspection and certification recommendations are accomplished by the 21 Engineering and Manufacturing District Offices located throughout the country.

The FAA's extensive initiative in engineering and manufacturing is also amply illustrated in its budget request for fiscal year 1976 for this subactivity where 622 permanent positions are listed and

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the view that the control of aviation rests exclusively in the hands of the federal government." Kohr v. Allegheny Airlines, Inc., 504 F.2d 400, 404 (7th Cir. 1974).

84 City of Winner v. Lineback, 86 S.D. 165, 192 N.W.2d 705 (1971) (validity of a regulatory ordinance).


$17,700,000 requested for the cost of the operation. The scope of the activity is summarized by noting:

Included within this subactivity are the costs associated with development and administration of safety standards governing the type, production, and original airworthiness certification of aircraft, engines, propellers, appliances and noise level certification. The agency responsibility in this area begins with the development of standards, continues through examination of applications of certificates, and on through engineering design and flight test phases. Following design approval, the agency's responsibilities extend to approval of quality control procedures for production; determinations that each product is of the proper configuration for safe operations; and that corrections are made for difficulties encountered in actual service.

Another area which may be profitably considered is the delegation option authorization procedures whereby the FAA delegates limited and specific authority to the holder of the authorization but only with respect "to products that are manufactured by the holder." The Administrator accepts certification by those persons for whom authorization has been formally requested when an airplane or airplane component meets certification standards and is airworthy.

In civil litigation, the authorization is sometimes referred to in tones of ill-natured sarcasm as sort of an honor system in which the manufacturer exercises supervision over its own operation to prevent or detect and correct nonconformance with rules and regulations and to approve what has been done as meeting federal standards. There is no support for the suggestion that the procedure is inappropriate.

Historically, under Part 410 of the Regulations of the Administrator, effective November 3, 1951, manufacturers eligible to use the delegation option procedure requested the Administrator to appoint a qualified individual as a Designated Manufacturer's Certification Representative (DMCR). To be eligible, the manu-

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29 Hearings, supra note 26, at 256.
30 Id.
32 Id. § 21.235.
facturer had to meet standards, and to be qualified, the individual had to hold "a responsible position in a manufacturer's organization with respect to the design and manufacture of airplanes." The DMCR functioned as a representative of the Civil Aeronautics Administration (CAA). A Type Certificate for a new type airplane would be issued by the CAA only after studying and reviewing the application by the DMCR together with supporting documents demonstrating compliance with airworthiness requirements. Production Certificates were similarly processed, and the DMCR was authorized to issue Airworthiness Certificates, Experimental Certificates and Certificates of Airworthiness for Export. Limitations were imposed on the application of delegation option authorization procedures, the CAA retained the right to make on-premises audits, and procedures were established for investigating, inspecting, suspending and revoking delegation option authorizations.

Currently, delegation option authorization procedures appear in FAR 21, Subpart J, Amendment 21-5, effective September 8, 1965. Amendment 21-5 incorporated the following changes, among others, granting the manufacturer the authority: 1) to determine and certify that the type design meets requirements; 2) to

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38 Id.
issue Airworthiness Certificates, Experimental Certificates and Export Certificates of Airworthiness; and 3) to designate persons with FAA approval to sign Airworthiness Certificates, Repair and Alteration forms, and Inspection forms. 46

A central fact in the delegation option authorization regulations is the limitation on the authorization delegated and the control maintained by the FAA to detect and prevent abuse of authority. In an FAA audit of a manufacturer's total operation, as many as twenty-seven FAA employees have participated and there is no limit on the number who may participate. In reviewing its visitor's registration book one manufacturer producing airplanes under delegation option authorization found there had been fifteen different FAA people sign in at least once a week during a calendar year.

The FAA's role as a regulator aside, no airplane manufacturer will remain long in business who knowingly tolerates questionable activity in the compliance area. The implications from such a course of conduct are too shocking to contemplate. A National Transportation Safety Board appraisal of the delegation system states:

The Board told the Subcommittee on Government Operations of the House Committee on Government Operations it believes FAA's concept of delegating some of its certification authority to manufacturers "has merit, especially if the governing regulations are periodically reviewed and updated, as necessary, in light of advances in the state of the art and of the lessons learned from service and accident experience."

Safety problems which the Board has found in the delegation program have involved "isolated circumstances" generally related to "the implementation rather than the concept of the program." The Board said most of these have been "the result of a lack of FAA surveillance," and urged FAA to "become more involved"—particularly in flight testing of the new and more sophisticated jet aircraft. 47

Many things in everyday life are routinely accomplished through compromise and under the pressure of economic influence, but "trade-off" and "economics" become evil words in aviation accident damage suits in which engineering compromise in design is rep-

resented as the work of the insensitive manufacturer who equates dollars and performance with human lives. This view is urged against the background of vivid mental images of the accident scene, the cause of deaths, and condition of survivors. Most major aviation accident sites may be described in words and pictures which arouse interest and emotion as is often the case in the reporting by newspapers of major air disasters, for example. Against a backdrop of human suffering, which is emphasized in adversary proceedings, the practical, realistic, and necessary application of economic and engineering principles becomes difficult, if not impossible, to argue in the courthouse where concepts of emotional and social justice have a controlling influence. Although it was not necessary to the decision, one appellate court observed in its review of defendants' verdicts in aviation wrongful death cases:

We have some confidence that the survivors must have received a type of workmen's compensation, and thus the dependents do not go away with nothing. Today, society demands that in cases such as this someone must pay. But things have not yet reached the point that courts are required to hold that everyone sued must pay.\(^4\)

It is a simple truth that an airplane performs its assigned mission as the result of a number of economic and engineering compromises. An armored combat vehicle supported, driven, and steered by caterpillar treads may provide an envelope safe to crash in a variety of circumstances and conditions, but to get that machine to perform a practical and realistic assigned task in the air will require an immense number of engineering compromises affecting the survivable expectancy of its occupants in the event of an accident.

This is not a perfect world. Total elimination of aviation accidents can be achieved only by grounding every airplane. Nor is justice perfect. But if the concept of justice in aviation accident suits is that "someone must pay," perhaps the ritual of negligence trials, holdovers from the days when equal justice under the law was the standard and sometimes "no one had to pay", has no application to modern concepts. If the "someone must pay" theory of recovery prevails and defendant manufacturers are merely among

\(^4\) Leverson v. Boeing Co., 510 F.2d 937, 938 (9th Cir. 1975).
the centers for redistributing dollars to compensate victims of accidents, lawyers as leaders in society should be able to devise a better system for accomplishing that objective. When things reach the point that "courts are required to hold that everyone sued must pay,"

society will be compelled to find the better way.

How do we then summarize the combination of court rulings, interpretive intent, federal responsibility, engineering technology and industry limitations?

First, the field of airplane crash protection is insufficiently documented to firmly define susceptible limits.

Secondly, it is impossible to design and build an airplane that will give universal protection.

Thirdly, a definite trade-off exists between crash protection and safety of flight.

Fourthly, all statistics confirm that general aviation accident rates have trended down. This has required some forty years of continued emphasis by both industry and government agencies. We must not allow crash protection to over-shadow that trend.

Fifthly, a joint effort of FAA and NASA, together with industry, is probably the only visible way to accomplish all participants' objectives. It will not be a short range effort.

Finally, when a society becomes over-responsive to sociological and emotional trends while ignoring the technological and economic limitations attached, that society inevitably suffers restrictions on the use and advantages, and even the loss, of the service supplying a public need and demand.

49 Id.
