

Some practical aspects of cold storage for films.

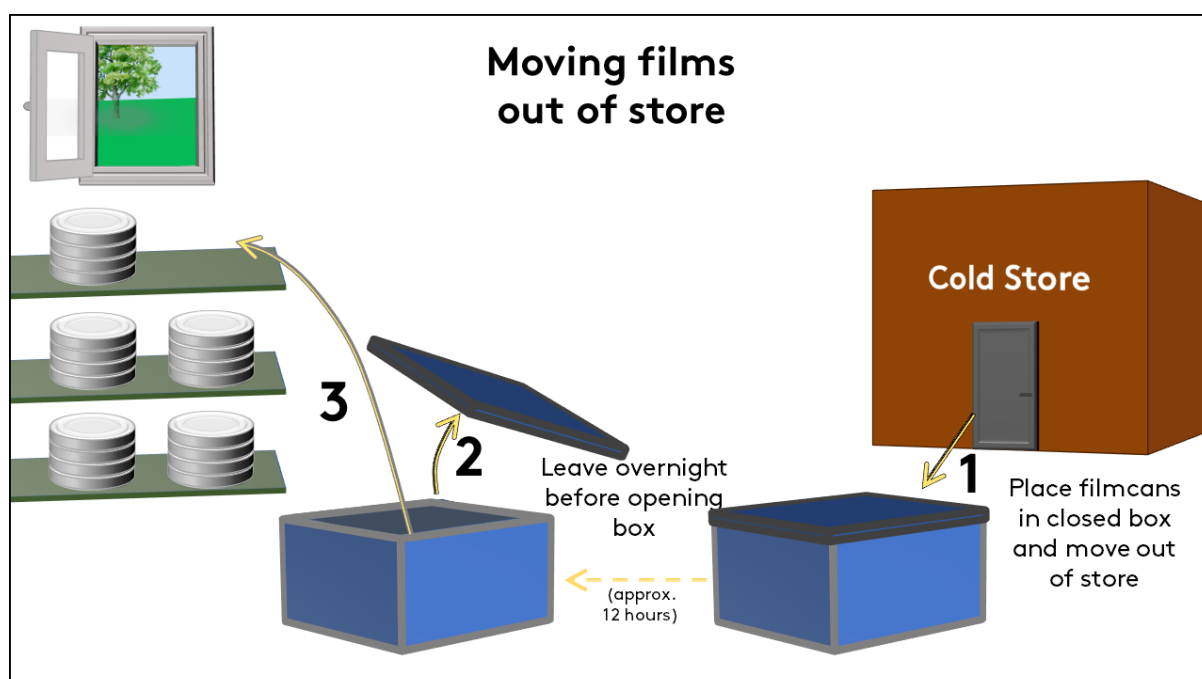
1. Fully-conditioned stores

Moving films in and out

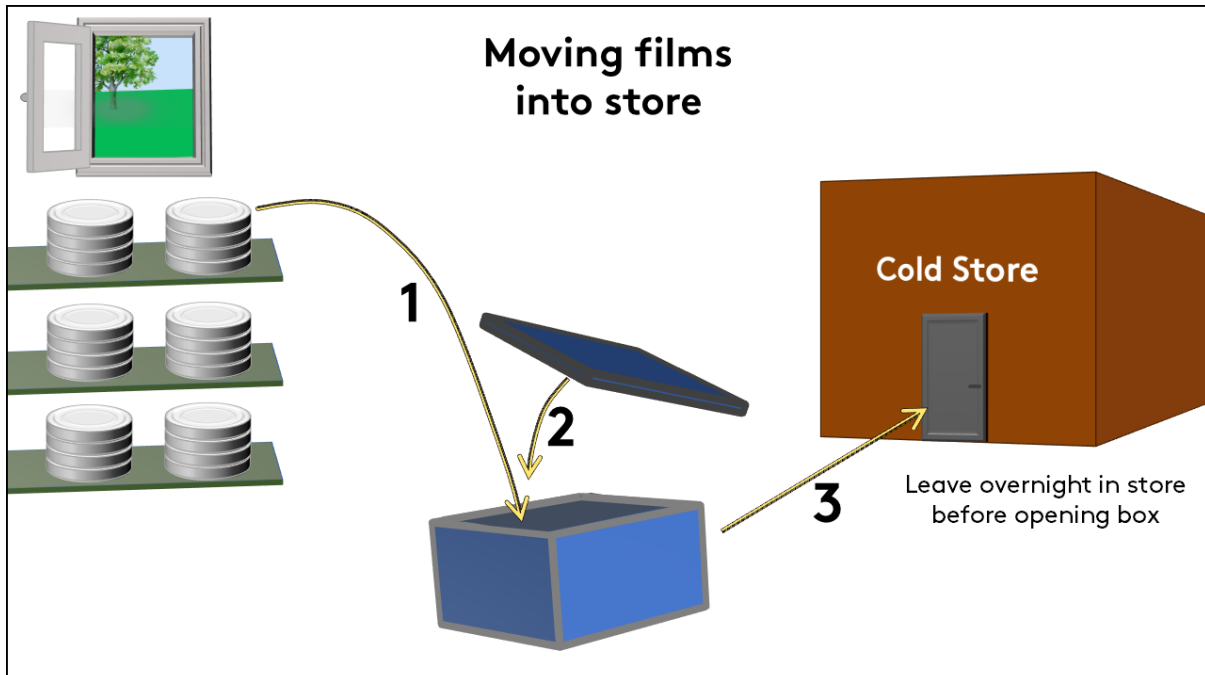
It is often assumed wrongly that films must be moved in stages through one or more intermediate conditioning rooms between the main store and the outside world. Conditioning rooms take up space, add complexity to the environmental control system, and are completely unnecessary.

Film is not adversely affected by the sudden temperature change from moving into or out from a low-temperature store, so the only requirement is to avoid moisture condensation on the film. Condensation might result from bringing a cold film into the warmer, more humid air outside the store, or moving a film can into a cold environment so that the moisture in the air inside the can condenses on the film. The latter is much less of a risk because there is only a very small amount of moisture contained in the air inside the can.

Avoiding condensation when taking films out of the store is simply a matter of allowing the film to warm up before being exposed to the outside air. A practical method is to place the film cans into containers prior to moving them out of the store, and allowing them to warm up overnight. The containers do not need to be insulated, but they should have closely-fitting lids and be reasonably moisture proof. Although it



may not be strictly necessary to take the same approach to moving films *into* the store, it may be safer and simpler for operational reasons to adopt the same procedure in both directions.



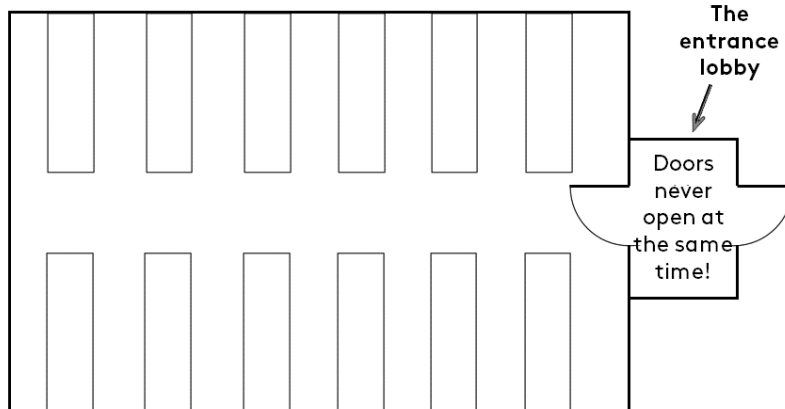
Research shows that a reel of film will take only a few hours to reach *temperature* equilibrium with its surroundings, but it can take weeks, or even months, to reach *moisture* equilibrium, largely depending on the temperature of the film. However it is safe to unwind and handle film before moisture equilibrium has been reached.

Entering and leaving the store

An essential part of a low-temperature store is the entrance lobby. A store which runs at a significantly different environment to its exterior conditions should never be open directly to the air outside the store.



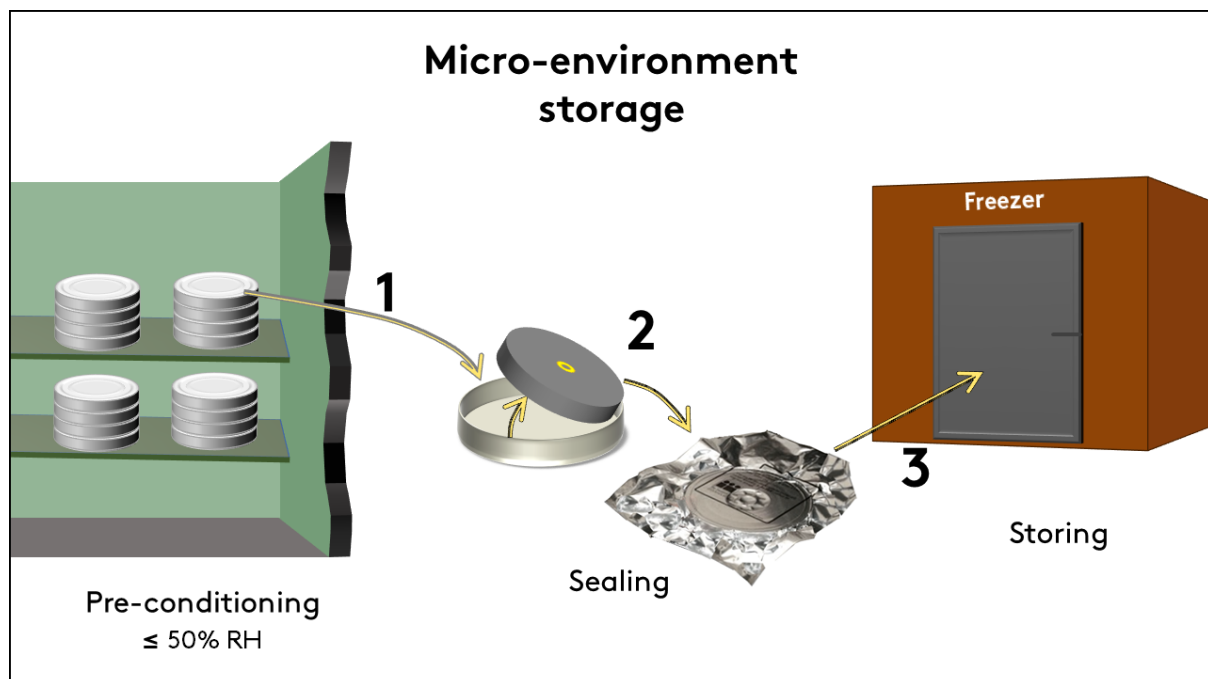
Warm, moist air entering the store will have a large impact on the internal conditions and it will take a lot of energy to remove the excess moisture and restore the set temperature. An entrance lobby is essential, and the internal and external doors should *never* be open at the same time.



This lobby does not require its own special conditions: its purpose is only to prevent a direct route for air between the interior and the exterior of the store. It should therefore be as small as practicable to minimise the amount of air entering and leaving the store each time someone passes through.

2. Micro-environment storage in stores with temperature control only

Instead of building and running a fully-conditioned store with both temperature and humidity control, it is equally possible to seal each film in its own micro-environment and then store it in a freezer without any humidity control.



The advantages of this approach to cold-storage are:

- Any freezer can be used, from small domestic units up to large industrial installations
- Very low temperatures can be reached more easily, typically $-18\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$), as used in the food industry
- The cost of installing and running the store is relatively low compared to a fully conditioned store
- The films are protected in the case of air-conditioning breakdowns
- Films can easily be moved in and out of store without the need for moisture-proof transit boxes.

The disadvantages are:

- Moisture-impermeable bags are required for each film
- Sealing equipment is needed
- A relatively low-humidity environment is needed to pre-condition the films
- Preparing each film for storage is labour-intensive
- Preconditioning and sealing means that it takes a significant amount of time to get a film into the store.

The choice between the two approaches will depend on factors such as the size of the collection, the staff resources, the reliability of power supplies, the level of access needed, and so on.

Film preparation

It is generally recommended that films are pre-conditioned below 50 %RH¹ before they are sealed up for storage. It is important to understand that:

- The aim is to ensure that the *moisture content* of the film is not too high
- The moisture content of the film depends primarily on the relative humidity of its surroundings
- The film can take a long time to reach moisture equilibrium with its surroundings: the colder the conditions, the longer it takes.

The exterior relative humidity in most parts of the world for most of the year is higher than 50 %, so it is likely that some pre-conditioning will be required regardless of where the archive is situated.

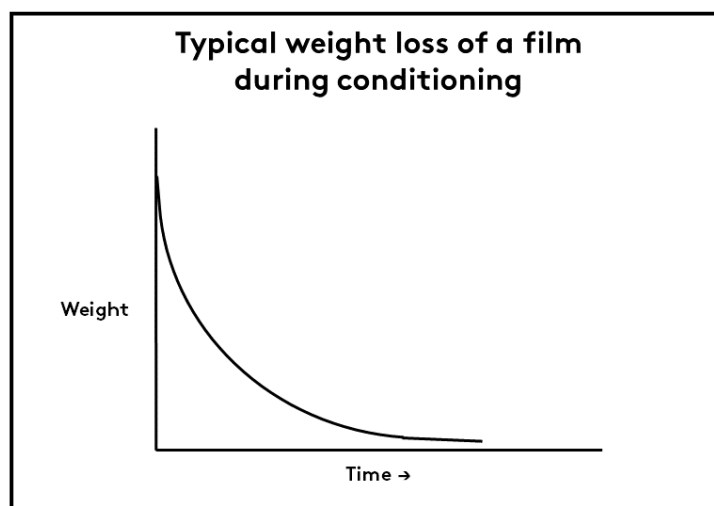
Any space where the relative humidity is maintained between 25 and 50 %RH can be used to pre-condition the films – an existing film store is ideal, but the length of time

¹ In *Moisture Relationships Of Photographic Film*, P.Z. Adelstein, J.-L. Bigourdan, & J.M. Reilly, it is stated that even films conditioned at 60 %RH and $20\text{ }^{\circ}\text{C}$ should suffer no ill effects from storage at below zero C temperatures.

for the films to acclimatise will need to be adjusted according to the temperature of the store (typically this will take 2 weeks at 20 °C, and 2 months at 5 °C). Needless-to-say, if the film is already housed in an air-conditioned film store at less than 50 %RH, then no further conditioning is needed.

In the absence of a humidity-controlled store, it might be feasible to construct a conditioning cabinet in which the films can be conditioned in batches².

A simple method of checking that the conditioning period is long enough is to weigh the reel of film before conditioning, and then weigh it at intervals until the weight loss slows down to a negligible rate. A 2 Kg reel of film (the approximate weight of a 35mm film of 1000 ft/300 m) can be expected to lose a few grams in weight as it dries out (dependent on the initial conditions), and the rate of weight loss will increasingly slow down as it approaches the end point.



Drying the film with a desiccant

An alternative approach is to seal the film in a bag with some desiccant in order to lower the moisture content of the film. This may be practicable for a small number of films, but it likely to be both expensive and labour-intensive for larger collections.

The simplest option is to use silica gel which is available in pouches and which must be activated before use by drying it out in an oven. The amount of silica gel to be used for each film does not need to be precise: around 2 to 3 % by weight of the film should result in an acceptable moisture level in the film.

It is also possible to use molecular sieves (zeolites) to remove moisture from the film, but care must be taken to use no more than the recommended amount (around 5 %

² This was the solution used in the FICA system devised in the 1980s by the Swedish Film Institute: the FICA cabinet was held at around 30 %RH and 20 °C, allowing each batch of films to be conditioned in 2 weeks.

by weight of film is generally recommended) because such material will aggressively absorb moisture and could conceivably dry the film out too much.

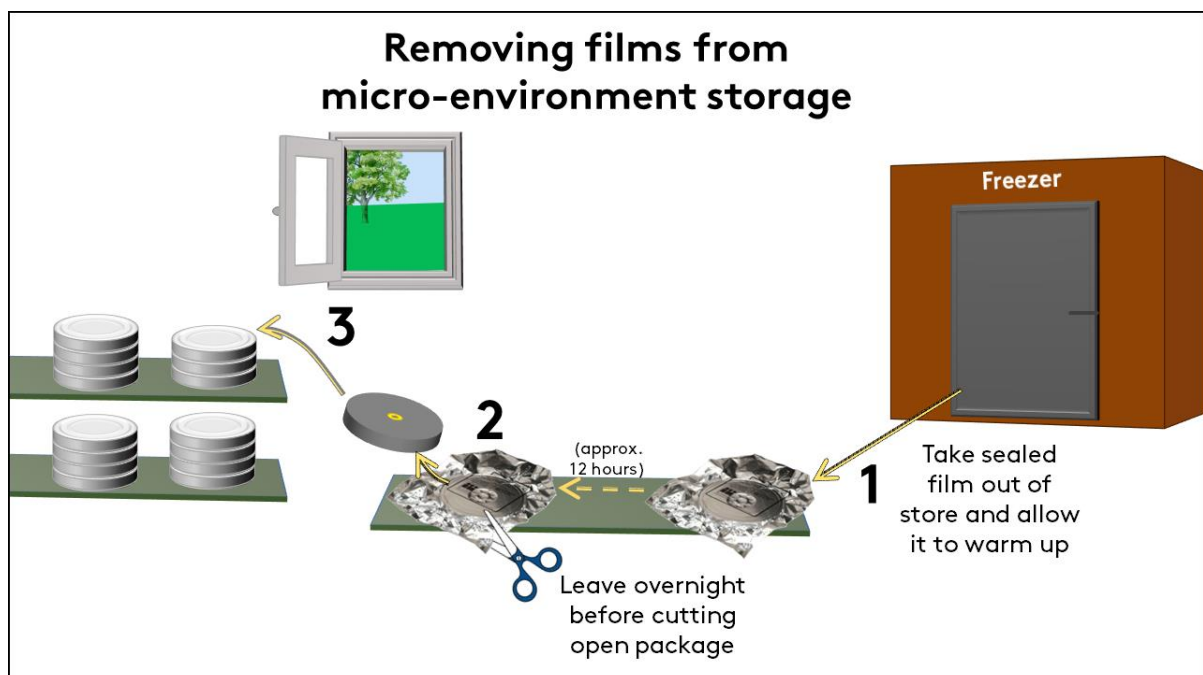
Enclosures

For long-term storage it is essential to seal the film in moisture-impermeable material. Normal polyethylene bags (e.g. supermarket freezer bags) are *not* sufficiently impermeable, and water will gradually diffuse through these into the interior of the bag. Such bags should only be used as a short-term measure.

Bags made from a composite of aluminium foil and polyester are recommended, and these are readily available³. Equipment that extracts the air from the bag and heat-seals them is also readily available.

Taking films out of micro-environment storage

Removing the films from store is simple. The sealed films can be taken directly out of store into ambient conditions and allowed to warm up overnight: this will allow the film plenty of time to warm up so that there is no chance of moisture condensation on the film when it is unsealed. The sealed bag is then cut open and the film can then be handled – as with open storage (see above), it is safe to unwind and handle film before moisture equilibrium has been reached: if the film is unwound there may be a small amount of temporary buckling due to the low moisture content of the emulsion, but this will naturally rectify itself as the film re-moisturises.



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³ It can be argued that any enclosure should pass the Photographic Activity Test (ISO 18916); however this test is primarily designed for materials closely in contact with photographs, whereas a reel of motion-picture film is primarily only in contact with itself, and so the enclosure can be expected to have a limited effect on the film, especially at low-temperature.