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Opportunities for international liaison: Acoustical standards in the new millennium

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ABSTRACT

The global economy of the new millennium presents both challenges and opportunities to manufacturers, consultants, researchers, and regulatory bodies when dealing with noise and vibration issues. Safety, interoperability, uniformity of data exchange, and quality assurance are no longer bound by national borders. Selected standards for acoustics, noise and vibration are examined from the perspective of international liaison opportunities. The processes for national adoption, international adoption, harmonization, as well as parallel standards that differ are discussed. The benefits and drawbacks of each liaison approach are examined as they apply in each case. A brief overview of the relationship between ASA and ANSI and international standards bodies is also presented.

Keywords: standards, ANSI, ISO, IEC, acoustics, noise
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1. INTRODUCTION

Standards are developed primarily to simplify product development, reduce unnecessary duplication, lower costs, increase productivity, promote safety, and permit interchangeability, compatibility, and interoperability. Standards help to advance scientific discovery and protect key environmental resources. Standards also offer benefits to all segments of business, industry, government, and consumers.

The development of a standard can be a lengthy process. To develop a useful, well written standard involves time and resources, and in most cases the working group members are volunteers. Furthermore, the consensus process followed by most Standards Developing Organizations (SDOs) requires oversight and accreditation. The costs, while often hidden, are not inconsequential. Therefore, it is always important to first examine the need and market for a standard. Likewise, similar to a research project, it is also worthwhile to determine if work already done in that area may be referenced, adopted or harmonized in some way. The various approaches to international liaison are illustrated by way of example. Although the examples given are from the U.S., the issues and options are likely to be similar in other countries. It may be the case that the user of a standard wonders how that particular method or measure came to be. The actual process often turns out to be surprisingly non-linear…

2. U.S. nationally adopted international standards

Standards in the United States, like most countries, may be new development projects, revisions, reaffirmations, or adoptions of existing standards. These are then submitted for approval as a National Standard. The SDO for acoustical, bioacoustical, vibration and shock, and noise standards is the Acoustical Society of America (ASA). An overview of the ASA Standards program and its relationship to corresponding ISO and IEC groups is shown in Figure 1. Because of the increasingly global marketplace, international standards are often considered for adoption. In the U.S., if adopted, these standards are designated as a Nationally Adopted International Standard (NAIS) [1].

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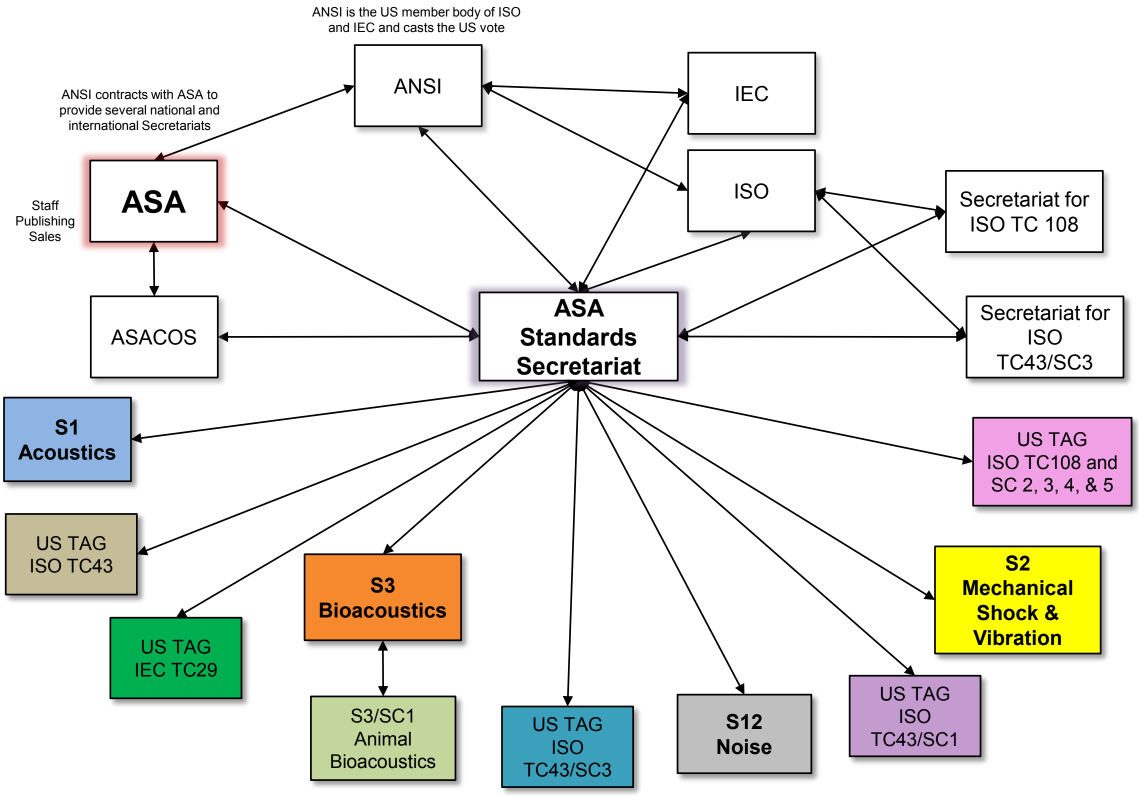

Figure 1 – The ASA Standards Program.

The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) have forged an international agreement on this process which is spelled out in ISO/IEC Guide 21-1 [2]. For the U.S., the American National Standards Institute (ANSI) describes this process in its ANSI International Procedures [3]. In addition, the Technical Advisory Groups (TAGs) have U.S. TAG procedures [4], [5] which are required to align with ANSI's International Procedures. Lastly, the ANSI-Accredited Standards Committees (S-Committees) – the consensus bodies actually doing the national adoption – have procedures related to national adoptions [6].

Generally speaking, the TAG has right of first refusal to adopt any standards developed by their committees. The main criterion is that the TAG has voted yes on the final ballot. Certain elements can be modified or added to the document. The S-Committees typically have a large overlap of membership with the TAG (> 90%). Therefore, if the TAG finds the ISO or IEC document favourable, the U.S. is generally prepared to adopt. In this case, the expedited method of national adoption may be used, which specifically says comments are not sought and will not be resolved. However, any comment, no matter how minor, triggers a 30-day review. In the U.S., our experience is that often comments are received, and although we had set out to expedite the adoption without resolving comments, this input is relevant and worthy of a proper resolution. This unfortunately negates the expediting and re-starts the process for a standard ballot, open to everyone for new comments [4], [5]. A few NAIS examples follow.

2.1 Sound level meters

Slightly different versions of the ANSI and IEC sound level meter standards have existed for decades. This was often referred to by users and manufacturers as 'The Atlantic Divide'. Manufacturers wishing to sell devices worldwide were required to design their products to fulfil both standards. Finally, after much discussion and debate, differences were resolved and the IEC standard was nationally adopted in the U.S. in 2015 as ANSI/ASA S1.4/IEC 61672 Electroacoustics – Sound Level Meters, Parts 1, 2, and 3. While all three parts were nationally adopted in their entirety (identical national adoption) an informative annex was added to Part 1 to provide information for U.S. users regarding the difference between the low-frequency tolerances in the new standard compared to earlier editions of ANSI S1.4.

2.2 Hearing damage risk criteria

ANSI/ASA S3.44-2016/Part 1 / ISO 1999:2013 (MOD) Acoustics – Estimation of Noise-induced Hearing Loss – Part 1: Method for Calculating Expected Noise-induced Permanent Threshold Shift is a modified (MOD) adoption, which includes corrections to errors discovered in the data tables during a review of the document as well as an additional clause for calculation using an alternative exchange rate. Ironically, the previous version of ISO 1999 was based on the previous version of ANSI/ASA S3.44. However, ISO 1999 was substantially revised before the U.S. standard was updated via this national adoption. So, occasionally, timing is everything!

2.3 Acoustic couplers

ANSI S3.7-1995 – Method for Coupler Calibration of Earphones, in addition to describing coupler calibration methods, contained detailed information about the audiometric ear, the 6cc coupler, and the 2cc coupler. Since that time, IEC 60318 was reorganized into several parts, which now include the same information about the aforementioned couplers (IEC 60318, Parts 1, 3, and 5, respectively). Given that the manufacture of these couplers has changed little if at all in more than 25 years, the fact that the IEC and ANSI/ASA specifications for these couplers are essentially identical, and the fact that manufacturers of these couplers do not produce different versions of the devices to meet alternative versions of the standards, national adoption of the IEC standards was deemed appropriate. The corresponding IEC documents were nationally adopted as ANSI/ASA S3.55, Parts 1 and 3 in 2014. Part 5, the 2cc coupler, was a modified (MOD) adoption in 2015, and included additional information. ANSI/ASA S3.7 itself was revised in 2016 and now references the nationally adopted S3.55 series as does the latest revision of ANSI/ASA S3.22 – Specification of Hearing Aid Characteristics.

A current list of ANSI/ASA NAIS Standards appears in the Appendix.

3. International adoptions of U.S. standards

A participating member (P-member) may submit a proposal for the initiation of new work items for the development of international standards. In the U.S., this must be approved by the appropriate TAG. A proposal may be based on an American National Standard (ANS) standard or a standard under development. In all instances, permission from the sponsor to propose documents as the basis for the initiation of international standards must be obtained. The U.S., as a P-member of a concerned ISO committee, may submit a nationally accepted standard using the fast-track procedure approved by the ISO and IEC, if the proposed standard has the approval of both the originating organization and appropriate U.S. TAG [2], [4].

3.1 Mechanical mobility transducers and excitation

For example, ISO 7626-1:1986 and ISO 7626-2:1990 were international adoptions of ANSI/ASA S2.31-1979 (R 2014) – Methods for the Experimental Determination of Mechanical Mobility, Part 1: Basic Definitions and Transducers and ANSI/ASA S2.32-1982 (R 2014) – Methods for the Experimental Determination of Mechanical Mobility, Part 2: Measurements Using Single-Point Translational Excitation, respectively. The ISO versions have small editorial differences to the U.S. counterparts and were updated in 2011 and 2015. The ANSI/ASA versions have not yet been revised. This effort was facilitated by the fact that the same person was chair of both the U.S. (S2) and ISO (TC 108) working group.

One downside of national adoption in the U.S. is that royalty fees are due to ANSI. This occasionally limits flexibility in distribution – for example the ability to make copies available for free to ASA members or to students.

4. Harmonization between U.S. and international standards

In some cases, parallel standards with similar or even identical requirements are maintained. For various reasons, harmonization may be the best option.

4.1 Information technology and telecom equipment noise

In the U.S., Parts 1 and 2 of ANSI/ASA S12.10 – Measurement of Airborne Noise Emitted by Information Technology and Telecommunications Equipment Parts 1 and 2 are regularly revised. These standards are harmonized with standards produced by ECMA International (formerly the European Computer Manufacturers' Association), which are also internationally adopted by ISO.

However, the U.S., ISO, and ECMA standards are rarely on the same revision cycle, and therefore one or the other may contain more recent updates. The current edition of ANSI/ASA S12.10 Part 1 is a modified adoption of the 10th edition of ECMA-74, which later became the basis for the revision of ISO 7779: 2010. The cost structure made it preferable to adopt the ECMA standard rather than the ISO standard. However, recent changes to ECMA's copyright policy may prevent its documents from being adopted by either ASA or ISO if they preclude the resolution of comments, which is required for ANSI compliance. Eventually, improved procedures may enable these issues to be overcome in the future.

4.2 Hearing aids

Over the past 15 years, the ANSI/ASA S3.22 – Specification of Hearing Aid Characteristics standard has been substantially harmonized with its international counterpart IEC 60118-7. This was facilitated by communication and cooperation between the chairs of the respective committees, as well as the overlap in membership in both working groups. Manufacturers are now able to run a single suite of tests that fulfil both QC standards. As is the case in most countries, hearing instruments are dispensed and regulated products. Therefore, a national standard is generally required in order to be referenced in the legislative code. The U.S. Food and Drug Administration references ANSI/ASA S3.22 in the Federal Register (Title 21, Part 801.420).

4.3 Occluded ear simulator

The ANSI/ASA S3.25 and IEC 60318-4 Occluded Ear Simulator standards had previously specified entirely different devices: The Zwislocki coupler in the case of ANSI, and the axially symmetric design of Brüel & Rasmussen, in the case of IEC. Although functionally similar, these devices provided acoustic impedance loads that differed by 1.2 dB at 1.25 kHz and by 2.8 dB at 10 kHz. Since both were widely deployed for decades, in the revision of ANSI/ASA S3.25 in 2009 it was decided to incorporate separate clauses specifying both embodiments. Since that time, production of the Zwislocki coupler has ceased. However, having both embodiments compliant with the ANSI/ASA standard enables a smooth transition period to a point sometime in the future when Zwislocki devices are largely replaced and the IEC standard is likely to be nationally adopted.

5. International standards used in the U.S. without adoption

In some cases, national adoption of an international standard is simply not feasible and the development of a parallel standard may not be worth the effort, as in the next two examples.

5.1 Balancing

For decades, the U.S. S2 Committee (Vibration & Shock) maintained balancing standards that were similar to their ISO counterparts, but not identical. But over time the U.S. appetite to maintain two separate documents waned. The ISO documents were regularly maintained but not the ANSI. For example, ANSI S2.19-1999 Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Residual Unbalance, Including Marine Applications, was withdrawn in 2011 because the ISO standards were more up to date and more widely used. National adoption was considered but there was no evidence that there would be a market for this standard.

5.2 Laboratory and working standard microphones

Another interesting ongoing case is the IEC 61094 series of measurement microphone standards. This entire IEC series has recently been updated and the U.S. delegation has actively participated in the revision work in IEC TC 29. IEC 61094-1 – Laboratory Standard Microphones and IEC 61094-2 – Electroacoustics – Measurement Microphones – Part 2: Primary Method For Pressure Calibration Of Laboratory Standard Microphones By The Reciprocity Technique have their U.S. counterparts in ANSI/ASA S1.15 Parts 1 and 2, respectively. These documents are partially harmonized. The status of any possible national adoption of the corresponding IEC standards is unknown at this time. The other standards in the IEC series related to working standard microphones do not have U.S. counterparts. The idea of national adoption for these was proposed; however, the demand for NAIS versions of these standards likely does not justify this action since the few customers in the U.S. requiring these standards can simply acquire the IEC standards directly.

6. U.S. standards that differ from their international counterparts

Lastly, it may be the case that competing methods or specifications are developed independently. Adoption of one method potentially obsoleting the other may be undesirable, particularly if backward compatibility is required. Likewise, harmonization typically only occurs over long periods, during which time multiple standards may co-exist. Several recent examples follow.

6.1 Loudness computation

The ANSI/ASA S3.4-2007 – Procedure for the Computation of Loudness of Steady Sounds uses the algorithm of Moore, Glasberg, and Baer. ISO 532: 1975 – Acoustics – Method for calculating loudness level, Part B uses the method of Zwicker. Not surprisingly, the different methods produce different results for same 1/3 octave input spectrum, particularly at low frequencies. In 2011, the U.S. TAG proposed the American National Standard for international adoption, setting off a great flurry of concern about the potential for disruption caused by this change. In an attempt to calm the uproar, it was finally agreed to develop two ISO standards: ISO 532-1 to encompass the updated Zwicker method and ISO 532-2 to cover the Moore, Glasberg, and Baer method. Work has continued for several years now and voting is currently underway at the Draft International Standard (DIS) stage for both parts. Along the way the working group also agreed to commence work on a third part after the first two are published. The current proposal for ISO 532-3 is to use the recent work of Moore and Glasberg to calculate the loudness of time varying sounds.

6.2 Acoustic test manikins

The ANSI/ASA S3.36-2012 and the IEC 60318-7 acoustic manikin standards are functionally similar, but differ in the details of their specification and verification methods. The IEC standard is for a manikin for measurements of air conduction hearing aids, while the ANSI standard does not have this restriction. The IEC standard is currently under revision and the U.S. delegation is active in this process. Ironically, first edition of the IEC manikin standard, IEC 60959, was an international adoption (albeit as a provisional guideline) of the initial version of the ANSI S3.36 standard, which came out first in 1985. The commercial acoustic test manikins currently available on the market all incorporate the IEC 60318-4 ear simulator and all possess similar median adult human dimensions. However, only one of these is typically used in the hearing industry, and its basic performance specifications have remained virtually unchanged since it was first released in the late 1970s.

7. CONCLUSION

As shown, international liaison with respect to standards can take many different forms. Since standards development work is ongoing, the examples given here form a necessarily incomplete list. Details of individual cases are the focus of the particular working group assigned to each project and are necessarily subject to change. It is therefore inevitable that many of these examples will soon be outdated. Nonetheless, this paper provides a snapshot of current international standards liaison activities.

The decision to develop a national standard or to adopt an international standard depends upon many factors and in each case the circumstances affecting that decision are different. The approaches presented here illustrate alternative possibilities to avoid or at least minimize unnecessary duplication of effort.

Undoubtedly, additional opportunities for international liaison will present themselves in the future. Up-to-date information and continued active participation in the standards development process will ensure that these opportunities are fully leveraged by all parties with a material interest in the particular subject matter.

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APPENDIX – ANSI/ASA Nationally Adopted International Standards (NAIS)

ANSI/ASA S1.4-2014/Part 1 / IEC 61672-1:2013 Electroacoustics – Sound Level Meters – Part 1: Specifications
ANSI/ASA S1.4-2014/Part 2 / IEC 61672-2:2013 Electroacoustics – Sound Level Meters – Part 2: Pattern Evaluation Tests
ANSI/ASA S1.4-2014/Part 3 / IEC 61672-3:2013 Electroacoustics – Sound Level Meters – Part 3: Periodic Tests
ANSI/ASA S1.11-2014/Part 1 / IEC 61260-1:2014 Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications

ANSI/ASA S2.1-2009 / ISO 2041:2009 (R 2014) Mechanical vibration, shock and condition monitoring – Vocabulary.
ANSI/ASA S2.72-2002/Part 1 / ISO 2631-1:1997 (R 2012) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements.
ANSI/ASA S2.72/Part 1-2010 / ISO 2631-1, Amendment 1:2010 (R 2012) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements.
ANSI/ASA S2.72-2003/Part 4 / ISO 2631-4:2001 (R 2012) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems.
ANSI/ASA S2.72/Part 4-2010 / ISO 2631-4, Amendment 1:2010 (R 2012) Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration – Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems.
ANSI/ASA S2.73-2014 / ISO 10819:2013 Mechanical vibration and shock – Hand-arm vibration – Measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand.
ANSI/ASA S12.5-2016 / ISO 6926:2016 Acoustics – Requirements for the Performance and Calibration of Reference Sound Sources Used for the Determination of Sound Power Levels.

ANSI/ASA S3.42-2012/Part 2 / IEC 60118-15:2012 Testing Hearing Aids – Part 2: Methods for characterizing signal processing in hearing aids with a speech-like signal.
ANSI/ASA S3.55-2014/Part 1 / IEC 60318-1:2009 Electroacoustics – Simulators of Human Head and Ear – Part 1: Ear Simulator for the Measurement of Supra-aural and Circumaural Earphones.
ANSI/ASA S3.55-2015/Part 3 / IEC 60318-3:2014 Electroacoustics – Simulators of Human Head and Ear – Part 3: Acoustic Coupler for the Calibration of Supra-aural Earphones Used in Audiometry.
ANSI/ASA S3.55-2014/Part 5 / IEC 60318-5:2006 (MOD) Electroacoustics – Simulators of Human Head and Ear – Part 5: $2cm^2$ Coupler for the Measurement of Hearing Aids and Earphones Coupled to the Ear by Means of Ear Inserts.

ANSI/ASA S12.11-2013/Part 1 / ISO 10302-1:2011– Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices – Part 1: Airborne noise measurement.
ANSI/ASA S12.11– 2013/Part 2 / ISO 10302-2:2011– Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices – Part 2: Structure-borne vibration measurements.
ANSI/ASA S12.50-2002 / ISO 3740:2000 (R 2012) – Determination of sound power levels of noise sources - Guidelines for the use of basic standards.
ANSI/ASA S12.51-2012 / ISO 3741:2010 – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms.
ANSI/ASA S12.53-2011/Part 1 / ISO 3743-1:2010 – Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for small, movable sources in reverberant fields - Part 1: Comparison method for a hard-walled test room
ANSI/ASA S12.53-1999/Part 2 / ISO 3743-2:1994 (R 2015) Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering methods for small, movable sources in reverberant fields - Part 2: Methods for special reverberation test rooms.
ANSI/ASA S12.54-2011 / ISO 3744:2010 Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane.
ANSI/ASA S12.55-2012 / ISO 3745:2012 – Determination of sound power levels of noise sources using sound pressure – Precision methods for anechoic and hemi-anechoic rooms.
ANSI/ASA S12.56-2011 / ISO 3746:2010 – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane.
ANSI/ASA S12.62-2012 / ISO 9613-2:1996 (MOD) –Attenuation of sound during propagation outdoors – Part 2: General method of calculation.