Storage for Infinity: Part 1

Museum 202, Section 3

Storage Facilities

presented by

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Course Agenda

Section I: Storage Philosophy

Section 2: Agents of Deterioration

Section 3: Storage Facilities

Section 4: Storage Furniture

Section 5: Conclusion

Section 3 Agenda

1: **Planning Storage Space**
2: **Storage Location**
3: **Construction**
4: **Environmental Controls**
5: **Storage Illumination**
6: **Pollution Control**
7: **Security**

Section 3 Agenda (cont.)

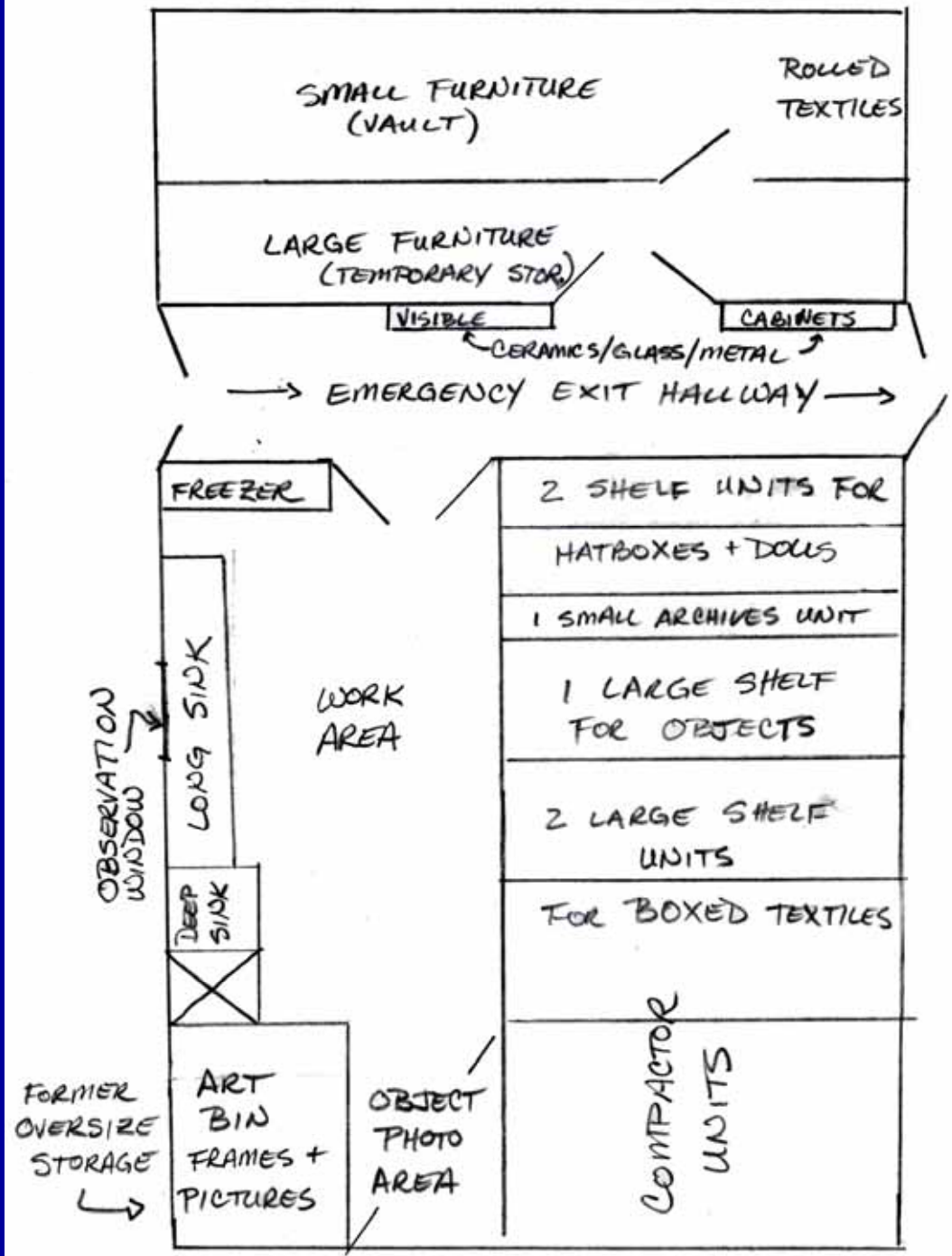
8: **Emergency Preparedness**

9: **Housekeeping and Maintenance**

10: **Building Inspections**

11: **Pest Control**

Planning Storage Spaces



Planning Storage: A team approach

- ***conservator*: preservation guidelines**
- ***curator & researchers*: access**
- ***collection manager*: storage management and collection use**
- ***registrar*: inventory control**
- ***mount maker*: supports**
- ***security staff*: collection safety**

Planning Storage:
Consider...

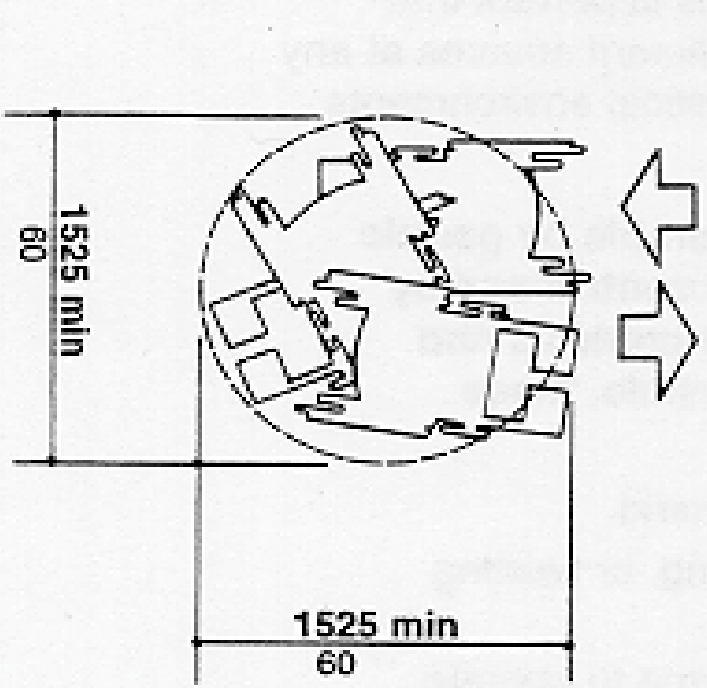
- **Environmental Risks**
- **Artifact Movement**
- **Maintenance Ease: cleaning under furniture, monitoring**
- **Security**
- **Special collection needs: storage during photography, wet collections...**

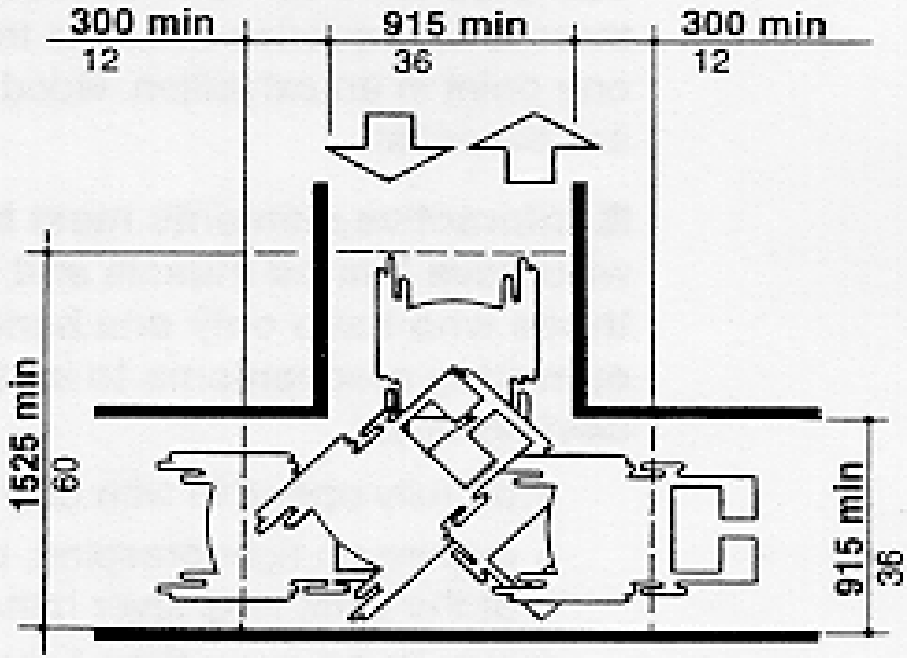
Object Movement

- Avoid bottlenecks
- Adequate ceiling height and wall width in corridors, doors, storage
- Temporary placement tables
- Smooth floors
- No clutter

ADA Corridors & Corners

Turning Radius: 60 in. / Corridor: 36 in.





a. 1525-mm (60-in.-) Diameter Space **b.** T-shaped Space for 180° Turns

Fig. 20 Wheelchair Turning Space

Planning Storage:
Consider...

- **Space efficiency**
- **Use outside professional to suggest different arrangements that could improve space use**
- **Objects and human safety**
- **Floor load (350 psf)**

Types of Collection Storage Vaults

- **Permanent**
- **Holding Area for Incoming Items**
- **Temporary/Traveling Shows**
- **Photography & Conservation (vaults next to labs)**
- **Research Areas**
- **Study Storage**

Permanent Archives Vault

Wright County Historical Society
Buffalo, Minnesota

Other Storage

- **Crates**
- **Exhibit Supports/Mannequins**
- **Storage Materials**
  - **boxes, paper, foam**

All can take up a lot of space.

Empty Acid-Free Boxes
in Boxes in Collection Storage Area

Planning Storage

- **Collection size (numbers & physical): current, in 20 years**
- **Storage furniture: current needs and in 20 years**
- **Location is critical: (a) staff, public, object movement (b) environmental risks**
- **Handling: frequency and purpose (exhibits, research)**

Not in Permanent Storage

- **Maintenance panels**
- **Holding area for new collections**
- **Food, animals, dermestid colonies**
- **Freezer**
- **Non- Collection Materials:**
  - **Exhibit props, museum store items, publications, cleaning supplies, paints, lumber, trash cans, lawn mowers, gas cans**

Maintenance Panels

Compromise Storage Security

Determining Space Needs

- Current storage square footage (SF)
- Number of objects in collection (C)
- Average number of yearly donations (D)

SF / C = Current space per artifact (S)

D x 20 = projected items in collection (F)

(F+C)xS = Space needs (no improvements) (NI)

NI x 2 or 4 = Space needs with improvements

Determining Space Needs

- Current storage (SF) : 5,000
- Nos. of objects (C): 100,000
- Average yearly donations (D): 300

SF / C = (S) = .05 sq. feet (about 2 1/2 sq. in.)

D x 20 = (F) = 6,000

106,000 x .05 = (NI) = 5,300

NI x 2 or 4 = 21,200 sq. ft. (10 in./artifact)

Useful Planning Tools

- Collection Management Plan
- General Conservation Survey Report
- Self-Assessment Tools (CALIPR)
- Written environmental control parameters
- Written maintenance requirements
- Security plan

Review Written Guidelines

How is the space used?

- **Integrated Pest Management**
- **Handling**
- **Access**
- **Storage area cleaning and care**

Review Written Guidelines

How is the space used?

- **Recommended Mount Materials & Techniques**
- **Temporary Storage Guidelines**
- **Disability Considerations**
- **Security: People and Collection**

Resources

***Smithsonian Guidelines for Accessible Exhibition Design*, 1996**

Smithsonian Guidelines for Accessible Design for Facilities and Sites

Both available on-line.

Resources

Smithsonian Accessibility Program

Arts and Industries Building

Room 1410 MRC 410

Washington, D.C., 20560

202-786-2942 (voice), 202-786-2414 (TTY), 202-786-2210 (fax), asmem113@sivm.si.edu

Construction

New Construction

- Pre-construction manual listing non-negotiable areas during later cost-cutting.
- Insulation and vapor barriers in walls, ceiling AND floor. (box within a box)
- Impenetrable walls, ceiling, floors, doors.
- HVAC, elevators and maintenance panels outside storage area.
- Seal cracks and crevices. Hardware cloth in walls and under floors.

Retrofitting Existing Structure

- Insulation and vapor barriers built inside walls, box within a box.
- Seal cracks and crevices. Hardware cloth in walls, ceiling and under floors.
- An elevator for more than one level.
- Build ramps to smooth floor transitions.
- Gutters under pipes and ducts.
- Block windows.

Storage Requirements

- **Climate Controls**
  - **temperature/humidity**
- **Minimize Pollution**
  - **gaseous**
  - **particulate**
- **Minimize Light**
- **Block Pests**

Storage Planning

Placement of

- **windows**
- **doors**
- **ventilation ducts**
- **sprinklers**
- **plumbing**

Public spaces vs. staff only areas

Storage Area:
Uncovered Windows

Windows Covered

Storage area has bare tungsten bulb, narrow door, and window shade. Light still enters through shade, causing fading. Need heavier material, sealed on sides.

Storage Area:
Water Above Storage

Sewage pipe

Ducts Near Ceiling

No Insulation

Insulated Ceiling Ducts

Water Drain Above Cabinet

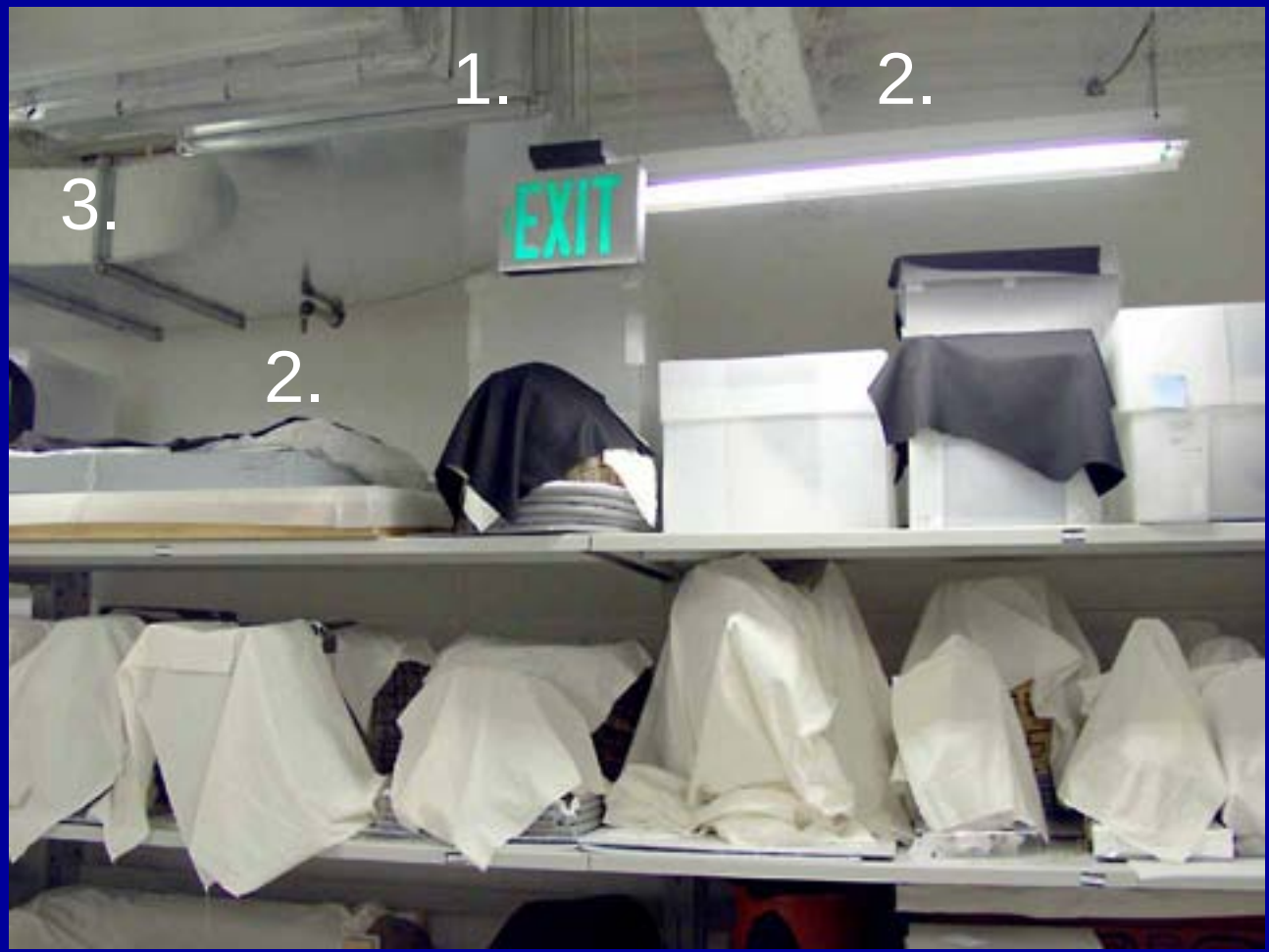
Leaky drain

Roof and gutter built by museum to protect storage cabinets.

Ceiling

Lower than expected because of suspended items

1. Exit light too low, had to be removed for cabinets to enter storage.
2. Awkward light and sprinkler placement.
3. Low ducts.



Storage Room Door

Problems

1. Hinges on outside.
2. Clutter in front.
3. Visibility blocked.
4. Difficult to open both doors.

Narrow Storage Door

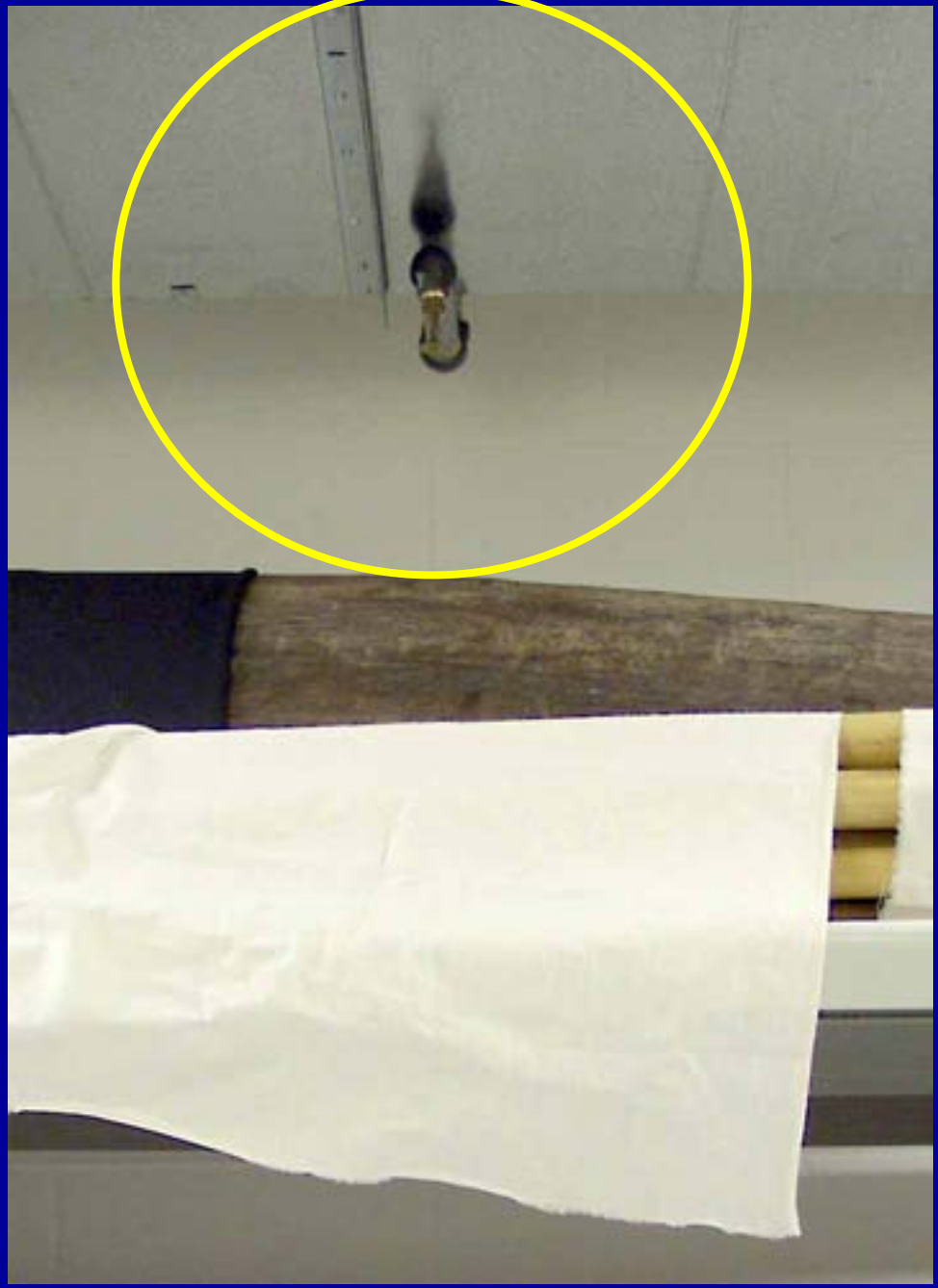
Difficult to enter room with a cart:

- sharp corner
- partially blocked by bookcase
- narrow door.

Clutter limits shelf access

Corridor Width

- Wide enough for a wheel chair (36 inches / 1 m.)
- Provide fire break.
- Easier for object movement.
- Keep clutter free.



Low Sprinkler Head

Required 20 inch radius makes the top storage shelf barely useable.

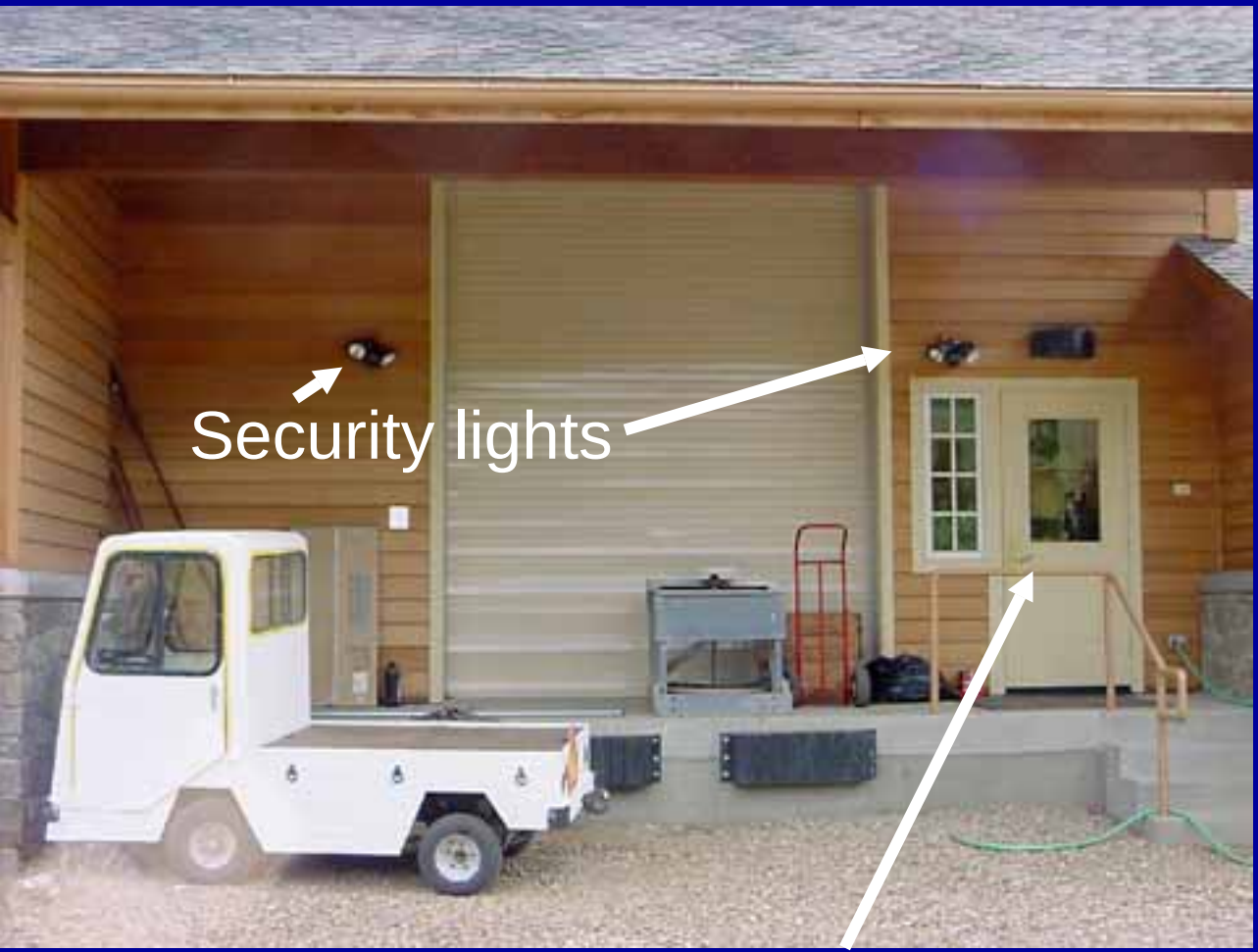
Collection Room Sink

- Better if located outside storage.
- Used for cleaning supplies, brushes and coffee cups more than collections.
- Added source of water problems.

Public Examination / Reading Rooms

- **Secure area**
- **Researchers observed**
- **Pencils, no pens/ink**
- **Sink nearby for clean hands**
- **Provide handling tools: gloves, bone folder, microspatula, acid-free paper**
- **Informational signs**

Loading Dock



Security window in small door.

- Easy path to storage area.
- Needs moveable lift.
- Difficult for freight trucks to back up to.
- Best if covered, secure area.
- Security lights attract pests.

Off-Site Storage

Storage Barn

Good “box within a box” candidate

No Regular House-keeping

- Years of accumulated dust/debris
- Rat, mice, bird feces

This storage area provides no protection.

Environmental Controls

Stabilizing T & RH

- **Put sensitive objects in best conditions**
- **Do not place next to or over heat or cold sources**
    - **heat: furnace vents, interior case lights, daylight**
    - **cold: exterior walls, floors, windows, doors (6 inch rule)**

HVAC

- Located outside storage rooms
- Filter incoming and recirculated air to ASHRAE 90-95% level
- Moderately dry environment
- Moderately cool environment

HVAC

Small unit for storage area located on second floor storage balcony.

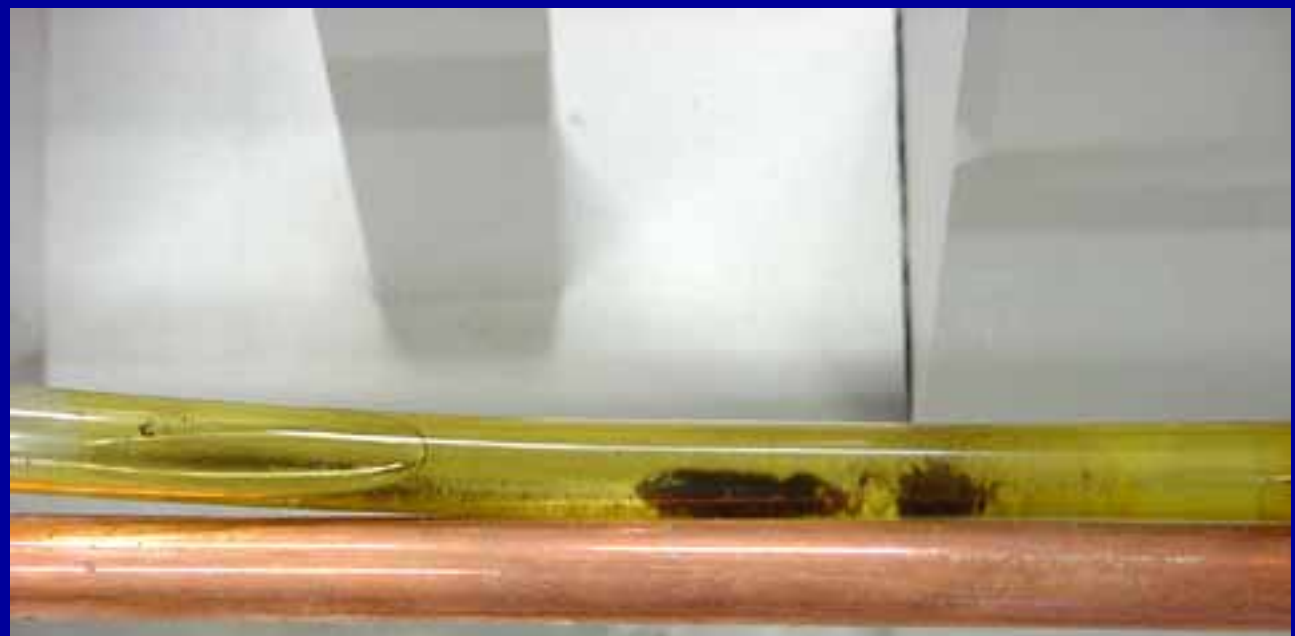
Area of concern: Air conditioning condensate line.

HVAC Condensate Lines

Detail of A/C condensate lines showing pressure fitted plastic connectors.

Hole in floor to main storage level.

A/C Condensate Line



Yellow liquid is “water” condensing from cooled air. Obviously something else is in the line, too.

A/C Condensate Drain

Liquid corrosive enough to damage copper pipe.

Floor Drain and A/C Condensate Line

Floor stains show prior water problems. Pipe should turn into drain.

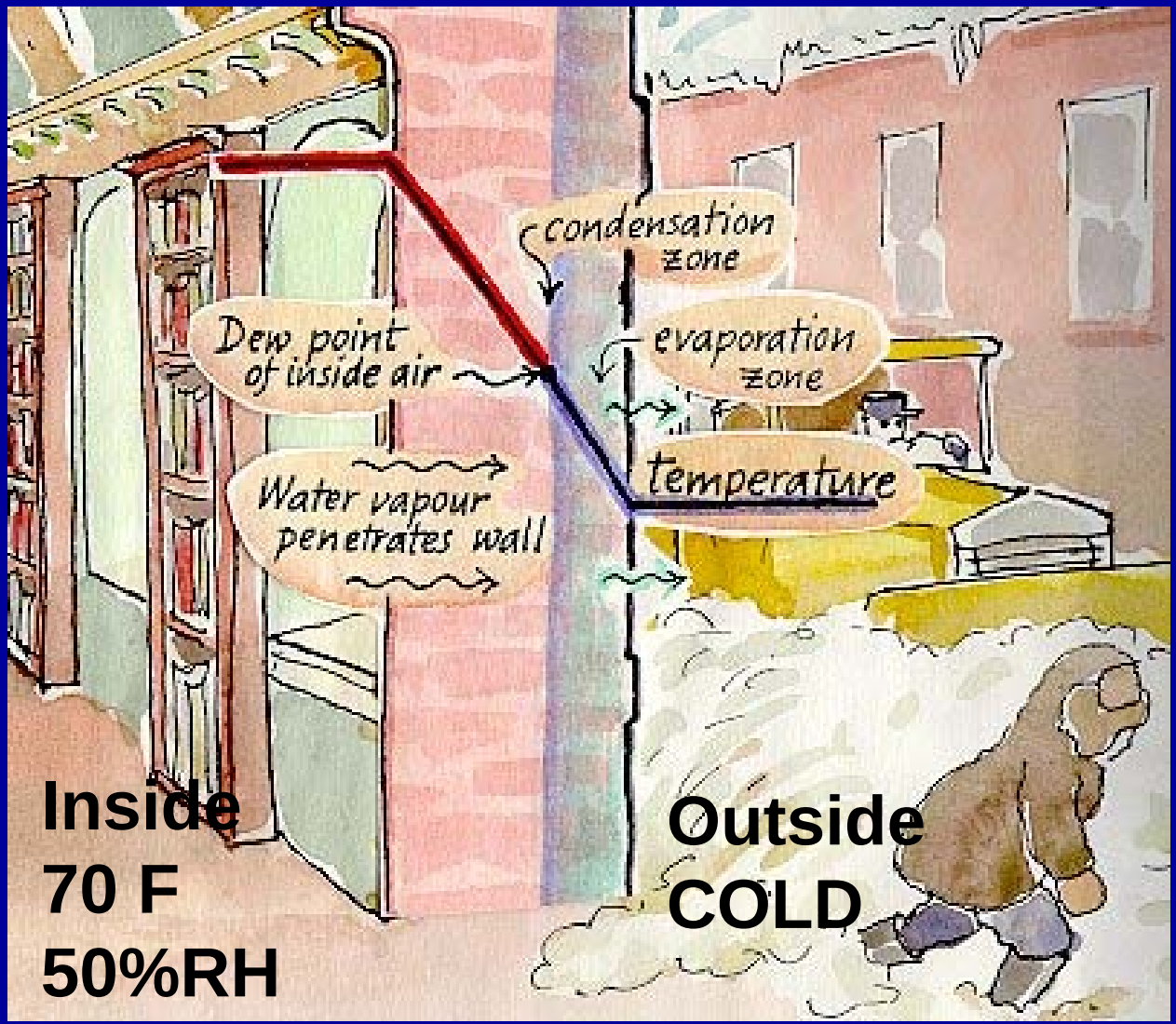
Adding moisture can harm your building

- Moisture freezes in walls
- Ice lenses push off masonry surface
- Moisture causes exterior paint bubbles
- Wood siding will rot

It is better to raise relative humidity by lowering temperature, than by adding water to the air.

Ice Forms in Walls

at condensation zone



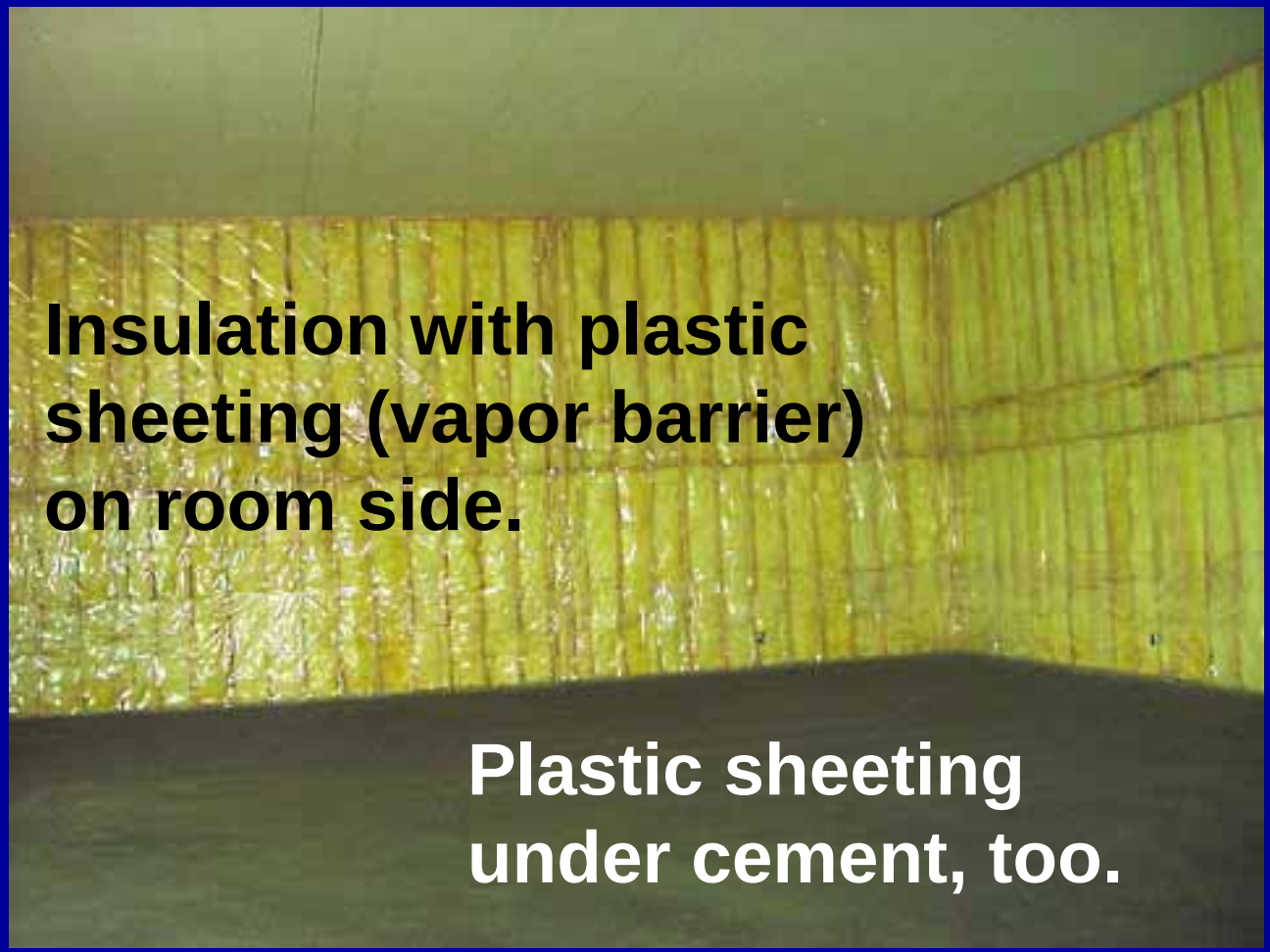
Need vapor barrier, insulation, and lower RH.

Walls deteriorate without them.

From Tim Padfield

New Construction

insulation and vapor barriers help keep moisture out of walls

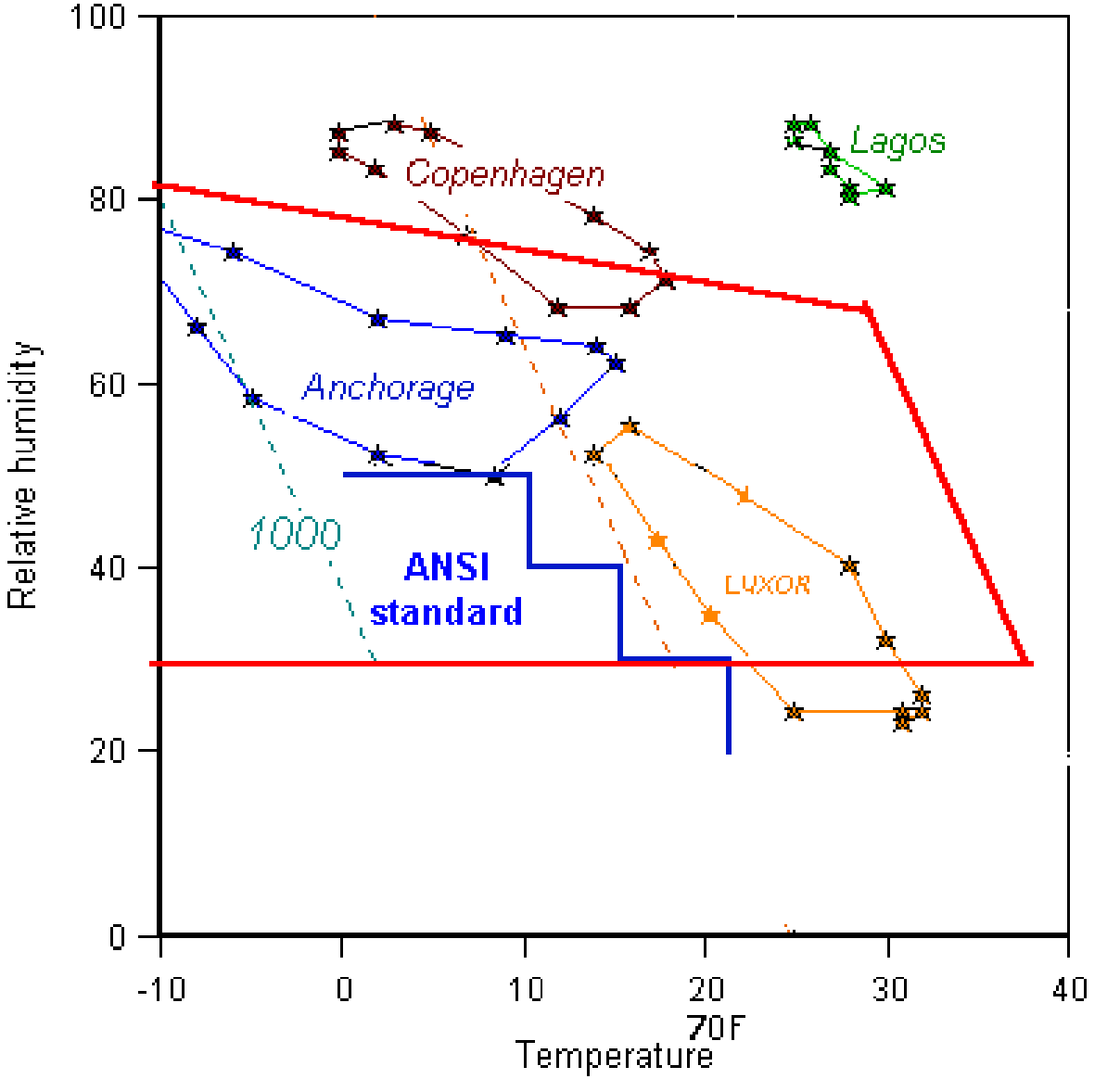


Dry Climates

- Does your outside humidity average 25% year round?
- DO NOT try for 50% inside your building
- You will:
  - Wreck the walls of your building
  - Harm the collection, which is acclimated to 25%

Dry Climates

- Try to stabilize RH at a reasonable level for your climate (25%)
- Do not travel sensitive items outside your region unless they are in sealed, climate-controlled containers.
- Be clear in loan documents that you DO NOT maintain Thomson's 50% RH in your building.



Within the red lines is the non-damaging climate for black and white photographs.

The blue lines are the ANSI standard for safe B&W storage.

The dotted lines are the climate for 1000 years (green) or 100 years (orange) longevity.

http://www.natmus.dk/cons/jsj/arrh2.htm from Tim Padfield

A Suggestion from Tim Padfield

- The ANSI standard requires HVAC
- Equipment life = 20 years
- Instead, adjust your climate slightly to bring it within the red lines.
- Less expensive to install and maintain
- More likely to be possible.
- Note that the longest life occurs below freezing.

Special Note

- Most of the climate storage standards come from photograph preservation
- We have some data, but not enough, about other materials
- Keep your ears open for new developments

Pollutants

Limiting Pollutants

- **Avoid**
- **Block**
- **Absorb**
- **Dilute**

Avoid Pollutants

- HVAC separate for storage
  - no air from the rest of the building
- Wood shops and other pollutant generators in separate structures
- Notice location of air intake and pollutant sources (roads, loading dock)
- Test building materials. Use those designed for allergy sufferers.
- Clean storage with ULPA or HEPA vacuum cleaners.

Block Pollutants

- 90-95% HVAC filtration for particles
- Seal wood cabinets and shelves
  - Aluminum foil
  - Marvelseal
  - Formica laminate
- Seal cement floors and walls
- Caulk and seal crevices
- Silicone gaskets on storage cabinets

Absorb Pollutants

- Activated Charcoal filters ($)
  - HVAC filters
  - Inside storage cabinets
- Potassium Permanganate filters ($$$$)
  - HVAC only

Dilute Pollutants

- Good air circulation within storage
  - Avoid dead spaces
  - Open up rooms (lots of cubby holes are harder to climate control)
- Vented storage cabinets
  - Filter at vent for dust or fumes

Limiting Environmental Effects

- **Building Controls:** **physical plant**
- **Portable Fittings:** **furnishings, portable equipment and supplies**
- **Procedures:** **staff training and policies**

Reducing Contaminants

- **Test Materials and Cases:**
  - **A-D strips**
  - **lead, silver & copper coupons**
  - **passive samplers (wide variety)**
  - **gas or aerosol dosimeters**
- **Cure coatings until smell gone (2 weeks?)**
- **Identify susceptible artifacts**

Reducing Contaminants

limiting the effects of poor storage materials

- **Use barriers: Mylar, fabric, aluminum foil, Marvelseal or Aclar**
- **Place Mylar or polyester felt under objects (barrier / separator)**
- **Filtered air flow in cases**

Storage Illumination

Buffalo Bill Historical Center
Cody, Wyoming

Storage Lighting

- **Internally UV filtered fluorescent lights with polycarbonate cover best (0 mW/l UV)**
- **High color rendering index (CRI)**
- **Bounce indirect light off ceiling/walls**
  - **Titanium dioxide in paint absorbs UV**
- **Wire sections to separate switches**
- **Design for maintenance ease**
- **Design for low-cost operation**
- **Design for higher lighting during monitoring and cleaning**

Lighting is one place where you CAN save money by saving energy.

Lamps / Bulbs

Suitability

- **color rendering**
- **color temperature**
- **amount of light generated (lumens)**
- **spectral power distribution (graph of wavelengths)**
- **lamp life**
- **fixture**
- **intensity**
- **cost (ease of changing & cost of bulb)**

Color

Color Temperature

- Warm: 3200 K & lower (1900K = candle flame)
- Cool: 4000 K & higher (5500K = sunlight)

Color Rendering Index (0-100 scale)

- 100 = no distortion
- 75-80 = OK
- 55-65 = fair/poor
- 0 = total distortion

Lamps / Bulbs

Incandescent (heat, some UV)

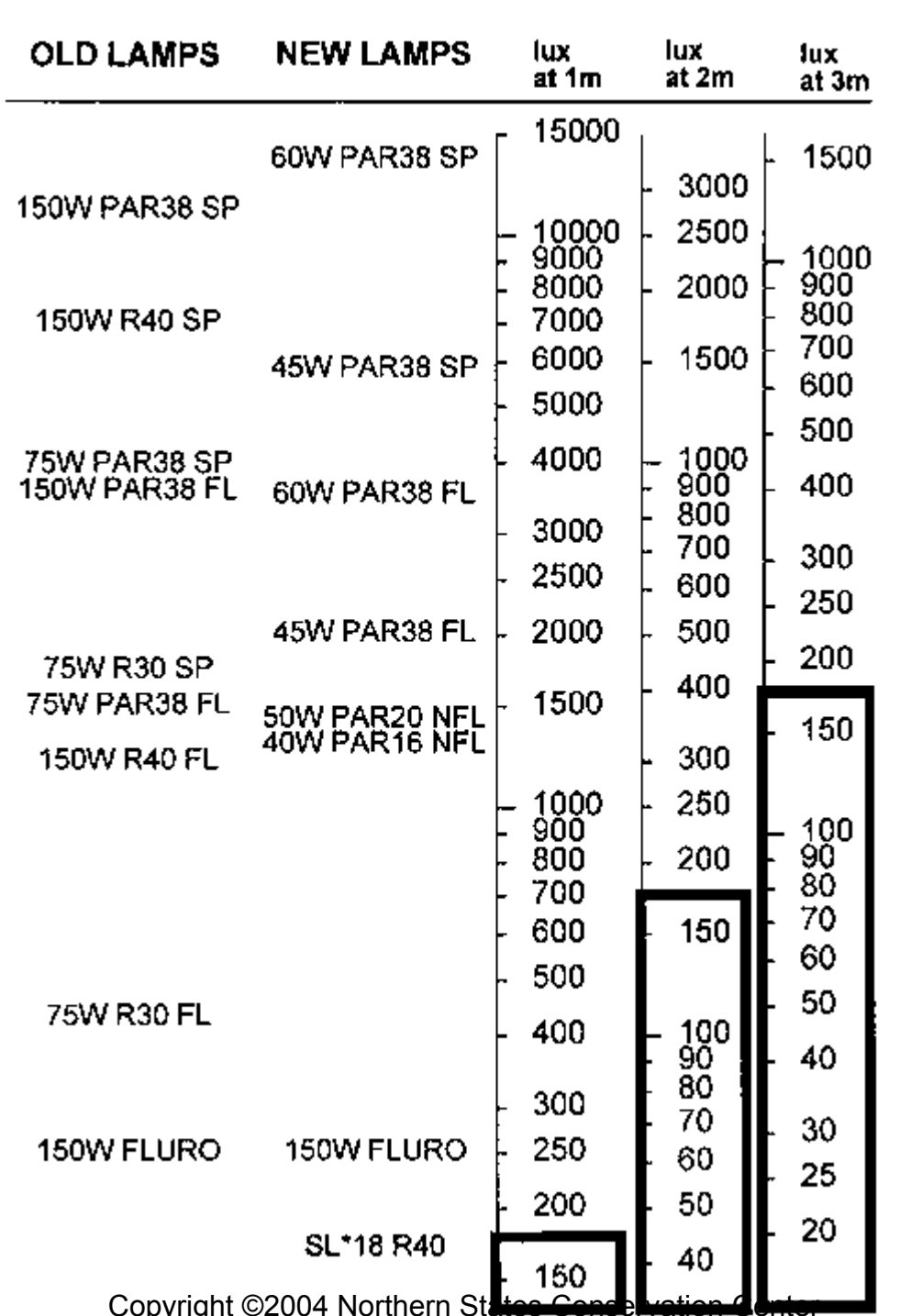
- **tungsten**
- **Quartz lamp: tungsten + inert gas**

Fluorescent (UV)

Fiber Optics (no heat, no UV, not good for general lighting)

High Intensity Discharge (LOTS of UV)

In the U.S., energy conservation resulted in all new light bulbs in the 1990s. This chart shows how old and new lamps compare.



Illuminance

Amount of visible radiation striking a point on a surface from all directions.

Measured as lux or footcandles

Over time, measured as lux hours or footcandle hours (cumulative)

- **(Lux hours = exposure time multiplied by illuminance in lux)**

Luminance

Visible radiation reflected or transmitted by a surface in the direction of the viewer.

It is a product of illuminance and surface reflectance.

(Ex. 1: same illuminance, glossy surface looks brighter than matte surface)

(Ex. 2: same illuminance and gloss, light surface looks brighter than dark surface)

Eye Adaptation

- **Light to dark adaptation: about 5 minutes**
- **Dark to light adaptation: seconds**

Perception of Brightness

- **An individual response with no unit of measure**
- **Approximately 10x luminance to sense doubled brightness**
- **Visual noise distractions**
- **Aging affects adaptation and perception**
- **Eye is drawn to brightest spot**

Visual Noise

- **Glare**
- **Pattern/Visual Clutter**
- **Inconsistent illumination**

Reducing UV Radiation

Eliminate wavelengths below 400 nm

- **limit exposure**
  - **shades, blinds, diffusers**
  - **sheet films or varnishes**
  - **rigid plastic sheet (polycarbonate)**
- **storage design**
  - **choose low UV bulbs**
  - **place items in low UV areas**
- **paint (titanium white)**

Reducing Visible Light

- **limit exposure**
  - **boxes**
  - **cabinets**
  - **blackout fabric drapes over shelves / large items**
  - **block windows**
- **phased lighting**
- **monitor exposure**
  - **blue wool fade cards**
  - **Hobo datalogger**
  - **light meter or camera**
  - **CCI light slide rule**

Reducing Visible Light

light and dust covers

Buffalo Bill Historical Center
Cody, Wyoming

Yellow Lighting

Yellow filters eliminate damaging blue light. However, they are annoying for staff.

Yellow Lighting

Yellow filters make it difficult to:

- Identify / examine artifacts
- Monitor for pests

Lights Too Close

Accessible Light Levels

Disability guidelines

- **Ambient: 5-30 fc**
- **Text panels: 10-30 fc**
- **Specimens, objects: 10-30 fc**
- **Ramps, stairs, pathways: 10-30 fc**
- **Directional signage: 20-30 fc**

(note: 1 fc is approximately 10 lux)

Security

Building for Security

- **Good exterior lighting**
- **Exterior clear of bushes and debris**
- **secure windows, doors and skylights**
- **check that telephone, power and emergency lines are tamper proof**
- **Solid exterior doors: wood, steel or aluminum alloy**
- **Door frames, window frames, keyholes, locks resist prying, twisting, or cutting**

Building for Security

- **Two locks on storage room doors**
- **Clear sight lines (no hidden entrances)**
- **Security window in door**
- **Lighting activated from exterior**
- **Seal/screen windows to prevent people from dropping materials out**
- **Locked cabinets, cages, vaults for valuable materials**

Security Procedures

- **Visitor log / guest book**
- **Control / limit keys**
- **Visitors to storage accompanied by a staff member**
- **Record of movement of objects and people in and out of storage**
- **Researchers supervised at all times Inventory control**
  - catalog the collection, identify valuable materials, conduct regular inventories

Reducing Theft / Vandalism in Storage

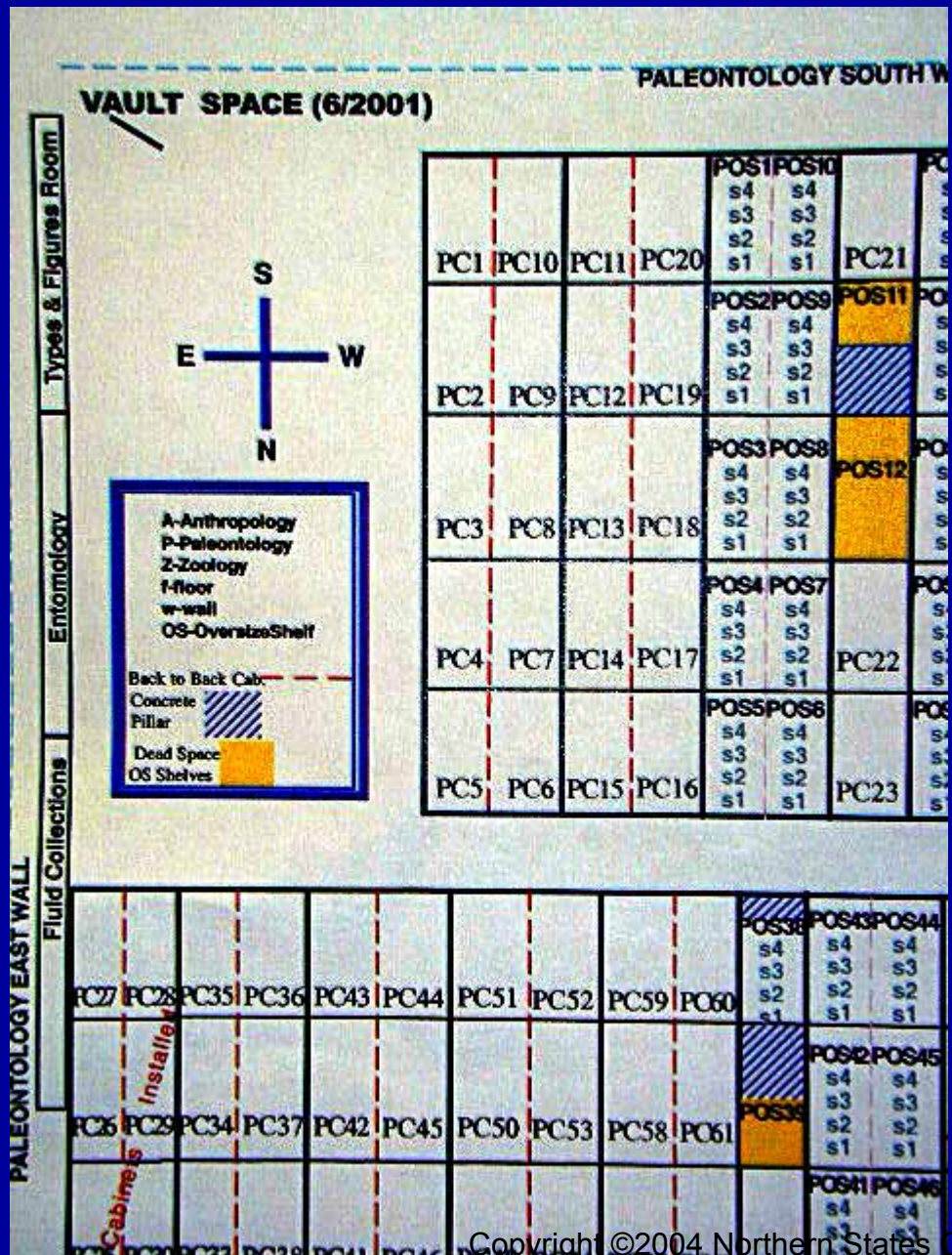
- **Security cameras with tape backups, motion detectors**
- **Lock and alarm doors to storage areas.**
- **Motion detectors inside storage areas.**
- **Appropriate lighting in all areas**
- **Research areas outside storage**
- **Locks on cabinets**

Electronic Access

Reducing Displacement

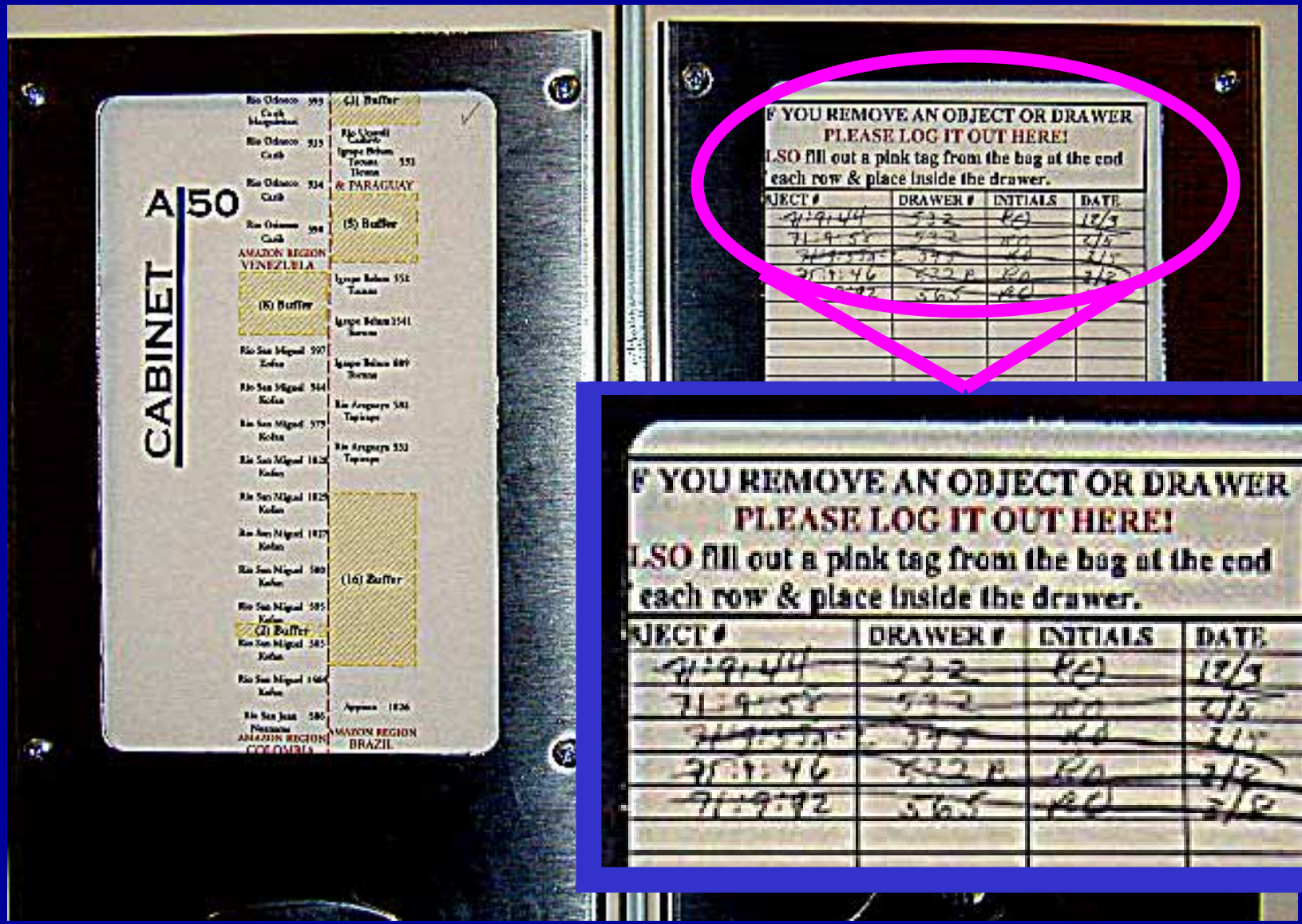
- **Annual inventory or partial inventory**
- **Sign items in and out**
- **Maintain a location file**
- **Place cards in storage spot when item removed**
- **Clear accession records and clear accession numbers on objects**
- **Maintain catalog to identify losses**

Map for Collections Storage



Cabinet Location

Artifact Location Record



Object Removal Labels

Maintaining Storage Security

- **Log sheets/notebooks at doors or electronic swipe cards**
- **Storage location plans in room and on each cabinet**
- **Object movement log forms (tied to location cards or computer record)**
- **“Object removed” placement cards**

Research Area Theft Deterrents

- **Staff in area when open**
- **Visitor log / guest book**
- **Clear sight lines (no hidden entrances)**
- **Appropriate lighting in all areas**
- **Lockers outside room, limit bags**

Alarms

- **Intrusion detection and alarm sensitive to sound and movement**
- **Early warning fire detection system tied to local fire or police department**
- **Water alarms**
- **Environmental fluctuation alarms**

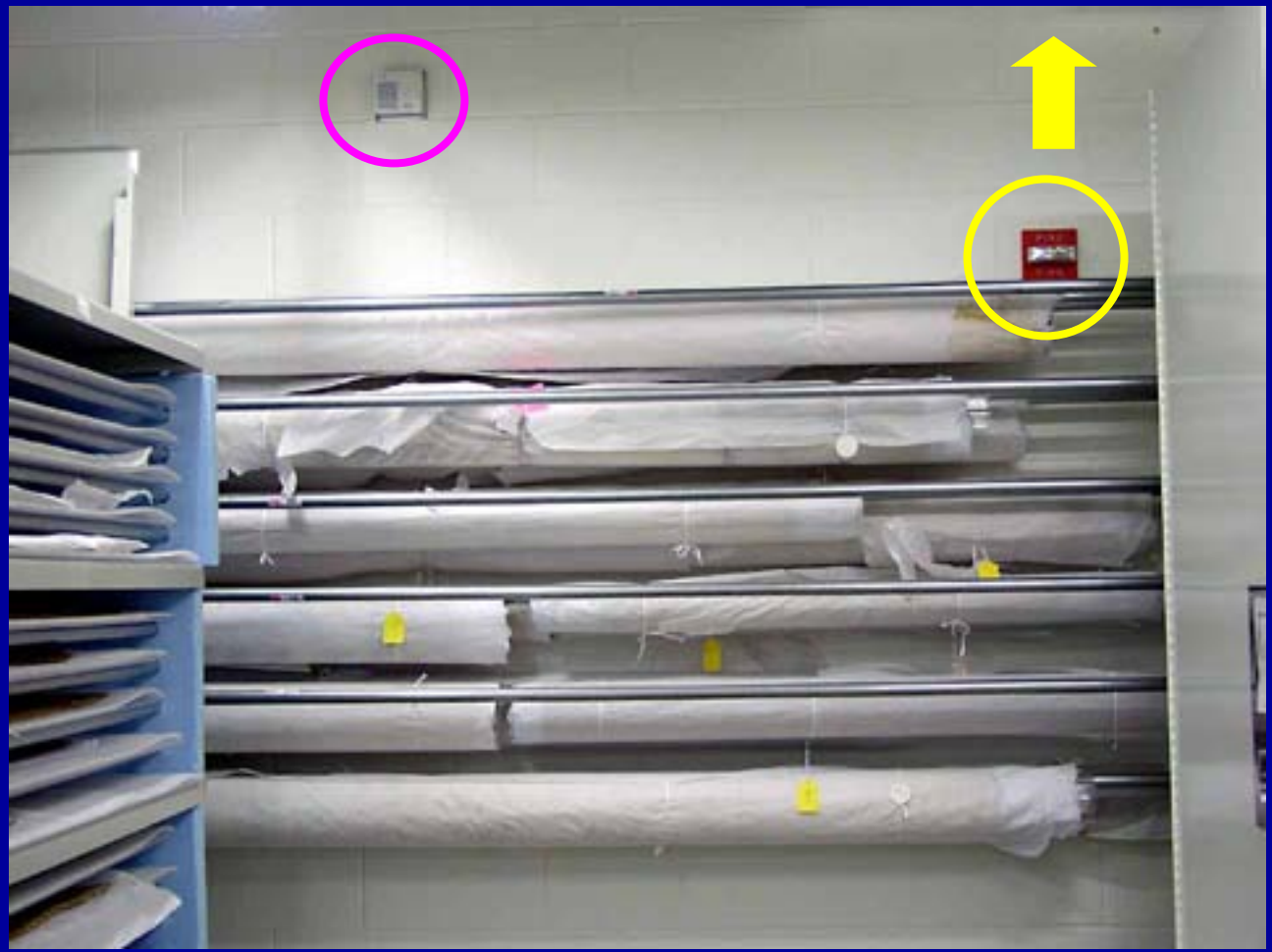
Alarm Placement

Why not line it up with the motion sensor? (pink circle)

Too expensive to change AFTER construction.

Cabinets could not block emergency light.
Thus, the corridor is 3 feet wider than necessary.

Alarm Placement



Why not move it up on wall and line it up with motion sensor? (pink circle)

Wall racks could not go up as high as desired because of low emergency light.

Emergency Preparedness:

Building Features

Fire Suppression

- Water-based, automatic fire suppression systems with regular maintenance
- Individually active heads
- Mist systems may not be good enough and may not meet fire codes
- NOT gas systems – too damaging to collections and staff
- NOT dry pipe ?

Fire Suppression

- Hand-held extinguishers by doors
  - inspect annually
- Train staff in their use
- Make sure everyone has a copy of the museum's disaster plan and knows response procedures for fires

Storage Room Wall

Equipment scattered over open wall made it impossible to use it for storage. Cabinets could not block emergency equipment.

Better planning would have consolidated the equipment.

Reducing Electrical Fire Risk

- **Wiring in rigid (EMT) or flexible conduit**
  - **installed/ maintained to National Electrical Code**
  - **UL listed wiring- National and local Electrical Code**
  - **grounded conductor identified continuously throughout system**

Reducing Electrical Fire Risk

- **Electrical Equipment:**
  - **installed/ maintained to National Electrical Code**
  - **UL listed wiring and devices,**
  - **NFPA 70 National Electrical Code**

Reducing Electrical Fire Risk

- **Extension Cords**
  - **not a substitute for fixed wiring**
  - **grounding type**
  - **internal circuit breaker on multiple outlet cords**
  - **unplug at the end of the day**

Reducing Fire from Construction

- **Non-combustible or fire retardent construction materials**
  - **structural steel: 2 hour fire resistance**
  - **structural wood: fire retardant and pressure impregnated**
  - **draperies, bunting: flame resistant, NEPA's Standard NFPA 701**

Reducing Fire from Construction

- **Regularly inspect and maintain wiring**
- **Place flammables in proper, labeled storage cabinets far from exit doors, collections and spark or heat sources**
- **Do not disguise or hide extinguishers and/or hoses**
- **Design space to stop fire & limit path obstructions**
- **Vent lights, audiovisual cabinets and other electrical equipment**

Reducing Water

- **Alarm water areas - drains, under pipes**
- **Water resistant cabinets**
- **Collections 3-6” off floors, 6” from walls**
- **Inspect after heavy rain or thaw**
- **Train janitors to limit water use**
- **Use packing crates supported by skids (polyethylene donuts) and wrap objects in water resistant packing materials**

Housekeeping and Maintenance

Good Housekeeping in Storage

- **Reduces damage from abrasion**
- **Reduces pest habitat**
- **Opportunity to monitor**
- **Less mold**
- **Better impression to visitors**
- **Models good practices**
- **Written housekeeping plan**
  - **regularly performed tasks in detail**
  - **special instructions for specific materials**

Cleaning Storage

- **Regular, at least weekly, vacuum cleaning with a high-filtration canister vacuum (ULPA best).**
- **No wet cleaning unless unavoidable - then monitor RH carefully during process**
- **Vacuum under all storage furniture**
- **Vacuum room corners, cracks and crevices**
- **Do not clean collection. (They should be protected from dust.)**

Building Inspections

The building is your first line of defense...

Basic Building Maintenance

- Prolongs equipment life
- Maintenance calendar - post visibly
- Regular filter changes for HVAC
- Caulk and seal new cracks and crevices
- Remove plants next to building (pest habitat and security risk)

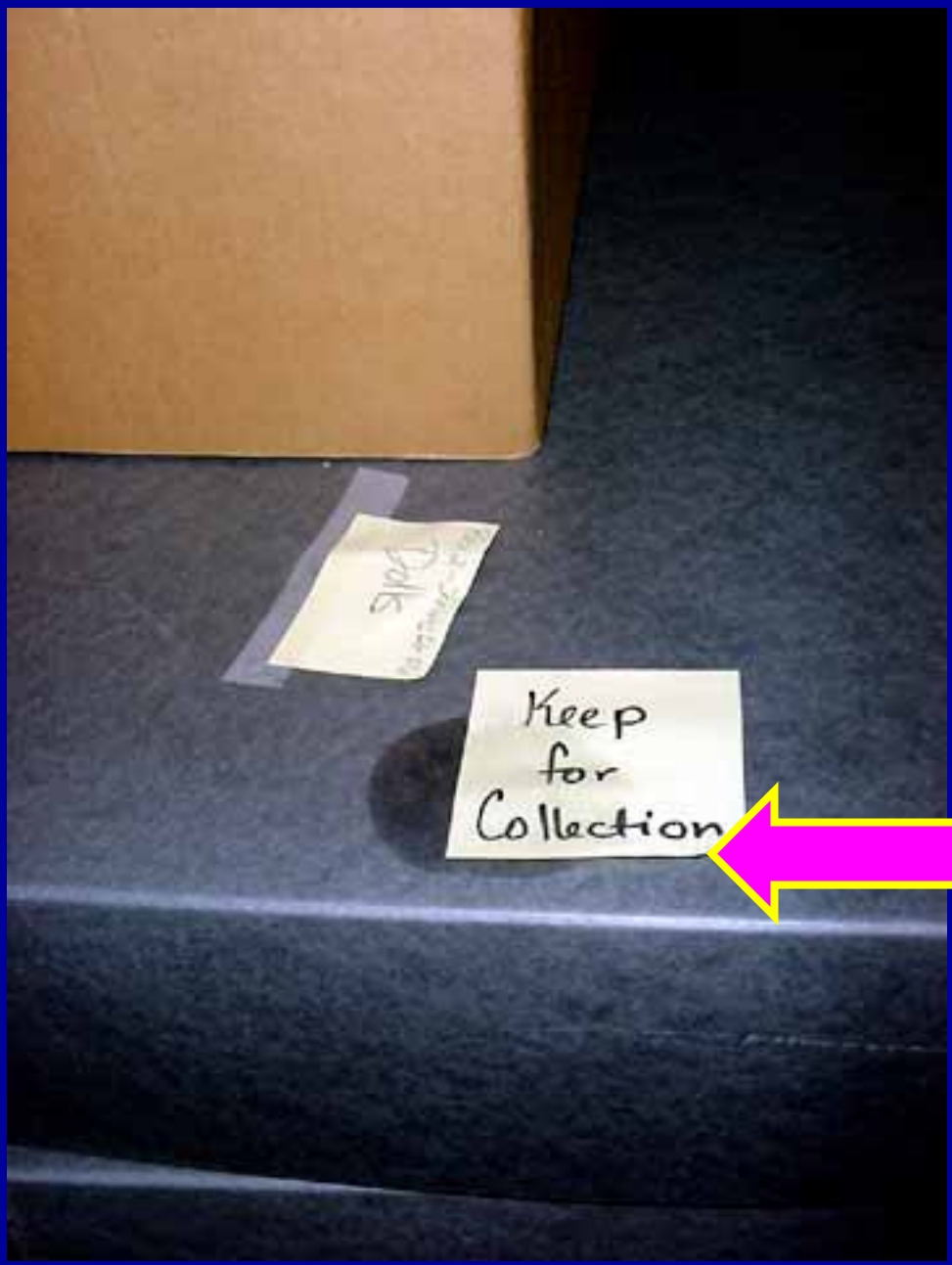
Regular Inspections

- **Quarterly inspections of structure, equipment and grounds**
- **Inspect collection and exhibit areas monthly**
- **Use a checklist (see CCI notes)**
- **Begin at the top of the building and work down.**

Regular Inspections

- **Check belts, hoses and oil moving parts in HVAC as recommended**
- **Routine inspections for pipe leaks, voids in seals around duct and pipe chases and other problems.**
- **Regular inspection of fire protection systems (NFPA)**
- **Monthly pest monitoring (IPM)**

Potential Water Leaks
Labeled Pipes in Storage



Water Drips

Moisture on box from condensation dripping off an uninsulated cold water pipe overhead.

Pest Control

Reducing Pests

- **Regular inspection**
- **Avoid wool carpets/ fabric**
- **Keep building clean and free of food, plants (none at staff desks)**
- **Caulk and seal cracks and crevices**
- **Treat construction wood before bringing into building**
- **Use elevated, insect resistant cabinets**

Integrated Pest Management

A Case Study of Risk Management

Analyze Situation

- **Use CCI Framework for Preservation**
  - **Building**
  - **Portable fittings**
  - **Procedures**

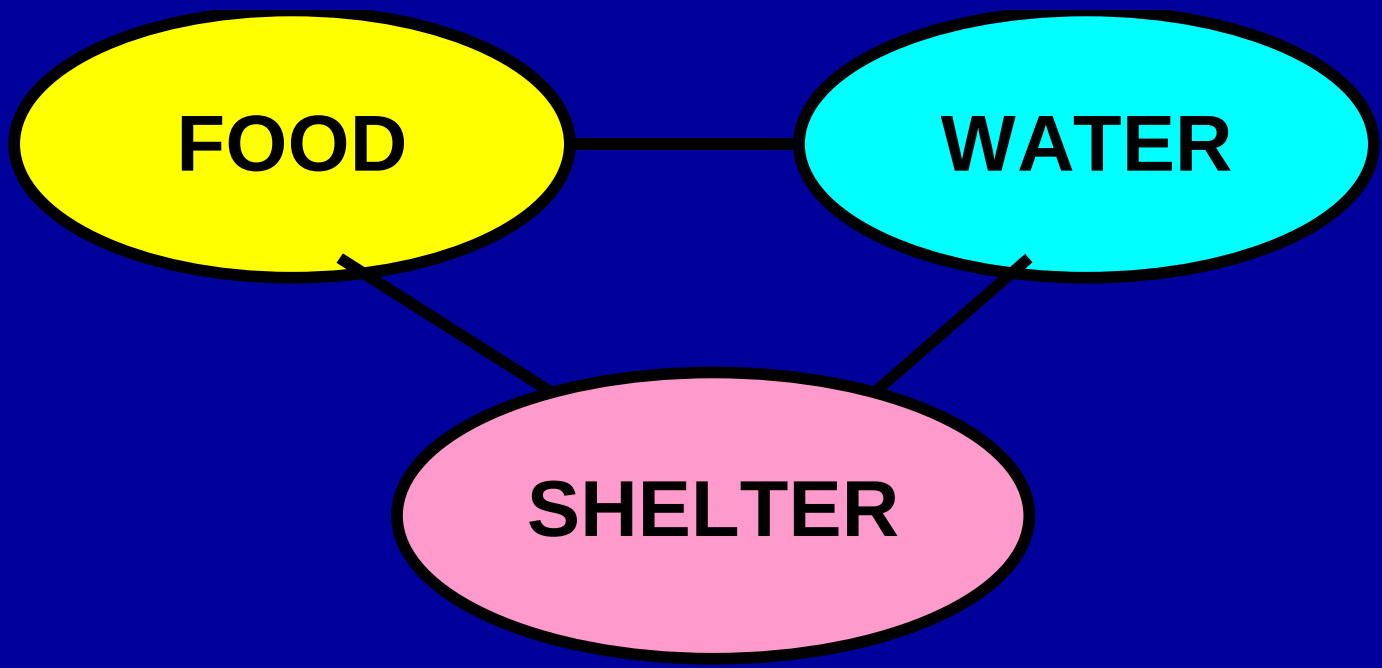
Actions

- **Avoid**
- **Block**
- **Detect**
- **Respond**
- **Recover/treat**

Avoid Problems

- **Eliminate attractants**
  - **Pest habitats (plants, cardboard)**
  - **Lighting**
  - **Food (garbage)**
  - **Water**
- **Establish sanitary perimeters**
- **Good house keeping**

Pest Attractants



Sanitary Perimeter

At least 3 feet of gravel or cement around the building.

Block Problems

- **Caulk and seal all holes in building**
- **Exclude pests from building**
  - **Sticky traps around drains & thresholds**
  - **Quarantine incoming organic items**
- **Exclude pests with storage furniture**
  - **Use pest resistant materials (metal)**
- **Pesticide barriers (perimeter pesticides)**

Covered Garbage Can

Sticky Trap by Drain

Detect

- **Monitor/ Trap**
  - **Insects: sticky traps, pheromone lures**
  - **Vermin: snap traps, box traps**
  - **Mold: inspection**
- **Identify pests**
- **Regular (monthly) inspections, keep log**

Monitor with Sticky Trap

Look for Flight Holes

Respond

- Good house keeping
- Pest Management Team
- Eradication methods
  - trapping
  - thermal controls (heat, cold)
  - controlled atmosphere
  - pesticide/fumigation
- Mold: Dehumidifiers & fans

Freezing
Insect Control

Recovery/Treatment

- **Evaluate techniques and procedures**
- **Improve sanitation**
- **Improve control methods**
- **Improve monitoring**
- **Restore artifacts (irreversible damage)**
- **Educate staff and public**

Procedures
Summary

- **Establish an IPM**
- **Remove and control food sources: place lids on garbage cans, keep building clean and free of food or plants**
- **Regular building inspection and maintenance**
  - **maintain seals**
- **Regular staff training**

Responding to Infestations

- **Identify pest and reason why present**
- **Isolate item or area**
- **Determine effective controls**

  (bag and freeze artifact, treat with heat, anoxic treatment or apply perimeter pesticides)
- **Clean item and area**
- **Monitor to ensure problem is resolved**

Pest Resources

Bio-Integral Resource Center

P.O. Box 7414

Berkeley, CA 94707

Tel: 510-524-2567, Fax: 510-524-1758

U. of Minnesota Extension Service

$5 Specimen identification

TEL 612-624-4771 or 888-624-4771

Café in Gallery Near Storage