Estimating ¼" Audio Reel-to-Reel Runtimes

Archivists are all too frequently confronted with the task of estimating the runtime for unmarked recordings in their collections in order to establish digitizing costs and data storage requirements. Determining an unknown runtime for a ¼" audio reel can be tricky due to the variables involved. These variables are:

1. Tape Thickness
2. Reel Diameter
3. Recording Speed
4. Track / Sides Arrangement
5. Portion Used for Recording

Ultimately, the two things which determine the runtime are the length of tape used for the recording and the recording speed. A recording's runtime can be calculated by dividing the length of tape used by the speed.

Tape Speed

The speed at which the tape is run is not determined by its manufacturer, it's set by the operator of the recorder at the time of recording. If the operator did not somehow indicate what speed was used, then the tape speed can only be determined by playing the tape. Tape speed is specified as inches per second, typically abbreviated IPS. The standard speeds for ¼" audio reels are:

- 1-7/8 IPS
- 3-3/4 IPS
- 7-1/2 IPS
- 15 IPS
- 30 IPS

Slow speeds are used to obtain enough runtime to fit the recording on a given length of tape. The slower the tape speed, the more content will fit on the reel. High speeds are used to maximize the fidelity of the recording. The higher the tape speed, the greater the fidelity. An operator would tend to use the highest speed that allows the content to fit; however, the operator may not use those criteria, if any, to select a speed.

If there are no clues about the speed used on a recording then some guessing may be required. 7.5 IPS is the most common speed for reels of 5" diameter or more. Smaller reels were most likely recorded using consumer grade equipment that can only operate at the two lowest speeds. Large professionally recorded reels containing music may be recorded at 15 IPS.

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Tape Length

Tape manufacturers sold tape in standard lengths on standard sized reels. Such tapes were originally contained in boxes upon which was printed the length. In most cases, the manufacturer also provided a chart on the box indicating the maximum runtimes for that length of tape at each possible tape speed. This at least provides an upper bound on the runtime for any given tape speed.

Here is an example of a manufacturer's chart indicating maximum runtimes for different length tapes at various tape speeds:

TIME CHART	RECORDING MINUTES USING BOTH SIDES							
	150 ft.	300 ft.	600 ft.	900 ft.	1200 ft.	1800 ft.	2400 ft.	3600 ft.
3-3/4 IPS	15	30	60	90	120	180	240	360
7-1/2 IPS	7.5	15	30	45	60	90	120	180
15 IPS		7.5	15	22.5	30	45	60	90

Not all reels of tape are premeasured lengths of tape on a reel in a marked box. Professional recordings were often created by an editor who physically cut and spliced together individual lengths of tape. In these cases, the reel may not be full and the finished length of tape is unknown. It may therefore be necessary to estimate the length of tape present.

Reel Diameter

Determining the reel diameter is the place to start when estimating tape length. Reel diameters are easily measured with a ruler. The common standard reel sizes are:

- 3 Inch
- 5 Inch
- 7 Inch
- 10-1/2 Inch

In order to estimate the length of tape on a given reel, however, one must also know the thickness of the tape.

Tape Thickness

Tapes eventually became available in one of four thicknesses starting with the thickest. In order to fit more tape on a given size reel, manufacturers decreased tape thickness. The two thinnest thicknesses result in very fragile tapes. Such fragile tape is not practical for use on large reels or for preserving important recordings because it easily breaks.

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In the United States, tape thickness was typically measured in thousandths of an inch, commonly referred to as a mil. One mil equals one thousandths of an inch. Tapes were originally manufactured to be 1.5 mil thick. Next came 1.0 mil tape, which is the most common thickness by far. Next came two varieties of 0.5 mil tape. Both were actually a bit thicker than 0.5 mil and were referred to as double and triple play.

Tape thickness can be measured with the right tools, but it can also be felt by hand. This is similar to feeling the weight of a piece of paper. If you've had any experience handling audio tape, you probably have a good idea of what a 1.0 mil tape feels like. You can probably judge the thickness of a tape simply by feeling it since the difference between the various thicknesses is fairly dramatic. 0.5 mil tapes are quite thin and fragile while 1.5 mil tapes would feel unusually stiff. It would be difficult to feel the difference between the two thinnest sizes, but, only those unlucky few will need to contend with that. Knowledge of the reel diameter together with the tape thickness can be used to establish the upper bounds for the length of tape. A more helpful chart showing all of the relationships between reel diameter, tape thickness, tape length, and maximum runtime can be prepared. However, there is still one variable to contend with, the arrangement of tracks on the tape.

Track Formats

The space available for recording on an audio tape can be divided into separate regions, or tracks, allowing for more than one stream of audio to be recorded on the tape. For example, a stereo recording requires two tracks for the left and right channels. The tracks run parallel to one another, side-by-side across the narrow width of the tape. The width of each individual track becomes smaller as the number of tracks increases. Smaller tracks result in less fidelity which is why ¼ inch tapes usually have no more than four tracks and may have only one.

The number of tracks on a tape is another attribute that is not determined by the manufacturer, but by the recorder used to make the recording. As with tape speed, there is no way to determine the track arrangement without playing the tape unless the operator labeled the recording.

The number of tracks on a tape isn't really relevant to estimating runtime, it's how the tracks are used that matters. Multiple tracks can be used simultaneously as is done when making a stereo recording. If, on the other hand, only half of the tracks are recorded at one time, the tape can be flipped over so that the remaining tracks can be used during a second pass of the tape. This produces a two-sided recording which doubles the tape's capacity. You will notice that the example chart given above makes the assumption that the tape will be used in this way, allowing the manufacturer to claim twice the capacity.

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Runtime Chart

Here is a chart that relates tape thickness, reel diameter, tape length, and tape speed to runtime. For simplicity, it assumes that the tape is single sided. The runtime values provided in the chart should simply be doubled if the tape is double-sided. This chart can be used to determine the greatest runtime possible for a given reel size and tape thickness. Values for tape speed may need to be guessed at based on the size of the reel and the purpose of the recording, keeping in mind that 7.5 IPS is the most common. Tape thickness can be guessed at by feel; again keeping in mind that 1.0 mil is the most common. For reels that are not full, a measurement of the diameter of the tape wrap can be substituted for the reel size. Guessing the number of passes is the most difficult, use what clues you can.

¼" Audio Reel			Runtime Minutes (Per Side)			
Reel Diameter	Tape Thickness	Tape Length	Tape Speed			
			1-7/8 IPS	3-3/4 IPS	7-1/2 IPS	15 IPS
5 Inch	1.5 mil	600 ft.	60 min.	30 min.	15 min.	7.5 min.
5 Inch	1.0 mil	900 ft.	90 min.	45 min.	22.5 min.	11.25 min.
5 Inch	0.5 mil Double Play	1200 ft.	120 min.	60 min.	30 min.	15 min.
7 Inch	1.5 mil					
5 Inch	0.5 mil Triple Play	1800 ft.	180 min.	90 min.	45 min.	22.5 min.
7 Inch	1.0 mil					
7 Inch	0.5 mil Double Play	2400 ft.	240 min.	120 min.	60 min.	30 min.
10.5 Inch	1.5 mil					
7 Inch	0.5 mil Triple Play	3600 ft.	360 min.	180 min.	90 min.	45 min.
10.5 Inch	1.0 mil					

It is standard practice at Video Transfer to provide sample files prior to the start of a preservation project. This can be helpful when estimating the size of an audio collection since the thickness, tape speed, and track configuration will be determined during the preparation of the sample file. If the sample tape is representative of the remaining tapes, its thickness, speed, and track configuration can used to estimate the size of the collection.

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