U.C. DAVIS AVIATION NOISE & EMISSIONS SYMPOSIUM

SYSTEMATIC METHOD FOR INCORPORATING NON-ACOUSTIC FACTORS IN AIRCRAFT NOISE REGULATORY POLICY

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TECHNICAL RATIONALE FOR FAA'S AIRCRAFT NOISE REGULATORY POLICY

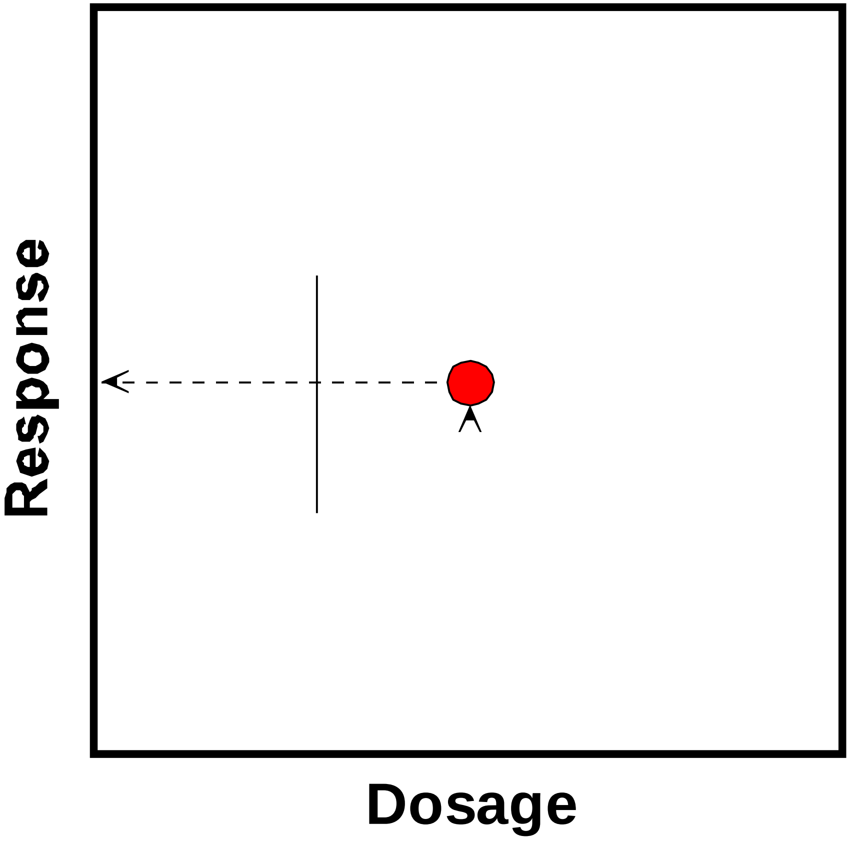
FAA maintains:

that the prevalence of high annoyance is the main effect of aircraft noise on residential communities;

that its noise regulatory policies are most usefully expressed in terms of a cumulative measure of noise exposure (Day-Night Average Sound Level, or DNL); and

that its policy positions on disclosure of "significant" aircraft noise-induced annoyance and noise mitigation are based on objective dosage-response analysis

BASIC NOTION OF A DOSAGE-RESPONSE RELATIONSHIP



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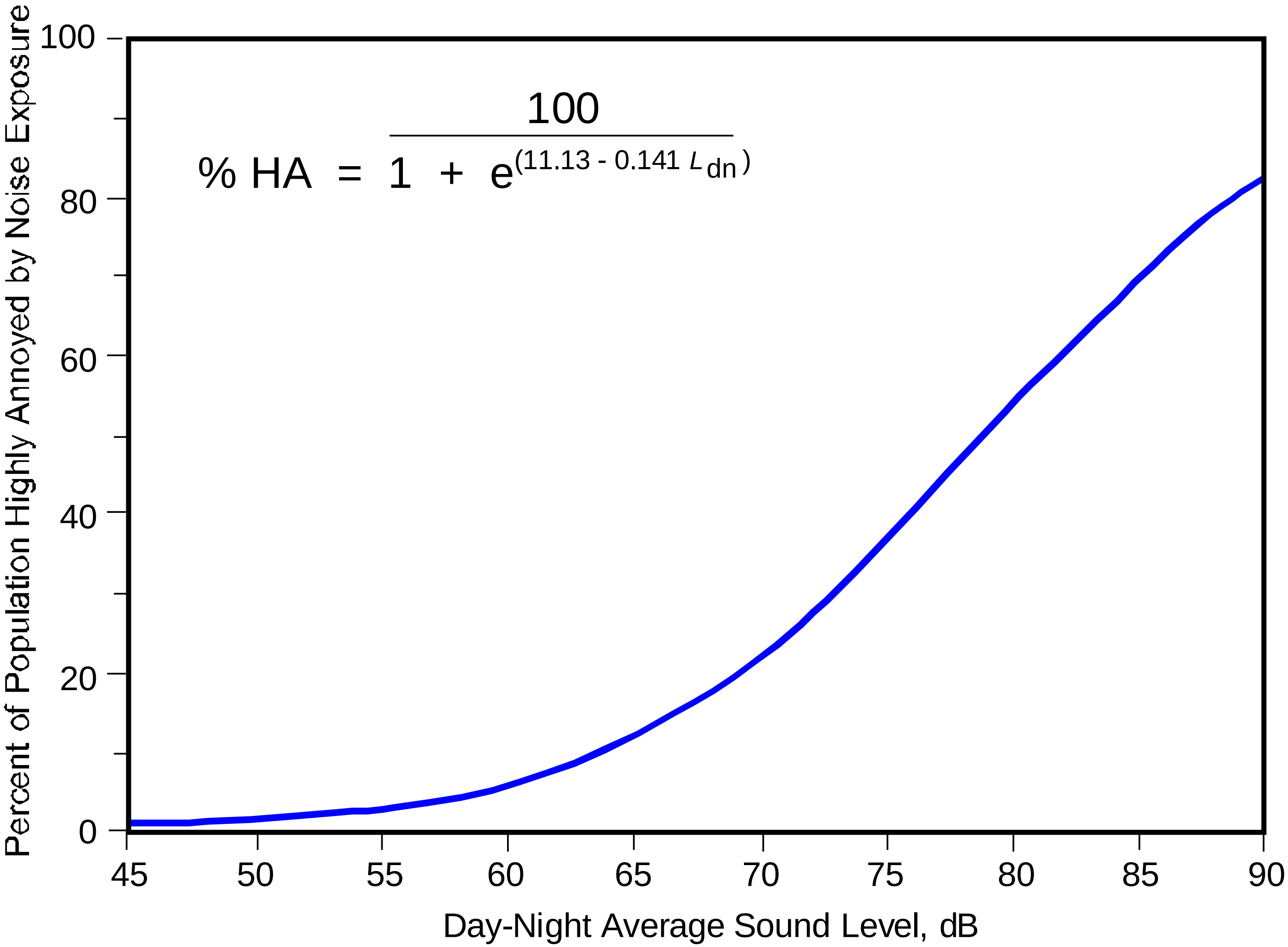
FICON'S 1992 DOSAGE-RESPONSE RELATIONSHIP FOR COMMUNITY RESPONSE TO TRANSPORTATION NOISE



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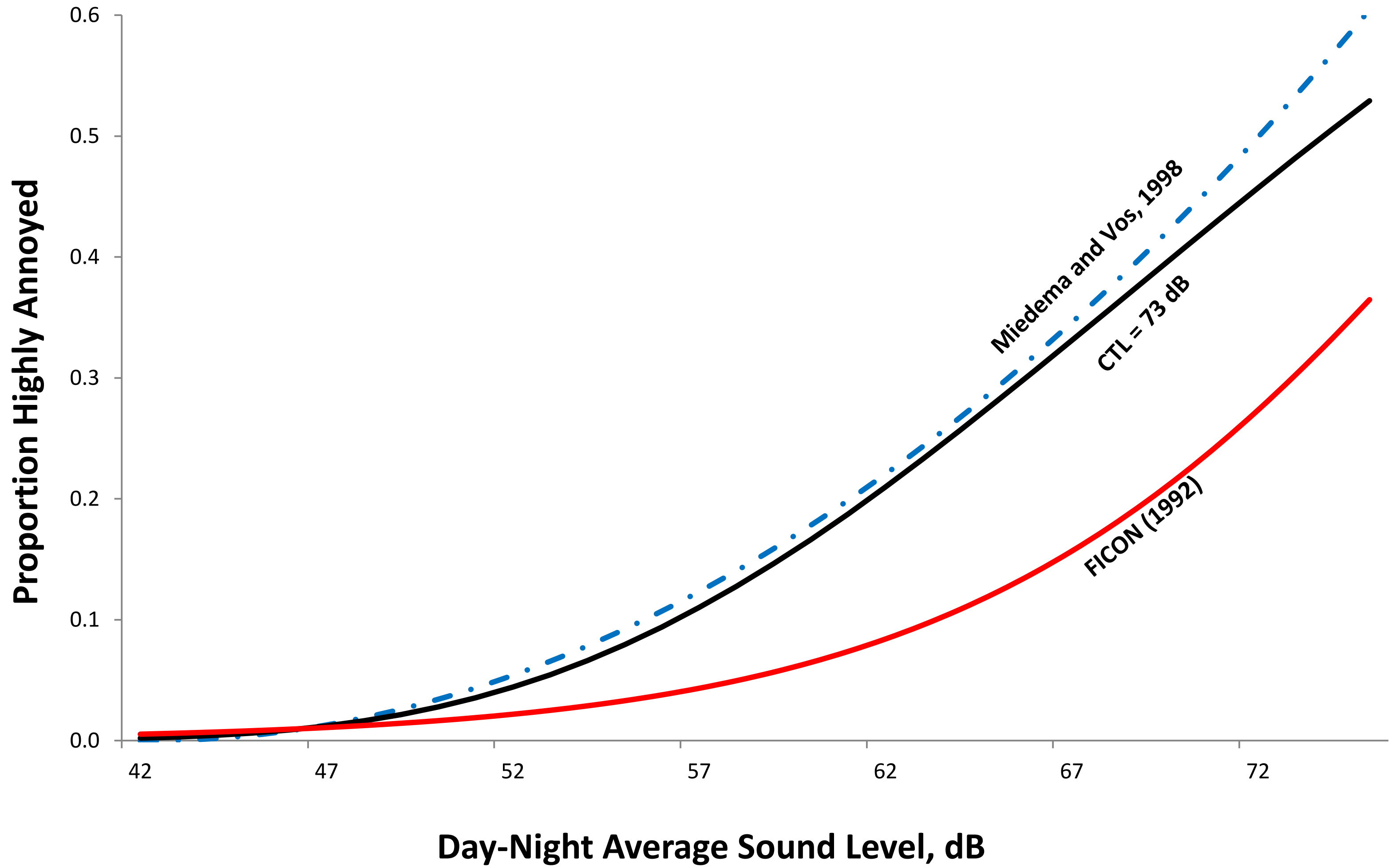
COMPARISON OF MODERN AIRCRAFT NOISE DOSAGE-RESPONSE FUNCTIONS WITH FICON (1992)



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ACTUAL ORIGINS OF FAA POLICY POSITIONS

FAA's regulatory rationale is derived from a simplistic, 1950s-era acoustic engineering perspective that annoyance prevalence rates are predictable from noise exposure alone

In reality,

community response to aircraft noise exposure is ***not*** well predicted by noise exposure alone; and

dosage-response functions do not in themselves support particular regulatory thresholds

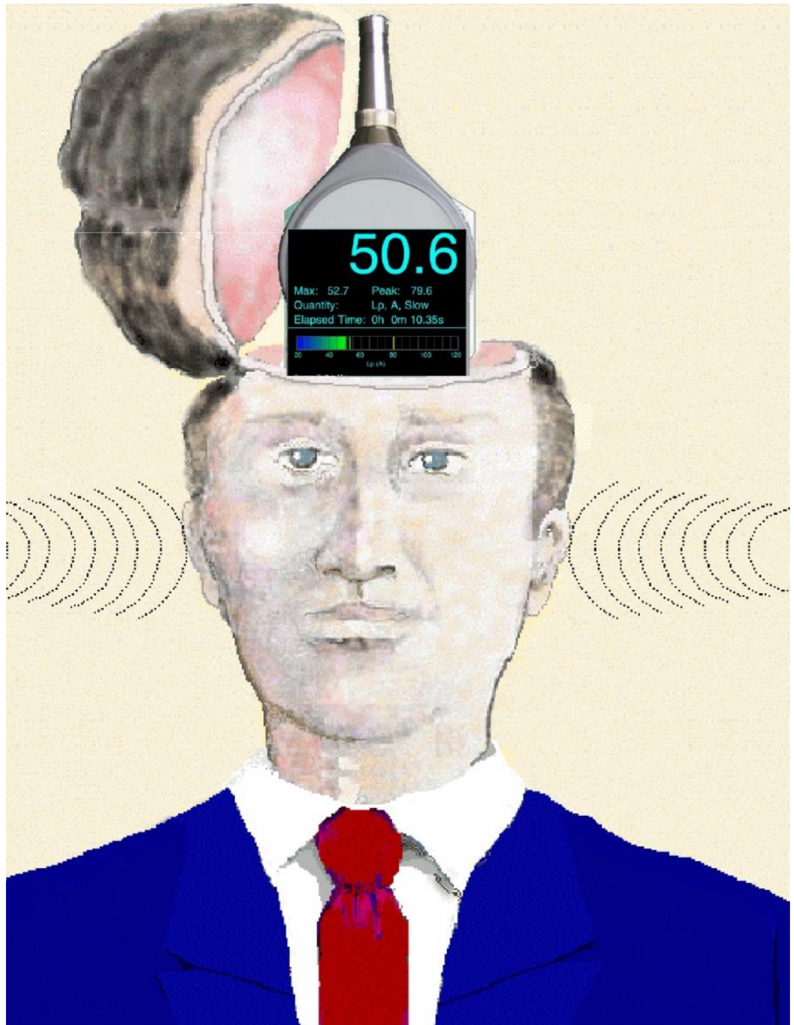
ACTUAL POLICY ORIGINS (CONTINUED)

FAA's aircraft noise regulatory policies long antedate both DNL and the development of dosage-response analysis

The familiar 65 dB DNL regulatory threshold is simply a mathematical conversion of an early 1950s-era measure ("Community Noise Rating", or CNR) into units of "Noise Exposure Forecast", or NEF), and thence into units of DNL

FAA's policy thresholds are based on 1) little more than the opinions of a few prominent, World War II-era consultants, and 2) the agency's former charter to promote civil aviation

SIMPLISTIC MODEL OF INDIVIDUAL ANNOYANCE



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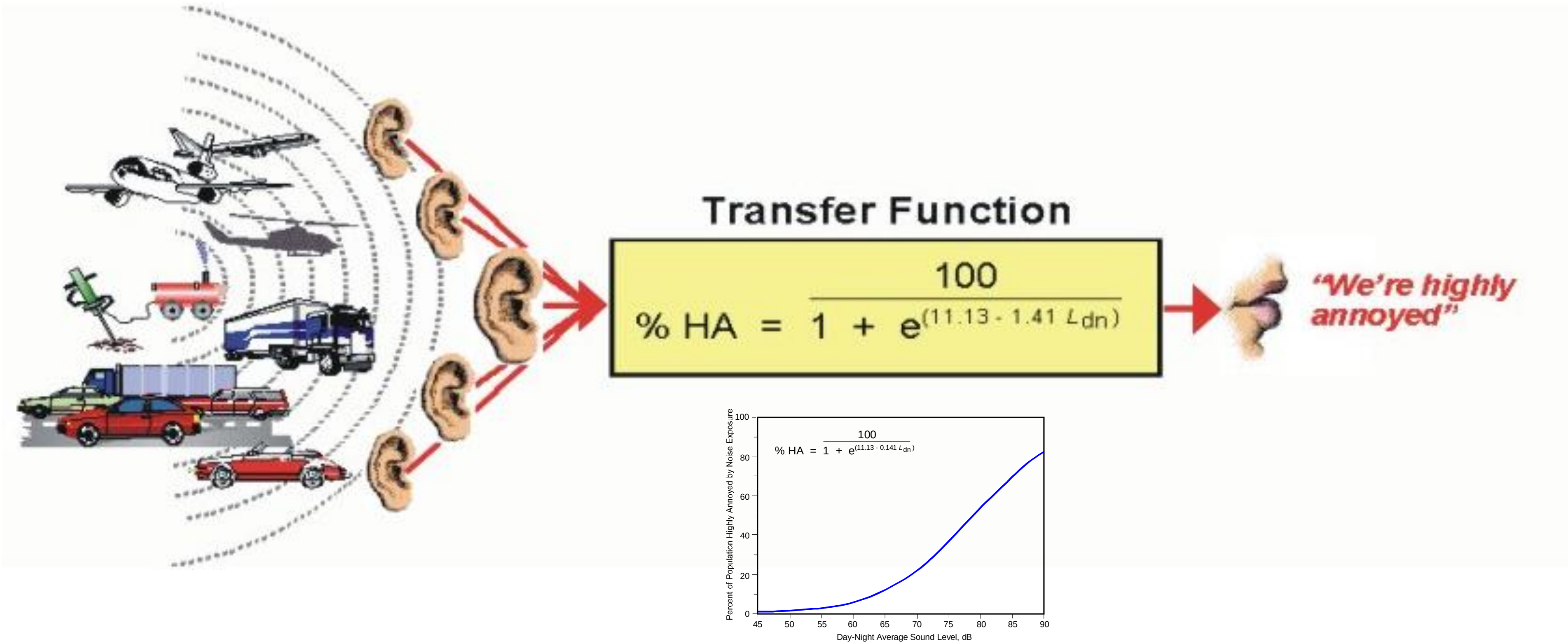
1992 FICON APPROACH TO PREDICTING THE PREVALENCE OF HIGH ANNOYANCE



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PEOPLE ARE MORE COMPLEX THAN SOUND LEVEL METERS

Communities vary widely in their sensitivities to noise exposure – the same noise exposure level that is insignificant in one community can be significant in another

Ignoring such variation is a recipe for misleading disclosures of environmental impact assessments of proposed airport infrastructure projects

Community reaction is **not** caused exclusively by noise exposure, and cannot be accurately or meaningfully predicted from noise exposure information alone

HOW DOES ANNOYANCE DIFFER FROM LOUDNESS?

Loudness (the subjective impression of sound amplitude) grows as the 0.3 power of sound level

Once the duration of a sound reaches about a quarter of a second (the "time constant" of the ear), it does not get any louder

Annoyance with noise exposure, however, continues to increase indefinitely with duration

It follows that annoyance can be predicted as duration-adjusted loudness

BASIC RELATIONSHIP OF COMMUNITY TOLERANCE LEVEL (CTL) APPROACH TO MODELING ANNOYANCE

$$p(\mathrm{HA}) = e^{(-A/m)}$$

where:

p(HA) is the proportion of the population highly annoyed by noise exposure;
A is a community's annoyance decision criterion;
and m is the noise dose, defined as:

$$m = (10^{(Ldn/10)})^{0.3}$$

(Converts a unit of sound pressure level to a value proportional to loudness)

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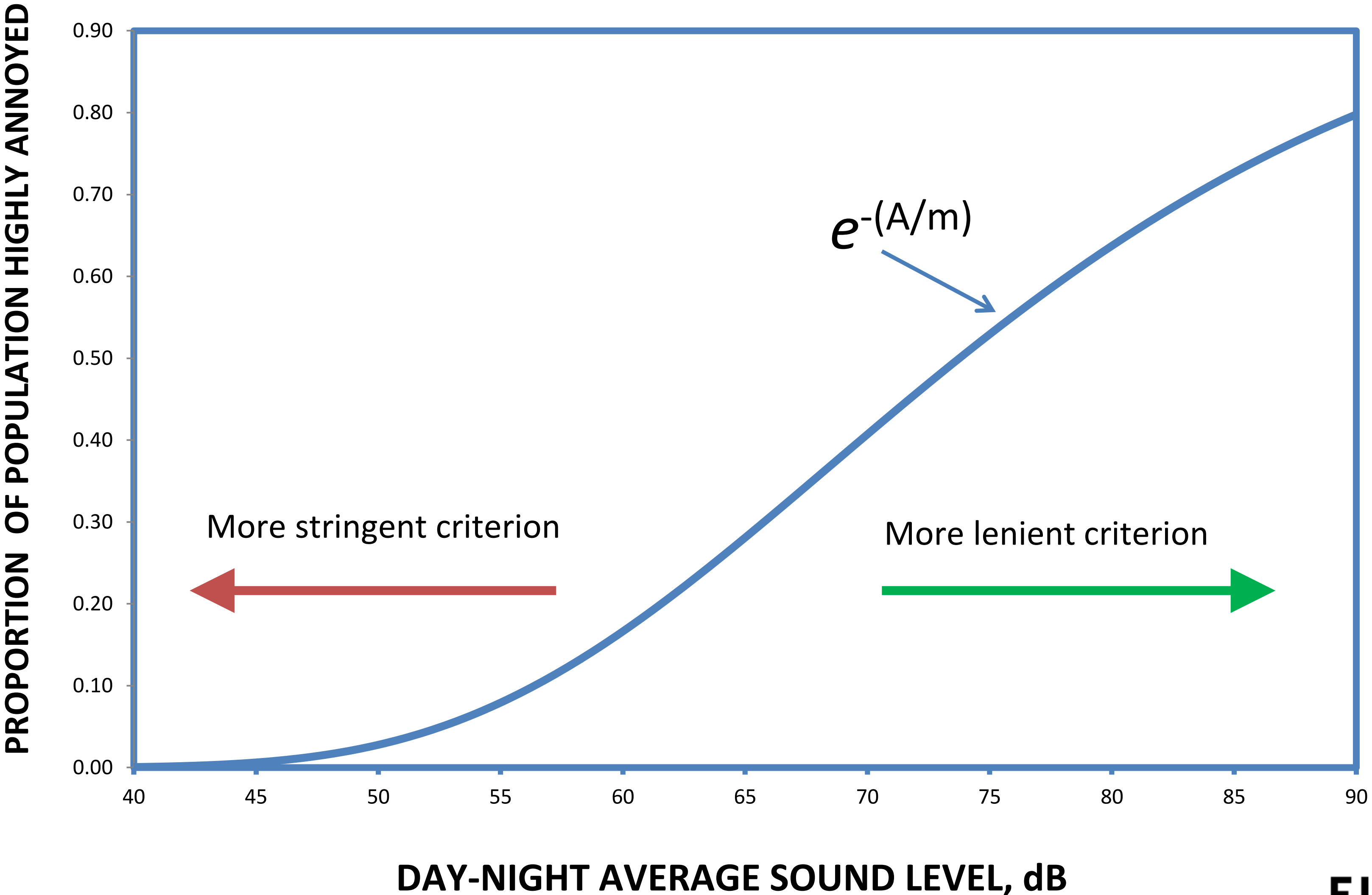
THE VALUE OF *A* TRANSLATES DOSAGE-RESPONSE RELATIONSHIP ALONG THE ABSCISSA



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WHAT IS A CTL VALUE?

A CTL value anchors the dosage-response function to the abscissa (exposure axis)

By convention, the CTL function is anchored to the exposure axis at the midpoint of the function, or 50%

CTL values are expressed in units of Day-Night Average Sound Level, in decibels

CTL is *not* itself a noise metric; it's simply a value of DNL at which half of a community is highly annoyed by a noise source

HOW DOES THE CTL EQUATION WORK?

A CTL value predicts the *joint* effects of acoustic and non-acoustic influences on the prevalence of high annoyance

A community's "annoyance decision criterion", *A*, segregates and fully expresses the net effect of all of the non-acoustic factors that affect the prevalence of annoyance

CTL attributes any deviation from the predicted rate of growth of annoyance in a community (DNL).[3] to non-acoustic factors

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MAIN ADVANTAGES OF CTL ANALYSIS

CTL analysis yields a systematic, community-level explanation of the relative influences of noise exposure and non-acoustic factors on annoyance prevalence rates, and permits:

… predictions of annoyance prevalence rates in actual, rather than generic (hypothetically average) communities

… direct, decibel-denominated comparisons of the tolerances of different communities to the same noise exposure levels

… airports to more effectively manage community response by identifying and treating its sources

REPLACEMENT OF 1992 FICON CURVE WITH A MODERN DOSAGE-RESPONSE FUNCTION

At the very least, the obsolete FICON curve must be replaced with one of the ISO 1996-1 functions

If FAA wishes to maintain its longstanding L_{dn} = 65 dB policy for defining "significant" noise exposure, then the associated %HA will increase from 12.3% to about 28%

If FAA wishes to continue to protect the same percentage (12.3%) of the population from exposure to highly annoying aircraft noise that the FICON curve associates with L_{dn} = 65 dB, the definition of "significant" noise exposure will have to be reduced by ~ 7 - 8 dB

CTL-BASED DISCLOSURE OF ENVIRONMENTAL IMPACTS

If FAA is content to continue generic disclosure of noise-related impacts of airport infrastructure projects (only for nominally average communities), such impacts can be defined with respect to a grand average CTL function

If FAA wishes to tailor its environmental assessments and disclosures of predicted noise impacts particular to actual communities, it can expand its FAR Part 150 studies to include community-specific social surveys from which CTL values can be calculated

Alternatively, FAA can quantify the uncertainty of its estimates of the significance of noise exposure with respect to a known distribution of CTL values across communities

SOME ADDITIONAL CTL BACKGROUND INFORMATION

"A first principles model for estimating the prevalence of annoyance with aircraft noise exposure," Fidell, S., Mestre, V., Schomer, P., Berry, B., Gjestland, T., Vallet, M., and Reid, T., J. Acoust. Soc. Am., 130(2), August, 2011, 791-806.

"A Review of U.S. Aircraft Noise Regulatory Policy," Fidell, S., Acoustics Today (2015), 11 (4), 26 – 34.

"A systematic rationale for defining the significance of aircraft noise impacts," Fidell, S., Mestre, V., Schomer, P., Horonjeff, R., and Reid, T., J. Acoust. Soc. Am. (2014), 136 (3), 1129-1138. (See also Erratum in J. Acoust. Soc. Am. 140 (4), 2016.

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