

Yukon Archives Standard for Digitizing Sound Recordings:

Creation of Audio Masters

Background

The Yukon Archives Digitization Policy establishes that *digitization is used by Yukon Archives for preservation reformatting of records and to create assets for enhancing access to its collections*. It clarifies this position by adding that *Yukon Archives will digitize records of particular media for preservation reformatting only when the Territorial Archivist is confident that a viable digital preservation management program is sustainable for that media*.

This standard defines the formats, and technical and processing specifications that Yukon Archives adopts for digitizing analog sound recording records within its permanent collections for purposes of both access and long-term preservation.^{1,2} It also addresses other ancillary issues associated with the adoption of these formats and specifications.

Definitions

Source Sound Recording – Sound recording selected by Yukon Archives as an object for digitization.

Preservation Master File – The primary role of the Preservation Master is to provide an authentic digital reproduction of the source sound recording, maintaining the integrity of the object of preservation and making possible a path to sustainability and long-term access. It provides essentially the same listening experience as the source sound recording; its level of quality allows it to substitute for the source sound recording (ex. if the source sound recording is damaged / destroyed or the requisite playback equipment is completely unavailable). The production master file may be created by processing the content from one or more preservation master files.

Production Master File – The primary role of the Production Master is to provide a high quality digital reproduction of the source sound recording that is sufficient for production, broadcast and the generation of derivative files. It is created without enhancement, optimized to facilitate researcher/user access, including reference and reproduction requests, playback on a device, and creation of derivative files. The production master file may be created from the source sound recording or by processing the content from one or more preservation master files. It may have levels of quality that rival those of preservation master file(s).

Derivative Files – Files created by sampling the production master file.³ They are not directly created from the source sound recording. Additionally, they are not used to generate further derivative files. They are frequently used for general digital access (i.e. internet or network access) and reproduction requests. Common audio derivatives include the access audio file, which is configured for convenient distribution and listening on a computer or portable player, and the sound bite, which is a short clip used to promote the full sound recording.

The Yukon Archives Standard for Digitizing Sound Recordings and Yukon Archives Sound Recordings

The *Yukon Archives Standard for Digitizing Sound Recordings* applies from the time of its completion and approval by the Territorial Archivist to the time at which it is superseded by a revised, modified standard. It therefore charts Yukon Archives requirements for digitizing sound recordings over a fixed period of time. At the time it is implemented, the standard will necessarily change and/or eliminate previously existing Yukon Archives standards and procedures for sound recording digitization and for managing the analog and digital assets that are their result. When implemented, it is not a retroactive standard; it does not suggest that sound recordings digitized according to previous standards should be redone nor their digital files be discarded. Digital files created under previous versions of the standard are managed and utilized alongside those created under the current standard.

¹ Yukon Archives may create and manage digital audio files that do not conform to this standard in order to meet alternate internal requirements (ex. exhibits) or in response to public reproduction requests; however, these non-standard audio files are not retained as preservation or production master files.

² For specifications regarding the migration of digital sound recording records see *Yukon Archives Standard for Migrating Digital Sound Recordings: Creation of Audio Masters*.

³ This standard does not document specifications for derivative files. Requirements for derivatives will reflect the purpose of the derivative file. See *Yukon Archives Digital Access File Standard* for details regarding access files, a specific type of derivative file.

To apply the *Yukon Archives Standard for Digitizing Sound Recordings* accurately, it is necessary to understand the different audio carriers that exist at Yukon Archives and the different designation of copies and masters that have been created and designated in the past. Further, it will be necessary, at some point, to make decisions on whether and how to manage these legacy assets.

Yukon Archives collections can include analog sound recordings on several carriers and physical formats:

- Magnetic tapes (audio cartridges, audio cassettes, audio reels)
- Grooved records (audio discs, cylinder recordings)

Key Principles

Sound Recording Significant Properties

When digitizing sound recordings for the creation of masters, Yukon Archives captures numerous audio characteristics that comprise the recording. Doing so allows for a greater understanding of the sound recording and places it within the context of its entire record, which more capably supports a wide range of user needs.

Significant properties of a sound recording that must be preserved include duration, number of sound tracks/channels⁴, sound field⁵, and track/channel assignment⁶. In general, artifacts present on the recording such as hums, skips, squeals, clicks, and so on, are also copied.⁷

Digitization is influenced by the physical format of the sound recording. Each face (for example, one side of a disc or one track on a tape) of the media is digitized separately. An unused face is not digitized.

If a recording has any form of recorded audio reference tone⁸ it is captured.

A beginning-to-end reproduction for each face is created; digitization captures all audio signals of the source sound recording from 5 seconds before its beginning (the first audio signal) to 5 seconds after its end (the last audio signal). Lengthy (greater than 5 seconds) heads and tails are not captured, whereas silence within and between audio signals are captured. Occasionally beginning-to-end reproduction of a sound recording is not possible or permissible due to the nature in which the recording was created, the media's condition, rights issues or other reasons. Such situations are addressed on a case by case basis and are noted in the metadata.

If a portion of a recording cannot be copied, it is noted in the metadata. If a sound recording's storage container requires copying, it is digitized according to the Yukon Archives digitization standard aligned to its media (ex. *Yukon Archives Standard for Digitizing Textual Records*).

Reference tones are included in preservation masters. Alternatively, if associated preservation masters are being created together, reference tones may be digitized separately as reference files for each batch. Reference tones need not be included in production masters.

Signal Extraction

When digitizing a sound recording Yukon Archives attempts to ensure that the digital audio signal can be retrieved and played back to the same (or better) fidelity standard than was possible when the recording was originally made. The ability to achieve this objective depends on the quality of the extraction of the digital file from the original recording, a process that is affected by the condition and cleanliness of the audio carrier; the availability, quality, and proper use of playback equipment; speed and playback equalization; removal of storage related audio artifacts (ex. print-through⁹); time and budget, etc. In other words, the quality of the playback equipment, audio path, target format, and standards must equal or exceed that of the original. In all cases of audio digitization, Yukon Archives refers to industry guidelines and best practices in order to redress or ameliorate these factors to the extent possible and to thereby ensure the best possible signal extraction. Yukon Archives also documents all aspects of the signal extraction process in the metadata as per industry guidelines and best practices.

⁴ Number of distinct streams within a sound recording.

⁵ The aural space to which the tracks/channels are mapped, e.g. mono, stereo.

⁶ Maps a sound track/channel to a designated output, e.g. front left, back right.

⁷ Exceptions include un-desired artifacts such as tape "print-through" which occurs in storage and noise caused by misaligned playback equipment, but all actions taken to remove or reduce these types of artifacts must occur prior to digitization efforts.

⁸ An artificially created sound used to test or adjust the audio signal or its system.

⁹ "Print-through" is the transfer of magnetic signals from one layer to another layer of the tape. This problem can be reduced by rewinding the tape prior to playback. Such removals should be done prior to signal extraction.

Audio Paths

Audio signal flow is the path an audio signal takes from source to output, including all the processing involved. The combination of reproduction equipment, signal cables, mixers, and other audio processing equipment used for digitization must be professional quality and have specifications that equal or exceed that of digital audio at the sampling rate and bit depth specified in this standard.

The signal must be routed using the cleanest, most direct signal path possible. During digitization, the signal should not pass through any test / calibration / non-essential equipment.

Digitization Environment

Whenever possible, digitization is performed in an appropriately designed, critical listening space. A critical listening space should have an ambient noise level well below that of the quietest sound to be digitized and should not distort any aspect of the recording. When such a space is not available, a room with a substantial amount of sound absorption that is quiet and removed from other work areas and traffic is selected. In such cases the technician is acutely aware of its sonic deficiencies and compensates accordingly during set up and digitization.

Capture Devices

A high quality capture device is critical to the accurate reproduction of a sound recording, enabling the acquisition of the greatest amount of detail. All capture devices used for sound recording digitization must comply with the *Yukon Archives Technical Specification for Capture Devices*.

Analog to Digital Converters

Analog to digital converters (A/D converters) must not affect the audio signal being extracted or add any extra noise. For this reason the A/D converter that is included in a computer's sound card is unacceptable and is not to be used. Yukon Archives accepts as standard the International Association of Sound and Audiovisual Archives (IASA) recommendation that signal extraction be conducted using a standalone A/D converter with specific specifications. The details of this specification are described in *Yukon Archives Technical Specification for Analogue to Digital (A/D) Converters*. Any audio digitization undertaken by Yukon Archives or contracted by Yukon Archives will ensure that the A/D converter used meets these specifications. Yukon Archives will however consider use of an interface that does not meet these specifications provided the equipment is recommended by a recognized expert in the digitization of analog audio recordings.

Playback Equipment

High quality playback equipment, including speakers, is critical for the accurate representation of a sound recording, enabling a listener to hear the greatest amount of detail. All playback equipment used during sound recording digitization must comply with the *Yukon Archives Technical Specification for Playback Equipment*.

Sound Cards

As noted above, a standalone A/D converter is to be used for creating digital audio records. The purpose of the sound card in audio preservation is to pass a digital signal and to return the converted digital signal to analog for monitoring purposes. The sound card must therefore have a reliable digital input and the ability to pass a digital audio stream without change or alteration; it must also be able to accept the bit depths and sampling rates specified in this standard. The details of Yukon Archives requirements for sound cards are described in *Yukon Archives Technical Specification for Sound Cards*. Any computer used for audio preservation at Yukon Archives or by contractors must contain sound cards that meet these specifications.

Bit Depth, Sampling Rate, File Format and Codec

Yukon Archives recognizes that standards based on contents (spoken word vs. music), original carriers, and recording methods (ex. recording speeds) – in terms of bit depth and sampling rate – sometimes vary within other institutions. Regardless of content, original carrier or recording method, Yukon Archives digitizes all analog sound recordings at the same standard; Yukon Archives does not attempt to define which analog sound recordings may be of a less than optimal quality suitable for a lower standard.

Sound recordings are captured in Broadcast Wave Format (BWF), a fully documented, widely adopted format which offers extended metadata information in the file header. BWF is limited to files that are less than 4 GB. If a recording presents itself requiring more than 4GB¹⁰, the digitization is completed in segments. Each digitized segment contains 5 seconds of recognizable overlap, with breaks occurring at logical locations.

¹⁰ At 24 bit 96 kHz, approximately 4 hours (mono) or 2 hours (stereo).

File formats that employ data reduction (compression) based on perceptual coding (lossy codecs) create files with significant information loss. This compromises their archival integrity and limits their potential future uses. Yukon Archives accepts as standard BWFs that employ Linear Pulse-Code Modulation (LPCM), a codec for uncompressed audio.

Table 1 defines Yukon Archives standards for bit depth, sampling rate, file format and codec for analog sound recordings (cassettes, reels, discs, etc.) that are digitized by Yukon Archives. The standards established for the preservation and production master files are ones which Yukon Archives believes provide reliable digital reproductions which capture the smallest significant details of the sound recordings for their intended purposes. For both preservation and production master files, the indicated file format and codec comprise a commonly accepted preservation file format.

	Content	Bit Depth ¹¹	Sampling Rate ¹²	File Format	Codec
Preservation Master	Spoken	24 bit	96 kHz	BWF (.wav)	LPCM
	Music	24 bit	96 kHz	BWF (.wav)	LPCM
Production Master	Spoken	24 bit	96 kHz	BWF (.wav)	LPCM
	Music	24 bit	96 kHz	BWF (.wav)	LPCM

Table 1. Bit Depth, Sampling Rate, File Format and Codec for Audio files created from Analog Sound Recordings

Audio Processing

Yukon Archives adopts and follows industry standards and best practices for all technical aspects (e.g. hardware, software, bit rate, sampling, etc.) of creating digital versions of analog sound recordings. Where appropriate, these details are documented and described in Yukon Archives' sound recording digitization procedures. In general, the following audio processing procedures are performed:

<i>Preservation Master File</i>	no audio enhancements, level changes or editing
<i>Production Master File</i>	no audio enhancements editing to split files into parts combining files that could not be created as one during digitization ¹³ editing to remove segments of extraneous silence or information ¹⁴

Preservation master files must maintain complete, unaltered content.

Production master file edits should not be made if the edit affects content or context. A mistake, like a skip on a disc resulting in a skip in the digital file, can indicate why data was lost. Rather than edit a skip out and have a jarring transition from one piece of audio to the next, the skip gives the researcher an understanding of the context that created that error. Production master files may have any extraneous silence or other information at their start or end removed. ADLs (Audio Decision Lists) are used to convey edit information as part of the metadata. In many cases, the production master will be a clone of the preservation master.

Metadata

There are three types of metadata that describe digital objects:

<i>Descriptive metadata</i>	used in the discovery and identification of a specific audio object
<i>Structural metadata</i>	used to display and navigate a specific audio object for a user, including information on the internal organization of the object
<i>Administrative metadata</i>	includes rights management metadata and preservation metadata represents the management information for the audio object (the date it was created, its file format, rights information, etc.)

¹¹ The bit depth fixes the dynamic range of an encoded audio event. 24 bit audio theoretically encodes a dynamic range that approaches physical limits of listening.

¹² The sampling rate fixes the maximum limit on frequency response.

¹³ For example, a locked groove on a disc or a broken tape.

¹⁴ Content deemed unquestionably irrelevant for archival use.

When creating metadata for digital audio objects, Yukon Archives maintains explicit, comprehensive, and discrete documentation of all technical details, data creation and record of changes, including dates and responsibility. These records are updated as is necessary.

Yukon Archives recognizes the importance of creating and managing an explicit metadata framework separate from the digital files themselves. In some cases however, it may be acceptable to integrate some metadata and content. The *Yukon Archives Metadata Standard for Audio Masters Created Through Digitization* indicates where metadata and content must be separated and where it may be integrated.

File Naming

The naming of digital files created through digitization is done according to the *Yukon Archives File Naming Conventions for Digital Files of Archival Material*.

Quality Assurance and Quality Control

Yukon Archives conducts quality assurance and quality control relating to digital files, their associated metadata, and the storage of both (including file transfer and data integrity). The specific technical and procedural areas in which quality assurance and quality control are applied are outlined in the *Yukon Archives Audio Digitization Quality Assurance and Quality Control Procedures*. Where appropriate, these procedures identify accuracy requirements and acceptable error rates.

Workflow

Prioritizing sound recordings for digitization is based on criteria established in the *Yukon Archives Digitization Policy*.

Preservation master files are created when the original record is at significant risk due to its physical and chemical stability, as well as the availability of reproduction technology. As most analog sound recordings in the Yukon Archives holdings are fragile and at risk, Yukon Archives routinely creates a preservation master file and a production master file of each analog sound recording that is digitized.

At required points in the workflow, technicians have the requisite technical skills and well-developed critical listening abilities.

Storage

Once quality control has been performed, preservation and production master files are moved to a managed storage environment.

Yukon Archives stores both preservation and production master files in an uncompressed state. Masters are stored separately from derivatives.

Preservation and production master files are stored with a level of data redundancy, such as a RAID hard-drive system. In addition, checksums are generated and stored and files are regularly backed-up.

Application of Standard beyond Yukon Archives

This standard applies to sound recordings that are digitized by Yukon Archives and its contractors for purposes of access and preservation reformatting. It does not and cannot apply to digitized or born-digital objects that are created by other agencies or individuals and received by Yukon Archives as either public records transfers or private records donations. Despite this lack of applicability beyond Yukon Archives, the standard is made available and recommended to Yukon Government departments and private individuals as a best practice that they are encouraged to follow.

There are a number of reasons why Yukon Government departments and private individuals are encouraged to follow this standard for digitizing sound recordings that will eventually come to Yukon Archives:

- Bit depth, sampling rate, file format and codec affect the quality of the audio record potentially received into Yukon Archives collections;
- Yukon Archives limits the number of file type and variations in specifications that it receives into its collections in order to contain the costs and the complexities of collection management;
- Yukon Archives considers the availability and completeness of metadata records accompanying digital objects as essential adjuncts of those objects.

In short, although this standard applies specifically to Yukon Archives digitizing its sound recordings, it also establishes the context in which digitized and born digital audio records are appraised for possible acquisition¹⁵. The specific details of the standard therefore serve as appraisal criteria for all digital audio records.

Related Documents

Yukon Archives Digitization Policy

Yukon Archives Technical Specification for Capture Devices

Yukon Archives Technical Specification for Analogue to Digital (A/D) Converters

Yukon Archives Technical Specification for Playback Equipment

Yukon Archives Technical Specification for Sound Cards

Yukon Archives Sound Recording Digitization Manual

Yukon Archives Metadata Standard for Audio Masters Created Through Digitization

Yukon Archives File Naming Conventions for Digital Files of Archival Material

Yukon Archives Audio Digitization Quality Assurance and Quality Control Procedures

Yukon Archives Technical Specification: WAV File Format

Yukon Archives Standard for Migrating Digital Sound Recordings: Creation of Audio Masters

Yukon Archives Digital Access File Standard

References

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Original signed by Ian Burnett
Territorial Archivist

November 5, 2015
Date

Revision History

May 2009

¹⁵ There are, of course, numerous other criteria by which records are appraised to determine whether they will be acquired by Yukon Archives.