International Telecommunication Union

ITU-T

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SERIES P: TELEPHONE TRANSMISSION QUALITY, TELEPHONE INSTALLATIONS, LOCAL LINE NETWORKS

Subscribers' lines and sets

Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers and assessment of daily noise exposure of telephone users

ITU-T Recommendation P.360

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ITU-T P-SERIES RECOMMENDATIONS

TELEPHONE TRANSMISSION QUALITY, TELEPHONE INSTALLATIONS, LOCAL LINE NETWORKS

Vocabulary and effects of transmission parameters on customer opinion of transmission quality	Series	P.10
Subscribers' lines and sets	**Series**	**P.30** **P.300**
Transmission standards	Series	P.40
Objective measuring apparatus	Series	P.50 P.500
Objective electro-acoustical measurements	Series	P.60
Measurements related to speech loudness	Series	P.70
Methods for objective and subjective assessment of quality	Series	P.80 P.800
Audiovisual quality in multimedia services	Series	P.900
Transmission performance and QoS aspects of IP end-points	Series	P.1000

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation P.360

Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers and assessment of daily noise exposure of telephone users

Summary

It is known that an excessive acoustic pressure level may produce auditory damage to the users. To prevent the occurrence of excessive acoustic pressure generated by the earphones of handset or headset, the telephony terminal equipment needs to implement devices to limit the acoustic pressure level.

This Recommendation proposes limits to the acoustic pressure generated by the handset and headset earphones and some guidance on how to measure it.

It also provides guidance on how to assess acoustic sound exposure of telephone users.

It also includes some guidance to avoid speech degradation due to the use of devices implemented in the terminal to prevent the occurrence of excessive acoustic pressure.

Source

ITU-T Recommendation P.360 was approved on 14 July 2006 by ITU-T Study Group 12 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation P.360

Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers and assessment of daily noise exposure of telephone users

1 Scope

The use of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers is recommended in ITU-T Rec. K.7. Methods for checking the efficiency of such devices in response to short duration impulses, longer duration disturbances, such as tones, and Daily Noise Exposure are given in this Recommendation. A method is also given for checking that such devices do not have adverse effects on normal speech signals.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation K.7 (1988), *Protection against acoustic shock*.

– ITU-T Recommendation O.6 (1988), *1020 Hz reference test frequency*.

– ITU-T Recommendation P.57 (2005), *Artificial ears*.

– ITU-T Recommendation P.58 (1996), *Head and torso simulator for telephonometry*.

– ITU-T Recommendation P.380 (2003), *Electro-acoustics measurements on headsets*.

– IEC Publication 60711:1981, *Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts*.

– IEC Publication 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements.*

– IEC Publication 61672-1:2002, *Electroacoustics – Sound level meters – Part 1: Specifications*.

– IEC Publication 61672-2:2003, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*.

3 Definitions and abbreviations

This Recommendation defines the following terms:

3.1 artificial ear: A device for the calibration of earphones incorporating an acoustic coupler and a calibration microphone for the measurement of the sound pressure and having an overall acoustic impedance similar to that of the average human ear over a given frequency band.

3.2 ear reference point (ERP): A virtual point for geometric reference located at the entrance to the listener's ear, traditionally used for calculating telephonometric loudness ratings.

3.3 ear-drum reference point (DRP): A point located at the end of the ear canal, corresponding to the ear-drum position.

Relevant abbreviations in ITU-T Rec. P.10/G.100 apply.

4 Efficiency of protection again excessive acoustic pressure

The testing methods provided in this Recommendation only cover the application of in-band signals, but the same sound pressure limits apply if ringing signals appear with the telephone set in off-hook conditions.

On the basis of the finding of scientific studies, several authors or organizations have proposed ear-damage risk criteria based on variations in acoustic pressure, under impulse conditions for which, parenthetically, there is no single definition. Likewise, ear-damage risk criteria have also been proposed for longer duration acoustic disturbances, such as tones. However, these criteria cannot be directly transposed to the test conditions and measurements described below. Nor could the results be cross-checked without introducing certain hypotheses that are not specified in this Recommendation, the purpose of which is merely to describe a method simple both in its application and in the analysis of the results obtained. The criteria recommended are based on experience gained in several countries about the telephone receiver quality necessary to ensure the safety of users and operators. Administrations may wish to adopt lower limiting levels to reduce user annoyance caused by acoustic disturbances, but the limiting levels should not be so low as to have adverse effects on normal speech levels.

ITU-T Recs P.57 and P.58 define several types of artificial ears. The use of the appropriate type of artificial ear is determined by the size or the type of the earpiece of the handset or of the headset.

4.1 Efficiency of protection against short duration impulses

In order to check whether a telephone set affords satisfactory protection against the risk of acoustic shocks due to short duration impulses, it is recommended that its characteristics be examined as follows:

a) The entire telephone set, including the protective device, is placed in normal operating conditions and powered.

b) Telephone sets with adjustable receive levels shall be adjusted to the maximum setting.

c) The earpiece of the handset or headset earphone is applied to an artificial ear conforming to ITU-T Recs P.64 and P.380 respectively.

d) The artificial ear is electrically connected to a measuring meter via a filter that carries out the DRP to Diffuse Field transfer function if Type 2 or 3 artificial ear is used. If Type 1 artificial ear is used, the filter should carry out the transfer functions from ERP to DRP and from DRP to Diffuse Field. The transfer functions between ERP to DRP and DRP to Diffuse Field are given by ITU-T Rec. P.58. The measuring meter can be any frequency analyser, sound pressure level meter or simply a Noise Dose Meter that is capable of performing peak measurements. The measuring meter should be correctly calibrated and having the necessary circuits for the measurements.

e) Electrical impulses are applied to the telephone set by a suitable assembly. For analogue two-wire terminals, the impulses are superimposed on the d.c. supply without the latter short-circuiting them. The 10/700-µs surge generator specified in clause 6.2 of IEC 61000-4-5 shall be used. The open circuit voltage shall be 1000 volts, and the short-circuit current shall be 25 amps. For analogue four-wire systems, the impulses are applied across the terminals of the receive circuit.

f) The telephone set is also checked for self-generated acoustic impulses such as those produced by operation of the hook switch or by pulse dialling.

g) For both cases e) and f) above, the peak acoustic pressure level observed (maximum instantaneous value) should be below the applicable national or regional safety regulations, e.g., U.S. Code of Federal Regulations, 29CFR1910.95 "Occupational noise exposure" and the Directive 2003/10/EC of the European Parliament on the minimum health and safety requirements.

NOTE 1 – It could be useful to repeat some tests more than one time, to ensure that the protection system is not damaged.

NOTE 2 – It is not necessary to test cordless phones for these short duration impulses. It is because in the longer duration disturbances test in 4.2 below, the test signal through the cordless link is already at the maximum excursion. The required maximum sound pressure level for the longer duration disturbances is much lower than the requirement for this short duration impulses test. If a cordless phone can pass the test in 4.2, it implicitly passes this test.

4.2 Efficiency of protection against longer duration disturbances

In order to check whether a telephone set affords satisfactory protection against the risk of acoustic hazards due to longer duration disturbances, such as tones, it is recommended that its characteristics be examined as follows:

a) The entire telephone set, including the protective device, is placed in normal operating conditions as regards current supply and its position for the exchange of a call.

b) Telephone sets with adjustable receive levels shall be adjusted to the maximum setting.

c) The earpiece of the handset or headset earphone is coupled to an artificial ear in conformance with ITU-T Recs P.64 and P.380 respectively.

d) The artificial ear is electrically connected to a measuring meter via a filter that carries out the DRP to ERP transfer function if Type 2 or 3 artificial ear is used. If Type 1 artificial ear is used, no correction filter shall be used. The measuring meter can be any frequency analyser, sound pressure level meter or simply a Noise Dose Meter that is capable of performing A-weighted sound pressure level measurements. The measuring meter should be correctly calibrated and be equipped with the necessary circuits for carrying out the measurement. The transfer function between the measuring reference point to ERP is given by ITU-T Rec. P.57.

   The transfer function can also be taken in account by post processing if a filter is not used.

   NOTE 1 – The maximum limits for these longer duration disturbances have been defined at ERP for many years. They have provided satisfactory protection against acoustic injury. The limits are then preserved as they have been historically proven.

e) For analogue terminals, a swept sine wave signal across the band is applied to the telephone set. Its amplitude is increased until it reaches +15 dBV across the set's terminals or until the steady-state acoustic output from the telephone receiver reaches its limiting value, whichever occurs first.

   For digital terminals, a digitally encoded signal, e.g., square wave, representing the maximum energy deliverable by the network transmission system and/or by the coding system is used.

f) The telephone set should also be checked for self-generated acoustic disturbances, such as tone dialling signals fed back to the receiver.

g) For both cases e) and f) above, the steady-state A-weighted sound pressure level should be below +31 dBPa(A) for the handset and +24 dBPa(A) for the headset "slow" response.

NOTE 2 – Tones or other disturbances which are inherently limited to less than 0.5-s duration should be evaluated as short duration impulses under 4.1. Repetitive disturbances, such as those which might be produced during automatic tone-type dialling, should be evaluated under 4.2 using the sound level meter set for "slow" response averaging.

4.3 Assessment of 8-hour Daily Noise Exposure of telephone users

Daily Noise Exposure is a time-weighted-average (TWA) of A-weighted noise exposure. Conventionally, it is for a normal 8-hour workday. It applies only to work-related environment, e.g., contact centre. The Daily Noise Exposure (TWA) measurement accounts for both normal and abnormal signals. The limit for the Daily Noise Exposure shall be referenced to regional and country requirements.

For a constant sound pressure level exposure that lasts 8 hours, the 8-hour TWA will be equal to the sound pressure level. For varying sound pressure, the 8-hour TWA can be calculated with Formula 1:

$$L_{EX,8h} = 10\log\left[\frac{1}{(t_2 - t_1)}\frac{1}{p_0^2}\int_{t_1}^{t_2} p_A^2(t)dt\right] \quad [\mathrm{dB(A)}] \tag{1}$$

where:

$L_{EX,8h}$ is the TWA of the noise exposure level for an 8-hour workday, dBSPL(A). It covers all noise present at work, including impulsive noise.

t_1 is the starting time.

t_2 is the ending time. For a nominal 8-hour working day, $t_2 - t_1 = 8$ (hours).

$p_A(t)$ is the instantaneous A-weighted sound pressure of the sound signal.

p_0 is the reference sound pressure of 20 µPa.

NOTE – The U.S. Code of Federal Regulations integrates only the sound levels above 80 dB, whereas in Europe, the Directive does not make such limitation.

Reducing the Daily Noise Exposure duration allows an increase in the Exposure Limit, vis-à-vis, reducing the exposure limit allows an increase in the exposure duration. There are two different trading relations:

In North America the trading relation is "5 dB per time-doubling"; a 5-dB increase/decrease in a constant sound level doubles/halves the acoustic energy of the exposure as does doubling/halving the duration of the exposure. This relation can be expressed in Formula 2 below:

$$T = \frac{8}{2^{\left[\frac{L_{EX} - 80}{5}\right]}} \quad [\mathrm{Hour}] \tag{2}$$

where:

T is the permissible noise exposure duration (hour).

L_{EX} is the corresponding maximum noise exposure level, dB(A).

In North America the highest Daily Noise Exposure is 115 dBA for 15 minutes exposure. The 5-dB trading relation does not apply above 115 dBA.

In Europe, the trading relation is "3 dB per time-doubling"; a 3-dB increase/decrease in a constant sound level doubles/halves the acoustic energy of the exposure, as does doubling/halving the duration of the exposure. This relation can be expressed in Formula 3 below:

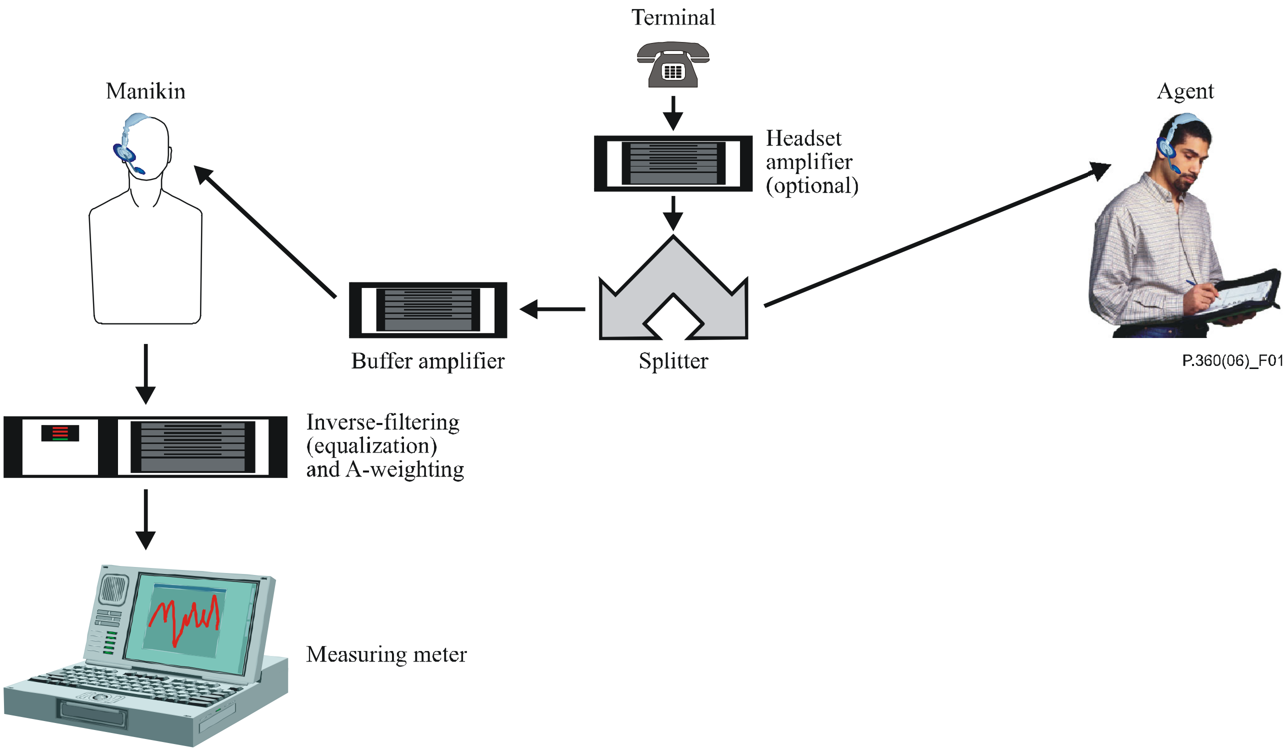
$$T = \frac{8}{2^{\left[\frac{L_{EX} - 80}{3}\right]}} \quad [\mathrm{Hour}] \tag{3}$$

where:

T is the permissible noise exposure duration (hour).

L_{EX} is the corresponding maximum noise exposure level, dB(A).

In order to check whether a telephone set affords satisfactory protection against the risk of acoustic hazards due to Daily Noise Exposure (TWA), it is recommended that the Daily Noise Exposure (TWA) be conducted on the site with the particular agent in question as shown in Figure 1.



Note – In practical implementation, inverse filtering and frequency weighting can be embedded in the measuring meter.

Figure 1/P.360 – Test setup for measuring Daily Noise Exposure (TWA)

A second headset that is "identical" to the agent's headset is required for this method. "Identical" means that the second headset must be the same brand, same model and from the same manufacturer as the agent's headset. If configuration options exist, both headsets should be configured in the same manner, e.g., headband or ear hook, ear cushion type, ear bud type, tone control, etc. This is required so that the replicated signal passing to the second headset will result in the same nominal acoustic signal being produced by the agent's headset.

As shown in Figure 1, a simple splitter should be used to duplicate the signal after the headset amplifier or any user adjustable receive volume control; one signal is applied to the agent's headsets and the other to the second headset via a buffer amplifier. The buffer amplifier shall impose minimal loading of the signal to the agent's headset. The buffer amplifier should then have high input impedance compared to the headset worn by the agent. The buffer amplifier should also have a low output impedance to minimize the voltage drop when driving the second headset. The buffer amplifier shall have unity gain, it should not reduce the bandwidth of the income signal nor add significant distortion or noise to the system. It is recommended that the buffer amplifier connects only to the receive channel. The transmit channel shall be open so that neither the agent nor the far end will be disturbed by stray microphone noise of the second headset.

In some cases a telephone turret provides a secondary socket for a second headset. In such cases, it is important to verify that both sockets provide same output level and the receive volume control on the turret (if any) controls both headsets simultaneously and equally. It has to be sure that there is no additional user-adjustable receive volume control between the turret and the agent's headset. It is equally important that the second headset does not alter the noise level from the agent's headset. It is recommended to disable or mute the transmit channel of the second headset.

The agent's headset should be the one normally used by the agent. The second headset should be fitted on the HATS. The acoustic coupling between the second headset and the HATS's ear should be similar to the manner in which the agent couples the headset to his or her head and ear. This similarity of acoustic coupling between the headsets and ears is critical to the TWA measurement. It is recommended that the position and coupling between the headset and ears should be monitored periodically during the course of the measurement.

As shown in Figure 1, the output from the HATS should be fed to the measurement meter via the Inverse-HRTF and A-Weighting Filters. The output signal from the Filters is the A-weighted equivalent Diffuse Field sound pressure level. The measuring meter can be any frequency analyser, sound pressure level meter or simply a Noise Dose Meter that is capable of performing Daily Noise Exposure measurement.

It is known that even with a same brand, same model and from a same manufacturer, a second headset can still have a different Receive Loudness Rating (RLR) level as the agent's headset. It is necessary to calibrate the second headset before the TWA measurement.

It is recommended to measure the TWA for the whole working day (mostly 8 hours). However, in some situations, due to the time and cost constraints, the whole working day measurement may not be possible. In such a situation, it is important that for each measurement of an agent, the shortened duration shall be long enough to cover a representative sample of the whole working day activity. A minimum of 2 hours is recommended. Assuming that the shorter duration is representative, it can then be extrapolated to give the noise exposure value for that individual for a whole working day or a particular shift pattern. It is also important to account for different shifts and breaks for the Contact Centre agents.

It is useful to also measure the background unobstructed noise level separately during the TWA measurement. It helps to understand the relation between the background noise level and the agent's listening level.

This test method does not apply to handsets and headsets whose receive volume control are on the handset and headset capsules.

For running a large scale monitoring campaign, an alternative equivalent method can be used as the one presented in Appendix I.

5 Effect on normal speech signals

It is recommended to check whether the strong-signal attenuation obtained by protective devices does not cause deterioration of the normal signals, e.g., by non-linear distortion. This may be done by conducting a series of measurements using steady-state sine wave signals at a frequency of 1000 ± 20 Hz and relating to the following magnitudes:

N is an electric voltage level at the terminals of the set. *N* is determined by the relation:

$$N = 20\log_{10}\frac{V_{rms}}{0.775} \quad [\text{dB}]$$

where:

V_{rms} represents the r.m.s. value of the voltage across the terminals. The value of V_{rms} = 0.775 volts (–2.2 dBV) gives $N = 0$ and corresponds to a power level of 0 dBm into 600 ohms.

$P(N)$ is an acoustic pressure produced by the telephone receiver under given conditions (This may be the pressure measured on an artificial ear in accordance with ITU-T Rec. P.57.) corresponding to the application of voltage level N across the terminals of the set.

$A(N)$ is an attenuation of the electroacoustic efficiency with respect to its reference value $N = –20$ dB. $A(N)$ is determined by the relation:

$$A(N) = 20 \log_{10} \frac{P(-20)}{P(N)} + \mathrm{N} + 20 \quad [\mathrm{dB}]$$

[$A(N) = 0$ when $N = –20$ dB].

The values obtained for $A(N)$ must match those in Table 1 which have been obtained from measurements carried out on several types of set fitted with various protective devices.

Table 1/P.360

N **[dB]**	***A(N)*** **[dB]**
–20	0
–10	< 0.5
0	≤ 2

NOTE 1 – It may be useful to make a few additional measurements to ensure that, at frequencies between 200 Hz and 4000 Hz, the values observed for *A(N)* are of the same order.

NOTE 2 – Some sets have special features, such as electro-acoustic sensitivity which depends on the conditions of d.c. current supply or on the level of the speech signals received. In that case, this evaluation may not apply.

Appendix I

Alternative daily noise exposure measurement

I.1 Introduction

The HATS method specified in this Recommendation needs a very careful execution both in respect of the selection of the second headset to be worn on the HATS, which should be in principle identical to the one used by the agent, and the positioning of the headsets on the agent and the HATS, which should be similar. This similar positioning is generally easily assured in limited measurement campaigns carried out by skilled test operators, but quickly gets more difficult if many measurements are to be carried out in the field by a large number of less-skilled test operators, not to mention the need of a large quantity of HATS.

Large-scale monitoring campaigns may be addressed to thousands of Contact Centre agents, scattered in different towns and following many different time shift patterns. As a consequence they should be run by complex territorial organizations, normally resorting to the existing field operation personnel. In order to complete a monitoring campaign within acceptable time-limits, many testing facilities may need to be operated in parallel, each able to monitor many operators at the same time.

Based on these considerations, the HATS-based method is not applicable to wide-scale monitoring campaigns and the alternative equivalent method described in the following has proven to be more suited to meet the above-mentioned constraints.

I.2 Description of the method

The method for running large-scale monitoring of the Daily Noise Exposure of Contact Centre agents is based on the following principles:

1) Electric monitoring of the signal at the input of the headset (i.e., after all volume controls).

2) Acoustic monitoring of the background noise in the working environment.

3) Correlation of the measured electric signal with the acoustic pressure at the eardrum by means of a statistically validated model of the headset response, as characterized on the HATS.

4) Calculation of the equivalent sound pressure level of the received speech in the Diffused Field, according to ISO 11904.

5) Power summation of the equivalent speech pressure spectrum in the Diffused Field and the ambient noise at the working environment, as measured by the environmental microphone of the test system.

The method is described in Figure I.1.

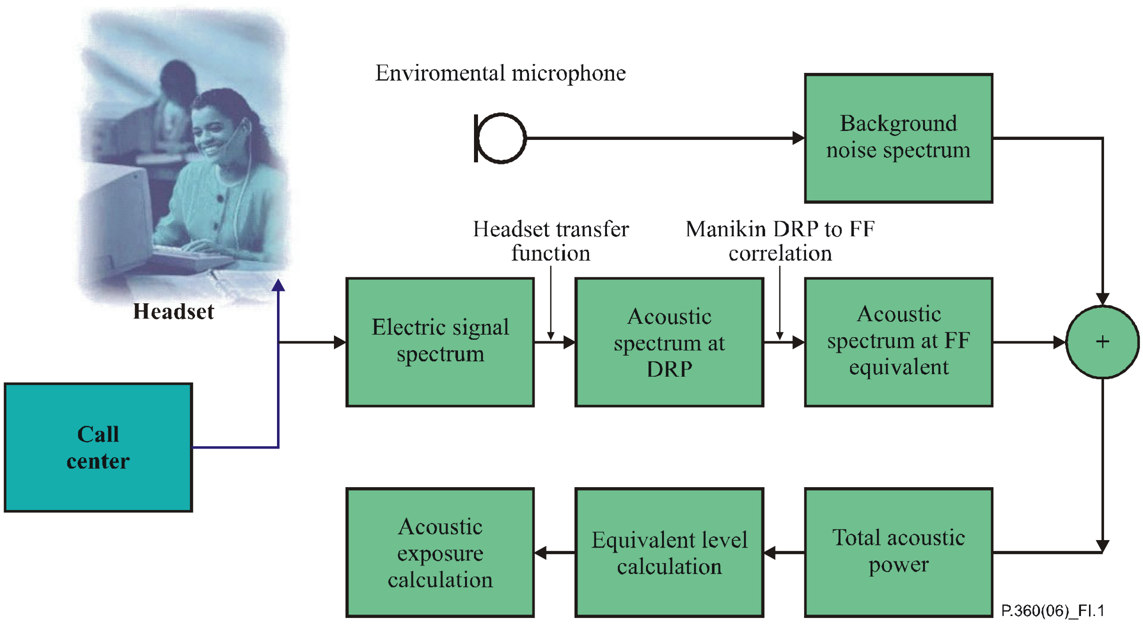


Figure I.1/P.360 – All spectra should be third/octave, real time measured. A weighting correction should be applied.

The noise level measured in the Open-Field should be power added to the equivalent speech pressure level, without taking into account the attenuation effect resulting from the coupling of the transducer to the ear. This is done in order to make a conservative estimation of this component of the acoustic exposure.

Apart from this peculiarity, this method runs like the HATS-based one, with the difference that the test signal, instead of being measured at the eardrum microphone of the HATS, is directly picked up at the headset terminals. The overall response of the "probe" composed by the second (in principle identical) headset plus the HATS, instead of being actually implemented in the actual measurement set-up, is accounted for by the testing software. This approach works as long as the non-linear effects occurring in the headsets transducers are of a limited extent, which is normally the case for monitoring campaigns on the Contact Centre agent's noise exposure.

I.3 Headsets characterization

One key aspect of this methodology is the correct statistical characterization of the headset sensitivity. Each headset type used in the Contact Centres under examination should be characterized on a HATS complying with ITU-T Rec. P.58.

In order to characterize the headset receivers at a level close to the operating conditions that it generates, a pink noise should be used at a level such to generate a sound pressure level of –10 dBPa at the DRP. The receivers should be coupled to the HATS ears by following the manufacturer-recommended wearing position (RWP) and by achieving the best acoustic coupling. The application force actually used for characterizing headsets should be documented in the records of the monitoring campaign.

Thirty receivers should be preferably used for characterizing each transducer type. For each receiver the test results should be confirmed by at least three test repetitions, each comprising the headset repositioning on the HATS, and should be computed as the dB average of the test repetition results.

As an example, Table I.1 provides the statistical results of the characterization of a typical headset type, while Figure I.2 gives the envelope of the average receiving responses of the 30 tested receivers.

Table I.1/P.360 – Characterization of a typical headset, 30 receivers tested, each individual response resulting from the average of three repetitions (Figure I.2)

Frequency [Hz]	Average [dBPa/V]	Standard deviation [dB]
100	–0.5	2.93
125	–0.7	1.77
160	1.6	1.95
200	3.8	2.88
250	6.8	2.66
315	9.0	2.22
400	12.2	2.14
500	15.9	1.92
630	18.6	1.36
800	20.9	0.94
1000	22.2	0.82
1250	23.8	0.62
1600	24.8	0.69
2000	25.0	0.96
2500	23.3	1.44
3150	16.5	1.62
4000	5.9	1.51
5000	–9.2	2.65
6300	–13.3	1.94
8000	–13.2	1.82
10000	–18.0	1.83

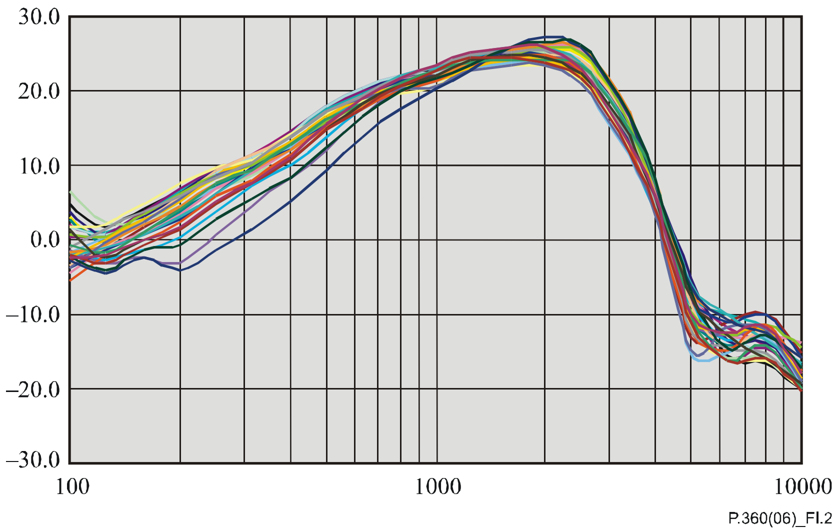


Figure I.2/P.360 – Characterization of a specific headset type (third-octave evaluated responses)

I.4 Test set-up validation

The validation of the test set-up should be carried out through three steps:

- Certification of the acoustic and electrical testing channels against the applicable IEC requirements (i.e., IEC 61672-1 and IEC 61672-2 (Sound level meters) or their evolution).
- Complementary validation of the acoustic and electric test channels with system-specific signals. This validation is aimed at checking the third-octave analysis accuracy and the behaviour of the test tool with signals close to those occurring in the actual use.
- Overall validation of the instrument by comparing the result of an acoustic exposure test against the result obtained by running in parallel the HATS measurement specified in 4.3.

The certification of the instrument against the IEC standards should be preferably carried out by an accredited metrological laboratory.

The complementary validation of the electric channels consists in comparing the third-octave test results of the electric measurements carried out by the test set-up under validation against those measured by a parallel operated calibrated instrumentation and should be carried out by feeding at least all the following test signals:

– pink noise;

– ITU-T Rec. P.50 shaped white noise, both continuous and pulsed (250 ms ON, 150 ms OFF);

– real speech.

The difference between the A-weighted equivalent levels, as calculated from the measured third-octave spectra, should comply with the uncertainty limits specified for Class 1 sound level meters.

Similarly, a complementary validation should be carried out for the acoustic channel, consisting in comparing the third-octave test results of the test tool under validation against those provided by a certified sound level meter exposed to the same noise signals:

– Hoth noise;

– Pulsed Hoth noise (5 ON, 5 OFF).

All the above tests may be executed on time windows of a few minutes, with the exception of at least one test, which should be carried out on a time window of 8 hours. This is intended as a software check against the possible occurrence of overflows in the integrating algorithms for long integration times.

Finally, an overall validation should be carried out by feeding a speech signal to an agent headset and by testing in parallel the noise exposure by this Guide methodology and by the test tool being validated. This validation should be carried out on at least three different headsets, both in a silent environment (≤–45 dBPa(A)) and in a noisier one (–24 dBPa(A)).

The two methods should provide results close to each other within the typical uncertainty associated with this testing methodology (the combined uncertainty of the method is typically about 2 dB).

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Series D	General tariff principles
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Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
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Series Q	Switching and signalling
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