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Here Comes the Boom: Reevaluating the Merits of FAA Prohibition on Civil Supersonic Flight

Jonathan Petree

Southern Methodist University, Dedman School of Law, jpetree@smu.edu

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**HERE COMES THE BOOM: REEVALUATING THE MERITS
OF FAA PROHIBITION ON CIVIL
SUPERSONIC FLIGHT**

JONATHAN PETREE*

I. INTRODUCTION.....	679
II. BACKGROUND: SONIC BOOMS, THE ERA OF PROHIBITION, AND THEORY IN PRACTICE	681
A. SONIC BOOM: DOWN TO A SCIENCE	681
B. MEASURE TWICE, CUT ONCE: QUANTIFYING THE BOOM	683
C. SONIC BOOMS & YOU: LITIGATION AND THEORIES OF LIABILITY	688
D. THE CONCORDE: COMMERCIAL SUPERSONIC TRANSPORT IN PRACTICE	695
III. ANALYSIS: THE PROHIBITION, ITS CONTINUED MERITS, AND POTENTIAL ALTERNATIVES	700
A. THE PROHIBITION.....	700
B. THE MERITS OF CONTINUED PROHIBITION AND PROPOSED ALTERNATIVES	704
IV. CONCLUSION.....	711

I. INTRODUCTION

LUDDITES BEWARE: advances in modern technology may warrant the reevaluation of Federal Aviation Administration (FAA) regulations that practically serve only to impede the technological growth within, and the subsequent evolution of, the aerospace industry. Our capacity to tear through the skies at su-

* Jonathan Petree is a candidate for Juris Doctor, May 2019, at SMU Dedman School of Law. He received his B.A. in Philosophy with a minor focus in History from the University of Arkansas in 2016. Mr. Petree would like to thank the SMU Law Review Association for providing assistance in publishing this comment and would like to thank his parents for their encouragement, guidance, and support.

personics speed has existed since the 1940s.¹ To put that in perspective, supersonic flight technology emerged alongside feats of the era such as: seventeen-cent gallons of gas, Ferrari's first sports car, and the invention of both Tupperware and Velcro.² In the following seventy years, supersonic flight technology impacted the aerospace industry at an ironically languid pace. Several factors account for the apparent grounding of our supersonic capabilities, including health and safety risks, economic viability, and the sonic boom.³ Additionally, in March 1973, the FAA enacted regulation that effectively prohibits civil supersonic flight within the United States.⁴

In recent news, however, President Donald J. Trump proclaimed December 17 to be national Wright Brothers Day, praising the very spirit of innovation and imagination that could make America "boom" again.⁵ President Trump's proclamation stated that, "[m]ore than a century after conquering flight, the Wright brothers continue to motivate and inspire Americans, who never tire of exploration and innovation. This great American spirit can be found in the design of every new supersonic jet and next-generation unmanned aircraft."⁶ Juxtaposing this "American spirit"—which ostensibly continues to fuel exploration and innovation—with the FAA prohibition's stagnating effect within the aerospace industry might reveal an internal dichotomy or tension among those values that supposedly define the American spirit.⁷ How can exploration or innovation be valued or practiced in the face of prohibition? Further, is prohibition fundamentally antithetical to those values?

Admittedly, these questions point to the FAA's regulation of supersonic flight as the univariate cause of its demise when sev-

¹ Nola Taylor Redd, *Breaking the Sound Barrier: The Greatest Moments in Flight*, SPACE.COM (Sept. 29, 2017, 11:43 PM), <https://www.space.com/16709-breaking-the-sound-barrier.html> [<https://perma.cc/6L3Q-K7UC>].

² See generally *1940's Important News and Events, Key Technology Fashion and Popular Culture*, THE PEOPLE HISTORY, <http://www.thepeoplehistory.com/1940s.html#tech> [<https://perma.cc/LM4F-TBKF>].

³ See generally NAT'L RES. COUNCIL, *COMMERCIAL SUPERSONIC TECHNOLOGY: THE WAY AHEAD 1* (2001), <https://www.nap.edu/read/10283/chapter/3> [<https://perma.cc/BB8C-GEAP>].

⁴ 14 C.F.R. § 91.817 (2018).

⁵ Proclamation No. 9686, 82 Fed. Reg. 60671, 60671 (Dec. 15, 2017).

⁶ *Id.*

⁷ Compare *id.* (celebrating American ingenuity, innovation, and exploration—specifically noting the design of new supersonic aircraft as an example of such), with 14 C.F.R. § 91.817 (prohibiting civil supersonic flight).

eral factors are responsible.⁸ This comment ultimately argues that outright prohibition by the FAA on civil supersonic flight is overly burdensome and, for all practical purposes, obfuscates technological evolution within the aerospace industry. In light of modern technological developments that promise to mitigate sonic boom nuisance, reevaluation of the FAA prohibition's necessity—especially when balanced against the benefits of potential regulatory alternatives—might reveal a clog in the inadequately maintained regulatory machine. To that end, the lack of literature evaluating the FAA regulation's merits since its inception in 1973 is surprising.⁹ In an endeavor to explore this regulatory landscape this comment first provides background information regarding supersonic flight. Second, this comment analyzes the FAA regulation's enactment and continued merit. Finally, this comment explores alternative proposals to the FAA regulation.

II. BACKGROUND: SONIC BOOMS, THE ERA OF PROHIBITION, AND THEORY IN PRACTICE

Information specifically regarding sonic booms—an inherent obstacle to civil supersonic flight—serves as the touchstone for this comment's analysis. Evaluating the FAA regulation's continued merit demands considering the sonic boom, corresponding litigation, and empirical observations of past civil supersonic transportation.

A. SONIC BOOMS: DOWN TO A SCIENCE

In October 1947, against the backdrop of the Mojave Desert, Air Force Captain Chuck Yeager rocketed through the previously impenetrable sound barrier at speeds in excess of 700

⁸ COMMERCIAL SUPERSONIC TECHNOLOGY: THE WAY AHEAD, *supra* note 3.

⁹ For a comprehensive list of law review articles citing § 91.817, see Michael Abramowicz & John F. Duffy, *Intellectual Property for Market Experimentation*, 83 N.Y.U. L. REV. 337, 370 n.88 (2008) (citing § 91.817 to illustrate a current impediment to supersonic travel and illustrating the necessity for market entrants to spend money on marketing and lobbying); Brian E. Foont, *American Prohibitions Against Gambling In International Aviation: An Analysis of the Gorton Amendment Under the Law of the United States and International Law*, 65 J. AIR L. & COM. 409, 419 n.40 (2000) (citing § 91.817 for the proposition that the Concorde “is only permitted to operate in and out of the United States pursuant to a waiver of the noise regulations for those aircraft.”); Thomas Lundmark, *Systemizing Environmental Law on a German Model*, 7 DICKINSON J. ENVTL. L. & POL'Y 1, 35 n.187 (1998) (citing § 91.817 as a corollary to the Aviation Safety and Noise Abatement Act of 1979 for “control and abatement of aircraft noise and sonic booms.”).

miles per hour.¹⁰ Modeled after a .50 caliber bullet and propelled by four rocket engines, Yeager's Bell X-1 research plane was a feat of technological innovation.¹¹ While the groundbreaking flight achieved supersonic speed for only twenty seconds, the significance of the occasion was marked by a thunderous clap left in the plane's wake—the first sonic boom.¹²

Sonic booms inextricably result from supersonic flight.¹³ Supersonic flight, past Mach 1.0, is achieved at speeds of around 760 miles per hour at sea level, with the requisite speed decreasing as altitude is increased.¹⁴ Not unlike the way a river flows around solid and stationary objects within its banks, sonic booms are created through the fluid-like displacement of pressurized air molecules by objects traveling at supersonic speeds (or speeds equivalent to or greater than Mach 1.0).¹⁵ This displacement does not solely occur at the time that the sound barrier is penetrated but continues for as long as the object remains in supersonic flight.¹⁶ Thus, traveling at supersonic speeds generates a continuous boom that tails the aircraft's flight path.

The magnitude of a sonic boom is influenced by “not only . . . the size, shape, and weight of the airplane, but also [by] the speed and altitude of flight.”¹⁷ “A larger and heavier aircraft must displace more air and create more lift to sustain flight”¹⁸ Comparatively, then, heavier planes generate more powerful sonic booms than lighter and smaller aircraft. Additionally, the design of the aircraft creates variances in sonic boom strength, with “fatter and more blunt” planes generating stronger shock waves than longer, slender planes such as the Bell X-1 flown by Captain Yeager.¹⁹ Altitude also significantly impacts perception of sonic booms at ground-level because greater flight altitude results in greater distances traveled by the shock

¹⁰ Redd, *supra* note 1.

¹¹ *See id.*

¹² *Id.*

¹³ William F. Baxter, *The SST: From Watts to Harlem in Two Hours*, 21 STAN. L. REV. 1, 1 (1968).

¹⁴ Commander Walter J. Murphy, *Sonic Boom—More Annoying Than Dangerous*, 1957 JAG J. 3, 3 (1957).

¹⁵ NASA *Armstrong Fact Sheet: Sonic Booms*, NAT'L AERONAUTICS & SPACE ADMIN., <https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-016-DFRC.html> (last updated Aug. 15, 2017) [<https://perma.cc/UCV9-WMZ4>].

¹⁶ Baxter, *supra* note 13.

¹⁷ *Id.* at 4–5.

¹⁸ NASA *Armstrong Fact Sheet: Sonic Booms*, *supra* note 15.

¹⁹ *Id.*

wave.²⁰ Moreover, the concentration of air molecules dissipates as altitude increases, thereby creating sonic booms that are progressively weaker with higher origination points.²¹ Although greater speeds do correlate to greater sonic boom strength, the change in magnitude is relatively insignificant after speeds of Mach 1.3.²² Instead, in-flight maneuvers more significantly impact sonic boom magnitude.²³

B. MEASURE TWICE, CUT ONCE: QUANTIFYING THE BOOM

Sonic boom magnitude is measured in “overpressure,” related in pounds per square foot (PSF).²⁴ Simply put, overpressure is “[t]he difference between the highest pressure experienced” and the normal atmospheric pressure.²⁵ According to NASA, overpressures of one PSF are unlikely to cause any structural damage.²⁶ Moreover, tests have demonstrated that structures without pre-existing physical defects remain undamaged in the face of 11 PSF overpressures.²⁷ To put these values into context, the Concorde—flying Mach 2.0 at a relatively low altitude of 50,000 feet—generated an average overpressure of only 1.94 PSF.²⁸ When Commander Walter J. Murphy wrote his comment on sonic booms in 1957, no shock wave had been measured in excess of 33 PSF.²⁹ However, in an experiment testing sonic booms generated from low-altitude supersonic flight, the McDonnell Douglas F-4C Phantom II military fighter bomber gen-

²⁰ *Id.*; see also Baxter, *supra* note 13, at 4 (“As it passes through the air, a shock wave gradually loses its energy because of air friction, and, if it travels far enough, the overpressure declines until the shockwave disappears.”).

²¹ NASA *Armstrong Fact Sheet: Sonic Booms*, *supra* note 15.

²² *Id.*

²³ Baxter, *supra* note 13, at 16–23; Anthony J. Ortner, *Sonic Boom: Containment or Confrontation*, 34 J. AIR L. & COM. 208, 213 (1968) (“Any form of aircraft acceleration, lateral, longitudinal or normal, can cause extreme focusing of the sonic boom.”). Note, however, that while in supersonic flight, the aircraft will ordinarily move in a straight line. “Therefore, serious magnifications of shock-wave strengths caused by turning probably will not constitute a major problem.” Baxter, *supra* note 13, at 22.

²⁴ NASA *Armstrong Fact Sheet: Sonic Booms*, *supra* note 15.

²⁵ Baxter, *supra* note 13, at 3–4.

²⁶ NASA *Armstrong Fact Sheet: Sonic Booms*, *supra* note 15.

²⁷ *Id.*; see Murphy, *supra* note 14, at 4 (“If plaster were in such bad condition that the vibration from the next passing truck or strong gust of wind would cause it to fall, it is conceivable that sonic boom could ‘trigger’ its falling. But most of the damage which has been attributed to sonic boom in claims presented to the Navy, Air Force, aircraft corporations, and insurance companies is fantastic.”).

²⁸ NASA *Armstrong Fact Sheet: Sonic Booms*, *supra* note 15.

²⁹ Murphy, *supra* note 14, at 4.

erated overpressures up to 144 PSF.³⁰ The plane flew with a ground clearance of only 85–125 feet (in contrast to normal flight altitudes of at least 30,000 feet) and at speeds ranging from Mach 1.11–1.3.³¹ Although the experiment generated overpressures astronomically more intense than those created in typical supersonic flight, the resulting damage was surprisingly minimal. Structural damage was nominal: findings were limited to glass breakage, plaster cracking, and loose items falling off of shelves.³² Human responses indicated that no “observable symptoms of temporary hearing loss” occurred, despite some ringing of the ears and momentary discomfort.³³ The exposures confirmed that “no direct injury [was] incurred from exposures to exceedingly intense sonic booms by healthy young and middle aged persons.”³⁴ In addition to this study, empirical observations from the 1957 National Aircraft Show, where one plane made a supersonic pass at an altitude between 200–1,000 feet, demonstrate that on the extreme end sonic boom damage may result in broken glass; falling items; and cracked plaster, concrete, and chimneys.³⁵

While these findings demonstrate that extreme sonic boom shock waves pose only a nominal physical threat to persons or property,³⁶ the more significant problem caused by the booms relates to their noise. “Nuisance noise generated by a commercial supersonic jet’s sonic booms during cruise, and by its power-

³⁰ See C. W. Nixon et al., *Sonic Booms Resulting from Extremely Low-Altitude Supersonic Flight: Measurements and Observations on Houses, Livestock and People*, AEROSPACE MED. RES. LABS. (OCT. 1968).

³¹ *Id.* at 8.

³² *Id.* at 18.

³³ *Id.* at 19.

³⁴ *Id.*

³⁵ Murphy, *supra* note 14, at 4.

³⁶ *Id.* (“If a sonic boom produced by aircraft at an altitude of under 1,000 feet can cause only glass damage, it is inconceivable that much damage could result from one produced by an aircraft at higher altitudes. Naval aircraft seldom, if ever, fly at supersonic speed below altitudes of 30,000 feet over, or adjacent to, land areas.”). Accord Ortner, *supra* note 23, at 211–12 (“[D]amage normally occurs at stress points within a structure. Built in stresses due to drying out of green lumber, hydration of concrete, and poor quality of workmanship create a potential failure of building materials.”); LAWRENCE R. BENSON, QUIETING THE BOOM: THE SHAPED SONIC BOOM DEMONSTRATOR AND THE QUEST FOR QUIET SUPERSONIC FLIGHT 13 (2013), <https://www.nasa.gov/sites/default/files/files/QuietingtheBoom-ebook.pdf> [<https://perma.cc/57AZ-UEAF>] (“There were more than 50 incidents of sample windows being broken at 20 psf to 100 psf but only a few possible breakages below 20 psf, and there was no physical or psychological harm to volunteers exposed to overpressures as high as 120 psf.”).

ful engines at takeoff and landing, has kept the speedy aircraft from entering service in the United States.”³⁷ For example, the Concorde created sonic booms with an average perceived decibel level (PLdB) of 105.³⁸ By comparison, making supersonic travel reasonable over U.S. land would require a reduction in noise levels to around 65–85 PLdB.³⁹ To test public reaction to extended sonic boom exposure, a joint task force led by the FAA, the Air Force, and NASA subjected Oklahoma City residents to eight sonic booms per day for over six months.⁴⁰ By the end of the six-month test (nicknamed Operation Bongo II), only a quarter of the 3,000 adults interviewed reported that the noise was so obstreperous that they could never learn to accept it.⁴¹ “Substantial numbers of residents reported interferences with ordinary living activities and annoyance with such interruptions, but the overwhelming majority felt they could learn to live with the numbers and kinds of booms experienced during the six month study.”⁴² In addition to the anthropocentric focus of Operation Bongo II, studies have also measured the reaction of livestock to sonic boom noise.⁴³ Ultimately, however, results of

³⁷ Jim Banke, *Sonic Boom Heads for a Thump*, NAT’L AERONAUTICS & SPACE ADMIN. (May 8, 2012), https://www.nasa.gov/topics/aeronautics/features/sonic_boom_thump.html [<https://perma.cc/ZX4K-MHVK>].

³⁸ *Id.*; Eli Dourado, *How to Legalize Supersonic Flight Over Land*, ELI DOURADO (Dec. 16, 2016), <https://blog.elidourado.com/how-to-legalize-supersonic-flight-over-land-deefff2dbdce> [<https://perma.cc/SET7-MS2S>]. According to perceived decibel level comparison charts, noise from the Concorde’s sonic boom is roughly analogous to standing within three meters of a fully operational power saw. See *Decibel (Loudness) Comparison Chart*, GALEN CAROL AUDIO, <https://www.gcaudio.com/tips-tricks/decibel-loudness-comparison-chart/> [<https://perma.cc/VA3H-S4ZG>].

³⁹ See Dourado, *supra* note 38. While NASA is currently working to produce supersonic aircraft that produce noise levels at or under seventy decibels, Dourado argues that booms of 85–90 decibels ought to be tolerated; sonic booms of 85–90 decibels would be 300 times quieter than those created by the Concorde. See Dourado, *supra* note 38.

⁴⁰ Paul N. Borsky, *Community Reactions to Sonic Booms in the Oklahoma City Area*, NAT’L OPINION RES. CTR. 1, 1 (Jan. 1965), http://www.norc.org/PDFs/publications/NORCRpt_101.pdf [<https://perma.cc/XPE6-FD7F>] (“A total of 1253 sonic booms were actually generated in the Oklahoma City area over a period of six months, from February to July 1964. The intensity of the booms was scheduled for 1.5 pounds per square foot (PSF) for most of the study and 2.0 PSF during the latter stage.”).

⁴¹ *Id.* at 2. General annoyance, however, ranged from a minimum of 25% to a maximum of over 75%. *Id.* at 4.

⁴² *Id.* at 1.

⁴³ See Nathalie M. Armas, *Military Aviation Noise and Its Effects on Domesticated and Wild Animals*, 12 PENN ST. ENVTL. L. REV. 367 (2004).

various tests have been inconclusive since different species of livestock respond to booms in different manners.⁴⁴ “Ten thousand chickens subjected to the entire six month Oklahoma City test sustained some or all of the following effects: disorientation, neurosis, loss of feathers, stoppage of egg laying, internal bleeding and death.”⁴⁵ “Only 4,000 of the original 10,000 chickens remained alive at the end of the period.”⁴⁶ In contrast, “the milk yield of dairy cows in an area of frequent sonic booms was similar to other cows not exposed.”⁴⁷ This highlights the importance of ecological considerations regarding the impact of sonic booms and the feasibility of supersonic travel over the United States. In fact, authorization to exceed Mach 1.0 under subsection (b) of the prohibition typically requires an environmental assessment and finding of no significant impact.⁴⁸

Finally, regulation of airport noise must be considered in addition to the general annoyance of sonic booms. The Department of Transportation (DOT) and the FAA are both regulatory entities responsible for the oversight of aircraft design and operation, including noise abatement.⁴⁹ Vested with the authority to regulate aircraft noise and sonic boom, the FAA enacted regulations such as 14 C.F.R. § 36—a comprehensive and exclusive noise standard regulation regarding aircraft type and certification of airworthiness. Essentially, the FAA regulates the maximum noise emissions that an aircraft may produce by reference to different “stage” designations.⁵⁰ The FAA’s stage designations are adopted from those of the International Civil Aviation Organization (ICAO), a United Nations agency.⁵¹ The stages range

⁴⁴ *Id.* at 377 (“Animal responses can depend on the animal’s hearing ability, the duration of the noise, the type of habitat, time of day and year, the activity the animal is engaged in at the time of exposure, sex and age of the animal, level of any previous exposure, and whether other physical stresses are present.”).

⁴⁵ Ortner, *supra* note 23, at 212.

⁴⁶ *Id.*

⁴⁷ Armas, *supra* note 43, at 380.

⁴⁸ Environmental Impacts: Policies and Procedures, 64 Fed. Reg. 55,526, 55,547 (Oct. 13, 1999).

⁴⁹ Richard W. Danforth, *The Airport Noise Abatement Powers of the Federal Government and Airport Owners: The FAA’s Checklist*, 5 SUM AIR & SPACE LAW. 3, 4 (1990); *see also* 49 U.S.C. § 44715 (2012).

⁵⁰ *Details on FAA Noise Levels, Stages, and Phaseouts*, FED. AVIATION ADMIN., https://www.faa.gov/about/office_org/headquarters_offices/apl/noise_emissions/airport_aircraft_noise_issues/levels/ (last updated Nov. 29, 2016) [<https://perma.cc/2Q7F-3EX6>].

⁵¹ Eli Dourado & Samuel Hammond, *Make America Boom Again: How to Bring Back Supersonic Transport*, MERCATUS CTR. 1, 28 (Oct. 26, 2016), <https://www.mer>

from one to five with one being the noisiest and five being the most conservative threshold for noise emissions.⁵² As technological capacity to mitigate noise production evolves, new aircraft are increasingly required to meet stricter thresholds in order to be certified for airworthiness.⁵³ Likely due to the outright prohibition on civil supersonic flight, Section 36 does not mandate a standard under which *new* supersonic jets are to be certified.⁵⁴ Current supersonic jets are required to operate only at stage two or better; however, as of 2018, new subsonic jets will be required to meet stage five noise levels after the FAA adopted the ICAO's more stringent standards.⁵⁵ Thus, it appears unlikely that new supersonic aircraft will be able to receive airworthiness certification at stage two noise emission thresholds.⁵⁶ Buttressing that prediction, a 2008 policy statement from the FAA and DOT described the latest noise limit at the time as stage four, "which applies to the development of future supersonic airplanes operating at subsonic speeds."⁵⁷ Therefore, newly designed supersonic aircraft will likely be required to meet the noise standards of a community in which they have been woefully absent for several decades. While the FAA's regulations wholly preempt the field of airport noise as to non-federal authorities, the "proprietary exception" allows airport owners to determine the acceptable level of noise created by aircraft operation.⁵⁸ Owners are free to refuse use of their airports to operators of loud aircraft.⁵⁹ Thus, the inherent noisiness of supersonic travel is like a gravitational force—constantly grounding the enterprise fighting to remain in the sky.

catus.org/system/files/mercatus-dourado-supersonic-transport-v1.pdf [https://perma.cc/AKT9-NWRE].

⁵² See 14 C.F.R. §§ 36.1(f)(1)–(14) (2017).

⁵³ *Details on FAA Noise Levels, Stages, and Phaseouts*, *supra* note 50 ("As noise reduction technology matures, the FAA works with the international community to determine if a new stringent noise standard is needed. If so, the international community through the International Civil Aviation Organization (ICAO) embarks on a comprehensive analysis to determine what that new standard will be.").

⁵⁴ Dourado & Hammond, *supra* note 51.

⁵⁵ *Id.*; see *Details on FAA Noise Levels, Stages, and Phaseouts*, *supra* note 50.

⁵⁶ See Dourado & Hammond, *supra* note 51, at 28–29.

⁵⁷ Civil Supersonic Airplane Noise Type Certification Standards and Operating Rules, 73 Fed. Reg. 62,871, 62,872 (Oct. 22, 2008) (to be codified at 14 C.F.R. pts. 36, 91).

⁵⁸ Danforth, *supra* note 49, at 3.

⁵⁹ *Id.*

C. SONIC BOOMS AND YOU: LITIGATION AND THEORIES OF LIABILITY

The propensity of sonic booms to cause structural damage necessarily makes them a source of litigation. Experts, however, are at odds regarding the extent of that propensity. For example, the Oklahoma City test results suggest that sonic booms did not significantly damage any of the local test houses.⁶⁰ The FAA rigged test houses with instruments to measure the sonic booms' physical impact on the various properties.⁶¹ Despite the results of the test, however, 40% of those surveyed believed that their houses had been damaged, indicating that individuals who believe sonic booms cause property damage are more likely to complain and report damage or annoyance.⁶² In addition to the Oklahoma City tests, the low-altitude sonic boom test generating overpressures between 108 PSF and 144 PSF found similarly expected results:

Observed structures in the exposed residential areas consisted of very old frame and brick buildings in poor states-of-repair and both old and new campers and trailers . . . However, the buildings and their states-of-repair probably are representative of the kinds of structures that may be expected in other remote areas selected as sites for future low-level supersonic flight programs.

Damage to structures was principally confined to glass breakage, plaster cracking and furnishings falling from shelves. In almost all cases glass breakage occurred at the side of the building facing the approaching aircraft. The extent and nature of the damage was not unexpected for the magnitude of the sonic boom exposures experienced. There was no damage in the trailers.

. . .

A relatively new station wagon located 50 feet from the track incurred no breakage throughout the tests, although covers for the dome light and spare tire compartment popped out during sonic boom exposures. An already cracked safety glass window (side rear) of an older Sandia station wagon was shattered by the first sonic boom to which it was exposed.⁶³

Therefore, these studies suggest that structural damage from sonic boom exposure is mostly insignificant but can be considerably exacerbated by latent defects already existing in the prop-

⁶⁰ Borsky, *supra* note 40, at 5.

⁶¹ *Id.*

⁶² *Id.*

⁶³ Nixon et al., *supra* note 30, at 18.

erty. Note, however, that low-altitude supersonic passes are unusual and overpressures as high as 144 PSF rarely occur outside of military testing or blatantly negligent flight operation. In one South Carolina case, plaintiff homeowners brought suit against their insurance company after sonic booms allegedly caused their plaster to crack and wood trim to separate from the wall.⁶⁴ Despite the damage to the interior of the house, all windows remained intact.⁶⁵ Plaintiff's injuries were ultimately attributed to constructional defects in the home after expert testimony described sonic boom functionality and the manner in which damage might be caused by them.⁶⁶ The court found that it simply would not have been possible for a sonic boom to cause interior damage without contiguously causing the home's windows to shatter.⁶⁷ Thus empirical observations and scientific governmental studies seem to support polemics denying the dangers of sonic booms.

In contrast to these studies' conclusions, recent law review articles and litigation reports posit that structural damage can be more severe than previous studies indicated.⁶⁸ The American Bar Association cites *Alexander v. Firemen's Insurance Co.* as the first case where considerable structural damage resulted in litigation.⁶⁹ There, the plaintiff constructed a metal frame building free of any perceivable imperfections, structural defects, or deterioration.⁷⁰ After what one witness described as the loudest sonic boom ever, the shock waves "unseated the girders beneath the building and capsized it."⁷¹ For those harboring doubts about gobbledygook governmental science, support for inculcating sonic booms came in the form of a twisted and mangled Texas warehouse. Another case of destruction from sonic boom shock waves involved an almost-completed control tower in Montgomery, Alabama.⁷² The control tower was a well-constructed mono-

⁶⁴ Stratton Hammon, *More on Sonic Booms: Litigation Is Showing Their Propensities*, 47 A.B.A. J. 1096, 1097 (1961).

⁶⁵ *Id.*

⁶⁶ *Id.*

⁶⁷ *Id.*

⁶⁸ See generally Ortner, *supra* note 23, at 211–13; Robert D. Batson, *Torts - Liability - Sonic Boom*, 36 J. AIR L. & COM. 117 (1970); Hammon, *supra* note 64, at 1096.

⁶⁹ Hammon, *supra* note 64, at 1097.

⁷⁰ *Alexander v. Firemen's Ins. Co.*, 317 S.W.2d 752, 754 (Tex. App.—Waco 1958, no writ).

⁷¹ *Id.* at 753.

⁷² Hammon, *supra* note 64, at 1097–98.

lith of reinforced concrete, steel, and aluminum ribs.⁷³ A supersonic aircraft passed by the tower at only 500 feet, shattering windows, twisting the aluminum ribs, and completely ripping off aluminum spandrels—"bolts and all."⁷⁴ The damage was so extensive, and so clearly caused by the passing aircraft, that both parties to the action agreed to stipulate that a sonic boom caused the damage.⁷⁵

The divergence in authority regarding the extent to which sonic booms are capable of causing significant property damage illustrates the complexities permeating sonic boom litigation. For example, expert witnesses often may have different theories of causation stemming from antipodal perceptions of sonic boom propensities.⁷⁶ The following paragraphs explore potential claims that plaintiffs might bring after being exposed to sonic booms. But there remains difficulty in proving—or disproving—a causal relationship between a sonic boom's occurrence and the ultimate harm asserted by a plaintiff.

The most apparent claim for a plaintiff to bring after suffering loss from sonic boom exposure is negligence. Simply put, claims of negligence must prove duty, breach of duty, causation, and harm.⁷⁷ Calling back to the variables mentioned earlier regarding sonic boom magnitude, the negligent act might be anything from flying too fast or too low to executing in-flight maneuvers at supersonic speed.⁷⁸ To prove causation, the plaintiff must convincingly establish that the sonic boom's overpressures were the proximate cause of the harm alleged.⁷⁹ In light of the previously described controversy among experts, the plaintiff must shoulder the heavy burden of proving that the sonic boom was the "substantial factor" which caused the damage to his property.⁸⁰ As an example of such difficulty, Batson cites *Dabney v. United States*.⁸¹ The case stands for the proposition that mere evidence of damage, without more, is insufficient to prove

⁷³ *Id.*

⁷⁴ *Id.* at 1098.

⁷⁵ *Id.*

⁷⁶ Compare Borsky, *supra* note 40, with Hammon, *supra* note 64.

⁷⁷ *Martindale v. Ripp*, 629 N.W.2d 698, 707 (Wisc. 2001).

⁷⁸ Batson, *supra* note 68, at 122 ("The altitude of flight is significant, since the energy of a shock wave is diminished by the friction created in its passage through air. At lower altitudes, shock waves produced by supersonic flight are not sufficiently dissipated . . .").

⁷⁹ *Id.*

⁸⁰ *Id.* at 123.

⁸¹ *See id.*

causation in an action for negligence.⁸² Plaintiffs' testimony that they noticed cracks, distortion of windows and doors, and buckled hardwood floors ultimately failed to overcome the defendant's suggestion that all such damage was merely a result of the building settling over the years.⁸³ In *United States v. Gravelle*, the Tenth Circuit wrestled with this very problem.⁸⁴ There, nine homeowners from the Oklahoma City area subjected to the government testing in Operation Bongo II brought claims against the government for property damage caused by sonic booms.⁸⁵ The government argued that causation could only be proven by expert testimony that solely relied on scientific data and further demanded that all other possible sources of causation be eliminated.⁸⁶ The Tenth Circuit rejected the government's argument, holding that the plaintiffs ought not be held to a standard of proof "impossible for them to sustain under the circumstances here imposed on them by the deliberate acts of the government."⁸⁷ Ultimately, the court decided that the standard of proof was met where the plaintiffs' experts posited that the damage was likely caused by the sonic booms, considering the homeowners' account of their properties' history.⁸⁸

In addition to proving that the overpressures caused the claimed damage, plaintiffs must establish that those overpressures were negligently produced.⁸⁹ This constitutes a heavy burden because most plaintiffs are not in a position to discern "the exact reason for production of the damaging overpressures."⁹⁰ Two possibilities exist for such plaintiffs: the doctrines of *res ipsa loquitur* and strict liability.

Res ipsa loquitur—Latin for "the thing speaks for itself"—is a doctrine through which negligence may be inferred from the surrounding facts and circumstances of the case.⁹¹ "The factfinder may infer that the defendant has been negligent

⁸² *Dabney v. United States*, 249 F. Supp. 599, 600 (W.D.N.C. 1965).

⁸³ *Id.*; *Batson*, *supra* note 68, at 123.

⁸⁴ *United States v. Gravelle*, 407 F.2d 964 (10th Cir. 1969).

⁸⁵ *Id.* at 965.

⁸⁶ *Id.* at 968–69.

⁸⁷ *Id.* at 969. In fact, the court took note that the government denied the existence of any property damage that could be proven under traditional rules of causation after exposing the plaintiffs' property to "a deliberate tort" in order to appease their curiosity as to what damage, if any, would result. *Id.* at 968.

⁸⁸ *Id.* at 969.

⁸⁹ *Batson*, *supra* note 68, at 123.

⁹⁰ *Id.*

⁹¹ 53 TEX. JUR. 3d *Negligence* § 108.

when the accident causing the plaintiff's harm is a type of accident that ordinarily happens as a result of the negligence of a class of actors of which the defendant is the relevant member."⁹² Thus, where plaintiffs are incapable of determining the cause of the damaging overpressures, *res ipsa loquitur* might nevertheless provide those plaintiffs with some relief. Applying the doctrine in the context of blasting, the Austin Court of Civil Appeals stated: "If a person in, say, blasting stumps sets off an explosion which levels his neighbor's house several hundred feet away, it would be rather ridiculous to require proof of the exact amount of explosive used in order to show that he used too much."⁹³ By analogy, where supersonic flight causes a sonic boom that sets off a shock wave causing structural damage to a plaintiff's property, it would be equally ridiculous to require the plaintiff to prove the exact cause of the damaging overpressure.⁹⁴ The ultimate applicability of *res ipsa loquitur* turns on whether the plaintiff can establish that damaging overpressures are the natural and ordinary result of negligent supersonic flight or flight maneuvers.⁹⁵

Strict liability offers another potential solution for sonic boom plaintiffs. Under traditional tort liability the plaintiff bears the

⁹² RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 17 (AM. LAW INST. 2010). Note that the third restatement's construction of the *res ipsa loquitur* doctrine eliminates the "exclusive control" element, found in earlier restatements. The exclusive control element required the plaintiff's harm to be caused by an agency or instrumentality within the exclusive control of the defendant. *Compare id. with* RESTATEMENT (SECOND) OF TORTS § 328D (AM. LAW INST. 1965). The third restatement's formulation of the *res ipsa* doctrine thus circumvents Batson's worry that convincing a fact-finder that the damage-producing shock-wave was within the defendant's exclusive control might be "troublesome." *See* Batson, *supra* note 68, at 125.

⁹³ *McKay v. Kelly*, 229 S.W.2d 117, 120 (Tex. Civ. App.—Austin, 1950), *aff'd*, 223 S.W.2d 121 (Tex. 1950).

⁹⁴ Furthermore, the plethora of factors affecting overpressure magnitude is likely to leave the plaintiff in an even more precarious position than those plaintiffs in blasting cases:

Not only is the plaintiff confronted with the problem of providing evidence to show the aircraft's altitude and flight path and to establish in fact who was operating the aircraft; but, complete preparation in sonic boom damage litigation requires knowledge involving several highly technical sciences, such as aerodynamics, the theory of flight, principles of jet propulsion, jet engines, aircraft structures, radar principles, communications and electronics, meteorology, navigation, stresses, building codes, manufacturing processes, and so forth.

Batson, *supra* note 68, at 124.

⁹⁵ *See generally* RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 17.

cost of damage unless he is able to show fault. In some instances, however, strict liability may attach where a defendant engages in abnormally dangerous activity.⁹⁶ Previously referred to as “ultrahazardous activity,” abnormally dangerous activities are those that create a foreseeable and highly significant risk of harm despite the exercise of reasonable care—not activities of “common usage.”⁹⁷ A strong argument exists for sonic boom classification as “abnormally dangerous” because sonic boom magnitude is dependent on several factors that cannot be controlled, even with exercise of the utmost care.⁹⁸ Thus, strict liability can offer plaintiffs a method to recover damages resulting from sonic boom shock waves without proof of fault. Furthermore, explosions—defined as a “sudden release of great pressure accompanied by noise”—are commonly considered abnormally dangerous activities.⁹⁹ It can certainly be concluded (or at least argued to the court) that sonic booms, based on that definition, ought to be classified as explosions and thus treated as an abnormally dangerous condition.¹⁰⁰ However, because application of strict liability requires that supersonic flight be deemed abnormally dangerous, the theory of liability could potentially be weakened if it is shown that reasonable care mitigates the dangers of supersonic flight.¹⁰¹ Moreover, “technological developments may so greatly improve supersonic flight that the ultrahazardous classification may change.”¹⁰²

Unfortunately, strict liability is wholly unavailable against the United States as a defendant under the Federal Tort Claims Act

⁹⁶ *Id.*

⁹⁷ *Id.* § 20.

⁹⁸ See Ortner, *supra* note 23, at 215.

⁹⁹ *Id.*

¹⁰⁰ However, “courts do not as yet take judicial notice that a sonic boom is an explosion, hence the fact must be proved.” Ortner, *supra* note 23, at 215. In fact, courts have explicitly found the opposite—that sonic booms are a unique phenomenon and cannot rightly be considered an explosion in the “ordinarily understood” sense of the word. See Hammon, *supra* note 64, at 1098. It is important to note that failure of this analogy or classification is not dispositive on the issue of strict liability—sonic booms may still be considered abnormally dangerous, despite their *sui generis* qualities.

¹⁰¹ See RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 20 cmt. b (“Aviation, for example, is potentially quite dangerous; but a jury might believe that these dangers can usually be averted if the pilot and airline exercise reasonable care . . . Arguments on behalf of strict liability, then, tend to begin with the premise that the accident has happened even though the defendant has fully exercised reasonable care while engaging in the activity.”).

¹⁰² Ortner, *supra* note 23, at 215.

(FTCA). Because civil supersonic flight is prohibited by 14 C.F.R. § 91.817, it follows that most defendants in sonic boom litigation are members of the military, regulatory agencies, or contractors working with the government. The FTCA acts as a waiver of the United States' sovereign immunity, exposing the government to liability for recognized causes of action.¹⁰³ Thus, plaintiffs who suffer from government negligence have recourse under the FTCA; unfortunately for plaintiffs in sonic boom cases, the government cannot be held answerable on theories of strict liability, or where "there has been no negligence or other form of 'misfeasance or nonfeasance.'"¹⁰⁴ In *Laird v. Nelms*, the Supreme Court held that damage from sonic booms is not actionable under the FTCA without proof of negligence either in the planning or operation of the flight.¹⁰⁵ In fact, the Supreme Court's decision effectively "eliminated strict liability under state law as a basis for suits against the United States under the FTCA."¹⁰⁶ The FTCA further complicates things for sonic boom plaintiffs through the "discretionary function exception."¹⁰⁷ Congress enacted the discretionary function exception to protect the government from unduly burdensome exposure to liability.¹⁰⁸ The exception shields the government from any claims based on an omission, exercise, or performance of a discretionary function or duty by any federal agency or employee of the government, regardless of whether that discretion was abused.¹⁰⁹ For example, in *Maynard v. United States*, the defendant government's motion for summary judgment was granted where the Commander of Strategic Air Command and the Chief of the Navigation Section decided to conduct supersonic flight

¹⁰³ See Richard B. Sorenson, *Use of the FTCA Discretionary Function Exception in Sonic Boom and Low Overflight Litigation*, 33 A.F. L. REV. 137, 137-38 (1990).

¹⁰⁴ *Laird v. Nelms*, 406 U.S. 797, 799 (1972).

¹⁰⁵ *Id.* at 797; see also 5 AM. LAW OF TORTS § 17:6 *Strict or Absolute Liability*; *Laird v. Nelms Doctrine* (2018) ("[T]he Federal Tort Claims Act requires that negligence be shown and . . . the United States cannot be held liable under the Act on any theory of strict liability for engagement in ultrahazardous activities.").

¹⁰⁶ Sorenson, *supra* note 103, at 142. *Accord* *Ward v. United States*, 471 F.2d 667, 670 (3d Cir. 1973) ("State laws permitting recovery on a strict liability theory for extrahazardous activities are not a basis for recovery, under the Act, against the United States."), and *Abraham v. United States*, 465 F.2d 881, 882 (5th Cir. 1972) ("The Court unequivocally held that the [FTCA] does not authorize claims, suits, or liability based on strict liability for ultrahazardous activity.").

¹⁰⁷ See Sorenson, *supra* note 103, at 137.

¹⁰⁸ *Id.* at 138.

¹⁰⁹ *Id.*; 28 U.S.C. § 2680(a) (2012).

operations and determined the route selection.¹¹⁰ Despite the plaintiff's injury, and regardless of whether or not the route selection was negligently made, the decision fell within the discretionary function exception since "it was an act of a subordinate taken in furtherance of governmental policy."¹¹¹ The discretionary function exception encouraged a notable distinction between negligent planning (which is protected as a discretionary function) and negligent operation (which is not protected, and subject to claims under the FTCA).¹¹² As an example of such a distinction, the Third Circuit offered the following example: "ordering an army maneuver is a discretionary function, but the negligent operation of an army vehicle during such a maneuver is not. The same distinction is applicable to the operation of aircraft."¹¹³ Plaintiffs subjected to property damage via sonic booms are thus denied recovery where proof of operational negligence—as opposed to negligent planning—is lacking.

D. THE CONCORDE: COMMERCIAL SUPERSONIC TRAVEL IN PRACTICE

"In theory, there is no difference between theory and practice. But, in practice, there is."¹¹⁴

When the Concorde first took commercial flight in January 1976, they represented a culmination of the technological developments of the twentieth century.¹¹⁵ After Chuck Yeager first broke the sound barrier in 1947, engineers across the world raced to develop the newfound aerospace technology into a

¹¹⁰ *Maynard v. United States*, 430 F.2d 1264, 1265–66 (9th Cir. 1970) (per curiam); Sorenson, *supra* note 103, at 142.

¹¹¹ Sorenson, *supra* note 103, at 142.

¹¹² *See Dalehite v. United States*, 346 U.S. 15, 42 (1953) ("In short, the alleged 'negligence' does not subject the Government to liability. The decisions held culpable were all responsibly made at a planning rather than operational level"); *Ward v. United States*, 471 F.2d 667, 670 (3d Cir. 1973) ("While the government affidavits here were sufficient to show that the decision to send supersonic flights through the Pittsburgh air corridor at the critical time was made in the exercise of a discretionary function, they were clearly insufficient to rule out the possibility of operational negligence.").

¹¹³ *Ward*, 471 F.2d at 670.

¹¹⁴ Jan L. A. van de Snepscheut, WIKIQUOTE, https://en.wikiquote.org/wiki/Jan_L._A._van_de_Snepscheut [<https://perma.cc/N7QC-APEJ>] (last updated Sept. 26, 2016).

¹¹⁵ *This Day in History: January 21*, HISTORY.COM, <http://www.history.com/this-day-in-history/concorde-takes-off> [<https://perma.cc/P5C9-JB9A>].

commercially viable supersonic passenger plane.¹¹⁶ The Concorde ultimately seized the day, beginning test flights in 1969 and commercial supersonic passenger flights in 1976.¹¹⁷ Topping out at speeds of 1,354 miles per hour (or Mach 2.04), the Concorde offered up to 100 passengers the ability to fly from New York to London in just three hours.¹¹⁸ Today, that same trip takes between 7.5–8.5 hours.¹¹⁹ In fact, almost all commercial flights today travel at less than half the speed demonstrated by the Concorde,¹²⁰ which ought to raise questions about the pace of technological development within the aerospace industry. Despite the Concorde's prowess, it failed. While supersonic commercial travel is theoretically feasible, practical considerations gleaned from the Concorde's experience offer unparalleled insight into the future of the aerospace industry's evolution.

The Concorde resulted from a joint operation between the British Aircraft Corporation and Sud Aviation, a French airline company.¹²¹ It represented more than just a plane: the Concorde was a monument to European proficiency, proving that European countries could “cooperate in complex ventures” and solidifying their position as leaders on the forefront of aerospace development.¹²² Four Rolls-Royce jet engines—the most powerful engines in commercial flight operation—made the Concorde's ludicrous speed possible.¹²³ Each engine produced a near-incomprehensible 38,000 pounds of thrust, collectively giving the Concorde a take-off speed of over 250 miles per hour

¹¹⁶ *Id.* (“In 1962 . . . Britain and France signed a treaty to develop the world's first supersonic passenger airline. The next year, President John F. Kennedy proposed a similar U.S. project. Meanwhile, in the USSR, Soviet leader Nikita Krushchev ordered his top aviation engineers to beat the West to the achievement.”).

¹¹⁷ *Id.*; *Concorde*, BRITANNICA.COM, <https://www.britannica.com/technology/Concorde> [<https://perma.cc/9ELP-99JV>].

¹¹⁸ *Concorde*, *supra* note 117.

¹¹⁹ *Flight Time New York to London*, TRIPIT.COM, <https://www.tripit.com/destinations/flight-time-new-york-to-london/> [<https://perma.cc/DVA5-5MG9>].

¹²⁰ *Airplane Speeds Have Stagnated for 40 Years*, MERCATUS CTR. (July 20, 2016), <https://www.mercatus.org/publication/airplane-speeds-have-stagnated-40-years> [<https://perma.cc/ZZT3-M6MH>].

¹²¹ *Concorde's History*, AEROSPACEBRISTOL.ORG, <http://aerospacebristol.org/the-story-of-concorde/> [<https://perma.cc/8AM5-9LUQ>].

¹²² *Concorde*, *supra* note 117.

¹²³ *Concorde's History*, *supra* note 121.

and a cruising speed of over Mach 2.0.¹²⁴ Although powerful and quick, the plane was heavy and the engines required massive amounts of fuel—over 5,500 gallons *per hour*.¹²⁵ Nevertheless, British Airways alone flew two and a half million commercial passengers on the supersonic aircraft and even used one Concorde to completely circumnavigate the world in thirty hours.¹²⁶ Despite its vast abilities, the only scheduled flight routes for the Concorde were between New York and London for British Airways and between Paris and New York for Air France.¹²⁷ The Concorde's last commercial flight took place on October 24, 2003, marking twenty-seven years of civil supersonic transport between its retirement and maiden commercial voyage in 1976.¹²⁸

Several factors contributed to the Concorde's demise, including the fatal Paris crash in July 2000.¹²⁹ As the Concorde rocketed down the French runway, a piece of metal caused one of the plane's tires to explode, subsequently puncturing the fuselage and starting a fire that caused two of the engines to falter.¹³⁰ The plane crashed merely sixty seconds after takeoff, killing all 109 persons on board the plane and four people on the ground.¹³¹ In addition, the September 11, 2001 attacks on the World Trade Center flattened the market for premium, first-class air travel, making the Concorde's rebound from the Paris travesty all the more insurmountable.¹³² Vicissitudes aside, the Concorde ultimately had its wings clipped due to cost and environmental concerns.

The development costs of the Concorde ran the UK and French governments upwards of one billion pounds while the

¹²⁴ *Celebrating Concorde*, BRITISH AIRWAYS, <https://www.britishairways.com/en-us/information/about-ba/history-and-heritage/celebrating-concorde> [<https://perma.cc/6P8D-ZKFH>].

¹²⁵ *Id.* The plane weighed over 400,000 pounds (185 tons) and carried nearly 26,300 gallons of fuel. *Id.*

¹²⁶ *Id.*

¹²⁷ *Concorde F.A.Q.*, CONCORDESST.COM, <http://www.concordesst.com/faq.html> [<https://perma.cc/GCX9-ZLTE>].

¹²⁸ *Celebrating Concorde*, *supra* note 124. The Concorde accumulated “over 240,000 flight hours across 81,000 flights before retiring in 2003.” Dourado & Hammond, *supra* note 51, at 10.

¹²⁹ See David Rose, *Doomed: The Real Story of Flight 4590*, THE GUARDIAN (May 12, 2001, 9:26 PM), <https://www.theguardian.com/world/2001/may/13/davidrose.focus> [<https://perma.cc/NNX8-JCK9>].

¹³⁰ *Id.*

¹³¹ *This Day in History: January 21*, *supra* note 115.

¹³² *Concorde F.A.Q.*, *supra* note 127.

production costs flew to the tune of nearly 41 million pounds per plane.¹³³ Adjusted closer to today's dollars, total costs were around \$27 billion by the time the Concorde was operational in 1976.¹³⁴ Additionally, booking a seat on the plane required deep pockets; standard one-way ticket prices of \$7,000 severely undercut the population of available consumers for civil supersonic flight.¹³⁵ Further, the Concorde's heavy weight of 185 tons, fuel consumption of 5,700 gallons of gas per hour, and vociferous sonic boom illustrate its inefficiency.¹³⁶ While flying at twice the speed of sound is undoubtedly an impressive feat, such speed forced the plane to battle against "considerably more drag than your standard airplane."¹³⁷ The Concorde thus had to consume a ridiculous amount of fuel—four times the fuel per passenger of a Boeing 747.¹³⁸ To ensure a range of over 4,000 miles, the Concorde had to carry over 26,000 gallons of gas—a significant factor contributing to the plane's overall weight.¹³⁹ Moreover, in just the plane's taxi to the runway, the Concorde's four jet engines would have already consumed as much fuel as the average car uses *in six months*.¹⁴⁰ As the price of oil increased over the Concorde's lifetime, such fuel efficiency simply was not sustainable and caused "both the prices of tickets and the toll on the environment to rise precipitously."¹⁴¹

In addition to monetary concerns, the noise produced by the Concorde severely limited its use for commercial transport. Sonic booms from the Concorde could be as loud as 135 decibels but typically fell within the 105–110 range.¹⁴² Through

¹³³ *Id.*

¹³⁴ Dourado & Hammond, *supra* note 51, at 12.

¹³⁵ Dara Bramson, *Supersonic Airplanes and the Age of Irrational Technology*, THE ATLANTIC (July 1, 2015), <https://www.theatlantic.com/technology/archive/2015/07/supersonic-airplanes-concorde/396698/> [https://perma.cc/CP66-EPW8].

¹³⁶ *Celebrating Concorde*, *supra* note 124.

¹³⁷ Steven Overly, *The Concorde Failed to Change How We Fly, But It Still Could*, WASH. POST (Feb. 13, 2017), https://www.washingtonpost.com/news/innovations/wp/2017/02/13/the-supersonic-flight-that-never-really-took-off-has-landed-for-good/?utm_term=.8cee5b3abcfb [https://perma.cc/XH7U-X8BC].

¹³⁸ *After Concorde*, THE ECONOMIST (Oct. 16, 2003), <http://www.economist.com/node/2142593> [https://perma.cc/U9HL-N7RM].

¹³⁹ *Celebrating Concorde*, *supra* note 124.

¹⁴⁰ Smithsonian Channel, *How the Crash of Flight 4590 Destroyed Concorde's Mystique*, YOUTUBE (Jan. 20, 2017), <https://www.youtube.com/watch?v=4zeDsJmcpM> [https://perma.cc/A343-ETXR].

¹⁴¹ Overly, *supra* note 137.

¹⁴² Dourado & Hammond, *supra* note 51, at 3.

monitoring its departures and arrivals at Dulles International Airport, the average departure clocked in at 119.4 PLdB and the average arrival at 116.5 PldB.¹⁴³ Because of the sonic boom produced, nearly half of the Concorde's potential routes were "off-limits."¹⁴⁴ "Ozone emissions and atmospheric pollution were the greatest environmental concerns and turmoil over the loud, disruptive boom that had the power to break windows were constant contentions."¹⁴⁵ One environmental activist, Richard Wiggs, created the "Anti-Concorde Project" and lobbied tirelessly against the development of commercial supersonic transportation.¹⁴⁶ The movement captured a widespread public sentiment that sonic booms posed significant risks not only to the environment but also to personal property and peace of mind.¹⁴⁷ Ultimately, Wiggs was successful. The FAA responded in 1973 by prohibiting supersonic transport over the United States, and the Concorde was "banned from landing in the United States altogether"¹⁴⁸ However, in 1976, the Secretary of Transportation responded to pressure from the British and French governments, and directed the FAA to allow up to two Concorde flights daily from New York's John F. Kennedy International Airport and one daily from Dulles International Airport for a sixteen-month testing period.¹⁴⁹ Because the testing period demonstrated that most of the Anti-Concorde Project's worries were unfounded, regular transatlantic flight between the United States and Europe took shape until the aircraft's retirement in 2003.¹⁵⁰

¹⁴³ Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. 28,406, 28,409 (June 29, 1978).

¹⁴⁴ Bramson, *supra* note 135.

¹⁴⁵ *Id.*

¹⁴⁶ Dourado & Hammond, *supra* note 51, at 12 (The Anti-Concorde Project was a result of Richard Wiggs's belief that "the Concorde represented a critical front line in the battle between technology and the environment.").

¹⁴⁷ See Bramson, *supra* note 135 ("The move came amid growing concerns that about the impact of sonic booms over land, including fears that the shock waves would damage buildings, shatter windows, and create intolerable noise near airports."); Samuel Hammond, *The Return of Supersonic*, NISKANEN CTR. (June 19, 2017), <https://niskanencenter.org/blog/return-of-supersonic/> [<https://perma.cc/ECE8-AU3T>].

¹⁴⁸ 14 C.F.R. § 91.817 (2018); Dourado & Hammond, *supra* note 51, at 12.

¹⁴⁹ See *British Airways Bd. v. Port Auth. of N.Y.*, 558 F.2d 75, 80 (2d Cir. 1977) ("In Secretary Coleman's view, a testing period of actual Concorde operations was an essential prelude to the final decision on the aircraft's acceptability in the United States.").

¹⁵⁰ See Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. 28,406, 28,409 (June 29, 1978). Note

The Concorde was polarizing. For some, the plane represented the pinnacle of technological possibility—a symbol of innovation and exploration that inspired awe both in the sky and at the landing strip.¹⁵¹ For others, the Concorde represented a brazen disregard of the environment and civil infrastructure, its sonic booms threatening to rip holes in harmony on the ground.¹⁵² Despite antipodal perceptions of its place within the aerospace industry, the Concorde flew boldly into the virgin skies of civil supersonic travel. Its legacy lives on to offer empirical guidance for those undertaking the development of supersonic flight technology. Conquering the Concorde's inefficiencies could finally make civil supersonic transportation a mainstay within the aerospace industry.

III. ANALYSIS: THE PROHIBITION, ITS CONTINUED MERITS, AND POTENTIAL ALTERNATIVES

A. THE PROHIBITION

Congress vested the FAA with federal regulatory authority in 1958 through the Federal Aviation Act.¹⁵³ The Administrator of the FAA is empowered to set standards and regulations to control and abate aircraft noise and sonic boom.¹⁵⁴ In 1973 the FAA issued the regulation prohibiting civil supersonic flight over the United States.¹⁵⁵ The regulation reads: “No person may operate a civil aircraft at a true flight mach number greater than 1 except in compliance with conditions and limitations in an authorization to exceed mach 1 issued to the operator under Appendix B of this part.”¹⁵⁶ Rather than impose a noise standard or threshold, the FAA enacted what essentially amounts to a speed limit for aircraft—no person may fly at supersonic speeds.¹⁵⁷ The FAA's stated purpose in promulgating the blan-

that the Concorde had considerable restrictions on its operation—it was still subject to Section 91.817 and was never permitted to hit supersonic speeds while in the United States. *See id.* at 28,420–41.

¹⁵¹ *See* Dourado & Hammond, *supra* note 51, at 10.

¹⁵² *Id.*

¹⁵³ John M. Werlich & Richard P. Krinsky, *The Aviation Noise Abatement Controversy: Magnificent Laws, Noisy Machines, and the Legal Liability Shuffle*, 15 *Loy. L.A. L. REV.* 69, 71 (1981). The Act has since been repealed and replaced with provisions in 49 U.S.C. § 40101 *et seq.*

¹⁵⁴ 49 U.S.C. § 44715 (2012).

¹⁵⁵ General Operating and Flight Rules, 38 *Fed. Reg.* 8,051, 8,051 (Mar. 28, 1973) (to be codified at 14 C.F.R. pt. 91).

¹⁵⁶ *Id.*

¹⁵⁷ *See id.*

ket prohibition was “to afford the public protection from civil aircraft sonic boom.”¹⁵⁸

Activists such as Richard Wiggs, the founder of the Anti-Concorde Project, reinforced the public fear of sonic booms through dissemination of propaganda.¹⁵⁹ In fact, one of the earliest proposed solutions to public fear regarding sonic booms was to create advertising and access to information about the relatively insignificant threat that sonic booms posed.¹⁶⁰ However, as the comments in the Federal Register indicate, the public largely demanded that the FAA regulate supersonic flight.¹⁶¹ Public commentary to the proposed regulation expressed concern for airport noise levels and the effect of exhaust from supersonic aircraft on the environment and upper atmosphere.¹⁶² In response, the framers of the regulation stated that its underlying policy was to shift the burden of establishing environmental acceptability from the potentially affected public to the proponent of the disputed action.¹⁶³ “Reasonable opportunity for the operators or manufacturers of civil supersonic aircraft to conduct sonic boom research is thus provided . . . in the form of closely controlled authorizations to exceed mach 1 in designated test areas.”¹⁶⁴ Thus, the burden now falls upon proponents of supersonic flight technology to demonstrate its acceptability.

Despite the blanket prohibition, some commentators urged that all opportunity for supersonic airworthiness testing be eliminated and stated that “no provision should exist for the issuance of an authorization to exceed mach 1 under any condition.”¹⁶⁵ Fortunately, the FAA rejected the suggestion as an irrational abandonment of emergent technology, and affirmatively encouraged environmentally responsible growth.¹⁶⁶

¹⁵⁸ *Id.* at 8,051.

¹⁵⁹ Hammond, *supra* note 147.

¹⁶⁰ Murphy, *supra* note 14, at 5 (“[W]e can all engage in . . . word-of-mouth advertising to pass the word to each other and to the public at large that sonic boom may be mighty loud and very annoying but is not very damaging.”).

¹⁶¹ See General Operating and Flight Rules, 38 Fed. Reg. 8,051 (Mar. 28, 1973) (to be codified at 14 C.F.R. pt. 91).

¹⁶² *Id.*

¹⁶³ *Id.* at 8,052.

¹⁶⁴ *Id.*

¹⁶⁵ *Id.*

¹⁶⁶ *Id.* (“Further, such research is also necessary to promote exploration and understanding of the complex interface between technology and quality of life so that both may be maximized . . .”).

In 1975, the Environmental Protection Agency (EPA) proposed a rule that would extend its prohibition on civil supersonic flight to the operation of any supersonic aircraft going to or from an American airport, unless that aircraft complied with noise requirements set out in 14 C.F.R. § 36.¹⁶⁷ The proposal reflected the EPA's belief that the noise standards set out in Part 36 ought to apply equally to supersonic airplanes, with no exception for idiosyncratic design features necessary for flight at supersonic speeds.¹⁶⁸ Finally, in 1978, the proposed rules became effective, requiring all civil supersonic airplanes—except for the Concorde—to comply with Part 36, at the time meaning noise levels of stage 2 or better.¹⁶⁹ Additionally, the rules prohibit civil supersonic aircraft from “producing sonic booms in the United States while they are going to or from U.S. airports, even if the airplane is outside the United States at the time.”¹⁷⁰ The FAA passed the provision “to protect the coastal areas of the United States from sonic boom.”¹⁷¹ Moreover, the 1978 report addressed the EPA's goal of uniform consideration regarding noise emissions, despite subsonic and supersonic distinctions. The FAA refused to commit itself to permanent future linkage between subsonic and supersonic noise levels (as desired by the EPA), but did commit to a hard operational noise limit of stage 2 for all present and future supersonic aircraft.¹⁷²

In establishing the proposed rules, the FAA considered public input from both written comments and public hearings.¹⁷³ The following areas of public concern served as the primary justifications for both the prohibition on supersonic flight and the adoption of the 1975 proposed rules. “By far the greatest num-

¹⁶⁷ Civil Supersonic Airplanes: Noise Requirements Submitted to FAA by EPA, 40 Fed. Reg. 14,051, 14,093 (Mar. 28, 1975) (to be codified at 14 C.F.R. pts. 36, 91).

¹⁶⁸ *Id.* at 14,095.

¹⁶⁹ See Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. 28,406 (June 29, 1978) (to be codified at 14 C.F.R. pt. 91).

¹⁷⁰ *Id.* at 28,406.

¹⁷¹ *Id.* at 28,419.

¹⁷² *Id.* at 28,414 (“The FAA's goal is not to certificate . . . any future design SST that does not meet standards then applicable to subsonic airplanes. If it is technologically infeasible to produce such an airplane, the FAA will consider setting a less stringent standard but in no event will that standard be less stringent than the noise levels of stage 2. However, the FAA does not believe that it would be appropriate to establish . . . a permanent future linkage between supersonic and subsonic noise levels below the stage 2 noise limits.”).

¹⁷³ See *id.* at 28,408.

ber of comments, numbered in the thousands, concerned the noise and other environmental impacts” of supersonic aircraft operations. Those comments elucidated the surprisingly vast extent of aircraft noise permeation and interference with quotidian social activity.¹⁷⁴ Many comments noted that civil supersonic travel burdened more people than it benefitted; only those with deep pockets could afford to avail themselves of the Concorde’s potential while many more were adversely impacted by its noisy hullabaloo.¹⁷⁵ Furthermore, many expressed concerns that increased airport noise would deleteriously impact property values in nearby neighborhoods.¹⁷⁶ For example, the Concorde’s PLdB on takeoff was twice as loud as a Boeing 707, four times as loud as a 747, and *eight times louder than a DC-10*.¹⁷⁷ Operational noise aside, a second concern with supersonic transport was its effect on air quality, ozone depletion, and climate change.¹⁷⁸ Lastly, public commentary indicated deep concern for supersonic transport’s inefficient fuel consumption.¹⁷⁹ The FAA thus had no shortage of justification for its blanket prohibition on civil supersonic flight.

Going forward, the FAA noted areas of improvement that supersonic flight technologies ought to address, including operational noise levels, balance between subsonic and supersonic capabilities, and fuel consumption.¹⁸⁰ Furthermore, the Concorde demonstrated a need to identify a market, tweak plane design and weight, and muffle the sonic boom.¹⁸¹ To meet airworthiness certification, operational noise at takeoff, approach, and mid-flight must be drastically curtailed, and engineering designs ought to account for that constraint from the beginning.¹⁸² Additionally, future supersonic aircraft ought to be designed to efficiently perform at both subsonic and supersonic speeds.¹⁸³

¹⁷⁴ *Id.* Aircraft noise impacted a range of dynamic social interactions, including “family life, . . . the conduct of businesses, the operation of schools and hospitals, the overall quality of life in airport neighborhoods, and the value of property around airports.” *Id.*

¹⁷⁵ *Id.*

¹⁷⁶ *Id.*

¹⁷⁷ *Id.* at 28,409.

¹⁷⁸ *Id.* at 28,410.

¹⁷⁹ *Id.* at 28,410–11.

¹⁸⁰ *Id.* at 28,413.

¹⁸¹ *See generally* Overly, *supra* note 137.

¹⁸² *See* Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. at 28,413.

¹⁸³ *Id.* at 28,413–14.

To mitigate noise at takeoff, optimal aircraft engines are high airflow and low exhaust; however, to efficiently cruise at supersonic speed, a high-exhaust engine is best.¹⁸⁴ The fuel consumption of the Concorde represents another obstacle for the evolution of supersonic flight. With gas prices up by 155% since 2003,¹⁸⁵ burning fuel at a rate of nearly 6,000 gallons per hour¹⁸⁶ is simply no longer economical. Moreover, the substantial weight of the Concorde only added to its inefficiency.¹⁸⁷ Therefore, new supersonic aircraft ought to be designed with weight and fuel efficiency in mind.

B. THE MERITS OF CONTINUED PROHIBITION AND PROPOSED ALTERNATIVES

Despite the FAA's intention to foster "environmentally responsible growth" rather than stagnate emergent technology, supersonic flight has failed to find a foothold in the aerospace industry in the decades following its prohibition. Supersonic flight technology has continued to develop, however, and proponents are becoming vocal about revisiting the possibility of civil supersonic transport.¹⁸⁸ Even the FAA is recognizing technological progress sufficient to warrant reexamination of its prohibition.¹⁸⁹ As a result of computer engineering, simulation testing, light-weight composite materials, and tweaked airplane design, the sonic boom has finally met its match.¹⁹⁰ Additionally, evolution of general aerospace technology makes overcoming the empirical problems with the Concorde much more feasible.¹⁹¹ With decades to test, develop, and understand the theoretical idiosyncrasies of supersonic flight, modern technology warrants a reevaluation, and possible repeal, of the FAA prohibition on civil supersonic flight. While research and development

¹⁸⁴ *Id.*

¹⁸⁵ *Retail Price of Regular Gasoline in the United States from 1990 to 2017*, STATISTICA, <https://www.statista.com/statistics/204740/retail-price-of-gasoline-in-the-united-states-since-1990/> [<https://perma.cc/Z26Q-XJJU>].

¹⁸⁶ *Celebrating Concorde*, *supra* note 124.

¹⁸⁷ *See id.*

¹⁸⁸ *E.g.*, Dourado & Hammond, *supra* note 51; *Airline Speeds Have Stagnated for 40 Years*, *supra* note 120; Banke, *supra* note 37.

¹⁸⁹ *See* Dourado & Hammond, *supra* note 51, at 18.

¹⁹⁰ *See* Tariq Malik, *Shushing Sonic Booms: Changing the Shape of Supersonic Planes*, SPACE.COM (Apr. 21, 2004, 7:00 AM), <https://www.space.com/2992-shushing-sonic-booms-changing-shape-supersonic-planes.html> [<https://perma.cc/SSG5-22WM>].

¹⁹¹ *See* Overly, *supra* note 137.

are demonstrating the potential acceptability of supersonic technology in theory, the practical development of those technologies in the aerospace industry will require soliciting the FAA for rule changes.

Sonic booms still pose the biggest threat to civil supersonic aviation.¹⁹² As the most significant obstacle in the path of supersonic travel, most developers have spent time researching and designing aircraft that mitigate sonic boom production.¹⁹³ NASA, through a joint operation with Lockheed Martin, has been developing a low-noise supersonic prototype that utilizes “aerodynamic techniques to achieve smoother pressure changes to minimize sonic booms.”¹⁹⁴ Honeywell claims that it has created technology capable of giving pilots real-time feedback of sonic boom magnitude, thus allowing pilots to visualize and monitor sonic boom footprints.¹⁹⁵ One of the most significant methods of mitigating sonic boom impact has been redesigning the shape and profile of aircraft.¹⁹⁶ The shape and character of the sonic boom supervenes on the shape and weight of the aircraft, thereby allowing researchers and developers to create “[l]ow-boom, shaped signatures” that reduce annoyance and eliminate the destructive potentiality of sonic booms.¹⁹⁷ “The two most important breakthroughs have been the invention of strong but lightweight materials and the use of computer simulations for optimizing aircraft shape to affect the pressure signature.”¹⁹⁸ Specifically, the use of carbon fiber rather than aircraft-grade aluminum fosters lightweight designs that ultimately displace less air and result in significantly lower overpressures.¹⁹⁹ Furthermore, computer software supplants the need for expensive and time-consuming wind-tunnel testing by instead using algorithms to “optimize wing shape, volume and lift distribution, the impact of thermal exhaust, and so on.”²⁰⁰

¹⁹² *Commercial Supersonic Technology: The Way Ahead*, *supra* note 3, at 1.

¹⁹³ See David Reid, *NASA and Honeywell Claim They Can Reduce Sonic Booms Over Land, Potentially Bringing Supersonic Flight to the Masses*, CNBC.COM (June 21, 2017, 4:59 AM), <https://www.cnbc.com/2017/06/21/nasa-and-honeywell-claim-they-can-reduce-sonic-booms-over-land-potentially-bringing-supersonic-flight-to-the-masses.html> [<https://perma.cc/RJ49-N5JN>].

¹⁹⁴ *Id.*

¹⁹⁵ *Id.*

¹⁹⁶ See Malik, *supra* note 190.

¹⁹⁷ *Commercial Supersonic Technology: The Way Ahead*, *supra* note 3, at 14.

¹⁹⁸ Dourado & Hammond, *supra* note 51, at 22.

¹⁹⁹ *Id.*

²⁰⁰ *Id.* at 22–23.

The “Quiet Spike” represents one method of using aircraft shape to mitigate sonic booms. Project Quiet Spike was a research venture by NASA and Gulfstream Aerospace investigating the mitigation impact of a “24-foot-long lance-like spike” protruding from the front of the plane.²⁰¹ The spike-nosed design has caught traction with several supersonic business jet developers and promises another method of shaping sonic booms into quieter configurations.²⁰² Aerion Corporation’s AS2 supersonic business jet is one notable example.²⁰³ Texas billionaire and Fort Worth native Robert Bass serves as the chairman for Aerion, a manufacturer of supersonic business jets.²⁰⁴ In collaboration with Lockheed Martin, the Aerion AS2 supersonic business jet is designed to travel up to Mach 1.5 over land without creating the obstreperous boom plaguing supersonic flight development.²⁰⁵ In addition to its spiked nose and sleek overall design, the plane departs from delta-wing design tradition and uses a thin wing and horizontal stabilizer to reduce friction drag by 70%.²⁰⁶ Aerion’s example illustrates the general technological development over the last forty years and brings supersonic flight technology closer to overcoming its inherent noisiness and sonic boom. While Aerion’s supersonic business jet only has the capacity to transport around twelve passengers, Denver-based startup, Boom, is working on a supersonic business jet that can carry up to fifty-five passengers.²⁰⁷

Another sonic boom mitigation technique is “Mach cutoff.” When flying at high enough altitudes, the shock waves from supersonic flight are dissipated into a phenomenon not quite as loud as the typical sonic boom.²⁰⁸ “The concept is that at speeds

²⁰¹ Gray Creech, *NASA Supersonic Jousting*, NAT’L AERONAUTICS & SPACE ADMIN. (Oct. 4, 2006), https://www.nasa.gov/vision/earth/improvingflight/supersonic_jousting.html [<https://perma.cc/AHW9-CE7V>].

²⁰² *See id.*

²⁰³ Leslie Josephs, *A Texas Billionaire Wants to Build a Supersonic Business Jet*, QUARTZ (May 24, 2017), <https://qz.com/990846/texas-billionaire-robert-bass-wants-to-build-a-supersonic-business-jet-with-ge-ge/> [<https://perma.cc/E77J-8ZLP>].

²⁰⁴ *Id.*

²⁰⁵ *Id.*

²⁰⁶ *A New Shape in the Sky*, AERION SUPERSONIC, <https://www.aerionsupersonic.com/technology/> [<https://perma.cc/RUS3-SDYN>].

²⁰⁷ BOOM, <https://boomsupersonic.com/> [<https://perma.cc/KRV3-ZZ6Z>].

²⁰⁸ Larry J. Cliatt, II et al., *Mach Cutoff Analysis and Results From NASA’s Farfield Investigation of No-boom Thresholds*, NASA ARMSTRONG FLIGHT RES. CTR. (June 1, 2016), <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160007349.pdf> [<https://perma.cc/2JBC-BZZU>].

of Mach 1.1 to 1.3, the shock wave produced by an aircraft can be buffered by altitude and weather, resulting in an ‘evanescent wave’ reaching the ground that ‘would sound much like distant thunder.’”²⁰⁹ The FAA considered use of Mach cutoff as a mitigation device, but ultimately concluded that the operational procedure was insufficient to unilaterally warrant exception from Section 91.817.²¹⁰ The FAA failed, however, to consider Mach cutoff as a means of circumventing the very problem Section 91.817 was addressed at—sonic boom nuisance—and instead used circular reasoning to support its dismissal of the operational procedure.²¹¹

The problem with the FAA’s prohibition on supersonic flight lies in its overly broad prohibition of flight speeds in excess of Mach 1.0 rather than a prohibition on sonic booms themselves or a noise limitation on supersonic flight.²¹² Section 91.817 serves only to impede tech developers from aiming at a specific benchmark for sonic boom acceptability.²¹³ Thus, pursuant to increased information and innovation in aerospace engineering that dramatically reduces sonic boom intensity, “[t]he ban on civil supersonic transport overland looks increasingly obsolete.”²¹⁴ Instead, a significant number of authors propose repealing the FAA prohibition on flying at Mach 1.0 speeds, replacing it with a supersonic noise standard that is “economically reasonable [and] technologically practicable.”²¹⁵ This would provide developers with a concrete objective in designing socially accept-

²⁰⁹ Memorandum from Lorlei Peter, Assistant Chief Counsel for Regs., Fed. Aviation Admin., to Dr. Lourdes Maurice, Exec. Director, Office of Env’t and Energy, Fed. Aviation Admin., 2016 WL 861763, at *1 (Feb 29, 2016).

²¹⁰ *Id.* at *4 (“In no case may the exploitation of the Mach cutoff phenomenon be regarded as compliance with § 91.817(a), since its use requires a violation of the terms of the regulation. Neither paragraph of the regulation can be read as allowing speed in excess of Mach 1 as long as the flight crew believes a sonic boom produced by the airplane will not reach the ground.”).

²¹¹ *See id.*

²¹² *See* 14 C.F.R. § 91.817 (2018).

²¹³ *See* Andrea O’Sullivan, *How the FAA Killed Supersonic Flight—and How It Can Revive It*, MERCATUS CTR. (July 26, 2016), https://www.mercatus.org/expert_commentary/how-faa-killed-supersonic-flight-and-how-it-can-revive-it [<https://perma.cc/6999-87UB>].

²¹⁴ Hammond, *supra* note 147.

²¹⁵ *See, e.g.*, Dourado & Hammond, *supra* note 51, at 28; Hammond, *supra* note 147; O’Sullivan, *supra* note 213; Jared Meyer, *Supersonic Flight: Make America Boom Again*, FORBES (Oct. 28, 2016, 11:16 AM), <https://www.forbes.com/sites/jaredmeyer/2016/10/28/supersonic-flight-make-america-boom-again/#2f47be371077> [<https://perma.cc/3BXH-E9CB>].

able supersonic aircraft. In fact, proposals for acceptable supersonic noise standards already exist:

In our view, an initial sonic boom standard should be informed by noise levels that we already accept in society, accounting for time and duration of the sounds. Lawnmowers, motorcycles, and kitchen blenders all operate in the 85–90 dB(A) range and are widely accepted for sustained durations during day-time hours. Consequently, we believe this range would also be acceptable for the short durations of sonic booms. Because decibels are measured on a base-10 logarithmic scale, 85 dB(A) is 100 times quieter than the Concorde's nominal boom of around 105 dB(A). During nighttime hours, we would recommend a noise standard on the order of another 100-fold reduction. This would place the overnight noise standard at 65–70 dB(A), a noise level that would be further dampened by the fact that most people are indoors during these hours.²¹⁶

Such a noise limitation would allow supersonic flight technology to develop in the marketplace while still affording the public protection from the sonic boom noise pollution for which Section 91.817 was originally enacted.²¹⁷

Airport noise and fuel efficiency were other significant concerns justifying the FAA prohibition on supersonic flight. While low-boom concept aircraft have demonstrably mitigated sonic boom concerns, a shortfall exists in that their design is optimized for supersonic cruise rather than for climb.²¹⁸ The FAA noted the future need for supersonic aircraft to balance optimal flight and noise levels at subsonic and supersonic speeds.²¹⁹ With the current state of engine technology, supersonic planes are still most efficient when taking off at maximum throttle.²²⁰ Consequently, supersonic engines—in order to maximize fuel efficiency—will necessarily be somewhat louder.²²¹ However, modern supersonic aircraft “would be quieter upon takeoff sim-

²¹⁶ Dourado & Hammond, *supra* note 51, at 26.

²¹⁷ See General Operating and Flight Rules: Civil Aircraft Sonic Boom, 38 Fed. Reg. 8,051, 8,051 (Mar. 28, 1973) (to be codified at 14 C.F.R. pt. 91) (“The purpose of this amendment is to afford the public protection from civil aircraft sonic boom.”).

²¹⁸ Dourado & Hammond, *supra* note 51, at 24.

²¹⁹ Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. 28,406, 28,413 (June 29, 1978) (to be codified at 14 C.F.R. pt. 91).

²²⁰ Dourado & Hammond, *supra* note 51, at 27.

²²¹ *Id.*

ply by virtue of being lighter and having better engines.”²²² Thus, supersonic travel would still produce more noise at takeoff than subsonic travel, but would create exponentially less airport noise than earlier supersonic aircraft like the Concorde. Furthermore, the lighter, better engines available for modern supersonic aircraft also alleviate some concerns about supersonic airplane fuel consumption: “Lighter materials and more efficient engines mean the jet would need to carry less fuel, which would make its taxiing weight lower. Lower weight means less thrust is necessary at takeoff.”²²³ In addition, modern engines are powerful enough to cruise at supersonic speeds without use of afterburners, “which waste fuel and are expensive to use.”²²⁴ For example, Boom’s fifty-five-seat supersonic business jet is sufficiently light and competently powered as to achieve takeoff noise better than stage four.²²⁵ Thus, the modern development of aerospace technology vitiates historical concerns about supersonic aircraft’s wildly inefficient fuel consumption. Furthermore, airport noise levels created by modern supersonic aircraft would be slight in comparison to the din of the Concorde, further distancing the relevance of the prohibition’s original justifications from the status quo.²²⁶

Ultimately, the FAA’s goal of decreasing airport noise is meritorious, and the FAA is committed to the continued reduction in noise pollution.²²⁷ But the goals of decreased airport noise and repealing the prohibition on supersonic flight are not mutually exclusive. In 1978, the FAA declared its hard commitment to stage two operational noise limits.²²⁸ However, in response to EPA pressure to regulate subsonic and supersonic aircraft equally, the FAA stated that it “does not believe that it would be appropriate to establish . . . a permanent future linkage between supersonic and subsonic noise levels below the stage 2 noise lim-

²²² *Id.*

²²³ *Id.*

²²⁴ *Id.* at 33.

²²⁵ BOOM, *supra* note 207.

²²⁶ See Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. 28,406, 28,413 (June 29, 1978) (to be codified at 14 C.F.R. pt. 91).

²²⁷ *Fact Sheet – The FAA Airport Noise Program*, FED. AVIATION ADMIN. (Jan. 13, 2015), https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=18114 [<https://perma.cc/8ML4-W6SH>].

²²⁸ Civil Supersonic Airplanes: Noise and Sonic Boom Requirements and Decision on EPA Proposals, 43 Fed. Reg. at 28,414.

its.”²²⁹ One suggested alternative to the blanket prohibition on supersonic flight balances the advancement of supersonic aviation with the concerns of property owners neighboring airports: use the current stage three operational limit for subsonic aircraft as the new standard for airworthiness certification for supersonic aircraft.²³⁰ “These communities already tolerate Stage 3 noise, and new Stage 3 supersonic aircraft would not appreciably increase noise levels.”²³¹ By mandating compliance with the status quo, the FAA would not subject airport neighbors to increased noise pollution and would allow practical development of supersonic technologies over time. Thus, continued prohibition of supersonic flight would represent an anachronistic continuation of “[k]nee-jerk techno-skepticism” rather than policy making warranted by evidentiary considerations.²³² Where supersonic aviation would impose no more noise pollution than is currently accounted for, the FAA ought to end its punitive prohibition.

The environmental justifications for prohibition on supersonic flight have similarly faltered in the decades since its promulgation. Richard Wiggs’s Anti-Concorde Project represented public concern that technological development came at the expense of environmental sanctity.²³³ “Ozone emissions and atmospheric pollution” represented the gravest concerns of environmental activists.²³⁴ However, those fears were ultimately demonstrated to be unfounded. After nuclear testing by both the United States and Soviet Union, large amounts of nitrogen and other particulates were injected into the atmosphere in an amount comparable to the flight of 500 Concorde every day for seven hours, for nearly five years.²³⁵ The resulting impact on the ozone layer was negligible.²³⁶ In fact, NASA conducted simulations investigating the environmental impact of burning eighteen million pounds of jet fuel at altitudes greater than 50,000 feet and concluded that the maximum ozone depletion for that

²²⁹ *Id.*

²³⁰ Dourado & Hammond, *supra* note 51, at 29.

²³¹ *Id.*

²³² See O’Sullivan, *supra* note 213.

²³³ Dourado & Hammond, *supra* note 51, at 12 (The Anti-Concorde Project was a result of Richard Wiggs’s belief that “the Concorde represented a critical front line in the battle between technology and the environment.”).

²³⁴ Bramson, *supra* note 135.

²³⁵ Dourado & Hammond, *supra* note 51, at 30.

²³⁶ *Id.*

limited area was only 0.038%.²³⁷ To put that in perspective, environmental activists were worried about ozone depletion of 20–60%.²³⁸ Thus, considering the fuel efficiency and lightweight design of modern supersonic aircraft,²³⁹ environmental concerns are ostensibly a non-issue for the ultimate analysis of the FAA regulation's continued justification.

IV. CONCLUSION

Considering the pace of technological advancement, the FAA prohibition on civil supersonic flight is anathema to innovation. Even though the Concorde brought to light significant concerns about sonic boom nuisance, environmental responsibility, and economic feasibility, the market for civil supersonic transportation is riper than ever. Specifically, smaller supersonic business jets have generated significant interest and overcome most of the economic inefficiencies that plagued the Concorde.²⁴⁰ The smaller design and lightweight composite material displaces significantly less air (resulting in lower overpressures), use of computer simulations optimizes aircraft shape and design to mitigate sonic boom impact, modern engines are more fuel efficient than ever, and smaller supersonic business jets are essentially ozone-neutral.²⁴¹ Because the FAA's prohibition on civil supersonic flight is foundationally outdated, the time has come to repeal and replace the prohibition with regulation that will allow room for development within the aerospace industry. Rather than prohibiting supersonic flight as a means to protect the public from sonic boom, the FAA ought to regulate the end itself. By establishing thresholds of acceptable noise for supersonic aircraft, the FAA can set a benchmark for research and development, fostering evolution within the aerospace industry that has been lacking for the last forty years.

²³⁷ *Id.*

²³⁸ *Id.*

²³⁹ See BOOM, *supra* note 207; *A New Shape in the Sky*, *supra* note 206.

²⁴⁰ See BOOM, *supra* note 207; *A New Shape in the Sky*, *supra* note 206.

²⁴¹ Dourado & Hammond, *supra* note 51, at 22, 27, 31, 37.