Subject: GENERAL INFORMATION - THE VOLUME UNIT (VU)

1. PURPOSE:-

The purpose of this procedure is to disseminate, to A.B.C. BROADCAST OPERATIONS AND ENGINEERING management and engineering personnel concerned, general information on the (vu) volume unit.

2. SCOPE:-

The material contained in this procedure is intended as an informative article—and should be of use or interest to most management and engineering personnel.

3. CREDIT:-

The material contained in paragraph 4 below has been taken from:

AMERICAN STANDARD PRACTICE FOR VOLUME MEASUREMENTS OF ELECTRICAL SPEECH AND PROGRAM WAVES. Number C16.5-1954 (Reprinted from the Proceedings of the I.R.E., Volume 42, no. 5, May 1954.)

4. REPRINT:-

THE VOLUME UNIT (VU)

Many audio engineers do not understand the vu, for it is a difficult unit to describe in words. Perhaps it would help to state what the vu is NOT:

The vu is not a unit of measurement for power or power level. (As are the watt and dbm.) The vu is not a unit of measurement of loudness. (As is the phon.) In fact, the vu has no relationship to any other unit of measurement encountered in electrical communication.

Nevertheless, it is one of the most useful tools of the audio engineer, as it is used in the stating of the level of complex nonrecurrent and nonperiodic waves (music and speech) of electricity.

The vu should not be used for steady-state waves, just as the dbm must not be used for complex material. The vu and the dbm are highly different units and must be treated so.

VOLUME IN VU IS NUMERICALLY EQUAL TO THE HIGHEST SCALE READING OBSERVED ON A STANDARD VU METER DURING A SHORT PERIOD OF TIME, ADDED TO THE DB ATTENUATION OF THE ATTENUATOR NETWORK THAT PRECEDES THE METER. (Occasional meter deflections of unusually high amplitude may be ignored.)

From the above strict definition, several things may be deduced. First, since the meter reading is constantly changing, the ballistic characteristics of the meter are of great importance. Second, the vu is far from being a precise unit of measurement because it depends on human interpretation of a constantly changing condition.

A "standard vu meter" has a reference point (marked "0") near the upper end of its scale. The ballistic characteristic must be such that: If a sinusoidal voltage of such amplitude as to give reference deflection under steady-state conditions is suddenly applied, the meter pointer must reach 99% deflection in 0.3 second. The pointer must then overswing the reference point by at least 1.0% but not more than 1.5%. When the signal is removed, the

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pointer must fall with approximately the same characteristics that it had when rising.

Unless a meter has the above dynamic behavior, it cannot be a vu meter and cannot be used to determine volume in vu.

Many meter manufacturers mark common AC voltmeters in vu and then call them vu meters. The use of such instruments should be discouraged. Langevin has checked many "vu meters" and found only two U.S.A. firms who produce a true device.

The attenuator preceding a vu meter is calibrated in db and marked in vu. It must be designed specifically for use with the impedances stated by the meter manufacturer. (All U.S.A. firms are standardized on one set of impedances and parameters.)

PEAK FACTOR

The previous was a brief discussion of the Volume Unit. Now a word about "peak factor"...also called "form factor" or "peak allowance".

Whatever we call it, the term means the number that would be added to the program volume in vu in order to determine a dbm level which would produce the same peak power.

Although it is obviously erroneous to do so, peak factor is stated in db.

Let us take an example of how to determine the "peak factor": Assume a vu meter and its attenuator connected across a line carrying program. We observe that the meter pointer deflects as high as -2 on the vu scale. The attenuator is set to +30 vu. Volume level of the program line is +28 vu. Now let us also connect an oscilloscope across the line and mark on its face the observed program peaks. Now remove the program from the line and substitute an audio sine-wave generator. Bring up the level of the generator until the peaks of the sine waves indicate to the marks previously made on the 'scope face. Change the attenuator until the vu meter again indicates near "0" on its scale. If the meter indicates (for example) -1, and the attenuator reads +40, the generator is producing +39 dbm. (Dbm, not vu, because of the steady-state sine wave.) The number 11 must be added to the previously-obtained 28 to get 39, so the "peak factor" is 11 db.

This factor of 11 db is fairly typical. It will be seen that "peak factor" depends on several variables such as program material, microphone technique, studio accoustics, etc. Bland, reverberant music with restricted exhuberance (such as "background" music) usually shows a factor of about 8 db. Medium-miked speech shows 10 db or so. Percussive music in a dead studio will show over 20 db. And if anybody cares to close-mike a xylophone, he will see 40 db. (That first hammer transient is a lulu.) Generally, factors over 20 db can be observed only with unusual program content in a system (including microphone) with extreme bandwidth. (The 40 db peak on the xylophone requires a microphone flat to over 100 kHz.)

It is fortunate that the human ear does not object to occasional clipping of program peaks, or else amplifiers would have to be much larger for many applications. AM radio stations and networks allow only about 10 db factor and clipping occurs often. If the amplifiers clip cleanly, without blocking or base-line displacement, the sound is acceptable. Magnetic tape recorders, even the best of studio machines, saturate on peaks quite regularly, although recording excellently. The peaks cannot be said to be "clipped" on magnetic recorders, as the overload characteristic is "soft"...however, peak distortion is severe. For sound-reinforcement purposes, reproduction is generally satisfactory if the volume of the amplifier (in vu) is kept to at least 10 (db) below the maximum rating of it (in dbm).