REVIEW OF USAF STUDIES OF MILITARY TRAINING ROUTE (MTR) NOISE

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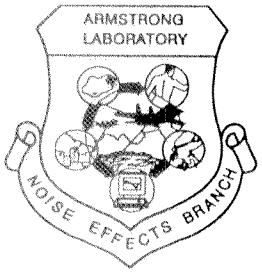
The USAF routinely conducts low-altitude, high-speed training missions on Military Training Routes (MTR)s and within Military Operating Areas (MOA)s. The noise produced by these missions can be characterized as sporadic, with short durations, rapid onsets and higher levels compared to noise generated around airbases. The L_{dnmr} noise metric has been used by the USAF as an interim metric to assess the impact of noise generated by MTR and MOA missions on the civilian population. The USAF conducted a series of acoustic and psychoacoustic studies to measure the noise levels and validate the L_{dnmr} metric. The acoustic studies measured the flight track dispersion across several MTRs and noise signatures from low-altitude, high-speed flyovers. The psychoacoustic studies primarily examined the contribution of sound exposure level, onset rate, and the sporadic nature of flyovers to the development of annoyance. From these acoustic and psychoacoustic studies a revised noise metric has been recommended. This validated noise metric and tract dispersion model are used in ROUTEMAP II and MOAMAP, which are the USAF programs for predicting the impact of noise generated by MTR and MOA operations, respectively.

Mr. Robert C. McKinley is a research psychologist for the Noise Effects Branch of Armstrong Laboratory of the United States Air Force. His primary research has been human response to noise. He is also interested in developing educational tools for addressing noise concerns. Bob started working for the Noise Effects Branch in December 1989. He has recently completed his masters degree from Wright State University in Human Factors Psychology.



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Review of USAF studies of Military Training Route (MTR) noise.

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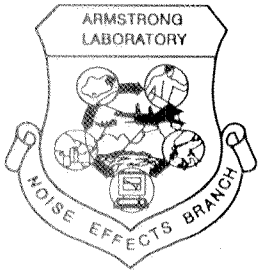

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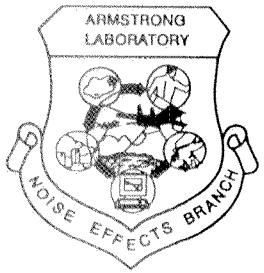
Introduction

- U.S. Air Force has a training requirement to fly low altitude, high speed aircraft operations.
- Noise characterized as:
  - sporadic
  - short durations
  - rapid onsets
  - higher levels compared to noise generated around airbases
- Interim L_{dnmr} metric used in ROUTEMAP.
- Wyle Laboratories has worked for Armstrong Laboratories to assess impact.



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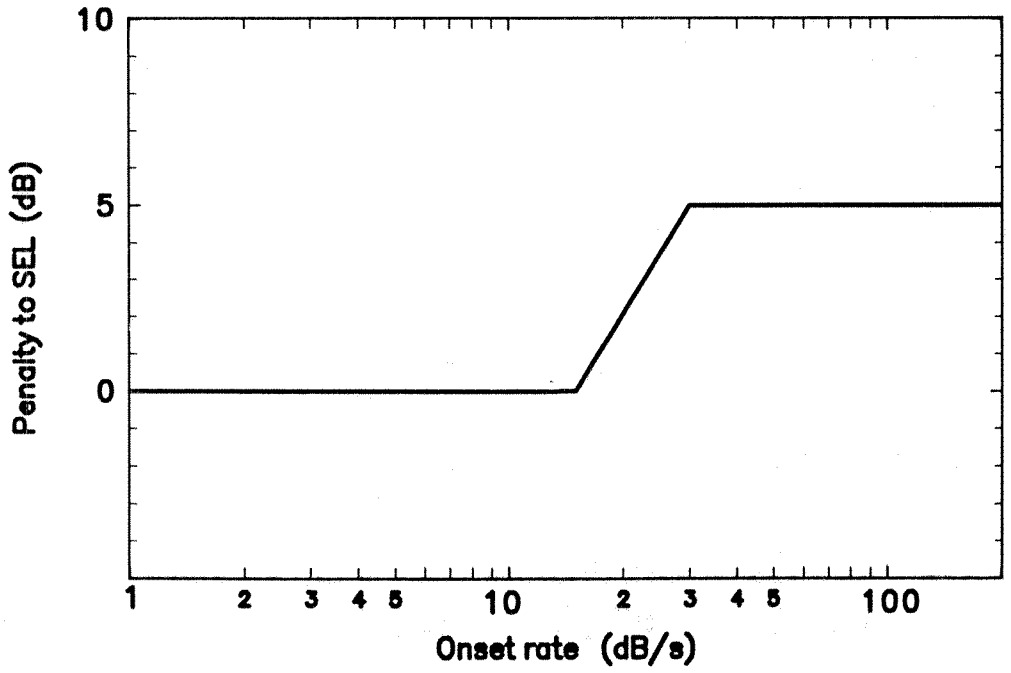
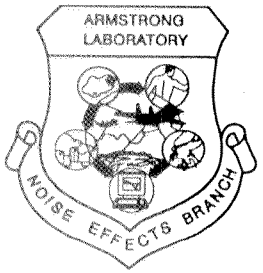
Interim L_{dnmr}

- Modification of the L_{dn} metric.
- Integration period equal to the calendar month with the highest number of operations.
- Up to 5 dB onset rate penalty added to the Sound Exposure Level.
- Penalty applied only to events with max A-weighted sound level exceeding ambient by 15 dB.

Interim Onset Rate Penalty

- No onset rate penalty for onset rates <15 dB/s.
- For onset rates between 15 and 30 dB/s penalty equals 16.6 $\log_{10}$(onset rate)-19.5.
- For onset rates > 30 dB/s penalty is 5 dB.





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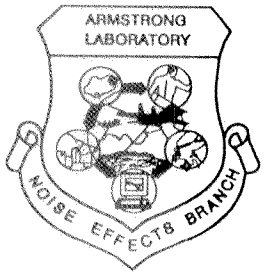
Noise Exposure Validation

In-house acoustic studies

- Measured noise signatures from low-altitude, high-speed flyovers.
- Onset rate predicted from measured data.

$$ONSET = 10.0^{**}(0.002247*Speed - 0.0003228*Altitude - 0.00014*Lateral\ Offset + 0.008987*SEL - 0.434)$$

- Measured excess attenuation for low-altitude flights at large lateral distances.



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Noise Exposure Validation

Wyle acoustic studies

- Flight track dispersion across several MTRs.
  - Distribution from "center-line" (IR) and "dispersed" (VR) flight operations
  - Dispersed (VR) distribution (SD = 0.17 Route width)
- Validated noise levels across several MTRs.

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L_{dnmr} Validation

Sequence of psychoacoustic studies

Study Setting	Noise Source	Exposure Time	# of Subjects
In-house Studies			
Laboratory	Simulated	5 x 30 min	>100
Wyle Studies			
Laboratory	Simulated	2 x 2 hr	76
Rented Home	Simulated	2 x 6 hr	60
Hybrid Own Home	Simulated & Real	1 month	63
*Own Home	Real	3 months	30

* Planned

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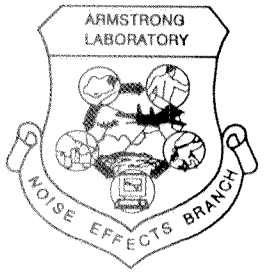
L_{dnmr} Validation

Psychoacoustic studies

- Examined the contribution to human annoyance of the following:
  - sound exposure level
  - onset rate
  - number of events
  - sporadic nature
  - background noise level
  - subject's task
  - setting
  - event duration



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Psychoacoustic studies

Results

- Significant
  - sound exposure level
  - onset rate
  - setting
  - event duration
  - background noise level
- Not significant
  - sporadic nature
  - subject's task
  - number of events independent of Leq

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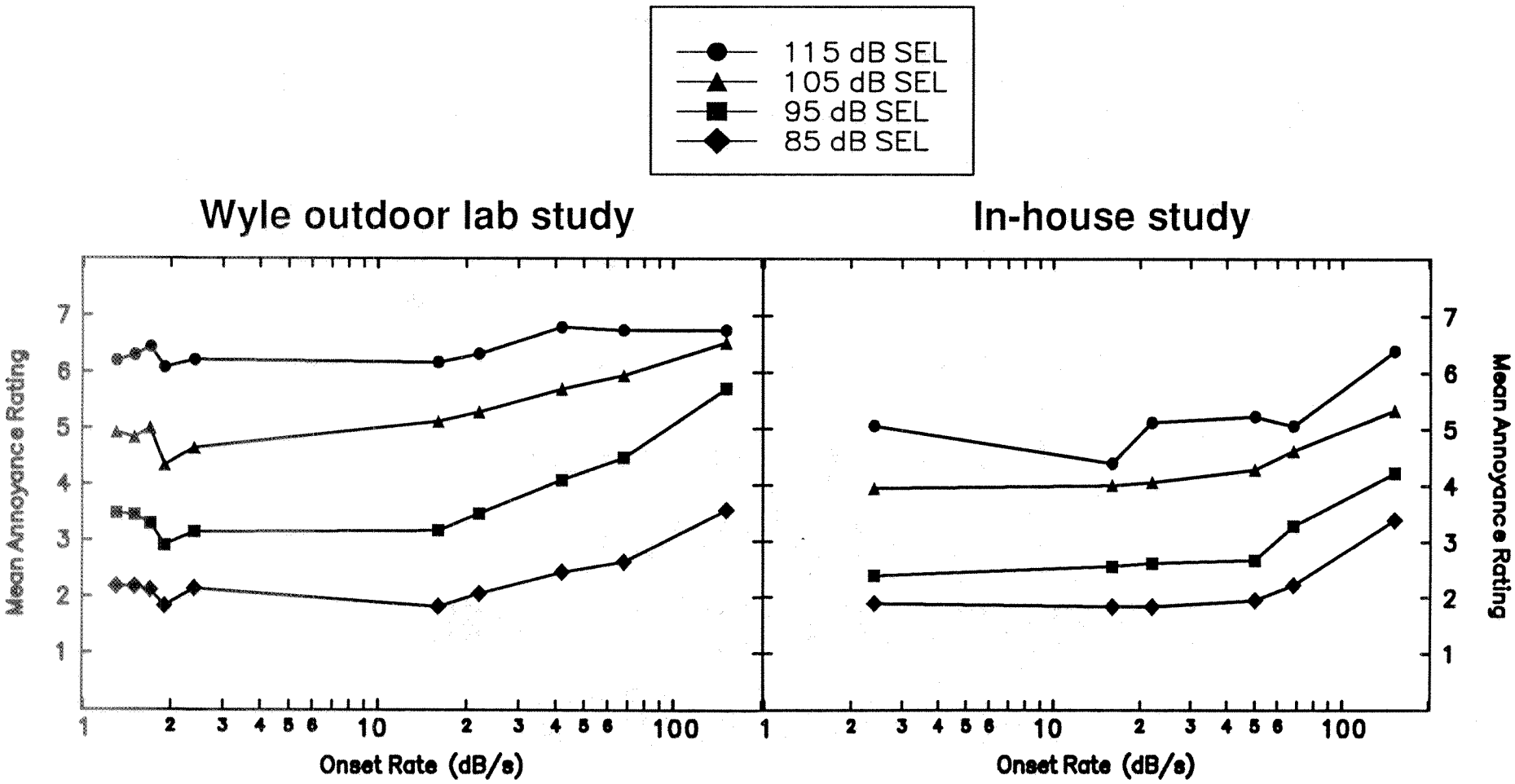
Effect of Onset Rate on Annoyance

Laboratory Studies



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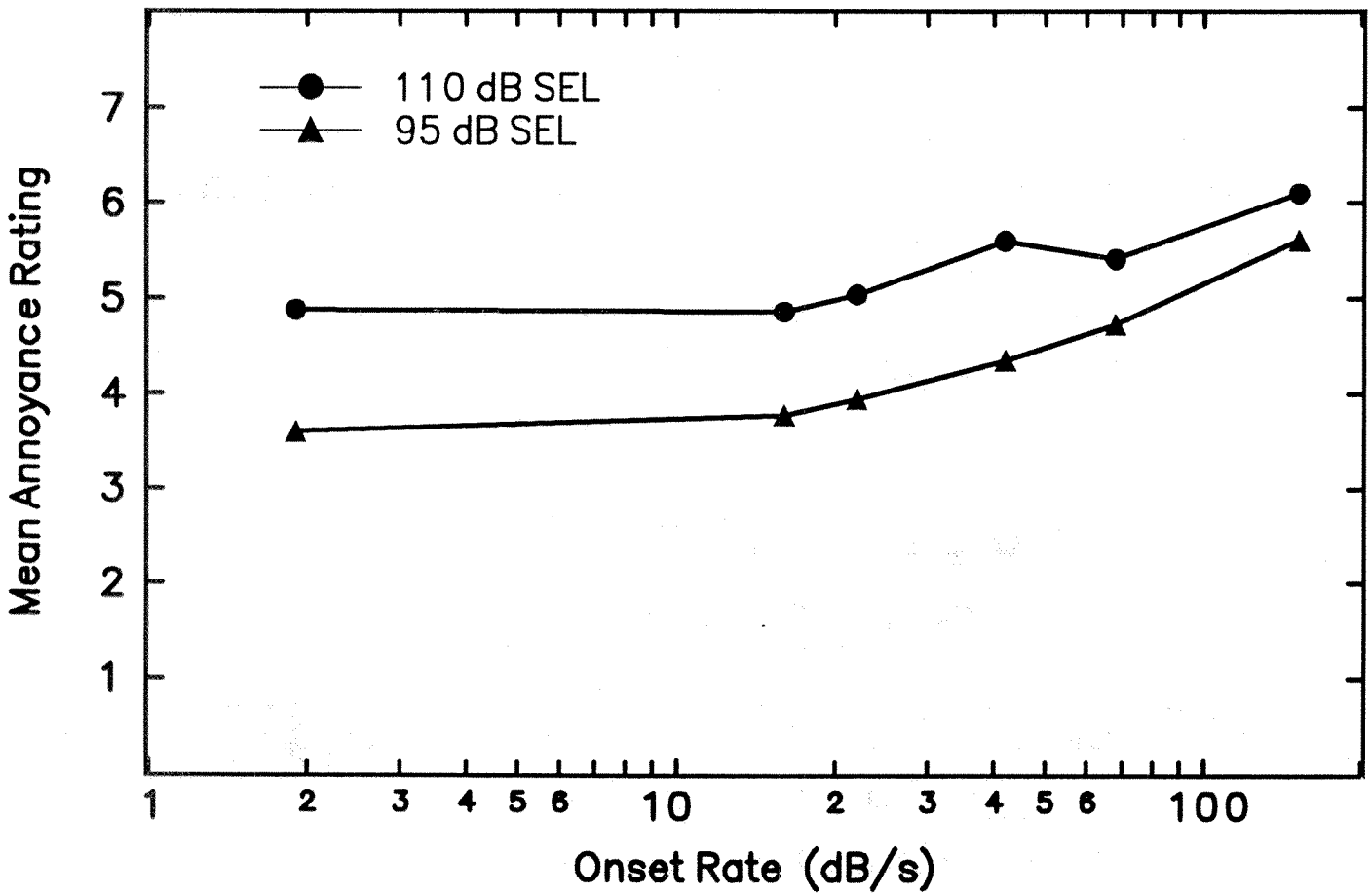
Effect of Onset Rate on Annoyance

Rented Home Study



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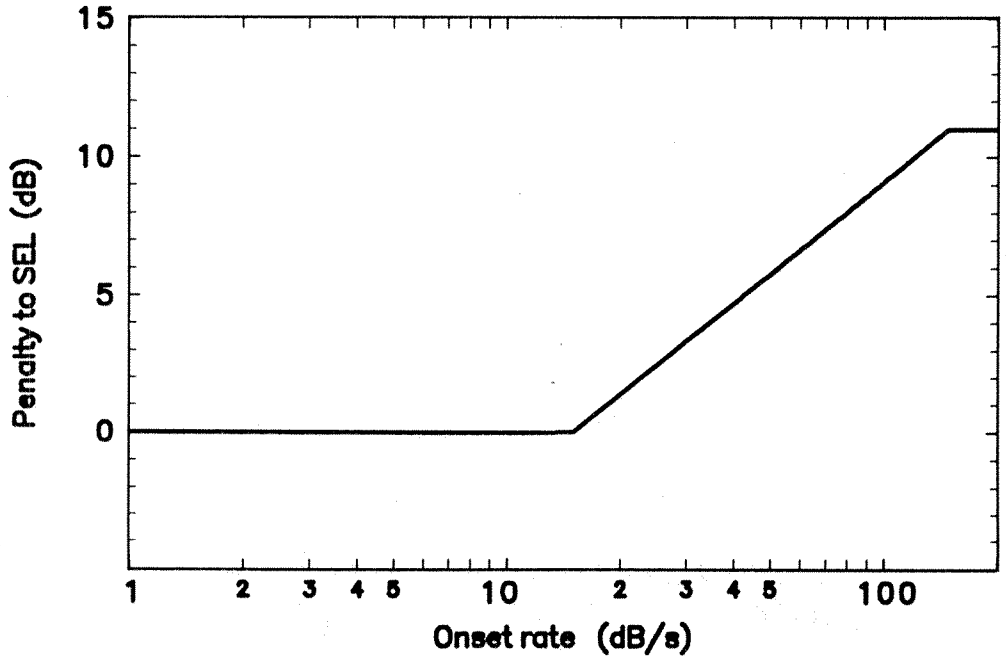
Onset Rate Penalty

New Recommended Penalty

- No onset rate penalty for onset rates <15 dB/s.
- For onset rates between 15 and 150 dB/s penalty equals 11 $\log_{10}$(onset rate)-12.9.
- For onset rates > 150 dB/s penalty is 11 dB.



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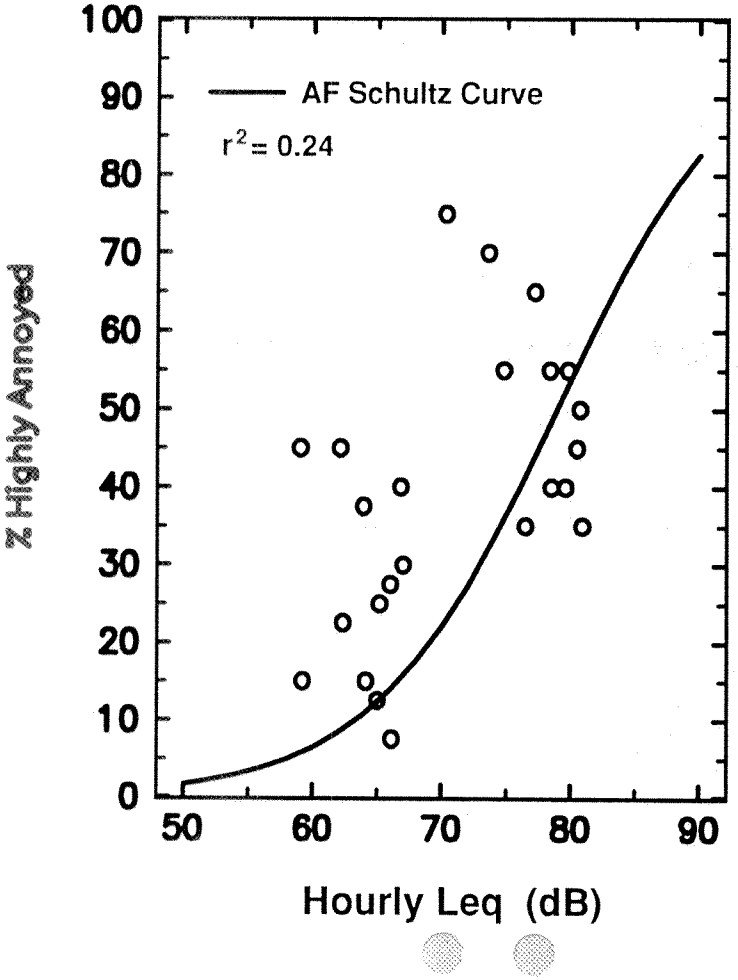
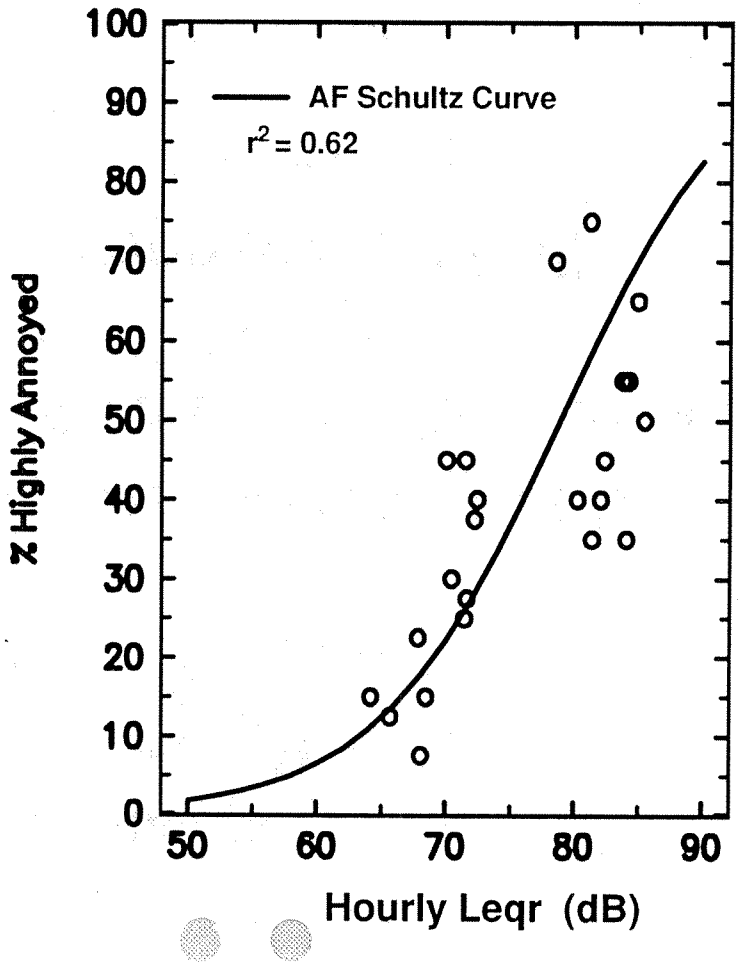
Leq vs Leqr
From WYLE Rented Home Study

Perectage of subjects highly annoyed for one-hour session





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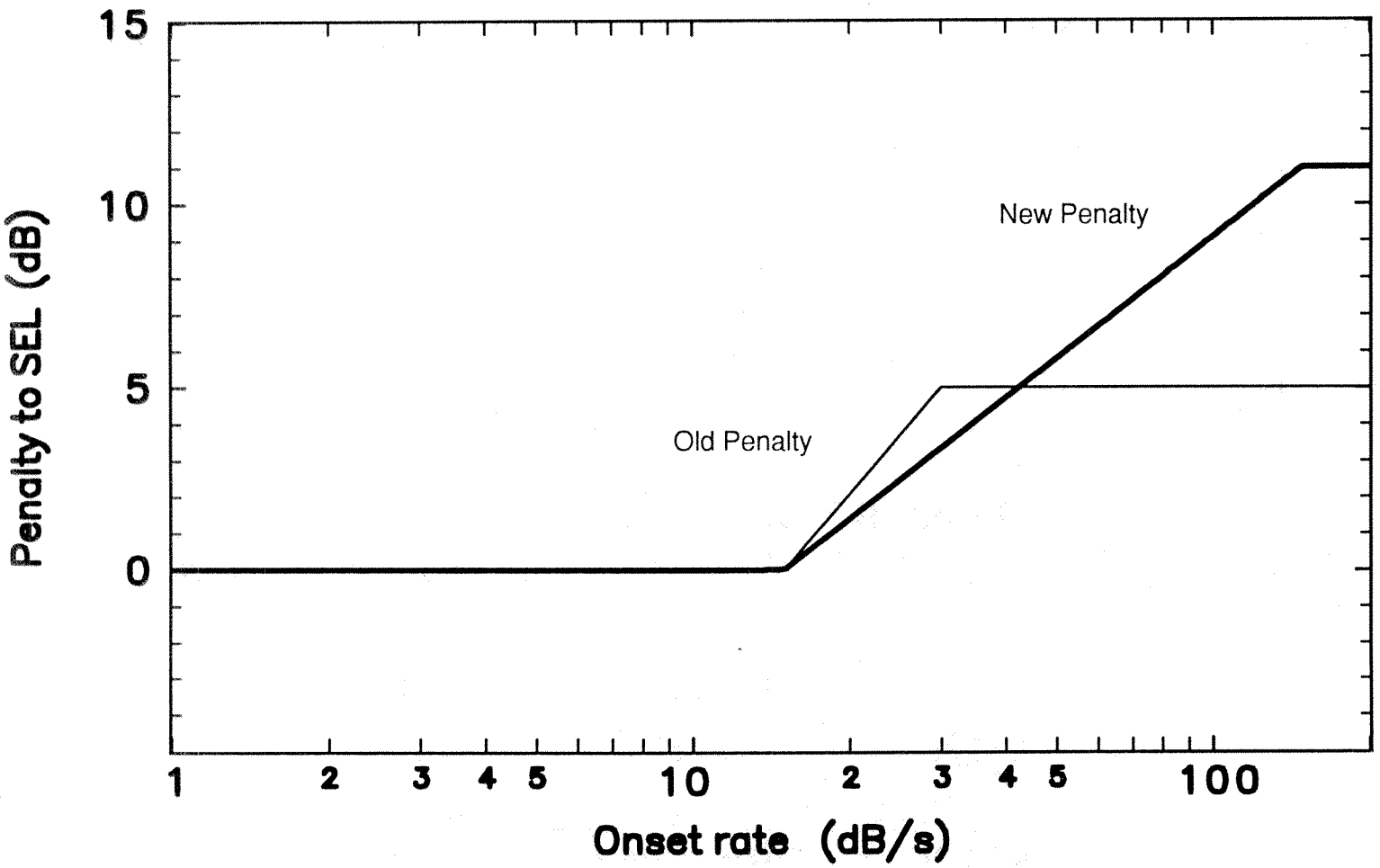
Onset Rate Penalty
Comparision



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Onset Rate Penalty
ROUTEMAP Comparision

F-4C under VR dispersed opertations at Altitude 125 ft,
550 kts, 98% RPM, 2 flights/day