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ISO 16283 versus ISO 140

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Abstract
The publication of the new standards ISO 16283 introduces some important changes regarding the associated old standards ISO 140. The objective of this paper it is to analyze the main differences between the standards, to find the main changes needed on the associated measurements, calculus and report procedures.

Keywords: ISO16283, ISO140, Building Acoustics, Sound Insulation.

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1 Introduction

The new standards for field measurement of sound insulation in buildings and of building elements are [1]: 1) ISO 16283-1 Airborne Insulation (1st edition 2014-02-15; under development ISO 16283-1:2014/CD Amd 1), 2) ISO 16283-2 Impact Insulation (1st edition 2015-11-15), 3) ISO 16283-3 Façade Insulation (1st edition 2016-02-01).

These standards cancel and replace the associated old standards [1]: 1) ISO 140-4:1998 Airborne Insulation, 2) ISO 140-5:1998 Façade Insulation, 3) ISO 140-7:1998 Impact Insulation, 4) ISO 140-14:2004 Guidelines.

There are several changes from the old ISO 140 standards to the new ISO 16283 standards, that are divided, in this paper, in the following 17 subchapters of chapter 2, which names are associated with ISO 16283 main chapters names: 2.1 Introduction, 2.2 Scope, 2.3 Normative references, 2.4 Terms and definitions, 2.5 Instrumentation, 2.6 General, 2.7 Default procedure (sound pressure level measurements), 2.8 Low-frequency procedure (sound pressure level measurements), 2.9 Background noise, 2.10 Reverberation time, 2.11 Conversion to octave bands, 2.12 Uncertainty, 2.13 Test Report and 2.14 Annexes.

The chapters “Frequency range” and “Recording results/Expression of results” are not included because there are no relevant changes.

2 Standards analysis

2.1 Introduction

All parts (1, 2 & 3) of ISO 16283 states in their "Introduction" chapter:

- "*Field sound insulation measurements that were described previously in ISO 140-4, −5, and −7 were (a) primarily intended for measurements where the sound field could be considered to be diffuse, and (b) not explicit as to whether operators could be present in the rooms during the measurement*".
- "*ISO 16283 differs from ISO 140-4, −5, and −7 in that (a) it applies to rooms in which the sound field may or may not approximate to a diffuse field, (b) it clarifies how operators can measure the sound field using a hand-held microphone or sound level meter and (c) it includes additional guidance that was previously contained in ISO 140-14*".

As we can see in the following subchapters the differences between ISO 140-4, -5, and -7, and ISO 16283-1, -2 and -3, are in fact much more than specified in the "Introduction" chapter. One of the differences, not expressed in the "Introduction" chapter, is the sound pressure level measurements division in two procedures: 1) default procedure and 2) low frequency procedure.

These names ("default procedure" and "low frequency procedure") can be misleading, so it is important to clarify that the "default procedure", for sound pressure level measurements, it is applicable also for low frequencies components. The "default procedure" must be used always for sound pressure level measurements, and for low frequency components must be used: 1) alone if the room volume is higher or equal to 25 m^3, 2) together with the "low frequency procedure" if the room volume is lower than 25 m^3. So the "low frequency procedure" could be called, more precisely, for sound pressure level measurements, as "complementary procedure for low frequency components if the room volume is lower than 25 m^3".

The reverberation measurements are also divided into "default procedure" and "low frequency procedure", but it is a little bit different from the sound pressure level measurements. For the reverberation measurements the "low frequency procedure" must be used alone, if it is necessary characterize the low frequency components and if the room volume is lower than 25 m^3.

There are some restrictions to the "low frequency procedure", for the sound pressure level measurements, e.g.: 1) it is not applicable for rubber ball as impact source (see Note 2 o ISO 16283-2 chapter 6), 2) it is not applicable for traffic sources (road, rail, aircraft) for façade insulation measurements (see Note 1 of ISO 16283-2 chapter 6).

For example, in the Portuguese Building Acoustics legislation (DL 96/2008 [2]), there are just two main cases where the low frequency components could be important for the insulation:

1. Number 3 of Article 10ºA (Auditoriums and Halls): $D_{2m,nT,\ w}$ must be enough to assure $L_{Aeq} \leq 30$ dB (A) inside, and once this L_{Aeq}, according with chapter 8.4.11 of ISO 1996-2 ([1]; Determination of environmental noise levels), must include 1/3 octave bands from 50 Hz to 10000Hz, could exist, e.g. in Acoustic Design, requirements of $D_{2m,nT,\ w}$ for low frequencies.
2. Number 4, b), of Article 10ºA (Auditoriums and Halls): $D_{nT,oit.,63Hz} \geq 45$ dB between Movie Theatres.

Since Auditoriums and Halls, and Movie Theatres, have usually a volume higher than 25 m^3, the characterization of sound insulations in these cases can be done, including the low frequency components, just with the "default procedure".

2.2 Scope

All parts (1, 2 & 3) of ISO 16283 state, in their "Scope" chapter, a limit for the room volumes and a limit for the frequency range: 1) 10 m^3 to 250 m^3 (in ISO 140 just in part 14 appears the upper limit of 250 m^3, so the lower limit of 10 m^3 it is something new), 2) 50 Hz to 5000 Hz (in ISO 140 this frequency range was already stated).

All the parts (1, 2 & 3) of ISO 16283 state also, in their "Scope" chapter, that the measurements can be done in "*unfurnished or furnished rooms where the sound field might, or might not approximate to a diffuse field*". As expressed in the "Introduction", this is one of the differences relatively to ISO 140.

In the following subchapter are presented relevant specific parts of the "Scope" chapter related with part 2 of the standard 16283. In part 1 there are nothing more relevant to present and in part 3 all the additional content are similar to ISO 140-5 content.

2.2.1 ISO 16283-2

Is stated that two impact sources are used in the standard (in ISO 140-7 just one, the tapping machine, is used) and is described the related type of real impacts in floors (in ISO 140-7 there are no description of the real impacts related): 1) tapping machine: "*can be used to assess a variety of light, hard impacts such as footsteps from walkers wearing hard-heeled footwear or dropped objects*", 2) rubber ball: "*can be used to assess heavy, soft impacts such as from walkers in bare feet or children jumping, as well as quantifying absolute values that can be related to human disturbance in terms of a Fast time-weighted maximum sound pressure level*".

The rating procedures in ISO 717-2 and the prediction method in ISO 15712-2 are applicable just to the measurements with the tapping machine. "*These two aspects facilitate the specification of impact sound insulation in national building requirements using only measurements with the tapping machine as an impact source*". Despite that, exist already some references trying to get limits from the impact measurements with rubber ball [3-5]. For the Portuguese Building Acoustics legislation [2], just the tapping machine must be used.

2.3 Normative references

In Table 1 are presented the normative references [1] of ISO 140-4, -5 and -7, and of ISO 16283-1, -2 and -3, and the relations.

Table 1 – Normative references of ISO 140 and ISO 16283.

ISO 140		ISO 16283		ISO 140		ISO 16283	
Part	Reference	Part	Reference	Part	Reference	Part	Reference
4, 5	ISO 717-1 →	1, 3	ISO 717-1	4, 5, 7	IEC 60942 →	1, 2, 3	IEC 60942
7	ISO 717-2 →	2	ISO 717-2	-	-	1, 2, 3	IEC 61183
4, 5, 7	ISO 354 →	1, 2, 3	ISO 3382-2	4, 5, 7	IEC 61260 →	1, 2, 3	IEC 61260
4, 5, 7	ISO 140-2 →	1, 2, 3	ISO 12999-1	4, 5, 7	IEC 60651 →	1, 2, 3	IEC 61672-1
-	-	3	ISO 15712-3	4, 5, 7	IEC 60804 ↗		
-	-	1, 2, 3	ISO 18233	4, 5, 7	ISO 140-3	-	-

As we can see in Table 1 there are common references in ISO 140 and ISO 16283 (ISO 717-1, ISO 717-2, IEC 60942 and IEC 61260) and references related (ISO 354 → ISO 3382-2, ISO 140-2 → ISO 12999-1, IEC 60651 & IEC 60804 → IEC 61672-1).

The reference to ISO 140-3 is just presented in ISO 140 because the new "Terms and definitions" chapters of 16283 are more complete, so it is not necessary allusion to terms and definitions of ISO 140-3.

The following references [1,6] are just presented in ISO 16283:

- ISO 15712-3: It is a standard related with prediction methods, with 2005 as the first version year, so was impossible its reference. ISO 15712-1 is related with airborne sound insulation between rooms, ISO 15712-2 with impact sound insulation between rooms, and ISO 15712-3 with airborne sound insulation against outdoor sound. All the parts of ISO 15712 are been replaced by ISO/DIS 12354.
- ISO 18233: It is a standard related with new measurement methods in building and room acoustics, with 2006 as the first version year, so was impossible its reference. Note that exist some references using an impulsive source, instead of the typical dodecahedron and associated amplifier, to perform the airborne sound insulation measurements, based in this standard [7].
- IEC 61183: It is a standard related with random-incidence and diffuse-field calibration of sound level meters, with 1994 as the first version year, so was possible its reference. Maybe appears just now in the ISO 16283 standards to clarify the necessity of this kind of calibration, as expressed in chapter "4.3 Verification" of all ISO 16283 parts.

2.4 Terms and definitions

The "Terms and definitions" chapters of ISO 16283 are much more complete than the related chapters of ISO 140, as we can see in Table 2.

Table 2 – Terms of ISO 140 and ISO 16283.

ISO 140		ISO 16283	
Part	Term	Part	Term
4, 5	average sound pressure level in a room.	1, 3	energy-average sound pressure level in a room.
7	average sound pressure level in a room.	2	energy-average impact sound pressure level in a room.
5	average sound pressure level on a test surface.	3	average outdoor sound pressure level on the test surface.
-	-	3	average outdoor sound pressure level at a distance 2m in front of the façade.
-	-	1, 3	corner sound pressure level in a room.
-	-	2	corner impact sound pressure level in a room.
-	-	1, 3	low-frequency energy-average sound pressure level in a room.
-	-	2	low-frequency energy-average impact sound pressure level in a room.
-	-	2	energy-average maximum impact sound pressure level in a room.
-	-	1, 2, 3	reverberation time.
-	-	1, 2, 3	background noise level.
-	-	1, 2, 3	fixed microphone.
-	-	1, 2, 3	mechanized continuously-moving microphone.
-	-	1, 2, 3	manually-scanned microphone.

ISO 140		ISO 16283	
Part	Term	Part	Term
-	-	1, 2, 3	manually-held microphone.
-	-	1, 2	partition.
-	-	1, 2	common partition.
4, 5	level difference.	1, 3	level difference.
4, 5	standardized level difference.	1, 3	standardized level difference.
7	standardized impact sound pressure level	2	standardized impact sound pressure level
4, 5	normalized level difference	3	normalized level difference
7	normalized impact sound pressure level	2	normalized impact sound pressure level.
-	-	2	standardized maximum impact sound pressure level.
4, 5	apparent sound reduction index	1, 3	apparent sound reduction index
-	-	1, 2, 3	equivalent absorption area
-	-	3	single event level
-	-	3	single event level difference
-	-	3	standardized single event level difference
-	-	3	normalized single event level difference

2.5 Instrumentation

In the new ISO 16283 standards this chapter presents three subchapters, not presented in old ISO 140:

- 4.1 General: Similar content to ISO 140 with standards update.
- 4.2 Calibration: Similar content to ISO 140 with standards update and update of the calibration procedure (no adjustment).
- 4.3 Verification: New content, with recommendation for verification period as presented in Table 3, where is presented also, for comparison, the verification period stated in the IPAC OEC013 (Portugal Specific Requirements for Accreditation of Acoustics and Vibration Laboratories [8]).

Note that the verification periods for Loudspeaker Directivity, Tapping Machine and Rubber Ball are not included in "Instrumentation" chapter but, respectively, in chapters A.2 of ISO 16283-1, A.1.2 of ISO 16283-2 and A.2.3 of ISO 16283-2.

Table 3 – Equipment verification periods according with ISO 16283 and IPAC OEC13.

Document	Equipment – Verification Period					
	Calibrator	Sound Level Meter	Filters	Loudspeaker Directivity	Tapping Machine	Rubber Ball
ISO 16283	1 year	2 years♣	2 years	2 years	Only once♥ Regularly♠	Only once
IPAC OEC13	1 year	2 years; 1 year♦	2 years	1 year	2 years	-

♣ There are "new" specification for verification of random incidence response of the microphone. ♦ Legal metrological verification. ♥ Distance between hammers, diameter of the hammers, mass of the hammers, time between impact and lift, and maximum possible falling height of the hammers. ♠ Velocity of the hammers, Diameter and curvature of hammer heads, falling direction of the hammers, and time between impacts.

2.6 General

This chapter of all parts of ISO 16283 explains better the measurement method including the new (relatively to ISO 140) low frequency procedure and the new possibility to use manually-scanned microphone or manually-held microphone. Despite the fact that all parts of ISO 16283 state: "*All measurement methods ... are equivalent*", must be noted that, according with references [9-10], the

Fixed Positions method seems to give better results, and it is also recommended due to uncertainties calculation (see chapter 2.11 of this paper). Despite also the fact that all parts of ISO 16283 state: "*In case of dispute, the airborne/impact sound insulation determined using measurement methods without an operator inside the receiving room shall be taken to be the reference result*", it is very important the presence of the operator to control any kind of problem in the measurements, like external background noise influence.

2.7 Default procedure (sound pressure level measurements)

This procedure, in all parts of ISO 16283, is similar to the related procedure of ISO 140. The main differences are the following [9]:

- Loudspeaker position (ISO 16283-1): Distance from room boundaries to loudspeaker: ≥ 1 m for separating partition.
- Loudspeaker and outside microphone position (ISO 16283-3): The loudspeaker and outside microphone position requirements are the same in ISO 16283-3 and in ISO 140-5, with the same statement: "*Systematic errors will occur at low frequencies due to interference effects*". In the special case of low frequency components, despite the fact that ISO 16283-3 does not include any additional requirement for loudspeaker and microphone outside position, maybe it is better to take into account some related references [11-12], that recommends the average of more than one position.
- Microphone positions (ISO 16283-1, -2 & -3 (indoor)): Possibility of manually-scanned microphone or manually-held microphone, and new specification for Fixed Microphone Positions: "*No two microphone positions shall lie in the same plane relative to the room boundaries and the positions shall not be in a regular grid*".
- Impact source and microphone positions (ISO 16283-2): The requirements for impact source and microphone positions are now different: "*The same number of microphone positions shall be used for each tapping machine position*".
- Emission spectrum (ISO 16283-1): The ISO 140-4 requirement of a difference in level not higher than 6 dB between adjacent one-third octave bands, changes in ISO 16283-1 for a difference in level not higher than 8 dB, and it is clarified that applies to the energy-average sound pressure level, not to each position in the case of fixed positions.
- Graphic equalizer (ISO 16283-1): There is a new statement: "*A graphic equaliser is often essential as there may be situations where the 8 dB requirement cannot be met without shaping the source signal*". According with reference [9] it is often possible verify the 8 dB requirement without using a graphic equaliser, but it is recommended to include in the loudspeaker "qualification procedure" (A.2 of ISO 16283-1, B.2 of ISO 16283-2 and C.2 of ISO 16283-3), the spectrum verification in free field: 8 dB between adjacent 1/3 octave (ISO 16283-1) and/or 6 dB for one-third octave bands that define the 125 Hz octave band, 5 dB for 250 Hz and 4 dB for bands higher than 250 Hz (ISO 16283-3).
- Level difference for single loudspeaker at more than one position (ISO 16283-1 & -3): It is clarified in the ISO 16283-1, relatively to ISO 140-4, that must be calculate the Level Difference for each loudspeaker position and after the energetic-average of the Level Differences, instead of the Level average of all emission and all receiver values and the final Level Difference. As shown in reference [9] the results, for one and other procedure, could be different, and the new procedure tends to give lower values (more conservative approach) than the "old" procedure.
- Impact sound pressure level for impact source at more than one position (ISO 16283-2): It is also clarified in the ISO 16283-2, relatively to ISO 140-7, that must be calculate the Impact Level for each position of the impact source machine, and after the average o these values, but

since are Levels (not Level differences) it is the same, as is proved in the expression (1), where L_b is the background levels and T the reverberation time.

$$L'_{nT} = 10\lg\left(\frac{1}{m}\sum_{j=1}^{m} 10^{\frac{LnT,j}{10}}\right) = 10\lg\left(\frac{1}{m}\sum_{j=1}^{m} 10^{\lg\left(\frac{\left(\frac{1}{n}\sum_{j=1}^{n} 10^{\frac{Lj}{10}}\right)-10^{\frac{Lb}{10}}}{T/T_0}\right)}\right) =$$

$$10\lg\left(\frac{1}{m}\sum_{j=1}^{m}\left(\frac{\left(\frac{1}{n}\sum_{j=1}^{n} 10^{\frac{Lj}{10}}\right)-10^{\frac{Lb}{10}}}{T/T_0}\right)\right) = 10\lg\left(\frac{1}{m\times n}\sum_{j=1}^{m\times n} 10^{\frac{Lj}{10}} + \frac{1}{m}\sum_{j=1}^{m} -10^{\frac{Lb}{10}}\right) - 10\lg\left(\frac{T}{T_0}\right) =$$

$$10\lg\left(\left(\frac{1}{m\times n}\sum_{j=1}^{m\times n} 10^{\frac{Lj}{10}}\right)-10^{\frac{Lb}{10}}\right) - 10\lg\left(\frac{T}{T_0}\right) \quad (1)$$

2.8 Low-frequency procedure (sound pressure level measurements)

The low-frequency procedure can be summarized in the following way:

- A minimum of 4 corners (two corners at ground level and two corners at ceiling level) shall be measured using a fixed or manually held microphone for each loudspeaker, or tapping machine, position.
- A minimum of 2 loudspeaker positions (ISO 16283-1), a minimum of 2 tapping machine (ISO 16283-2) and a minimum of 1 loudspeaker position (ISO 16283-3) must be used.
- The maximum values (corner) $L_{Max,f}$ for each n loudspeaker, or tapping machine, positions, and for each frequency f (for different frequencies the maximum value can occur in different corners) must be used for calculate the L_{Corner}, as presented in expression (2):

$$L_{\text{Corner}} = 10\log\left(\frac{10^{\frac{LMax,f,1}{10}}+\cdots+10^{\frac{LMax,f,n}{10}}}{n}\right) \quad (2)$$

- "*The low-frequency energy-average sound pressure level in the 50 Hz, 63 Hz and 80 Hz bands is calculated by combining L from the default procedure and L_{Corner} from the low-frequency procedure using Formula*" (3) (note that in the case of the low frequency components do not apply the rule of the energetic-average of the Level Differences; the Level Difference must be calculated after all emission and receiver averages):

$$L_{\text{LF}} = 10\log\left(\frac{10^{\frac{LCorner}{10}}+2\times 10^{\frac{L}{10}}}{3}\right) \quad (3)$$

2.9 Background noise

The only thing new in this chapter it is the necessity of background noise measurements in the corner points (low frequency procedure) and the new statement of round rule for the background noise.

2.10 Reverberation time

In all parts of ISO 16283 the "Reverberation time" chapter is more complete than in ISO 140, and the main new specifications are:

- Standards update: Change from reference to ISO 354 for reference to ISO 3382-2 and ISO 18233 [1].

- Number of measurements and decays: All parts of ISO 16283 establish, for Integrated Impulse Response Method: "*Using an impulse source, the minimum number of measurements required for each frequency band is six. At least one source position and six fixed microphone positions shall be used*".
- Loudspeaker Directivity: It is strange that differently to the established in ISO 3382-2 (no specific requirement for directivity, for reverberation measurements), all parts of ISO 16283 establish the same requirement of loudspeaker directivity for insulation measurements.
- Low frequency procedure: "*This procedure requires that the reverberation time is measured in the 63 Hz octave band instead of the 50 Hz, 63 Hz, and 80 Hz one-third octave bands and that this single measured value is used to represent the 50 Hz, 63 Hz and 80 Hz bands*".

2.11 Conversion to octave bands

In ISO 16283-1 and -2 the only thing new, in the conversion to octave band, is the one decimal round rule. In ISO 16283-3 beyond one decimal round rule there are additional statements for standardized or normalized (including single event) level differences: instead of energetic operation directly in Difference level 1/3 octave values, must be done the energetic operation in 1/3 octave outside and inside levels and in the end calculate the difference.

2.12 Uncertainty

In all ISO 16283 parts is stated: "*The uncertainty of the measurement result shall be determined in accordance with the method given in ISO 12999-1*".

Reading the ISO 12999-1, and some references related [13], seems that it is not necessary to calculate the standard deviation of the measurements (only possible in the fixed microphone method) to calculate the uncertainty, which contradicts, somehow, some Guidelines, e.g. the Portuguese Acoustics Uncertainty Guideline [14]. The uncertainty must be expressed according with the default value presented in ISO 12999-1: "*... the uncertainty of the measurement can be reduced by further independent measurements, which means other persons measure with other equipment*".

2.13 Test Report

The test report shall include at least the information stated in Table 4, according with ISO 140 and ISO 16283.

Table 4 – Test report information in ISO 140 and ISO 16283.

ISO 140		ISO 16283	
Part	Information to be included	Part	Information to be included
4, 5, 7	Standard reference.	1, 2 3	Standard reference.
4, 5, 7	Measurement organization name.	1, 2 3	Measurement organization name.
4, 5, 7	Client name and address.	1, 2 3	Client name and address.
4, 5, 7	Test date.	1, 2 3	Test date.
4, 5, 7	Description and identification of the building and test arrangement.	1, 2 3	Description and identification of the building and test arrangement.
4	Volumes of source and receiving rooms.	1	Volumes of source and receiving rooms and area of any separating element.
4	Area for R'.	-	-
5	Façade and façade elements description.	-	-

ISO 140		ISO 16283	
Part	Information to be included	Part	Information to be included
5	Volume of the receiving room.	2	Volume of the receiving room.
7	Volume of the receiving room.	3	Volumes of receiving room and area of any separating element.
5	Test surface area.		
-	-	2	Impact source.
4	D_n, D_{nT} or R' /Hz	1	D_{nT} or R' /Hz.
7	L'_{nT} or L'_n /Hz	2	L'_{nT}, L'_n or $L'_{i,Fmax,V,T}$ /Hz
5	$D_{2m,nT}$ or $R'_{45°}$ /Hz	3	$D_{2m,nT}$ or $R'_{45°}$ /Hz
4, 5, 7	Test procedure description and equipment.	1, 2, 3	Test procedure description, equipment and low frequency procedure.
4, 5, 7	Limits of measurement due to background noise.	1, 2, 3	Limits of measurement due to background noise.
4, 7	Flanking transmission (if measured).	-	-
4, 5, 7	Single-number ratings.	1, 2, 3	Single-number ratings.
4, 7	Result obtained by a field method.	1, 2, 3	Result obtained by a field method.
-	-	1, 2 ,3	Single-number rating uncertainty (should)
5	Any deviation from the test method	-	-

2.14 Annexes

There are Annexes of ISO 140 that disappear in ISO 16283:

- ISO 140-4 and ISO 140-7, Annex B, octave band procedure:
  - Must be highlighted that for Legal Requirements related with octave bands (e.g. the Portuguese DL 251/87 [15]), instead of the conversion to octave band from 1/3 octave bands measurements must be done the original octave bands procedure.
- ISO 140-4, Annex C, flanking transmission:
  - Exist now a new standard under development [1]: ISO/NP 10848-1: Acoustics - Laboratory and field measurement of the flanking transmission of airborne and impact sound between adjoining rooms - Part 1: Frame document.
- ISO 140-4, Annex D, and ISO 140-7, Annex C: guidelines for low frequency:
  - Since exist now a low frequency procedure this old annex is not needed anymore.

There are Annexes of ISO 140 that pass to ISO 16283 with practically no changes:

- ISO 140-5, Annex A, determination of area S.
- ISO 140-5, Annex B, control of sound transmission.
- ISO 140-5, Annex C, examples of verification of test requirements.

There are Annexes of ISO 140 that pass to ISO 16283 with some changes:

- ISO 140-4 and ISO 16283-1, Annex A, requirements for loudspeakers:
  - For the loudspeaker qualification procedure is now stated an angle step of 1º or 5º.
- ISO 140-7 and ISO 16283-2, Annex A: Impact Sources:
  - There are now requirements for the rubber ball and statements about verification.
- ISO 140-5, Annex D, measurements with aircraft and railway traffic noise.
  - The low frequency procedure must not be used for road, railway and aircraft traffic noise, just for the loudspeaker.
- ISO 140-4 and ISO 140-5, Annex E, and ISO 140-7, Annex D: “Forms for the expression of results”:
  - In ISO 16283-1 it is necessary now to write the “Area of common partition”, and the octave band form disappears.
  - In ISO 16283-2 there are now form for tapping machine and form for rubber ball, and the octave band form disappears.

There are new Annexes of ISO 16283 that did not exist in ISO 140:

- ISO 16283-2, Annex B, and ISO 16283-2, Annex C, Requirements for loudspeakers:
  - For reverberation measurement, and for façade, the same loudspeaker requirements of airborne insulation (ISO 16283-1, Annex A) apply now.
- ISO 16283-1, Annex C, D & E, and ISO 16283-2, Annex D, E & F: "Additional Guidance":
  - The guidelines of ISO 140-14 appear now in Annex of ISO 16283-1 and ISO 16283-2.

3 Conclusions

The differences between ISO 140 and ISO 16283 standards are a lot, from small to big changes, with the possibility of influence in the results. So it is very important, for who works with these standards, to know well which are the differences.

The authors hope that this paper can help to find and understand the main differences.

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