Handling the Turbulence Case

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I. INTRODUCTION

SINCE THE WRIGHT brothers lifted off at Kitty Hawk, all pilots have encountered turbulent atmospheric conditions at some time or another. Courts, as well, have grappled with cases involving injuries sustained by passengers as a result of turbulence encounters since the 1930s. Although we have come a long way this century in understanding the phenomena of the effect of air turbulence on aircraft, determining airline liability for the injuries sustained by a passenger injured during the course of a turbulence encounter, particularly clear air turbulence, is still perplexing and remains the focus of a great deal of litigation.

The litigation scenario usually involves a passenger injured in an unannounced turbulence encounter. The claim is denied, and the airline disclaims liability on one of two grounds: first, that the turbulence could not have been reasonably anticipated, or second, that the passenger failed to follow in-flight safety precautions or abide by timely warnings. The injuries caused by a turbulence encounter range from minor to catastrophic.

As recently as October 7, 1999, a jury sitting in the United States District Court for the Southern District of New York rendered a $2,225,000 verdict allocated among thirteen plaintiff
passengers (ten adults and three children), represented by Kreindler & Kreindler. The plaintiffs suffered emotional distress as a result of twenty eight seconds of severe turbulence ranging from positive two gs to negative one half g on American Airlines Flight 58 from Los Angeles to JFK Airport on June 26, 1995. The plaintiffs claimed that the American Airlines pilots should have circumnavigated a thunderstorm in the area and should have illuminated the seatbelt sign prior to encountering the turbulence. The flight required an emergency landing in Chicago. American Airlines conceded liability on the eve of trial. Half of the plaintiffs suffered from post-traumatic stress disorder and the average award ranged between $150,000 and $215,000.1

In January 1997, two TWA jets trailing each other and bound for St. Louis hit severe turbulence over Missouri's Bootheel.2 The pilots of each plane declared emergencies. A flight attendant at the rear of one of the aircraft was thrown into the ceiling, causing her head to burst through one of the panels. A passenger and four other flight attendants were treated for bumps and bruises.

In March 1997, Mexicana Airlines Flight 199, en route from Mexico to Chicago's O'Hare Airport, flew into clear air turbulence injuring four crew members and nineteen passengers.3 Also in March 1997, United Flight 2370, on its descent into Burbank, encountered severe air turbulence caused by the Santa Ana Winds.4

"Center," the first officer radioed from the careening flight deck, "do you, ah, have any indication how far down this goes?" Good God, I thought, we're going to crash in the Northridge Fashion Center. We didn't, of course, but more than a few ashen souls walked off that plane convinced they'd cheated death.5

Not so lucky were the passengers on board American Airlines Flight 242 on July 10, 1997 who sustained injuries in a turbu-

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5 Id.
TURBULENCE CASE

ence encounter.\(^6\) Even worse was United Airlines Flight 826 on December 28, 1997, in which one passenger was killed and approximately one hundred others were injured.\(^7\)

There have been so many injuries caused by turbulence that the investigators for the General Accounting Office (GAO), the investigative arm of Congress, conducted an analysis of more than 22,000 accidents from 1987 through 1996 for which the National Transportation Safety Board (NTSB) had made findings of probable cause. More than twenty-five percent of these accidents were weather related, and turbulence was the most frequent factor or cause cited in accidents involving major air carriers.\(^8\)

The Federal Aviation Administration (FAA) provides other enlightening statistics concerning the frequency and potentially fatal consequences of turbulence accidents:

- Approximately fifty-eight airline passengers are injured by turbulence annually while not wearing seat belts. From 1981 through December 1997, major carriers reported 342 cases of turbulence resulting in 3 deaths, 80 serious personal injuries and 769 minor injuries;
- Of the eighty passengers seriously injured, approximately seventy-three were not wearing their seatbelts, and at least two of the three death cases involved passengers who were not wearing their seatbelts;
- Generally, two-thirds of the turbulence related accidents occurred above thirty thousand feet. In 1997, however, approximately half of the accidents occurred above thirty thousand feet.\(^9\)


\(^7\) See Mark Hosenball, A Fatal Jolt over the Pacific, Newsweek, January 12, 1998, at 34.

\(^8\) NTSB Reporter, Vol. 16, No. 7, July 1998. According to the GAO report, 71.4% of weather related air carrier accidents were caused by turbulence and 65% of air carrier injuries were caused by turbulence. Id., at 3, 6.

\(^9\) FAA, Facts About Turbulence (visited Aug. 29, 1999) <http://www.faa.gov/apa/turb/Facts/fact.htm>. These statistics are provided as part of “Turbulence Happens,” the FAA multimedia campaign to educate the public about turbulence, its consequences, and methods to avoid injury.
In 1996, the FAA launched a nationwide safety campaign to promote the use of safety belts throughout flights in an effort to prevent turbulence related injuries.10

With that as background, this article addresses the handling of an air turbulence case. One point bears emphasis at the outset: the passenger can win his case if he can establish by a reasonable preponderance of the evidence that the turbulence was foreseeable and that his injury could have been prevented, avoided, or minimized. Most air turbulence injuries are avoidable, and airlines will be liable if pilots fail to take reasonable precautions to detect and avoid meteorological conditions in which a potential injury-causing turbulence encounter is likely.

First and foremost, lawyers must understand how to determine whether a turbulence case exists in the first place. They must learn how to identify the nature of the turbulence in order to assess whether the encounter was foreseeable. Among the many questions to ask are: was the turbulence windshear, was it microburst, was it related to a thunderstorm, was it associated with precipitation, what time of year did it happen, where did it happen, and what did the weather radar disclose or what could it have disclosed if used properly? They must explore in depth the weather conditions that prevailed in the vicinity of the turbulence encounter as well as along the flight path before and after the encounter. They must determine whether the cockpit crew should have been able to either avoid the turbulence altogether or warn the passengers in advance of the lurching of the aircraft to avoid or minimize any injury or death. They must search for the experiences of other aircraft traveling in the general vicinity of the one in question.

What may look like a clear air turbulence case at first glance, in which the defendant can hide behind the claim of an unavoidable accident or act of God, may well turn out to be an avoidable incident had the crew paid proper heed to the prevailing weather and warned the passengers. Increasing awareness of the threat and damage of unexpected turbulence has caused many airlines to mandate the use of seatbelts at all times passengers are seated and has prompted the recent Federal Aviation Regulation requiring airlines to instruct passengers to keep...

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their seat belts fastened while seated. This regulation’s purpose, of course, is to promote safety. But while certainly not conclusive, the regulation also provides some measure of a litigation defense. Passengers, however, are entitled and expected to leave their seats, and turbulence caused injuries can be sustained even by seated passengers.

II. A LESSON IN METEOROLOGY: UNDERSTANDING THE BASICS OF TURBULENCE

The three principal causes of turbulence are convective currents, obstructions to wind flow, including mountain waves, and windshear (or any combination of these conditions). In addition, wake turbulence is also a significant cause of turbulence, however, it is an aircraft operational phenomenon rather than a pure meteorological event. Wake turbulence accidents usually occur when large aircraft generate wing tip vortices during takeoff or landing, causing a smaller plane traveling too close to the large plane to become uncontrollable and crash. The standard air traffic controller warning, “caution wake turbulence,” is intended to alert trailing planes to keep their distance from larger planes in front of them in order to allow the wake turbulence to dissipate.

A. CONVECTIVE CURRENTS

Convective currents, a common cause of turbulence at low altitudes, are both ascending and descending vertical air movements. Like Sir Isaac Newton’s law, “[t]o every action there is

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11 The Code of Federal Regulations now mandates the following: “After each takeoff, immediately before or immediately after turning the seat belt sign off, an announcement shall be made that passengers should keep their seat belts fastened, while seated, even when the seat belt sign is off.” 14 C.F.R. § 121.571(a)(2) (1999).

Another regulation requires: “[T]he ‘Fasten Seat Belt’ sign shall be turned on during any movement on the surface, for each takeoff, for each landing, and at any other time considered necessary by the pilot in command.” 14 C.F.R. § 121.317(b) (1999).


13 See FSS Aviation Weather, supra note 12, at 88.

14 FAA, Order 7110.65, Air Traffic Control §§ 2-1-19, 3-9-7 (1999) [hereinafter Air Traffic Control].
always opposed an equal reaction," for each ascending current there is a corresponding downward current.

Land and water surfaces heat the adjoining air differently. For example, during the day, barren land radiates heat readily while water and vegetation do so more slowly. The resulting lack of uniform heating causes convective currents. On warm summer afternoons when winds are light, convective currents are quite active. As cold air moves over a warm surface, the air becomes unstable at lower levels. Convective currents often extend several thousand feet above the surface causing rough, choppy air. This is the reason, as most passengers are aware, that flying above the cloud level produces a smoother ride than flying immediately below it.

Convective currents can also create difficulty in landings because they affect the rate of descent. On approach to an airport, turbulence can cause abrupt changes in airspeed and may require an increase or decrease in airspeed beyond normal approach speed. While this procedure seems to conflict with the general rule of reducing airspeed for penetrating turbulence, the approach speed is generally below that recommended for turbulence penetration.

When convection exists in higher altitudes, it produces large cumulus and cumulonimbus clouds with anvil-like heads. These cumulonimbus provide a visual warning of potentially vio-

\[\text{15 John Bartlett, Familiar Quotations 282 (Justin Kaplan ed., 16th ed. 1992).}\]
\[\text{16 See FSS Aviation Weather, supra note 12, at 80-81. Naturally, for each ascending current the descending current is not necessarily the same level of intensity or geographic size, and it may be located a distance away. See id. at 81.}\]
\[\text{18 See FSS Aviation Weather, supra note 12, at 81.}\]
\[\text{19 See Pilot’s Handbook, supra note 17, at 109.}\]
\[\text{20 See FSS Aviation Weather, supra note 12, at 81.}\]
\[\text{21 There are generally two types of clouds, cumulus and stratus. Localized intense vertical currents lifting moist air to its condensation point create cumulus clouds. Broad horizontal currents create stratus clouds, which means “spread out.” Clouds near the surface of the earth are usually called either cumulus or stratus, unless they are causing precipitation, in which case the term “nimbus,” which means rain cloud, is added. Clouds at intermediate heights (5,000-20,000 feet) are referred to as altostratus or altocumulus, with the added prefix “alto” meaning high. Meteorologists refer to the “alto” cloud group as middle level clouds. Clouds that form in the higher levels of the troposphere (20,000-50,000 feet) include the prefix “cirro,” which means curly, because clouds at that level have a curly appearance. See Pilot’s Handbook, supra note 17, at 119.}\]
lent convective turbulence. Convective currents can still be active, however, even in the absence of cumulus clouds if the air is too dry for cumulus clouds to form. This has been referred to as clear air turbulence (CAT), discussed in more detail in section D.

**B. Obstructions to Airflow**

Both man-made and natural obstructions interrupt otherwise smooth wind flow creating mechanical turbulence. As wind blows around an object or obstruction it forms eddies or gusts with fluctuations in air speed and direction. Mechanical turbulence fluctuates according to wind speed and the nature of the obstruction. The greater the speed or rougher the surface, the greater the turbulence. The physical appearance of the clouds identifies whether the turbulence is caused by convective or mechanical mixing. Rows or bands of stratocumulus clouds indicate mechanical mixing, while a random pattern is consistent with convective clouds.

Airports are particularly susceptible to mechanical turbulence, which naturally produces gusty surface winds. When flying in a low level approach, or climbing, airspeed changes can be so rapid and drastic that an aircraft can even stall. Therefore, when gusty conditions prevail, the pilot must anticipate the need for changes in airspeed by maintaining a margin of airspeed above normal approach. The *Pilot's Handbook of Aeronautical Knowledge* recommends that landings and take-offs in gusty conditions should be made at higher speeds in order to maintain sufficient control.

A quite different situation is caused when calm air crosses a mountain barrier because wind flows across the barrier in layers causing "mountain waves." These mountain waves can extend 100 miles or more downwind from the barrier. The waves remain relatively stationary while the wind blows through them,

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22 Cumulonimbus clouds, which are extremely dangerous, sometimes take the form of a continuous or virtually continuous line, caused by a front or squall line. They can be extremely turbulent, in part, because they are formed by rising air currents. See *Pilot's Handbook*, supra note 17, at 123.

23 See FSS AVIATION WEATHER, supra note 12, at 81.


25 See FSS AVIATION WEATHER, supra note 12, at 82-83.

26 See *id.* at 83.

27 See *Pilot's Handbook*, supra note 17, at 113.

28 See FSS AVIATION WEATHER supra note 12, at 83-84.
and as such, are sometimes also called "standing" waves. Under each wave crest is a circular rotation, called a rotor, which can produce violent turbulence. Mountain wave turbulence is prevalent when winds of forty knots or more blow across a mountain or ridge. Reports of turbulence due to mountain waves run the gamut from extremely minor to severe enough to damage aircraft and injure passengers. Consequently, any degree of turbulence caused by a mountain range is possible and should be anticipated.

*British Airways Board v. The Boeing Co.* provides an example of severe damage caused by mountain wave turbulence. A British Airways aircraft disintegrated mid-air when it encountered severe CAT in the form of a mountain wave near Mt. Fuji, Japan on March 5, 1966. British Airways claimed the accident was due to a manufacturing defect, while Boeing claimed that the "pilot flew close to Mt. Fuji at too low an altitude," causing it to encounter CAT so extreme that it exceeded the design capabilities of the aircraft. Boeing's motion for summary judgment was granted because British Airways produced no evidence to controvert Boeing's theory.

The FAA provides pilots with the following information and recommended precautions associated with flying over mountainous terrain:

1. pay attention to visible cues;
2. turbulence can be expected when wind at mountain top level exceeds twenty-five knots; extreme caution should be exercised when the component of the wind perpendicular to the mountain range exceeds forty knots;
3. convective clouds on the windward side of a mountain indicate unstable air and are consistent with turbulence on close proximity to either side of the mountain;
4. standing lenticular and rotor clouds indicate a mountain wave and turbulence can be expected many miles to the leeward side of the mountain;
5. when flying towards mountains from the leeward side, begin the climb a great distance from the mountains—100 miles in a mountain wave and thirty to fifty miles otherwise;

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29 See id. at 83-85.
30 See id. at 85.
31 585 F.2d 946 (9th Cir. 1978).
32 See id. at 949.
33 Id. at 950.
34 See id. at 951.
6. avoid flying through mountain passes and valleys in high winds.\textsuperscript{35}

C. Windshear

Much has been written about windshear. Though it can be deadly, many pilots do not fully appreciate the risks associated with windshear. It has been a substantial factor in several tragic and avoidable crashes and numerous deaths and injuries. Remarkably, during the period 1964 through 1986, at least thirty-two accidents and incidents involving windshear have been documented, resulting in over 600 fatalities and nearly 250 injuries.\textsuperscript{36} These statistics prompted the FAA to publish the Pilot Windshear Guide.\textsuperscript{37}

Among the many disasters involving windshear that have occurred in the last few years, some of the most notable include the Delta Flight 191 crash at Dallas-Fort Worth on August 2, 1985, the Northwest 255 crash at the Detroit Metropolitan Airport on August 16, 1987, and the USAir Flight 1016 at Charlotte International Airport on July 2, 1992.\textsuperscript{38}

Windshear is an abrupt change "in wind speed and/or direction over a short distance."\textsuperscript{39} It can be horizontal or vertical, and it "generates eddies between two wind currents of differing velocities."\textsuperscript{40} The differences may be in wind direction, speed, or both.\textsuperscript{41}

There are several causes of low level windshear, including temperature inversions, frontal zones, and thunderstorms.\textsuperscript{42}

\textsuperscript{35} See FSS Aviation Weather, supra note 12, at 85-86.

\textsuperscript{36} See FAA and U.S. Dep't of Transp., Advisory Circular No. 00-54, Pilot Windshear Guide, App. 1, § 2.0 (Nov. 25, 1988) [hereinafter Pilot Windshear Guide].

\textsuperscript{37} Id.

\textsuperscript{38} Many other crashes have been attributed to windshear, including the August 1975 crash of Continental Flight 426 in Denver, the July 1982 crash of Pan Am Flight 759 in New Orleans, and the June 1975 crash of Eastern Airlines Flight 66 in New York (JFK).

\textsuperscript{39} Major John E. Richardson, Wind Shear, Flying Safety, Aug. 1981, at 5.

\textsuperscript{40} FSS Aviation Weather, supra note 12, at 86.

\textsuperscript{41} The FAA has defined windshear as "[a]ny rapid change in wind direction or velocity, and 'severe windshear' as [a] rapid change in wind direction or velocity," causing airspeed changes greater than 15 knots or vertical speed changes greater than 500 feet per minute." Pilot Windshear Guide, supra note 36, App. 1 § 2.2.

\textsuperscript{42} See FSS Aviation Weather, supra note 12, at 86-87.
High level CAT is associated with a jet stream or strong circulation.\textsuperscript{43}

1. Windshear with a low-level temperature inversion

On a clear night with light surface winds, temperature inversions form near the earth's surface, and wind immediately above the inversion can be rather strong. As an aircraft climbs or descends through the inversion, windshear can be encountered close to the ground. The shear plane and gusty winds move closer to the ground as the inversions dissipate.\textsuperscript{44}

2. Windshear in a frontal zone

Wind fluctuates abruptly in frontal zones, but not all fronts necessarily have associated windshear. Usually, shear creates a problem in fronts having steep wind gradients.\textsuperscript{45} Given that windshear is most dangerous when it occurs close to the ground, it is important to be able to calculate the approximate height of the front above an airport.\textsuperscript{46} When the temperature across the front at the surface is ten degrees Fahrenheit, and the front is moving at thirty knots or more, there is a high likelihood that windshear is present on approach.\textsuperscript{47}

3. Windshear associated with a thunderstorm

A violent and potentially devastating aspect of a thunderstorm is the associated windshear. The winds surrounding a thunderstorm are “complex” and windshear can occur on all sides of a cell.\textsuperscript{48} A rapid change and increase in wind at low levels immediately before the arrival of a thunderstorm produces what is known as the “first gust” or the “gust front.” These gusty winds are caused by large downdrafts hitting the ground and spread-

\textsuperscript{43} See id. at 86-88. See also infra section D.

\textsuperscript{44} See Richardson, supra note 39, at 7. In the Southwest, in fact, a ninety degree change in direction and a twenty or thirty degree increase in surface winds within the space of a few minutes is not unusual. See id.

\textsuperscript{45} See id. at 5-6.

\textsuperscript{46} See Pilot's Handbook, supra note 17, at 116. When a cold front is moving at thirty or more knots, the frontal or windshear zone will usually be five thousand feet above the airport approximately three hours after the frontal passage. When a warm front is moving through an area close to an airport, windshear may exist from the surface to five thousand feet, above ground level (AGL) approximately six hours before the front passes the airport. See id.

\textsuperscript{47} See Richardson, supra note 39, at 6.

\textsuperscript{48} See Pilot's Handbook, supra note 17, at 114.
ing horizontally. Approach under these conditions can be treacherous given the possibility of shear.

Much closer in proximity to the thunderstorm than the "first gust" is a microburst that is an extremely powerful localized downdraft from a thunderstorm. In some cases, the strength of a microburst can exceed that of an aircraft. As early as 1988, the FAA emphasized that "IT IS VITAL TO RECOGNIZE THAT SOME MICROBURSTS CANNOT BE SUCCESSFULLY ESCAPED WITH ANY KNOWN TECHNIQUES!" The dangers associated with windshear cannot be overstated. Otherwise ordinary approaches can become dire emergencies in seconds.

These gusty winds have been known to alter direction by as much as 180 degrees and achieve speeds of 100 knots ten miles ahead of a storm. Wind speed may increase by as much as fifty percent between the surface and 1,500 feet, presenting a potentially dangerous shear condition for a flight on approach. See Richardson, supra note 39, at 6.

Microbursts are not only associated with thunderstorms. They also occur with lighter precipitation corresponding to convective clouds and relatively dry conditions of light rain or virga (precipitation which evaporates before reaching the earth's surface). See Pilot Windshear Guide, supra note 36, App. 1 § 2.2.

A downdraft can exceed 720 feet vertical velocity at 300 feet above ground level. See id.

The FAA has provided the following Microburst Windshear Guidelines:

TABLE I

<table>
<thead>
<tr>
<th>OBSERVATION</th>
<th>PROBABILITY OF WINDSHEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESENCE OF CONVECTIVE WEATHER NEAR INTENDED FLIGHT PATH:</td>
<td></td>
</tr>
<tr>
<td>With localized strong winds (Tower reports or observed blowing dust,</td>
<td>HIGH</td>
</tr>
<tr>
<td>rings of dust, tornado-like features, etc.)</td>
<td></td>
</tr>
<tr>
<td>With heavy precipitation (Observed or radar indications of contour, red</td>
<td>HIGH</td>
</tr>
<tr>
<td>or attenuation shadow)</td>
<td></td>
</tr>
<tr>
<td>With rainshower</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>With lightning</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>With virga</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>With moderate or greater turbulence (reported or radar indications)</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>With temperature/dew point spread between 30 and 50 degrees Fahrenheit</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>ONBOARD WINDSHEAR DETECTION SYSTEM ALERT</td>
<td>HIGH</td>
</tr>
</tbody>
</table>
PIREP OF AIRSPEED LOSS OR GAIN:
15 knots or greater \quad \text{HIGH}
Less than 15 knots \quad \text{MEDIUM}

LLWAS ALERT/WIND VELOCITY CHANGE:
20 knots or greater \quad \text{HIGH}
Less than 20 knots \quad \text{MEDIUM}

FORECAST OF CONVECTIVE WEATHER \quad \text{LOW}

\text{Id. App. 1 § 2.4.2. tbl. 1.}

NOTE: These guidelines apply to operations in the airport vicinity (within 3 miles of the point of takeoff or landing along the intended flight path and below 1000 feet AGL). The clues should be considered cumulative. If more than one is observed, the probability weighting should be increased. The hazard increases with proximity to the convective weather. Weather assessment should be made continuously.

CAUTION: CURRENTLY NO QUANTITATIVE MEANS EXISTS FOR DETERMINING THE PRESENCE OR INTENSITY OF MICROBURST WINDSHEAR. PILOTS ARE URGED TO EXERCISE CAUTION IN DETERMINING A COURSE OF ACTION.

Table 1, designed specifically for convection weather (thunderstorm, rainshower, virga), provides a subjective evaluation of various observational clues to aid in making appropriate real time avoidance decisions. The observation weighting is categorized according to the following scale:

HIGH PROBABILITY:
Critical attention need [sic] to be given to this observation. A decision to avoid (e.g., divert or delay) is appropriate.

MEDIUM PROBABILITY:
Consideration should be given to avoiding. Precautions are appropriate.

LOW PROBABILITY:
Consideration should be given to this observation, but a decision to avoid is not generally indicated.

Although encountering weather conditions described in Table 1 above 1000 feet may be less critical in terms of flight path, such encounters may present other significant weather related risks. Pilots are therefore urged to exercise caution when determining a course of action. Use of Table 1 should not replace sound judgement in making avoidance decisions.

Windshear clues should be considered cumulative. The probability for each single observation is given. However, if more than one windshear clue is observed, the total probability rating may be increased to reflect the total set of observations.

Example:
Nearing destination, VIRGA is seen descending from high based clouds over the airfield (MEDIUM PROBABILITY). Commencing approach, a PIREP is received indicating that another flight just experienced a 10 knot airspeed loss on final approach to the same airport (MEDIUM PROBABILITY). Therefore, it would be appropriate to raise the total avoidance decision weighting to HIGH PROBABILITY (indicating a decision to avoid is appropriate).

\text{Id. § 2.4.2.}
Windshear can be vertical, horizontal, or both simultaneously. Horizontal shear occurs when an aircraft flies through a wind-shift plane. Vertical shear occurs near the ground when a change in velocity or direction “drastically alter[s] lift, IAS [indicated air speed], and thrust requirements and can exceed the pilot’s capability to recover.” Vertical shear can also occur aloft, especially near thunderstorm updrafts.

D. Clear Air Turbulence

Clear air turbulence (CAT) implies turbulence without clouds. The term also is used to convey high level windshear turbulence. CAT is different from storm related turbulence because it cannot be seen and lacks precipitation or other visual cues to warn of its presence. CAT can toss a huge jet, like it did to United Airlines Flight 826 cruising between Tokyo and Honolulu on December 28, 1997.

The jet stream is a narrow meandering river of winds moving around the globe with wave-like motion. To be considered a jet stream, the concentrated winds must have a speed of at least fifty knots. In the upper atmosphere, jet stream segments move along pressure ridges and troughs.

A turbulent energy exchange, near the jet stream and along the boundary between cold and warm air masses, creates CAT. Since the greatest differentiation between warm and cold weather exists in the winter, CAT is most prevalent during that season. CAT occurs most often in an upper trough on the polar or cold side of the jet stream. That is to say, “it is most common near upper air fronts and the tropopause, the thin layer of air that marks the boundary between troposphere and stratosphere and generally has a temperature of -55°C to -65°C.” CAT also

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54 Richardson, supra note 39, at 7.
55 See Hosenball, supra note 7, at 34. The Boeing 747 aircraft lurched up for six seconds, then dropped several hundred feet, killing one passenger and injuring approximately one hundred others. See id.
56 See GLEIM, supra note 12, ch. 13, at 145.
57 See id.
58 See id. at 146.
59 See id. at 148.
60 See id.
frequently occurs along the jet stream north and northeast of a quickly deepening surface low.62

E. MEASURING AND DETECTING TURBULENCE

The Federal Aviation Administration has provided the following guidelines to define the relative degree of turbulence:

- **Light Intensity**: "turbulence that momentarily causes slight, erratic changes in altitude and/or attitude. Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly."63

- **Moderate Intensity**: "turbulence that is similar to light turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control. Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Walking and food service are difficult."64

- **Severe Intensity**: "turbulence causing large, abrupt changes in altitude and/or attitude, usually causing large variations in indicated airspeed. Aircraft may be momentarily out of control. Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking are impossible."65

- **Extreme Intensity**: "turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage."66

1. **Clear Air Turbulence Detection**

Conventional thinking has been that "pilots have no defense against turbulence—especially the most treacherous type: clear air turbulence . . . . Today scores of researchers and safety advocates are challenging that conventional thinking. With advances in computing power and new schemes for deciphering its mysteries, they are pursuing ways to make turbulence obvious to airline crews."67 These analytical tools are of critical importance to aviation litigants because their use will enable litigants to know whether an air turbulence injury or death claim has merit. While methods for detecting CAT have advanced, pilot training

62 See Gleim, supra note 12, at 148.
63 FAA and U.S. DEP’T OF TRANSP., AERONAUTICAL INFORMATION MANUAL ¶ 7-1-20, Tbl. 7-1-6 (1998) [hereinafter AERONAUTICAL INFO. MANUAL].
64 Id.
65 Id.
66 Id.
67 McKenna, supra note 61, at 40.
and experience remain the principle tools available to predict CAT.

One of the most significant tools being developed to detect CAT is a Doppler laser radar device called a lidar. The lidar beams forward from the aircraft’s nose to sense the movement of dust and natural aerosol particles in turbulent air several miles ahead of the aircraft. When the beam strikes particles in the air, it bounces back to the aircraft, showing different air patterns. Above 22,000 feet, however, where most large aircraft cruise, there are few particles, moisture, or other pollutants that the lidar can beam back to the aircraft.

The National Center for Atmospheric Research and NASA/Dryden began a series of tests in March and April of 1998, using the lidar built by Coherent Technologies, Incorporated. These experiments may lead to the development of a “real-time lidar turbulence detector for commercial aircraft.” The lidar on a NASA aircraft is capable of detecting turbulence a few seconds before impact, but, this may not be sufficient time to avert the potential disaster.

Some other notable gains in CAT detection are the gathering of “truth data” to improve the forecasting of turbulence, and the increasing budget dedicated to the aviation weather research program. The WSR-88 Doppler weather radars, dubbed NEXRAD, may also be used to predict turbulence. The NEXRAD provides coverage of more than 90% of the U.S. skies at altitudes above 10,000 feet.

Northwest Airlines is credited with having the fewest turbulence encounters among the U.S. carriers, in large measure because of their in-house meteorological department that produces turbulence plots. Their meteorological department prepares turbulence plots for six U.S. geographical regions, the transatlantic region, and India. In addition, Northwest has a team of meteorologists in Tokyo issuing turbulence plots for Asia. These plots rank the anticipated turbulence on a zero-to-
seven scale, with seven meaning extreme turbulence, identify wind speed and direction, and indicate where the turbulence is expected. Each area of turbulence is tagged either red or amber, red indicating to avoid the turbulence and amber indicating to watch the weather. It is important to note that Northwest meteorologists find frequent correspondence between altocumulus standing lenticular clouds and clear air turbulence.72

2. Low Level Windshear Detection

Because windshear is frequently associated with thunderstorms, the best means to “detect” it is actually to avoid flying near the thunderstorm system altogether. To do so, pilots should rely on Pilot Reports (Pireps), the information available on the in-flight radar as well as the obvious cues of thunderstorms visible to the cockpit crew out of the window.73

The FAA has long warned that the “best way a pilot can cope with windshear is to: (a) Know it is there. (b) Know the magni-

73 The FAA has spelled out a list of instructive “do’s and don’ts” concerning thunderstorm flying:

(1) Don’t land or takeoff in the face of an approaching thunderstorm. A sudden gust front of low level turbulence could cause loss of control.
(2) Don’t attempt to fly under a thunderstorm even if you can see through to the other side. Turbulence and windshear under the storm could be disastrous.
(3) Don’t fly without airborne radar into a cloud mass containing scattered embedded thunderstorms. Scattered thunderstorms not embedded usually can be visually circumnavigated.
(4) Don’t trust the visual appearance to be a reliable indicator of the turbulence inside a thunderstorm.
(5) Do avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo. This is especially true under the anvil of a large cumulonimbus.
(6) Do clear the top of a known or suspected severe thunderstorm by at least 1,000 feet altitude for each 10 knots of wind speed at the cloud top. This should exceed the altitude capability of most aircraft.
(7) Do circumnavigate the entire area if the area has 6/10 thunderstorm coverage.
(8) Do remember that vivid and frequent lightning indicates the probability of a strong thunderstorm.
(9) Do regard as extremely hazardous any thunderstorm with tops 35,000 feet or higher whether the top is visually sighted or determined by radar.

AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-26.
tude of the change. (c) Be prepared to correct or go around.”

In fact, the Pilot Windshear Guide, by the FAA, stresses:

The primary lesson learned is that the best defense against wind-
shear is to avoid it altogether. This is especially important be-
cause shears will exist which are beyond the capability of any
pilot or airplane. In most windshear accidents, several clues—
LLWAS [Low Level Windshear Alert System] alerts, weather re-
ports, visual signs—were present that would have alerted the
flight crew to the presence of a windshear threat. In all in-
stances, however, these clues were either not recognized or not
acted upon.

Therefore, one of the most critical means of avoidance is to
thoroughly evaluate the weather.

The National Weather Service provides a wealth of weather
information in conjunction with the FAA. “Aerodrome forecasts
are prepared by approximately 100 Weather Forecast Offices
(WFOs). These offices prepare and distribute approximately
525 aerodrome forecasts [4] times daily for specific airports in
the 50 States, Puerto Rico, the Caribbean and Pacific Islands.

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74 Major John E. Richardson, Wind Shear Part II, FLYING SAFETY, Sept. 1981, at 18 [hereinafter Richardson II].

75 Pilot Windshear Guide, supra note 36 § 2.3. The FAA’s Pilot Windshear Guide
enumerates the many lessons learned from evaluating numerous windshear en-
counters during takeoff after liftoff, during takeoff on the runway, and during
approach. See id. §§ 2.3.1-2.3.3.

76 The complete “Air Traffic Control Package” can be requested at the re-
gegional office of the FAA Office in which the accident occurred. To obtain the
regional office address, write to the National Headquarters of the Federal Avia-
tion Administration, 800 Independence Avenue, S.W., Washington, DC 20591.
The complete weather package including the weather for the entire route of the
aircraft can be obtained by writing to:

1) Director
National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Tel: (828) 271-4800

2) Director
National Oceanic & Atmospheric Administration
National Weather Service
SSMC2
1325 East-West Highway
Silver Springs, MD 20910

This package should include all forecasts, surface weather observation,
NOTAMS, FIREPS, SIGMETS, radar weather photographs and winds aloft.
These forecasts are valid for 24 hours and amended as required.  

The FAA also maintains a nationwide network of automated Flight Service Stations to address the weather needs of pilots. There are several weather observation programs that provide important data in manual and automated fashion.

Manual remarks consist of reports from airport locations staffed by FAA or National Weather Service employees who manually observe, calculate, and enter their observations into the communication system. Manual Input remarks will include sky conditions, visibility, weather and obstructions to vision, temperature, dewpoint, wind, and altimeter setting.

The Automated Weather Observation System provides weather conditions at a specific airport with minute-by-minute weather observations. These automated observations evaluate ceiling and sky cover, clouds, visibility, surface wind conditions at the specific terminal, and obstructions or impairments to vision. Automated remarks will include density altitude, variable visibility, and variable wind direction.

These manual and automated remarks can provide indispensable cues and warnings about potential turbulence encounters at low altitudes or on landings. They will also provide additional clues for windshear, including references to thunderstorms, rainshowers, or blowing dust.

Large differences between the temperature and dewpoint spread will warn pilots of low humidity. Dew point is very significant to pilots because it represents an important condition of the air. Water vapor condenses and becomes visible as temperature reaches the dewpoint. The water vapor then becomes dew or frost on the landing surface and becomes fog, clouds, rain, or snow in the air.

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77 Aeronautical Info. Manual, supra note 68, ¶ 7-1-1(b).
78 See id. at ¶ 7-1-10.
79 See id.
80 The FAA provides a pamphlet, entitled “NOTAM AND WEATHER CONTRACTIONS TRANSLATOR,” which defines the commonly used contractions for area forecasts, SIGMETS and other weather information. The pamphlet can be requested by writing to:
Federal Aviation Administration
Air Traffic Publications Branch, ATX-420
Room 428
800 Independence Avenue, S.W.
Washington, D.C. 20951

81 Pilot’s Handbook, supra note 17, at 118.
3. Weather Advisories, Radar, and Other Means of Detecting Turbulent Conditions

The National Weather Service issues a variety of weather advisories that serve to alert pilots of the possibility of encountering hazardous weather conditions. These advisories include Severe Weather Forecast Alerts (AWWs), Significant Meteorological Information or SIGMETs (WSs), Convective SIGMETs (WSTs), Center Weather Advisories (CWAs), and Airmen's Meteorological Information or AIRMETs (WAs).\(^82\) To evaluate the risk of windshear, each of the above alerts should be fully explored, as well as the Low Level Windshear Alert System (LLWAS), visual observations from the cockpit, Pilot Reports (PIREPs), and Airborne Weather Radar.

a. Severe Weather Forecast Alerts (AWWs)

Pilots should always pay attention to aviation severe weather forecasts. Severe weather forecasts are unscheduled messages identifying areas of possible severe thunderstorms or tornados. Air Route Traffic Control Centers (ARTCC) broadcast the forecasts on all frequencies, except the emergency frequency, when any of the weather conditions alerted to is within 150 miles of the airspace under their jurisdiction.

b. SIGMETs (WSs)

SIGMETs are unscheduled in-flight advisory forecasts that warn of the development of hazardous weather conditions. SIGMETs are critical to all types of aircraft and specify the period for which the advisory is valid.

A SIGMET will be issued by the Aviation Weather Center when any of the following exist: "(1) [s]evere or extreme turbulence, or clear air turbulence (CAT) not associated with thunderstorms; (2) [s]evere icing not associated with thunderstorms; (3) [d]uststorms, sandstorms, or volcanic ash lowering surface or inflight visibilities to below three miles; or (4) [v]olcanic eruption."\(^83\)

c. Convective SIGMETs

Three convective SIGMET bulletins covering the Eastern, Central, and Western United States are issued. Each convective

\(^82\) See AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-5(a).
\(^83\) Id. ¶ 7-1-5(e).
SIGMET bulletin will (1) be comprised of one or more SIGMETS, (2) be valid for two hours (unless it is superseded), and (3) contain a forecast or an observation and a forecast. Convective SIGMETS are issued for forecasts of any of the following weather conditions (1) severe thunderstorms expected to produce, surface winds greater than or equal to 50 knots, hail of 3/4 inches or greater in diameter, or tornadoes; (2) embedded thunderstorms; (3) a line of thunderstorms; or (4) thunderstorms greater than or equal to VIP level 4 intensity affecting 40% or more of an area at least 3,000 square miles.

d. AIRMETs (WAs)

Airmen's Meteorological Information may be important to any pilot, and are issued every six hours for all domestic air space. They are based on forecasts of moderate icing or turbulence, sustained winds greater than thirty knots or within 1,000 feet of the surface, and extensive areas of visibility below three miles. They are of special significance to pilots without instrument ratings.

e. Center Weather Advisories (CWAs)

Center Weather Advisories are unscheduled in-flight, flow control, and air crew advisories. They have a short lead time and are issued to supplement a SIGMET, Convective SIGMET, or AIRMET that has already been issued. They will also be issued when either (1) an in-flight advisory has not been issued, but based on current pilot reports, weather conditions meet SIGMET or AIRMET requirements; or (2) when weather conditions do not meet SIGMET or AIRMET requirements, but pilot reports or other sources of weather information indicate that present or anticipated meteorological conditions will adversely affect the safe flow of traffic.

f. The Federal Aviation Administration’s Windshear Detection Plan

The FAA now uses an integrated plan for windshear detection to improve the safety and capability of most airports. The plan integrates the Terminal Doppler Weather Radar (TDWR), the Weather System Processor (WSP), and the Low Level Windshear

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84 See id. ¶ 7-1-5(d)(2).
85 See id. ¶ 7-1-5(c)(1)-(4).
86 See id. ¶ 7-1-5(h).
87 See id. ¶ 7-1-5(g).
weather conditions, turbulence of moderate degree or greater, and windshear.91

i. Turbulence PIREPs

Pilots are encouraged to report turbulent conditions to Air Traffic Control as soon as is practicable, and should indicate the following “(1) [a]ircraft location, (2) [t]ime of occurrence in UTC, (3) [t]urbulence intensity, (4) [w]hether the turbulence occurred in or near clouds, (5) [a]ircraft altitude or flight level, (6) [t]ype of aircraft, [and] (7) [d]uration of turbulence” (this may be based on time between two locations or over one location).92 The classification of intensity should correspond to that previously enumerated earlier in Section II E.93 The pilot should also report the duration in the following terms: occasional - less than 1/3 of the time; intermittent - 1/3 to 2/3; continuous—more than 2/3.94

ii. Clear Air Turbulence PIREPs

The Aeronautical Information Manual emphasizes that “CAT has become a very serious operational factor to flight operations at all levels and especially to jet traffic flying in excess of 15,000 feet.”95 Consequently, all pilots experiencing CAT conditions are urged to report the time, locations, and intensity (light, moderate, severe or extreme) as quickly as practicable.96

iii. Windshear PIREPs

As unexpected changes in direction and wind speed can wreak havoc on departing and arriving aircraft at low altitudes, pilots are urged to make prompt reports of any windshear conditions they experience. The accepted reporting method is to identify the specific gain or loss in airspeed and the respective altitudes at which the plane experienced the change in airspeed.97

91 See AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-18(a).
92 Id. ¶ 7-1-20(a).
93 See id., tbl. 7-1-26.
94 See id.
95 Id. ¶ 7-1-22.
96 See AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-22.
97 See id. at ¶ 7-1-21(b).
Not all airports in the United States have an LLWAS. In fact, LLWAS was incorporated in only 110 airports in the United States in 1988. Many of these systems have been replaced by advanced technology including TDWR and WSP. While all LLWAS systems will eventually be phased out, thirty-nine airports will be upgraded to the LLWAS-NE (Network Expansion), the latest software and sensor technology. This system continues to provide controllers with windshear warnings and alerts, and provides the location of the hazard in relation to the runway. The system can accommodate as many as thirty-two sensors located at an airport.

Currently windshear and microburst information and warnings are shown on ribbon display terminals in the tower cabs. Because data is standardized in the LLWAS, TDWR, and WSP systems, the controller does not interpret the data, but rather simply reads the displayed information directly to the pilot.

g. Visual Observations From the Cockpit

Because microbursts often occur in convective weather conditions, such as those presenting cumulus clouds, thunderstorms, rain showers, and virga, microburst windshear can be indicated by some of these obvious visual clues. Microburst windshear may also be indicated by rain “accompanied by curling outflow, a ring of blowing dust or localized dust in general, flying debris, virga, a rain core with rain diverging away horizontally from the rain core or tornadic features (funnel clouds, tornados).”

h. Pilot Reports (PIREPs)

PIREPs are the direct perceptions of the pilots who have observed cloud types and turbulence during actual flights. PIREPs issued from the cockpits of commercial aircraft concerning abrupt airspeed changes on approach can indicate the presence of windshear. Their reports of current weather conditions of turbulence are also critical to aid meteorologists in creating forecasts.

FAA air traffic facilities must ask for PIREPs when the following weather is reported or forecast: ceilings at or below 5,000 feet, visibility at or below 5 miles, thunderstorms and related

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89 See id. at ¶ 7-1-31.
weather conditions, turbulence of moderate degree or greater, and windshear.  

i. Turbulence PIREPs

Pilots are encouraged to report turbulent conditions to Air Traffic Control as soon as is practicable, and should indicate the following “(1) [a]ircraft location, (2) [t]ime of occurrence in UTC, (3) [t]urbulence intensity, (4) [w]hether the turbulence occurred in or near clouds, (5) [a]ircraft altitude or flight level, (6) [t]ype of aircraft, [and] (7) [d]uration of turbulence” (this may be based on time between two locations or over one location).  

The classification of intensity should correspond to that previously enumerated earlier in Section II E.  

The pilot should also report the duration in the following terms: occasional - less than 1/3 of the time; intermittent - 1/3 to 2/3; continuous—more than 2/3.

ii. Clear Air Turbulence PIREPs

The Aeronautical Information Manual emphasizes that “CAT has become a very serious operational factor to flight operations at all levels and especially to jet traffic flying in excess of 15,000 feet.” Consequently, all pilots experiencing CAT conditions are urged to report the time, locations, and intensity (light, moderate, severe or extreme) as quickly as practicable.

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91 See AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-18(a).
92 Id. ¶ 7-1-20(a).
93 See id., tbl. 7-1-26.
94 See id.
95 Id. ¶ 7-1-22.
96 See AERONAUTICAL INFO. MANUAL, supra note 63, ¶ 7-1-22.
97 See id. at ¶ 7-1-21(b).
i. Weather Radar Services

The National Weather Service utilizes a “network of radar sites for detecting coverage, intensity, and movement of precipitation.”[^98] Scheduled observations are made on an hourly basis for flight planning purposes.[^99] The National Center for Environmental Prediction collects the information disseminated in the reports and uses it to prepare national summary radar charts.[^100] It is important to know, however, that clouds and fog are not detected by the radar and that a clear radar display does not necessarily mean that there is no significant weather or turbulence in the area covered by the radar site.[^101]

Access to weather radar displays is available in several locations. The center weather service units in ARTCCs have access to the weather radar displays. Additionally, all en route flight advisory service facilities have the capability to access the radar displays from individual weather radar locations.[^102]

j. Airborne Weather Radar

Airborne weather radar should be used routinely to evaluate the presence of convective cells. Although incapable of detecting windshear, airborne weather radar is a critical tool for avoiding thunderstorms. Heavy precipitation pictured on the radar associated with the visible clues of convective clouds indicates the possibility of microbursts. In addition, some airborne radars can detect some types of turbulence in precipitation.

III. THE SEATBELT RULE

The Federal Aviation Regulations specify that no one can operate an airplane unless: “(a) [T]here are available during the takeoff, enroute flight, and landing . . . (2) [a]n approved safety belt for separate use by each person on board the airplane who has reached his second birthday . . . ”[^103] “In an effort to avoid injuries caused by turbulence . . . American, United and Alaska airlines . . . require passengers to keep lap belts fastened when-

[^98]: Id. at ¶ 7-1-11(a).
[^99]: See id. ¶ 7-1-11(b).
[^100]: See id.
[^101]: See id. ¶ 7-1-11(c).
[^102]: See id. ¶ 7-1-11(d).
Many other airlines have followed this practice. This policy, prompted by serious turbulence-related injuries, has been in place since late spring, 1988. Nonetheless, the FAA has not made the requirements mandatory. Instead, the Code of Federal Regulations now mandates that "[a]fter each takeoff, immediately before or immediately after turning the seat belt sign off, an announcement shall be made that passengers should keep their seat belts fastened, while seated, even when the seat belt sign is off."\textsuperscript{105} Another regulation requires that "[t]he 'Fasten Seat Belt' sign shall be turned on during any movement on the surface, for each takeoff, for each landing, and at any other time considered necessary by the pilot in command."\textsuperscript{106}

IV. THE APPLICABLE LAW

A. Res Ipsa Loquitur

The doctrine of res ipsa loquitur\textsuperscript{107} has been addressed in numerous turbulence cases. Res ipsa loquitur generally applies when:

a. the occurrence resulting in the injury was such as does not ordinarily happen if those in charge use due care;

b. the instrumentalities involved were under the exclusive management and control of the defendant;

c. and the defendant possesses superior knowledge or means of information as to the cause of the occurrence.\textsuperscript{108}

In the absence of any questions of fact, the jury resolves these questions.\textsuperscript{109}

The doctrine has been successfully applied in a few aviation cases,\textsuperscript{110} but has been generally unavailable in turbulence cases.


\textsuperscript{105} 14 C.F.R. § 121.571(a)(2) (1999).

\textsuperscript{106} 14 C.F.R. § 121.317(b) (1999).

\textsuperscript{107} The doctrine of res ipsa loquitur has been rejected by many states as inappropriate for turbulence cases. \textit{See} Lee S. Kreindler, \textit{Aviation Accident Law} § 2.09 (Mathew Bender, revised 1998).


\textsuperscript{109} \textit{See} Cudney, 254 S.W.2d at 666.

\textsuperscript{110} \textit{See}, e.g., Lobel v. American Airlines, 192 F.2d 217 (2d. Cir. 1951). In \textit{Lobel}, the aircraft engines stopped abruptly, and res ipsa loquitur was applied because the defendant airline had exclusive control of the aircraft and the accident was not one which ordinarily happens without someone's negligence. \textit{Id.} at 219-20. The doctrine was also successfully invoked in several cases in the 1950's. \textit{See} Hass-
As early as 1946, the doctrine was rejected as inappropriate in turbulence cases.\textsuperscript{111} In \textit{Cudney v. Midcontinent Airlines, Inc.}, Mrs. Cudney was thrown from her seat and suffered personal injuries when the aircraft encountered turbulence. Although the seatbelt signal was lit, Mrs. Cudney was not wearing her seatbelt.\textsuperscript{112} In refusing to apply res ipsa loquitur, the court stated:

The concern here is with the first element, whether the occurrence, the sudden and violent jerking, jolting drop of the plane, causing the plaintiff to be thrown from her seat, was one which ordinarily does not occur in the absence of negligence . . . .

. . . . [I]t is urged that the defendants may have been negligent in flying in the thundershower area and in the path of the downdraft, if in fact the downdraft was the cause of the sudden and unusual movement of the plane. But, there is no evidence that flying conditions were abnormal or that there was any hazard attached to flying in the wide thundershower area or that it was possible to forecast danger of flying into downdrafts under the prevailing conditions. There is no evidence that deviation from course or any other action on the part of the pilots would have either anticipated or avoided the downdraft, if that caused the dropping movement of the plane. 'It appears now to be common knowledge with regard to the operation of airplanes that downdrafts, which vary in effect according to their extent, are not uncommon. It is true that such a manifestation of nature, like the weather, is commonly referred to as an act of God . . . . In short, it is not possible at this date, as it may be in another day, to say that it is the common experience of mankind that commercial airliners do not lurch and drop for some distance except for negligence in the operation of the plane and, therefore, it is not now possible to confidently apply the doctrine of res ipsa loquitur to the mere occurrence in the circumstances relied upon by Mrs. Cudney, as it is in the instance of certain crashes,—there is now no such balance of probabilities.\textsuperscript{113}

In another turbulence case, the California Court of Appeals rejected the application of the res ipsa loquitur doctrine because “an injury arising from an encounter with air turbulence

\begin{itemize}
\item man v. Pacific Alaska Air Express, 100 F. Supp. 1 (D. Alaska 1951), aff'd sub nom. Des Marais v. Beckman, 198 F.2d 550 (9th Cir. 1952) (unexplained disappearance of an aircraft); Northwest Airlines, Inc. v. Rowe, 226 F.2d 365 (8th Cir. 1955) (unexplained crash of airplane into mountain).
\item \textsuperscript{111} See \textit{Cudney}, 254 S.W.2d at 667.
\item \textsuperscript{112} See \textit{id.} at 663-64.
\item \textsuperscript{113} \textit{Id.} at 666-67 (quoting Small v. Transcontinental & W. Air, 216 P.2d 36, 37 (Cal. Ct. App. 1950)).
\end{itemize}
cannot be said to ordinarily occur only because defendant was negligent."

In a more recent case applying New York law, the court for the Southern District of New York refused to apply res ipsa loquitur where the plaintiff was injured due to clear air turbulence. The court reasoned that because the doctrine does not apply where there is unexpected CAT, the plaintiff had to establish that the pilot should have foreseen the turbulence and taken steps to avert it.

A host of other cases also reconfirm the commonly held position that res ipsa loquitur will not apply in turbulence cases. These cases universally reject the notion that turbulence can be avoided and that the crew can take measures to avoid the turbulence. It is critical, therefore, that the plaintiff focus on establishing the negligence of the crew and therefore avoid the need to succeed on the doctrine of res ipsa loquitur.

B. ESTABLISHING THE NEGLIGENCE OF THE AIRLINE

In Ness v. West Coast Airlines, the plaintiff was ejected from his seat when the plane suddenly dipped while the fasten seat belt sign was turned off. At the close of plaintiff's evidence, the trial court granted the defendant's motion for a directed verdict. In remanding for a new trial, the appellate court recounted the evidence that tended to show meteorological conditions consistent with air turbulence: cumulonimbus clouds south of the departure city moving in the direction of the flight,

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114 Kohler, 214 Cal. Rptr. at 725.

115 See Karuba v. Delta Air Lines, Inc. 23 Av. Cas. (CCH) 17,470 (S.D.N.Y. 1991). The court also determined that it was not necessary for the captain to illuminate the seatbelt sign because the weather briefings prior to takeoff showed no thunderstorm activity en route. Id. at 17,471-72.

116 See, e.g., Kelly v. American Airlines, Inc. 508 F.2d 1379 (5th Cir. 1975) (holding that where air turbulence was caused by either weather conditions or wake turbulence, both of which could not be avoided, the doctrine of res ipsa is inappropiate); Gafford v. Trans-Texas Airways, 299 F.2d 60 (6th Cir. 1962) (holding that res ipsa loquitur is unavailing because the turbulence that caused the aircraft to lurch was not claimed to be caused by the negligence of the crew in operating the aircraft); Lazarus v. Eastern Air Lines, Inc., 292 F.2d 748, 750 (D.C. Cir. 1961) ("The dip of an airplane in flight which was only sharp enough to upset a cup of tea is not an incident which probably would not have happened unless the pilot had been negligent.") (emphasis added); Ness v. West Coast Airlines, 410 P.2d 965 (Idaho 1965); see also, Eastern Air Lines, Inc. v. Silber, 324 F.2d 38 (5th Cir. 1963).

117 410 P.2d at 966.
a low pressure area along the course of the flight, and the turbulence located over rough mountainous terrain.\textsuperscript{118}

In evaluating the meteorological evidence, the court stated:

The evidence would support a finding that the sudden downward movement of the plane was caused by air turbulence, which defendant should have anticipated, and that defendant's failure to warn plaintiff of the probability of such motion, and the consequent failure of plaintiff to use his seat belt, was sufficient to establish causal connection between defendant's failure to warn plaintiff and the resultant injury.\textsuperscript{119}

Proving negligence in turbulence cases is rarely that easy. In \textit{Schultz v. American Airlines},\textsuperscript{120} the plaintiff claimed that the turbulence "was so extreme that he was thrown repeatedly against his seat belt and the seat partition causing his spleen to bleed and eventually rupture."\textsuperscript{121} The passenger who sat next to Schultz testified that the flight was uneventful, and others aboard the aircraft testified that there was some "bumpiness," but not to the degree described by Schultz. A maintenance log indicated that, "[i]n flight during turbulence, yellow aft air stair light illuminated."\textsuperscript{122} After the jury was deadlocked at five to one following one and a half days of deliberation, the trial court granted American's motion for a directed verdict.\textsuperscript{123}

In \textit{Kohler v. Aspen Airways},\textsuperscript{124} the applicable weather forecast predicted occasional moderate turbulence within 5,000 feet throughout Nevada. When the plane entered the Tahoe region at about 10,000 feet, it fell some 500 feet in a few seconds, causing the plaintiff, who was belted in, to injure her neck.\textsuperscript{125} Finding for the defendant, the jury believed the defendant's witnesses, all of whom testified that the turbulence was unexpected and could not have been avoided.\textsuperscript{126}

In \textit{Stiles v. National Airlines},\textsuperscript{127} an aircraft crashed off the coast of Alabama losing all of its 41 passengers and crew of five. The court held that the accident was caused by the airline using dis-

\textsuperscript{118} See id. at 967.
\textsuperscript{119} Id. at 968.
\textsuperscript{120} 901 F.2d 621, 622 (7th Cir. 1990).
\textsuperscript{121} Id. at 622.
\textsuperscript{122} Id., at 623-24.
\textsuperscript{123} See id. at 621, 624.
\textsuperscript{124} 214 Cal. Rptr. 720 (1985).
\textsuperscript{125} See id. at 721-22.
\textsuperscript{126} Id. at 722.
\textsuperscript{127} 161 F. Supp. 125, 130 (E.D. La. 1958).
patchers who were not trained in meteorology and incapable of appreciating turbulent weather conditions and forecasts. The dispatchers also failed to advise the crew of prior turbulent weather reports in the vicinity of the accident, and permitted the flight to proceed in a route that was unsafe for air travel in light of the known severe turbulent conditions. Therefore, establishing the negligence of an airline is easier where the turbulence is foreseeable and either could have been avoided or the passengers could have been forewarned.

C. THE CONCURRENT DUTIES OF PILOTS AND AIR TRAFFIC CONTROLLERS

1. There is a delicate marriage between pilots and air traffic controllers

The duties and responsibilities of every air traffic controller are defined and circumscribed by the Air Traffic Control Handbook, the purpose of which is stated as follows: “Controllers are required to be familiar with the provisions of this order that pertain to their operational responsibilities and to exercise their best judgment if they encounter situations not covered by it.”

As most manuals do, the Air Traffic Control Handbook proceeds from the general to the specific. Significantly, section 2.2 of the Handbook defines the duties and priorities in the following terms:

2-1-2. DUTY PRIORITY
a. Give first priority to separating aircraft and issuing safety alerts as required in this order. Good judgment shall be used in prioritizing all other provisions of this order based on the requirements of the situation at hand.

Note-
Because there are many variables involved, it is virtually impossible to develop a standard list of duty priorities that would apply uniformly to every conceivable situation. Each set of circumstances must be evaluated on its own merit, and when more than one action is required, the controllers shall exercise their best judgment based on the facts and circumstances known to them. That action which is most critical from a safety standpoint is performed first.

128 See id.
130 Ronald E. Morgan, Foreword to Air Traffic Control, supra note 14.
131 Id. at 2-1-2a (emphasis added).
These provisions lay the groundwork for cases in which the plaintiff claims the government is at fault for an air crash. Air traffic controllers must provide accurate information and warnings in accordance with the Air Traffic Control Handbook.\footnote{See In re Air Crash Disaster Near Ceritos, Cal., 23 Av. Cas. (CCH) 17,448, 17,452 (C.D. Cal. 1989).}

In some circumstances, an air traffic controller is held to a superior duty of care to the pilot. In \textit{Ingham v. Eastern Air Lines, Inc.},\footnote{373 F.2d 227, 233 (2d Cir. 1967).} the court determined that the air traffic controllers negligently failed to accurately report current and deteriorating weather conditions at the airport of the intended landing to the crew of the aircraft. The trial judge found that the air traffic controllers' "duty" was properly articulated in the Air Traffic Control Procedure Manual then in force, which provided:

At locations where official weather reports are obtained by the controllers through routine procedures and the ceiling and/or visibility is reported as being at or below the highest "circling minima" established for the airport concerned, a report of current weather conditions, and subsequent changes, as necessary, shall be transmitted as follows: . . .

. . . By approach control facilities, to all aircraft at the time of the first radio contact or as soon as possible thereafter, . . .\footnote{Id., at 233 (alteration in original) (quoting FAA, \textsc{Air Traffic Control Procedures Manual} § 265.2).}

The appellate court determined that the words "as necessary" in the regulation imposed a duty upon air traffic controllers to advise the crew of the descending aircraft that weather conditions at the airport were deteriorating.\footnote{See id. at 240.}

Similarly, in \textit{Gill v. United States}\footnote{285 F. Supp. 253 (E.D. Tex. 1968) aff'd, 449 F.2d 765 (5th Cir. 1971).} the court held that while the "primary responsibility for the safe operation of the aircraft" belongs to the pilot, providing an incomplete or inaccurate reporting of weather information will give rise to liability if it is found to be a "proximate cause of the crash."\footnote{Id. at 256, 260; see also Jatkoe v. United States, 19 Av. Cas. (CCH) 17,833 (E.D. Mich. 1985).} A common law duty to warn may exist where the controller knows of a danger reasonably within his knowledge.\footnote{See Gill, 285 F. Supp. at 260.}

The level of care naturally increases in accordance with the level of danger presented under the circumstances. Conse-
quently, a higher level of care is required when an aircraft is in immediate and extreme danger, when the controller is in a superior position to judge that danger, when a pilot declares an emergency or states that he’s in distress, or when the pilot has relied on the controller for certain explicit information.

In a Fifth Circuit wake turbulence case, the court emphasized that the controllers had a superior duty to warn the pilot of the danger of wake turbulence because of their superior position for observing the level of danger to a small aircraft taking off in the wake of a larger plane.139 When such information is within the unique knowledge of the air traffic controllers, their failure to communicate such information may give rise to liability.

In 1974, for example, the Tenth Circuit was quick to affirm the trial court in finding the government negligent for failing to warn a pilot of a small aircraft that he was flying too close to a larger TWA 707 jet, and thus was likely to encounter wake turbulence.140 The court reasoned:

[T]he pilot Yates was peculiarly susceptible to the control of the controllers since he was piloting a light plane in between heavy jets. Once he received and followed the controller’s instructions with respect to landing he was not free to disregard the directions given and exercise independent initiative. For all practical purposes, he was in complete control of the tower. The hazardous traffic pattern, the direction which enhanced the danger and the failure to direct as to turbulence all contributed to the tragic result.141

Similarly strong language was used in another wake turbulence case in which the Hawaii District Court held the government partially at fault:

Discretion and judgment should have been exercised by the controllers to avoid this acute and obvious hazard, whereas [the] Chief Controller . . . emphatically testified that he did not consider that he had any duty, and did not even attempt, to exercise any judgment or discretion whatsoever, beyond giving the stereotyped routine cautionary language of the book. These considerations reinforce this Court’s finding of negligence on the part of the government.142

139 See Hartz v. United States, 387 F.2d 870, 872 (5th Cir. 1968).
140 See Yates v. United States, 497 F.2d 878 (10th Cir. 1974).
141 Id. at 883.
142 Furumizo v. United States, 245 F. Supp. 981, 1012 (D. Haw., 1965), aff’d, 381 F.2d 965 (9th Cir. 1967). Note, that the court held the company that gave
Similarly, in *Hensley v. United States*, the court determined that air traffic controllers may be held liable for failing to provide information that is reasonably apparent to the controller and not apparent to the pilot when the controller is in a better position to assess the danger to the pilot. The government has been held responsible in numerous other wake turbulence cases. The government also conceded liability in two cases arising out of the crash of USAir Flight 1016 on July 2, 1994, in the United States District Court in Columbia, South Carolina.

Air traffic controllers have also been held negligent for failing to relay weather information that a pilot had requested. A wealth of cases have held that despite air traffic control negligence, the sole responsibility for an aircrash rests with the pilot. It is well known that the pilot-in-command is the final authority regarding the safe conduct of a flight and operation of the aircraft. The extent of this responsibility is codified in the Federal Aviation Regulations (FARs). FAR 91.3 provides in pertinent part:

(a) The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.
(b) an in-flight emergency requiring immediate action, the pilot in command may deviate from any rule of this part to the extent required to meet that emergency.

The numerous cases addressing this issue demonstrate that the pilot is the one in charge. Even despite inadequate weather information from air traffic controllers, courts have often held that full responsibility for air crashes rests with the pilot as the final authority. In *Hensley*, for example, the plane “crashed shortly after the pilot reported encountering . . . heavy turbulence.” Although the personal representatives of the survivors alleged that the air traffic controllers were negligent in permitting the aircraft to fly into a thunderstorm, or soliciting and pro-

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144 See id. at 723; see also Hartz 387 F.2d at 873 (superior knowledge of air traffic controller to evaluate danger of wake turbulence).
145 See, e.g., Neal v. United States, 562 F.2d 338 (5th Cir. 1977); Dickens v. United States, 545 F.2d 886 (5th Cir. 1977).
148 14 C.F.R. § 91.3 (1999).
viding PIREPs, the court found that the pilot was responsible and that the controllers had not contributed to the crash.\textsuperscript{150}

The Aeronautical Information Manual (AIM) teaches pilots "about the limited ability of air traffic control radar to display weather data. Pilots are also taught that air traffic control radar does not depict turbulence."\textsuperscript{151} Pilots have been held responsible for: continuing to fly into thunderstorms despite adverse weather advisories;\textsuperscript{152} flying into forecasted IFR conditions;\textsuperscript{153} penetrating a storm for over 100 miles;\textsuperscript{154} flying into forecasted deteriorating weather;\textsuperscript{155} flying into forecasted IFR conditions;\textsuperscript{156} flying into cloud-obscured terrain;\textsuperscript{157} and failing to obtain a weather briefing and crashing on a VFR flight into clouds.\textsuperscript{158} Pilots are routinely "regarded as being in the best position to judge outside conditions."\textsuperscript{159}

One of the earliest cases examining the relationship between a general aviation pilot and air traffic controllers is \textit{Kullberg v. United States}.\textsuperscript{160} In \textit{Kullberg}, the estate of the deceased pilot, Richard Kullberg, commenced an action alleging that the government had failed to provide adequate weather information and vectoring services, causing the decedent, a VFR-only pilot, to fly "inadvertently" into instrument meteorological conditions (IMC).\textsuperscript{161} The district court held that the controllers had not breached any duty to Kullberg because Kullberg continued his flight in deteriorating conditions, failed to request weather advisories en route, deliberately flew into IMC conditions, and,

\begin{itemize}
\item \textsuperscript{150} See \textit{id.} at 723.
\item \textsuperscript{151} \textit{Id.} at 720. \textit{See, e.g., In re Air Crash at Dallas/Fort Worth Airport}, 919 F.2d 1079 (5th Cir. 1991).
\item \textsuperscript{152} See Barbosa v. United States, 811 F.2d 1444, 1448 (11th Cir. 1987).
\item \textsuperscript{153} See Spaulding v. United States, 455 F.2d 222, 227 (9th Cir. 1972).
\item \textsuperscript{154} See Black v. United States, 441 F.2d 741, 744-46 (5th Cir. 1971).
\item \textsuperscript{155} See Davis v. United States, 643 F. Supp. 67, 77-78 (N.D. Ill. 1986), \textit{aff'd}, 824 F.2d 549 (7th Cir. 1987).
\item \textsuperscript{156} See Lombard v. United States, 601 F. Supp. 10, 12 (E.D. Mo. 1984), \textit{aff'd}, 767 F.2d 929 (8th Cir. 1985).
\item \textsuperscript{157} See Baker v. United States, 417 F. Supp. 471, 483-86 (W.D. Wash. 1975).
\item \textsuperscript{159} Beattie v. United States, 690 F. Supp. 1068, 1077 n.48 (D.D.C. 1988); \textit{see also} Brock v. United States, 596 F.2d 93 (4th Cir. 1979); Black v. United States, 441 F.2d at 741 (5th Cir. 1971); American Airlines, Inc. v. United States, 418 F.2d 180 (5th Cir. 1969).
\item \textsuperscript{160} 271 F. Supp. 788 (W.D. Pa. 1964).
\item \textsuperscript{161} See \textit{id.} at 789-90.
\end{itemize}
although not certified for instrument flight, attempted to fly an instrument approach.\textsuperscript{162}

That reasoning was followed by the Fifth Circuit in \textit{In re Crash At Dallas Fort Worth Airport}.\textsuperscript{163} In affirming the district court, the Fifth Circuit stated: "The [District] Court’s finding that the crew’s deliberate decision to land through a known thunderstorm located at the end of the runway, when they could easily have gone around, was the sole proximate cause of this disaster is not clearly erroneous."\textsuperscript{164} The airline claimed that the crash was caused by the controllers who failed to provide pertinent weather information. While the Court found the controllers negligent for failing to relay weather information to the crew, it held that \textit{their negligence was not a proximate cause of the crash}.\textsuperscript{165}

V. CONCLUSION

Preparation, as in any litigation, is key. Knowing the prevailing weather conditions, the other data that was or could have been available to the cabin crew, and the applicable law will enable the lawyer to properly and thoroughly handle the turbulence case.

\textsuperscript{162} See \textit{id.} at 800.
\textsuperscript{163} 919 F.2d 1079 (5th Cir. 1991).
\textsuperscript{164} See \textit{id.} at 1088.
\textsuperscript{165} See \textit{id.} The district court found that it was negligent for the air traffic controllers not to relay the following: a thunderstorm off the approach end of the runway threshold; "heavy, heavy rain" (described by witnesses as a curtain of water) observable from the Tower; cloud to ground lightning strikes; cumulonimbus clouds reported to Tower personnel; and radar information showing precipitation on the north end of the runway. See \textit{id.} at 1085.