Article: Preservation of Negatives at the British Columbia Archives
Author(s): Betty Walsh
Topics in Photographic Preservation, Volume 11.
Pages: 97-103
Compiler: Brenda Bernier

Topics in Photographic Preservation is published biannually by the Photographic Materials Group (PMG) of the American Institute for Conservation of Historic & Artistic Works (AIC). A membership benefit of the Photographic Materials Group, *Topics in Photographic Preservation* is primarily comprised of papers presented at PMG meetings and is intended to inform and educate conservation-related disciplines.

PRESERVATION OF NEGATIVES AT THE BRITISH COLUMBIA ARCHIVES

BETTY WALSH

Presented at the 2005 Winter Meeting in Vancouver, British Columbia, Canada
An earlier version was presented at the CAC Twenty-ninth Annual Conference Victoria, B.C. May 2003

The British Columbia Archives hold an estimated 5 million still photographs, dating from the mid-19th century to the present. The archivist estimates that 250,000 cellulose nitrate and 500,000 acetate negatives are mixed within the collection. Cellulose nitrate and acetate films deteriorate at normal room temperatures. Deteriorating nitrate and acetate films give off nitrogen dioxide and acetic acid which damage other collections. Since 1990, staff have been identifying the film bases, segregating the bases from each other, and keeping them in cold storage.

IDENTIFICATION OF FILM BASES

I started out by identifying the film bases in two large collections. Cellulose nitrate was introduced in 1889, and discontinued in 1951. Cellulose acetates were first produced in the 1920's and are still manufactured as roll film bases. Polyester film was introduced in 1955 and is the most stable film today.

If we know the date of a negative, we can compare its date and format against the dates that Eastman Kodak stopped manufacturing nitrates (see table 1). For example, the BC Forest Service Collection dates from 1913 to the 1980's. Thanks to the finding aid, we determined that the negatives produced before the late 1930's were nitrate. Then we focused on the transition from nitrates to acetates from the late 1930's to the early 1950's.

Table 1. Dates Eastman Kodak stopped manufacturing nitrate films, with more information on roll film sizes.

Date of last nitrate film manufactured in the U.S.	**Type of film**
1933	X-ray film
1938	Roll film in size 135 (35mm still camera film)
1939	Portrait and Commercial Sheet Film
1942	Aerial Film
1949	Film pack
1950	Roll film, for example: 616 (film width 2 ¾"or 7 cm) 620 (film width 2 7/16") 828 (film width 1 3/8 "or 3.5 cm)
1951	35 mm motion picture film

Sources: (Calhoun 1953, Mannheim 1975)

This time period is a tricky one for identifying films. Different film formats and bases are mixed together, and they can look the same. For example, it's well known that photographers bought 35mm motion picture film, and respooled it into their still cameras, long after Kodak discontinued 35 mm amateur film on a nitrate base. I found 35mm nitrate negatives dating from 1949 in the BC Forest Service Collection.

FILM PACK NEGATIVES

Kodak stopped making film pack nitrates in 1949, ten years after nitrate sheet films were discontinued. We often find nitrate film pack mixed between acetate sheet film negatives from the 1940's.

Film pack negatives look similar to sheet film. On first look, the film base is thinner than sheet film, and the image may be off center. Individual sheets of film were attached to backing papers (Mannheim 1969). Sometimes, the strips leave paper and adhesive residue from the package at one end. Others have dark patterns at the location of the strips. The film may also have an exposure number on one edge (e.g. 1-12). Unlike sheet films, film pack negatives do not have notches or nitrate edge markings.

I found that Agfa and Ansco film packs, embossed with the company and film names from the late 1930's until 1951, were nitrates. They are Agfa and Ansco Supreme Pan, Agfa Super Plena, Agfa Super Pan Press, and Agfa Super Pan.

Of course, it's easiest if the film tells you what it is. Starting in the 30's, manufacturers printed or embossed "nitrate" or "safety" on to the edges of the film. In our collections, the last Agfa nitrate sheet film was exposed in 1945.

NOTCH CODES

Sheet films can be identified by the notches cut into the upper right corner of the film. In the darkroom, these help the photographer identify the emulsion side, manufacturer, and product. I consulted notch code charts in David Horvath's *The Acetate Negative Survey: Final Report* (Horvath, 1987)

Our master copy negatives required more research. The films were not dated, and they had been reorganized so that all 3 bases were mixed together. I researched the films by interviewing the current and retired supervisors of the Archives photo lab. Kodak and Ilford were kind enough to send additional notch charts (Anderson 1995, Ilford 1995). As a result, I compiled a list of notch codes and film markings for the films in the Archives' collections. The list was correlated with the Kodak appendices in the Horvath survey, so that we have a list of films used in this region.

Film notches should be considered carefully. Up to 1949, Kodak marked its nitrate films with a V shaped notch in the upper right corner. The safety films had a U shaped notch. However, from 1949 to 1974 the single V notch indicated a popular acetate film, Super Pan Press Type B (Horvath 1987; Anderson 1995). For the undated master negatives, this created problems – safety and nitrate negatives, with the same notch, were located near to each other. Not all of the acetates had safety edge prints.

Notches indicate certain brands of negatives that are predisposed to deteriorate. The best examples are films manufactured by Dupont, and sold under the Defender and Dupont Defender names. A half circle notch is common in our collections. Its shape is different from the Agfa/Ansco and Kodak notches in the Horvath survey.

OTHER METHODS OF FILM IDENTIFICATION AND ASSESSMENT

Another way to identify films is evidence of deterioration in the later stages. However, in the early stages, the negatives look the same.

When all else failed, the film bases were tested. Polyester negatives were identified with polarizing filters. Nitrates and acetates were identified by diphenylamine tests, burn tests, and FTIR spectroscopy through the assistance of the University of Victoria (Walsh 1995).

While the negatives were identified, the levels of deterioration were assessed visually. When AD strips were introduced in the mid-1990's, I put them to work checking acetate films.

After I had researched film identification and assessment - I gave "film bees" to Archival Preservation Services staff. The unit applied the techniques in two projects funded by the Canadian Council of Archives, the preservation of the Master Copy Negatives and the BC Forest Service Collection. The negatives were identified, documented, rehoused, and segregated from other bases in one step.

Depending on the collection, the negatives were scanned for access, and duplicated by the interpositive method.

COLD STORAGE

Next, the negatives were packed into cold storage. Cold storage will preserve unstable bases and the dyes in color photographs. We are currently using household frost free freezers. We were able to purchase them with grants from the Canadian Council of Archives for the two negative projects. We can store priority films quickly, and build up our storage in increments.

Household freezers are not humidity controlled, so that the photographs need sealed packaging. I chose the Critical Moisture Indicator package designed by Mark McCormick-Goodhart for the Smithsonian Institution. (McCormick-Goodhart 1995b, 1996a, 1999, 2003)

The system starts with a stack of twenty-five negatives in their paper envelopes, 1" thick. The stack is packed into a zip-closure polyethylene bag. It is placed inside a second resealable bag with two sheets of oven dried mat board. At low temperatures, polyethylene has a slow rate of moisture vapor transmission. The mat board absorbs moisture which migrates in from the outside.

We used a toaster oven to dry the mat board. A careful operator can dry small batches. (Caution: do not push the toast button!) For future work, I would recommend either a small convection oven or a laboratory oven.

The mat board is dried in the oven at 90-100° C for 5 minutes, and cooled for 1-3 minutes before going into the bag. A protective folder, with a cobalt salt indicator card, was put inside the second bag. When the moisture indicator turns lavender, it's time to thaw the package and change the mat board. The dry mat board will work for 15-20 years. Our films have been in the freezer for five to seven years without any indicator changes.

The packages are packed into Coroplast boxes, which help to organize and protect them in the freezers. This method is different from the commercial Metal Edge packaging, which was not available when the work started. Moreover, the Archives' system suits the storage of 4 x 5 and 5 x 7 sheet films.

FROST FREE FREEZERS

Finally, the boxed negatives are stored in household frost-free upright freezers. We chose uprights because they take up the least floor space, and give easy access. Frost free freezers were appealing because of their convenience. Moreover, the manual uprights had cooling coils in the shelves. The coils prevented us from moving the shelves to accommodate different sizes of boxes.

Only two North American manufacturers make frost free uprights: Woods, a Canadian company, and Frigidaire. We purchased Woods freezers from 1996 to 2000. The Woods freezers have a design flaw, where water freezes in a drain hole in the freezers, leading to an icy puddle in the bottom. In 2003, we bought Sears Kenmore freezers which are built by Frigidaire. One of the 3 new Kenmores is under repair. The freezer repairman says that frost free freezers require more repairs than manual defrost models. I recommend budgeting for freezer maintenance in the future.

The nitrates were not stored in explosion proof freezers, as recommended by Wilhelm and McCormick-Goodhart. We are currently conducting more research on this issue. Readers should consult with the appropriate regulations and safety experts when planning their own nitrate cold storage

TESTING THE COLD STORAGE ENVIRONMENT

I researched and tested the storage conditions. The Woods freezer has a set point of -18°C, while the Kenmores are set at around -16°C. Twice a day, the temperature rises to near freezing as the freezer defrosts. I tested the temperature inside the film package, inside a Woods freezer. If the freezer is filled with frozen materials (known as the thermal mass), the temperature in the package will rise only 2.0–2.5° C during a defrost cycle.

The RH in the Woods freezer was measured with an Enerlog 2000 datalogger loaned from the Archives Association of BC. The RH in the freezer averaged 56% with lows of 36% and highs of 94% in a full freezer during the defrost cycle. This is comparable to the Image Permanence Institute's tests of its Sears Kenmore freezer, which had an average RH of 50% with a rise to 100% during defrosting (Adelstein et al. 1997).

The environment inside the package was also tested with the datalogger. Twenty-five 4 x 5 color acetate transparencies were housed into acid free envelopes with the datalogger adjoining them. The RH inside the package dropped from 40% at room temperature to 33% in the freezer. This is consistent with McCormick-Goodhart's tests which show that photographs will overbuffer the relative humidity in a sealed package. (McCormick-Goodhart 1995a, 1996b, 1996c)

The packages need to warm up, while sealed, to prevent condensation. I tested the warm-up times. A 4 x 5 package equilibrated 100% to room temperature after 2½ hours on a rack. On a bench top, it took 3½ hours. The results are consistent with the instructions for the Metal Edge freezer kit (Metal Edge n.d.). At a summer extreme of 60% RH and 24° C, the package would warm up past the dew point after 1½ hours.

CONCLUSIONS

So far, Archives Preservation staff have preserved 19,150 negatives in the freezers: 9,375 nitrates in 3 freezers, 2,175 deteriorating acetates in another freezer, and 7,600 color negatives on acetate base in two freezers, for a total of 5 freezers. Each freezer can take 2,200 5 x 7 sheet films, or 3,600 4 x 5 films. Preservation staff have expanded to "vinegar syndrome" motion picture film: 355 motion picture film elements are packaged into 4 freezers.

We now have 18 freezers. We are now planning for cold storage in the remaining 9 freezers. Two are used as temporary storage for the contents of freezers under repair. The remaining freezers will be used for priority storage of deteriorating films.

The freezers are a stopgap for a large collection. Over the years, archivists and conservators have been requesting large scale cold storage vaults. However, we have not succeeded – yet. A recent merger with the Royal British Columbia Museum is giving us another opportunity. We don't have far to go for ideas. Sue Bigelow of the City of Vancouver Archives has successfully implemented a vault based on and McCormick-Goodhart and Wilhelm's latest specifications. (Bigelow 2004; McCormick-Goodhart and Wilhelm 2004). The vault consists of sealed cabinets in a walk-in freezer. With the new vaults, we won't have to identify, rehouse and segregate at all.

Through the application of ongoing research, testing, and practical experience, we have been able to implement a program for deteriorating films. We will continue to adapt as research comes along.

ACKNOWLEDGEMENTS

I would like to thank the following people and institutions for their assistance: My supervisors, Barry Byers and Robert Davison, generously supported my work. Louise Bourassa, Ted Plouffe, and Derek Swallow, from the BC Archives' Archival Preservation Services, learned to identify and freeze the negatives on their own. Carlo Mocellin, George Piercey, Peter Robin, and Peter Westoby were the collective memory of the Archives' photo lab. Peter Krause, Rod Parsons, and John Placo from Ilford Photo gave me information about notch codes and polyester films. Stanton Anderson of Eastman Kodak provided information about films and notch codes. Rosaleen Hill, of the Archives Association of BC, kindly loaned a datalogger. The Canadian Council of Archives awarded grants for the cold storage materials and equipment. Finally, I would like to thank Mark McCormick-Goodhart for generously sharing his research before it became widely available.

REFERENCES

Adelstein, P.Z., Bigourdian, J.-L., and Reilly, J.M. 1997. Moisture relationships of photographic film. *Journal of the American Institute for Conservation* 36:193-206.

Anderson, S. 1995. Letter to the author October 24.

Bigelow, S. 2004. Cold storage of photographs at the City of Vancouver Archives. http://www.cdncouncilarchives.ca/Storage_English.pdf (accessed April 22, 2004)

Calhoun, J. M. 1953. Storage of nitrate amateur still-camera film negatives. *Journal of the Biological Photographic Association* 21(3):1-13.

Ilford Photo. 1995. Advance information: sheet film notch codes. Photocopy sent to author September 21. Paramus, NJ.

Horvath, D. 1987. The acetate negative survey: final report. University of Louisville, Louisville, Kentucky.

Mannheim, L.A. [1969] 1975. Sizes and packings. *The focal encyclopedia of photography: desk edition.* 1395–1398.

McCormick-Goodhart, M. H. 1995a. Moisture content isolines of gelatin and the implications for accelerated aging tests and long term storage of photographic materials. *Journal of Imaging Science and Technology* 39(2):157-162.

McCormick-Goodhart, M.H. 1995b. Letter to the author May 5.

McCormick-Goodhart, M.H. 1996a. On the cold storage of photographic materials in a conventional freezer using the critical moisture indicator (CMI) method. Draft paper sent to author January 31.

McCormick-Goodhart, M. H. 1996b. The allowable temperature and relative humidity range for the safe use and storage of photographic materials. *Journal of the Society of Archivists* 17:7-21.

McCormick-Goodhart, M. H. 1996c. Moisture content isolines and the glass transition of photographic gelatin; their significance to cold storage and accelerated aging. *Research Techniques in Photographic Conservation: Proceedings of the Conference in Copenhagen 14-19 May 1995*. Copenhagen, Denmark. 65-70.

McCormick-Goodhart, M. H. 1999. Methods for creating cold storage environments. In *Care of Photographic Moving Image & Sound Collections.* Leigh, England: Institute of Paper Conservation. 19–23.

McCormick-Goodhart, M.H. 2003. On the cold storage of photographic materials in a conventional freezer using the critical moisture indicator (CMI) method. www.wilhelm-research.com/pdf/CMI_Paper_2003_07_31.pdf (accessed February 24, 2004)

McCormick-Goodhart, M.H., and Wilhelm, H. 2004. The design and operation of a passive humidity-controlled cold storage vault using conventional freezer technology and moisture-sealed cabinets. *Final Program and Proceedings: IS&T Archiving Conference,* San Antonio. 176-82.

Metal Edge West, Inc. n.d. The Safecare Image Archive Freezer Kit. Commerce, California.

Walsh, B. 1995. Identification of cellulose nitrate and acetate negatives by FTIR spectroscopy. *Topics in Photographic Preservation* 6:80-97.

Walsh, B. 2003. Preservation of negatives at the BC archives. *Conference Abstracts of the Canadian Association for Conservation of Cultural Property Twenty-ninth Annual Conference.* Victoria, BC, Canada. 34.

BETTY WALSH
Conservator,
Royal British Columbia Museum

Papers presented in *Topics in Photographic Preservation, Volume Eleven* have not undergone a formal process of peer review.