5.3.1 Introduction

5.3.1.1 Long Play (LP) microgroove[1] records first made their appearance around 1948, pressed in flexible vinyl[2] and hailed as ‘unbreakable’ in comparison to the preceding commercial records pressed from a rigid (and easily broken) shellac base.

5.3.1.2 By the time the vinyl disc was developed there was a greater industry agreement on standards. Grooves were cut at 300-400 to the inch as opposed to the 100 or so grooves per inch that was characteristic of the shellac pressings, and with a standard sized and shaped stylus on a cutting lathe that revolved at a speed of 33 1/3 rpm. 7” vinyl records, both singles and ‘Extended Play’ (EP), were made to be replayed at 45 rpm and in some cases 33 1/3 rpm. Larger diameter discs were on rare occasions produced for replay at 16 2/3 rpm for speech, where up to 60 mins could be recorded on one side. Equalisation characteristics still varied between companies, (see Table 2 Section 5.3 Equalisation Chart for Pre-1955 LP Records) however, many preamps catered for these variations. Eventually agreement was reached and the RIAA (Record Industry Association of America) curve became standardised throughout the industry.

5.3.1.3 Stereo records were commercially available from around 1958, and initially many records were produced in both mono and stereo versions. The groove walls are at right angles to each other and inclined by 45º to the vertical. The inner wall of the groove contains the left channel information, and the outer groove the right channel information recorded perpendicular to the respective groove wall. This has remained the standard, although at the time of its introduction a small number of stereo discs were made with a combination of lateral and vertical technology, an approach that was soon discontinued. Stereo pick-ups may be used to play mono records, but playing a stereo record with a mono pick-up will cause severe groove damage.

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1 As some late generation coarse groove recording were pressed in vinyl the use of the term “microgroove” is preferred to using “vinyl” as a collective description.

2 “Vinyl” is a colloquial term for the material of the discs which basically consists of a polyvinyl chloride / polyvinyl acetate co-polymer (PVC/PVA)

5.3.2 Selection of Best Copy

5.3.2.1 As with historical mechanical and other obsolete formats (see Section 5.2.2 Selection of best copy [8]) selection is primarily made visually, for speed and to prevent wear. Staff should be well versed in the codes and identifiers used by the various record companies and usually placed just outside the label. This may reveal alternative or later takes, remasterings, or pressings. In selecting the best copies for digitisation, co-operation with other collections should be considered.

5.3.2.2 The working space must make parallel, oblique light available as overhead fluorescent lighting may obscure evidence of wear. The quality of light must be such that it is very clear what constitutes merely heavy modulation and what constitutes wear. If two copies only exist, and they display different wear characteristics, then retain both and transfer both.

5.3.3 Cleaning and Carrier Restoration

5.3.3.1 LPs should be handled very carefully, never allowing fingers to touch the groove area of any vinyl disc. Sweat and other skin borne deposits may in themselves cause replay noise, however they will also attract and adhere dust to the surface and enable the growth of moulds and fungi increasing replay noise. Cotton gloves should be worn when handling discs. If appropriate gloves are not practical, discs should be withdrawn from (and replaced in) their sleeves in a manner that ensures the finger tips are placed on the label area and the base of the thumb at the edge, leaving the groove area untouched.

5.3.3.2 Dust, the enemy of all sound recordings, is a major problem with LPs for two reasons. The finer groove means dust particles are comparable in size with the stylus and cause clicks and pops. The electrostatic nature of vinyl increases the attraction of dust to the surface of the disc.Various commercial devices have been developed in an attempt to neutralise these static charges, from carbon-fibre brushes to piezo-electric ‘guns’ that ‘fire’ a neutralizing charge at the record surface, all of which are effective to varying degrees.

5.3.3.3 The most effective way of cleaning records is to wash them. Cleaning machines, such as the well known Keith Monks machine, coat the surface with a cleansing fluid which is then removed by a tracking suction device which moves across the surface to suck up both the fluid and any dust or dirt in the grooves. A simpler method is washing, avoiding the label area, with demineralised water and a mild detergent or non-ionic wetting agent such as diluted (1 per cent) Cetrimide (n-cetyl pyridinium chloride) which has anti-fungal and anti- bacterial properties. The disc may then be brushed in a circular motion with a soft camel hair paint brush, again avoiding the label area, and rinsing off, once more using distilled water. Greasy deposits on vinyl discs may be removed with isopropyl alcohol. As non-vinyl discs may be affected by alcohol, care should be taken to ensure that the solvent does not cause damage to the disc.

5.3.3.4 Record cleaning solutions which do not disclose their chemical composition should not be used. All decisions about the use of solvents and other cleaning solutions should only be made by the archivist in consultation with the appropriate technical advice by qualified plastics conservators or chemists.

5.3.3.5 As with historical mechanical and other obsolete formats (see 5.2.3 Cleaning and Carrier Restoration), ultrasonic cleaning may be effective. Care should be taken in the selection of solvent, though a 1 per cent solution of Cetrimide in distilled water is an appropriate cleaning solution. The label should be kept clear of the fluid, and the disc rotated slowly until the whole groove area has been wetted.

5.3.3.6 Perhaps the most effective method of reducing the effects of dirt, dust, and static charge is to play the records wet. This may be achieved by simply covering the disc with a Cetrimide solution, or by tracking a soft wet brush ahead of the stylus.Wetting the record can dramatically reduce the incidence of clicks and pops, however, it has the effect of increasing surface noise in all subsequent ‘dry’ plays. Wet playing using liquids containing alcohol is not recommended as the polymer bearings of cantilevers may chemically react with negative results.

5.3.3.7 The most frequently needed restoration of a disc recording is flattening. The following approach applies whether the disc is dish-shaped or bent. A thermostatic oven (a laboratory style oven is mandatory, a domestic oven is not appropriate) is required at a setting usually not exceeding 55º C and provided with two very clean sheets of hardened and polished glass, thickness 7 mm, 350 mm square. After hand cleaning and drying the record it is

placed on the pre-heated bottom sheet in the oven and the top sheet is suspended in the oven. After ca. half an hour the record is inspected and may well have sunk to a flat position. If not, the elasticity is tested as an indication of softening, and experience will tell if placing the hot top plate on the record might have the desired effect. The sandwich is left for half an hour, and the top sheet is lifted using gloves. If the record is perfectly flat, the complete sandwich is removed from the oven and left to cool on an insulating support. If flattening has not been obtained, the temperature is raised in 5º C intervals and the procedure repeated. Never apply the flattening force unless the softening is sufficient.

5.3.3.8 Flattening discs is a useful process because it can make unplayable discs playable; however, current research into the procedure of flattening discs with heat shows that it causes a measurable rise in subsonic frequencies, and even in the low audible frequency range (Enke 2007). Though the research is not conclusive the point should be noted in determining whether to flatten a particular disc. The analysis of the affect of flattening was carried out on vinyl discs but the range of tests were not extensive and further research is required. The possibility of such damage should be weighed against the benefit of enabling the playing of the disc.

5.3.4 Replay Equipment

5.3.4.1 Optical replay is available for LPs and should be investigated before selecting any transfer equipment, however contact transducers, or styli, are presently more common, perceived as less complicated and preferred by most technicians.When using contact transducers there are so many variables in the reproduction chain that exact repeatability of any particular replay is not possible. Pick-up arm, cartridge, stylus, tracking force, previous groove deformation or wear all contribute to the variability in replay. Even temperature can affect the replay characteristics of a cartridge/stylus combination to some degree. However, if LPs are to be captured for digitisation high quality components in the playback chain from stylus to recording equipment will ensure the most accurate audio capture.

5.3.4.2 Perhaps the most important part of the replay chain is the cartridge/stylus combination. Moving coil pickups, considered by some to be the most sensitive, tend to have a price tag and lack of robustness that precludes their use for anything but very careful domestic use. A good,high compliance,low tracking force (less than 15 mN, commonly quoted as 1.5 grams) variable reluctance (moving magnet) cartridge with a bi-radial (“elliptical”) stylus will be the most practical choice.Replay styli should include a range from 25 µm (1 mil), commonly used on early mono LPs, to 15 µm (0.6 mil), including conical, elliptical and truncated styli depending on the age and condition of discs to be played.

5.3.4.3 Attention should be given to the adjustment of vertical tracking angle (VTA) of the pickup system, which ideally should match the VTA produced in the recording process. The recommended playback VTA during the 1960s was 15±5º, which changed by 1972 to 20º±5º. It is impossible, however, to check the VTA of a given record (unless with test records which permit the evaluation of the intermodulation distortion of a vertical signal). As a basic adjustment, however, attention should be given to the horizontal position of tone arm, parallel to the surface of the record, under the appropriate tracking force. This should ensure the VTA intended by the pick-up system manufacturer. Any deviation from there can be achieved by lifting or lowering the tone arm.

5.3.4.4 Another angle to be adjusted is the tangential tracking angle (TTA).With tangential tone arms it must be insured that the system is mounted to lead the stylus exactly along the radius of the disc. With conventional (pivoted) tone arms a compromise must be made by adjusting the position of the stylus (= effective tone arm length) with the help of gauge, generally supplied by precision equipment manufacturers.

5.3.4.5 A high quality, low noise preamp capable of reproducing the standard RIAA curve as well as reproducing a flat transfer of the audio will be required. If pre-1955 records are being transferred, then a preamp capable of coping with the equalisation variations listed in Table 2 Section 5.3 Equalisation Chart for Pre-1955 LP Records, may be necessary. Multiple setting preamplifiers are not readily available, and it may be preferable to modify the equalisation after the normal preamp output, or applying custom equalisation to a flat transfer in the digital domain.

5.3.4.6 Vital to calibrating the replay chain is a test record cut with the recording characteristics of the records being transferred, and adjusting the frequency band of a graphic or parametric equaliser to achieve the proper output. An accurate RIAA test disc can be used to calibrate the system for non RIAA equalisation providing the characteristics of the replay curve are known. Finding an appropriate test record may prove difficult and even if available, older test records can suffer from wear and no longer give an accurate response, especially at the higher frequencies.

5.3.4.7 The vast range of playback components available in the 1960s and 1970s is no longer offered, and whilst not as difficult to locate as replay equipment for 78s, a much more limited range is now available. Though relatively impervious to damage and decay, LPs can become inaccessible if suitable replay equipment becomes unavailable. Although a good stock of spares and consumables is recommended for medium term access, it is important to note that styli and assemblies do not have an infinite shelf life.

5.3.5 Speed

5.3.5.1 Adherence by the recording companies to the standards reduced concern regarding speed setting that was common with earlier formats. A turntable equipped with strobe measurement and manual adjustment of speed is recommended as a minimum to ensure replay equipment complies with standards. The use of a crystal oscillator drive is preferable.

5.3.6 Replay Equalisation

5.3.6.1 The need for equalisation and the manner in which it was developed is explained in Section 5.2.6. Equalisation is also applied to microgroove recordings and primarily involves reducing the level of frequencies below about 500 Hz which is the LF turnover below which the recording is constant amplitude, and boosting those above about 2 kHz. Between 500 Hz and 2 kHz the recording is characterised by constant velocity (see 5.2.6). The application of equalisation in the recording process has to be compensated for in the replay chain. Many companies had their own, usually minor, variations on this theme, and for accurate reproduction, exact replay equalisation needs to be applied (see Table 1 Section 5.3 below).

5.3.6.2 Records made after about 1955 complied with what is now known as the RIAA (Record Industry Association of America) curve which became a well observed standard throughout the industry. RIAA replay characteristics are defined by a replay cut of 6 dB/octave from 20 Hz to 500 Hz, a flat shelf between 500 Hz and 2.12 kHz (318 µs and 75 µs respectively) and a 6 dB/Octave treble cut from 2.12 kHz. The flat shelf is approximately 19.3 dB below zero.

5.3.6.3 The Equalisation curves for replay are listed below.

Equalisation Curves by Name	LF Roll-off	LF Turnover	HF Roll-off Turnover (-6 dB/octave, except where marked)	Roll-off @ 10 kHz
AES	50 Hz	400 Hz (375)	2500 Hz	-12 dB
FFRR (1949)	40 Hz	250 Hz	3000 Hz*	-5 dB
FFRR (1951)		300 Hz (250)	2120 Hz	-14 dB
FFRR (1953)	100 Hz	450 Hz (500)	3180 Hz (5200)	-11 dB (-8.5)
LP/COL	100 Hz	500 Hz[3]	1590 Hz	-16 dB
NAB		500 Hz	1590 Hz	-16 dB
Orthophonic (RCA)	50 Hz	500 Hz	3180 Hz (5200)	-11 dB (-8.5)
629		629 Hz (750)		
RIAA	50 Hz	500 Hz[4]	2500 Hz	-13.7 dB

Table 1 Section 5.3 Equalisation Curves by Name

Equalisation Chart for Pre-1955 LP Records[5]	LF Roll-off	LF Turnover	HF Roll-off Turnover (-6 dB/octave, except where marked)	Roll-off @ 10 kHz
Audio Fidelity		500 Hz (NAB)	1590 Hz	-16 dB
Capitol		400 Hz (AES)	2500 Hz	-12 dB
Capitol-Cetra		400 Hz (AES)	2500 Hz	-12 dB
Columbia		500 Hz (COL)	1590 Hz	-16 dB
Decca		400 Hz (AES)	2500	-12 dB
Decca (until 11/55)	100 Hz	500 Hz (COL)	1590 Hz (1600)	-16 dB
Decca FFRR (1951) 3dB slope		300 Hz (250)	2120 Hz	-14 dB
Decca FFRR (1953) 3dB slope		450 Hz (500)	2800 Hz	-11 dB(-8.5)
Ducretet-Thomson		450 Hz (500)	2800 Hz	-11 dB(-8.5)
EMS		375 Hz	2500 Hz	-12 dB
Epic (until 1954)		500 Hz (COL)	1590 Hz	-16 dB
Esoteric		400 Hz (AES)	2500 Hz	-12 dB
Folkways		500 Hz (COL)	1590 Hz	-16 dB
HMV		500 Hz (COL)	1590 Hz	-16 dB
London (up to LL-846)	100 Hz	450 Hz (500)	2800 Hz	-11 dB(-8.5)
London International	100 Hz	450 Hz (500)	2800 Hz	-11 dB(-8.5)
Mercury (until 10/54)		400 Hz (AES)	2800 Hz	-11 dB
MGM		500 Hz (NAB)	2800 Hz	-11 dB
RCA Victor (until 8/52)	50 Hz	500 Hz (NAB)	2120 Hz	-12 dB
Vox (until 1954)		500 Hz (COL)	1590 Hz	-16 dB
Westminster (pre-1956) or		500 Hz (NAB) 400 Hz (AES)	1590 Hz 2800 Hz	-16 dB -11 dB

Table 2 Section 5.3 Equalisation Chart for Pre-1955 LP Records

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3. modified from NAB: less bass below 150 Hz, requiring about 3 dB boost.

4. RIAA and NAB are very similar.

5. This information is taken from several sources: the “DialYour Discs” chart which appeared in High Fidelity magazine during the early 1950s, the chart compiled by James R. Powell, Jr. and published in the ARSC Journal, and the jackets of various early LPs. “Turnover” (col. 2) is the frequency below which the record manufacturer diminished the bass when mastering the disc, requiring a corresponding boost during playback. In the chart, turnover is stated using the name of the recording curve, as given on most older pre-amps; a list of these curves and their turnover frequencies is at the end of the chart. "Roll-off"(col.3) is the amount of treble cut at 10kHz required during playback to compensate for pre-emphasis added during disc mastering. In the chart, roll-off is stated in dB.

5.4 Reproduction of Analogue Magnetic Tapes