Low-Temperature Film Storage: From Research To Implementation

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Low-Temperature Film Storage: Why Is a Good Idea

- Slows down chemical decay
- Stabilized actively decaying film
- Minimizes risk for contamination
- Implementation can be customized
- A few simple recommendations need to be follow
- Is cost-effective

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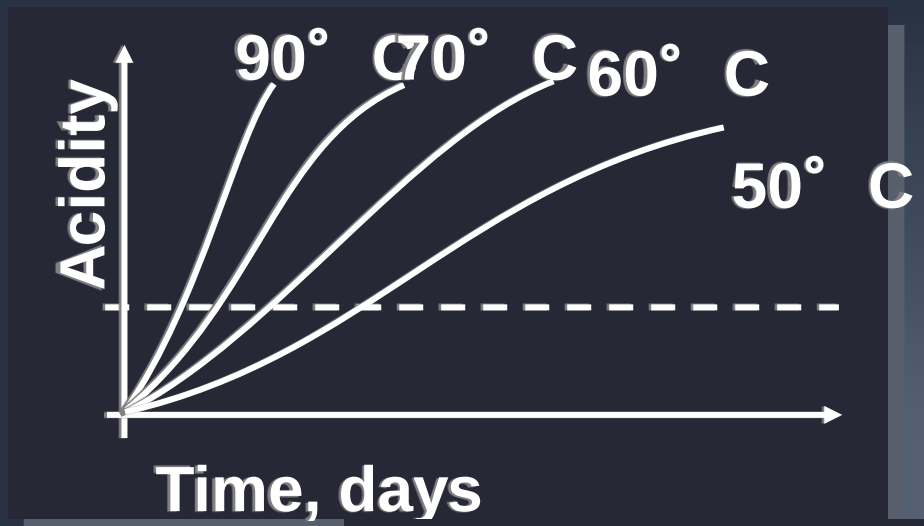
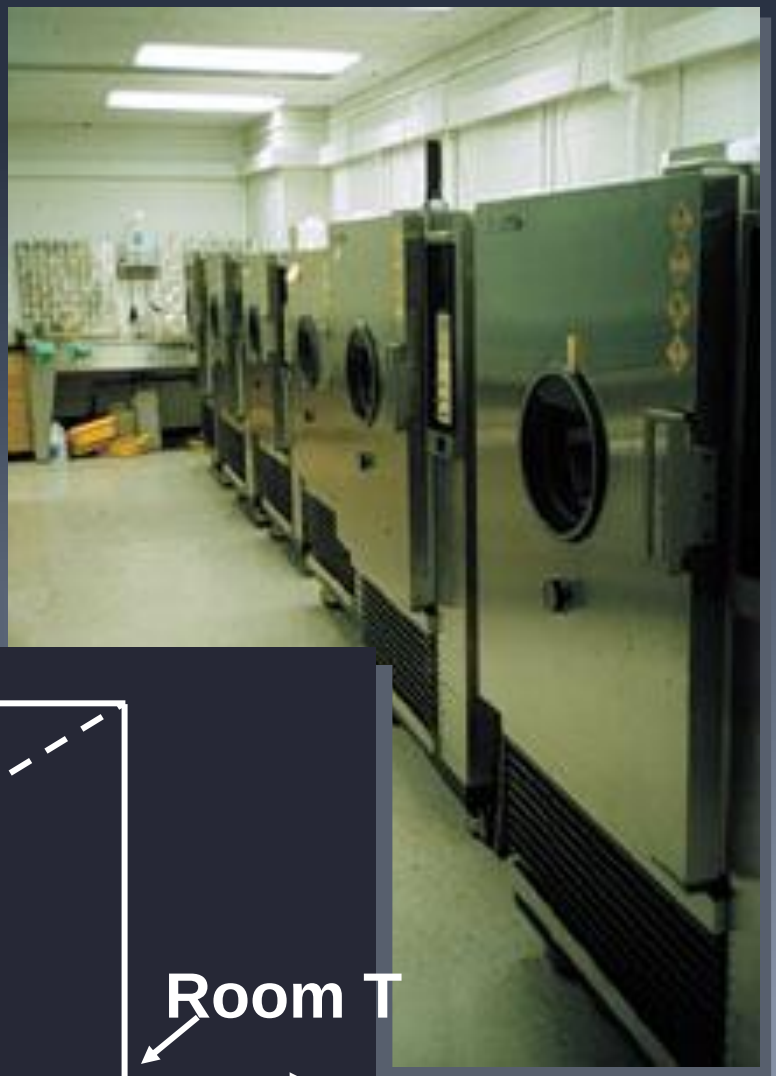
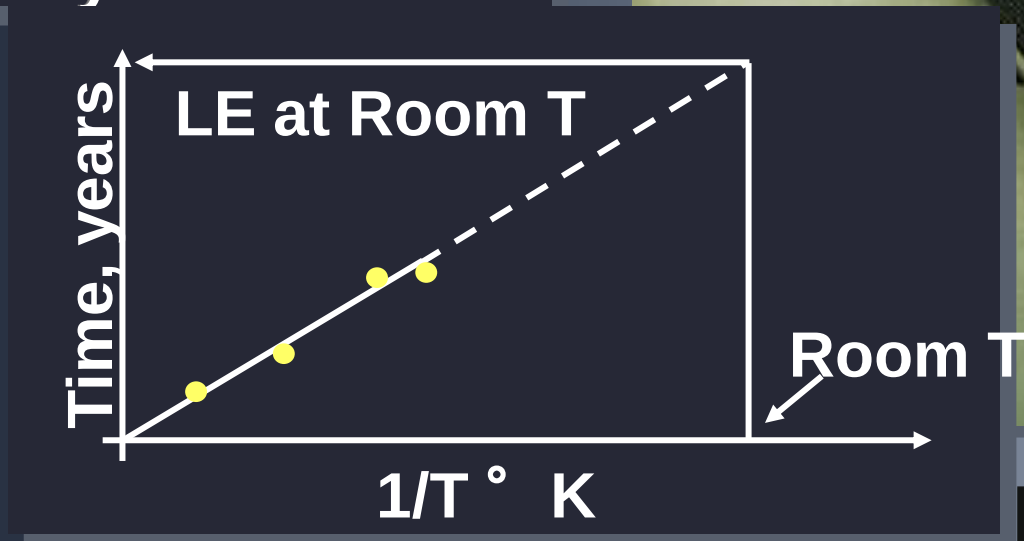
Accelerated Aging Applied to Film Chemical Stability







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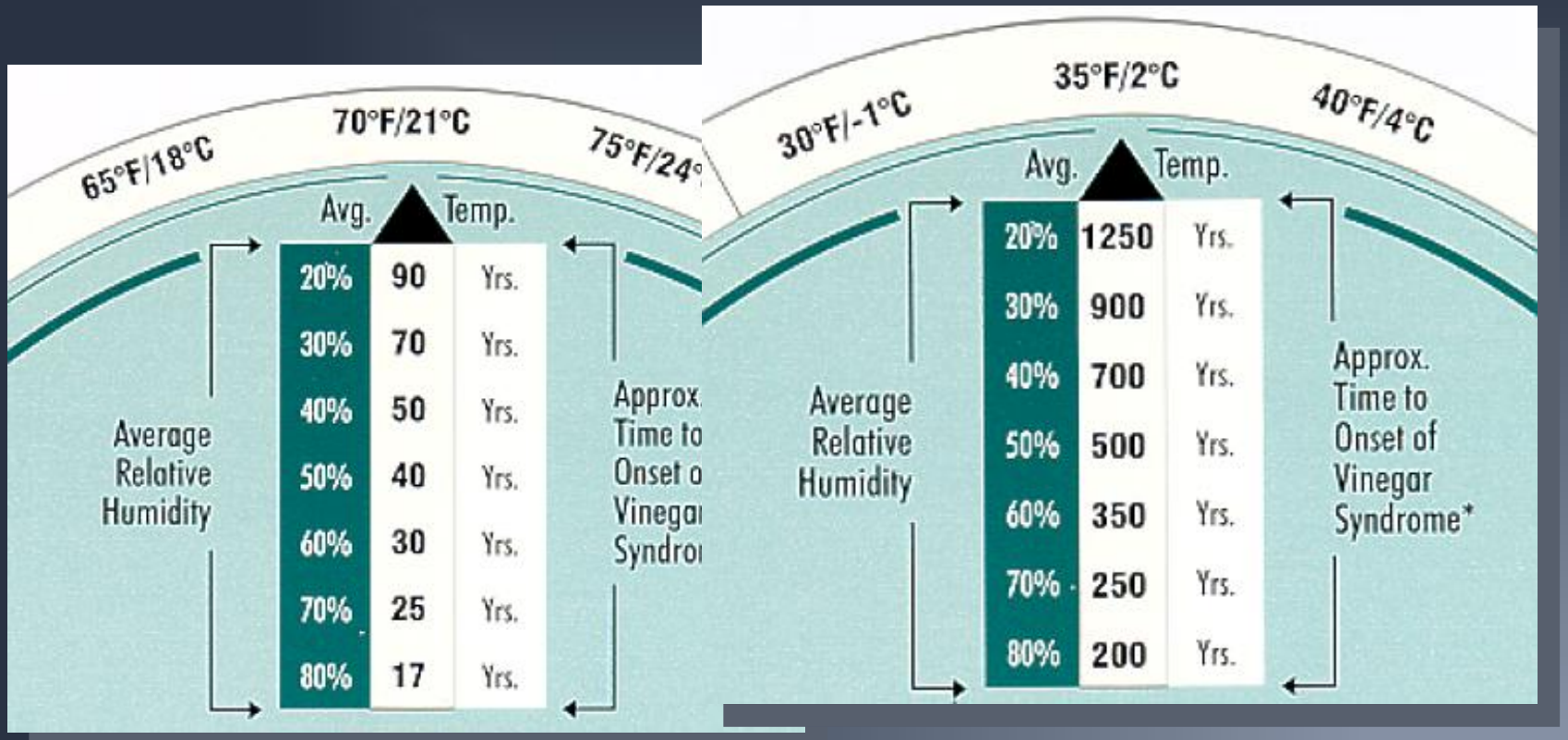
Temperature and RH Govern Acetate Stability



From *IPI Storage Guide for Acetate Film*

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Cold Storage Is Good…

Storage Conditions	Glass Plates	Nitrate	Acetate		Polyester	
			B&W	Color	B&W	Color
ROOM	Fair	No	No	No	Good	No
COOL	Good	No	No	No	Good	No
COLD	Very Good	Good	Good	Good	Very Good	Good
FROZEN	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good

From *IPI Media Storage Quick Reference, 2nd edition, 2009*

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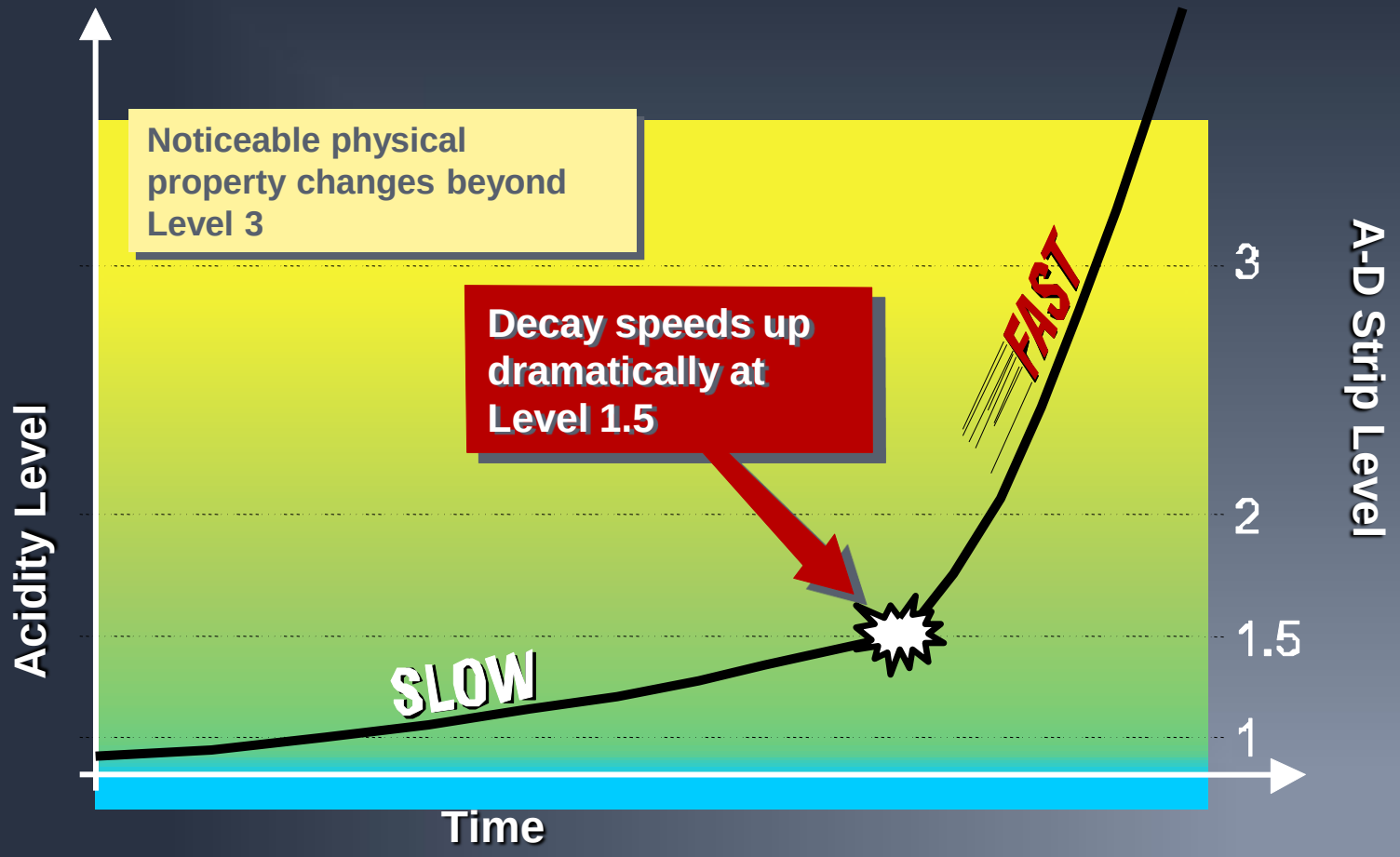
… But May Not Be Good Enough for Degrading Acetate



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Optimizing Acetate Chemical Stability

Film Condition	Time to A-D Strip Level 2 (years)		
	14°C (57°F) 60% RH	5°C (41°F) 35% RH	-5°C (24°F) 30% RH
Fresh	75	500	>2000
A-D Strip level 1.5	<15	<200	>500

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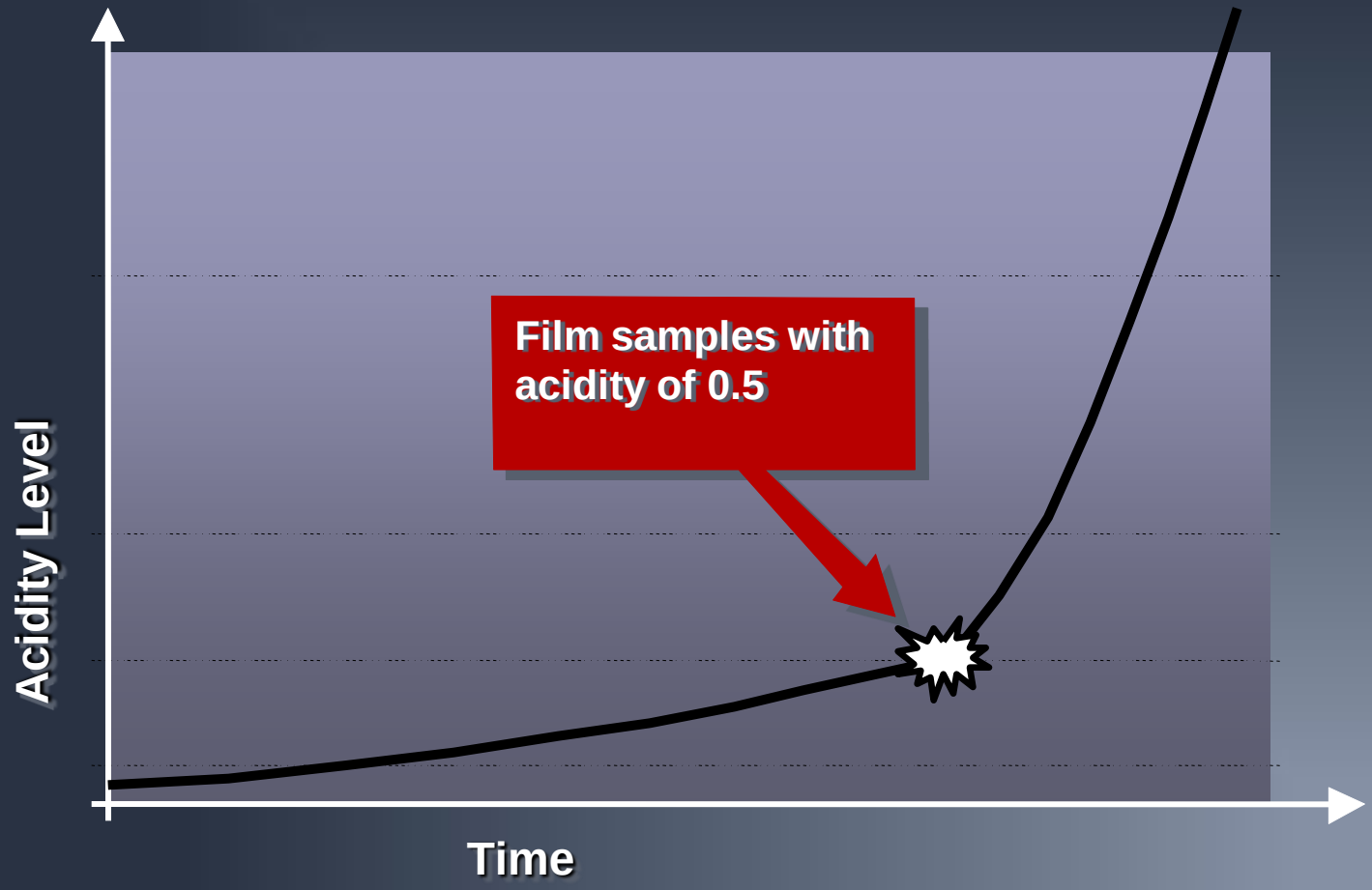
Frozen Storage “Stops” Acetate Decay. Really?



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Room Vs. Frozen Storage

21˚ C (70˚ F), 50-55% RH

-16˚ C (3˚ F), 50-60% RH

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Film Acidity Changes: Temperature Matters

Years	Freezer 3°F	Room 70°F
5	No change	2 to 3 times greater
6.5	No change	4 to 5 times greater
>10	No change	9 to 13 times greater
>15 years	No change	>20 times greater

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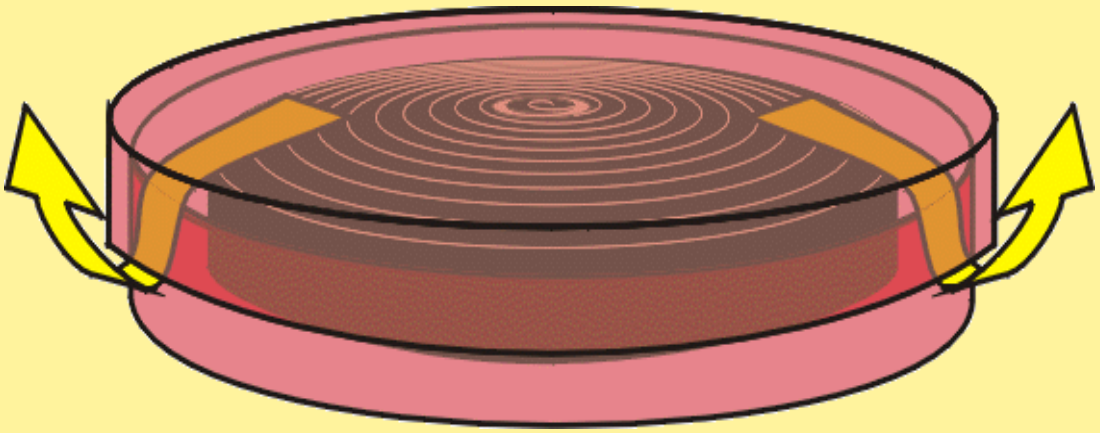
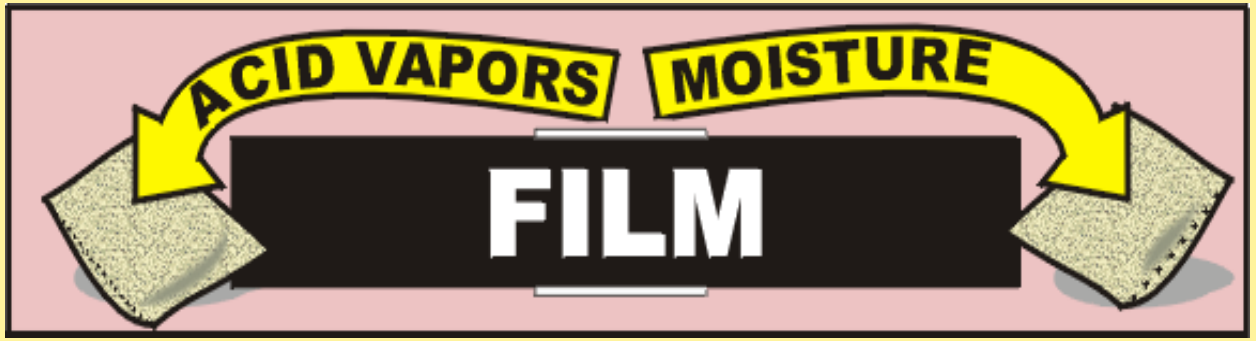
Are There Other Alternatives To Cold/Frozen Storage?



VENTED CAN

ADSORBENTS IN SEALED CAN



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…Not Really

- Neither vented enclosures or use of adsorbents is a response to control acetate decay
- Both alternatives help but don't stabilize decaying materials
- In cold storage both have marginal benefits in comparison with the effect of temperature

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Dealing With Degrading Acetate

- Removing degradation-by- products can affect film shrinkage
- Removing Moisture Can Affect Dimensional Stability
- Subfreezing temperature and constant moisture content should stabilize degrading acetate

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How to Implement Low-Temperature Storage

- Temp.- and RH-controlled vault
- Sealed packages inside freezer
- Goals are to provide low temp. and to control film moisture content

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Implementing Cold/Frozen Storage

- Involves temperature and RH changes
- Requires to understand equilibration rates
- Creates new Temp., RH and moisture content relationships

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Temperature Equilibration Is Relatively Fast: Hours

Materials	Configuration	Time for 90% E
1,000-ft. 35mm roll	One roll in metal can	3.5 hours
	Six rolls in metal can	7.5 hours
4 x 5-in. sheet film	Stack of 500 sheets in metal drawer	6.25 hours
3.5 x 5-in. RC prints	1,000 prints in cardboard box	4 hours

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Full Moisture Equilibration Takes Time (data at 20˚ C/ 68˚ F)

Materials	Enclosures	90% Equil.
HC Book	Book on shelf	one month
35mm Film	None	Two weeks
35mm Film	Metal can	Six months
2” datatape	Plastic container	Six months

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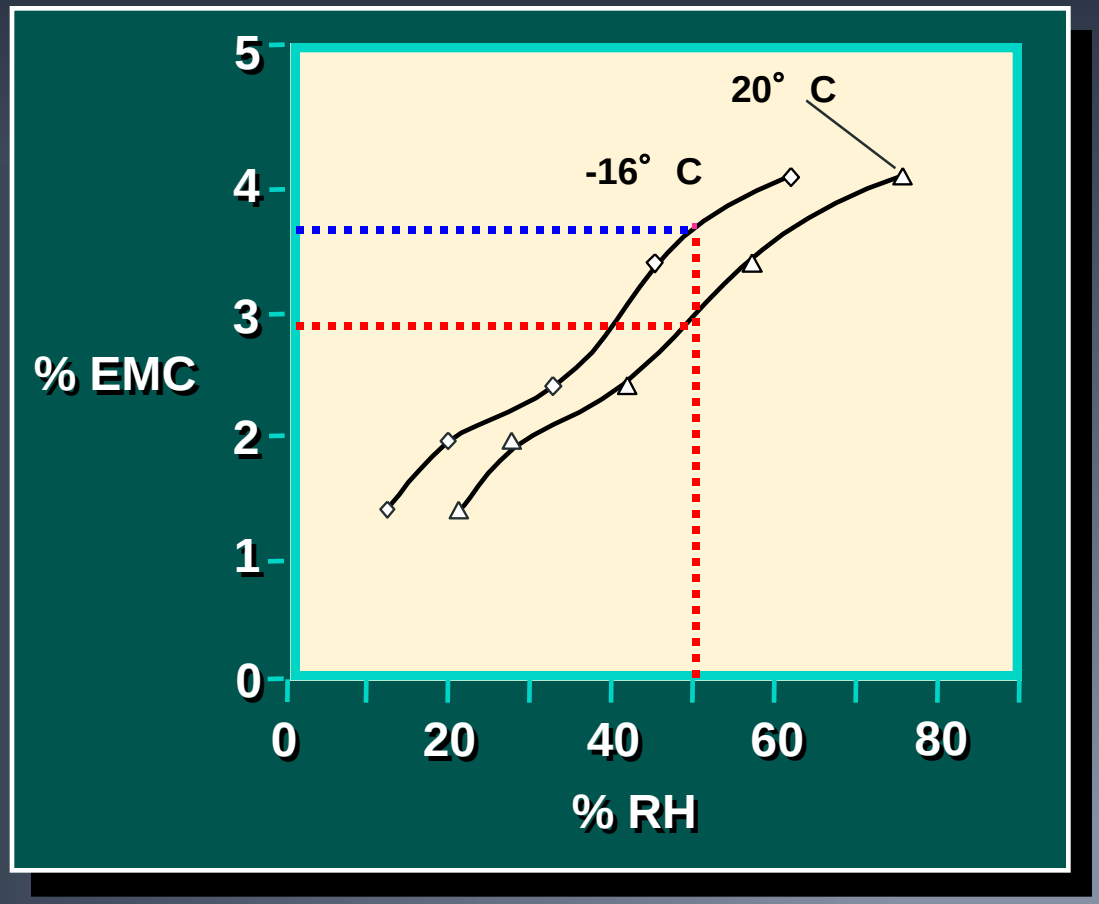
Moisture Relationships Vs Temp.

- Film is hygroscopic
- Moisture content depends on RH…and Temperature



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Temp.- and RH-Controlled Vault

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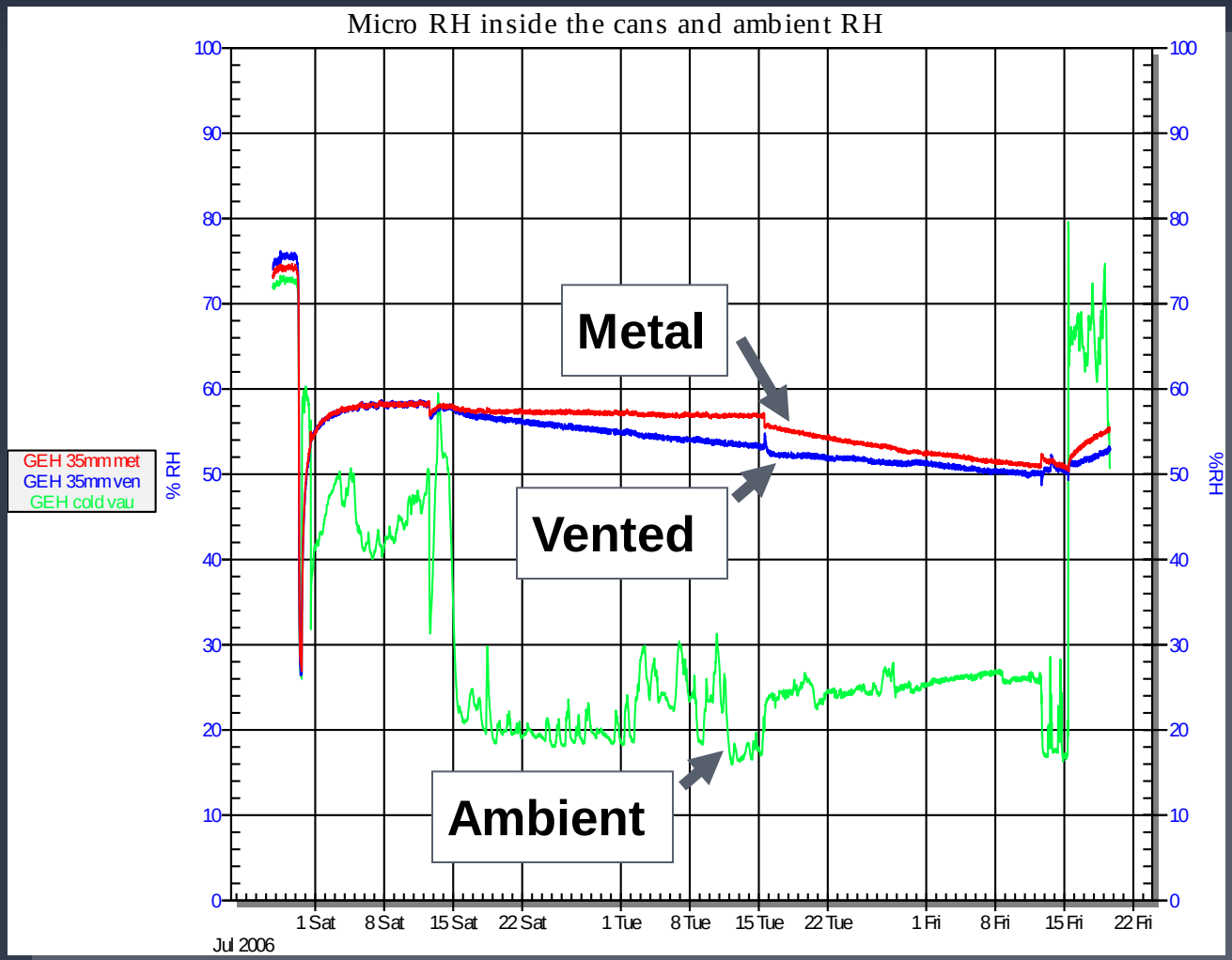
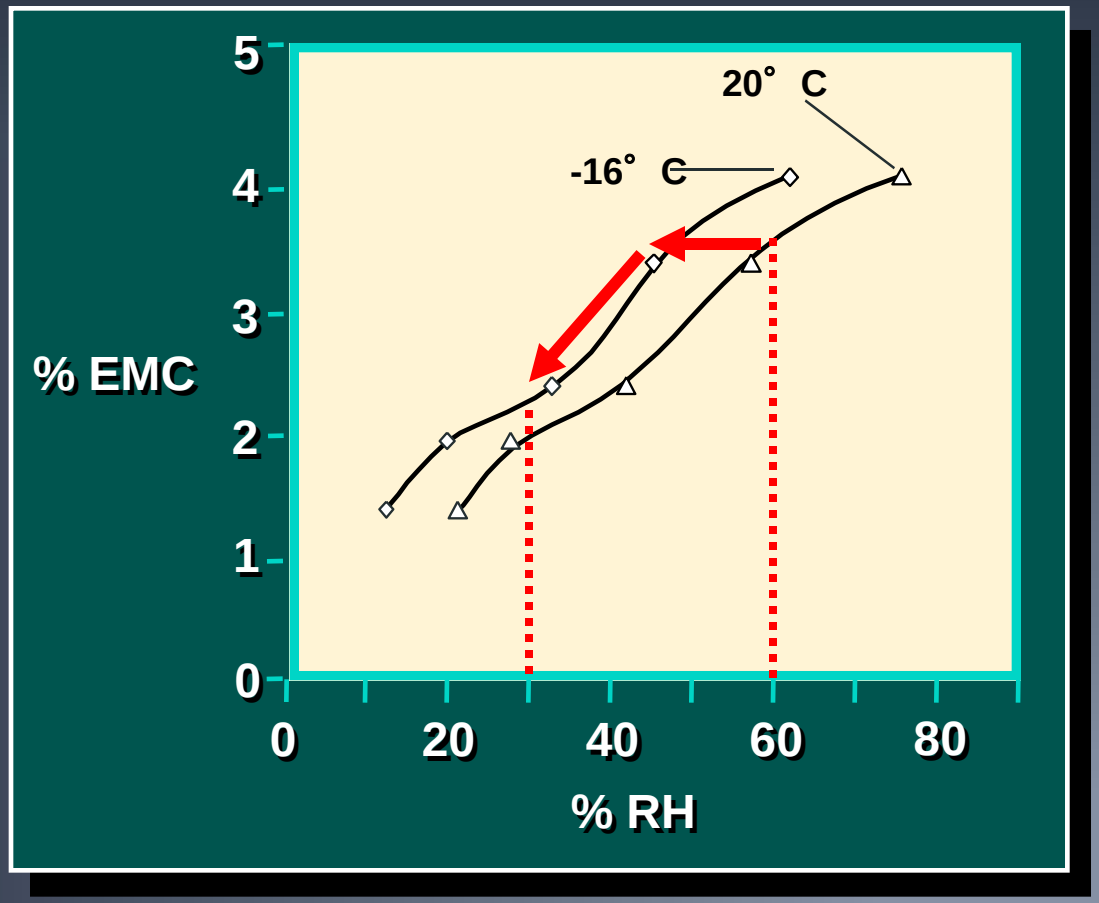
Moisture Equilibration Takes Months or a Year Inside Cans

- 40° F
- Micro-RH versus ambient
- 3-month period



Option 1: Cold Storage with Temp. and RH Control

- % EMC determined by temp. and RH set points inside the vault



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Temp.- and RH-Controlled Cold/Frozen Storage

- No need for special housings
- Film equilibrates to temp. and RH set points
- Temp. equilibration takes hours
- RH equilibration takes months or a year
- No need for acclimatization

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Option 2: Using Freezers

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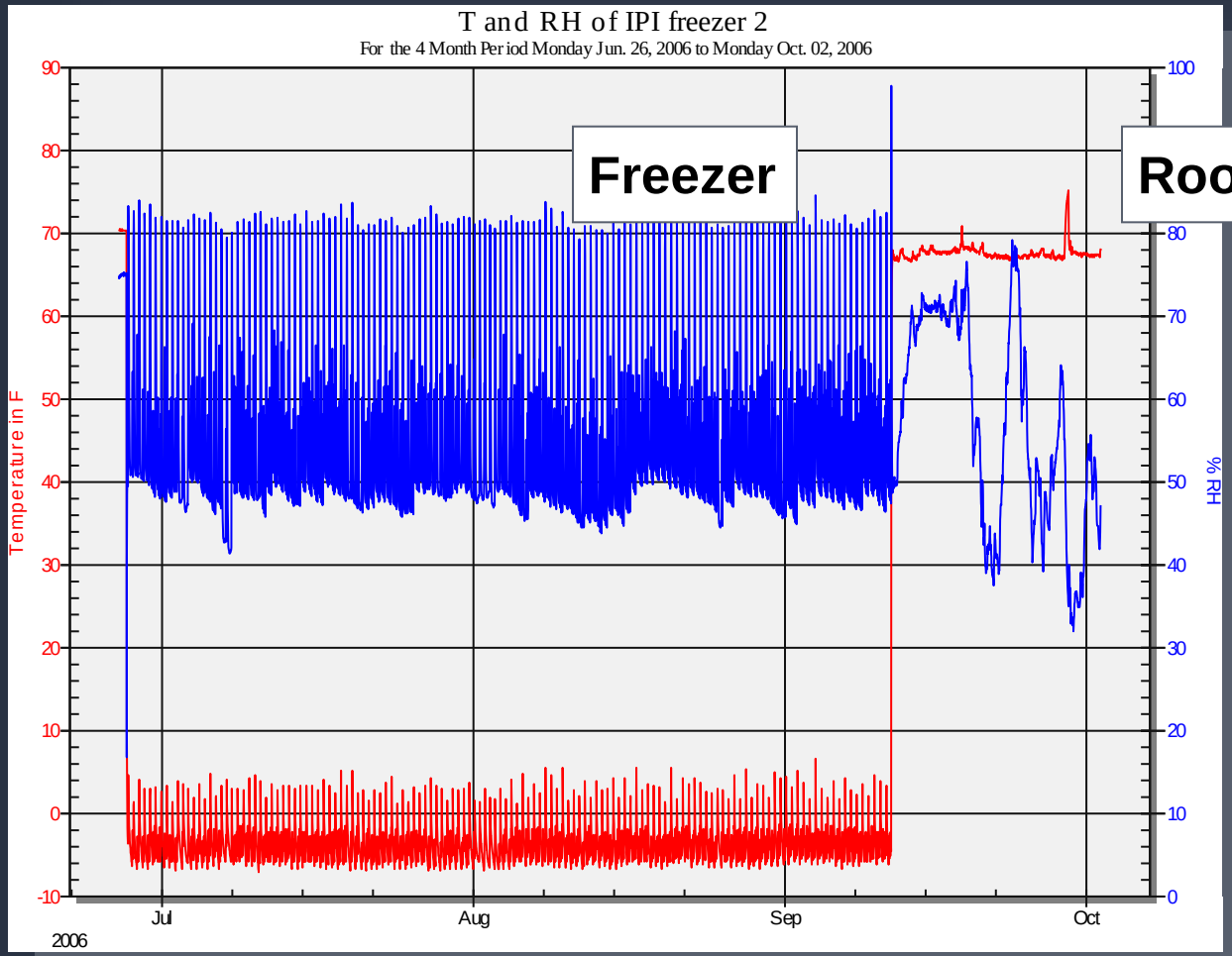
Household Frost-Free Freezer Controls Only Temperature



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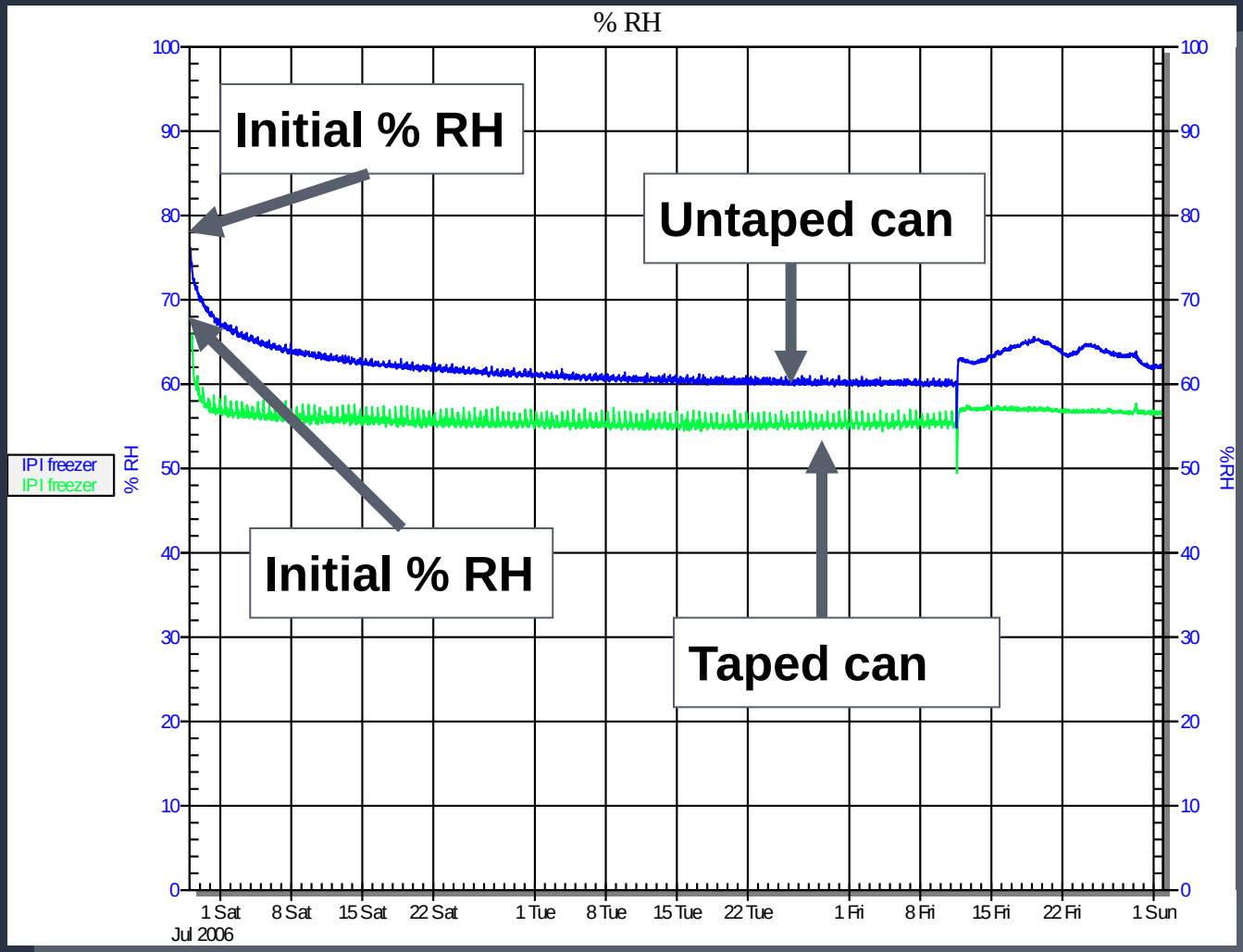
Micro RH Inside Can at 0° F



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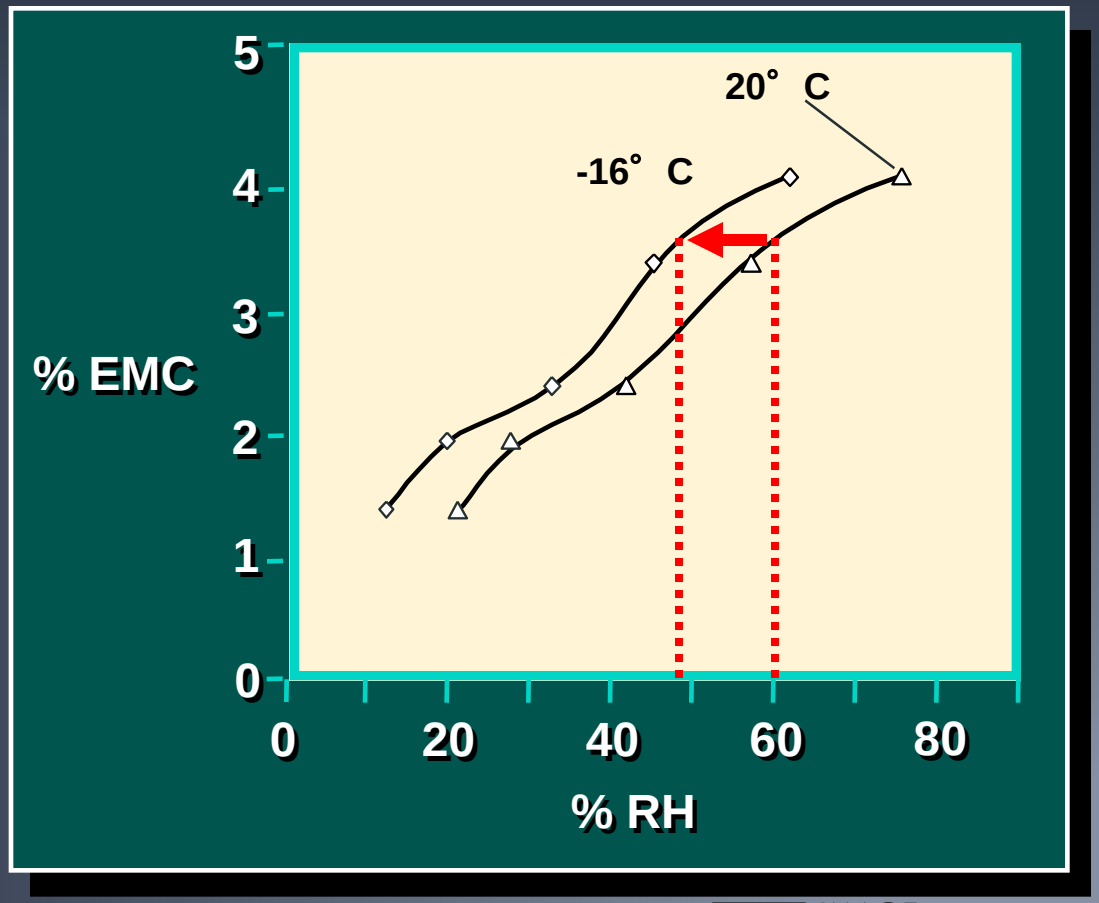
Temperature Control Only: Use Moisture-Proof bags

- Moisture content depends on initial conditions
- Micro RH is reduced



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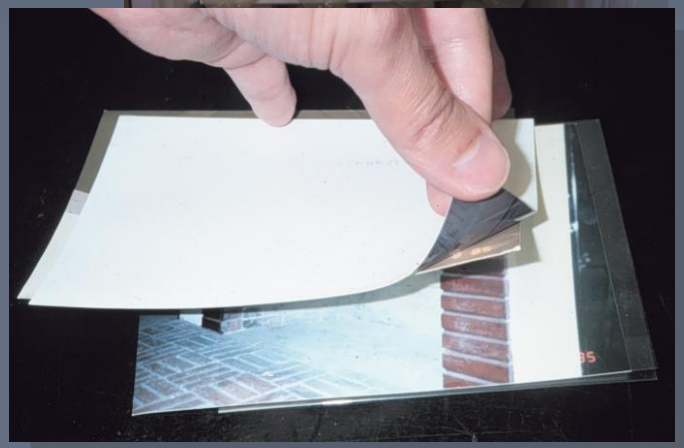
When Only Low Temperature Is Controlled

- Use moisture-proof enclosure
- Initial micro RH will be reduced
- Moisture content remains essentially constant
- Prepare materials at room temp. and 35% to 60% RH



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Retrieving Film from Cold/Frozen Storage: Avoid Condensation on Film Materials

- Evaluate risk
- Choose among two access procedures
- Determine appropriate conditions

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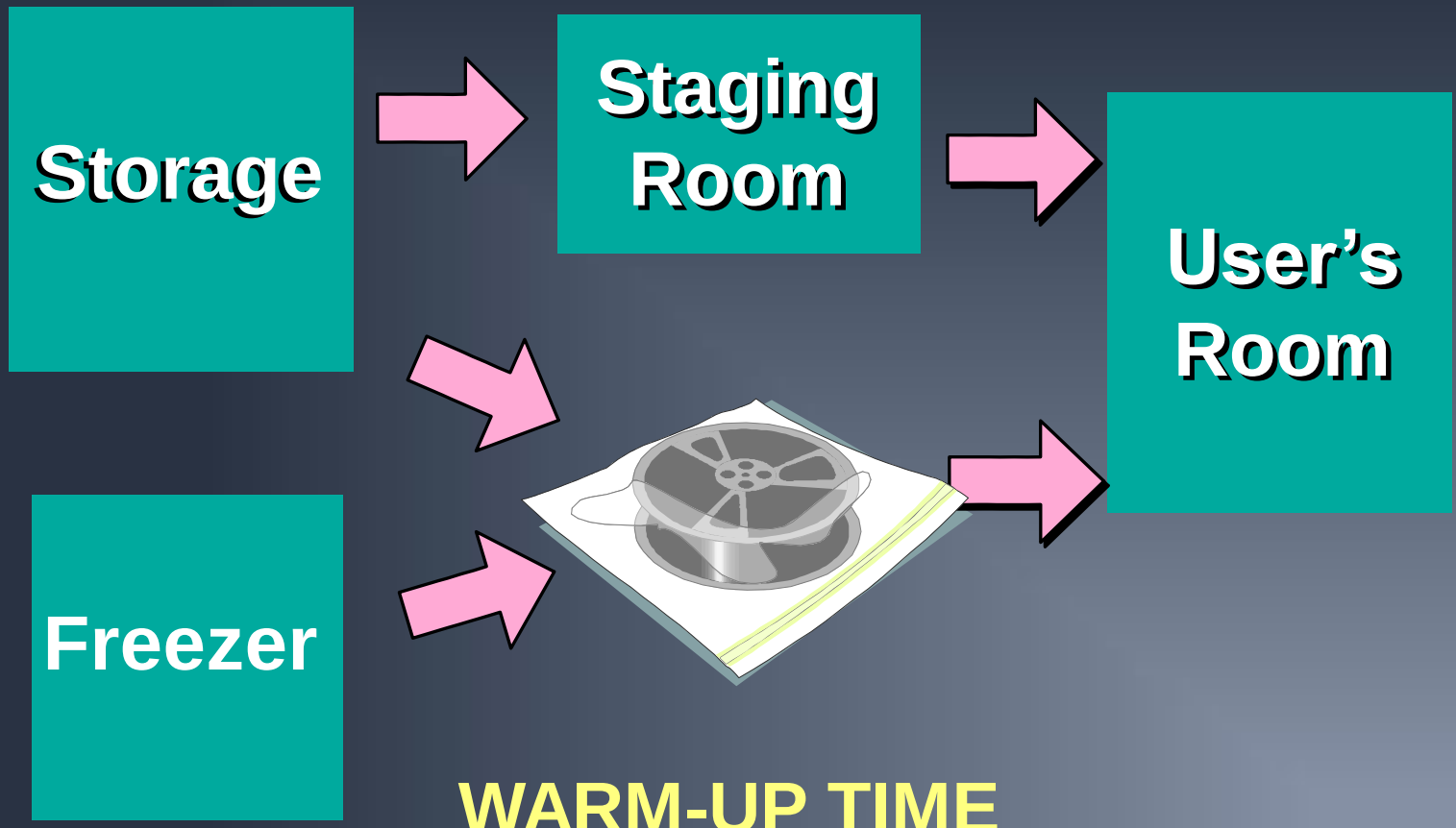
Cold/Frozen Storage Access: Two Options



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When Using Moisture-Proof Packaging

- Moisture-proof package provides protection against condensation
- No need for a staging room with controlled Dew Point
- 24-hour warm-up time is common practice

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Key Recommendations When Using Frost-Free Freezers

- Use effective moisture-proof packaging systems
- Prepare materials at moderate RH
- Allow warm-up time before direct access to the materials

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