This document is a citizen comment submitted to the Federal eRulemaking Portal for ***'Docket No.: FAA–2023–0855: Request for Comments on the FAA's Review of the Civil Aviation Noise Policy'***.

I ask FAA to join me in supporting the Aviation-Impacted Coummunities Alliance (AICA) comments submitted at Docket No FAA-2023-0855-2206. AICA has worked very hard to connect impacted citizens and organize our concerns about these ongoing (and at some locations expanding) aviation impacts. There are many good and solid proposals offered within the AICA comments.

My own comments follow, and are organized as follows:

Part 1: provides a summary & overview of this NPRM-RFC[1] document

Part 2: provides FAA's specified questions, and this citizen's comments and suggestions

Part 1: Summary, & General Concerns

The comments that follow are provided by a retired FAA air traffic controller. During his career, he assisted many local residents toward mitigating aviation impacts. Since retiring, he has spent decades studying aviation impacts and working to assist residents across the nation. What he has found is that his former employer, a federal agency with supreme authority over all regulatory aspects of aviation, is failing. FAA is effectively a captured regulator. FAA is not serving the nation; instead, FAA is serving to enable excessive operations (and impacts) by aviation players, who gain financially with FAA inaction and delays, often aided by current FAA employees who have conflicts of interest due to other non-FAA aviation work.

People are being damaged; communities are being destroyed. This NPRM-RFC is centered on Aviation Noise, which is one of the three primary aviation pollutants (the others being air pollutants, and contamination of ground and water). In 2023, we are seeing FAA's programs lead to rising noise pollution in many areas, but these two rise above:

1. At major airline hub airports, where NextGen technologies are automating procedures by both aircraft navigational systems and ATC systems, to tweak flow rates higher, all in the goal of accommodating airlines wanting higher airport capacities. FAA has been aggressively 'collaborating' with industry to achieve these goals, despite the fact that airline operations have been declining for more than two decades.[2] Under these changes, thousands of homes are inundated with nearly nonstop stress-inducing noise patterns. Worst-case examples today include JFK, LGA, DCA, SEA, BOS, and many others.
2. At general aviation airports, where consolidation of flight training programs is creating intensive concentration of closed pattern operations at a select few airports. Private-equity funded, national-scale, flight schools are importing students from across the globe, and profiting from the impacts they impose upon communities below. The Front Range of Colorado is the current worst-case example. Operations at BJC, APA, and a handful of other regional non-towered airports have soared, as have pollutant impacts, in some cases doubling in a few years… yet no environmental analysis or public engagement process preceded any of this growth. On top of this problem, hobbyist pilots and some affiliated with these flight schools and other operators are using social media to identify and then bully the few citizens who try to aid their neighbors by

1 Notice of Proposed Rulemaking, Request for Comments
2 Please see the 2-pg Data Analysis using FAA's data: 'Ops Trends at 39 Major Airports 1980-2022'.

speaking up. The bullying even includes an aviation variant of road-rage: the use of small planes to descend and circle low over homes of known concerned citizens, to intimidate them… and FAA is doing nothing to curtail this bullying. It is as if there were no real regulation by FAA; no accountability for the players who gain profits or just pursue their hobby, while spewing pollutants (often including lead toxins) in the air above our homes.

So here we are, today, offering comments requested by FAA, to assist this huge and deeply-funded agency in their quest of a review of aviation noise policies. Which begs the question: ***what exactly is the current 'Aviation Noise Policy' being reviewed?***

Talking with aviation impact victims, studying social media and other online content, reviewing the history of Congressional discussion and legislation directing FAA actions, and studying FAA itself, paints a very bleak picture. Combined with the simple reality, confirmed over time, that these problems are persistent, and we can see: whatever the official policy is declared to be means nothing, in comparison to what is actually happening near airports across our nation.

Here are a few observations, useful in trying to define the current 'Aviation Noise Policy':

- FAA's primary strategy continues to be to delay, delay some more, and delay forever. Take this current NPRM-RFC, as an example. FAA's current request for comments contains lengthy text about Congressional actions back in the late 1970's, but what else transpired in the other years before ***Docket No.: FAA–2023–0855***? Why is there zero reference to FAA's NPRM-RFC [Docket No.: 30109] in July 2000? (screencap at right) Why does that version include the word 'abatement' 65 times, including in the very title, yet 'abatement' is almost entirely absent from the 2023 NPRM-RFC document? We were at the same point and on the same path 23 years ago. But, then, we were more inclined to acknowledge the need for abatement. Is this actually evidence of how FAA is regressing, on noise and other impact matters?

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[Docket No.: 30109]

Aviation Noise Abatement Policy 2000

AGENCY: Federal Aviation Administration, DOT.

ACTION: Proposed policy document, Request for comments.

SUMMARY: In 1976, the Department of Transportation published its Aviation Noise Abatement Policy, which provided a course of action for reducing aviation noise impact. The principles contained in that document and subsequent legislative and regulatory action have resulted in a dramatic reduction in the number of Americans adversely exposed to aviation noise.

The changes in transportation use, public expectations, and technology warrant a review of the policy, which the Department is now undertaking. In particular, the Department is considering issuing a revised policy statement, which may extend to all forms of transportation noise, in order to provide direction to its efforts over the next 25 years.

compatible usage of noise impacted lands. Finally, it presents a selective listing of reference materials that form the basis for the Federal Government's aviation noise policies.

DATES: Comments must be received on or before August 28, 2000.

ADDRESSES: Comments should be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC–200), Docket No. [30109], 800 Independence Avenue, SW., Washington, DC 20591. Comments may be examined in the Rules Docket in Room 915G on weekdays between 8:30 a.m. and 5:00 p.m., except on Federal holidays.

FOR FURTHER INFORMATION CONTACT: Thomas L. Connor, Noise Division, AEE–100, Office of Environment and Energy, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591; telephone, (202) 267–8933; facsimile, (202) 267–5594.

SUPPLEMENTARY INFORMATION: Interested persons are invited to participate by submitting such written data, views, or arguments as they may desire. Comments should identify the regulatory docket or notice number and should be submitted in triplicate to the

- More about delays: the Neighborhood Environment Survey (NES) was announced in 2015[3], and data collection completed by late 2016. FAA spent huge sums on contractors to do the survey

3 See the 2-pg Press Release, by Laura Brown

and the analysis, and then sat on it. For years. Nothing further to inform or engage the people of this nation (those on the receiving end of the impact equation). In April 2020, FAA Administrator Steve Dickson did send cover letters and a 21-page report to Congressional leaders; it made reference to the NES, suggested it was still being evaluated, and suggested the metrics were reliable, generally dismissing how the old DNL metric (and Schultz Curve) were thrashed by the NES data.

- Then, more delay tactics. In January 2021, another NPRM-RFC. FAA asked questions similar to those asked before (and now, in 2023, FAA is asking them again!). It would appear FAA lost the results from 2021, or did not like the results. So, here we go again. The 2023 version ***SHOULD*** have offered concrete proposals, to engage feedback from the broader public; instead, FAA delays again by pretending to be interested in ***what ELSE*** we may have to add.

> **DEPARTMENT OF TRANSPORTATION**
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> **Federal Aviation Administration**
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> **[Docket No. FAA–2021–0037]**
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> **Overview of FAA Aircraft Noise Policy and Research Efforts: Request for Input on Research Activities To Inform Aircraft Noise Policy**
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> **AGENCY:** Federal Aviation Administration (FAA), Department of Transportation (DOT).
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> **ACTION:** Notice of research programs and request for comments.
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> **SUMMARY:** The FAA is releasing a summary to the public of the research programs it sponsors on civil aircraft noise that could potentially inform future aircraft noise policy. The FAA invites public comment on the scope and applicability of these research initiatives to address aircraft noise.
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> The FAA will not make any determinations based on the findings of these research programs for the FAA's noise policies, including any potential revised use of the Day-Night Average Sound Level (DNL) noise metric, until it has carefully considered public and other stakeholder input along with any additional research needed to improve the understanding of the effects of aircraft noise exposure on communities.

- There was also a GAO Report, later in 2021, and Testimony in 2022, by Heather Krause. Yet again, in these two products, GAO hurt those impacted as much as they helped. Yes, the GAO work did confirm FAA's need to do more to engage impacted citizens and upgrade noise policy. But, in both work products, GAO perpetuated the myth that ***We the People must endure these impacts to accommodate the radical growth (metastasis?) of aviation geowth***. The GAO work products echo the following disinformational line from the current FAA NPRM-RFC document: *"As operations have increased substantially since the mid-1970's, the number of people adversely exposed to aviation noise (levels above the Day Night Average Sound Level of 65 decibels) in the U.S. has declined..."* That 'substantial increase' obscures the fact that growth ended decades ago; FAA's data shows that, at the top 39 U.S. Airports, operations increased 31% between 1980 and 2000, but have since declined 15% by 2019 (and 25% by 2022). More importantly, if you look at the data and recognize how the few remaining major airlines are concentrating into just a handful of airline hub, you see another important fact: *Since 2000, only <u>two</u> major airports from this list of 39 have seen operations growth in excess of average population growth: JFK (up 29%) and DEN (up 21%) … and the total for the other 37 airports was down 17% from 2000 to 2019, and down 28% from 2000 to 2022.*

- Congress responded a few years ago, ordering FAA to create regional Noise Ombudsman offices, to improve interactions and better engage citizens… and since, those Ombuds offices have proven to be just a diversion and an obstacle; no help at all.

- Impacts can grow dramatically, and when citizens try to control the quality of their home environment, they get run-arounds, everywhere. They are broadly ignored by the FAA bureaucrats; there are FSDO officials in Massachusetts with work connections to the flight schools they oversee. The airport authorities, like Mike Fronapfel at KAPA and Keith Miller at KGAI, who cry about federal grants that prevent any local control, then cheer on the arrival of yet another large operation (such as a new flight school branch). Citizens are disrespected and tagged as

'NIMBYs' (which they are ***NOT***), while pilots and operators are treated like heroes and economic saviors (**which they are *NOT***).

As a final concern, there is the question of what FAA will do with these NPRM-RFC comments from all these good citizens. The italic text below is excerpted from the current (2023) NPRM-RFC. It reads like a pharma disclaimer; everything but the 'oily discharge' line. It is very hard to read, just for the language and flow. But even harder is the reality it indicates: FAA is so beholden to the aviation industry, it will do ***NOTHING*** significant or substantial, with the end product from this NPRM-RFC. How many people may have read this, and what fraction of those gave up before even starting to write? Here's the excerpt:

> The FAA has provided technical and financial support for airport noise compatibility planning since 1976. FAA's current program derives from the Aviation Safety and Noise Abatement Act of 1979 (ASNA), implemented through 14 CFR Part 150 (Part 150) in 1985. ASNA directed the FAA to establish by regulation a single system for measuring aircraft noise exposure, to identify land uses that are normally compatible with various noise exposure levels, and to receive voluntary submissions of noise exposure maps and noise compatibility programs from airport proprietors. Airport sponsors who prepare noise exposure maps are immune from certain future liability for noise damages. After preparing the map, airport operators may prepare noise compatibility programs. These programs contain measures that an airport operator plans to take to reduce existing or prevent the development of new noncompatible land uses in the area covered by the noise exposure map. Airport sponsors must consult affected parties and provide the opportunity for a public hearing. Airport proprietor participation in airport noise compatibility planning is voluntary. Over 230 airports are participating in the program and 193 airports have FAA approved NCPs in place—this includes

D. Immediate Effect of the Noise Policy Review

The FAA notes that none of the changes currently being considered through this noise policy review will immediately affect the level of noise to which an individual, community, or noise-sensitive area (e.g., park, school, hospital, etc.) is exposed. A downward adjustment to the definition of existing significant noise exposure will not change the actual noise environment. Nor will real-world noise experienced by individuals and communities be changed if the FAA changes its criteria for identifying significant new noise exposure associated with proposed actions being examined in an environmental review conducted pursuant to NEPA. No policy change on its own will cap or reduce the levels of aviation noise. The FAA normally takes actions that enhance the safety, efficiency, and capacity of U.S. airspace while considering associated noise impacts. As these actions are proposed, the FAA analyzes and discloses publicly the modeled change in the noise environment to help the public understand how their experience of aviation noise will change over time.

E. Next Steps

The FAA intends to give serious consideration to stakeholder input on the policy. If the FAA decides to revise the policy, any revisions will also consider modern aviation noise research and how the evolving use of the U.S. airspace affects experiences of aviation noise. Any revisions to the policy will also promote more effective public disclosure of noise impacts under NEPA. In summary, this review should improve implementation of the major tenets of the 1976 Aviation Noise Abatement Policy, which sets forth the goals, policies, and strategies the FAA should employ to reduce the impact of aviation noise.

F. Purpose of This Notice

The FAA invites comments through this notice to inform its consideration of these foundational elements of the policy. The FAA recognizes that exposure to aviation noise is a pivotal quality-of-life issue for the public and welcomes input on how the FAA's assessment and disclosure of noise impacts may improve community understanding and expectations regarding future noise exposure. The most helpful comments would reference a specific recommendation, explain the reason for any recommended change, and include supporting information.

Part 2: Comments to FAA's Specific Questions

The FAA's NPRM-RFC document (FAA-2023-0001] included an arduous list of questions and blather, along with this line: *"Finally, the FAA requests that commenters identify the number of each question to which a response is submitted."* Here are my short comments, structured per FAA's request...

1. Vehicle Type. [4]

My Comments: Here, in 2023, FAA is declaring that their policy from 1976 applies only to jets, and implying that we thus lack noise abatement policy for drones and small general aviation (GA) planes. The implication is infuriatingly disingenous, and it is clearly wrong. FAA has 'forever' required the production of noise contour maps within FAA funded airport master plans, including at airports with either zero or only-unscheduled commercial jet operations. FAA has also taken enforcement actions against individuals flying tiny hobby droes, treating them as pilots and actual aircraft. The ANAP (see attached jpg) at 'Section 4, Airport Noise Policy' refers to providing *"...further relief from excessive aircraft noise...,"* and includes ample language about how FAA *"...will assist (airport) proprietors in attaining their noise abatment goals...."* The reference is to aircraft noise, not jet noise; and, it is not clear when or how FAA's policies morphed so far away from actually trying to achieve noise abatement.

> 4. Airport Noise Policy
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> To bring about further relief from excessive aircraft noise, airport proprietors are encouraged to develop aggressive noise abatement programs for their airports. The FAA will assist proprietors in attaining their noise abatement goals and will advise them on how their proposed plans affect the overall air transportation system. The FAA will accept preliminary proposals from airport sponsors for comprehensive noise abatement plans and will fund a select number of innovative noise abatement model plans and demonstrations. In addition, the FAA will encourage noise abatement plans from airport proprietors in conjunction with both applications for major airport development grants and proposals to establish use restrictions, such as curfews or scheduling and equipment restrictions. The FAA will advise airport operators whether proposed use restrictions are unjustly disciminatory or place an undue burden on interstate or foreign commerce because of their impact on the national air transportation system. Where necessary, the FAA will seek adjudication of the constitutional issues involved if it believes that a use restriction established at an airport is unjustly discriminatory or creates an undue burden on interstate or foreign air commerce.
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> *source: ANAP 1976*

Why is FAA playing this way, so late in the game? People have been screaming about NextGen-generated airline pattern impacts for more than a decade, and there has been plenty of noise about repetitive flight patterns for skydiving operators and closed patterns at GA airports that import flight students. Stop the delays; get on with it: show us some aggressive policy proposals that restore the balance lost between the tiny aviation community and the large majority impacted by these elites. The 0.1% versus the 99.9%.

2. Operations of Air Vehicles.

My Comments: Just like with the prior question, this is a pathetic display by FAA, pretending to seek citizen help while inventing new policies for mitigating aviation impacts. We citizens are disrespected when you treat us like this. Look, it is very simple: if an aircraft makes noise that has real and reasonable potential to annoy or cause stress and other impacts, including sleep-loss and other health reactions, the activity of that aircraft needs to be properly balanced with the health needs of those impacted. Big plane or small drone, personal heli-

4 In this section, FAA falsely implies that only jets were part of the Aviation Noise Abatement Policy issued in November 1976. ANAP is a 66-page PDF, and it nowhere limits aviation noise to jets.

copter or flying lawnmower;... so long as the noise level at any moment rises above the ambient noise to become a repetitive irritant, as perceived by a rational person, it needs to be acknowledged as an impact. And from there, the mitigation of that acknowledged impact should reasonably include the application of some metric(s) and method(s) or rule(s) that can achieve appropriate mitigation. Honestly, given FAA's horrible track record, it seems clear this is something EPA or another non-FAA authority needs to do.

So, please do not try, as you are here, to bog the public down with blather about defining which vehicles should be subject to Aviation Noise Policy, and how. Use what we have been telling you for many decades now, and compile some aggressive and balanced noise mitigation proposals; ***THEN***, after you do the work you resist, ask us for our NPRM-RFC feedback.

3. <u>DNL</u>. *What views or comments do you have about the FAA's core decisionmaking metric, DNL? How would these views regarding DNL be resolved if the FAA employed another noise metric (either in addition to, or to replace DNL) or if the FAA calculated DNL differently? Please explain your reasoning.*

<u>My Comments</u>: The metric is broken, and has been from day one. NES validated this fact. DNL should be abandoned entirely. We should not even be talking about DNL. That said, the most appropiate metric to replace DNL should be a model of actual estimated excess decibels over background noise levels, for the use of each primary flow at an airport at full capacity, for an hour duration. Show each of us, for our local airport, how bad an hour can be (number of ops, max decibel peaks, average decibels per operation), and show us also how many times these hours might repeat in a day, in a month, and in a year; then, we have enough data to see just how adversely impactful the airport operations are, on our homes, and on our lives. With that data, we can meaningfully engage for or against airport growth proposals.

4. <u>Averaging</u>. *DNL provides a cumulative description of the noise events expected to occur over the course of an entire year averaged into a representative day, described as an Average Annual Day (AAD).*

<u>My Comments</u>: Bad metric. Total failure. Replace it. Yesterday. Please?

5. <u>Decisionmaking Noise Metrics</u>. *The FAA currently uses DNL as its primary decisionmaking metric for actions subject to NEPA and airport noise compatibility planning studies prepared pursuant to 14 CFR part 150. a. Should different noise metrics be used in different circumstances for decisionmaking?*

<u>My Comments:</u> Hello? … yes. Yesterday. Please.

6. <u>Communication</u>. *a. Please identify whether and how the FAA can improve communication regarding changes in noise exposure (e.g., what information FAA communicates, where and with whom FAA communicates, what information methods FAA uses to communicate and the venues at which FAA shares this information).*

<u>My Comments:</u> use the internet. Similar to the way airport data is compiled and shared online via Form 5010's. In fact, obligate your airport authorities to post key metrics reated to noise (and other) aviation impacts. Log each fuel delivery (the large trucks feeding the tanks at the airport) by date, by volume, and by fuel type. Log daily operations, broken down by type (if possible), suh as local, itinerant, commercial, recreational (most non-commercial), military, etc. Log flight school data (number of students, number from out of area, logged flight sessions per day, etc., all sanitized to protect personall info, but sufficient to measure

the operational impacts). Log the true and constantly validated figures on based aircraft, overnight leases, etc. Make sure we all know what is happening at OUR local airport.

7. NEPA and Land Use Noise Thresholds Established Using DNL or for Another Cumulative Noise Metric. *The FAA has several noise thresholds that are informed by a dose-response curve (Schultz Curve), which historically provided a useful method for representing the community response to aircraft noise.*

My Comments: NES showed you years ago what you knew decades ago: Schultz Curve is a perpetuated injustice, obscuring impacts upon many people, to narrowly benefit aviation money that is often not even local! Throw it out!!

8. FAA Noise Thresholds Using Single-Event or Operational Metrics. *As the FAA learned from the results of the NES, people are bothered by individual aircraft noise events, but their sense of annoyance increases with the number of those noise events. Should the FAA consider employing new FAA noise thresholds using single-event or operational metrics?*

My Comments: Of course, new metrics. Yesterday. Please!!

9. FAA Noise Thresholds for Low- Frequency Events. *Should FAA establish noise thresholds for low-frequency events, such as those associated with the launch and reentry of commercial space transportation vehicles*

My Comments: They make noise, they are in the air we all supposedly own and share, together. It's noise, it's impactful. So, yes, of course.

10. Miscellaneous. *What other issues or topics should the FAA consider in this review regarding noise metrics, the method of calculating them, the establishment of noise thresholds, or FAA's method of communicating the change in noise exposure?*

My Comments: post-pandemic, more people are working at home, and more people are gaining a focus on quality of life, and thus the need to protect their home from arbitrary impacts. Use your supreme authority to advocate to Congress, to legislate for local airport control and management. Change grant assurances to include an 'obligation' for airport sponsors to provide timely and thorough airport data, either to an FAA web clearinghouse, or to an acceptable locally administered website.

Also, the technologies related to NextGen enable us to hold recreational pilots accountable for bullying and/or unsafe activities. FAA needs to advocate ***FOR THE PEOPLE***, encourage Congress to mandate expanded transparency for those few aviation players who repeatedly impact citizens or communities. The right to fly recreationally, and the right to make money, using public airspace and publicly funded airports, should carry with it an obligation to show data about your impacts. Mandatory data compilations via *'ADS-B ON'* would be very helpful, as they would enable FAA experts to precisely and efficiently investigate the facts behind each noise or other incident. FAA has the tools and can control the rogue aviation cowboys.

11. Literature Review. *In this review, the FAA will examine the body of scientific and economic literature to understand how aviation noise correlates with annoyance as well as environmental, economic, and health impacts. The FAA also will evaluate whether any of these impacts are statistically significant and the metrics that may be best suited to disclose these impacts. A bibliography of this body of research is available for review in the Background Materials tab in the Docket and as Appendix 1 to the FAA framing paper entitled, The Foundational Elements of the Federal Aviation Administration Civil Aircraft Noise Policy: The Noise Measurement System, its Component Noise Metrics, and Noise*

Thresholds. This framing paper is available at: https://www.faa.gov/ noisepolicyreview/NPR-framing. Please identify any studies or data regarding civil aviation noise not already identified by the FAA in the bibliography that you believe the FAA should evaluate. Please explain the relevance and significance of the study or evidence and how it should inform FAA decisions regarding the policy.

My Comments: Here, FAA is framing this NPRM-RFC effort as if the agency is doing a thorough review of material… while overlooking the fact FAA has had all this material forever, and even funded or created much of the literature. The offer to add materials sounds kind, but better kindness would be to ***advocate for the people*** to restore meaningful local controls. These airports belong first to our local communities, and we should have the right to impose fees, reject impactful aviation activities, limit operational intensities, and apply curfew hours, and other management and mitigation actions, all to preserve the quality of our communities. FAA needs to advocate on our behalf, and against the elite minority who currently are over-privileged with what lobbyists have gained from Congress.

In the U.S., FAA data shows recreational pilots constitute roughly 0.1% of the national population; their use of our GA airports needs to be regulated, and restricted consistent with quality of life for the other 99.9%.

Additionally, regarding impacts associated with major airline hub airports, we should have the right to limit just how busy our local major airport can become. Over decades, we have seen FAA's (and Congress') support of excessive growth at a few airports, while many others are all but abandoned by the major airline. Just look at FAA's data, for the operations history at CVG, PIT, STL, CLE, DTW, PDX, IAD, and many others. This is not a healthy industry, when you see how drastically and how often an airport transitions from boom to bust.

We can do better, and we need FAA working with us, to make these changes. And, a focus on Noise Policy is but one critical element and first step, to move forward and reform.

Thank you for soliciting these comments. Please use them with the respect due to all of us.

Jeff Lewis
aiREFORM.com

Total Operations at 39 Major Airports, 1980-2022

Airport	1980 Ops	FY85 Ops	1990 Ops	2000 Ops	2019 Ops	2022 Ops	ID	90 vs 80	95 vs 90	00 vs 95	05 vs 00	10 vs 05	15 vs 10	19 vs 15	22 vs 19	00 vs 80	22 vs 00	ID	19 vs 00	%chg per yr	1980 rank	2022 rank
New York Kennedy	311,777	338,600	337,222	358,951	463,198	453,396	JFK	8%	4%	2%	1%	11%	11%	4%	-2%	15%	26%	JFK	29%	1%	21	8
Denver	485,695	502,900	484,130	528,604	640,098	615,734	DEN	0%	-2%	11%	7%	12%	-14%	17%	-4%	9%	16%	DEN	21%	1%	6	4
Fort Lauderdale	284,544		224,709	292,462	331,455	286,181	FLL	-21%	6%	22%	13%	-18%	2%	19%	-14%	3%	-2%	FLL	13%	0%	25	22
San Diego	155,914	252,700	212,553	207,916	231,354	210,263	SAN	36%	15%	-15%	10%	-17%	2%	19%	-9%	33%	1%	SAN	11%	0%	39	29
San Francisco	371,222	396,200	440,090	430,554	458,502	355,002	SFO	19%	-1%	-1%	-18%	10%	11%	7%	-23%	16%	-18%	SFO	6%	0%	12	16
Las Vegas	364,355	301,900	399,761	521,300	554,027	581,116	LAS	10%	26%	3%	18%	-18%	4%	6%	5%	43%	11%	LAS	6%	0%	13	5
TOTALS (top 6)	1,973,507	1,792,300	2,098,465	2,339,787	2,678,634	2,501,692		6%	-9%	23%	-10%	-5%	-1%	36%	-7%	19%	7%		14%	0%		

This table compiles FAA's annual operations data for 39 airports, going back to 1980. Page 1 shows the top 6 airports, and page 2 shows the bottom 33 airports. Ranking is by growth from 2000 to 2019. A color-scale (green to red) is used to help show trends of growth versus decline in 'percent change ops'.

Key findings of this analysis include:

For all 39 airports, total ops grew 15% from 1980 to 1990, grew 31% from 1980 to 2000…

...but total ops have since declined: down 15% from 2000 to 2019, and down 25% from 2000 to 2022.

Airlines have been concentrating ops at key airports. Total ops at the top 6 airports grew 19% from 1980 to 2000, and 7% from 2000 to 2022…

...but at the vast majority (33 of the 39 airports), total ops grew 34% from 1980 to 2000, then declined 30% from 2000 to 2022.

Since 2000, only two major airports have seen operations growth in excess of average population growth: JFK (up 29%) and DEN (up 21%)…

...and the total for the other 37 airports declined sharply: down 17% from 2000 to 2019, and down 28% from 2000 to 2022.

Total Operations at 39 Major Airports, 1980-2022

Airport	1980 Ops	FY85 Ops	1990 Ops	2000 Ops	2019 Ops	2022 Ops	ID	90 vs 80	95 vs 90	00 vs 95	05 vs 00	10 vs 05	15 vs 10	19 vs 15	22 vs 19	00 vs 80	22 vs 00	ID	19 vs 00	%chg per yr	1980 rank	2022 rank
Chicago O'Hare	734,555	768,100	810,346	908,977	919,704	711,561	ORD	10%	11%	1%	7%	-9%	-1%	5%	-23%	24%	-22%	ORD	1%	0%	1	2
Seattle	216,418		355,005	445,677	450,487	401,351	SEA	64%	9%	15%	-23%	-8%	21%	18%	-11%	106%	-10%	SEA	1%	0%	31	11
Orlando	157,535		281,947	366,278	366,169	364,907	MCO	79%	22%	6%	-2%	-12%	0%	16%	0%	133%	0%	MCO	0%	0%	38	14
Atlanta	609,466	749,900	790,502	913,449	904,301	724,145	ATL	30%	-4%	20%	7%	-3%	-7%	2%	-20%	50%	-21%	ATL	-1%	0%	2	1
Newark	204,324	400,200	386,613	457,182	449,543	408,607	EWR	89%	10%	8%	-4%	-7%	2%	8%	-9%	124%	-11%	EWR	-2%	0%	32	10
Houston Intercontinent	290,443	316,300	314,436	490,568	478,070	400,965	IAH	8%	20%	30%	15%	-6%	-5%	-5%	-16%	69%	-18%	IAH	-3%	0%	22	12
New York La Guardia	319,891	367,300	361,458	392,047	374,539	356,081	LGA	13%	-4%	13%	3%	-9%	0%	2%	-5%	23%	-9%	LGA	-4%	0%	20	15
Honolulu	385,463	353,900	407,093	345,496	326,837	316,732	HNL	6%	-8%	-8%	-4%	-20%	18%	4%	-3%	-10%	-8%	HNL	-5%	0%	10	19
Salt Lake City	285,104	252,300	303,345	366,933	344,765	321,941	SLC	6%	18%	2%	24%	-20%	-15%	11%	-7%	29%	-12%	SLC	-6%	0%	23	18
Sacramento	170,733		161,239	149,969	138,523	130,514	SMF	-6%	11%	-16%	12%	-27%	-12%	28%	-6%	-12%	-13%	SMF	-8%	0%	36	34
Los Angeles	534,414	546,000	679,861	783,684	691,257	556,913	LAX	27%	8%	7%	-17%	-11%	14%	6%	-19%	47%	-29%	LAX	-12%	0%	4	6
Washington National	354,717	330,600	317,055	342,790	298,310	296,999	DCA	-11%	-1%	9%	-19%	-1%	8%	0%	0%	-3%	-13%	DCA	-13%	0%	14	21
New Orleans	198,515	280,600	156,425	167,502	143,651	121,886	MSY	-21%	12%	-4%	-20%	-10%	8%	10%	-15%	-16%	-27%	MSY	-14%	0%	33	35
Boston Logan	340,896	402,700	449,688	508,283	432,853	384,294	BOS	32%	6%	7%	-17%	-12%	2%	15%	-11%	49%	-24%	BOS	-15%	0%	16	13
Baltimore	222,673	283,700	302,224	315,348	262,794	219,276	BWI	36%	-4%	9%	-2%	-11%	-11%	7%	-17%	42%	-30%	BWI	-17%	0%	29	25
Dallas/Ft. Worth	467,139	547,900	731,224	865,777	720,007	656,676	DFW	57%	20%	-2%	-17%	-9%	4%	6%	-9%	85%	-24%	DFW	-17%	0%	7	3
Santa Ana	569,779	521,600	522,942	387,864	318,485	327,150	SNA	-8%	-10%	-18%	-5%	-26%	1%	16%	3%	-32%	-16%	SNA	-18%	0%	3	17
Philadelphia	334,683	350,700	411,294	483,567	390,321	284,141	PHL	23%	-1%	19%	11%	-14%	-11%	-5%	-27%	44%	-41%	PHL	-19%	0%	19	24
Miami	376,820	329,500	480,876	516,545	416,773	458,478	MIA	28%	20%	-10%	-26%	-1%	10%	1%	10%	37%	-11%	MIA	-19%	0%	11	7
Tampa	237,244	267,700	238,646	278,632	217,502	212,995	TPA	1%	10%	6%	-3%	-27%	-3%	15%	-2%	17%	-24%	TPA	-22%	-1%	28	28
Minneapolis St. Paul	284,572	362,000	382,960	522,253	406,073	310,235	MSP	35%	22%	11%	2%	-18%	-7%	0%	-24%	84%	-41%	MSP	-22%	-1%	24	20
Portland	219,404		269,650	317,477	238,384	176,507	PDX	23%	12%	5%	-17%	-15%	-2%	9%	-26%	45%	-44%	PDX	-25%	-1%	30	30
Detroit	268,240	366,300	387,848	554,580	396,909	284,606	DTW	45%	31%	9%	-6%	-13%	-16%	5%	-28%	107%	-49%	DTW	-28%	-1%	26	23
Phoenix Sky Harbor	390,464	394,300	498,522	638,757	438,891	418,856	PHX	28%	10%	17%	-12%	-20%	-2%	0%	-5%	64%	-34%	PHX	-31%	-1%	9	9
San Jose Municipal	415,543	364,900	326,520	299,844	205,886	166,038	SJC	-21%	-19%	14%	-27%	-37%	7%	38%	-19%	-28%	-45%	SJC	-31%	-1%	8	31
San Juan, PR	191,151		204,994	236,903	159,261	150,054	SJU	7%	-10%	28%	-16%	-18%	-4%	1%	-6%	24%	-37%	SJU	-33%	-1%	34	33
Memphis	337,603	332,100	327,127	386,335	229,451	213,418	MEM	-3%	10%	7%	2%	-15%	-35%	5%	-7%	14%	-45%	MEM	-41%	-1%	17	27
Kansas City	184,301		163,102	218,194	123,399	102,905	MCI	-12%	25%	7%	-21%	-15%	-18%	4%	-17%	18%	-53%	MCI	-43%	-1%	35	37
Oakland	487,584	370,600	402,001	449,050	242,757	213,670	OAK	-18%	28%	-13%	-23%	-37%	-2%	12%	-12%	-8%	-52%	OAK	-46%	-1%	5	26
Buffalo	162,167		140,009	165,334	80,036	66,584	BUF	-14%	8%	10%	-20%	-1%	-12%	-31%	-17%	2%	-60%	BUF	-52%	-1%	37	39
St. Louis	336,560	411,300	439,000	484,224	193,939	158,517	STL	30%	18%	-7%	-39%	-37%	0%	4%	-18%	44%	-67%	STL	-60%	-1%	18	32
Cleveland	247,286		274,383	331,899	126,999	101,314	CLE	11%	-3%	25%	-22%	-25%	-39%	8%	-20%	34%	-69%	CLE	-62%	-1%	27	38
Pittsburgh	353,100	360,900	385,806	448,181	148,119	121,688	PIT	9%	16%	0%	-40%	-46%	-2%	5%	-18%	27%	-73%	PIT	-67%	-2%	15	36
TOTALS (bottom 33)	10,888,787	10,031,400	12,664,141	14,539,599	11,634,995	10,140,004		16%	9%	6%	-9%	-15%	-3%	6%	-13%	34%	-30%		-20%	0%		

This table compiles annual operations data for 39 airports, going back to 1980. Page 1 shows the top 6 airports, and page 2 shows the bottom 33 airports, as ranked by growth.

Press Release – FAA To Re-Evaluate Method for Measuring Effects of Aircraft Noise

For Immediate Release

May 7, 2015
Contact: Laura Brown
Phone: (202) 267-3883; Email: laura.j.brown@faa.gov

WASHINGTON – The U.S. Department of Transportation's Federal Aviation Administration (FAA) will soon begin work on the next step in a multi-year effort to update the scientific evidence on the relationship between aircraft noise exposure and its effects on communities around airports.

"The FAA is sensitive to public concerns about aircraft noise. We understand the interest in expediting this research, and we will complete this work as quickly as possible," said FAA Administrator Michael Huerta. "This Administration takes its responsibility to be responsive to communities' concerns over air noise seriously. Our work is intended to give the public an opportunity to provide perspective and viewpoints on a very important issue."

Beginning in the next two to three months, the FAA will contact residents around selected U.S. airports through mail and telephone to survey public perceptions of aviation noise throughout the course of a year. This will be the most comprehensive study using a single noise survey ever undertaken in the United States, polling communities surrounding 20 airports nationwide. To preserve the scientific integrity of the study, the FAA cannot disclose which communities will be polled.

The FAA obtained approval from the Office of Management and Budget last week to conduct the survey and hopes to finish gathering data by the end of 2016. The agency will then analyze the results to determine whether to update its methods for determining exposure to noise.

The framework for this study was developed through the Airports Cooperative Research Program (ACRP), which is operated by the Transportation Research Board of the National Academies of Sciences. This methodology will be used to determine whether to change the FAA's current approach, as well as consideration of compatible land uses and justification for federal expenditures for areas that are not compatible with airport noise.

Aircraft noise is currently measured on a scale that averages all community noise during a 24-hour period, with a ten-fold penalty on noise that occurs during night and early morning hours. The scientific underpinnings for this measurement, known as the Day-Night Average Sound Level (DNL), were the result of social surveys of transportation noise in the 1970s.

In 1981, the FAA established DNL 65 decibels as the guideline at which federal funding is available for soundproofing or other noise mitigation. This method was reaffirmed in studies conducted during the late 1980s and early 1990s.

During the ensuing years, aircraft manufacturers incorporated technologies that resulted in dramatically quieter aircraft. However, residents around many of the largest U.S. airports have expressed concerns about aircraft noise associated with the continuing growth of the aviation industry. The FAA is taking an updated look at its approach for measuring noise as part of an ongoing dialogue with stakeholders, including communities and leaders of a number of cities across the nation.

If changes are warranted, the FAA will propose revised policy and related guidance and regulations, subject to interagency coordination, as well as public review and comment.

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Copied 1/14/2021 from: https://www.faa.gov/news/press_releases/news_story.cfm?newsId=18774

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., SW.
Washington, DC 20591

April 14, 2020

The Honorable Roger Wicker
Chairman, Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

This letter transmits the Federal Aviation Administration's (FAA) report to Congress on an evaluation of alternative noise metrics as directed by Senate Appropriations Report 116-109 (pg. 42) for fiscal year 2019 and the requirements of Section 188, "Study regarding day-night average sound levels", of the FAA Reauthorization Act of 2018 (the Act) (Pub. L. 115-254).

Section 188 of the Act directed the FAA to submit a report evaluating alternative noise metrics to the current average day-night level standard to the appropriate Congressional committees. While not directed by the Act to include as a report, the information contained in the document also fulfills the FAA's response to Section 173.

We look forward to continued collaboration with your staff and would be happy to schedule time to brief you further if desired.

We have sent identical letters to Chairman DeFazio, Ranking Member Cantwell, and Ranking Member Graves.

Sincerely,

Steve Dickson
Administrator

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., SW.
Washington, DC 20591

April 14, 2020

The Honorable Peter A. DeFazio
Chairman, Committee on Transportation
and Infrastructure
House of Representatives
Washington, DC 20515

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Sincerely,

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U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., SW.
Washington, DC 20591

April 14, 2020

The Honorable Maria Cantwell
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Senator Cantwell:

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Sincerely,

Steve Dickson
Administrator

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., SW.
Washington, DC 20591

April 14, 2020

The Honorable Sam Graves
Committee on Transportation
and Infrastructure
House of Representatives
Washington, DC 20515

Dear Congressman Graves:

This letter transmits the Federal Aviation Administration's (FAA) report to Congress on an evaluation of alternative noise metrics as directed by Senate Appropriations Report 116-109 (pg. 42) for fiscal year 2019 and the requirements of Section 188, "Study regarding day-night average sound levels", of the FAA Reauthorization Act of 2018 (the Act) (Pub. L. 115-254).

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Sincerely,

Steve Dickson
Administrator

Federal Aviation Administration

Report to Congress

FAA Reauthorization Act of 2018
(Pub. L. 115-254)
Section 188 and Sec 173

April 14, 2020

Table of Contents

1. Introduction

Since its inception, the Federal Aviation Administration (FAA) has worked to better understand, quantify, and address noise concerns from aircraft. As part of this effort, various noise metrics have been developed over several decades of research to inform federal policies. As will be discussed in this report, no single metric can cover all situations due to the dynamic acoustical and operational characteristics of aviation noise. The appropriate use of noise modeling and noise measurement will also be reviewed and the context in which each are applicable are discussed.

Congress directed an evaluation of alternative metrics in Senate Appropriations Report 116-109 (pg. 42) for fiscal year 2019 and the FAA Reauthorization Act of 2018 (Pub. L. 115-254) requested the FAA to provide this report in response to **Sec. 188:** ***Study regarding day-night average sound levels. Within 1 year the Administrator shall evaluate alternative metrics to current average day-night level standard, such as use of actual noise sampling to address community airplane noise concerns.***

While not directed to include in a report, the information contained in this document also fulfills the FAA's response to **Sec. 173:** ***Alternative airplane noise metric evaluation. Within 1 year complete the ongoing evaluation of alternative metrics to the current Day Night Level (DNL) 65 standard.***

2. Purpose of Noise Metrics for Environmental Regulation and Policy

This section introduces the topic of noise and the FAA's use of noise metrics for environmental regulation and policy. "Noise" is defined as unwanted sound. The term "noise metric" refers to a type of noise measurement or noise descriptor. Sound itself is a complex phenomenon, which varies in level over time as well as frequency content.[1] Therefore, many noise metrics exist in order to capture and include the various aspects of sound; no single noise metric can cover all situations. The FAA uses noise metrics for two primary purposes:

1. To assess community noise exposure through requirements under the National Environmental Policy Act (NEPA) and other related noise programs like 14 CFR Part 150.
2. To assess aircraft certification through 14 CFR Part 36.

The noise metrics used for each of these purposes are different as they address different characteristics of noise as will be described below.

2.1 Community Noise Exposure

Community responses to noise vary from person to person, even if noise levels do not change. However, changes in noise exposure affect individual and community responses, and substantial increases in man-made noise can have a negative impact. Consequently, it is

[1] Frequency content refers to the timbre of a sound, often comprised of a collection of pitches, or frequencies.

important to understand which characteristics of noise cause a negative response and how exposure to noise with those characteristics affects people's lives.

In order to reflect human response to sound equitably across communities, a meaningful metric or set of metrics should:

- Have a highly reliable relationship between noise exposure and people's response to noise.
- Consistently be applied uniformly in communities surrounding airports.
- Account for noise level, duration, and time of occurrence.

The Day-Night Average Sound Level (DNL) incorporates all of these elements and is the metric FAA uses to inform environmental decision making for noise.

As stated in the previous section, "noise" is unwanted sound in a community. However, individual expectations regarding noise may vary based on different factors, including whether the community is in a quiet rural area or a bustling downtown city. For example, a new, potentially intrusive noise may generally be more noticeable in a quiet rural area compared to an urban environment, even though the overall noise levels can be higher in an urban environment. Thus, the ambient (or background) sound level affects how people perceive new noise sources. "Ambient" sound is defined as the existing acoustic environment to which a potential intrusive sound is being compared. Figure 1[2] shows typical existing ambient sound levels (i.e., Day-Night Average Sound Level [DNL]; see Section 3 for a discussion of DNL) ranging from a "small town residential area" to a "downtown city."

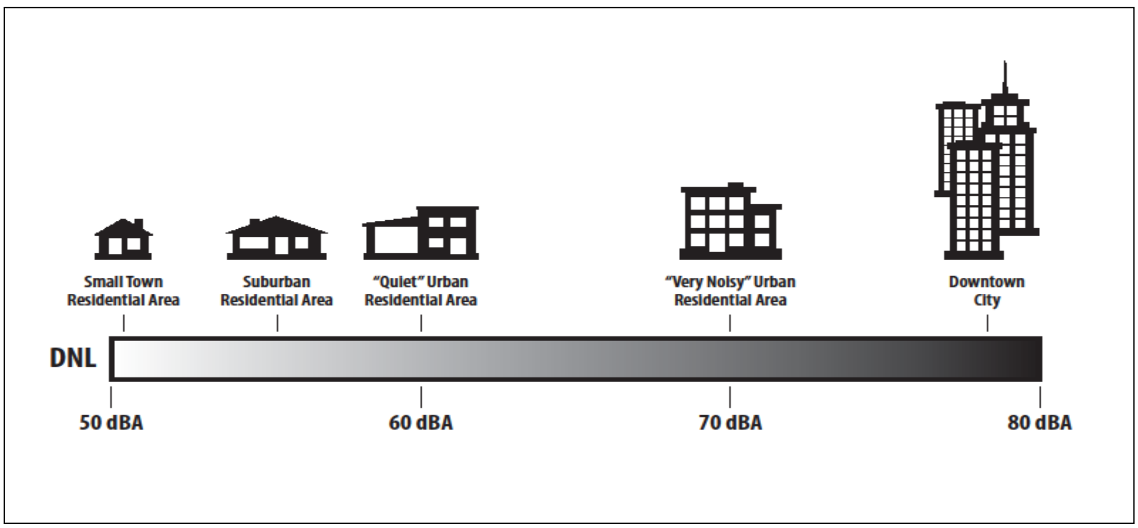

Figure 1. Typical Day-Night Average Sound Levels

Common community noise sources include sources inside and outside of buildings. For example, a person indoors can experience the noise from vacuum cleaners, air conditioners, televisions, etc. Example sources of outdoor noise entering a house include lawn mowers, vehicular traffic, railroads, and aircraft. A new, potentially intrusive noise source can range from acceptable to unacceptable depending on a number of factors, including the following:

[2] U.S. Environmental Protection Agency. 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.

- Magnitude of the noise level relative to ambient sound levels.
- Character of the noise.
- Number, time of day, and elapsed time of noise events.

For these reasons, a metric responsive to cumulative noise exposure over the full range of aircraft operational conditions is most appropriate to assess community noise exposure.

2.2 Aircraft Certification

The purpose of the noise certification process is to ensure that the latest available safe and airworthy noise reduction technology is incorporated into new aircraft designs, thereby minimizing aircraft noise levels experienced by communities.

The Federal Aviation Administration applies noise certification standards to regulate the maximum noise level that an individual civil aircraft can emit. The United States aircraft noise standards are defined in the Code of Federal Regulations Title 14 Part 36 – Noise Standards: Aircraft Type and Airworthiness Certification (14 CFR Part 36). Rigorous noise measurement procedures are used in the aircraft certification process. For aircraft certification, single aircraft event metrics are most appropriate for finding compliance. In the case of U.S. large airplane and helicopter regulations, the increased designation by “stage” for such applicable standards are an indication of noise stringency increases that lower the maximum allowable noise levels.

As noise reduction technology matures, the FAA works with the international community to determine if a new stringent noise standard is appropriate. If so, the international community, through the International Civil Aviation Organization’s Committee on Aviation Environmental Protection, embarks on a comprehensive analysis to determine a new noise standard.

The FAA publishes certificated noise levels in the advisory circular, “Noise Levels for U.S Certificated and Foreign Aircraft.” This advisory circular provides noise level data for aircraft certificated under 14 CFR Part 36 and categorizes aircraft into their appropriate “stages.” Any aircraft that is certified for airworthiness in the U.S. must comply with noise standard requirements to receive a type certificate.

3. Noise Metrics Acoustic Background and History

3.1 Background on Acoustical Frequency Weighting

Many metrics used to predict or describe noise effects corresponding to the human response to noise rely on A-weighting to express the spectral (frequency) content of noise as a single-valued number. First identified in the 1933 Fletcher-Munson curves,[3] the A-weighting network intentionally focuses on frequencies in the mid-range and is less influenced by both low and high frequency sounds. A-weighted noise levels correspond better to human response to noise[4] than do other weightings.

[3] Fletcher, H. and W.A. Munson. 1933. Loudness, Its Definition, Measurement and Calculation. Journal of the Acoustical Society of America. Volume V. October.
[4] Federal Railroad Administration. 2012. High-Speed Ground Transportation Noise and Vibration Impact Assessment. U.S. Department of Transportation. Office of Railroad Policy and Development. DOT/FRA/ORD-12/15. September.

The A-weighting network was originally developed for sounds of relatively low level. Additional B- and C-weighting networks were developed for application to sounds of increasing absolute level. The B-weighting network had little use in noise analyses, however, and was eventually dropped from the sound level meter standard. Figure 2[5] shows the frequency response characteristics of A- and C-weighting.

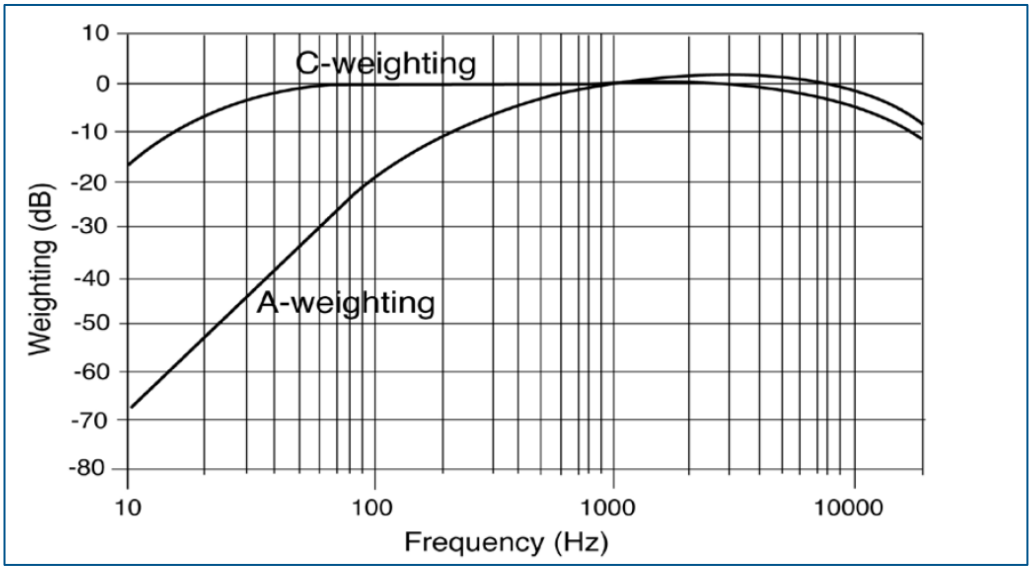

Figure 2. Frequency Response Characteristics of A- and C-Weighting.

The rationale for favoring A-weighted noise metrics can be traced to the very first community noise survey,[6] and for the convenience of manufacturing analog sound level meters. Modern digital sound level meters can easily measure sound with various weightings and/or at individual frequencies.

In some cases, no weighting is used, which is referred to as a “linear” decibel value, and simply denoted dB.

C-weighting (dBC) is currently used for certain applications, such as loud, impulsive noise or noise sources with substantial low frequency content (e.g., sonic booms, commercial space launches, or artillery ranges). C-weighting has essentially little to no weighting between 31.5 hertz (Hz) and 8 kilohertz (kHz), and thus is similar to a “linear” decibel (dB) value.

Measurement of sound includes both frequency and temporal characteristics. Various frequency weightings, such as A-weighting as previously discussed, allow sound measurements with different frequency or spectral content to be represented by a single number.

The time varying nature of sound levels can be characterized by cumulative and single event metrics. Maximum sound level over a given time interval (L_{max}) can be measured as well, but depending on how much levels vary, the L_{max} may not be representative of longer-duration measurements.

[5] ANSI S1.4 -1983 “Specification of Sound Level Meters.”
[6] Fletcher, H., A.H. Beyer, and A.B. Duel. 1930. “Noise Measurement,” in City Noise, Report of the Noise Abatement Commission, Department of Health, City of New York.

3.2 History of Modern Noise Metrics

The framework of modern noise metrics (including DNL) can be traced back to the Composite Noise Rating (CNR) of the 1950s.[7,8,9] The CNR began in a form where aircraft noise spectra[10] were compared to reference spectra at various levels. The CNR included adjustments for time of day, ambient conditions, and other factors. By the 1960s, the CNR had evolved into the Noise Exposure Forecast (NEF)[11] which accounted for multiple noise events. These early noise metrics were later replaced due to the acknowledgement of the need to account for noise level, duration, the number of noise events, and time of day.

The effort to develop a noise metric to evaluate noise in the vicinity of an airport began in California in 1969 with the adoption of Public Utilities Code Section 21669:

> *The department [of Aeronautics] shall adopt noise standards governing the operations of aircraft and aircraft engines for airports operating under a valid permit issued by the department to an extent not prohibited by federal law. The standard shall be based upon the level of noise acceptable to a reasonable person residing in the vicinity of the airport.*

In 1970, the California Aeronautics Board adopted the community noise equivalent level (CNEL) as the measurement of an airport's "noise footprint."[12]

In 1972, Congress passed the Noise Pollution and Abatement Act (commonly referred to as the Noise Control Act), which directed the U.S. Environmental Protection Agency (EPA) to coordinate the programs of all federal agencies relating to noise research and noise control and to publish information on the levels of environmental noise necessary to protect the public health and welfare with an adequate margin of safety;[13] however, the authority to manage aviation noise was retained by the FAA. In 1974, EPA, in its "Levels"[14] document, recommended DNL (also expressed as L_{dn}) as the best metric to describe the effects of environmental noise in a simple, uniform and appropriate way. DNL replaced or supplemented earlier noise metrics, including CNEL, for federal purposes.

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[7] Rosenblith, W.A., K.N. Stevens, and the staff of Bolt, Beranek, and Newman. 1953. Handbook of Acoustic Noise Control, Vol. 2, Noise and Man. USAF Report WADC TR-52-204.
[8] Stevens, K.N., W.A. Rosenblith, and R.H. Bolt. 1953. Neighborhood Reaction to Noise: A Survey and Correlation of Case Histories (A). *J. Acoust. Soc. Am.* Vol 25(833).
[9] Stevens, K.N., and A.C. Pietrasanta. 1957. Procedures for Estimating Noise Exposure and Resulting Community Reactions from Air Base Operations. USAF Report WADC TN 57-10.
[10] "Spectra" refers to a frequency spectrum which typically includes the magnitude of individual frequencies from 31.5 hertz to 20 kilohertz. Hertz is equivalent to cycles/second.
[11] Bishop, D., and M.A. Simpson. 1970. Noise Exposure Forecast Contours for 1967, 1970 and 1975 Operations at Selected Airports. DOT/FAA Office of Noise Abatement, FA68WA-1900. September. BBN Report No. 1863.
[12] CNEL is still in use in California; FAA recognizes it as an alternative metric and has allowed California airports to present annual noise exposure in terms of CNEL, rather than DNL, for consistency with state protocols.
[13] Congress discontinued funding for the EPA Noise Office in 1981.
[14] U.S. Environmental Protection Agency Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (Mar. 1974).

In 1979, Congress passed the Aviation Safety and Noise Abatement Act (ASNA), which required the FAA to establish:

(a) A single system of measuring noise, for which there is a highly reliable relationship between projected noise exposure and surveyed reactions of people to noise, to be uniformly applied in measuring noise at airports and the areas surrounding such airports; and

(b) A single system for determining the exposure of individuals to noise which results from the operations of an airport and which includes, but is not limited to, noise intensity, duration, and time of occurrence.[15]

Taking into consideration existing information on noise metrics, in 1981, in accordance with ASNA, the FAA adopted DNL as its standard metric. The FAA uses the DNL metric for purposes of determining an individual's cumulative noise exposure and for land use compatibility under 14 CFR part 150. The FAA also uses DNL for assessing the significance of predicted noise impacts under NEPA.

4. Noise Metrics Overview

This section provides background on the range of noise metrics most commonly used for evaluations of transportation noise or for other related purposes. Sections 5 and 6 will then introduce where these metrics are in active use by the FAA or other agencies for regulatory purposes.

4.1 Cumulative Metrics

Cumulative noise metrics consider both the sound level and the duration, and are useful in quantifying long-term community noise exposure. Depending on the situation, different length of time periods, such as hourly, daily or annual can be considered by cumulative metrics.

The following are examples of cumulative noise metrics.

Level Equivalent (L_{eq})

The Level Equivalent (L_{eq}) is the equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time. L_{eq} is essentially the average sound level during the measurement interval and takes into account the cumulative effect of multiple noise events.

Day-Night Average Sound Level (DNL)

The DNL noise metric captures all the acoustic energy within a 24-hour period, adding a 10 dB penalty between the hours of 10:00 p.m. and 7:00 a.m. to account for people's increased sensitivity to noise at night. Night-time ambient sound levels are often approximately 10 dB lower than daytime sound levels, so the 10 dB adjustment can also be thought of as

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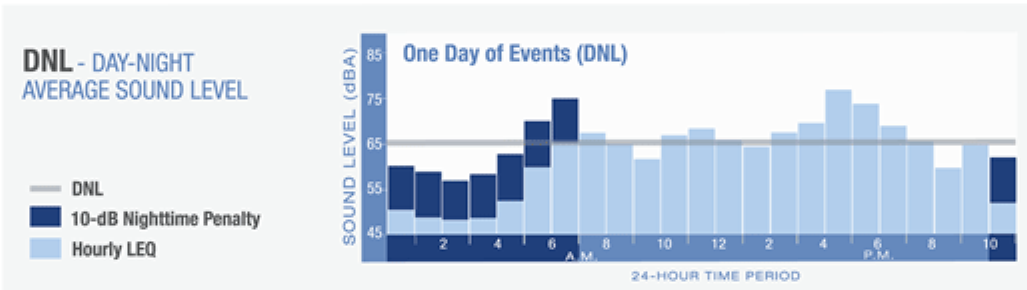
[15] 49 U.S.C. § 47502(1)(A)(B), (2), (3).

compensating for this drop-in sound level. DNL is usually expressed in terms of A-weighted sound levels, but other frequency weightings can be used, such as C-weighting (i.e., CDNL).

DNL represents an average day of hourly weighted Leq noise levels as shown in the schematic below.



DNL is also most often considered commutatively over an Average Annual Day and provides a consolidated summary of the annual noise exposure. The American National Standards Institute (ANSI) comments[16] on the appropriateness of the annual average DNL with respect to long-term community noise exposure: “Ordinarily, land-uses are long-term, continuing nature, and the yearly day-night average sound level is appropriate for these land uses. For other land uses, compatibility is to be assessed by the average sound level during the time interval of interest for the land use involved.”

Community Noise Equivalent Level (CNEL)

The Community Noise Equivalent Level (CNEL) metric, used in California[17], is similar to the DNL metric, but in addition to the 10 dBA nighttime penalty, it also adds a 4.77 dBA penalty for sound levels occurring during the evening hours (7:00 p.m. to 10:00 p.m.).

4.2 Single Event Metrics

Single event metrics focus attention on the noise attributes of individual noise events such as an aircraft flyover.

Sound Exposure Level (SEL)

The SEL metric captures all the acoustic energy of a noise event and normalizes it as if the event occurred in one second. The SEL takes into account both sound level and duration, and therefore allows direct comparison between two different noise events with different durations and/or sound level. The SEL (in conjunction with number of daytime and nighttime noise events) also can be used to calculate DNL.

Maximum Sound Level (L_{max})

Maximum sound level (L_{max}) is the maximum sound level measured within a desired measurement interval.

[16] “Sound Level Descriptors for Determination of Compatible Land Use” (ANSI S12.40-1990).
[17] CNEL may be used in lieu of DNL for assessment of FAA actions in California.

4.3 Operational-Acoustic Metrics

"Operational-Acoustic" refers to metrics such as Number-above (NA), Time-above (TA), and Time-audible. These types of metrics include non-acoustic information, such as number of aircraft or time elapsed exceeding a certain noise level threshold. This type of metric is a linear measure (as opposed to logarithmic), which in some situations can aid in providing supplemental noise information to the public. Contours (isopleths) of these of Operational-Acoustic metrics can be superimposed on maps showing noise level contours from acoustic metrics, such as DNL.

Number-above (NA)

The NA metric combines single event noise level information with aircraft movement data. NA contours commonly show the number of aircraft above a given noise level threshold over a specified time period (e.g., 70 dBA and 24 hours).

Time-above (TA)

The TA noise metric measures the total time, or percentage of time, that the A-weighted aircraft noise level exceeds an indicated level. TA correlates linearly with the number of flight operations and is also sensitive to changes in fleet mix.

Time-audible

The Time-audible metric quantifies the duration at which noise from a transient noise source occurs at a noise level greater than the existing ambient noise level. The noise source must also be detectable by a human observer with normal hearing, who is actively listening.

This metric is highly dependent upon an accurate representation of ambient sound levels, both temporally and geo-spatially. For example, a listener's particular location and time at that location would need accurate and reliable ambient sound level data for comparison with accurate aircraft noise levels. For these reasons, the Time-audible metric can be difficult to represent accurately in areas with dynamic or variable ambient noise levels.

For typical vehicle noise levels, this metric is most applicable for projects within or involving noise sensitive areas at very low and constant ambient noise levels, such as national parks. Low and constant ambient noise levels are desired because this metric is most sensitive where the source noise is distinguishable from the ambient noise.

4.4 Low Acoustic Frequency Noise Metrics

Pounds Per Square Foot (PSF): A direct measure of the peak overpressure from an acoustical event. Most often considered for high intensity noise events where structural concerns are relevant.

C-weighted SEL (CSEL) and C-Weighted DNL (CDNL): Analogous to SEL and DNL, but incorporates a C-weighting to be more responsive to lower acoustic frequency noise. CSEL is the recommended[18] metric for evaluating human response to sonic booms.

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[18] National Research Council. 1981. Assessment of Community Response to High-Energy Impulsive Noises. Report of CHABA Working Group 84, W. J. Galloway, Chairman.

5. Noise Metrics in use by FAA

As introduced in section 3.2, the DNL noise metric was adopted by FAA to meet the requirements established by ASNA and codified in 14 CFR Part 150. DNL is also used by the FAA in making determinations for Federal Actions it assesses under NEPA as specified under FAA Order 1050.1F. The DNL metric is an example of a cumulative A-weighted[19] noise metric and represents the exposure level over a complete 24-hour period. DNL accounts for the noise level of each individual aircraft event, the number of times those events occur, and the time of day/night in which they occur. DNL includes a 10 decibel[20] (dB) noise penalty added to noise events occurring from 10:00 p.m. to 7:00 a.m. to reflect the increased human sensitivity to noise and lower ambient sound levels at night. To ensure that all of the variable operational conditions over the course of a year are considered, FAA considers the Average Annual Day when calculating DNL[21]. Average Annual Day DNL is used to assess noise from all fixed wing and rotorcraft aircraft in both the vicinity of airports and in the extended airspace.

In addition to regulation of aircraft operations, the FAA's Office of Commercial Space Transportation issues licenses to operate non-federal launch sites and to operate launch vehicles. Commercial space launch vehicles typically produce two different types of noise: launch noise (from rocket engines) and sonic booms (generated during supersonic flight). Launch noise can be assessed using several different noise metrics. The DNL metric has been used for commercial space projects for public disclosure and because the FAA uses the DNL metric when determining significance under NEPA, but its suitability is uncertain primarily because of the relatively small number of noise events (i.e., launches per year). CSEL and CDNL may also be considered in some cases for commercial space noise evaluations.

While DNL is used for all FAA noise-based decision-making purposes, the FAA encourages the use of other supplemental metrics as a communication tool to highlight unique situations where applicable. Section 8 will discuss the use of noise metrics for supplemental purposes.

6. Noise Metrics in use by U.S. and State Government (outside FAA)

Federal and state agencies other than the FAA employ similar noise metrics to evaluate a project's noise impacts. For example, the U.S. Department of Housing and Urban Development (HUD), Surface Transportation Board (STB), and U.S. Department of Defense (DOD) also employ the DNL metric to determine Land Use Policy according to Federal Land Use Policy guidelines. The Federal Highway Administration (FHWA) primarily uses the L_{eq} metric while the Federal Railroad Administration (FRA) and Federal Transit Administration (FTA) use both L_{eq} and DNL metrics. Daytime L_{eq} metrics are typically used for activities with little or no nighttime activity, while DNL is used to account for daytime and nighttime activity.

[19] A-weighted metrics weight the acoustic frequency of noise to approximate that of human hearing.
[20] The decibel (dB) is a logarithmic relationship of sound pressure levels, which is designed to collapse a large range of pressure values into a more manageable range. A 10-dB increase is perceived as a doubling of loudness, while a 3-dB increase is perceived as just noticeable to most people.
[21] Average Annual Day DNL may also be noted as Yearly DNL or YDNL

It is important to draw a distinction between a particular noise metric and any accompanying noise threshold values (in decibels) used to inform project or policy determinations. Determinations of threshold values depend on multiple technical and policy considerations that, while related to the choice of noise metric, require separate consideration.

The following examples illustrate how different agencies and departments apply various noise metrics.

6.1 Level Equivalent (L_{eq}) Metric

FHWA uses the loudest one-hour L_{eq}[22] to assess impacts associated with highway noise. FHWA's impact criteria for residential receptors has been 67 dBA (L_{eq}) (or 70 dBA L_{10}) at exterior use areas since 1976. In many cases, highway noise levels peaking in the range of 66 dBA (L_{eq}) often are in the range of 65 DNL if measured over a 24-hour period.

FHWA employs both "absolute" and "relative" noise impact criteria. "Absolute" refers to the 67 dBA (L_{eq}) threshold for noise-sensitive outdoor use areas, including those of residences. "Relative" noise criteria refer to a potential increase in noise level due to a highway project. FHWA allows individual states to determine their own "relative" noise criteria which can vary between 5 and 15 dBA above ambient sound levels, defined as a "substantial increase." Impacts can occur under one, the other, or both; at which point the highway agency must consider abatement for those impacts.

6.2 DNL and L_{eq} Metrics

Originating from FTA guidance[23], The FTA and FRA[24] essentially use the same noise metrics and procedures, including consideration of existing ambient noise levels and project noise levels for environmental noise impact analysis as shown in Figure 3.

For FTA, these procedures include how to calculate light rail transit noise levels for various trains using consistent configurations and distances from the rail line. Transit bus projects also often include highway elements and may require FHWA noise procedures to be used, in conjunction with FTA noise procedures. The FTA noise manual provides guidance on choosing the correct procedures for such multi-modal projects.

For FRA, existing and project noise levels are expressed in terms of dBA, delineated by times of use. Specifically, the manual requires: "L_{dn} is used for land use where nighttime sensitivity is a

[22] Federal Highway Administration. 23 CFR Part 772: Procedures for Abatement of Highway Traffic Noise and Construction Noise -- Final rule. Federal Register Vol. 75, No. 133, 1 July 2010.
[23] Federal Transit Administration. 2018. Transit Noise and Vibration Impact Assessment. FTA Report No. 0123. September.
[24] FRA follows FTA guidance for assessments of rail vehicles operating below 90mph. For rail vehicles operating above 90mph further guidance is provided in: Federal Railroad Administration. 2012. High-Speed Ground Transportation Noise and Vibration Impact Assessment. U.S. Department of Transportation. Office of Railroad Policy and Development. DOT/FRA/ORD-12/15. September.

factor; L_{eq} during the hour of maximum transit noise exposure is used for land use involving only daytime activities."

Figure 3 is applicable to both L_{eq} and DNL. Figure 3 shows that the "allowable project noise level" decreases with decreasing existing ambient noise levels. It is interesting to note that a project noise level of DNL 65 dBA covers a wide range of typical ambient noise level conditions as an impact threshold.

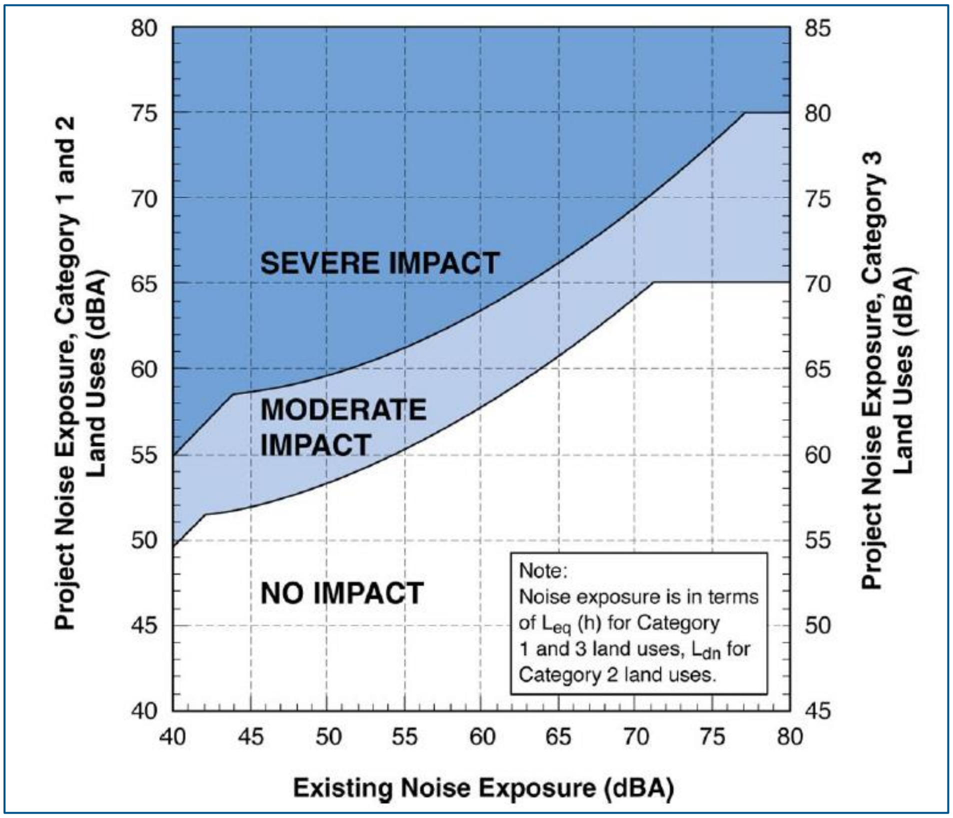

Figure 3. Federal Railroad Administration Noise Metrics/Criteria

6.3 30-Day Average DNL Metric

As an example of long-term versus mid- and short-term noise exposure, the FTA uses a 30-Day Average DNL for certain construction projects warranting a detailed construction noise analysis[25]. Construction projects usually have noise metrics and thresholds which consider the temporary nature of construction projects.

[25] Specific procedures for assessing construction noise impacts are provided in 2018 FTA Report No. 0123

6.4 DNL Metric

Based on Federal land use guidelines[26] and similar to the way in which FAA assesses compatible land use[27], HUD[28] considers an environmental noise level of less than DNL 65 dB as acceptable, a noise level between DNL 65 and 75 dBA normally unacceptable, and a noise level above DNL 75 dB unacceptable. HUD also employs a building interior standard of DNL 45 dB. HUD noise analysis considers the effects of highways, railroads, airports, and military installations for all of its property related expenditures, including loans, planning assistance, and support of new construction. Common use of Federal land use guidelines, including the DNL noise metric, provides HUD with a consistent defensible method for considering aircraft noise in its decision making. Where aircraft noise is a consideration, use of a noise metric other than that considered by FAA, would add complexity and could negatively impact the process for granting home loans and property development.

The DOD primarily uses the DNL metric for environmental noise analysis with caveats: "Although local conditions regarding the need for housing may require residential use in these zones, residential use is discouraged in DNL 65-69 dBA and strongly discouraged in DNL 70-74 dBA. The absence of viable alternative development options should be determined, and an evaluation should be conducted locally prior to local approvals indicating that a demonstrated community need for the residential use would not be met if development were prohibited in these zones."[29] Existing residential development is considered as pre-existing, incompatible land use.

The DOD promotes long-term compatible land use in the vicinity of military installations via the Air Installations Compatibility Use Zones (AICUZ) program. DOD employs detailed land use compatibility recommendations based on Standard Land Use Coding Manual (SLUCM) land use codes and DNL or CNEL noise areas on and around air installations.

AICUZ studies use the A-weighted DNL noise descriptor except in California, where the CNEL descriptor is used. Supplemental noise metrics may also be used to augment the DNL or CNEL analysis as noted by the Federal Interagency Committee on Urban Noise (FICUN). Since land use compatibility guidelines are based on yearly average noise levels, aircraft noise contours should be developed based on average annual day operations.

As a minimum, contours for DNL 65, 70, 75, 80, and 85 dBA are plotted on maps for Air Force, Navy, and Marine Corps air installations as part of AICUZ studies. The Army applies Operational Noise Management Program DNL designations of 60–65, 65–75, and greater than 75 dBA at its air installations. Contours below DNL 65 dB are not required but may be provided if local conditions warrant discussion of lower aircraft noise levels, such as in rural and desert areas, or where significant noise complaints have been received from areas outside DNL 65 contours.

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[26] Federal Interagency Committee on Urban Noise. 1980. Guidelines for Considering Noise In Land Use Planning and Control. June.
[27] 14 CFR Part 150.
[28] 24 CFR Part 51.
[29] Department of Defense Instruction 4165.57 (August 31, 2018).

Supplemental noise metrics may be used to augment DNL and CNEL noise analyses to provide additional information to describe the noise environment in the vicinity of air installations.

The STB regulates and decides disputes involving railroad rates, railroad mergers or line sales, and certain other transportation matters. The STB environmental review regulations for noise analysis[30] have the following criteria:

- An increase in noise exposure as measured by a DNL of 3 dBA or more.
- An increase to a noise level of DNL 65 dBA or greater.

If the estimated noise level increase at a location exceeds either of these criteria, STB estimates the number of affected receptors (e.g., schools, libraries, residences, retirement communities, nursing homes) and quantifies the noise increase. The two components (3 dBA increase, DNL 65 dBA) of the STB criteria are implemented separately to determine an upper bound of the area of potential noise impact. However, noise research indicates that both criteria components must be met to cause an adverse noise impact.[31,32] That is, noise levels would have to be greater than or equal to DNL 65 dBA and increase by 3 dBA or more for an adverse noise impact to occur.

6.5 Comparable International Noise Metrics (LAeq 16h, Lden)

Airports in the United Kingdom use similar cumulative noise metrics as used in the United States, such as the LAeq,16hr and L_{den} metrics.

6.5.1 LAeq,16hr

This noise metric is the A-weighted equivalent continuous noise level, assessed over an average daytime / evening period (7:00 a.m. to 11:00 p.m.) in the summer months. This metric was selected as a result of the United Kingdom Aircraft Noise Index Study[33] social survey which measured human response to aircraft noise expressed by a sample of people living at different places around five English and one Scottish airport. This study found that a ten-decibel nighttime noise penalty was not warranted for these particular airport communities.

6.5.2 L_{den}

In 2002, the European Commission published Directive 2002/49/EC, establishing a common environmental noise indicator for the European Union.[34] The L_{den} is the A-weighted equivalent continuous noise level, evaluated over an annual average 24-hour period, with a 10-dB penalty added to the levels at night (11:00 p.m. to 7:00 a.m.) and a 5 dB penalty added to the levels in the evening (7:00 p.m. to 11:00 p.m.) to reflect people's increased sensitivity to noise during these periods.

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[30] 49 CFR 1105.7e(6).
[31] Coate, D. 1999. Annoyance Due to Locomotive Warning Horns. Transportation Research Board, Transportation Noise and Vibration Subcommittee A1FO4. San Diego, CA. August 1-4.
[32] Surface Transportation Board. 1998. Draft Environmental Assessment for Canadian National and Illinois Central Acquisition, Finance Docket No. 33556.
[33] Survey of noise attitudes 2014: Aircraft CAP 1506, 2017
[34] Survey of noise attitudes 2014: Aircraft CAP 1506, 2017

7. Role of Noise Measurements vs. Noise Modeling

Aircraft noise measurements and noise models have different attributes and roles.

Noise measurements are used for the aircraft certification process, as described in Section 2.2. Noise measurements are also an integral part of the data required for noise modeling; where carefully controlled measured aircraft (source) noise levels by aircraft type and model form the basis of the noise information utilized by aviation noise models. In contrast to these carefully controlled noise measurements, noise measurement data collected in dynamic "real world" situations from noise monitors in the vicinity of an airport can include various sources of error (as will be discussed later in this section).

Noise modeling refers to the use of computational models to generate noise results at single locations, or over a grid of locations. Modeled noise contours at various noise levels, usually in units of decibels, can also be plotted to show regions of equal noise exposure. Noise measurements provide the aircraft source noise data for the various aircraft types and are used by the FAA Aviation Environmental Design Tool (AEDT)[35] for its noise calculations. These data are also validated against noise certification data to ensure accuracy. The FAA uses AEDT to dynamically model aircraft performance in space and time to predict fuel burn, air emissions, and noise levels. This type of modeling allows the input of detailed airport runway configurations, aircraft fleet mix and operations, flight corridors, and a detailed layout of land use and communities adjacent to the airport. Noise modeling allows the overlay of noise contours or single location noise values on detailed land use and community mapping. Noise modeling is used to assess a wide variety of proposed federal actions, such as those resulting from airfield changes or changes in airspace management. Many other federal and international agencies that are responsible for noise impact assessment also employ noise modeling techniques.

Due to the need to generate detailed noise results over large areas, noise modeling is the only practical way to accurately and reliably determine geospatial noise effects in the surrounding community when analyzing proposals related to aviation noise. The many challenges and limitations to using noise measurements for evaluating airport vicinity noise are summarized below:

- Non-aircraft sound can have a large influence on noise monitoring data, which can be difficult to separate from aircraft noise during data post-processing.
- Long-term (e.g., year-long) noise monitoring requires regular maintenance and calibration of the individual noise monitors on a continuous, year-round basis, which has considerable costs.
- To ensure the same accuracy and fidelity of data generated by noise models, an extremely large number of noise monitoring locations is required. (e.g. tens of thousands of noise monitors, collecting year-round data in the vicinity of an airport would be needed to match the fidelity and accuracy of noise modeling).
- Noise monitoring data is not capable of analyzing either "what if" scenarios or proposed future action airport and air space scenarios.

[35] Data is managed by the European Organization for the Safety of Air Navigation (EUROCONTROL) through the Aircraft Noise and Performance (ANP) database

Airport vicinity noise measurements are therefore not appropriate for assessing environmental project determinations or for considering single project validation of noise modeling results. While these limitations make it unsuitable for “real world” noise measurements to consistently inform environmental decision making, the FAA does review noise measurement data when provided as part of an environmental report. In cases where data from modern, well maintained noise monitoring systems are provided, a close agreement between measured and modeled results is typically found, which further validates noise modeling accuracy.

The different roles of aviation noise measurements and modeling are also understood in the international aviation community. For example, the European Civil Aviation Conference states that “the measurement of long-term sound exposures from aircraft is not normally possible as it would require acceptable weather conditions and 100% functional instrumentation and data collection for the entire time period of interest—normally up to 12 continuous months. (And to generate even rudimentary contours this would have to be done at a very large number of locations.)”[36] The United Kingdom’s Civil Aviation Authority states that provided “sufficient noise measurements are collected from a large enough number of locations and that the data is normalised appropriately, it is relatively straightforward to produce validated noise estimates. There are, however, a number of difficulties and limitations with such simplistic models. Data from a large number of measurement sites would be extremely expensive and time consuming to collect and process for a major airport, especially if aircraft noise contours were required on a regular basis. Further, such models do not provide a capability to assess the effects on the contours of changes to aircraft flight profiles, for forecasting or ‘what if’ analyses.”[37]

Other domestic federal state and local agencies, including all federal domestic transportation agencies also employ modeling for noise level predictions when conducting noise measurements would be impractical.

While airport noise monitoring is not generally used for predictive purposes, a noise monitoring program is often a useful tool to inform the airport and neighbors about current aircraft activity and corresponding noise levels in the community. This type of noise monitoring may be accomplished via a permanent noise monitoring system; however, these systems can be quite sophisticated and require numerous permanent noise monitoring stations distributed throughout the community adjacent to the airport.

8. Role of Supplemental Metrics

As discussed in Section 3, FAA’s environmental decision-making for noise must use a metric that considers the magnitude, duration, and frequency of the noise events under study. The DNL noise metric uniquely meets these requirements. However, in specific situations, additional information focused on a more targeted type of noise exposure may require the use of supplemental noise metrics.

[36] European Civil Aviation Conference. 2016. CEAC Doc 29 4th Edition Report on Standard Method of Computing Noise Contours around Civil Airports Volume 1.
[37] D.P. Rhodes, and J.B. Ollerhead. 2001. Aircraft Noise Model Validation. Environmental Research and Consultancy Department, Civil Aviation Authority, Internoise.

Individually, supplemental metrics may not fully consider the magnitude, duration, and frequency of the noise events, but may be used to support further disclosure and aid in the public understanding of community noise exposure.[38] Supplemental noise analyses are often useful to describe aircraft noise exposure from unique operational situations or for noise sensitive locations to assist in the public's understanding.

For example:

- Single event metrics like SEL and Lmax or Leq-type metrics associated with specific time periods may be useful in categorizing the noise associated to short-term activities or from individual flights, but do not fully consider the number of flights or account for the operational variations over a longer-term period.
- Operational-Acoustic metrics like NA and TA provide an alternative way to consider noise exposures over longer time periods while emphasizing details about aircraft operational characteristics, but do not fully consider the cumulative intensity of aircraft noise.
- For typical vehicle noise levels, time audible provides a comparison of aviation noise to the underlying ambient noise levels, but is only a practical consideration where ambient noise occurs at relatively low constant levels.

There is no single supplemental metric that is preferable in all situations and the selection of an appropriate supplemental metric depends on the circumstances of each analysis. However, where warranted, consideration of established supplemental metrics is encouraged.

In addition to the established supplemental metrics discussed above, ongoing research activities sponsored by the FAA and the broader research community are working to develop a greater understanding of other noise-related impact criteria. New supplemental metrics based on this research could then be developed.

Examples of these potential supplemental metrics include:

- N75 (Speech Interference): Considers speech interference (i.e., disruption) between a speaker and listener at a normal conversation distance.
- % Awakening (Sleep Disruption): Based on a standard ANSI[39] developed to predict sleep disturbance in terms of the metric "percent awakenings" or numbers of people awakened.
- L_{eq} (8) (Learning): Based on a standard ANSI has developed[40] to consider the effects of noise on classroom learning.

[38] For example, the FAA's 2005 Environmental Impact Statement for the Modernization of Chicago O'Hare International Airport provided supplemental noise metrics (SEL, Lmax, and TA).
[39] ANSI/ASA S12.9-2008. 2008. Part 6 Quantities and Procedures for Description and Measurement of Environmental Sound—Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes.
[40] ANSI S12.60-2002. 2002. American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.

- L_{max}(c) (Rattle): Considers the effects from low frequency aircraft operations[41,42] including the potential to induce “rattle” to structures.[43]

9. Summary

In summary, no single noise metric can cover all situations. However, the DNL metric, and similar versions such as L_{den}, are being used world-wide to assess aircraft noise effects on communities. In 1992, the Federal Interagency Committee on Noise (FICON) report[44] concluded that DNL is the recommended metric and should continue to be used as the primary metric for aircraft noise exposure. The successor to FICON, the Federal Interagency Committee on Aviation Noise (FICAN) has also reaffirmed this recommendation in their 2018 report[45].

In accordance with ASNA, the FAA adopted DNL as its standard metric. The FAA uses the DNL metric for purposes of determining an individual’s cumulative noise exposure, for land use compatibility under 14 CFR part 150, and for assessing the significance of predicted noise impacts under NEPA. Federal and state agencies other than the FAA, as well as international agencies, employ similar noise metrics to evaluate a project’s noise impacts.

Table 1 compares the various noise metrics discussed in this report, specifically in terms of ASNA requirements for a metric to account for noise level, time of day, and number of events.

Table 1. Noise Metrics

	Noise Level	Time of Day	Number of Events
L_{eq}	✓		✓
DNL	✓	✓	✓
LAeq(hr) (e.g. 16hr, 8hr)	✓	✓	✓
L_{den}	✓	✓	✓
CNEL	✓	✓	✓
SEL and CSEL	✓		
L_{max}	✓		
PSF[a]	✓		
NA[b]	✓		✓
TA[c]	✓		
Time Audible[d]	✓		

[a] PSF, or pounds per square foot, is functionally a measure of “noise level” instead of decibels. PSF is typically used as a measure of the peak overpressure of a sonic boom.
[b] NA is the number of noise events above a certain noise level threshold.

[41] Federal Aviation Administration. 2004. Nonmilitary Helicopter Urban Noise Study.
[42] Schomer, P., and R.D. Neathammer. 1985. The Role of Vibration and Rattle in Human Response to Helicopter Noise. U.S. Army Corps of Engineers. Technical Report N-85/14. September.
[43] Hubbard, H.H. 1982. Noise Induced House Vibrations and Human Perception. Noise Control Engineering Journal. Vol. 19., No. 2.
[44] Federal Agency Review of Selected Airport Noise Analysis Issues (FICON), 1992
[45] FICAN Research Review of Selected Aviation Noise Issues (FICAN), 2018

[c] TA is the time of noise events exceeding a certain noise level threshold.
[d] Time Audible is the amount of time noise events exceed ambient sound levels. This could be interpreted as taking into account the number of noise events.

Noise modeling is the only practical way to predict geospatial noise effects in a surrounding community when analyzing proposals related to aviation noise. Noise modeling is also necessary for a wide variety of other proposed federal actions, such as those resulting from airfield changes or changes in airspace management. The assessment of these actions requires the review of future case proposals and can therefore only be considered through predictive modeling.

Finally, while the DNL metric is FAA's decision-making metric, other supplementary metrics can be used to support further disclosure and aid in the public understanding of community noise effects.