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THE VOLPE CENTER ROLE IN THE DEVELOPMENT OF TRANSPORTATION-RELATED NOISE POLICY AND REGULATIONS: A PRESENTATION OF TWO CASE STUDIES

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INTRODUCTION

For the past three decades, the U.S. Department of Transportation's John A. Volpe National Transportation Systems Center Acoustics Facility (Volpe Center) has been providing noise-related technical support to various government organizations at the Federal and state level, including the Federal Aviation Administration (FAA), the Federal Highway Administration (FHWA), the Federal Railroad Administration (FRA), the National Aeronautics and Space Administration (NASA), the California Department of Transportation (Caltrans), as well as others. The technical support has laid the foundation for many related policy and/or regulatory decisions. Although the Volpe Center is not a policy-setting organization within the Government, one of its chief roles is to provide the necessary technical support to the policy and regulatory decision makers. This paper presents two case studies which demonstrate the Volpe Center's role in augmenting related policy and/or regulatory decisions in the area of transportation-related noise.

CASE STUDY 1: DEVELOPMENT OF APPENDIX J of 14 CFR PART 36

On February 5, 1988 Appendix H of Federal Aviation Regulation (FAR) Part 36, *Noise Standards: Aircraft Type and Airworthiness Certification*, became effective [1]. This Appendix, which is still applicable today provides requirements for the noise certification of light helicopters. These requirements are fairly rigorous, especially for the smaller manufacturers. They include the setup of a three microphone array and a test matrix which includes at least six runs representative of takeoff, approach and level flyover conditions. The requirements also include the measurement of helicopter time-space-position information and detailed meteorological data. In the early 1990s, it was estimated that an Appendix H noise test could range in cost from between $121,000 and $239,000. These figures did not include the often substantial costs associated with instrumentation and personnel training. Consequently, it was concluded, not only by the FAA, but by the International Civil Aviation Authority (ICAO), the international authority responsible for aircraft noise certification, that a simpler, less costly requirement was needed.

During the period July 22 through 26, 1991, the FAA's Office of Environment and Energy (AEE), in conjunction with the Volpe Center's Acoustics Facility, the FAA's Rotorcraft Directorate and associated aircraft certification offices, the U.S. Army Corps of Engineers, and several U.S. helicopter manufacturers, conducted a helicopter noise measurement study at a test site in Champaign, Illinois. The objective of the study was to obtain the field data necessary to examine the feasibility of a simplified helicopter noise certification procedure.

To accomplish the above objective a field data collection system was assembled which effectively provided for the simultaneous acquisition of acoustic data using: (1) an online processing system consisting of a Type 1 integrating sound level meter (SLM); and (2) an offline system consisting of a more complex arrangement built around a digital tape recorder, setup for consistency with the existing FAR Part 36, Appendix H (see Figure 1). Data were collected at the three Appendix H measurement positions, centerline, and 492 ft to the sideline relative to the nominal helicopter flight track. Various configurations (e.g., with and without a muffler) of five light helicopters were tested. The five model helicopters, a Schweizer 300 and 330, an Enstrom 280 FX and TH-28 and a Rotorway Exec 90, were flown in accordance with the procedures outlined in Appendix H. A more extensive description of the study can be found in Reference [2].

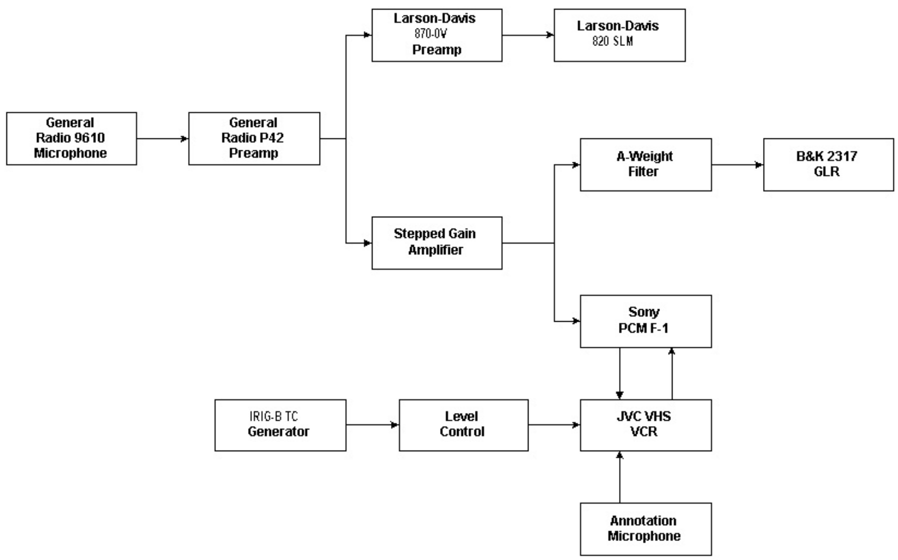

Figure 1. Acoustic Measurement System

The tape recorded data were reduced in accordance with the procedures of Appendix H. In addition to the computation of the effective perceived noise level (EPNL) as required under the Appendix, the sound exposure level (SEL) was also computed to facilitate comparison with the online data measured using the SLMs. It was determined that the online SEL based on the operator-estimated 10 dB down points was 0.4 dBA higher than the tape-derived SEL with an average standard deviation of 0.2 dBA; and the on-line reprocessed SEL (based on the precise 10 dB down points) averaged 0.02 dBA higher than the tape-derived SEL with a standard deviation of 0.2 dBA. Hence it was concluded that simple, less-costly online measurements provided a viable alternative to the more complex Appendix H approach – given that certain prerequisites were met.

On September 11, 1992 Appendix J of 14 CFR Part 36 became effective. Appendix J provides an alternative noise certification procedure for primary, normal, transport, and restricted category helicopters not exceeding 6000 lbs maximum takeoff weight. Appendix J requirements call for the measurement of at least six level flyover runs. These runs can be measured using a single Type 1 integrating SLM. The noise metric required under Appendix J is the SEL which can be obtained directly with an SLM. although some minor adjustments to the field-measured level may be required under Appendix J. Appendix J also provides for substantially relaxed requirements for the measurement of meteorological and time-space-position information. At the time of applicability, FAA estimated the total cost savings to helicopter manufacturers as a result of Appendix J would be $5.43 million over the subsequent 15 years.

CASE STUDY 2: FAA POLICY ON ONE-THIRD OCTAVE-BAND FILTERS USED FOR AIRCRAFT NOISE CERTIFICATION

In March of 1995 the International Electrotechnical Commission (IEC) released IEC 1265, "Electroacoustics, Instruments for measurement of aircraft noise - Performance requirements for systems to measure one-third-octave band sound pressure levels in noise certification of transport-category aeroplanes". The Volpe Center Acoustics Facility was requested by the FAA to evaluate this standard for possible adoption in the appropriate portions of FAR Part 36.

Section 4.6 of the standard states that the one-third octave-band filters used for aircraft noise certification "shall comply at least with the class 2 electrical performance of IEC 1260, over the range..." The class 2 specifications in IEC 1260 allow for the use of a fairly wide range of filter shapes. Although this raised some initial technical concern from the standpoint of consistency in filter shapes the reality was that the vast majority of manufacturers of one-third octave-band analyzers used in noise certification-related analyses have traditionally used filters that are based on a third-order Butterworth design, per American National Standard S1.11-1986, as well as on other standards. This was and is still true of analyzers manufactured by Bruel and Kjaer Instruments, the Hewlett-Packard Company, Quad Tech, Inc. (formally GenRad Instruments), Norwegian Electronics, as well as other manufacturers.

Currently, the author is only aware of one manufacturer, Larson Davis Laboratories, that offers an alternative to the third-order Butterworth design in a *stand-alone*, one-third octave-band analyzer. Certain analyzers manufactured by Larson Davis offer two filter shape options, a so-called "long" filter shape and a "short" filter shape, where the "short" filter is essentially consistent with the Butterworth design and the "long" filter shape attempts to emulate an "ideal" filter, i.e., a filter with infinite attenuation characteristics outside of the passband. Concerns regarding the use of the non-traditional "long" filter setting were further exacerbated by statements in the Larson Davis user's guides for their analyzers which states that "Before the advent of digital filters, many commercially available 1/3 octave analog filters were based on a 6-pole design [third-order Butterworth]. In instances where it is desired that the results of the measurement match as closely as possible the results which would have been obtained using one of these older analog filters, the short filter is recommended".

As a result of the above concerns the Volpe Center Acoustics Facility conducted a study to determine if there was a repeatable bias associated with the Larson Davis "long" filter setting. The study was conducted using analyzers from three major manufacturers, including the Larson Davis Model 2900 with both the "long" and "short" filter setting. These analyzers were used to process acoustic data from various types of aircraft measured under conditions which could be considered typical of certification. The aircraft included two commercial jets (a modern jet with high-by-pass-ratio engines [HBPR] and a McDonnell Douglas MD80), two general aviation, propeller driven aircraft (DeHavilland DHC-6 and Cessna 182RG) and two helicopters (McDonnel Douglas MD902 Explorer and Sikorsky S76B). Various noise descriptors were computed, but the primary descriptor of interest was EPNL since it is required for transport-category noise certification and helicopter noise certification under FAR Part 36, Appendix H. Figure 2 summarizes the results. It displays the difference in slow-scale averaged (required under FAR Part 36) EPNL values (six run average values) as a function of the six aircraft types tested. All data are referenced to the Larson Davis "long" filter, i.e., the difference represents the EPNL value computed for each analyzer minus that computed using the same input data set for the Larson Davis "long" filter (a negative difference means a larger EPNL value was obtained with the "long" filter). As can be seen there is a consistent negative bias associated with the Larson Davis "long" filter. On average it is about 0.2 to 0.3 dB. Consequently, it was concluded that in many instances the Larson Davis "long" filter would likely result in different certified noise level as compared with the more traditional Butterworth filter.

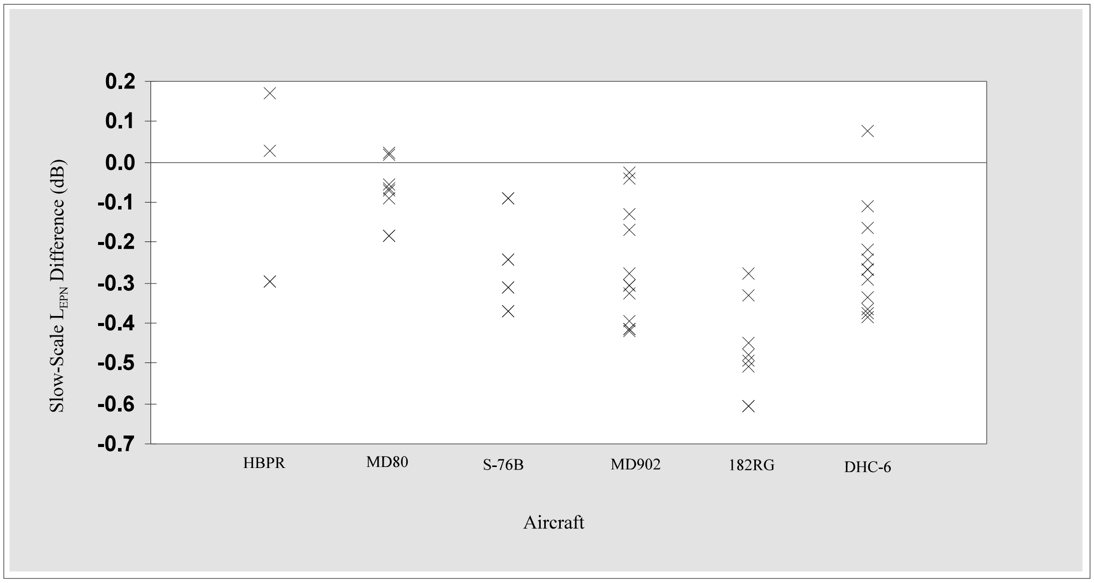

Figure 2. Difference in Slow-Scale EPNL, Re: "Long" Filter

In a policy memorandum dated March 10, 1997 the FAA, while not precluding the use of the "long" filter stated that any applicant proposing to use a "non" third-order Butterworth filter design for the purpose of aircraft noise certification must demonstrate that its use will not result in a different certificated level as compared with data processed using the traditional Butterworth design. This policy was established as part of FAA's mission to promote uniformity of implementation of the noise certification requirements of FAR Part 36, a role in which the Volpe Center Acoustics Facility provides substantial technical support.

CONCLUSIONS

Acting as a technical long-arm to its many and varied government sponsors, the Volpe Center Acoustics Facility has provided the technical data necessary to support important transportation-related noise policy and regulatory decision over the past three decades. It is anticipated that the Center will maintain this important level of support for years to come.

ACKNOWLEDGMENTS

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