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**Sanitary wares - Test method for flushing noise of
toilet**

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Sanitary wares - Test method for flushing noise of toilet

1 Scope

This Standard specifies the facility conditions and measuring instruments, sample installation and commissioning, sound pressure level measurement, result calculation, uncertainty of measurement and test report for flushing noise detection of toilets (not including toilets and smart toilets that use pressure flushing devices).

This Standard applies to the flushing noise detection of toilets (not including toilets and smart toilets that use pressure flushing devices).

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the dated version applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 3768-2017, Acoustics - 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

GB/T 3785.1, Electroacoustics - Sound level meters - Part 1: Specifications

GB/T 6952, Sanitary wares

GB/T 15173, Electroacoustics - Sound calibrators

GB/T 26730, Sanitary ware - Gravity water flushing devices and supports

JC/T 764, WC seats

JC/T 932, Drainage fittings for sanitary wares

ISO 3744, 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

Note: When it comes to the arbitration of the detection result of flushing noise of the toilet sample, the detection result of the semi-anechoic room shall prevail.

4.2 Measuring instruments

The sound level meter for measurement shall meet the requirements for Grade-2 instrument in GB/T 3785.1; it is recommended to use a Grade-1 instrument. The sound calibrator shall meet the Grade-1 accuracy requirements in GB/T 15173.

5 Sample installation and commissioning

5.1 Sample quantity and specifications

Take a toilet sample.

5.2 Toilet matching requirements

5.2.1 For matching products, install the to-be-tested toilet sample in accordance with the manufacturer's instructions; conduct a connection tightness test under the test static pressure of $0.14 \text{ MPa} \pm 0.01 \text{ MPa}$, to ensure that the toilet and its flushing devices have the overall tightness in good condition.

5.2.2 For non-matching products, the to-be-tested toilet sample can be equipped with a gravity flushing device that meets the requirements of rated water consumption, has an anti-siphon function and meets the requirements of GB/T 26730; the working water level of the flushing tank shall meet the needs of the normal flushing process. The WC seats shall comply with JC/T 764. The sanitary ware support that is used for the wall-mounted toilet sample shall meet the requirements of GB/T 26730. Use a flange, of a suitable size, that conforms to JC/T 932, to adjust the drainage method of the rear-row toilet sample to the bottom delivery type. Then, perform the connection tightness test under the test static pressure of $0.14 \text{ MPa} \pm 0.01 \text{ MPa}$, to ensure that the toilet and the flushing devices have good overall tightness.

5.3 Installation and orientation of the toilet sample

Place the to-be-tested floor-type toilet sample or the sanitary ware support that contains the wall-mounted toilet sample on the floor of the semi-anechoic room or rigid-wall room; make the distance between the center and any wall not less than 1.5 m. Adjust the actual water consumption of the sample to be less than or equal to the nominal water consumption; fill the toilet water seal to the normal water level. When installing the toilet sample, suitable sound insulation measures such as rubber pads shall be used to avoid interference noise between the sample (or sanitary ware support) and the ground during the test.

6.4.2 In the full flushing mode, take a complete normal flushing cycle as the measurement period of the sound level meter's audio frequency signal acquisition, from the start of the drain valve button to the close of the inlet valve.

6.4.3 Take the normal flushing cycle of the to-be-tested toilet sample as the measurement period; use the A-weighted equivalent sound level fast-time weighting characteristic "F" of the sound level meter to determine the A-weighted accumulative percentage sound pressure level $L_{pAi(B)(50)}$ and $L_{pAi(B)(10)}$ of the background noise on the hemispherical measurement surface and record them.

6.4.4 Before testing the flushing noise of the toilet sample, it shall meet the requirements for water consumption in GB/T 6952.

6.4.5 Under the specified test static pressure, start the flushing device and time it in the normal way (generally no more than 1 s); use the A-weighted fast-time weighting characteristic "F" of the sound level meter to respectively measure the A-weighted cumulative percentage sound pressure levels $L_{pAi(50)}$ and $L_{pAi(10)}$ of the toilet flushing noise on the hemispheric measurement surface and record them.

Note: When a multi-channel acoustic analyzer is used for automatic audio frequency signal acquisition, the acoustic signal acquisition time of the instrument can be set to no more than 125 ms.

7 Result calculation

7.1 Calculation of the average value of A-weighted cumulative percentage sound pressure level

Under normal flushing cycle conditions, the A-weighted cumulative percentage sound pressure level average value $\overline{L'_{pA(50)}}$ and $\overline{L'_{pA(10)}}$ of the flushing noise of the to-be-tested toilet sample are respectively calculated in accordance with Formula (1) and Formula (2):

$$\overline{L'_{pA(50)}} = 10 \lg \left(\frac{1}{N_M} \right) \sum_{i=1}^{N_M} 10^{0.1 L'_{pAi(50)}} \dots\dots\dots (1)$$

$$\overline{L'_{pA(10)}} = 10 \lg \left(\frac{1}{N_M} \right) \sum_{i=1}^{N_M} 10^{0.1 L'_{pAi(10)}} \dots\dots\dots (2)$$

Where:

$\overline{L'_{pA(50)}}$ -- During the normal flushing cycle, the A-weighted cumulative 50% sound pressure level average value of the toilet flushing noise that is measured on the hemispherical measurement surface, in decibels (dB);

Keep one significant digit after the decimal point for the measurement results of the A-weighted cumulative percentage sound pressure level of toilet flushing noise and background noise $L_{pAi(50)}$, $L_{pAi(10)}$ and $L_{pAi(B)(50)}$, $L_{pAi(B)(10)}$; round the calculation results of the average values $\overline{L'_{pA(50)}}$, $\overline{L'_{pA(10)}}$ and $\overline{L'_{pA(B)(50)}}$, $\overline{L'_{pA(B)(10)}}$ to the nearest integer. Keep one significant digit after the decimal point for the calculation results of the background noise correction value $K_{1A(50)}$, $K_{1A(10)}$ and the environmental correction value K_{2A} of the A-weighted cumulative percentage sound pressure level; round the calculation results of the A-weighted sound power level $L_{WA(50)}$ and $L_{WA(10)}$ to the nearest integer.

8 Uncertainty of measurement

8.1 Combined standard uncertainty u_{LWA} of the A-weighted sound power level measurement

The uncertainty u_{LWA} of the toilet flushing noise sound power level that is measured according to this Standard is characterized by its total standard deviation σ_{tot} ; it's calculated according to Formula (12):

$$u_{L_{WA}} \approx \sigma_{tot} = \sqrt{\sigma_{R0}^2 + \sigma_{omc}^2} \dots\dots\dots (12)$$

Where:

u_{LWA} -- uncertainty of sound power level, in decibels (dB);

σ_{tot} -- total standard deviation, in decibels (dB);

σ_{R0} -- reproducibility standard deviation of the measurement method, in decibels (dB);

σ_{omc} -- standard deviation of the uncertainty that is caused by the installation and test conditions of the to-be-tested toilet sample, in decibels (dB).

8.2 Determination of σ_{omc}

Under the test static pressure of $0.14 \text{ MPa} \pm 0.01 \text{ MPa}$, the same standard test operator uses the same sound level meter, and, according to the test procedures that are specified in Chapter 6, uses the point that is numbered 10 on the hemispheric measurement surface as the microphone position coordinate, to perform at least 6 repeated measurements of the A-weighted cumulative percentage sound pressure level average values $\overline{L'_{pA(50)}}$ and $\overline{L'_{pA(10)}}$ of the flushing noise of the same toilet sample that is installed at the same position in the test room (The toilet needs to be re-installed before each measurement), and corrects the background noise for the measurement results.

8.3.2 Uncertainty caused by the measurement method

Assume that the uncertainty components in this Standard are not related to each other, and the modeling method is complete and correct, then, the method uncertainty that is caused by the residual uncertainty is $u_{\text{method}} = 0.6 \text{ dB}$, and the sensitivity coefficient is $C_{\text{method}} = 1$.

8.3.3 Repeatability standard deviation of sound pressure level measurement

Under the test static pressure of $0.14 \text{ MPa} \pm 0.01 \text{ MPa}$, the same standard test operator uses the same sound level meter, and, according to the test procedures that are specified in Chapter 6 of this Standard, uses the point that is numbered 10 on the hemispheric measurement surface as the microphone position coordinate, to perform multiple times (at least 6 times) of repeated measurements of the A-weighted cumulative percentage sound pressure level average values $\overline{L'_{pA(50)}}$ and $\overline{L'_{pA(10)}}$ of the flushing noise of the same toilet sample that is installed at the same position in the test room (The sound level meter needs to be repositioned before each measurement).

The uncertainty of the measured value $u_{L'_{pA(50)}}$ and $u_{L'_{pA(10)}}$, namely their standard deviations $s_{L'_{pA(50)}}$ and $s_{L'_{pA(10)}}$, are calculated according to Formula (16) and Formula (17) respectively; the upper limit is not more than 1.5 dB.

$$u_{L'_{pA(50)}} = s_{L'_{pA(50)}} = \sqrt{\frac{1}{N-1} \sum_{j=1}^N (L'_{pA(50),j} - L'_{pA(50)av})^2} \dots\dots\dots (16)$$

$$u_{L'_{pA(10)}} = s_{L'_{pA(10)}} = \sqrt{\frac{1}{N-1} \sum_{j=1}^N (L'_{pA(10),j} - L'_{pA(10)av})^2} \dots\dots\dots (17)$$

Where:

$L'_{pA(50),j}$ -- toilet flushing noise A-weighted cumulative 50% sound pressure level of the j^{th} repeated measurement, in decibels (dB);

$L'_{pA(50)av}$ -- arithmetic average of all repeated measurement results of $L'_{pA(50),j}$, in decibels (dB);

$L'_{pA(10),j}$ -- toilet flushing noise A-weighted cumulative 10% sound pressure level of the j^{th} repeated measurement, in decibels (dB);

$L'_{pA(10)av}$ -- arithmetic average of all repeated measurement results of $L'_{pA(10),j}$, in decibels (dB).

The sensitivity coefficients $C_{L'_{pA(50)}}$ and $C_{L'_{pA(10)}}$ of the measured value are calculated according to Formula (18) and Formula (19) respectively:

issued by its calibration certificate; the corresponding sensitivity coefficient is $c_{slm} = 1$.

8.3.9 Uncertainty caused by the number of limited measurement points

The uncertainty which is introduced by the number of limited measurement points u_{mic} is calculated according to Formula (22) and Formula (23); the corresponding sensitivity coefficient is $c_{mic} = 1$.

$$u_{mic} = \frac{S}{N_M} = \frac{1}{\sqrt{N_M}} \sqrt{\frac{1}{N_M - 1} \sum_{i=1}^{N_M} (L'_{pAi(50)} - L'_{pA(50)av})^2} \dots\dots\dots (22)$$

$$u_{mic} = \frac{S}{N_M} = \frac{1}{\sqrt{N_M}} \sqrt{\frac{1}{N_M - 1} \sum_{i=1}^{N_M} (L'_{pAi(10)} - L'_{pA(10)av})^2} \dots\dots\dots (23)$$

Where:

N_M -- number of microphone positions;

$L'_{pA(50)av}$ -- arithmetic average of the measured values of $L'_{pAi(50)}$, in decibels (dB);

$L'_{pA(10)av}$ -- arithmetic average of the measured values of $L'_{pAi(10)}$, in decibels (dB).

8.3.10 Uncertainty caused by the angle difference between the sound source acoustic emission direction and the measurement surface normal

In a semi-anechoic room, the uncertainty which is caused by the angle difference between the acoustic emission direction of the toilet flushing noise and the hemispherical measurement surface normal is $u_{angle} = 0.25$ dB; the sensitivity coefficient is $c_{angle} = 10^{-0.1K2A}$. For a rigid-walled room, it is recommended to analyze the influence of the sound source and its directivity, measurement distance and other factors to determine the standard uncertainty reasonably.

8.3.11 Uncertainty caused by the frequency spectrum shape and tuned sound

Since there is no audible tuned sound in the toilet flushing process, it can be assumed that the uncertainty which is introduced by the frequency spectrum shape and tuned sound is $u_{tone} = 0$ dB; the sensitivity coefficient is $c_{tone} = 1$.

8.4 Extended uncertainty of measurement U

The extended uncertainty of measurement U is calculated according to Formula (24):

$$U = k\sigma_{tot} \dots\dots\dots (24)$$

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