

### 1. SCOPE

This Operational Practice is recommended by Free TV Australia and refers to the measurement of audio loudness as distinct from audio level. It sets out guidelines for measuring and matching the loudness of programmes, promotional spots and commercial advertisements that are presented contiguously in digital television broadcasting on Australian television services. It is intended as an aid to avoiding the excessive loudness contrasts that can be annoying to consumers. The importance of matching and managing the loudness of soundtracks for television broadcasting is outlined in Appendix 3.

This document should be considered in conjunction with Free TV Australia's OP-48 *Audio Levels and Loudness*. Notwithstanding the guidelines in that OP, this document provides an extra perspective of loudness metering that can now be employed as an adjunct to the audio measuring regime in all stages of the production and broadcasting process. This OP is intended to supplement the sound engineer's ability to consistently measure and match loudness to a reference value where traditional level measurements with VU meters and PPMs have required extraordinary and subjective interpretation because segments that are ostensibly equal in electrical level can be different in perceived loudness.

### 2. MEASURING LOUDNESS AS WELL AS AUDIO LEVEL

The question that arises for many in the field of soundtrack production is "what is wrong with the familiar VU meter and the PPM meter that have been in service for many many years?"

The VU and PPM meters were both developed some 70 years ago and these meters do not accurately measure the reproduced perceived loudness which can be affected by tonal balance and especially the degree of level compression.

Loudness is a human perception that can be difficult to quantify and thus to measure. The International Telecommunications Union (ITU) utilised very extensive human testing to devise a measurement processing algorithm that has been recently updated and published as Recommendation ITU-R BS.1770-3 "*Algorithms to measure audio programme loudness and true-peak audio level*". When implemented in a suitable metering system it provides a good approximation to human loudness perception suitable for television and radio programme audio loudness measurement.

As a result of this development and the adoption of the principles in BS.1770 by administrations in Europe and the USA, the broadcast and production industries have the ability to measure and hopefully better control the loudness of audio material by using these loudness measurement units to supplement level measurements.

Meters conforming to the Recommendation ITU-R BS.1770-3 indicate a unit-value for the loudness summed over an appropriate interval of time. This method provides a good facsimile of the processes involved in the human perception of loudness that cannot be directly reproduced by VU meters or PPMs.

Recommendation ITU-R BS.1770-3 has a companion Recommendation ITU-R BS.1771 "*Requirements for loudness and true-peak indicating meters*" giving operational, display and control requirements. The loudness instrument that has been specified in this

Recommendation was conceived to be as simple and inexpensive as possible. The configuration of loudness meters is outlined in Appendix 1.

While loudness is a concern of the audience, broadcasters also need to take account of headroom in the transmission chain, and so along with the loudness algorithm, a true peak algorithm was defined in BS.1770-3. Although the level meter may still be useful for preserving headroom in some broadcasting systems, only a true peak indicating meter is capable of representing the excursion of the wide dynamic range signals that can occur in digital audio systems.

**Loudness and level are two different things.** If two different audio segments are aligned to equivalent loudness, their level measurements may not be equal. That may, at first be confusing for those who have been trained in VU or PPM meter operation.

A loudness meter compliant with BS.1770-3 is a long term integrating meter suitable for measuring the finished product e.g. a 30 second commercial or a 90 minute movie. It is NOT a production tool to be used for mixing. Its purpose is to *normalise* the finished soundtrack to a standard loudness value and to that end, such meters will be found in Post/Mastering, Distribution and Broadcasting. Production techniques should remain as present with VU/PPM or equivalent meters, using standard level control techniques. The production process can now be completed by *normalising* the soundtrack using the BS.1770-3 loudness measuring method.

The architecture and workflow of each production or operation will be different and normalisation may be performed at different points, including the “Ingest” or quality control point of a broadcast plant.

### 3. LOUDNESS REFERENCE LEVEL

Loudness normalisation begs the question – *to what loudness target?* This has now been answered by the ITU. For the purpose of loudness measurement we are measuring the electrical (data) signal of the soundtrack in question. We are not concerned with acoustic levels. The answer to the question is, *-24LKFS*<sup>1</sup>. In other words the BS.1770-3<sup>2</sup> Loudness meter brings with it a new scale and measuring unit, the LKFS:

“L” for loudness,  
“K” indicating the unique filtering of the meter algorithm, and  
“FS” for full scale (digital).

If a signal does not measure *-24LKFS*, the adopted *target loudness*, then correction (normalisation) to match that value is very simple.

EXAMPLE A: if a soundtrack measures *-28LKFS*, this means it is “softer” (further down the scale) than the target. This is simply corrected (normalised) by applying a 4dB gain increase – the steps between LKFS units are equal to 1dB intervals.

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<sup>1</sup> Refer ITU-R BS.1864 Operational practices for loudness in the international exchange of digital television programmes.

<sup>2</sup> Loudness measurements made on BS.1770-2 and BS.1770-3 meters are identical.

EXAMPLE B: if a soundtrack measures -18LKFS, this means it is “louder” (further up the scale) than the -24LKFS target. This is corrected (normalised) by applying 6dB of attenuation (gain reduction). Remember that the BS.1770-3 compliant meter is indicating relative levels of perceived loudness. It is not indicating differences in electrical levels in the same fashion as VU meters and PPMs.

#### 4. RECOMMENDATIONS

The following principles are recommended for effective management of loudness in digital broadcasting:

- a) All loudness measurements should be made using a meter complying with Recommendation ITU-R BS.1770-3 and indicating its loudness measurement with a numerical readout. Note: Meters compliant with earlier versions of ITU-R BS.1770 may be used but will not have the full feature set available on BS.1770-3 meters. See point 5(d) below.
- b) That for the exchange of digital television programmes not employing metadata to indicate loudness level, then the target loudness level value should be -24LKFS.
- c) The permitted deviation from the target loudness level of -24LKFS shall generally not exceed +/- 1 loudness unit, except for programmes where exact normalisation to target level is not practicable.
- d) That for the exchange of soundtracks on digital television programmes that employ metadata to indicate a loudness level, then that metadata value should correspond to the measured loudness value as per BS.1770-3<sup>3</sup>. This value should be used for the “Dialnorm” metadata word in an AC-3<sup>4</sup> transmission encoder.

Loudness normalisation as described above will bring signals to the standardised ITU loudness level of -24LKFS. The loudness of such soundtracks will then match and the listener will be provided with more consistent perceived loudness when segments are presented sequentially.

#### 5. MEASUREMENT PRACTICES.

In both the cases of Recommendations 4 (b) and 4 (d) above it is possible to measure the loudness value in two ways.

- By measuring the dialogue component only.
- By measuring the full mix i.e. all components of the mix.

Both methods have their place in the production of digital soundtracks for television depending on the nature of the programme content.

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<sup>3</sup> The audio coding schemes used by Australian television broadcasters are outlined in Appendix 2

<sup>4</sup> Also known as Dolby Digital.

With most TV programme soundtracks which tend to be dialogue centric, the first method is satisfactory – the dialogue to be measured is defined as “normal dialogue” i.e. normal spoken dialogue, not shouting and not whispering.

With music soundtracks or soundtracks where music or other material may be more significant, then the second method is desirable.

Note for multi-channel audio measurements; at this time the LFE track has not been included in the BS.1770-3 algorithm.

**a) Dialogue Only Measurement**

Dialogue-only measurement presents a problem in that the dialogue has to be separated for measurement. In the case of multi-channel soundtracks this may seem easy as the centre channel (dialogue channel) is available for measurement. However, a BS-1770-3 meter will measure the sum of all channels (except the LFE) in a 5.1 mix thus choosing an appropriate section of content is still required. In the case of mono and stereo soundtracks, separating the dialogue for measurement is only possible using either a specialised metering system, or by manually reading a short-term meter. When the loudness meter or soundtrack content does not provide a reliable method to separate dialogue, a measurement of the full mix should be made.

**b) Short Form Material**

Due to the increased difficulty in isolating dialogue in short form soundtracks particularly where other soundtrack elements are high in level in the mix, It is recommended that **all** short form soundtracks such as commercials, promotions and similar shall use the measurement method of **full mix** measured over the total duration of the soundtrack.

**c) Long Form Material**

In the case of long form soundtracks the measurement method shall be as best defined by the nature of the programme genre as in [5] above. Because of time constraints, it will usually be necessary to measure a sample of the soundtrack. It is **vital** that the sample be of sufficient duration and **representative** of the total soundtrack, otherwise a false reading will occur, leading to incorrect normalisation.

**d) Implications of Revisions to BS 1770**

Recently the original BS-1770 recommendation has been revised to BS-1770-3. The revised recommendation includes a feature for gated measurement of programme loudness, thus measuring “foreground loudness”<sup>5</sup>. This revision can improve the accuracy of measurements of programmes with wider loudness ranges. Where possible, Loudness meters incorporating the revised standard should be used and have their gate set with a relative threshold of 10LKFS below the ungated LKFS

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<sup>5</sup> Loudness measurements made on BS.1770-2 and BS.1770-3 meters are identical.

loudness level. The latest version of BS-1770, -3 also includes a better defined filter for True Peak measurement.

**e) Relative Levels between Program Segments**

Loudness differences can occur between programmes, between programmes and commercials/promotions, and between services. Thus the basic problem is one of **relative** levels between the above and this requires both programme and commercial/promotion content be normalised for transmission to a loudness of -24LKFS.

**f) Dealing With Wide Loudness Ranges in Programs**

Very wide loudness range soundtracks provide an additional problem to meaningful loudness measurement. Fortunately these soundtracks are in a minority. Further work is being done to standardise a method of measuring “Loudness Range” and defining what may or may not be a problem with respect to range. Prior to the availability of loudness measurement these soundtracks required a degree of compression to reduce the loudness range to an acceptable level and to provide a soundtrack which can be more reasonably matched to normalised programme listening. (Further information can be found in the AES Convention Paper 7948 – October '09 – Loudness Descriptors To Characterize Wide Loudness Range Material)

**g) Dialogue or Full Mix Measurement**

In the process of measurement the loudness value should be noted as an LKFS value and whether the measurement is referenced to dialogue or full mix should be indicated. This information should be recorded in the metadata stored with the programme (or, as a minimum, written on the soundtrack labelling).

**h) True Peak Level**

BS.1770-3 also specifies a “True Peak” meter (previous Peak meter devices have largely been inaccurate). The display of this True Peak meter may be configured as a moving bar-graph, or, as simply as a warning light flashing when a preset level is reached. If such a meter is used, it is necessary to ensure that the True Peak level does not exceed -2dBTP i.e. that the material as measured does not go to 0dBTP.

**i) Working in a File-based Environment**

File-based operations will become more common in the future. The system architecture and work flow will be different, but the necessary corrections and normalisation are the same as for existing digital (or analogue) systems. Purpose-designed file based devices are now available for this necessary loudness processing.

## APPENDIX 1

### **LOUDNESS METER CONFIGURATIONS**

Some implementations of loudness meters may provide a moving bar-graph as an additional display to the numerical readout. The scale on this bar-graph will most probably be calibrated in “LU” units (Loudness Units) with respect to 0LU which is the target loudness value (-24LKFS). Thus the scale is read as so many LU units above or below 0LU. The step between LU units, as with the step between LKFS units is equal to 1dB on all channels.

## APPENDIX 2

### **AUDIO CODING SCHEMES SPECIFIED IN AUSTRALIAN TELEVISION BROADCASTING**

In Australia two quite different audio coding schemes for digital television services are applied.

- MPEG-1 Layer II (commonly just called MPEG).

This coding scheme codes two audio channels (Stereo). It is most commonly associated with the Standard Definition digital television service. From the point of view of this document, its important characteristic is that it does **NOT** have an inbuilt level control mechanism i.e. metadata.

- Dolby Digital, otherwise known as AC3.

This coding scheme codes from one to six audio channels – and is thus used for multi-channel 5.1 transmission. It is most commonly associated with the High Definition digital television service. Dolby Digital does incorporate an inbuilt level control mechanism using control information called “Metadata”. This Metadata (control information) is inserted by the television broadcaster and travels with the soundtrack bit stream to the DTV receiver. This Metadata has many components, but the part we are concerned with, in the context of loudness, is the Metadata word “Dialnorm” (dialogue normalisation). This Dialnorm data word controls the gain (actually attenuation) of the audio signal in the Dolby Digital decoder in the DTV receiver. The decoder output is specified to be at a constant level (-31LKFS).

The “value” of this Dialnorm word which is inserted during the transmission process is in fact a variable which can have any value between 1 and 31.

**For any given programme or soundtrack, the key to understanding the value of Dialnorm inserted at transmission is that it is the LKFS Loudness number measured for that programme or item with the BS.1770-3 meter.**

When the Dolby Digital decoder in the DTV receiver reads the Dialnorm value, it does some internal sums and applies the correct value of attenuation to the signal to give an output of -31LKFS. Thus it does this process for each programme or item – producing a constant -31LKFS loudness output, **but only if the original Dialnorm words have been correctly measured using the BS.1770-3 meter.**

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If the Dialnorm words are not appropriate then the loudness output will not be consistent and the listening experience will be compromised.

Thus the key to successful soundtrack production is that every programme or soundtrack must be read by a BS.1770-3 meter, and that information; the Dialnorm number, then be transmitted with that programme or soundtrack as part of its unique Metadata.

Australian television broadcasters encourage the accurate authoring of the Metadata supplied with programmes soundtracks i.e. the Dialnorm number being valid and not just set at the Dolby Digital default value. If this is not the case the broadcaster will find it necessary and wise to measure the Dialnorm value and make appropriate corrections.

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**APPENDIX 3****THE IMPORTANCE OF MATCHING LOUDNESS**

As a result of the findings of an Australian government inquiry in 2001/2002<sup>6</sup>, Australian free to air broadcasters have given an undertaking to the Australian Communications and Media Authority that they will manage the loudness of advertisements relative to adjacent programming, within the terms of the broadcasting industry's voluntary Code of Practice. This approach relies on co-operation between advertisers, producers and broadcasters. It differs from some other countries wherein regulations for loudness management are mandatory and there are penalties in place for broadcasters and advertisers who fail to comply with those regulations.

In Australia some basic loudness management techniques have been implemented in the form of Free TV Operational Practice OP 48<sup>7</sup> which advises producers to be conservative in their use of techniques such as compression, limiting and spectral manipulation (equalization) that can increase the perceived loudness of audio material.

It is well understood that television viewers are not happy or satisfied with a sequence of audio segments which vary in loudness, especially when there is excessive contrast between programme and commercial soundtracks. This is not a new issue and has been the subject of many complaints over the years. However, it is true that the advent of digital audio transmission with its possible wider loudness range has made the problem more difficult to manage.

This problem is worldwide, not just local, and as a result the International Telecommunications Union (ITU)<sup>8</sup> has been working on this problem for some years and has recently finalised the initial Recommendations that are necessary to create standardised worldwide loudness measurement and control. These are;

Recommendation ITU-R BS.1770-3 defines the measuring algorithm – the instrument or measuring tool, and also defines a means of measuring true peak levels.

Recommendation ITU-R BS.1864 *Operational practices for loudness in the international exchange of digital television programmes* defines how to use the measuring instrument to achieve consistent loudness in the exchange of digital soundtracks accompanying television programs.

A number of administrations have now in place recommended practices with advice implementing the BS.1770 method to achieve consistent loudness in broadcasting operations e.g. ATSC A/85 (2009) *Techniques for Establishing and Maintaining Audio Loudness for Digital* and EBU Recommendation R128 *Loudness normalisation and permitted maximum level of audio signals*; are two such recommendations that are referenced in this OP.

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<sup>6</sup> Refer [http://www.acma.gov.au/WEB/STANDARD/pc=PC\\_91342](http://www.acma.gov.au/WEB/STANDARD/pc=PC_91342)

<sup>7</sup> Refer [http://www.freetv.com.au/Content\\_Common/pg-Engineering-Guides.seo](http://www.freetv.com.au/Content_Common/pg-Engineering-Guides.seo)

<sup>8</sup> Australia and Australian television broadcasters participate in the development of international standards in the ITU – refer <http://www.itu.int/ITU-R/index.asp?category=study-groups&mlink=rsg6&lang=en> .



It should be noted that the ITU has also published Recommendation ITU-R BS.1771 which describes notional physical attributes for an instrument for measuring loudness. Although some current instruments may be labelled *BS.1771-Compliant*, the human-interface of current loudness meters is more sophisticated than that described in BS.1771, and a single number display (e.g. **-24**) is now the preferred presentation for the loudness of the material being measured.

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