

Guide to the Basic Technical Equipment Required by Audio, Film and Television Archives

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Edited by George Boston
Written by members of the
Coordinating Committee for the Technical Commissions of the
International Organisations for Audio, Film and Television Archives.

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SECTION 4. AUDIO ARCHIVES

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and William Storm

1. The Archivists Goal

Before describing re-recording techniques, we must first establish what re-recording means to the audio archivist. Re-recording can mean different things to different people. To a collector it may simply mean the copying or transfer of discs to tape for personal pleasure and use. To a commercial operator it may represent a means to generate new revenues.

To the audio archivist, re-recording serves a very specific function; it is a means to preserve the original sonic content of a recording.

In the first two examples, subjective manipulation of the sound during the transfer process is common. The collector may alter the original sound to suit his own taste or the peculiarities of his play-back system. The commercial operator may choose to sell "enhanced" recordings in the belief that they will be more acceptable to modern audiences. These subjective re-recording processes are a luxury - some might call them abuses - not permitted the audio archivist.

The archivist's function is to preserve history, not to rewrite it. Given this precept, the archivist must always strive to maintain objectivity in the application of various re-recording techniques. This rule is easy to state but can be extremely difficult to put into practice.

The first obstacle is to determine what constitutes an audio archival recording. Current thinking in the field defines several types of re-recording of which three are legitimate for archival consideration.

- Type 0 - Inter-archival "replica" ¹
- Type I - Audio history ²
- Type II - Re-creation of the original sound source
- Type III - Subjective transfer

Type III contradicts the role of the archivist and is not acceptable for archival purposes. Types 0, I and II, however, all deserve serious consideration by archivists.

Note 1: The inter-archival "replica" was labeled Type 0 by its author, George Brock-Nannestad, in a letter to William Storm in June 1983.

Note 2: Types I and II were labeled in William Storm's article "The Establishment of International Re-recording Standards", IASA Phonographic Bulletin, No. 27, July 1980.

1.1 The Three Types of Archival Re-recording

1.1.1 Type 0: The Replica

In Type 0, ". . . the intention must be to provide the researcher with a secondary source which is the equal (or at least equivalent) to the original source in as many respects as possible. Indeed, a replica might be preferred and, at least, imagined. If we take one side of an old disc recording, one might obtain a replica by making a negative impression in a suitable polymer and then make another positive from that. Alternatively, one might do what was certainly performed in 1903: grow a metal negative from the disc recording for use as a stamper in a vinyl compound."³

Except for cylinder "replicas" made by pantographic means, today's audio archives do not have the mechanical, chemical or human resources to replicate original disc and cylinder recordings as previously described. This is not to say that the idea should be dismissed: it is simply not current practice. For this reason, Type 0 recording will not be discussed further in this paper. It is, however, a topic that deserves future consideration.

1.1.2 Type I: Audio History

What did a 1910 recording sound like to the people of that time? That is a question addressed by Type I re-recordings. A Type I re-recording is defined as the perpetuation of the sound of an original recording as it was originally reproduced and heard by the people of the era. A Type I re-recording is meant to give listeners a literal historic perspective on the recording and reproduction of sound. This implies the use of the same type of recording machine and medium as used for the original recording.

The original replay equipment, however, introduces replay distortions typical of the technology of the period while modern equipment will normally only add minor replay distortions. The modern equipment will, therefore, faithfully reproduce the sound captured on the historical carrier with real fidelity. The use of modern equipment to replay historic recordings is, therefore, a sub-group of Type I re-recording and is defined as Type IA. Type IA re-recordings will include all the distortions introduced by the original recording equipment but not those introduced by the replay equipment of the period.

Note ³: George Brock-Nannestad, letter of June 3, 1983 to William Storm.

1.1.3 Type II: Recreation of the Original Sound Source

What did Enrico Caruso really sound like in person? This a related but different question to that addressed in Type I re-recording. Historically, all recording and reproducing systems have inherently distorted, to various degrees, the "true" sound (artist) that they have tried to capture.

In a Type II re-recording, the re-recording engineer tries to determine what these distortions are and then, using that information, reconstructs as objectively and as accurately as possible a faithful reproduction of the original sound source (artist).

In short, a Type II re-recording strives to recreate the sound of the original sound source (artist).

2. The Re-recording Studio

Given the precept - "the function of the archivist is to save, not to rewrite, history" - the following guide-lines should be observed in setting up a re-recording laboratory for sound.

2.1 Equipment and Acoustics

2.1.1 Electronic Equipment

All equipment should be calibrated to ensure linearity of the signal path ie. what goes in should come out unaltered. There should be little or no coloration of the original sound because of equipment deficiencies. Properly installed and maintained professional, not consumer, standard equipment has little difficulty in meeting this requirement.

2.1.2 Loudspeakers

The loudspeaker system is worth special consideration. Loudspeakers are still the weakest link in the audio chain and yet they are vitally important to our perception of the sound. It is, after all, the loudspeaker system that couples the electronic systems to our ears and minds. Underestimating the loudspeaker's importance is a major mistake as it will undoubtedly influence critical recording decisions. Speakers selected to reproduce sound objectively should:

- a. have a wide frequency range - at least 25 to 16,000 Hertz.
- b. Have a flat response - ± 3 dB or less.
- c. Have low intermodulation distortion - 0.5% or less.
- d. Have minimal differences in arrival time at the listening position of sound from the different drive units within the speaker - one millisecond or less.

e. Be properly placed in the room for optimum performance.

2.1.3 Room Acoustics

Item 2.1.2 e. above refers to yet another major acoustic weak link in the audio chain - the listening environment. An acoustically poor room can defeat even the best loudspeaker system. As with the electronic equipment and the loudspeaker, the room itself should not colour the sound. A treatise on this topic is beyond the scope of this chapter; archivists should, however, be aware of its importance and consult experts in the field prior to setting up a laboratory.

2.1.4 Summary

In summary, the equipment and acoustic environment used in a re-recording laboratory should be of a professional quality and capable of accurately measuring, recording and reproducing the signals fed into the system.

Signals in this case, refers to original recordings or reproducing systems. These are the subjects of study whose characteristics are to be examined. Such an examination will be impossible if the re-recording testing, recording and reproducing systems are not neutral to begin with.

2.2 Personnel

Given sufficient funds and the correct technical advice any archive can set up a re-recording laboratory. Success for such a facility will, however, only come with the employment of trained professional personnel to perform the work. The degree that the staff must be technically competent will vary with the types of re-recording they are expected to produce.

Type I electrical re-recording requires significantly less technical equipment and knowledge than is needed for Type II re-recording or for Type I acoustic re-recording. In neither case, however, should re-recording be performed by persons not trained in the idiosyncrasies and requirements of the audio recordings that they wish to re-record. Without such knowledge, irrevocable damage can be done to the original recordings.

In short, despite otherwise good intentions, do not allow anyone to re-record original records unless they are qualified to perform the work.

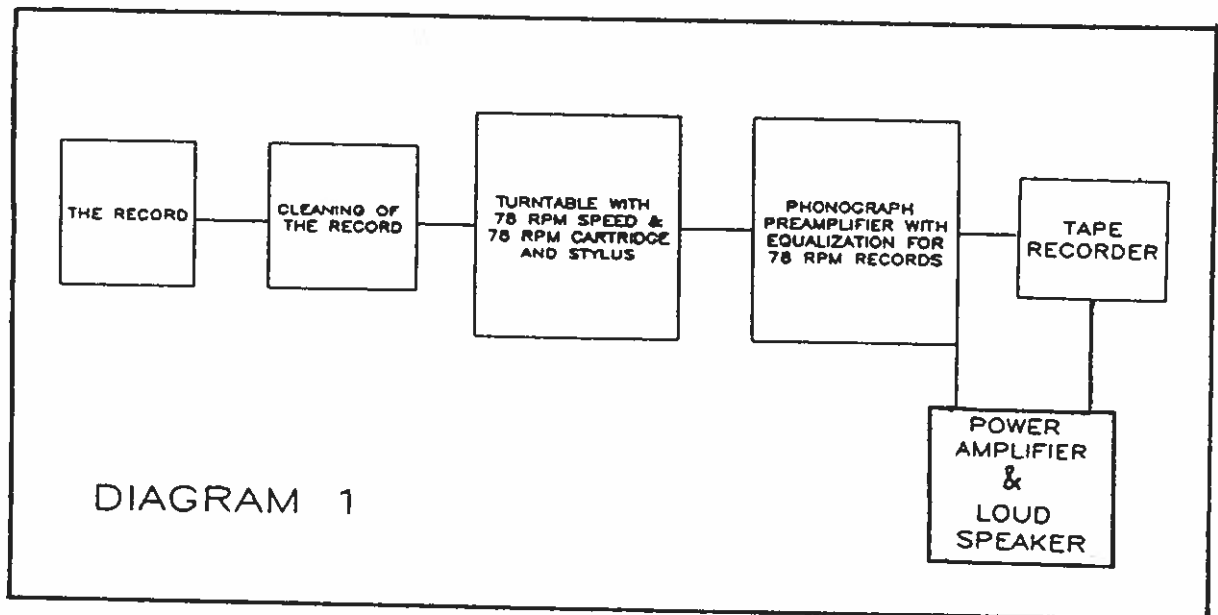
3. Practical Applications

3.1 Commercial Discs

3.1.1 Overview of Re-recording Commercial Discs

Not all archives are going to have the budget and personnel to perform all types of re-recording but, given some training and the right equipment, Type IA electrical re-recording of commercial 78, 45 and 33 $\frac{1}{3}$ rpm discs should be within the capability of most archives.

Re-recording commercially issued 78rpm discs is a reasonable starting place. The minimum equipment needed is shown diagrammatically in Diagram 1.



The re-recording would take the following sequence:

- a. The record is selected.
- b. The record is thoroughly cleaned.
- c. The proper stylus (needle) and tracking force (weight) are determined.
- d. The record is played on the turn-table at the correct speed.
- e. The signal is sent to a pre-amplifier.
- f. The pre-amplifier's output is sent to the recorder and the power amplifier. The power amplifier, in turn, sends a boosted signal to the loudspeaker so that the signal can be heard. Once recorded, the tape signal can also be sent to the power amplifier and loudspeaker to check the quality of the copy and for listening purposes.

The tape recorder selected for producing master preservation copies should be an analogue reel-to-reel machine. Full track recording is recommended for mono recordings and half track stereo for stereo recordings.

This system and procedure is similar to most people's home stereo operation. There are, however, a number of very important differences.

The stylus is not the same as used on modern stereo recordings. Over the history of 78rpm recordings, stylus size and tracking force varied. So the first important difference is stylus size and tracking force and their proper selection. Please also note that the 78rpm disc was monophonic. This factor must be taken into account in the electrical set-up.

In addition to stylus variation, manufacturers also varied the electrical play-back characteristics of 78rpm discs. This factor must be taken into account when playing back the discs. The simplest way to manage this problem is to use a pre-amplifier that permits the selection of different play-back equalization curves. This is not a major problem as pre-amplifiers built for 78rpm discs usually have labeled selector switches or some accompanying literature that indicates the proper curve to use for various makes and labels of disc. In addition, these specialized pre-amplifiers will usually convert a stereo cartridge output signal into the mono signal required for re-recording 78rpm discs.

Proper selection of stylus size and tracking force accompanied by correct play-back and equalization does not solve all the problems that might be encountered. Accounting for these variables will, however, normally permit acceptable re-recording of most commercially issued 78rpm discs that are in reasonably good condition.

In fact, re-recording personnel who have not accounted for these factors and have resorted to the use of noise reduction devices without first understanding basic play-back parameters, will find that most of the unwanted noise is created by not employing the correct play-back equalization.

3.1.2 Choice of Equipment

Given this general perspective, a number of practical points must be considered in selecting re-recording equipment. Nowadays, record players capable of playing 78rpm discs are becoming increasingly difficult to find. The same will apply to 33 and 45rpm disc players before many years are gone. Indeed, most record companies have already ceased to produce vinyl discs in favour of the CD.

The requirements for equipment to play predominantly shellac based 78rpm discs are basically the same as for the vinyl LP with the following points being emphasized:

- a. Variable speed turn-table.
- b. More robust cartridge cantilever.
- c. Range of stylus sizes.
- d. Choice of replay equalization characteristics.

Taking these points in turn:

a. Variable Speed Turn-table - Usually the only reason for having a "pitch" control on a 33rpm turn-table is to allow the user to "tune" the record to a "live" instrument. The speed of the record machine is likely to have been close enough to the nominal speed of the replay machine to satisfy all but those blessed (or cursed) with "perfect pitch".

Variable speed is, however, an essential requirement for playing so-called 78s because many of them were in fact recorded at speeds greatly different to that nominal speed. 80rpm was a common speed for many of the earlier recordings and some early recordings on the Victor label were recorded at 76rpm. A range of speeds from 60 to over 86rpm may be necessary to cope successfully with acoustic recordings made prior to about 1920. Pathe records, in particular, usually run at speeds between the high 80s to over 100rpm. A speed range of between 72 and 84rpm will, however, cover over 90% of commercial pressings.

To achieve this variation it may be necessary to use a professional machine although it may be possible to find an example of a good quality "domestic" machine such as those made by Lenco and Thorens. These will serve perfectly well at a cost much less than that of a professional model.

Ideally a means of speed read-out is a desirable feature to permit the rapid setting of play-back speed where this is known.

b. Robust Cartridge Cantilever - The tracking force requirement of the pick-up for 78rpm discs is usually more than that required for the satisfactory tracking of a vinyl LP, even a warped one. For example, a two or three millimetre ripple on a record revolving at 33rpm is not going to put as much strain on the stylus assembly or try to throw it as far out of the groove as the same degree of warp on a record revolving at 78rpm. Badly warped 78s can require tracking weights of 100 mN (10 grams) or more. A typical 78rpm disc will require a tracking weight of up to 50 mN (5 grams). Very badly warped discs may even have to be played, and re-recorded, at half speed to keep the stylus tip in contact with the groove walls.

c. Styli - A vinyl LP has a well defined groove size and an equally well specified stylus shape to play it. The only real choice is between a round and an elliptical stylus profile. There are a number of manufacturers offering a wide variety of styli for sale with a wide range of prices. While the same is, to some extent true for 78s, very few manufacturers offer 78 coarse groove styli as standard - Shure and Stanton being two of the exceptions - and a far greater range of stylus sizes is needed to get the best results from a range of records.

The normal size is a 65 μm (0.0025 inch) radius, spherical ended cone but a range of sizes from 50 μm (0.002 inch) to 100 μm (0.004 inch) in 12 μm (0.0005 inch) steps should be aimed for. It may be necessary to go to a specialist supplier for anything but the "normal" 78 tip.

Compared to a standard size, a stylus tip from the range quoted above can often be found to give significant improvements in terms of surface noise or distortion. Unfortunately these two undesirable characteristics are frequently mutually exclusive. One is then forced to choose between styli that give less noise but more distortion than the "standard" or one that decreases the distortion but at the expense of an increase in the perceived noise.

For points with a diameter larger than the standard 65 μm (0.0025 inch), a stylus with an elliptical profile is to be preferred to reduce tracing distortion due to what is known as the "pinch effect". The truncated elliptical profile usually gives better results than the normal conical, or even, the normal elliptically shaped stylus.

One company that is world recognized in its ability to grind diamond or sapphire points to almost any shape and size and to attach them to almost any make of stylus on request is Expert Pickups⁴. They are also willing to advise on the subject.

So far the discussion has assumed that the grooves in the disc are modulated from side to side, ie. are laterally cut and that the pick-up used is a standard stereo cartridge. In this case the two channels of the cartridge are connected in series or, preferably, left as separate left and right outputs that are combined electrically in the pre-amp to give a monophonic output. There were, however, a few records that had the grooves modulated vertically - "hill-and-dale" cut; the Pathe label being one noted example. If these discs are played with the same set-up, there will be very little signal produced, but lots of noise.

Note ⁴: Expert Pickups, P.O. Box 3, Ashstead, Surrey KT21 2QD, England

To get the correct signal from a vertically modulated groove, one of the outputs from the pick-up cartridge has to be inverted or made "anti-phase" with reference to the other. This may be achieved by reversing the "hot" and "ground" connections on one side of the cartridge or, a much preferable method, by having a "Phase Inversion" switch on the pre-amp. This latter method makes for easier and safer switching between laterally and vertically cut discs.

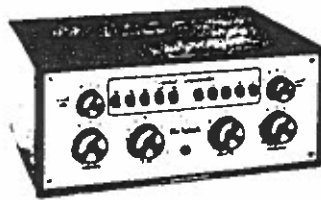
The grooves of vertically cut discs are usually wider than standard 78s and require a cylindrical, not cone shaped, stylus with a spherical tip of between 100 μm and 200 μm (0.004 and 0.008 inches) radius. If this cannot be obtained, it is often possible to use any stylus shape and size providing that it is not too large to sit fully in the groove.

d. Equalization - To achieve the optimum fidelity of reproduction from the records it is necessary to "equalize" for the magnetic and mechanical groove characteristics. These early recordings were made with very different characteristics to those used for the standard microgroove LP RIAA equalization curve.

Apart from Decca frr recording, which applied some treble lift above 6.3KHz, no treble boost was applied to the recording process and, therefore, no treble roll-off is needed in the play-back pre-amp. Also, as a general rule, less bass cut was used; the turnover frequency for the application of bass boost being half that of the RIAA curve ie. a replay requirement for bass boost of below 250Hz instead of the 500Hz of the RIAA specification. Over the history of 78s, the turnover point varied between manufacturers and even between labels issued by the same manufacturer. The attached chart (Chart 1) is part of the instructions for a typical good quality audio equalizer made in the 1950s - the last days of the 78 - by MacIntosh Audio and lists some of the record labels that the equalizer will handle.

The chart gives a good indication of the sheer number of record labels, many of them employing their own equalization curves, current during the era of the 78rpm record. It can also be seen that playing commercial 78s through a pre-amp intended for LPs will give an excess of output in the bass frequencies and a lack of sparkle in the treble. While this configuration may sound quieter, it is incorrect. It will also not permit specialized noise reduction units such as the "Packburn"⁵ to work at their best. These rely on the steep rise transients generated by scratches and cracks in the disc surface for their operation and any treble attenuation, whether caused by using the wrong equalization or by using a tone control, will interfere with this process.

Note ⁵: The Packburn is a signal processing device that, in some circumstances, can reduce the effect of pops, clicks and surface noise on records. Further details from Packburn Electronics, PO Box 335, Dewitt, N.Y. 13214, U.S.A.



RECORD COMPENSATION with the McIntosh Professional AUDIO COMPENSATOR

The recording process requires that the loudness of the music over portions of the sound spectrum be artificially raised or lowered to get the most on the record. (Treble range is boosted to mask surface noise; bass range reduced in volume to conserve groove space and reduce distortion.) To get the most out of the record we must reverse this process. Recommended reverse or playback characteristic curves are given on this chart.

The McIntosh Professional Audio Compensator, like all McIntosh Audio equipment, is designed and

built to the highest standards. Because of this, a single knob to select recording curves has been avoided. The curve for a single recording company will vary from record to record and year to year and would therefore make equipment changes necessary.

The McIntosh Compensator can be used with any amplifier. However, the finest results will be obtained when used with McIntosh basic amplifiers MC-30 (30 watt) or MC-60 (60 watt), because of their extremely high quality performance with unmatched low distortion.

MANUFACTURER	Speed	BASS [Turnover]	TREBLE [Roll-off]	MANUFACTURER	Speed	BASS [Turnover]	TREBLE [Roll-off]
ALLEGRO	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	COLUMBIA *	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		LP	NAB			300	NAB
AMERICAN RECORDING SOCIETY *	33	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	CONCERT HALL * CONTEMPORARY * CORAL	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		NAB	ORTHO			AES	AES
ANGEL	33	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	COOK	33	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
		NAB	AES			NAB	AES
ATLANTIC *	33	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	DECCA *	33 45 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		NAB	NAB	DIAL	33	LP	NAB
AUDIOPHILE	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	ELECTRA	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		300	-8			629	NAB
BACH GUILD, BANNER	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	EMS *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
		LP	NAB			AES	AES
BARTOK BOSTON *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	EPIC *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		629	NAB			LP	NAB
BLUE NOTE *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	ESOTERIC	33	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
		AES	AES			NAB	AES
CAEDMON	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	EUROPEAN	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		629	-11			280	0
CAPITOL *	45	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	FESTIVAL	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		NAB	AES			LP	NAB
CAPITOL *	33 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	FOLKWAYS	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		AES	AES			629	NAB
CANYON * CAPITOL - CETRA COLOSSEUM *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	GOOD TIME JAZZ *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
		AES	AES			AES	AES
CETRA - SORIA COLUMBIA *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	HANDEL SOC. HAYDN SOC. *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		LP	NAB			LP	NAB
COLUMBIA *	45	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	LONDON *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		NAB	NAB			LP	-10

Each person plays his records in a room with individual acoustical characteristics. To assure yourself of the greatest listening pleasure, you will want to use

the additional FINE bass and treble control knobs. (Turning to the left of 0 adds de-emphasis; turning to the right of 0 adds emphasis.)

MANUFACTURER	Speed	BASS (Turnover)	TREBLE (Roll off)
LONDON *	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> 290	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> -6
LYRICORD *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> 629	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
MERCURY *	33 45 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
MGM	33 45 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
MONTILLA	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ORTHO	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ORTHO
NEW RECORDS OCEANIC * OXFORD	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
PERIOD	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
PHILHARMONIA *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
RACHMANINOFF SOCIETY	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
RCA VICTOR (OLD)	33 45 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> 900	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> -10
RCA VICTOR (H. M. V.) NEW RIAA CURVE	33 45 78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ORTHO	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ORTHO
REMINGTON *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
RENAISSANCE	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
STRADIVARI	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
TECHNICORD	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> 900	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
TELEFUNKEN	78	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> 0
URANIA (OLD)	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
URANIA (NEW) *	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> AES
VANGUARD * VOX * WESTMINSTER	33	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> IP	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> NAB
* RIAA, ORTHO, New NABT. New AES used on recordings made since 1955		<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> RIAA	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> RIAA

Set FINE Bass and Treble Controls to 0
except as noted below:
1 Set Fine Bass Control to -2

The flexibility of the McIntosh Compensator enables you to create dozens of playback settings for the finest listening quality. Any possible curve used in recording can be accurately equalized. Depressing the Bass switches reduces the amount of Bass. Depressing the Treble switches reduces the amount of Treble, in varying degrees.

Starting from any given setting, the reading is progressively increased by moving each succeeding switch individually to "up" position, going from left to right. Example: Bass—XXXXX (280); OXXXX (290); X0XXX (310); XX0XX (320); XXX0X (340); XXXX0 (400); ("X" indicates switch in "down" position).

The important point is to adjust your McIntosh Compensator for the reproduction most pleasing to you. When you find that setting, make a permanent record of it on a label provided with the McIntosh. Attach this label to your record or record jacket for ready reference.

BASS	Turnover Frequency c. p. s.	TREBLE	Decibels of Attenuation at 10,000 c. p. s.
00000	1200	00000	— 0
X0000	950*	X0000	— 5 *
0X000	850	0X000	— 7
00X00	800	00X00	— 9
XX000	750*	XX000	—10 *
000X0	680	X0X00	—11
X0X00	640	000X0	—12
0XX00	620	0XX00	—13
X00X0	610	X00X0	—14
0X0X0	600	XXX00	—15 *
0000X	590	0X0X0	—15.5
XXX00	580*	00XX0	—16
00XX0	500	XX0X0	—17
XX0X0	490	X0XX0	—18
X000X	480	0000X	—18.5
0X00X	470	0XXX0	—19
X0XX0	460	XXXX0	—20 *
0XXX0	450	X000X	—20
00X0X	440	0X00X	—20.4
XX00X	430	00X0X	—20.7
000XX	410	XX00X	—21
XXXX0	400*	X0X0X	—21.4
X0X0X	390	000XX	—21.6
0XX0X	370	0XX0X	—22
X00XX	360	X00XX	—22.4
0X0XX	350	XXX0X	—22.9
XXX0X	340	0X0XX	—23
00XXX	330	00XXX	—23.4
XX0XX	320	XX0XX	—23.6
X0XXX	310	X0XXX	—24
OXXXX	290	OXXXX	—24.5
XXXXX	280*	XXXXX	—25 *

X—Indicates switch is down
*—Front Panel Calibrations

McIntosh LABORATORY, INC.
3 CHAMBERS STREET
BINGHAMTON, NEW YORK
Sport Division, 23 Warren St., New York 7, N. Y. Cable: Almonico, New York

The preceding discussion assumes some form of magnetic cartridge. Any other type of cartridge eg. crystal, will require different treatment. Acoustic recordings will also require rather different curves. Theoretically, a "straight line treble roll-off" from about 100Hz will be required.

3.1.3 Summary

From a technical stand-point, Type IA re-recording of 78rpm discs is relatively easy. It is a reasonable way to begin teaching potential re-recording personnel that many factors affect the performance of this task. Re-recording modern discs follows the same basic procedure and can also be included in this repertoire.

3.2 Tape Transfer

3.2.1 Overview of Tape Transfer

Tape transfers are the second major activity in the field of audio preservation. Many archives, especially in the academic and cultural domains, produce or receive original tape recordings on formats not generally recommended for archival use, eg. analogue cassettes. In addition, early recordings made on acetate tape may be physically in danger. In all these cases a transfer to a more permanent medium is necessary. At the time of writing this article, the recommendation from all sources - the manufacturers of machines and signal carriers, archivists and the recording industry - is that sounds to be stored for archival reasons should be recorded on standard play (50 μ m/1.5mil) matt backed polyester tape with low print-through characteristics. A brand that has proved its life expectancy and reliability and made by a reputable manufacturer is to be recommended. The choice of tape is not an area to make cost savings in.

Sound recordings have been made on magnetic tape for over fifty years. In this time many formats have been used. The main variations are in tape width, tape speed and in track layout on the tape. These are discussed later in this section. Whatever the format of the recording, there is one fundamental requirement of any replay machine: it must not alter any of the physical dimensions or damage the tape in any way. For example, the transport must not stretch the tape, the guides must not crease or otherwise damage the edges and the heads must not remove oxide.

For many 0.25 inch/6.3mm recordings, a good quality, modern machine will be available with excellent tape handling characteristics. The amplifiers and heads will be of better quality than the originals. Problems may arise with some of the less common standards, particularly the very slow speed recordings. With these, the original machines may have to be used with, if suitable ones can be obtained, modern heads and amplifiers.

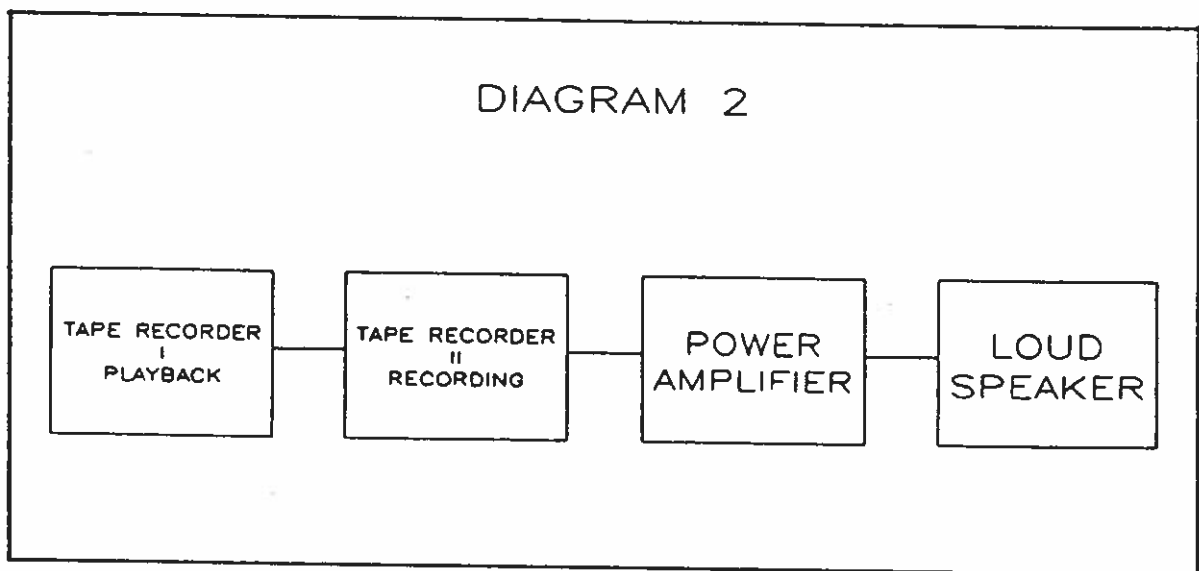
3.2.2 Re-recording Tapes

Before playing any tape, it is recommended that it be carefully spooled back and forth two or three times before copying. This will help to relieve any packing tensions in the tape and reduce the effect of print-through. A visual inspection of any adhesive tape joints should be made and any splices that show signs of age should be renewed.

The basic system for tape transfers is shown in Diagram 2. The procedure is as follows:

- a. The tape to be copied is selected and rewound if necessary.
- b. The tape track format and size are determined.
- c. The designated play-back machine should have the correct head and speed configuration required by the tape in question.
- d. The azimuth of the tape is checked and the replay heads adjusted if necessary.
- e. The correct equalization is selected.
- f. The signal from the play-back machine (the source) is then sent to the recording machine (tape). A tape/source switch on the recording machine or on the monitoring control desk will permit the replay output of either machine to be sent to the power amplifier and loudspeaker.
- g. If the signal from the original tape is under or over-modulated, adjust the replay level controls. This will avoid the introduction of additional unwanted noise or distortion to the new copy.

It must be noted that all of the above procedure assumes the use of a properly calibrated, professional system and trained technical staff.



3.2.3 Tape Formats

The biggest problems, technically and economically, are often the determination of the track configuration, the equalization and the speed of the original tape. The following are some examples of the tape variables that may be encountered:

a. Tape Width

0.15 inch/3.81mm	Used for compact audio cassettes. Also used for the digital R-DAT and S-DAT cassettes.
0.25 inch/6.3mm	The most common tape width. Used for all professional master tapes and for many non-professional purposes.
0.5 inch/12.7mm	Used mainly for semi-professional, multi-track recordings.
1.0 inch/25.4mm	Used for professional 8 track and semi-professional 16 track recordings.
2.0 inch/50.8mm	Used for professional 16 and 24 track recordings

b. Tape Recording Equalization

Tape Speed	NAB Equalization	CCIR (IEC) Equalization
3 ³ / ₄ ips/9.5cm/s ⁶	3180/90 μ s ⁷	∞ /200 μ s (pre-1962) 3180/120 μ s (1962-1968) 3180/90 μ s (post-1968)
7 ¹ / ₂ ips/19cm/s	3180/50 μ s	∞ /100 μ s (pre-1966) ∞ /70 μ s (post-1966) 3180/50 μ s (DIN 19h)
15ips/38cm/s	3180/50 μ s	∞ /35 μ s
30ips/76cm/s	3180/50 μ s 17.5 μ s (AES)	∞ /35 μ s

In general, NAB standards are used in North America, Japan and on domestic equipment world-wide. CCIR (IEC) standards are used in Europe. The correct equalization, unless given in documentation accompanying the tape or known from other sources eg. the recording machine instruction manual, can only be estimated from the

Note ⁶: ips - inches per second; cm/s - centimetres per second

Note ⁷: First figure refers to the low frequency equalization and the second to the high frequency.

origin and age of the tape. Although equalization characteristics are recognized standards, not all recording machines were re-aligned as the standards changed.

The analogue magnetic recording process is highly dependent on the careful alignment of the tape recorder to the chosen equalization characteristic and to the correct parameters for optimum performance from the chosen tape and, above all, on the regular maintenance of these alignments. The quality of tapes recorded on well maintained machines should not be sacrificed by neglecting to find the correct equalization and aligning the replay machine to it. This is particularly important for older recordings. It should also be noted that tapes originating from poorly maintained equipment may differ to a greater degree from their potentially correct performance than is possible to achieve by wrongly selecting any of the various standard equalizations.

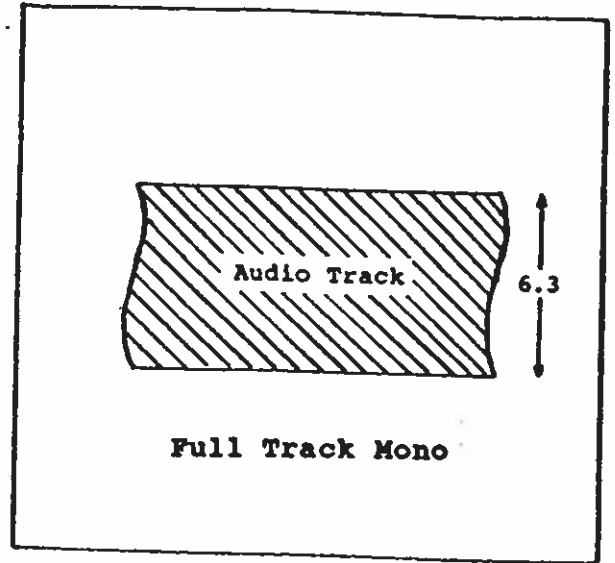
c. Tape Speed - Analogue

$15/16$ ips/2.4cm/s	Used for early "tape-letters" and for logging machines.
$17/8$ ips/4.75cm/s	Used for non-professional speech recordings. Also the standard speed for compact audio cassettes.
$33/4$ ips/9.5cm/s	Used for non-professional speech and music recordings. Also the "high speed" on some modern compact cassette recorders.
$71/2$ ips/19cm/s	Used for professional speech and non-professional music recordings. Also used for the NAB cartridge machines and the 8 track music cartridges used for background music systems and in-car entertainment.
15ips/38cm/s	Used for most professional recordings.
30ips/76cm/s	The original professional recording speed. Now used by some commercial music studios for master tapes.

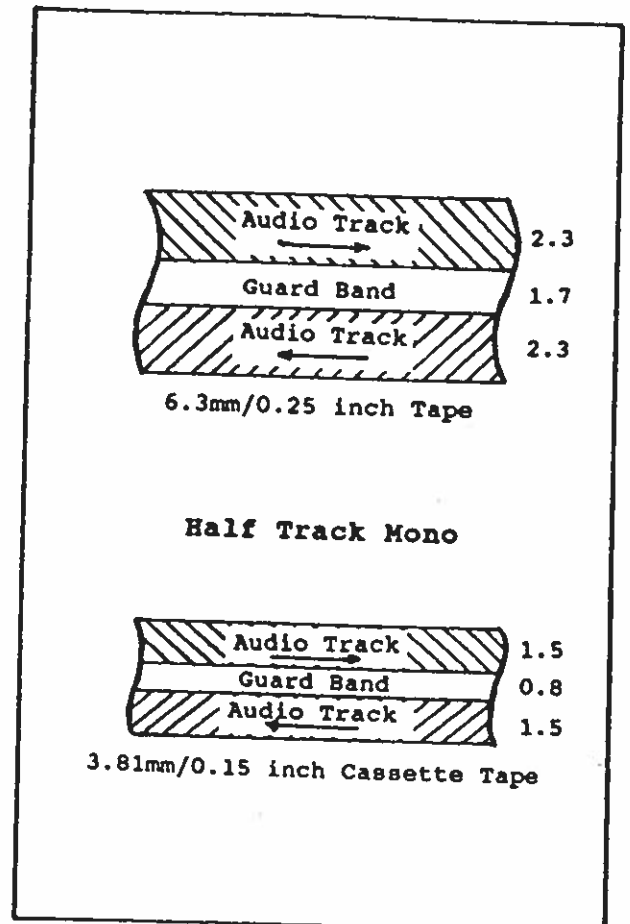
d. Tape Track Layouts

The sketches that follow illustrate the common track layouts that may be found on 0.25 and 0.15 inch tape recordings. For wider tapes, the format is usually that of a multi-track ie. with erase head gaps that erase only the width of track covered by the record and replay head gaps (see Fig. 6 for basic principles).

1. **Full Track Mono** - One direction of recording only. Used by early domestic and professional machines prior to the advent of stereo. The gaps in all the heads cover the full width of the tape.



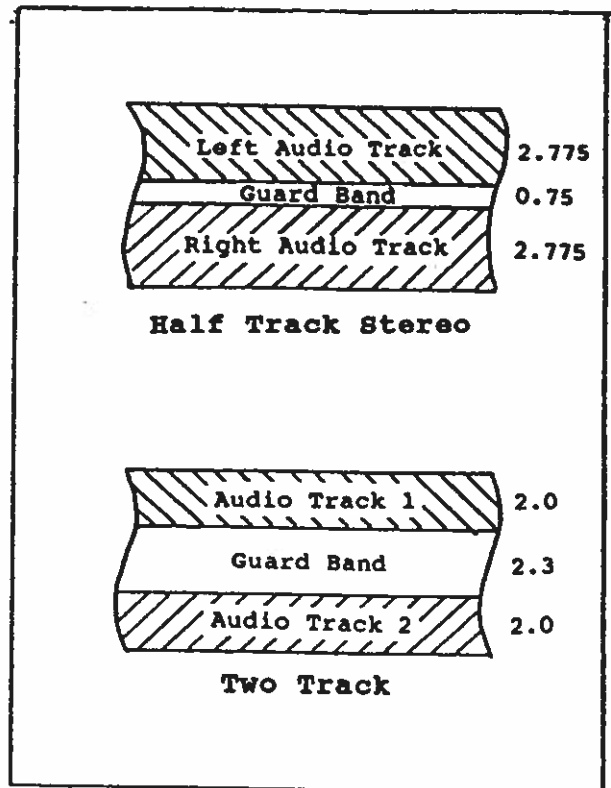
2. **Half Track Mono** - The second track is recorded by turning the tape over and, thus, reversing the direction of travel of the tape. Used for domestic and semi-professional machines and for mono compact cassette recorders. All head gaps cover slightly less than half the width of the tape.



3. **Half Track Stereo and Two Track Machines** - One direction of recording only. The stereo format records the stereo signal in one pass and is found on early domestic stereo and on professional machines.

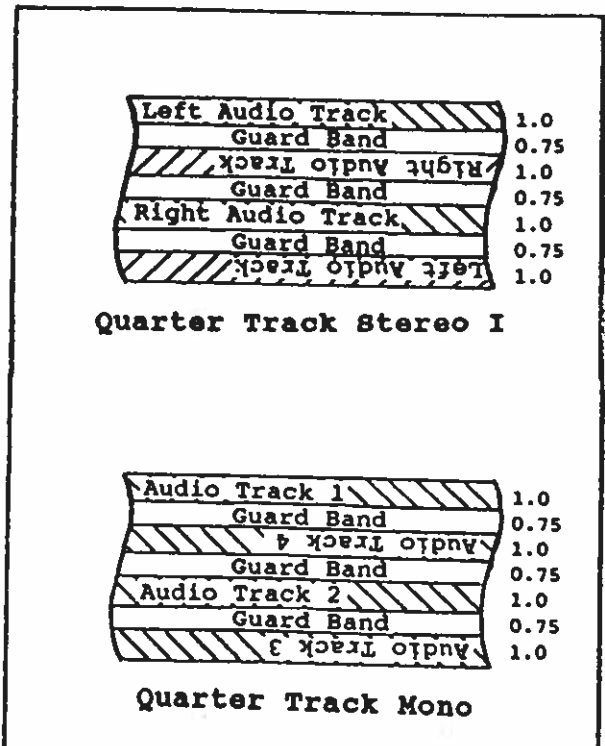
The two track format can either have both tracks recorded at the same time - one stereo or two unrelated signals - or at different times. This format is mainly used for professional work.

The stereo erase head wipes the full width of the tape while the two track erase head can be switched to wipe either or both halves of the tape as required. The record and play-back heads on the stereo format have a narrower guard band in the centre than the twin track format.



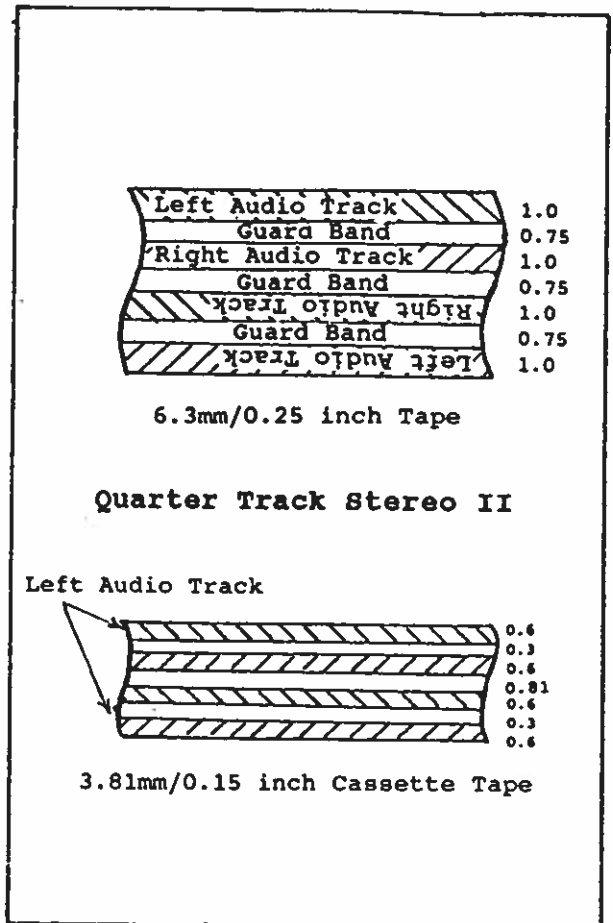
4. **Quarter Track Stereo I and Quarter Track Mono** - The second stereo and third and fourth mono tracks are recorded by turning the tape over. In the mono format, the one set of record and replay amplifiers are switched between odd and even tracks.

Used on early domestic formats as magnetic cross-talk within the head is minimized. Later head improvements led to the track layout shown in the next section.



5. Quarter Track Stereo II

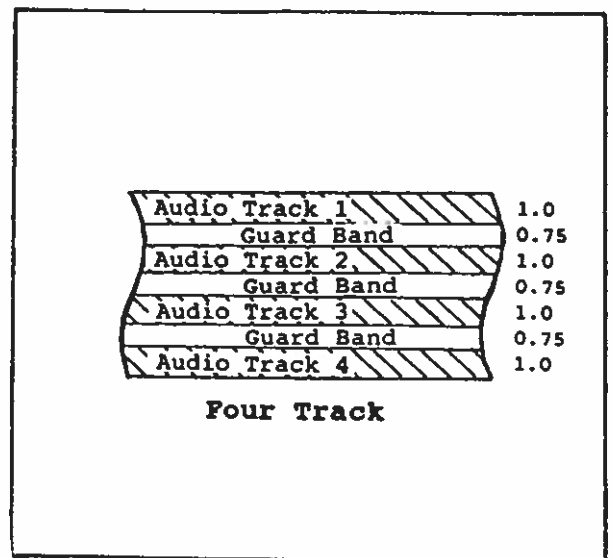
This track layout improves the azimuth and phase relationship for stereo recordings. The format is also used on stereo compact cassette recorders.



6. Four Track Recorder -

This has four sets of record and play-back amplifiers and switch any combination of amplifiers into operation to record and play-back any combination of tracks. It is a domestic and semi-professional format used for simple multi-track music recordings.

The same basic principles are used in professional multi-track machines but with 8, 16 or 24 sets of amplifiers and recording on 1 or 2 inch wide tape.



7. **Half Track Stereo, Two Track Mono and Split Track Mono With Centre Track Synchronizing Signals** - These are used primarily in film and video areas. The centre track is not used for audio but either for a simple film synchronizing signal or the SMPTE/EBU digital time code signal.

The half track stereo machine has an erase head with two audio sections which are switched on and off together and a separately switched section for the centre synchronizing signal track.

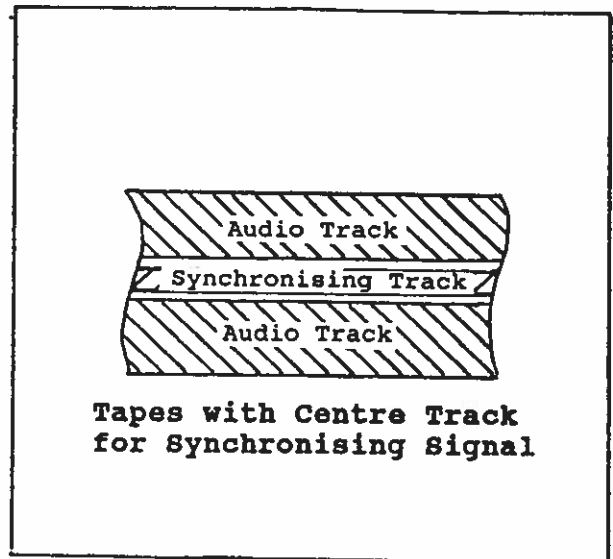
The split track mono machine has the same erase head arrangement but the one set of record and play-back amplifiers are connected to both audio sections of the head.

The two track machine has the two audio sections of the erase head, as well as the audio sections of the record and play-back heads switchable separately.

These are the most common speeds and formats an archivist is likely to encounter. There are, however, others; for example, three audio tracks on either 0.25 inch/6.3mm or 0.5 inch/12.7mm tape.

These variations have economic import because proper play-back of the original tapes must not only be done on a machine that can safely handle the tape at many different speeds but the machine must also have replay heads that match the original format. Quarter track stereo heads, for example, will not play back half track stereo or even full track mono tapes satisfactorily. In both cases, signal to noise ratio will be sacrificed and there is a potential loss of information.

In practical terms, archives must purchase professional machines that can cover the full range of speeds and track formats that are likely to be encountered. No one machine is normally able to handle all speeds although some modern machines are capable of running at several speeds and may, therefore, reduce the number of units necessary. On the other hand, these more versatile machines will cost more. Another requirement is an exchangeable head block. This will permit different formats of play-back head to be used and, therefore, reduce the necessity of buying separate machines for each format. To take advantage of this



interchangeability of head blocks, it is necessary to have a machine with sufficient play-back channels to handle the anticipated maximum number of tape tracks ie. if the archive wishes to play four track, in line tapes, then the archive must have a machine with four replay chains and a four track head block.

It must be emphasised, however, that if interchangeable head blocks are used, the machine must be completely re-aligned before use unless a separate set of amplifiers, pre-aligned to the new head block, are installed at the same time. An alternative is to use a machine that has a micro-processor to store amplifier settings and can re-align the amplifiers automatically as required. These machines, however, do have a limit on the number of amplifier settings that can be stored in the machine's microprocessor at any one time.

3.2.4 Audio Cassette Machines

Audio Cassette machines are also of interest to sound archives but only to play-back any audio cassettes received from sources outside the archive and for making low quality access copies. Audio cassettes are not suitable for archival purposes.

There are some very good cassette machines on the market with excellent tape handling performance. It is unlikely that a cassette will be received that is recorded at $3\frac{3}{4}$ ips. If one is received and the archive does not have a machine that is switchable between $1\frac{7}{8}$ and $3\frac{3}{4}$, the cassette can be copied by running the record machine at half speed when making the copy ie. if, for example, you want to copy the cassette to 15ips, run the recorder at $7\frac{1}{2}$ ips.

3.3 Cylinder Records

This section is intended to give some general introductory information on the subject only. Because of the extreme fragility of cylinders and the danger of damaging or destroying them when playing them, it is strongly recommended that no re-recording of cylinders is attempted without thorough training. Furthermore, if only a few cylinders are to be re-recorded, the authors strongly recommend that they are sent to an archive specializing in this type of work.

3.3.1 Machine Requirements

players for 78 rpm recordings are hard to find, then machines play cylinder records are extremely rare. In many cases they can only be found in antique shops and museums.

Unless a Type I re-recording illustrating the sound of the original system is being made, such machines are not desirable from an archivist's point of view. The relatively crude play-back mechanism can cause irreparable damage to the soft wax and, being acoustic rather than electrical system, the use of a microphone to gather the sound from the horn will further complicate the re-recording process.

It is possible to convert the acoustic sound-box of an Edison machine to take a modern magnetic cartridge. One institution that has done this and is willing to give advice on the subject is the Rogers and Hammerstein Archive⁸. Such a conversion reduces the effect of two of the objections to playing cylinders on the original play-back machines - the excessive wear and the need for a microphone to record the sound. It does not, however, eliminate the third problem - the noise of the clockwork drive mechanism which tends to be transmitted through the body of the machine to the pick-up. To overcome this, the clockwork drive mechanism and the pick-up screw have to be replaced by a quiet electric motor. However, rather than modify an original machine, it is almost as easy to make a suitable machine from first principles. This approach has been taken by a number of archives and institutions including BBC Radio and the National Sound Archive in the United Kingdom, the Vienna Phonogrammarchiv in Austria, the Belfer Audio Archives in the United States of America and the Canadian Museum of Civilization.

Footnote 8: See appendix 3 for addresses

Cylinder machines have much the same requirements as machines for 78rpm discs. The speed must be variable from the "standard" 160rpm and be able to include 144 and 120rpm recordings. Because of the mechanical drive systems and speed governors, the speeds can be even more nominal than the 78rpm speed for discs. If your collection includes cylinders made in the field, the speed can vary from 100 to 200rpm. It is not unknown for the speed to vary within a recording.

3.3.2 Storage of Cylinders

If the cylinders have not been stored in a vertical position, then it is likely that they will have deformed from the true, circular cross-section that they started with. They will have become oval or egg shaped. In fact, even if they have been stored in an upright position, it will not guarantee that they remain perfectly circular.

3.3.3 Pickup Arm and Stylus

If a slight eccentricity poses great tracking problems when the pick-up is being deviated 78 times per minute, then think how much more this will apply when the deviation is occurring 160 times per minute. A pick-up with a very low inertia is, therefore, desirable. This achieved by using the shortest possible tracking arm.

The arm drive needs to be able to cope with the two different groove pitches of 100 and 200 grooves to the inch (25.4cm). If the arm is driven along the cylinder by a lead screw, as on the original Edison machines, then this needs to be taken into account and a suitable speed dividing mechanism between the mandrel speed and the lead screw rotation must be devised and installed. The variable groove pitch is not a problem for a servo or self-tracking arm mechanism. These types tend, however, to stick in any circumferential cracks and skate across very shallow grooves. There is probably no perfect answer to the tracking problem.

Grooves are in general very much greater in radius than for standard 78rpm discs and for a groove pitch of 100 to the inch, the recommended stylus is of the order of 200 μ m (0.008 inches) and for the Blue Amberol cylinders with 200 grooves per inch, a stylus of about 100 μ m (0.004 inches). Stylus radius seems less critical for vertically modulated than for laterally modulated grooves.

3.3.4 Equalization

Since cylinders were exclusively acoustic recordings, electrical play-back requires similar treatment and equalization to that for acoustic 78rpm discs. It may be worth pointing out that almost no significant modulation above about 6KHz could be recorded so there is little point in trying to boost the high frequencies in the play-back process. All this will normally achieve is an increase in surface noise.

3.3.5 Summary

Re-recording of cylinders is a highly specialized field and, it must be repeated, should only be undertaken by fully trained technicians with the right equipment.

4. Test Equipment and Maintenance Routines

The quality of the equipment used to record and replay audiovisual carriers determines the quality of the recording or of the replay. The calibration of the equipment is, therefore, of vital importance to maintaining the quality of the recording. This is especially true for analogue recordings. Moreover, mis-aligned equipment may actually damage the carrier that is being preserved. The need for competent maintenance technicians, ideally on the permanent staff of the archive, cannot be overemphasised. If the technicians are supplied from another part of the institution housing the archive or by a contractor, the archive staff must insist on checking the work to ensure that the necessary high standards are being maintained.

4.1 Test Equipment

No technician can work efficiently without the correct tools. The minimum required includes all the necessary materials for frequent cleaning of the machines; de-magnetizers to de-gauss heads, guides etc.; the indispensable calibration tapes and discs for the alignment of the machines; and test equipment such as a low distortion sinewave generator, a harmonic distortion meter, a precision voltage meter that includes internationally standardized weighting filters and a wow and flutter meter to check speed stability. Instruments that produce written documentation are very helpful to the archive by making the keeping of technical status reports of each piece of equipment in the archive easier.

4.2 Frequency of Testing

In setting routine inspection and service intervals, it should be remembered that electronic equipment may fail unexpectedly at any time. Short inspection periods are, therefore, desirable. The following periods have been found by experience to be practical.

4.2.1 Analogue Tape Recorders

Cleaning	Daily or, if an abrasive tape is used, more frequently.
De-magnetizing	Weekly
Short Scale Frequency Test	With every new roll of tape
Complete Re-alignment and Test	Every 50 to 100 hours of operation. More frequently if the machine has been transported or loaned out.

4.2.2 Disc and Cylinder Players

Every 100 to 200 hours of operation. The styli and cantilever whenever the player has, or is suspected of having, been mis-treated eg. the tone arm dropped on to a record.

4.2.3 All Other Electronic Equipment

Every 200 to 500 hours of operation.

5. Handling and Storage of Sound Recordings

Although this guide is emphasizing the basic technical equipment required by an audio-visual archive, a short note about the handling and storage of sound records cannot be omitted.

5.1 Physical Damage

In contrast to written information with its comparatively high level of redundancy, both in the formation of the individual letters and the overall text, each fraction of a second of an analogue recording is unique information. This means that the information on an A-V carrier requires, by its very nature, more care and attention in terms physical and chemical integrity. While a speck of mould on a page of a book rarely prevents the reader from understanding and appreciating the message being conveyed, similar damage to an A-V carrier can cause severe signal degradation if not loss. In fact, the playing of a carrier with a physical defect may actually increase the damage.

Even digital recordings are not immune to physical defects on the carrier. Although a certain degree of auto-repair is possible because of the way the samples of sound are coded, it is not difficult to damage the carrier to such an extent that repair is beyond the capability of the error-correction system. The density of data packing on digital carriers is much greater than on the equivalent analogue recording and this also makes the digital carrier vulnerable to physical damage.

5.2 Storage Conditions

Handling and storage of sound carriers has to be optimised to maintain the physical and chemical integrity of the carrier and its full readability for as long as possible. Recommendations for storage conditions for sound carriers are similar to those for other A-V carriers and may be summarized as follows:

- a. Replay and recording equipment has to be kept in conditions that minimize stress and other physical damage. Tape recorders must also be free from magnetic fields that may affect the tape path and, thus, the recorded signal.

b. Handling of carriers must be done in such a way that unnecessary contact with dust and other contaminants is avoided. Under no circumstances should data carrying areas be touched by the fingers. Operational areas should be kept clear of dust - the floors should not be carpeted and the air conditioning should be fitted with dust filters.

c. Special conditions apply to the handling of old and/or fragile recordings such as cylinders, acetate discs and acetate tapes. Personnel unfamiliar with the peculiarities of these types of carrier should be given training by more experienced staff before being allowed to handle them. At no time should tapes be edited or repaired with any material other than proper splicing tape supplied by a reputable manufacturer.

d. Climatic control of the storage vaults for all sound-carriers should keep the temperature to $20^{\circ}\text{C} \pm 3^{\circ}\text{C}$ and the relative humidity to $40\% \pm 5\%$. These variations are the long term variation. Short term variations - those over a period of a week or less - must be kept within closer tolerances. This will normally require the continuous operation of the air conditioning plant with, if possible, a back-up system. If a back-up system is not possible, the archive should invest in good thermal insulation for the vault. Caution should also prevail if the recordings are to travel outside the archive.

e. Magnetic tape is susceptible to damage by strong stray magnetic fields. For analogue recordings, a field strength of 5 Oe (400 A/m) in the case of AC fields and 25 Oe (2000 A/m) for DC fields has been determined experimentally as the maximum permissible. In a sound archive, the likeliest sources of such magnetic fields are dynamic microphones, headphones, loudspeakers and meter movements. Tapes should be kept at least 15cm away from such devices. It is wise to keep tapes at a greater distance from heavy power transformers, large electrical motors etc. The vault should also be as far away as possible from lightning conductor rods.

f. The storage position for all recordings other than certain soft, instantaneous disc recordings is generally in a vertical plane. Tape stored on flangeless hubs should be stored in their box on the central hub support; discs and tapes on flanged hubs should be stored in their boxes or sleeves in a vertical position. For all tapes and cassettes of all kinds, it is very important that the wind should be as even as possible to avoid blocking and leafing of the tape (blocking being the raising of a block of tape consisting of a number of turns of tape and leafing the raising of one or two turns of tape above the general level of the spool). This is best achieved by re-winding the entire length of tape in one steady pass.

6. Section Summary

6.1 The Common Formats

It is reasonable to assume that most audio archives could, with the appropriate equipment and some training of personnel, undertake the re-recording of commercially issued discs. The archive should also be able to re-record the common types of audio tape recordings. These would be examples of Type IA re-recording.

6.2 Less Common Formats

If the archive wishes to undertake Type II re-recordings or wishes to re-record less common originals such as cylinders, vertically discs, direct cut discs with aluminium, steel or glass supports for the lacquer surface, wire recordings etc. then the required investment in time, personnel, training, hardware and facilities is much greater.

The average audio archive will not be equipped to perform this work. They may, however, have many of these recording formats in their collection. Rather than risk damaging the recordings by re-recording them in their own laboratories to make access copies, it is advisable for the archive to seek the services of an archive specializing in that type of re-recording.

A discussion of the total requirement for a laboratory able to re-record all the possible formats is beyond scope of this book. The IASA Technical Committee will be pleased to advise if more information is required or if the help of a specialist archive is sought. Archivists must be careful, however, not to employ the services of any re-recording service that is performing Type III, or subjective, re-recording.

6.3 Conclusion

This section has outlined the following points:

a. The role of the archivist is to faithfully preserve the content of original sound recordings.

b. Three types of re-recording, with one sub group, are legitimate for archival preservation; a fourth is not.

Type 0 represents a replica of the original artefact.

Type I is the replay of a historic carrier using a machine of the same era.

Type IA is the replay of a historic carrier using a modern machine and technology.

Type II represents the faithful reproduction of the original sound source (artist).

Type III, or subjective , re-recording does not fulfil the requirements for archival re-recording. It puts the aesthetic opinion of the technician between the original sound and the listener and is, therefore, not suitable for archival work.

c. It is essential to fully document the process of re-recording any historic carrier. The make, model and serial number of all machines and audio processing equipment used in the record/replay chain, details of the equipment settings used, the equalizations used, the size of stylus etc. must be noted to allow future researchers to, if necessary, restore the sound to as near its original form as possible. The performance curves of the various equipment should be kept and these should include the results of performance checks carried out by the archive as well as the literature produced by the manufacturers. As with other archive disciplines, the A-V archive technician should, as far as possible, employ restoration techniques and materials that can have their effects reversed. This requires full documentation of the re-recording process to make any required reversal possible.

d. Audio archive laboratories who specialize in audio research and restoration should be used as re-recording agencies by other archives requiring the less common formats to be re-recorded.

e. The attitude that the archivist takes to re-recording is the most important issue. Given historical accuracy as the goal, all of the technical considerations will become apparent with time and experience.