

DOES THE NEW SOUND LEVEL METER STANDARD IEC 61672 MAKE ANY DIFFERENCE TO MY MEASUREMENT?

Richard Tyler. A.V.I. Ltd., 13C Old Bridge Way, Shefford. Beds. SG17 5HQ.

1. INTRODUCTION.

For over 10 years now, a Working Group in the IEC (International Electrotechnical Commission) has been revising and updating the International Standards for sound level meters, to replace the existing standards which are now quite elderly. IEC 60651:1979 (1) for sound level meters and IEC 60804:1985 (2) for integrating-averaging sound level meters will shortly be withdrawn and all new sound level meters will have to comply with IEC 61672 if they are to meet the latest requirements. Many specifications have been changed and more added, which in turn will probably mean longer development times and higher costs for new instruments, but will this result in better measurements?

The author has been a member of IEC/TC29/WG4, the group responsible for producing the new Standard, since the project started. In this paper I will examine the principal differences between the existing and the new Standards, and attempt to quantify their effect on measurements made with sound level meters.

2. THE BACKGROUND TO IEC 61672.

The progress towards the new Standard has been slow and at one time almost stopped when rules for producing new Standards changed just when this Standard was approaching completion. Originally it was conceived as having three sections: the first would contain the requirements for any type of sound level meter, the second would be the tests to be performed by any laboratory certifying the meter as conforming to the standard (pattern or type approval) and the third the tests required to periodically verify that the meter was still performing acceptably. The first section was originally completed several years ago and drafts of the second and third parts were under discussion when the requirement to include measurement uncertainty was suddenly introduced by the IEC. None of the discussions on the new standard up to that point had really considered this aspect of "tolerances" at all, and the need to include the component of the measurement uncertainty in the tolerance allowed for each aspect of the meter caused a considerable delay in rewriting the requirements. In many cases, it was necessary for National Laboratories to make measurements and evaluate their uncertainties before a revised "tolerance" could be safely included in the new standard. This in turn led to some rethinking of other aspects of the requirements and delayed completion of the main text.

2.1 Current proposals for the Standard.

As a result of this delay, it was agreed to split the document into several parts. IEC 61672-1 will be the requirements, IEC 61672-2 will be the tests for pattern evaluation, IEC 61672-3 will be the tests for periodic verification and a new part, IEC 61672-4, will be the OIML report format. Each part will be published separately. This last section, which has yet to be started, is a new aspect for IEC Standards. In the past the Organisation for Legal Metrology (OIML) have produced separate

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standards. These detail the format and content of reports used to show that pattern evaluation according to International requirements has been correctly and completely effected by a National Laboratory, which has been approved for the purpose. Now the IEC working group is producing this as well as defining the tests, thereby removing the need for a separate group at OIML (many of whom were often in the IEC Group too).

2.2 Current progress of the Standard.

At the time of writing (October 2001), IEC 61672-1 was undergoing its final vote, which, if positive as expected, will lead to publication early in 2002. This lays down the requirements for all new meters and allows manufacturers to design and specify instruments to this specification.

IEC 61672-2 for the pattern evaluation tests has been completely drafted and is undergoing its final comment stage. A planned meeting of the working group in November 2001 should produce the final version which will need another vote before publication. With a smooth passage, this should also be published in 2002.

IEC 61672-3 for periodic testing has yet to be completed and has not been seen by anyone other than the working group. The completion of this part will be accelerated once part 2 has been approved as it is essentially a subset of part 2,

IEC 61672-4 likewise can only be produced when part 2 is finalised.

3. WHAT ARE THE MAIN DIFFERENCES IN IEC 61672?

The first difference is the reduction in the number of types or classes of meter defined. In the past there were Types 0, 1 2 and 3. Now there will only be Class 1 or Class 2. As an approximation, Class 1 is a little better than the existing Type 1, but not a Type 0; Class 2 is very similar to the existing Type 2. Class 1 is intended as the precision device and Class 2 as the general purpose unit.

However, in terms of the Standard, the biggest single difference is the inclusion of Uncertainty budgets in every tolerance quoted. This has the effect to the casual observer of appearing to make the tolerances no better, or in some cases worse, than the old standards, but the working group has been at great pains to ensure that the values are realistic and wherever possible has actually reduced the margin of error allowed to the manufacturer. As an example, the tolerance given for the accuracy of a Type 1 meter's frequency response at 12.5kHz used to be between +3 and -6 dB. This figure is unchanged in the new standard for a Class 1 meter, but the tolerance now includes an uncertainty of measurement of 1.0 dB, so the combined effect of the tolerance and level of uncertainty means that the meter will only pass testing to the new standard if the true answer lies between +2 and -5 dB, thus tightening the requirements of the meter's performance. The same comparison at 250 Hz had the tolerance as ± 1.0 dB, but the new standard now says ± 1.4 dB, but the uncertainty allowed is 0.4 dB, so the true answer still has to lie within ± 1.0 dB, thus no change. More information regarding uncertainties and sound level meters can be found in ref. (3).

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3.1 Specific changes from IEC 60651 and 60804.

3.1.1 Mandatory requirements.

Certain features have been made mandatory if compliance to the new standard is claimed. For a meter claiming to operate as a sound level meter, an integrating sound level meter and an integrating-averaging sound level meter, (which most new designs usually do), A weighting, F (fast) time weighting, A weighted time-average sound level (L_{eq}) and A weighted sound exposure level (SEL) must all be available. In addition, a Class 1 meter must have C weighting in some form. A "hold" facility to capture maximum and peak levels is also mandated, as is a means of inserting the specified electrical test signals. Sound level meters with fixed microphones and no means of a test laboratory inserting electrical test signal are no longer permitted.

3.1.2 Frequency weightings.

A weighting is the only frequency weighting mandated, but additionally C weighting, and the new Z weighting are specified in the Standard. B weighting has been removed, but manufacturers are free to include any other weightings provided they are defined by the manufacturer and the tolerances in the Standard are adhered to. Z (or zero) weighting is what has often been called linear or flat in the past, and essentially defines an unweighted bandwidth over the same range of frequencies as the other weightings fitted to identical tolerances.

3.1.3 Acoustic testing.

In order to more fully assess the true measuring capability of a sound level meter, more emphasis has been placed on acoustic testing than in the previous standards. This is evident in the tests for frequency response already mentioned where the test for one of the specified frequency weightings is to be performed both acoustically and electrically. This is to ensure that effects such as the shape of the sound level meter case and all microphone through to display errors are taken into consideration in one measurement. By testing the meter acoustically and then electrically, the errors introduced acoustically can be determined and other weightings can then be tested purely electrically with the acoustic errors added to give the overall performance. This has proved a little controversial as any other errors in the meter's measurement, such as linearity, are also included in the supposed acoustic response. These are reduced to almost zero if the weighting tested is the Z weighting. However this may not be possible to use. It is not mandated that this is fitted and ultimately the choice of weightings fitted lies with the manufacturer.

The tests of directional response have been considerably increased. In addition to normal incidence, tolerances have been defined for changes in direction of up to 30°, 90° and 150°, and these have to be tested from 250 Hz up to 8 kHz for Class 2 and up to 12.5 kHz for Class 1 in each plane of symmetry. For pattern evaluation, it is suggested that increments of not more than 10° are used and that at higher frequencies, increments of not more than one-twelfth octave steps are applied. This makes for a considerable amount of acoustic testing which is both time-consuming and difficult to achieve with high precision, so is likely to prove expensive. However, this is a fundamental aspect of the overall design of a meter, and will not change from unit to unit of the same design if all other manufacturing details are kept the same, so it will not be necessary to include this in the periodic testing.

Meters meeting all the acoustic requirements to the tolerances specified will have considerably better measuring capabilities than many of the designs currently on sale. This is because the methods specified for measuring and testing the performance in the past have not been interpreted as including all the factors which are now mandatory in the new standard.

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3.1.4 Effects of Temperature, Humidity and Atmospheric Pressure.

The requirements here have been changed as in attempting to define the uncertainties for the new standard, it was found that several of the original tolerances were smaller than the measurement uncertainties which, at that time, were not included! It was also accepted that the tight temperature tolerances expected for all 4 Types of sound level meter in the old standard were unrealistic and widely ignored for Types 2 and 3. Consequently, the new Class 1 temperature tolerance is ± 0.8 dB with 0.3 dB uncertainty included (was ± 0.5 dB for all types) but for class 2 is now ± 1.3 dB with 0.3 dB uncertainty. The operating temperature range has also been altered. Class 1 retains the original -10° to $+50^\circ\text{C}$ whilst Class 2 is now 0° to $+40^\circ\text{C}$. The reference temperature is now 23°C (was 20°C) to align with the specifications for microphones, and the tolerances define the maximum change from this point to any other within the permitted range.

Humidity has also acquired a Class 1 and a Class 2 specification, slightly tighter than before for Class 1, slightly wider for Class 2. Atmospheric pressure effects have been defined over a slightly wider pressure range with slightly widened tolerances, so the overall effect is no real change.

Once again, the tests for each of these three properties are time-consuming, especially those for temperature and humidity. In the past, these tests have often been performed too quickly with inaccurate results, and ignored altogether for cheaper instruments whose microphones were frequently quite good thermometers as well! In order to try and alleviate the problems whilst not increasing the time to test horrendously, a combined temperature and humidity test has been introduced. Selected combinations of temperature and humidity are defined for each Class of meter and tighter tolerances than are permitted for either test when carried out separately have been introduced. If the meter passes these tests at the tighter tolerances it is deemed to meet the standard for both parameters. If the meter fails these tests, it is still permissible to test each parameter separately to the full tolerances and for the meter to pass if these individual tests are to specification. Time for the meter to stabilise to any temperature or humidity is defined as a minimum of 7 hours for each change after an initial 12 hours at the reference point of 23°C and 50% RH. Again these are tests of the model and should only be required at pattern evaluation stage.

3.1.5 Peak Response.

The requirements in IEC 60651 for peak response made no reference to a frequency weighting and were often applied to any weighting the meter happened to possess. Whilst the tests defined would usually be met by testing with A weighting or no weighting (Linear), testing with C weighting was often very marginal due to the effects of transients on that particular weighting. As the use of C weighted Peak has become more widespread recently, the new Standard has changed the tests to now define C weighted peak only. If a meter is fitted with Peak, it must also have C weighting, although not necessarily have C weighting for anything else other than Peak measurements. This in turn has led to a need for an ability to have a C weighted r.m.s. parameter available during testing, which in practice will mean that any meter measuring Peak will have C weighting available for all the measurements it can make. No test is now specified for any other frequency weighting.

3.1.6 Underrange and Overload indicators.

Meters will now be required to indicate underrange as well as overload. The display of numbers below the bottom of range will not be allowed unless a warning flag of some sort is also displayed and saved with any stored data using these numbers. On measurement ranges where the self-noise of the instrument is on-scale, underrange need not be indicated provided the linearity range specification for that range is fulfilled to the permitted tolerances.

Overload detection remains unaltered, although the tolerances and tests have been tightened.

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3.1.7 Level Linearity.

The biggest change here is the requirement for all meters to have at least a 60 dB dynamic range meeting the tolerances. The old standards only required this value for a Type 1 integrating meter, and reduced to as little as 15 dB for a plain sound level meter. The confusing concept of primary indicator range in IEC 60651 is removed and all the valid measurement range of the entire meter has to meet the same tolerance for all measurements. These tolerances, now including uncertainty, have been slightly simplified but remain essentially similar to those currently in use.

3.1.8 EMC.

The requirements for radio frequency emissions from the meter and its susceptibility to static discharges remain unaltered from the fairly recent additions to IEC's 60651 & 60804. However, the requirements for the meter to be unaffected by radio frequency fields incident on it have been made more demanding. The field strength has been increased to 10V/m across the slightly wider spectrum of 26 – 1000 MHz. The tolerances, now allowing for uncertainty, remain effectively unaltered. This is an attempt to improve the immunity of the meter from the ever-increasing presence of interference from such sources as mobile telephones.

3.1.9 Other Changes.

Time weightings F and S only are now specified. The I or impulse weighting has been removed as its results are often misleading, but a specification for it is included in an informative annex for historical reference.

Multichannel sound level meters are now defined and tests of crosstalk between channels are included in the new Standard.

Tests on the adequacy of the power supplies for acceptable changes between different supplies (either change of battery voltage or changes from internal to external supplies) are now included.

The requirements to be included in the handbook for the meter have increased significantly and it is mandated that this be in printed form.

4. WHAT DOES THIS MEAN TO MEASUREMENTS?

It is often said that modern sound level meters are already so good and contain so many features that the errors in measurement are now due to the operator of the meter and not the meter itself. If this is true, do we need a new standard and what will it achieve? It is undoubtedly true that the operator can have a very significant effect on the accuracy of the readings made with the meter. Where were they standing in relation to the microphone, what about sound reflections at the site chosen and wind and weather effects if measuring outdoors? These effects can often make whole dB's-worth of differences and here we are demanding accuracies in the meter of tenths of a dB. Are these differences worth having and at what price?

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It is impossible to give an exact answer to these questions as the circumstances in which sound level meters are used vary enormously as does the importance of accuracy. What the new Standard achieves can be broadly summarised as follows:-

- The basic parameters remain essentially unchanged.
- The acoustic response, both at normal incidence and for sound arriving from other directions, are defined more accurately, which in turn should lead to more accurate measurement of the sound field.
- The performance of the meter in changing environmental conditions is defined more accurately, and can now be applied sensibly to both Classes of meter, whereas before it was often ignored for Types 2 & 3.
- The dynamic range is more in keeping with real-life measuring situations.
- The EMC requirements are in keeping with the types of interference that can be expected today.

Overall, what the new Standard should achieve is a uniformity of measurement accuracy across all conditions that meters are expected to cope with, to the same degree of accuracy as was previously often obtained only in a test laboratory under controlled conditions.

4.1 What will this improvement cost?

The effect of the new Standard on a well-designed, good quality meter already in existence could be minimal. Where accuracies have been tightened, some designs may not be capable of achieving the new accuracy, but many will. Also the additional tests and test methods now prescribed may require minor changes to existing designs, such as adding an underrange indicator if one was not already displayed. For many meters at the low-cost end of the market, this will, however not be true. It is an unfortunate fact that many of these meters make claims to meet IEC 60651 and IEC 60804 which, if tested properly, are shown to be completely false, but because there is no mandatory testing of these meters to demonstrate the claims made for them, many people are misled into thinking their meter is better than it is.

The new Standard will not eliminate this problem, but it may make it a bit more obvious. Only in countries where evidence of a successful Pattern Evaluation test having been completed is required before products can be put onto the market claiming compliance to IEC 61672 will the improvements described in the paper become effective. In countries (such as the UK), the onus will be on the customer to ask if the meter has undergone successful testing. With this sort of information becoming available on the Internet, this is becoming easier to establish, but educating customers to ask this sort of question is a lot more difficult.

However, the reputable manufacturers will obtain the necessary Approval, and will probably make it more evident than in the past as it will undoubtedly take longer to acquire and cost more. One estimate is that the total time to test a new sound level meter to IEC 61672-2 has increased four-fold over the tests currently being made at laboratories like the PTB in Germany. Only the manufacturer has to pay this, and then only once for each model, but this is bound to have some effect on the selling price of the meter. For a Class 2 meter which was never tested in the past, will manufacturers bother spending all this money when they have not needed to up to now? Probably only if market forces insist, and that will take time to occur in some countries, but almost certainly will lead to price rises for new instruments.

4.2 Periodic verification.

So far I have largely concentrated on the design and pattern evaluation aspects of the new Standard, largely because at present these are the best-defined parts. What also has a considerable bearing on measurement accuracy is whether the instruments are maintained and checked regularly. Part 3 will define the tests to be repeated at whatever interval is thought appropriate. It is unlikely that the Standard will mandate any period (although it may recommend annual or bi-annual) for this to occur as different countries impose National Legislation in this area from time to time, but the tests to be performed can be standardised. As only an outline of the requirements has so far been drafted, it is impossible to say how expensive it will be to perform these tests, but as a target, the total time to test and report has been set at 1 day per meter maximum. If this becomes reality, it will probably increase costs considerably for the laboratories which perform all the tests included – a cost which will inevitably be passed on to the end user. At present, there is no provision for omitting any tests if the meter has that measurement capability, but this may yet change. For a Class 1 meter, the increase may be quite small, especially if the tests can be automated, but for a Class 2 meter at the lower end of the price range, the cost of this testing may well prove higher than the purchase price of the meter. With meter prices generally declining in real terms, but testing needing a skilled operator whose costs continue to rise, this will become an increasing problem which is difficult to easily resolve.

There is no doubt that having equipment regularly checked by competent laboratories is the most reliable method of ensuring the meter is not giving false or misleading results. Anything that promotes more people to have regular checks made is to be encouraged. The increases in measurement performance that the new Standard will produce can easily be lost if the cost of periodic checks deter users from having them made. The working group has a daunting task to try and balance the conflicting requirements of an adequate test routine versus the cost of performing it. Whatever is produced, laboratories such as those UKAS accredited in the UK, will need to produce new procedures to cover the tests in the new Standard, and will soon have to phase out testing to BS 7580 part 1, currently the only Standard defining an adequate set of tests to the specifications in IEC 60651 & 60804, for new meters. Currently, hardly any Type 2 meters are regularly checked. If the new Standard can alter this situation, it will indeed be a significant improvement in overall measurement accuracy.

5. CONCLUSION.

IEC 61672 will make differences to sound level meters in many ways.

- Improve the standardisation of testing both at pattern evaluation and periodic verification stages.
- Make significant improvements to the accuracy of meters under a much wider range of external conditions than previously.
- Give the user more information about the meter's performance and how best to realise it.

However, this is likely to be at increased costs to both the manufacturer and the user. Not every aspect of sound level meter measurements is covered though. Manufacturers have always been able to innovate and add different measurement capabilities that are not defined in any Standard and there is no reason to believe this will not continue to happen. As their usage becomes more common, some of these parameters do in turn become Standards. It is surprising to note that, despite its long history of use, the percentile level, or L_n as it is usually referred to, is not included in

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IEC 61672, which is a shame as there are many different methods employed to produce these answers, and a standard method and test would have been very helpful. It was the wide diversity of methods (and results) that caused the abandonment of its inclusion in the new standard as no consensus could be reached on a single method for its derivation. Equally, although Z weighting does at least define tolerances for a uniform frequency response over the audio bandwidth, it does nothing with any infra- and ultra-sound components which different designs of meters may or may not cope with. Measurements made on this weighting will still be subject to the variability of the meter's design below 10 Hz and above 20 kHz, and this can produce dramatically different readings of the same noise source on different meters.

Whilst there are a few omissions from IEC 61672, when it is complete and published, it will represent a significant advance over the existing Standards that is likely to remain valid for many years to come, leading to overall improvements in sound measuring accuracy.

6. REFERENCES

- 1) IEC 60651:1981 Specification for Sound Level Meters
- 2) IEC 60804:1985 and IEC 60804 Ed.2:2001 Specification for Integrating-Averaging Sound Level Meters
- 3) Uncertainty budgets – are we certain we understand them? R. Tyler. Proc. IOA vol.23 part 1 pp.1 – 7. February 2001.