

July 27, 2011

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Washington, DC 20460

Mr. Owen Sanford
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Sent via E-Mail: radulovic.verena@epa.gov; osanford@icfi.com; tbolioli@terranovum.com; audiovideo@energystar.gov

Re: Draft 1 Version 3.0 ENERGY STAR Audio/Video Specification

Dear Ms. Radulovic and Messrs. Sanford and Bolioli:

Bose Corporation is a U.S.-based engineering, manufacturing, and retail distributor of electronics and audio equipment with approximately 3,400 employees in operations in Framingham and Stow, Massachusetts; Columbia, South Carolina; and Yuma, Arizona. Bose Corporation is also a member of the Consumer Electronics Association ("CEA"), which may be submitting comments on this same matter.

Bose appreciates this opportunity to provide its comments on the Draft 1 Version 3.0 ENERGY STAR Audio/Video Specification that was released on June 24, 2011 ("Draft 1").

The Proposed Draft 1 Proposed Test Method Does Not Reflect Real-World Operating Conditions and, therefore, Overestimates Amplifier Power Consumption and Misdirects Energy Efficient Product Designs

The following comments were developed based upon a technical review of the Draft 1 specification and an analysis of Bose Corporation product usage data. The technical analysis was conducted by Mr. Rob Parker, Bose Fellow and Chief Engineer of the Home Entertainment Division of the Bose Corporation.

Bose Corporation understands that Draft 1 is being developed to highlight, reward and provide marketing advantage to covered amplifiers that consume less power from the electrical power grid than other similarly positioned amplifiers that are sold in the marketplace. Unfortunately, the currently proposed test method set forth in Draft 1 has little correlation to the true operating conditions of amplifiers when used in the home setting. Therefore, unless the test procedure is modified, ENERGY STAR Version 3.0 will fail to be a good predictor of relative power consumed from the electric utility grid from the use of covered amplifiers and it will not influence designers to make the best choices relating to reduced real power consumption. A simplification of the test methodology (described herein) could fix these deficiencies.



Section 3.7 of Draft 1 details Amplifier Efficiency Requirements. It specifies an arbitrary output power level (1/8th power) relative to an arbitrary reference (MUP), based upon an arbitrary signal (1 kHz sine wave). These choices facilitate easy measurement, but none of these choices reflect how consumers use audio amplifiers under real-world conditions.

One significant discrepancy between how people use audio systems under real-world conditions and the Draft 1 test method is the following:

Users of audio equipment adjust the volume control to the sound pressure level that is appropriate for the situation (background music, watching news on TV, watching a home theater DVD), with no regard to what fraction of the amplifier's power they are using. For example, if a person were listening to the evening news one night with a 40 watt amplifier, and by the next night, they installed a 200 watt amplifier; the person would adjust the volume to the same loudness, thus not changing the amount of audio power delivered to the speaker.

By contrast, the Draft 1 test method implies that the person using the two amplifiers would consume 5 watts the first night (with 40 watt amplifier), and 25 watts the second night (with 200 watt amplifier), thus playing the news 14 dB louder on the second night. Thus, **measuring at a fixed percentage of MUP is not consistent with customer behavior and overestimates the amount of power consumed by amplifier products under real-world operating conditions.**

Another significant discrepancy between how people use audio systems under real-world conditions and the Draft 1 test method is that the power level chosen (1/8th of MUP) is much louder than the level at which most amplifiers typically operate. This is supported by a study that Bose Corporation conducted to determine how consumers use Bose products.

In order for Bose to understand how customers use its products, one popular product type was analyzed for the following parameters: hours plugged in, hours on, and hours in each volume control range. When any unit of that chosen product type was returned for service, data was captured and analyzed. This data set represents approximately 3 million hours of Bose products being plugged into the AC power grid, and approximately 370,000 hours of being tracked in the "on" power state.

For each volume control range, the average audio power to the speakers has been measured using music which was specifically selected to have near-mean audio demands (voice and movie material exhibit lower average audio power demand than music). By weighting the average audio power delivered to the loudspeaker in each volume range by the fraction of time that each volume range was used, Bose learned that the average speaker power consumed when the unit was playing was less than ½ watt! The detailed data is shown in the Table below. Since most audio amplifiers exhibit MUP significantly greater than 4 watts, we can say with confidence that **typical listening is done at power levels significantly less than 1/8th power.** Thus, **measuring at 1/8th power is not consistent with customer behavior and overestimates the amount of power consumed by amplifier products under real-world operating conditions.**

**BOSE CORPORATION:
VOLUME VERSUS TIME USAGE MODEL DATA**

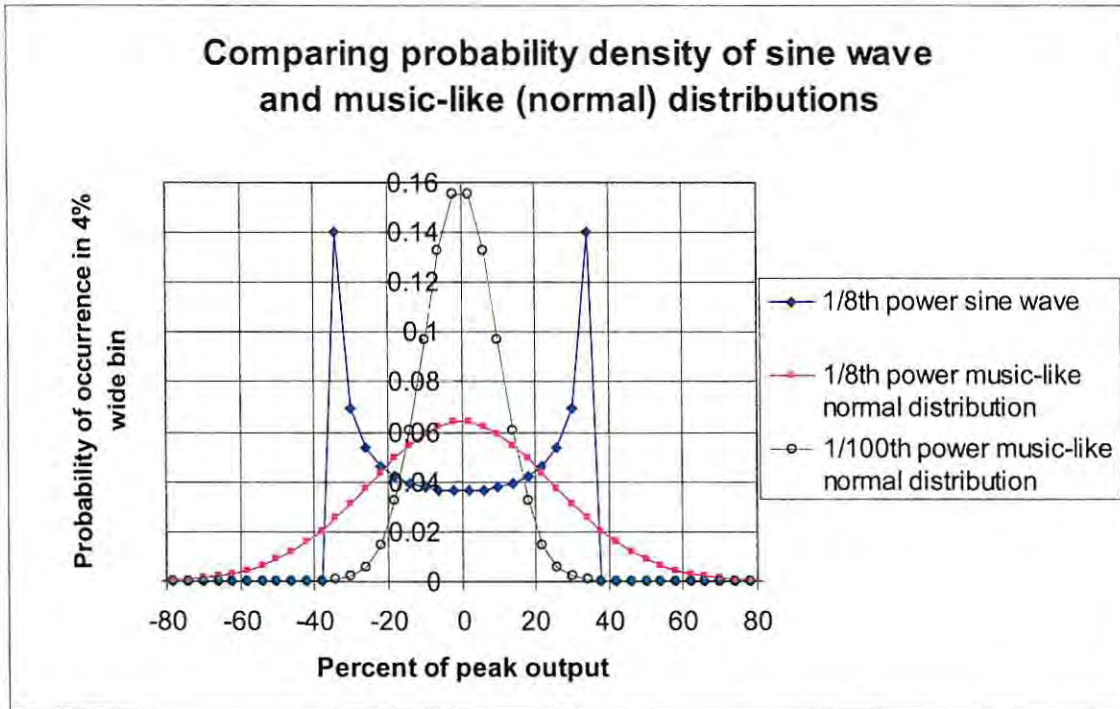
Volume range	Interpolated audio power, watts	% of on-time (smoothed)	watts x % time
0 - 5	0.0001	1.0	0.0001
6 - 10	0.001	2.3	0.003
11 - 15	0.002	3.6	0.01
16 - 20	0.005	5.0	0.03

21 - 25	0.010	7.1	0.07
26 - 30	0.017	10.1	0.17
31 - 35	0.036	13.5	0.49
36 - 40	0.058	15.4	0.90
41 - 45	0.131	13.0	1.71
46 - 50	0.265	9.7	2.57
51 - 55	0.490	6.4	3.14
56 - 60	0.993	4.3	4.27
61 - 65	1.57	3.0	4.70
66 - 70	2.61	1.9	4.96
71 - 75	3.79	1.3	4.92
76 - 80	5.22	0.9	4.43
81 - 85	6.32	0.8	4.74
86 - 90	7.43	0.5	3.71
91 - 95	7.54	0.2	1.51
96 - 100	7.66	0.1	0.77

Average audio power when active (watts)

0.43

Bose contends that there are additional discrepancies related to the Draft 1 test method. One of these is the use of sine waves. Sine waves are convenient signals because sine wave generators are readily available and specified signals can be consistently produced. Unfortunately, single tone sine waves bear no resemblance to real audio signals. A sine wave spends little time near zero, instead spending most of its time near the peaks of the waveform. Real music, however, spends more time near zero than any other value, having a probability density function which resembles a normal distribution. The graph below compares the probability density function of $1/8^{\text{th}}$ power sine wave and normally distributed signals at two power levels. Since the measured efficiency is the average of the time weighted instantaneous efficiency, **$1/8^{\text{th}}$ MUP sine wave efficiency puts a very high weighting on the instantaneous efficiency at approximately 35% of peak output voltage, a value at which real program material spends a negligible amount of time.** The proposed test method, therefore, would encourage manufacturers to focus on the promotion of efficiency near this value, as can be done in a certain class of amplifier (Class G), with little regard to the power consumed by these products when the output is near zero, a far more likely case during normal operating conditions.



For measuring $1/8^{\text{th}}$ MUP, speakers are replaced by resistors. There is little resemblance between a fixed resistor and a speaker's impedance versus frequency. The magnitude of speaker impedance can vary wildly ($\sim 8:1$) with respect to frequency. The impedance can be dominated by resistance, or dominated by non-energy consuming reactance. The highest efficiency speakers are more reactive, which reduces power consumption in certain amplifier types and increases power consumption in other amplifier types. **Using resistors as speaker loads during the test fails to drive the design community to choose the most efficient amplifier for the speaker.**

For those audio systems that include loudspeakers as an integral part of the system, the actual output of the system is sound pressure, not watts. A more correct measurement of system efficiency should include the conversion of electrical watts to sound pressure, since the transducer efficiency varies widely, depending on a long list of speaker design elements. Unfortunately, the proposed test method's measurement of efficiency, which includes the acoustic elements of the system, is encumbered with numerous practical difficulties. As the Draft 1 test method is written, there is no consideration given to the efficiency of the loudspeaker. **This brings into question the method of specifying efficiency as an electrical-only measurement.** We don't advocate including the transducer's efficiency as a part of the test method, rather we raise the issue as another indication of the limitation of the proposed test method.

Bose Corporation contends that the above-referenced points provide a compelling case that the proposed Draft 1 test method of measuring and specifying efficiency, while convenient, does not correlate with the actual power consumed from the electric utility grid by audio amplifiers, **nor does it compel designers to make design decisions that minimize power consumed.** Both are flaws that must be addressed in order to provide a valid and accurate and technically defensible energy consumption test method for amplifier products.

As an alternative method, Bose recommends that the ENERGY STAR A/V Specification test method should **adopt idle power** as the measured and specified attribute **that represents the product in use, while playing audio.** The actual use case of audio amplifiers in homes is quite



close to idle power based upon Bose data set that illustrates how customers actually use audio products. Although customers play systems loudly from time to time, necessitating high power amplifiers, most listening is done at levels which are not loud. It is worth restating that the Bose data demonstrates that the estimate of typical audio power at 0.43 watts was based upon music, which implies that TV or radio voice at the same peak loudness would use even less power. **Idle power with zero audio output power is a much closer approximation to the typical use case of home audio systems than 1/8th MUP (as proposed in the proposed Draft 1 test method).**

Section 3.6.2 of Draft 1 sets forth proposed Idle State Requirements. The Section appears to reward products that enter Auto Power Down (“APD”) under 30 minutes and that cannot be disabled since such products are excluded from the Draft 1 proposed idle state requirements. If Energy Star were to adopt the recommendation that idle power be adopted to represent the energy consumption of audio products during use, EPA would be required to remove Section 3.6.2, which would otherwise be a loophole allowing an amplifier with high idle power to meet the ENERGY STAR specification.

Please note that the Bose data set does not represent the typical energy consumption behavior exhibited by professional audio amplifiers that provide power to stadiums, theaters, nightclubs, etc. If, in the opinion of Energy Star, these amplifiers collectively result in power consumption worthy of attention, it may be that Section 3.7 of Draft 1 has some applicability to that class of amplifier.

Bose is committed to producing innovative audio products that delight our customers and that are designed on a foundation of a thorough understanding of the technologies and the customers. We encourage the authors of Version 3.0 ENERGY STAR A/V Specification to give strong consideration to the comments and data provided by Bose. Bose urges the US EPA to address the shortcomings that are contained in the Draft 1 Version 3.0 ENERGY STAR A/V Specification in order to avoid adopting a standard which is not representative of the true power consumed from the electric power grid by amplifier products during real-world operating conditions. The proposed test method overestimates the power consumption of amplifiers and, therefore, will direct product designers to make design choices that will not correlate well with the actual energy consumption of covered devices.

The Proposed Draft 1 Version 3.0 Energy Star A/V Specification Requires Auto Power Down After a Period of Time that Will Encourage the Disablement of APD for Audio Equipment

Draft 1 contains a provision that will require ENERGY STAR A/V products to automatically power down (“APD”) into Sleep Mode when not in active use after two hours or less. Draft 1 proposes that APD timing begins when one of the following criteria have been met: (1) the device has ceased performance of all primary functions, or (2) the last user input has been received (e.g., remote control signal, volume adjustment).

Bose contends that the proposed time frame for APD is too short in the case of audio devices, particularly audio devices that are often listened to in passive mode. Passive listening occurs when a user listens to the radio or a repeating CD changer or similar product for an indeterminate period of time – often using the audio as background sound when performing other activities. Examples include background music where the controls are set and are not changed by the user for many hours. Under the proposed draft, the lack of user input over that period of time will trigger APD, which is proposed as two hours or less.

Bose objects to the proposed two hours or less APD time frame because two hours is insufficient for audio equipment, which is often used in passive listening mode. A two hour APD timeframe will result in consumer dissatisfaction and encourage consumers to turn off the APD function for most audio equipment. The European Union is suggesting a 4 hour APD time frame in its energy



related product regulation. Bose is urging a 16-hour time frame for APD because this time frame represents a typical day of passive listening. At the end of 16 hours, one can be fairly certain that the unit may have been left on mistakenly, which should trigger APD requirements. Although a time frame of user inactivity may be suitable for video products, loss of signal is a better way to trigger auto power down requirement for audio equipment which are often used for long periods of time without any user interaction.

The Proposed Draft 1 Version 3.0 Energy Star A/V Specification Fails to Recognize the Energy Consumption of Product Functionality that is Associated with Displays

Although the Draft 1 specification allows additional power for displays, the proposed specification does not take into account product functionality that supports displays. For example, although a simple LED indicator light does not draw a lot of power, additional power may be needed to power electronics that must operate to support the indicator lights, such as monitoring operating conditions and conveying information to users using an LED indicator (e.g., changing the indicator light color to indicate that a charge cycle is complete or that audio has ended and the unit is in standby, etc.) The power consumption of the display should not be limited to the display itself but it should also consider the underlying functionality that supports the display, which may vary from product to product. Bose encourages EPA to take these additional functions into account when setting display limits.

The Proposed Draft 1 Version 3.0 Energy Star A/V Specification Would Require that ENERGY STAR Products Meet Certain Non-Energy Related Environmental Characteristics, which are outside the scope of the ENERGY STAR Program

In Draft 1, the U.S. EPA is proposing that ENERGY STAR qualified Audio/Video products be free of certain toxic materials, including lead and mercury. EPA seeks additional feedback from stakeholders on whether any existing standards that address recycled content in and/or design for recyclability of products could apply to Audio/Video products.

Bose Corporation opposes the inclusion of non-Energy related environmental requirements in the Version 3.0 ENERGY STAR A/V Specification. ENERGY STAR is an energy efficiency program and the inclusion of other environmental characteristics is outside the program's scope. There are other programs that address broader environmental issues, such as the Electronic Product Environmental Assessment Tool, and ENERGY STAR should remain solely focused on energy efficiency – an area in which its staff possesses unique expertise.

Bose Corporation opposes the proposed inclusion of non-energy related environmental requirements in the Version 3.0 ENERGY STAR A/V Specification because there has been no scientific assessment as to the impact of recycled content and/or design of recyclability on the functionality, performance, and safety of A/V products. Until such scientific assessment has been done, such issues should not be included in any regulatory or non-regulatory program, including ENERGY STAR. For example, Bose products contain plastic enclosures that are required to meet specific flame retardant specifications through the use of flame-rated materials. It is unclear whether these requirements can be met with alternative substances. Further, Bose Corporation specifies no regrind on many of our plastic parts, and UL does not allow more than 25% regrind under the plastic molders program. It is unclear how the proposed environmental requirements would impact these specific A/V requirements.

In closing, Bose urges the U.S. Environmental Protection Agency to develop a Version 3.0 ENERGY STAR A/V Specification that is based on real-world operating conditions. Specifically, Bose Corporation urges the EPA to: (1) adopt idle power as the measured and specified attribute that most closely represents the product in use for home audio products; (2) increase the APD timeframe to address the passive listening usage requirements of audio products; (3) allow extra power budget for displays to address both display power needs and additional functionality that is



linked to the display; and (4) eliminate the proposed addition of non-energy, environmental requirements to the Version 3.0 ENERGY STAR AV Specification.

Thank you for your consideration of these comments. Please let us know if you have any further questions.

Sincerely,
BOSE CORPORATION

A handwritten signature in cursive script that reads "Kathryn A. Jackson".

Kathryn A. Jackson
Associate General Counsel &
Assistant Secretary