TALKBACK

"Talkback" questions are answered by professional engineers, many of whose names you have probably seen listed on the credits of major pop albums. Their techniques are their own and might very well differ from another's. Thus, an answer in "Talkback" is certainly not necessarily the last word.

We welcome all questions on the subject of recording, although the large volume of questions received precludes our being able to answer them all. If you feel that we are skirting any issues, fire a letter off to the editor right away. "Talkback" is the Modern Recording & Music *reader's technical forum.*

The Flux is the Crux

I have heard that Nakamichi uses a different type of equalization for recording than other deck manufacturers, and therefore tapes made on their machines are not entirely compatible with other machines. To the best of your knowledge, is this true?

—Steve Riley
Pocatello, Idaho

Thank you for this opportunity to clarify a common misconception regarding Nakamichi's adherence to standards. The question of what constitutes "standard equalization" is really quite simple—one carefully reads and adheres to published standards. The IEC (International Electrotechnical Commission) publications are *the* accepted standards throughout the world; the one that applies to cassette recording is Publication 94.

Publication 94 specifies the standard *recording* curve in terms of the short-circuit flux on tape as a function of frequency. In theory, the short-circuit flux can be determined by measuring the voltage developed across the terminals of an *ideal* playback head. Please note that it is the *recorded flux level* that is specified—not the playback equalization—for here is the crux of the misunderstanding.

If the ideal playback head existed, it would only be necessary to provide electrical equalization with a low-frequency break point of 3180 μs and a high-frequency break point of 120 μs (for Type-I tape) and 70 μs (for Type-II, III, or IV tape). Unfortunately, the ideal playback head does *not* exist. The main differences between a "real" and an "ideal" playback head stem from the finite polepiece length and the finite gap length of the real head, the magnetic losses in the core and the electrical ones in the windings, and the less-than-perfect contact between polepiece and tape.

Polepiece length affects response primarily at very low frequencies; it produces the so-called "contour effect" otherwise known as "head bumps." The other differences between the real and the ideal affect the high-frequency portion of the spectrum. The head's surface finish has a major impact on "spacing loss" which is most severe at short wavelengths (high frequencies). "Gap loss" comes into play as the recorded wavelength begins to approach the effective magnetic length of the gap. Similarly, the losses caused by the head's finite electrical inductance are most severe at high frequencies, and, in general, magnetic losses in the core also increase with frequency. Fortunately, it is possible to either calculate or empirically determine many of these losses. For example, core and winding losses are easily determined by forcing an appropriate current through the windings with the head connected to the playback amplifier. The difference between the ideal response and the measured response establishes the losses involved. Gap and spacing losses are readily calculated *if* one knows the true magnetic gap length and the actual tape-to-head separation. Since "work hardening" of the magnetic material prevents the true magnetic pole from being actually at the surface of the head, it is imperative that the head be fabricated in such a way as to minimize damaging the magnetic material and thus losing control over where the effective magnetic pole is located.

Play-head losses can be determined quite accurately if proper care is taken in the fabrication of the head. Knowing the losses, one can compensate for them in the playback electronics and so produce the same effect as if one had started with the ideal head specified by the standard. In fact, to be in compliance with the standard, *one must compensate for the playback head losses* for the standard specifies *recorded flux as seen by an ideal playback head.* It does *not* specify playback equalization. If you think about it, this makes a great deal of sense. It is the magnetic recording that is taken from machine to machine, and therefore it is the *recording* that must be standardized. Playback equalizers do not hop from deck to deck and it would be rather foolish to standardize them independently from the playback head with which they are used.

Compensating for play-head losses requires substantial additional circuitry; it also requires carefully controlled head fabrication so that the compensation works. Thus it is not surprising that many less expensive decks avoid this complexity. It is not difficult to convince oneself that one is in compliance with standards merely by adopting a 70 or 120 microsend *electrical* playback equalization, and one can find test tapes whose high frequencies are boosted beyond standard level to confirm one's delusion. On such tapes, a properly equalized deck such as a Nakamichi will appear to have too hot a high end. On a tape recorded in

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accordance with IEC standards, a Nakamichi will have a flat response.

We are very sensitive to this point because some have suggested that Nakamichi recorders are "non-standard" and implied that we have in some way "cheated" in order to achieve the response for which we are famous. Quite the contrary; we have always adhered to the letter of the standard. Actually, as play-head technology improves, we find several competitive decks meet IEC standards at least to as high a frequency as typical test tapes extend.

—Ken Ohba
Marketing Manager
Nakamichi Research (U.S.A.), Inc.
Santa Monica, Ca.

International Equalization— —Red Tape?

I read the letter in the December "Talk Back" column written by Mr. Ohba of Nakamichi Research, and I thought that I could shed some light on the playback equalization controversy. I spoke to Mr. Ohba about this matter, and we both agreed that information from a calibration tape manufacturer might clarify the issue.

Mr. Ohba's thorough description of the equalization process is accurate in every detail. An interesting point that might not be clear, however, is that the only way to measure magnetic flux on a tape is to measure the voltage induced across a head. When the German DIN standards established the 120 us calibration tape standard, BASF and Philips used the best ferrite heads available at the time (mid-60's) as reference heads. It is always an uncomfortable fact that the time for initial standards is also the time when little information is available and equipment is relatively crude.

When the cassette came of age, vastly improved heads, especially the Nakamichi crystalloy head with its incredibly small gap, showed how accurate the original reference head was. The calibration standard had too much high frequency compensation added. The new heads could better resolve the short wavelength flux and produced a rising high frequency response. In 1974 DIN decided to reduce the level of short wavelength flux on the calibration tapes but remain close to the original but technical "wrong" standard in order to maintain compatibility. DIN also made several other minor changes over the years, but Japan was never fully informed about what was happening in Europe. A great deal of misunderstanding arose from the lack of technical communication.

What everyone needed was communication and cooperation on an international basis. The IEC (International Electrotechnical Commission) was established to provide a forum and to set "*the* accepted standards throughout the world," as Mr. Ohba points out. BASF and TEAC worked together on the question of calibration accuracy and compatibility, and both companies manufacture the IEC calibration tapes used to align the heads and playback amplifiers of cassette recorders for flat frequency response at both 120 us and 70 us equalization.

Playback EQ can be a complicated matter because mechanical azimuth misalignment can easily disguise the electrical accuracy of the tape and the amplifier. Nakamichi's ability to resolve incredibly short wavelengths for extended high frequency response is due to the design and finish of heads with extremely small playback gaps and not to "tricks" with equalization. The IEC calibration standard manufactured by BASF will show flat frequency response on all Nakamichi recorders produced for the last few years. This compatibility assures complete compatibility with all other recorders adhering to international standards.

—Terence D. O'Kelly, Manager
Technical Marketing Services
BASF Systems Corporation
Bedford, MA