

# IIC International Training Centre for Conservation

Inaugural Programme

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**Scientific Approaches to  
Preventive Conservation**



## Relative humidity control

25 September 2015

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# Relative humidity

- RH control
  - No environmental control
  - Air conditioning
  - Conservation heating
  - Comfort heating
  - Humidification
  - Dehumidification



# Relative humidity

Easier in historic houses than museums:

- Many historic houses are closed in the winter
- T can be controlled for object comfort rather than people comfort

More difficult in historic houses than museums:

- Architectural importance of building
- Ductwork and space for plant difficult
- Adding moisture may cause condensation
- Taking away moisture may draw soluble salts through structure



# No environmental control

- Monitor T/RH for one year
- Survey state of building
- Monitor conditions of artefacts over time
- Establish priorities using preventive conservation framework
- Security/fire prevention/building maintenance may be more important than RH control
- Do not be afraid to do nothing if other priorities exist



# No environmental control

- What is the climate in buildings with no environmental control in your countries?
- In the UK buildings are damp
- Average external RH is 75-90%
- Summer sun can give rise to excessive solar gain
- External shading is more helpful than internal
- Some houses have external blinds











# No environmental control

- In tropical climates T/RH high for much of year
- Mould would be expected but often does not occur
- Importance of ventilation and air circulation
- Do not interfere with a building that works
- Air conditioning may be a disastrous addition







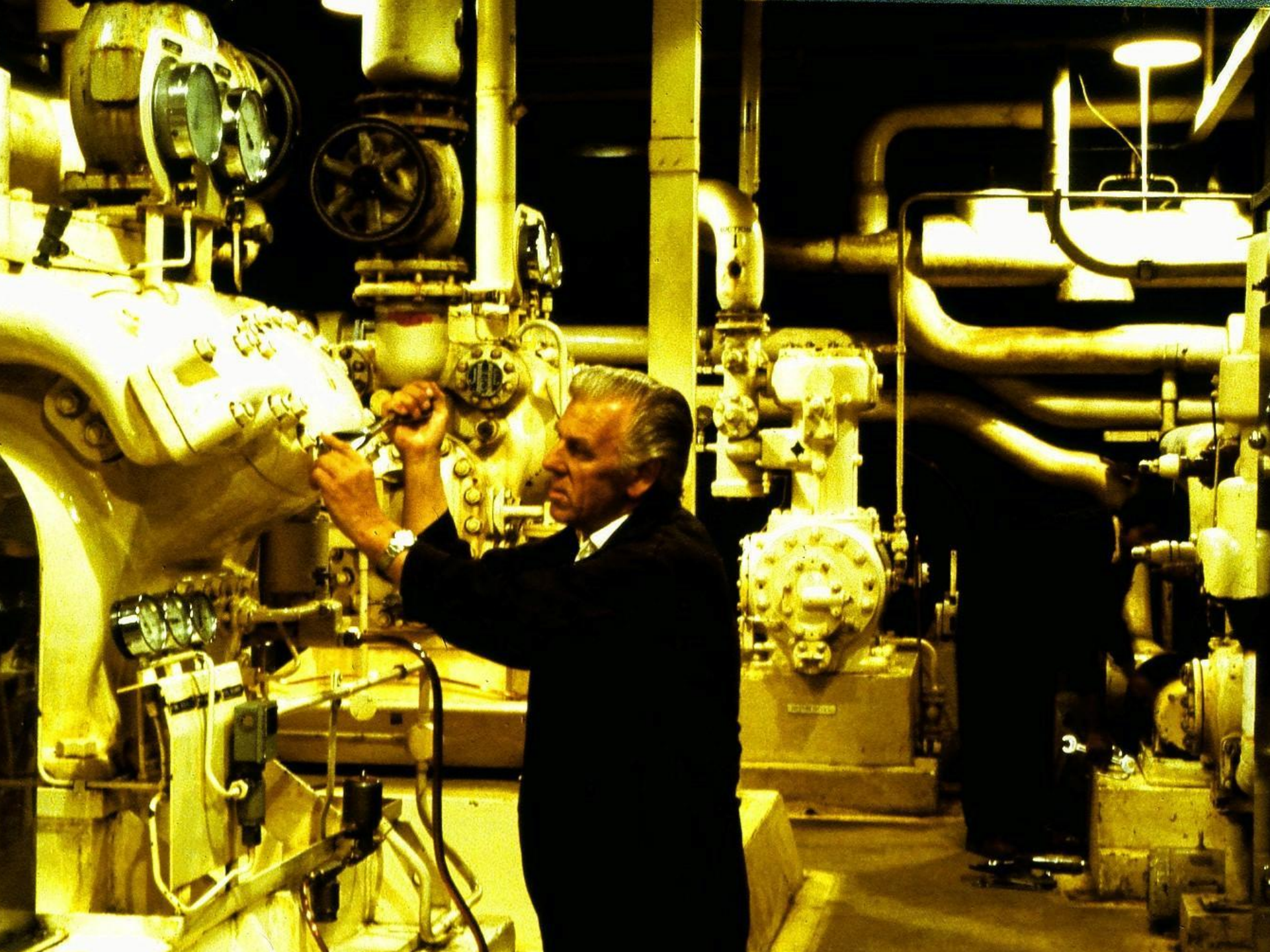


# Air conditioning

- Needed for full T/RH control and pollution removal
- Very expensive and destructive of building fabric
- Plant and ductwork occupy much space
- Humidification may cause problems





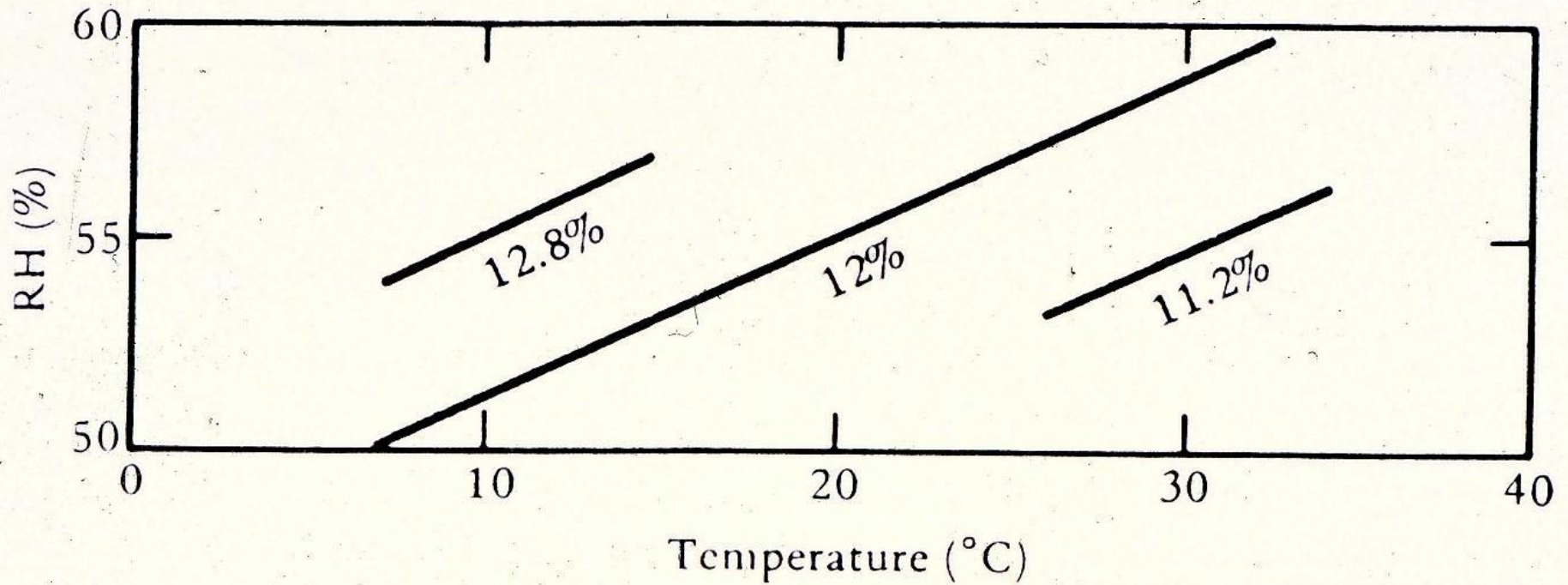


# RH control by adjusting temperature

- T less important to control than RH
- T changes may affect some materials with high T coefficient of expansion
- Keep dimensional stability by keeping moisture content constant
- Dimensional change may cause damage to constrained objects
- Change in moisture content of wood caused by 4% change in RH same as 10C







RH required to maintain constant EMC in wood under varying temp.

# Conservation heating

- Temperature is adjusted to provide RH levels with a target band
- Humidistatically-controlled heating
- In the UK raising the T by 5C will reduce average RH to approx 60%
- Amount of heating required in other climates can be determined by studying meteorological data and using psychrometric chart





# Conservation heating

<b>Month</b>	<b>AMC</b>	<b>Ta (C)</b>	<b>RHa (%)</b>	<b>RH (T=Ta+5C)</b>
January	4.1	3.2	87	60
February	3.9	2.9	83	59
March	4.3	4.4	80	58
April	5.0	6.5	82	59
May	5.9	9.2	82	59
June	7.5	12.5	82	60
July	8.0	13.3	83	60
August	8.2	13.4	85	60
September	7.6	12.4	85	60
October	6.4	9.8	86	60
November	4.8	5.4	87	61
December	4.1	3.1	86	60

# Conservation heating

- Low winter T is not high enough for comfort
- Comfort heat offices and staff rooms
- Use heating mats or local heaters for short time
- Wear warm clothes!



# Electric heaters with humidistats

- Electric heaters can be controlled directly with humidistats
- Trial to test power of heater and electrical consumption
- Cheap hear humidistats require frequent recalibration and have large switching differential
- Use electronic humidistat with inbuilt upper/lower T limits

















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# Building management systems

- BMS to control heating systems on scale of whole building
- Computer, outstations, T/RH sensors, valves etc
- Live T/RH readings, alarms, power consumption, data storage
- High quality RH sensors calibrated twice a year
- Can use BMS to control electrical heaters or wet heating system









ELECTRONIC MOI CALIBRATOR  
100-200

0.42

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# Cooling to reduce RH

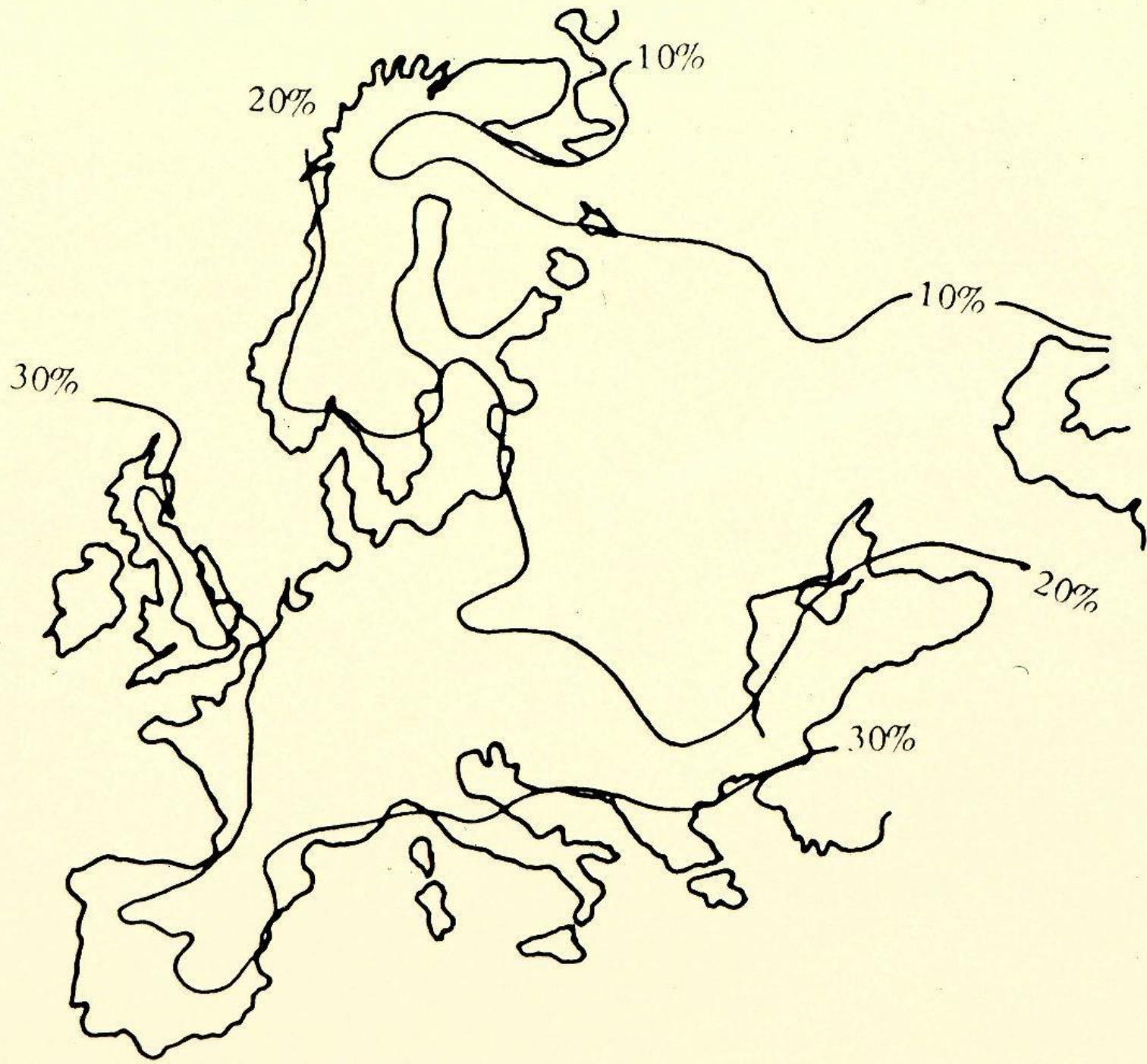
- Hot humid conditions may be improved with room air-conditioning
- Air passes over cooling coils, water condenses out, air passes back into room
- Condensing coils are outside window
- Could be operated on RH priority
- Room must be well-sealed

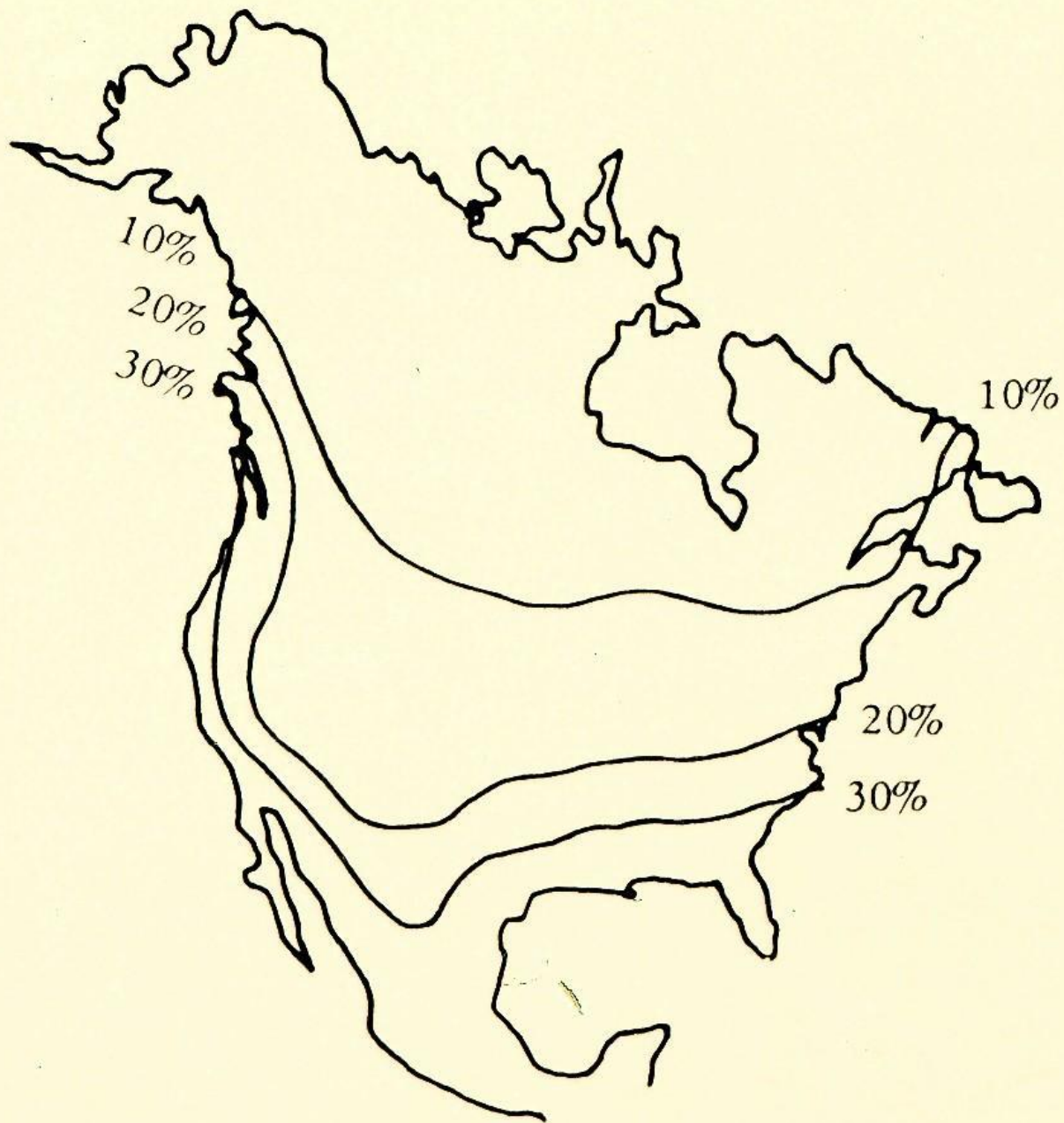


# Comfort heating

- Museums open to public in winter need to heat to comfort conditions of 18C+
- In museums and historic houses usually closed in winter, comfort heating may be required for events
- Comfort heating may be needed in shoulder months (April and October)
- Increase T to no more than 18C for as short a time as possible
- This gives objects less time to react to RH change







# Humidification

- Heating to 18C without adding moisture to air causes low RH
- Winter dryness problem for museums open during winter
- Problem in historic houses occupied by family or tenants in winter
- Potential problem if historic houses open in winter or hold events







# Humidification

Reasons not to use humidification in historic houses:

- Increase in vapour pressure
- Moisture travels through building fabric if convective routes are blocked
- Condensation or freezing may occur in fabric
- Fungal growth or corrosion possible
- Condensation in unheated areas





# Humidification

- Atomising/centrifugal
- Ultrasonic
- Steam
- Evaporative





# Dehumidification

- Uses approx one third the energy of heating for same level of control
- Reduces air moisture content/vapour pressure
- Space must be well-sealed

BUT

- Soluble salts drawn thro' building fabric
- Control lost when museum is open increasing rate of RH change



# Dehumidification

- Desiccant
- Refrigerant



# Dehumidification in storage

- Storage spaces can easily be well-sealed
- Desiccant dehumidification is standard, low cost method of control
- Use fans to ensure air circulates and there are no stagnant damp areas







# Exhibition Rooms

- Rooms can be sealed as long as there are no building defects
- Windows and doors need draught-proofing
- Chimneys need blocking
- Dehumidification brings down RH without raising T so good in summer

BUT

- RH control lost when museum is open to the public and fluctuations can be worse











# Relative humidity

- RH control (7)
  - No environmental control (8)
  - Air conditioning (9)
  - Conservation heating (10)
  - Comfort heating (11)
  - Humidification (12)
  - Dehumidification (13)

