

# SITES

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

# CRATE SPECIFICATIONS



Smithsonian Institution  
Traveling Exhibition Service



Smithsonian Institution  
Traveling Exhibition Service

ELY (2)  
I N C  
12/2002; updated  
2 /2005

# SITES

## CRATE SPECIFICATIONS

Smithsonian Institution Traveling Exhibition Service

### Table of Contents

<b>Introduction and General Notes:</b>	<b>pp. 3-5</b>
<b>Basic Crate Shell Construction:</b>	<b>pp. 6-16</b>
<b>Single Painting Crate:</b>	<b>pp. 17-18</b>
<b>Tray Packing:</b>	<b>pp. 19-20</b>
<b>Slotted Crate:</b>	<b>pp. 21-22</b>
<b>Cavity Packing:</b>	<b>pp. 23-24</b>
<b>Sliding Tray and Brace Packing:</b>	<b>pp. 25-27</b>
<b>Slat Crate:</b>	<b>pp. 28-29</b>
<b>Floor Joist Pallet:</b>	<b>pp. 30-37</b>
<b>Custom 3-D Blanket:</b>	<b>pp. 38-39</b>
<b>Pallet with Blanket for Exhibition Element:</b>	<b>pp. 40-43</b>
<b>Crating Odd Sized Items</b>	<b>pp. 44</b>
<b>Crating Odd Shaped Items</b>	<b>pp. 45- 46</b>
<b>Labels and Markings for Crate Interiors:</b>	<b>pp. 47-52</b>



# CRATE SPECIFICATIONS

## Smithsonian Institution Traveling Exhibition Service

### Introduction and general notes:

Designing and fabricating crates for traveling exhibitions requires planning, care, skill, and great attention to detail. A SITES crate is designed to protect its contents in many different situations and make efficient use of space and material. These specifications are for use in traveling exhibitions; crates use for one-way or short local trips will be much less elaborate.

Over the life of a traveling exhibit, crates will be shoved, lifted, dropped, flipped, turned, hit, bumped and stacked. They may be subject to shock and abuse and will probably be packed, moved, and unpacked thirty or forty times. Sometimes crates will move on pallet jacks or dollies, more often they will be pushed or dragged across floors, trucks, or pavement. At times they will be lifted with forklifts, or just shoved with the ends of the forks. Loaded onto trucks, planes or ships, crates will often be exposed to extremes of weather conditions on loading docks, airport tarmacs and non-climate controlled trucks.

The overriding concern in crating and packing of this type is for the safety and protection of the objects. Consideration must be given to the safest method to handle the object during the packing and unpacking process. Because traveling exhibit crates have to withstand external forces over a period of years, and still protect its contents, special considerations, materials and techniques are required for their design and construction. Objects are to be packed in a manner suitable for multiple packing and unpacking. Crates containing objects should be designed to travel through doorways on the horizontal axis, without being angled except with advance permission from SITES. Before making any alteration or substitutions to the procedures or materials specified for crate and packing construction, or if there are any questions concerning the correct packing configuration of objects, contact SITES.

There are several factors to consider when planning the size of a crate. The simplest factor is the truck door. Any crate must be able to fit through a standard tractor trailer door – Height 104” x Width 87.” If there is any possibility the exhibition will travel by sea or air freight, those dimensions change – sea containers have doors of 89”H x 84”W. Pallets for 747 planes accommodate crates 96”H x 96”W. If the exhibition is going to travel in a panel truck, then the door sizes change again. Don’t forget that fork lifts, pallet jacks and/or dollies add height to the crate.

The type of shipment is important in determining crate sizes. SITES defines shipping its exhibitions in two ways: outgoing and pro-rated. Outgoing refers to shipments arranged by each venue. SITES generally designates its smaller, less complex exhibitions for outgoing shipping, and venues taking such exhibitions generally have fewer amenities and staff. It is important that the crating for these exhibitions be as light as practical and



that, if possible, the crates are manageable for two handlers during truck loading situations or a raised loading dock may not be available. We have found through experience this size to be no larger than 33"W x 40"D x 30"H, with a weight of no greater than 250-300 lbs. Crates this size and weight can also be stacked during transport, making for a more efficient load.

Pro-rated exhibitions are contracted with a specific carrier for an entire tour. These exhibitions tend to be larger, more complicated, with more exhibition furniture and with higher security restrictions. Most pro-rated exhibitions ship in exclusive use trucks to major facilities with appropriate equipment for larger and heavier crates. However, a few pro-rated exhibitions are for space reservations on a truck, which means the crates have the same size and weight needs for easy handling as those in outgoing shipping exhibitions. The SITES registrar will provide guidance about the exhibition type and its shipment method.

Crates also need to move into and through museums. The infrastructure of museums varies widely. Many are in historic or old buildings and do not have modern loading docks or roll up doors. Exhibition areas are often accessed only by standard double doors, with an opening of 80"H and 64"W. Crates may travel in standard passenger elevators rather than freight elevators. Museums may have staffs who aren't experienced with handling large and heavy crates, with potential for mishandling and damage to the crate and its contents. By consulting with the SITES Registrar as to the anticipated type of venue, the crate sizes can be adjusted as appropriate for the venues. There are often times when more and smaller crates are more protective of the contents.

Another factor is the stability of the crate. Tall, heavy crates are difficult to move as one can't see over the top. They can also become unstable. The plywood sides and lids of very large crates can warp and shift out of true, making the fasteners no longer line up and the crate difficult to open and close. It is difficult to move warped crates as they don't rest properly on pallet jacks and/or dollies.

Also consider how the crate is to be unpacked. Contents should be arranged so no special equipment is needed for unpacking and so the installation crew can reach the contents and remove them. Respect people's backs – museum staffs get injured when they can't use their legs while lifting items from a crate. Don't put heavy items at the top of a tall crate – few people have enough upper body strength to raise heavy objects over their heads safely. Don't make the crates too deep and avoid vertical slot packing – it's difficult to pull out an item when bending at the waist as you can't use your legs for leverage. When packing heavy exhibition elements, consider the use of sliding plywood trays in the interior of side load crates so museum staffs can pull out the tray and then lift up the object rather than pull on the item or reach down for the item. Another strategy to avoid reaching in or lifting up heavy items is to have two removable lids or the crate shell lift off a bottom pallet. For graphic panels, use trays or horizontal slot packing.

As a general rule, multiple items are packed into each crate. Items in a particular crate can be sorted by a number of variables. Lender, exhibit sequence, object classification, size, weight, and material can affect how items are grouped within an exhibit crating layout. Each object within a crate must be identified, located and secured in a specified



space within the crate. A list of all objects packed in each crate must be in that crate. An overall crating list will specify every object in the exhibit and the crate in which it is packed. Instructions as to handling, unpacking and repacking must be clear and understandable.

When packing any piece of a traveling exhibition, whether it be the museum object, a framed text panel, a Plexiglas vitrine, a base or a mount, always pay close attention to the structure and particular characteristics of the individual piece. Surface protection and the proper points of support and contact should be considered carefully. The amount of material used to support objects should take into account appropriate dynamic cushioning curves. The effect of shock, vibration, and atmospheric conditions should be taken into account when packing. Remember, damage, especially surface damage, can occur from too much packing material as well as too little. The materials used need to withstand repeated unpacking and repacking of the contents.

These crate specifications are general to accommodate the widest possible range of objects. There will be occasions and circumstances that warrant additional or more specific packing and crating guidelines. As a general rule, confirm with SITES beforehand about the type of crates to be used. For assistance with or additional questions concerning crating or packing, contact SITES Registrar's Office.



SITES follows these standards for all wood products used in our crates: International Standards For Phytosanitary Measures No. 15 (ISPM 15) is an International Phytosanitary Measure developed by the International Plant Protection Convention (IPPC) that directly addresses the need to treat wood materials of a thickness greater than 6mm, used to ship products between countries. Its main purpose is to prevent the international transport and spread of disease and insects that could negatively affect plants or ecosystems. ISPM 15 affects all wood packaging material (pallets, crates, dunnages, etc.) requiring that they be debarked and then heat treated or fumigated with methyl bromide and stamped or branded, with a mark of compliance. This mark of compliance is colloquially known as the "wheat stamp". Products exempt from the ISPM 15 are made from alternative material, like paper, plastic or wood panel products (i.e. OSB, hardboard, and plywood).





# Basic Crate Shell Construction

## Crate shell materials:

½" exterior grade AC fir plywood

1" x 4" heat treated, solid pine or poplar battens

4" x 4" pine or fir (skids)

Skid-Mates® (heavy duty plastic cushioning substitute for solid wood skids)

Wood glue : Aliphatic-resin (yellow carpenter's glue) or polyvinyl-acetate (PVA white glue)

1 ½" x .086 common round wire nails

3" x .120 screw shank nails

#6 bugle head drywall screws, various lengths

#8 washer head Robertson (square) drive screws, various lengths

Spun-bonded polyethylene olefin fibers (Tyvek®)

Aluminized polyethylene and nylon barrier film (Marvelseal®)Application:

The basic crate shell can be configured to either open from the top or from the side. Lids are attached with a metal to metal threaded bolt plate system for durability. Crates for large paintings that ride vertically may need to be lowered flat before packing and unpacking. Most crates will have skids that allow for the use of a pallet jack for movement. Allow for 3 ½" clearance (from the floor) for lowered forks on pallet jacks. In the planning stage, take final crate size and weight into consideration. Loading docks, gallery access, interior doors, corridor sizes, trucks, sea containers, and airline cargo restrictions will affect the size, movement and mode of transit of the finished crates. Certain restrictions and regulations may apply to crates being shipped overseas, check applicable sources before beginning construction. Contact SITES for information concerning these limitations.

## Panel construction:

The basic crate panel is constructed using ½" exterior grade AC fir plywood reinforced with 1" x 4" solid wooden battens. (For heavier objects, ¾" plywood with battens can be substituted for the crate floor panel.) Battens and joints are glued with polyvinyl-acetate or aliphatic-resin adhesive. Glue joints and seams should be reinforced with nails. For attaching battens to plywood panels, drive 1 ½" common round wire nails with diamond points through the batten and plywood and crimp the exposed points back into the panel. This is best accomplished with a pneumatic nail gun on a steel faced worktable.

Finishing nails are not acceptable for use in the construction of crate panels. Pneumatic driven 15 or 16 gauge wire staples are acceptable for panel construction but are not as strong as the crimped nail system. When larger panels are required, use diagonal battens for reinforcement. Cover flat butt joint seams in the plywood with a 1" x 4" solid wood batten, glued and nailed. For attaching crate wall panels together, use 3" screw shank nails after gluing the joint. Reinforce the joint with # 8-3 ½" washer head Robertson (square drive) screws. After the joints are secured, corner edge battens are added with wood glue and nails. The lid end of these corner edge battens serves as a locator when attaching the lid.



### **Bolt plates and bolts:**

Securing the lid to the crate are case hardened, zinc plated, cold rolled steel bolt plates.

The top plate is

1/8<sup>th</sup> inch thick, 2" x 2 3/4" with four smooth sided holes. Three are 15/16<sup>ths</sup>" and countersunk to accept # 6 bugle head, drywall screws, used for attachment to the crate lid. One is 11/32<sup>nds</sup>", not countersunk, for the bolt that connects the lid to the crate. The threaded plate that attaches to the crate wall is 3/16" thick, 3 1/2" long x 3/4" wide. It is also case hardened, cold rolled zinc plated steel. The plate has three holes; two are smooth sided, 15/16<sup>ths</sup>" and countersunk for # 6 bugle head, drywall screws; the center hole is threaded for a 5/16<sup>ths</sup>" - 18 coarse thread, grade 5 (case hardened) hex head bolt (the bolt will have a 1/2" hex head). The bolts are 2" in length.

Each threaded plate is set in a routed mortise along the crate wall and secured with two 5/8" # 6 bugle head drywall screws. The mortise is 3/16" deep, 3/4" wide and long enough to accommodate the threaded plate. Center the mortise on the crate wall. Bolts are set 7" from each corner and equidistance along each lid edge. Generally, do not exceed 24" from bolt to bolt. There is a 15/32<sup>nds</sup>" clearance hole that passes through the crate lid and down into the center of the mortise for the crate bolt. The exposed edge of the crate wall containing threaded bolt plates is covered with a 3" wide, water activated, non-asphaltic, kraft paper tape. See schematic drawings. Cam locks, draw latches, hinges and hasps are unacceptable as lid attachment devices. The threaded bolt plates must withstand numerous openings and closings of the crate; therefore, bolt plates should be ordered from Balint Tool and Stamping Company, 48 Eagle Street, Brooklyn, NY 11222, 718.392.4040.

### **Gasket:**

2" wide x 1/8" adhesive-backed polyvinyl chloride (PVC) 12 lb. density.

Gasket is attached to the underside edge of the crate lid. Apply a bead of hot melt glue around the interior edge of the gasket. Remove the gasket face tape before final packing.

### **Skids:**

Fir or pine 4" x 4" x 12" lumber beveled at the ends on the bottom. To attach the skid to the crate, glue to the bottom of the crate, nail and screw from the inside of the crate with 3" screw shank nails and #8 3" washer head Robertson drive screws. Stacked 2x4's or plywood are not acceptable as skids. Attach skids parallel to the length of the crate unless the overall crate size does not permit pallet jack entry. Narrow width crates can have full width skids running front to rear. Be aware of standard pallet jack widths. Skid-Mates® are acceptable substitutes when solid wood skids cannot be used.

### **Exterior coating:**

Crate exteriors are sealed with two coats of clear, semi-gloss, water-based polyurethane or acrylic. Coating should cover all sides, including the bottom of the crate. Apply with either roller or sprayer. Allow drying before stenciling crate.



## **Stencils:**

Black and red stencil ink meeting Fed. Spec. CID A-A-208 Type 4 for porous and nonporous surfaces. Stencil in a pattern consistent with schematic drawings. Stencil lettering is 2" high block type. Stencil imprints should be clear and crisp. Each crate should be able to be identified from each visible side as to the crate number and the SITES exhibit number. Each crate should have its dimensions, rounded to the next higher inch, marked on at least three visible sides. The crate containing the condition report book is designated with a 5" high, green, five pointed star on each side and the top. The green-stenciled star can be an acrylic spray paint. A red, triangular, inked stencil marks the upper right hand corner of the lid. This red marking extends 2" around the corner and onto the top of the crate. Several symbols are also stenciled onto the crates: a broken wine glass for fragile and an umbrella for keep dry. The size of these stencils may vary, but keep within the scale of the crate as a general rule. See drawings for more detail. Overall crate dimensions are noted on the crate using the English system (inches) with the crate height listed first. When possible, weigh each crate and mark the crate accordingly.

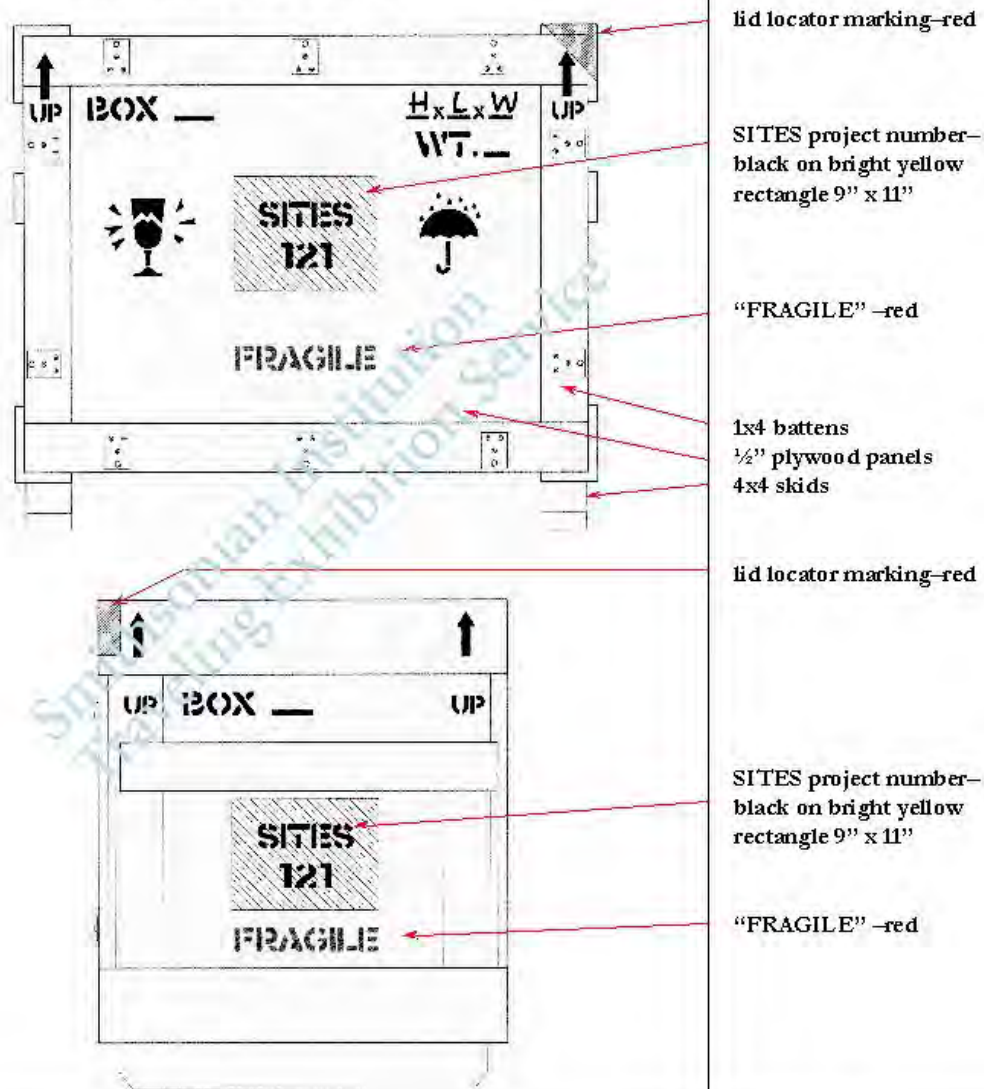
## **Exhibition number:**

The word "SITES" with the SITES exhibition number below is stenciled within a bright yellow painted acrylic 9" x 11" rectangle on each face of the crate as shown in schematic drawings. The lettering should be 2" high block type. Each SITES exhibit is assigned a specific exhibition number; contact SITES for the number of the exhibition to be stenciled on the crates.





## CRATE STENCILING



**SITES**

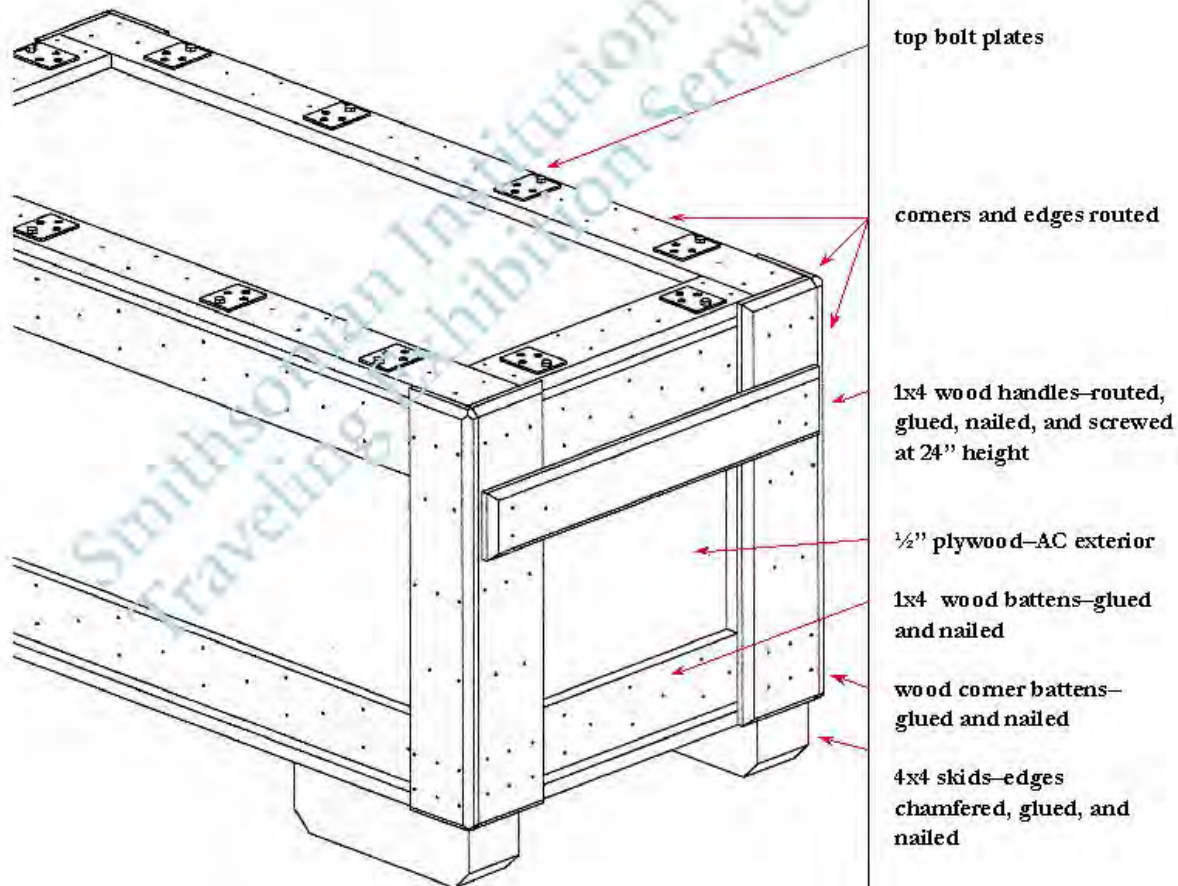
Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada Drawings by  
Meredith Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

## TOP-LOADING CRATE



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

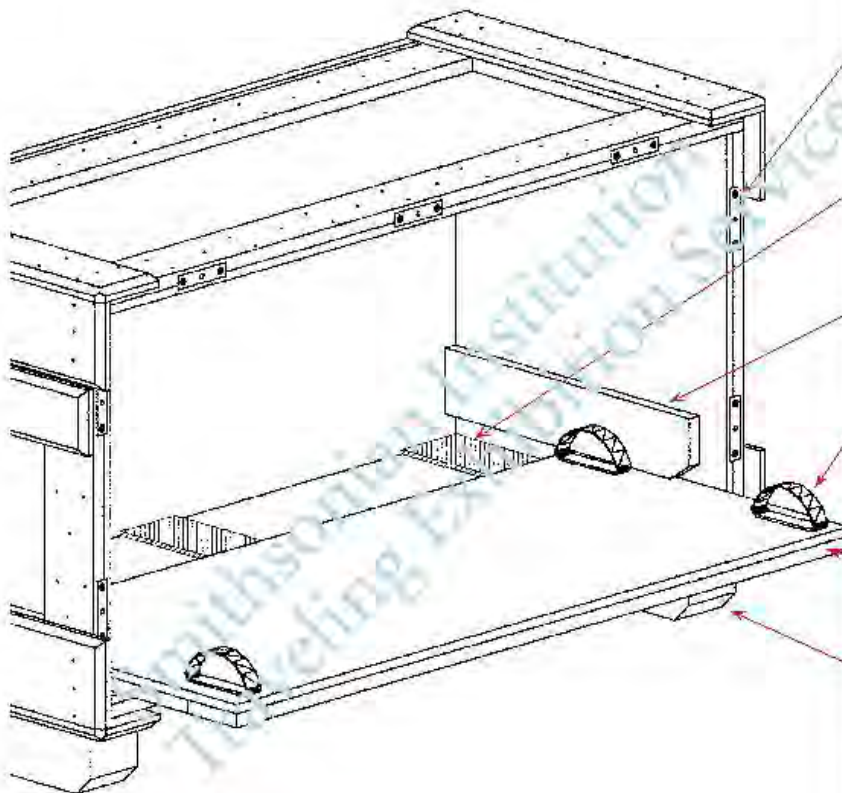
Design and specifications by  
Rick Yamada Drawings by  
Meredith Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

## SIDE-LOADING CRATE WITH SLIDING TRAY

SHOWN WITHOUT LID



threaded bolt plates—  
routed, screwed, and  
paper taped

1/4" tempered masonite  
strips—attached with  
countersunk screws

wall batten secures tray—  
screwed from outside

cotton web strap handles—  
hot-melt glued and  
screwed to tray

1/2" or 3/4" plywood and  
batten panel—battens on  
underside of tray

4x4 skids



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

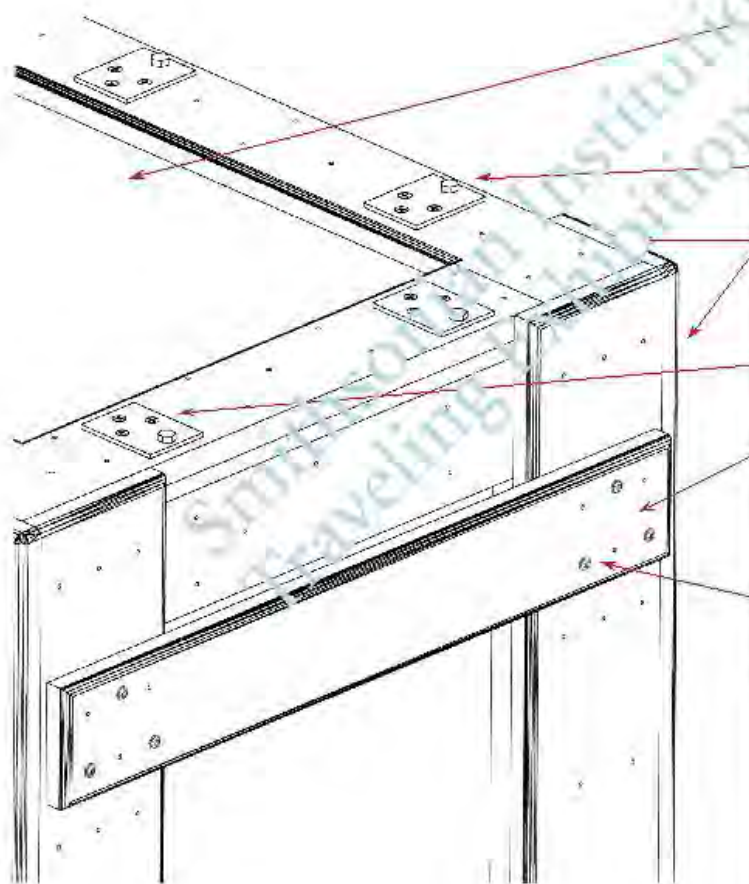
Design and specifications by  
Rick Yamada Drawings by  
Meredith Ellis  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service



## BOLT CRATE CORNER DETAIL



1/2" exterior A/C plywood panels with 1x4 battens—glued and nailed

top plate—screwed onto crate lid

exposed corners and edges routed

1" #6 bugle head drywall screws—course threaded

1x4 wood handles—routed, glued, nailed, and screwed at 24" height

2" square drive, pan-headed screws—course threaded



**SITES**

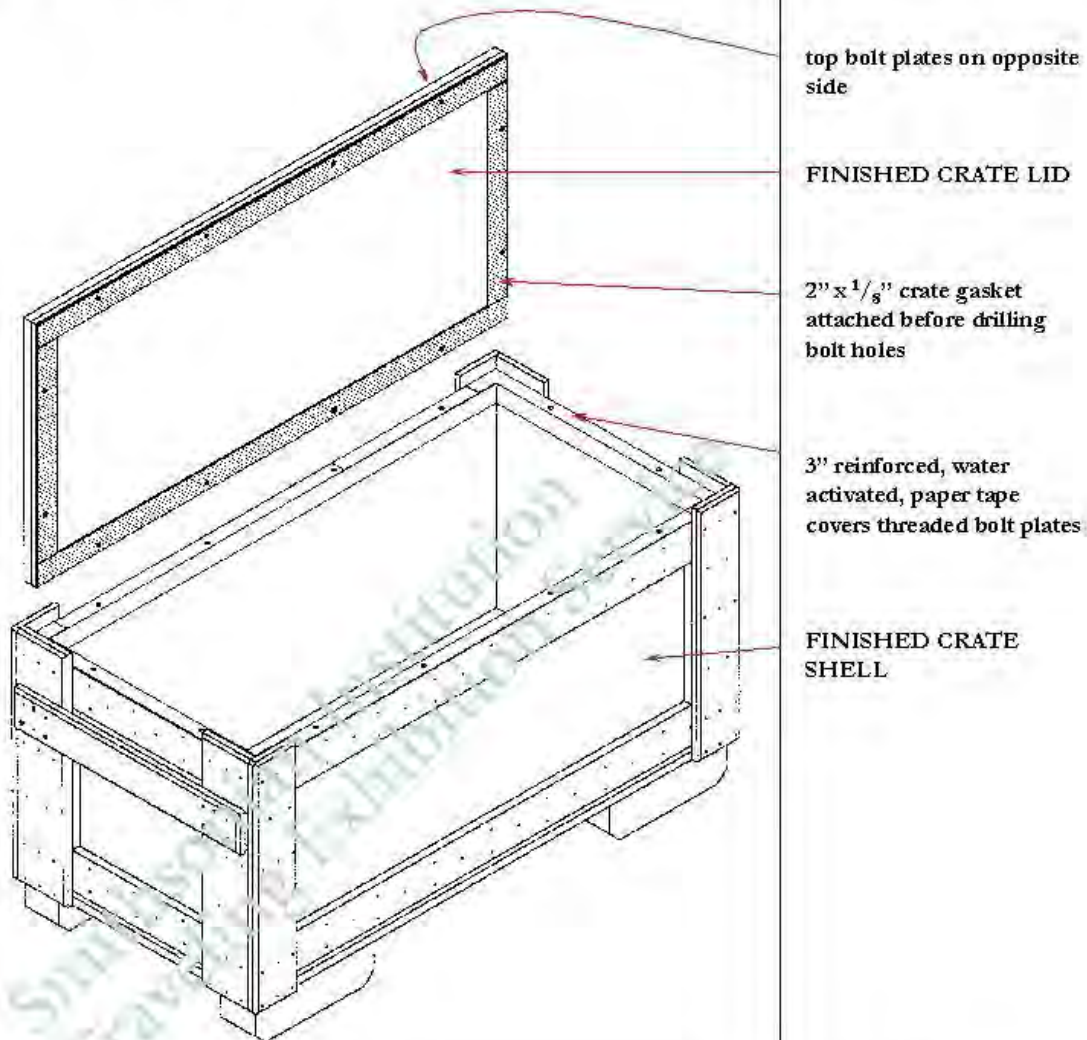
Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Meredith Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

## GASKET INSTALLATION



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

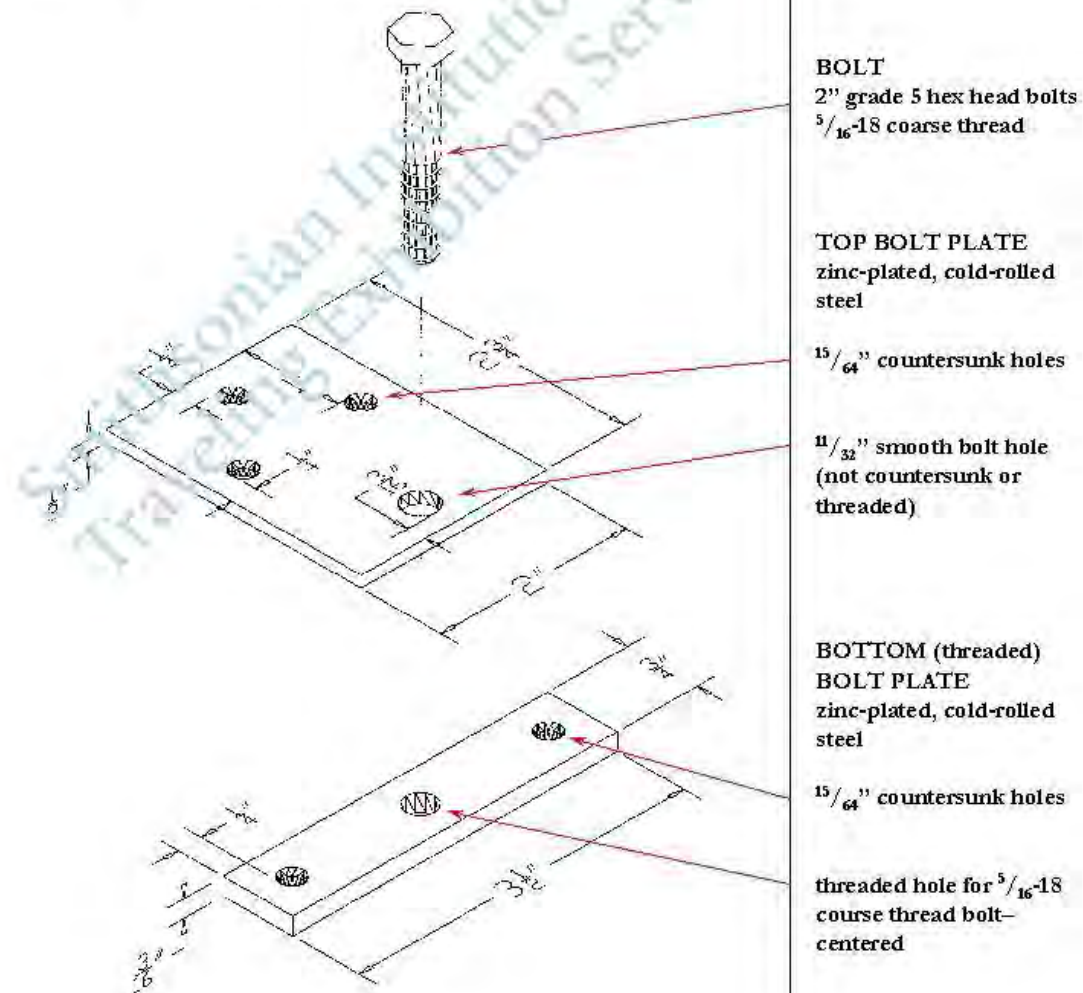
Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service



## BOLT PLATE DIMENSIONS



**SITES**

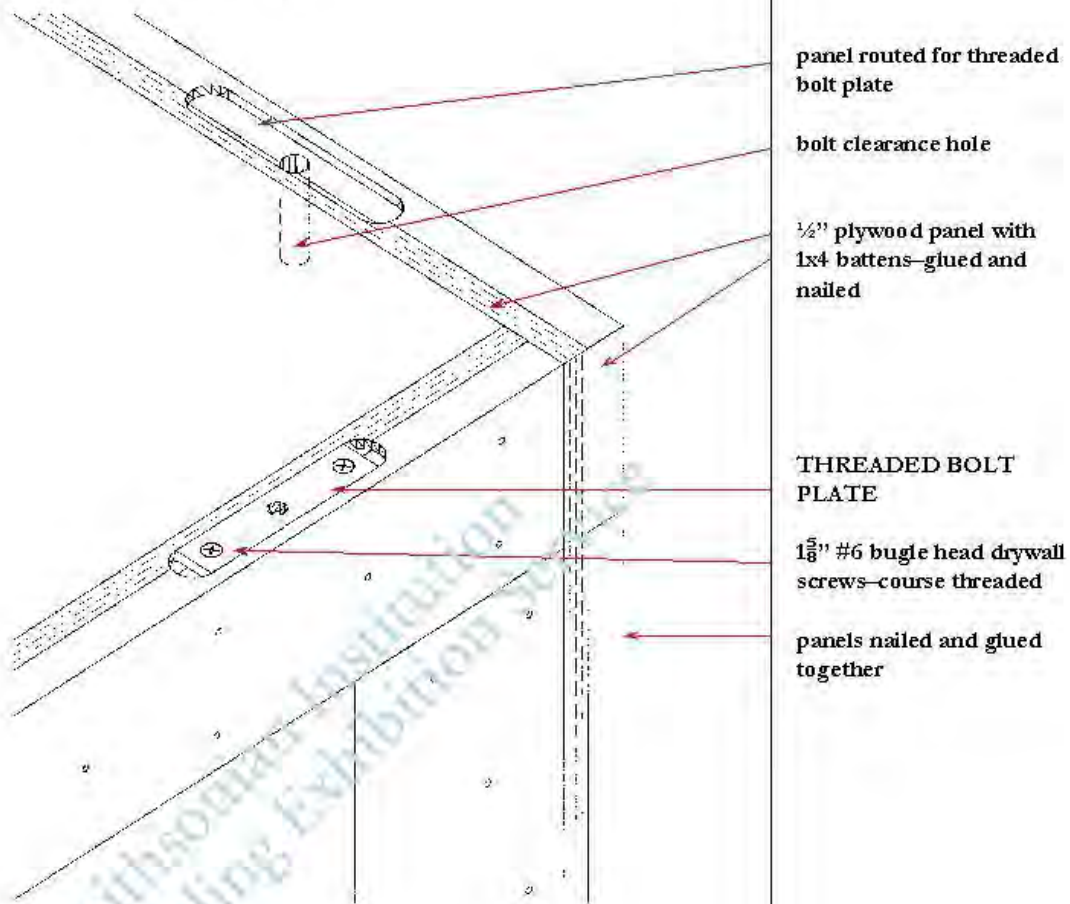
Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

## THREADED BOLT PLATE INSTALLATION



**SITES**

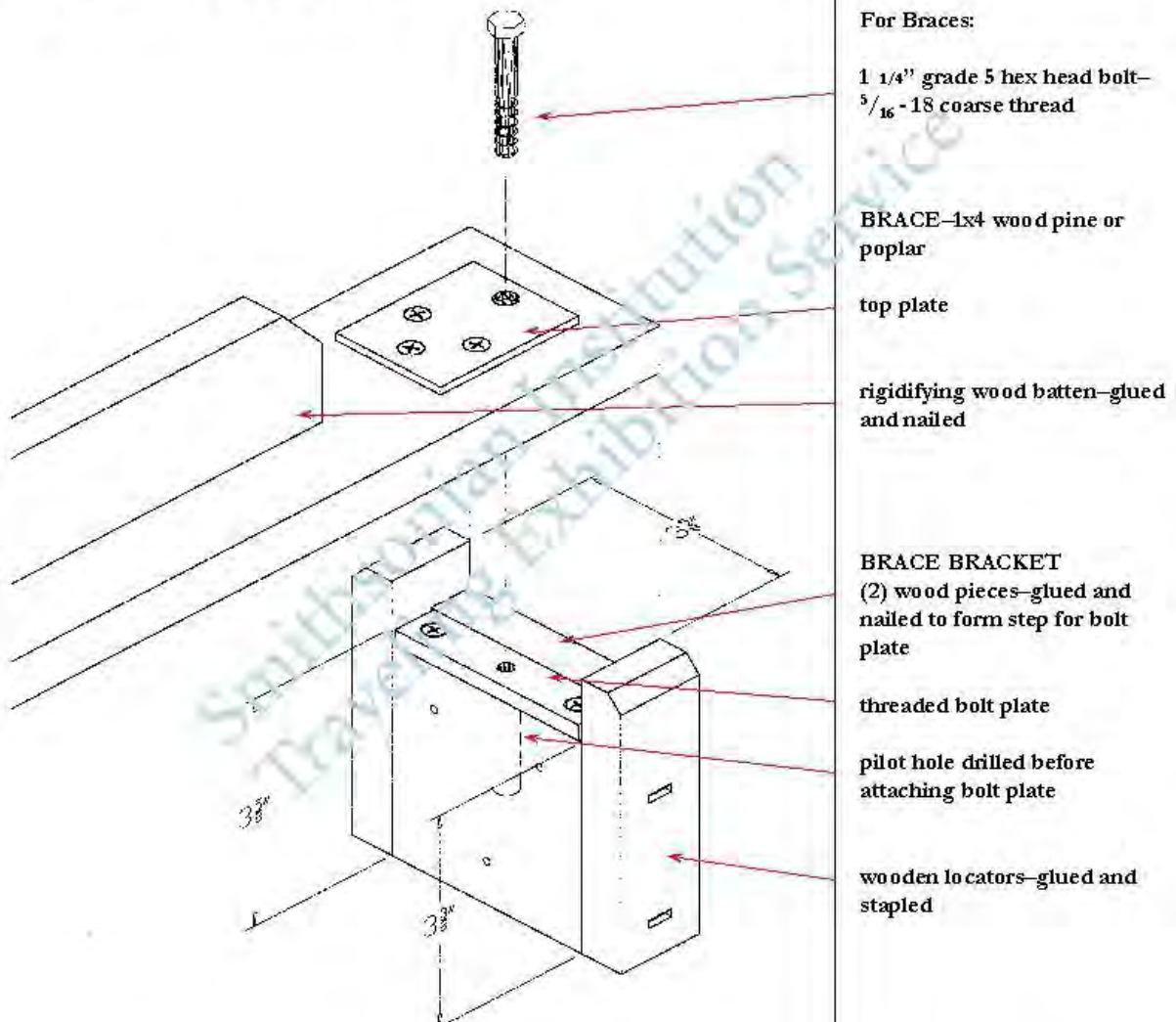
Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

## BRACE ASSEMBLY



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

# Single Painting Crate

## Materials:

Refer to basic crate construction for exterior shell

Expanded polyethylene closed cell foam (Ethafoam ®) white, 2.2 lb density

Hot melt adhesive (ethylene acetate copolymer) that meets FDA requirements 175.105

Irradiated, cross linked, closed cell polyolefin foam (Volara®)

Spun-bonded polyethylene olefin fibers (Tyvek)

Aluminized polyethylene and nylon barrier film, (Marvelseal)®

## Application:

Attach 2" x 2" strips of expanded polyethylene foam (Ethafoam ®) with hot melt adhesive to the walls and lid of the crate at spaced intervals. The strips (crate bumpers) support and cushion the frame without causing abrasion during transit. The actual number of strips will vary, depending on the weight of the framed object. Foam loading should conform to dynamic cushioning curves for the weight of the object and the density of the foam. For gilt frames, line the strips with a cross linked irradiated foam (Volara®). This is attached using heat fusing or hot melts glue. For ornate or very heavy frames contact SITES for alternative packing methods. See schematic drawing for typical placement.

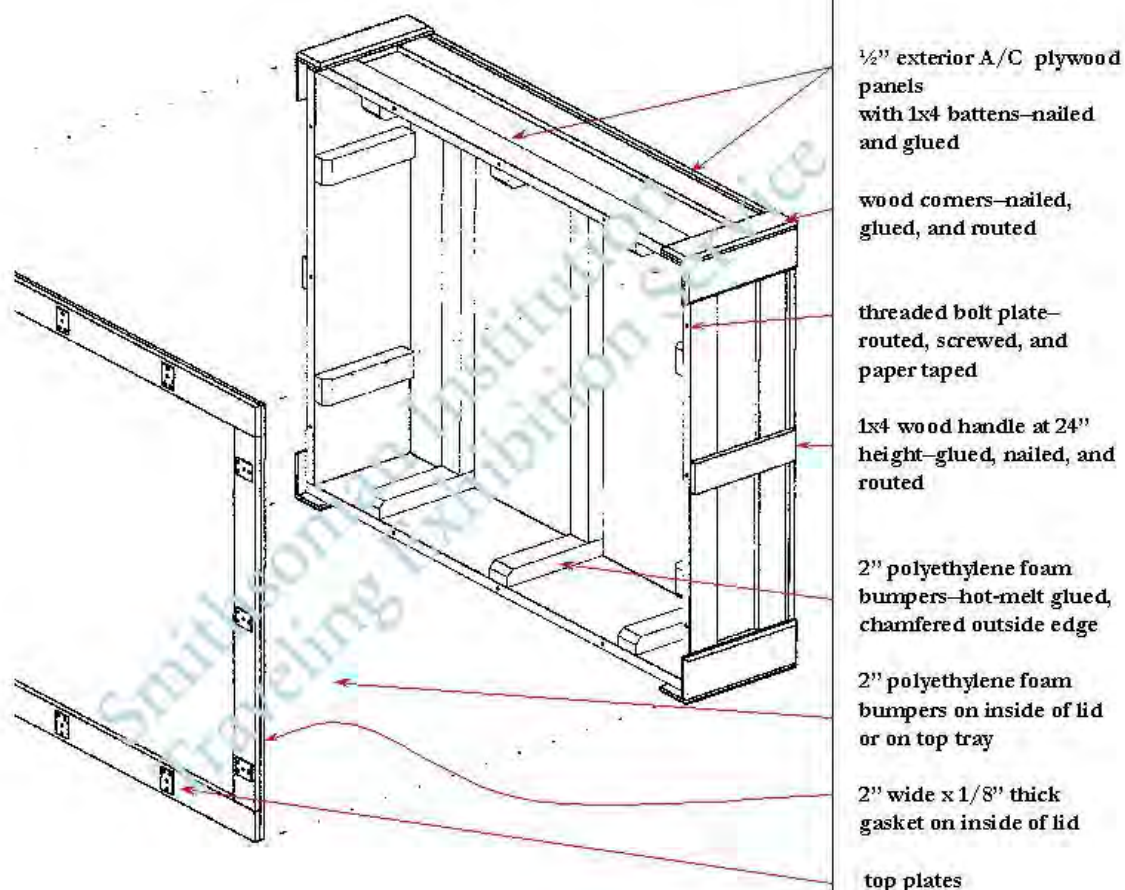
Do not use contact cement to attach foam bumpers. Generally, paintings are not wrapped for traveling exhibitions, but there may be instances where the crate interior may need to be lined with a barrier material, such as Tyvek® or Marvelseal®. Contact SITES if there are questions concerning wrapping paintings or crate lining.

Generally, single painting crates that ride vertically do not have 4" x 4" skids attached for reasons of stability. 2" x 4" skids are acceptable in those cases.





## SINGLE PAINTING CRATE



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications  
by Rick Yamada.  
Drawings by Merlin Ellis.  
©2002 Smithsonian  
Institution and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service



# Tray Packing

## Materials:

Refer to basic crate shell construction for exterior shell

½" White, clay coated paper liners laminated to an extruded polystyrene center (Fome-Cor®)

½" White, clay coated paper over a honeycomb kraft paper interior (Airlyte ® Graphic Arts Board)

6 mil, 1" wide, white paper hinge tape for edging trays

Strips of expanded polyethylene closed cell, 2.2 lb density (Ethafoam®)

Hot melt adhesive (ethylene vinyl acetate copolymer)

Irradiated, crosslinked, closed cell, polyolefin foam (Volara®)

## Application:

Used for packing multiple framed objects of differing sizes into the same crate. Layers of ½" Fome-Cor® or Airlyte ® (with edges taped with white paper hinge tape) are cut to fit within a crate. The crate is lined with 2" strips of expanded polyethylene foam (crate bumpers) attached to the sides, lid and bottom at intervals to support and cushion the trays. The crate can be oriented to ride vertically or flat, depending on the specific needs of the framed objects. Each framed object is fitted and sized onto its tray by using strips of polyethylene foam around the frame. The height of the strips is determined by the frame's depth. Leave ¼" space between the depth of the frame and the top of the polyethylene strip (tray bumper). Hanging hardware or security plates may necessitate additional depth or space on the tray.

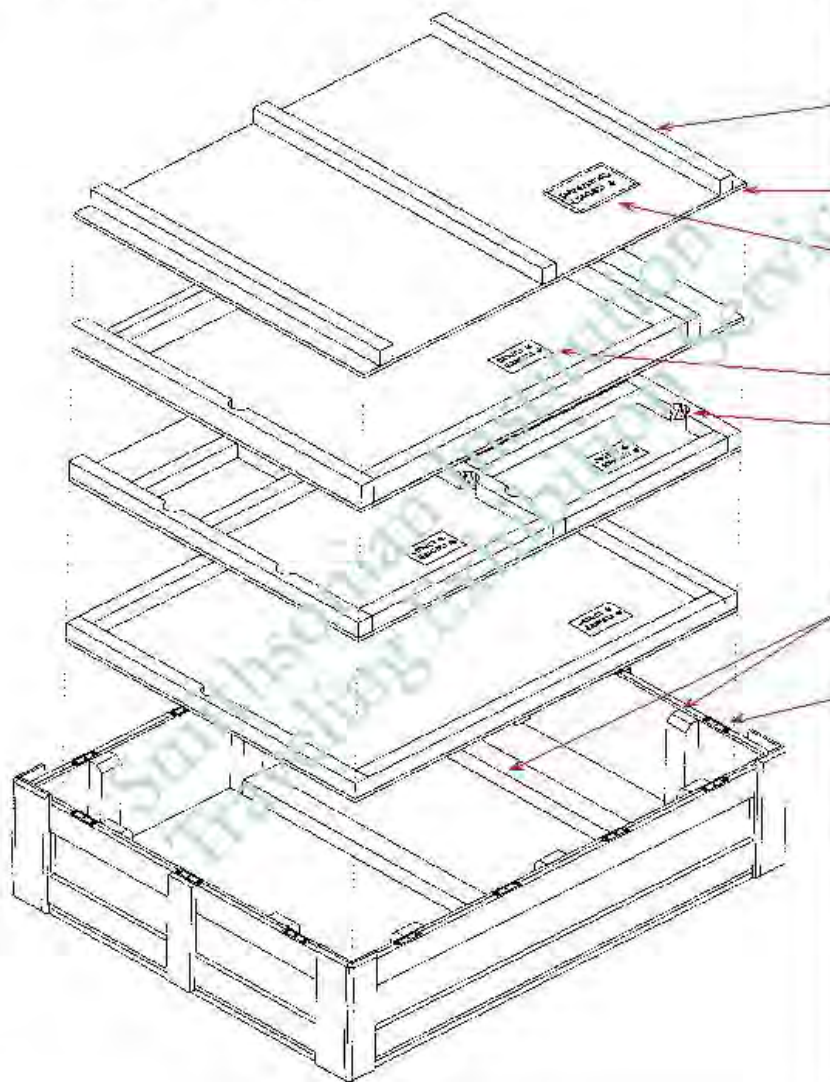
The trays are stacked within the crate and the frames are supported and cushioned. Attach additional strips if necessary to support the outer edges of the tray. The top layer holds no object, but has a list of the crate contents and any special instructions attached. On the inside edges of the tray bumpers, cut finger access holes for lifting framed objects out of the tray. A label or tag on the back should identify each framed object in a crate. A corresponding label should identify each tray as to which frame fits into it. This label when possible should be visible when the object is packed onto the tray.

When packing and unpacking the crate, individual frames should be moved on and off the trays before the trays themselves are moved. Instructions should reflect this on the top layer of the crate. Each tray should be identified with the crate number it fits into. If necessary, trays can be numbered in the sequence they are packed in the crate. Gilt frames may require lining the tray bumpers with a softer material such as Volara®. Do not line tray bumpers with polyester felt. Cardboard trays are not acceptable. Ornately carved or heavy frames require special packing techniques. In such cases, contact SITES for technical assistance.

Most SITES exhibits will have a set of Condition Report Notebooks. These should be packed near the top layer of the crate for easy access. The crate containing these books is noted with a green star stenciled to the crate exterior. (see crate shell construction)



## TRAY PACKING



SHOWN WITHOUT LID

**TOP TRAY**  
2" polyethylene foam  
bumpers

1/2" foam-cor® – edges  
taped  
crate number and list of  
contents

**PACKING TRAYS**  
item number and title

holes cut for gripping  
painting

2" polyethylene foam  
bumpers

threaded bolt plates—  
routed, screwed, taped

**Note:**  
Crate example rides  
vertically and packs flat



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

# Slotted Crate

## Interior materials:

Refer to basic crate shell construction for exterior shell

Solid wood strips either pine or poplar, various sizes

1/8" thick Polyester felt strips with an adhesive backing, various sizes

Expanded polyethylene foam strips (Ethafom®)

1/2" exterior AC plywood panels

Hot melt glue (ethylene vinyl acetate copolymer)

Wood glue, (aliphatic-resin or polyvinyl-acetate)

## Application:

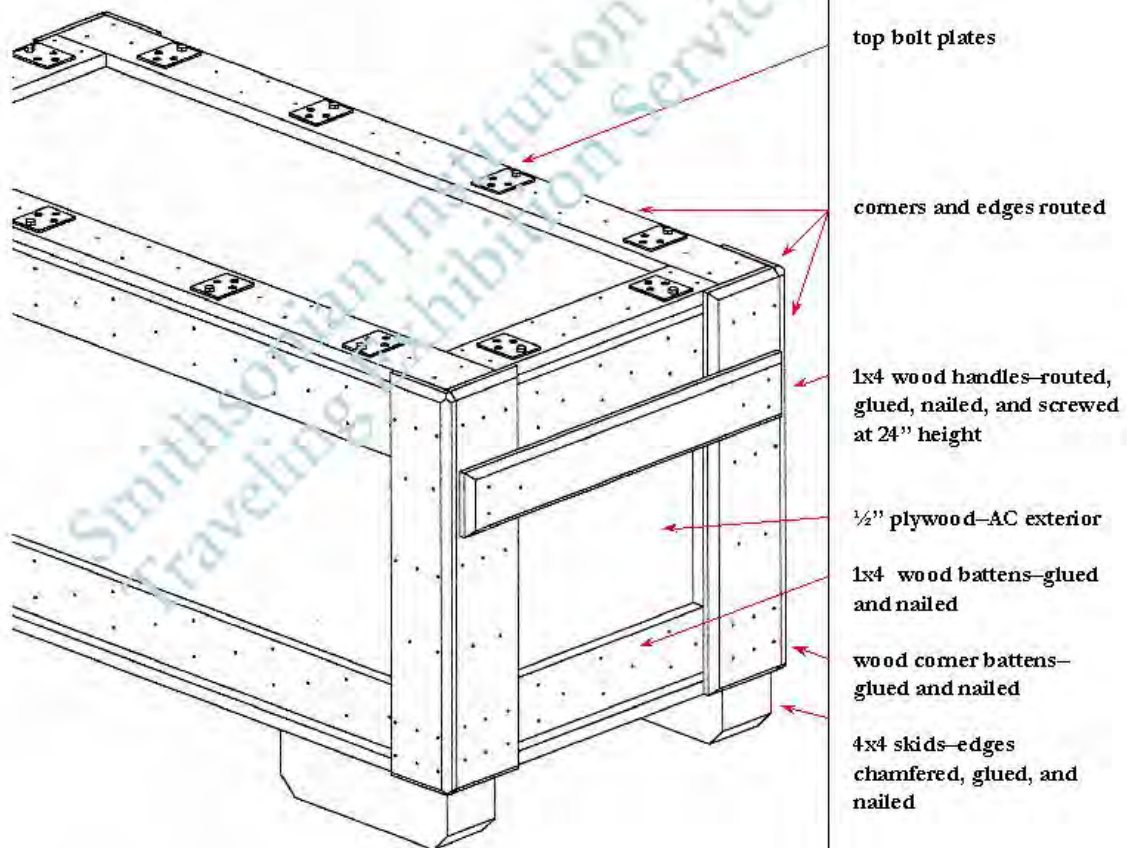
Generally used to pack graphic, text panels, or structural exhibit elements, slotted crates can also be used for framed objects if the frame stock is uniform and smooth, and the objects are mounted securely in frames. If there is any doubt as to whether objects are suitable for this method of packing, contact SITES.

The slotted crate can be either top loading or end loading, depending on the material being packed. Wooden strips faced with polyester felt allow panels and frames to slide in and out of the crate with minimal force. Expanded polyethylene (Ethafom®) is not suitable material for slots; it is used for cushioning the frames at the bottom and lid of the top loading crate and the back and lid of the end-loading crate. Wood strips are configured to limit the movement of the frames while in transit, but allow easy packing and unpacking. Each slot is identified with the piece that it holds. Size variations are accommodated by buildups and plywood panels attached to the crate walls.

Surfaces in contact with frames or panels are covered with polyester felt. Felt should be securely attached to slots with hot melt glue and stapled at the ends. Be careful that any surface coming in contact with the packed object does not have protruding screw points, staples, glue residue or anything that could damage the object.



## TOP-LOADING CRATE



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service



# Cavity Packing

## Materials:

Refer to basic crate shell construction for exterior shell  
Polyester urethane foam (2 lb. density)  
Nomex®, (DuPont spunlaced aramid fiber sheeting)  
Tyvek®, (DuPont spunbonded olefin sheet product)  
Hot melt glue (ethylene vinyl acetate copolymer)  
Cotton muslin (unbleached and unsized)  
Marvelseal®, (Aluminized polyethylene and nylon barrier film)

## Application:

Generally used for packing fragile, three dimensional objects, cavity (or contour) packing is stacked layers of polyester urethane foam in a top loading crate with negative spaces (cavities) cut and contoured to fit the objects. The safety of the objects is of primary concern. If there are any questions as to how to pack objects using this method, contact SITES.

For ease of loading and unloading the foam layers, the crate interior can be lined with Tyvek®. Heavier and/or larger objects are packed in the lower layers of the crate. Lighter and more fragile objects are placed higher in the crate. Generally, the foam is 2” and 4” thick layers. Allow for foam on all sides, top and bottom, surrounding the objects to adequately cushion and protect the objects while in transit. Be aware of contact points on the object. Take into consideration proper dynamic cushioning curves when cutting cavities. Cut cavities with care using a sharp razor knife. Surfaces of the cavities are lined with a barrier material such as Nomex®, Tyvek® or cotton muslin. Choice of the lining material depends on the surface of the object being packed.

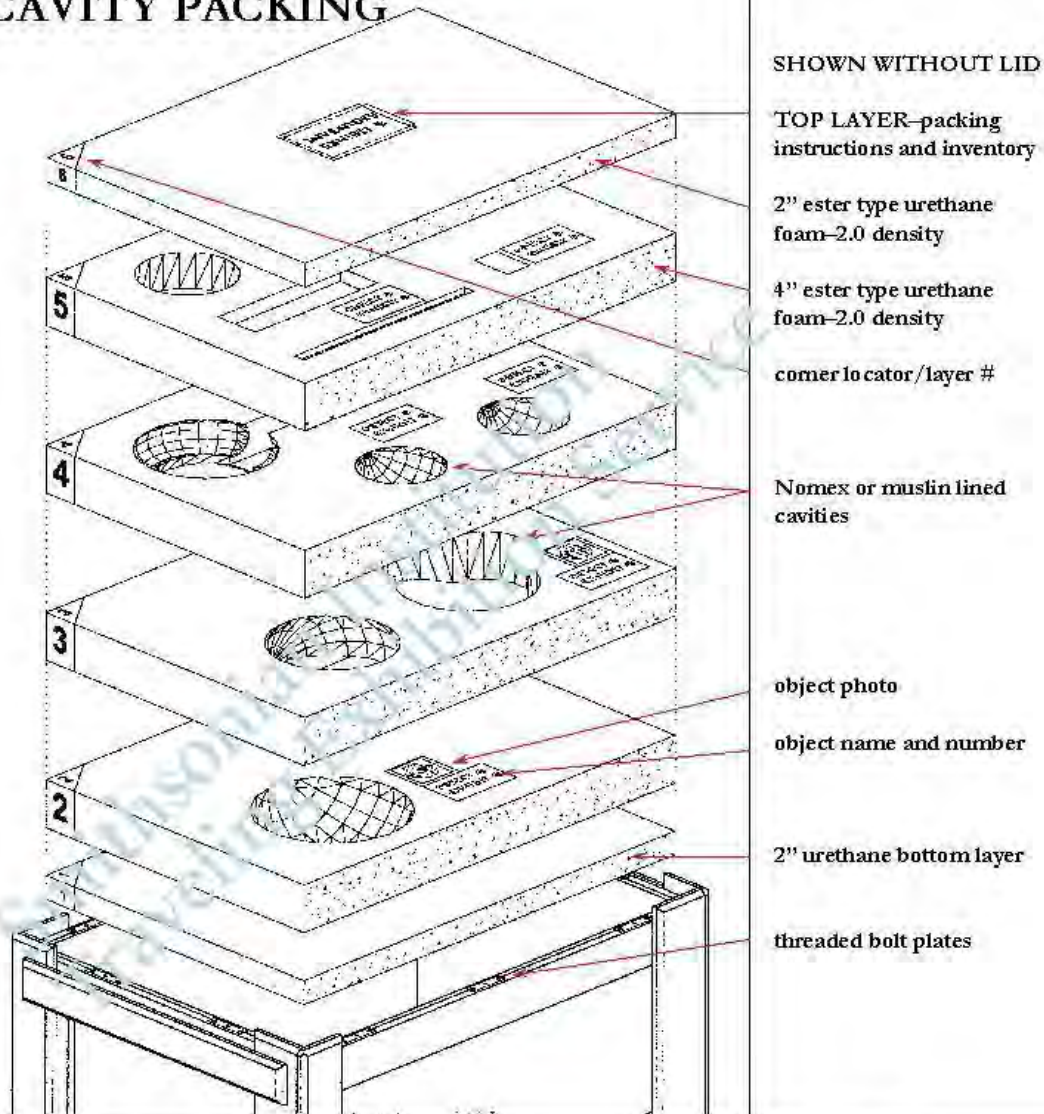
Identify each cavity with the object it holds. A photo of the packed object in the cavity along with the name or title, exhibition number and any special handling instructions should be attached to the foam beside the cavity. See drawings for details.

Packed objects are removed from cavities before each foam layer is removed from the crate. When packing, the foam layer should be placed in the crate before objects are packed into cavities. Foam layers are sequentially numbered beginning with layer one at the bottom of the crate and ending at the top layer. Foam layers are also marked clearly as to how they are configured in the stack. General packing instructions and an inventory of objects in the crate are listed on the top layer. Each layer of foam should also be marked with the crate number and the SITES exhibit number.





## CAVITY PACKING



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service

# Sliding Tray and Brace Packing

## Materials:

Refer to basic crate shell construction for exterior shell

½" or ¾" exterior AC plywood panel

1" x 4" heat treated pine or poplar battens

1/8<sup>th</sup>, tempered masonite

Expanded polyethylene foam (Ethafoam®)

Crosslinked polyethylene foam (Volara®)

Polyester urethane foam

Nomex® (DuPont spunlaced aramid fiber sheeting)

Tyvek® (DuPont spunbonded olefin sheet product)

Cotton or nylon straps

## Application:

The sliding wooden tray allows the safe removal of the object from its crate with a minimal amount of handling. The object and the tray are secured into the crate during transit by several methods. Safety of the object is the primary concern. If there is any question about how to safely secure an object onto a tray, contact SITES.

The wooden tray is ½" or ¾" exterior AC plywood with the A side to the top. 1" x 4" solid wood battens are attached to the C side with glue and nails. Any protruding nail points are crimped back into the plywood. Two strips of tempered masonite are glued and screwed to the bottom outer edges of the crate interior. These strips facilitate the movement of the tray in and out of the crate. Securing the tray from above are two wood battens attached to the crate wall with glue and drywall screws. Allow 1/16<sup>th</sup> spacing between the surface of the tray and the wall battens. Loops of cotton or nylon webbing attached to the tray using wafer head screws act as handles for the tray. The crate lid secures the tray from movement during transit.

Object can be secured onto the tray and into the crate by using a fitted brace. The brace is attached to the crate wall by means of a permanently mounted bolt fixture. The bolt plates are the same as used on the crate lid. The bolts are shorter than the 2" lid bolts however. Use 1¼" 5/16 – 18 coarse thread, grade 5, hex head bolts for braces. The brace is made of solid pine or poplar. A T-beam configuration is stronger and more rigid, but depending on the object, a single batten could be used. The T-beam is two lengthwise wooden battens glued and screwed perpendicular along the center of one. Leave space at each end for a top bolt plate. Padding of appropriate foam and barrier material is attached to the underside of the brace. Contour the foam to fit the contact points on the object.

The bolt fixture that attaches to the crate wall is made of two blocks of ¾" wood with a threaded bolt plate attached to the inner facing block. The two blocks are glued and stapled together. There is a clearance hole below the bolt plate. Two edge locator



pieces are also glued and stapled to the block. The fixture is glued and screwed to the crate wall from the outside at the appropriate position that secures and cushions the object. See drawings for details.

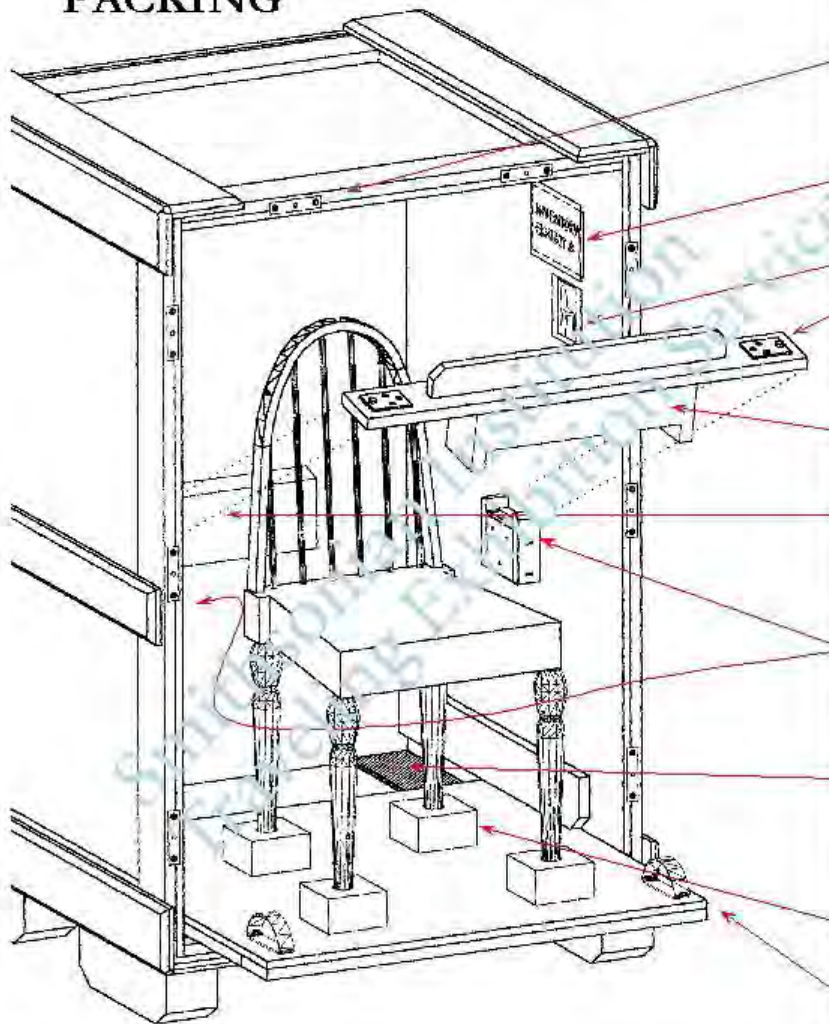
On the interior side wall of the crate are packing and handling instructions, an inventory of the contents of the crate, and photos of the packing configuration of the objects. See “Labels and Markings for Crate Interiors,” pp. 47 – 52 for more details.



Smithsonian Institution  
Traveling Exhibition Service



## SLIDING TRAY AND BRACE PACKING



SHOWN WITHOUT LID

threaded bolt plates—  
routed, screwed, taped

packing and handling  
instructions  
inventory and crate no.

item photo

BRACE  
1x4 wood brace, bolt plate  
attached

foam-padded and covered  
with muslin or Nomex

ester type urethane foam—  
muslin or Nomex covered,  
hot-melt glued to crate  
wall

bolt fixtures (2 per brace)—  
screwed to crate wall from  
outside of crate

tempered masonite  
runners—attached with  
countersunk screws and  
glue

polyethylene foam—volara  
faced

sliding tray



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada. Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.



Smithsonian Institution  
Traveling Exhibition Service



# Slat Crate

## Materials:

½" or ¾" AC exterior plywood  
1" x 4", Heat treated pine or poplar battens  
2" x 4"s, fir or pine  
4" x 4" fir or pine (skids)  
Wood glue (Aliphatic-resin or polyvinyl-acetate)  
1 ¼" x .086 common round wire nails  
3" x .120 screw shank nails  
#6 bugle head drywall screws, various lengths  
#8 washer head Robertson drive screws, various lengths

## Application:

Used for exhibit furniture, vitrines, wall or floor cases or any object that does not require the protection of a solid wood paneled crate. The slat crate can be a top loading or side loading crate, depending on the contents. The slat crate (or cage) is made primarily of 1x4 solid wood battens attached to a ½" or ¾" plywood deck supported by a floor joist configuration of 2 x 4's.

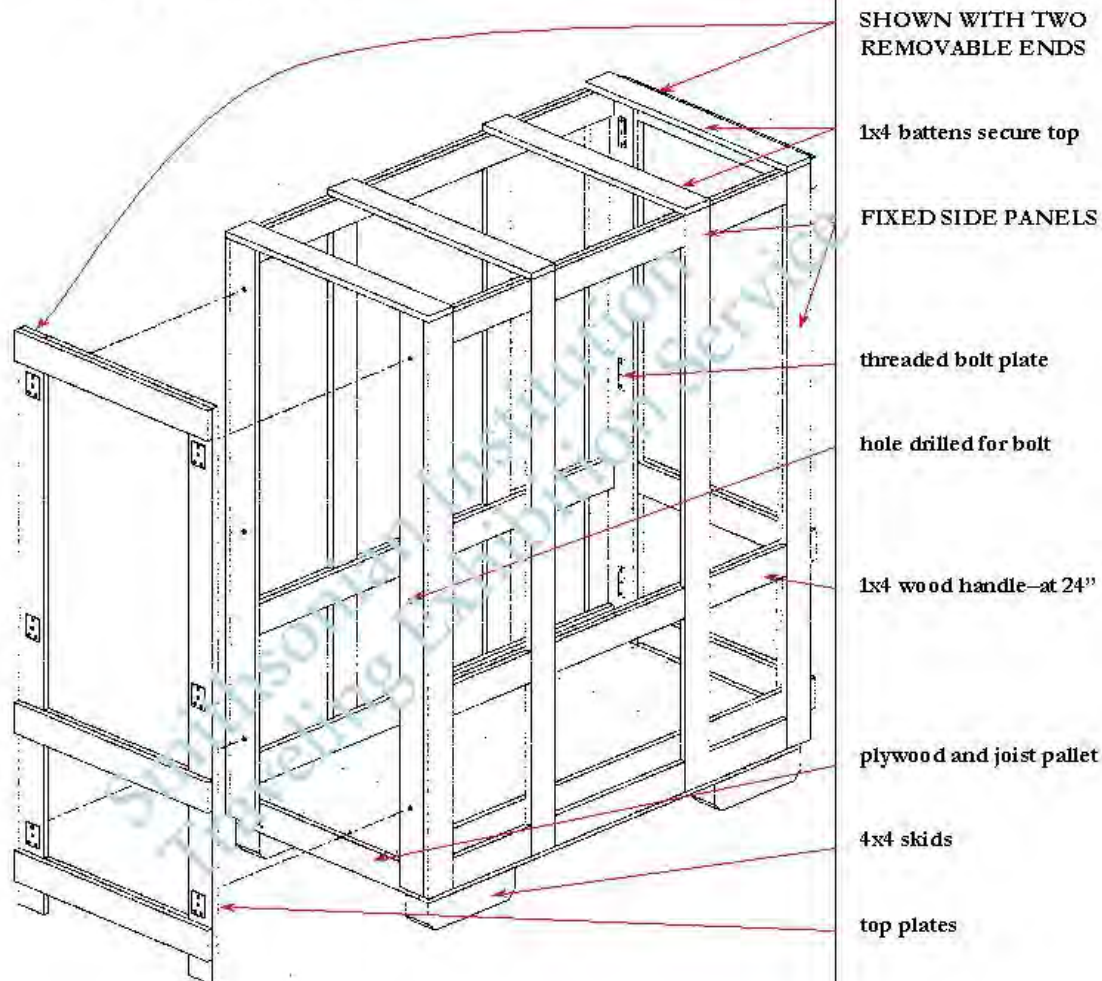
4 x 4 skids are attached before the plywood deck is attached to the floor joist frame. The lid is attached using the same top and threaded bolt plates that are used in the construction of the solid sided crates. After drilling holes for the bolts however, the threaded plates are placed on the inner surface of the structure surrounding the lid and screwed in place. Vertical L-beams are in the four corners with battens attached both horizontally and vertically forming a cage structure. The L-beams extend below edges of the plywood deck surface and attach to the 2" x 4" structure with nails and screws.

The interior of the slat crate can be configured as a slot crate or with bottom and side blocks that secure the object in place. Surfaces should be protected and the object identified in the packing. Padded web straps with buckles can be used as well as wood braces to secure objects in slat crates. If there are any questions concerning construction or packing using this method, contact SITES.





## SLAT CRATE



**SITES**

Smithsonian Institution  
Traveling Exhibition Service  
Washington D.C.

Design and specifications by  
Rick Yamada Drawings by  
Merlin Ellis.  
©2002 Smithsonian Institution  
and Ely, Inc.

**ELY**  
I N C



Smithsonian Institution  
Traveling Exhibition Service

# Floor Joist Pallet

## Pallet materials:

1/2" or 3/4" exterior grade AC fir plywood  
2" x 4"s, heat treated, fir or pine (floor joists)  
4" x 4" pine or fir (skids)  
1" x 4" heat treated, solid pine or poplar battens  
1 1/2" x .086 common round wire nails with diamond points  
3" x .120 screw shank nails  
#8 washer head Robertson (square) drive screws, various lengths  
Wood glue: Aliphatic-resin (yellow carpenter's glue) or polyvinyl-acetate (PVA white glue)

## Applications:

As part of the crating for large exhibition components, especially exhibition cases with acrylic bonnets. Pallets may be used by themselves, with braces or other items, and with custom blankets.

Remember, in general crated/palletted items should not exceed 6 1/2" feet in height or 5 feet in width. The goal is to move them through a standard 7 foot double door without mullions using a pallet jack. If this is a problem, call SITES.

## Construction:

### Pallet Deck:

See drawings (6 pages) of step by step construction of a floor joist pallet.

The pallet is made of a 1/2" or 3/4" AC exterior plywood, supported from below by a floor joist configuration of 2" x 4"s, of fir or pine. Joints are glued and reinforced with nails. Acceptable glues are mentioned in the SITES crating specifications. For attaching battens to plywood panels, drive 1 1/2" common round wire nails with diamond points through the batten and the plywood and crimp the exposed points back into the panel. This is best accomplished with a pneumatic nail gun on a steel faced worktable. Finishing nails are not acceptable for use. The pallet must extend beyond the base of the exhibition element it contains by at least 4" in all dimensions.

### Skids:

See following drawings (6 pages) of step by step construction of a floor joist pallet. Additional details are found under skids in SITES Basic Crate Shell Construction, pp. 4-5, SITES Crating Specifications.

4" x 4" fir or pine skids beveled at the ends on the bottom are attached to the bottom of the pallet. To attach the skid to the crate, glue to the bottom, nail and screw from the



deck with a 3" screw shank nails and #8 3" washer head Robertson drive screws. Stacked 2" x 4"s or plywood are not acceptable as skids. The skids must allow for 3 ½" clearances (from the floor) for lowered forks on pallet jacks. Attach skids parallel to the length of the pallet unless the overall pallet size does not permit pallet jack entry. Narrow width pallets can have full width skids running front to rear. Be aware of standard pallet jack widths; the cross members of the joist construction should not interfere with the use of a pallet jack. SkidMates® are acceptable substitutes when solid wood skids cannot be used.

### **Exteriors and Stenciling:**

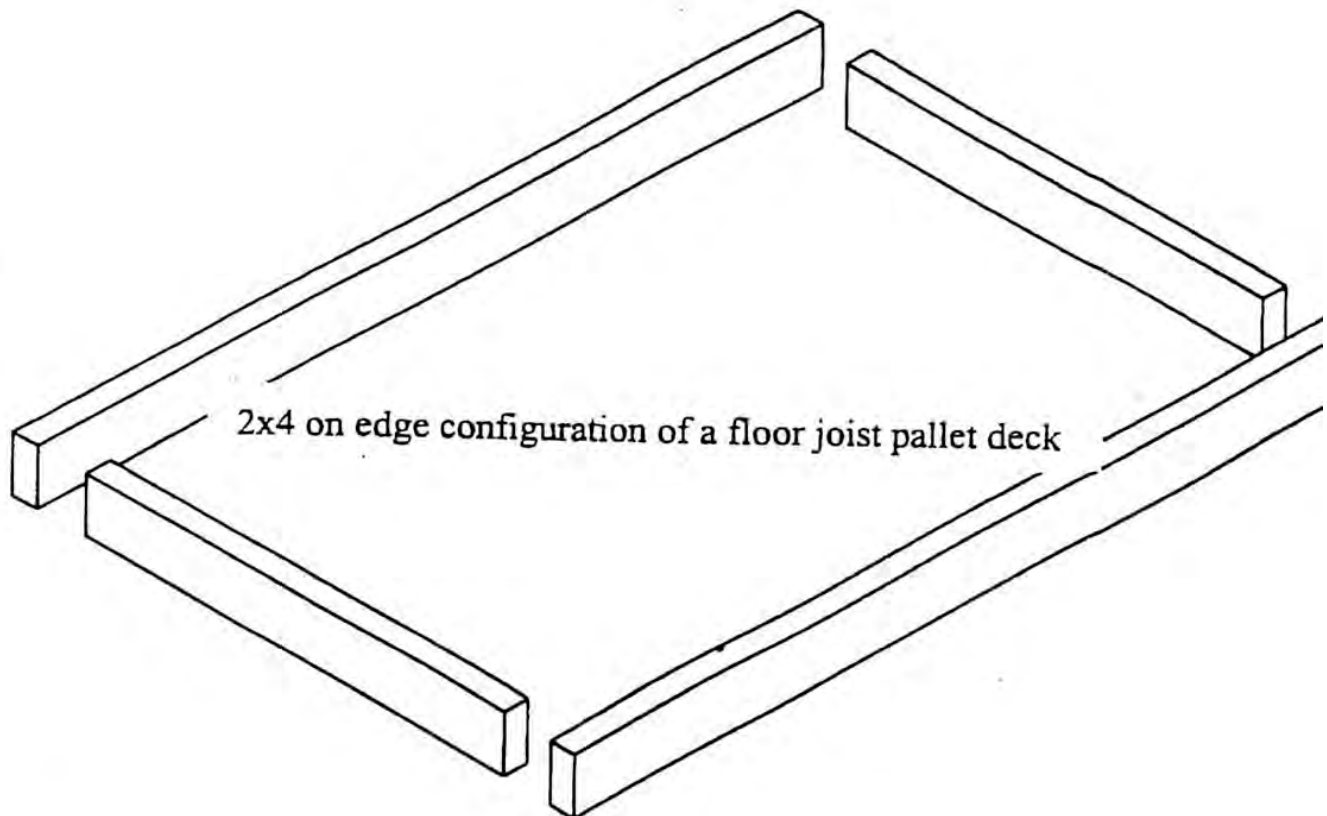
See SITES Crating Specifications, p. 5, for more details on these items.

Pallet exteriors are sealed with two coats of clear, semi-gloss, water-based polyurethane or acrylic. Coating should cover all sides except the underside. Apply with either roller or sprayer. Allow drying before stenciling crate.

Follow the stenciling specifications in SITES Crate Specifications, p. 5. SITES standard is HxWxD. SITES also asks that crated/palletized components be weighed. The exhibition number is to be marked on each disjoint part of the crate/pallet (lid, blanket, shell, etc.) and will be provided by the SITES Registrar. SITES will provide the item number for each pallet. Remember, you do not have to paint the pallets yellow!



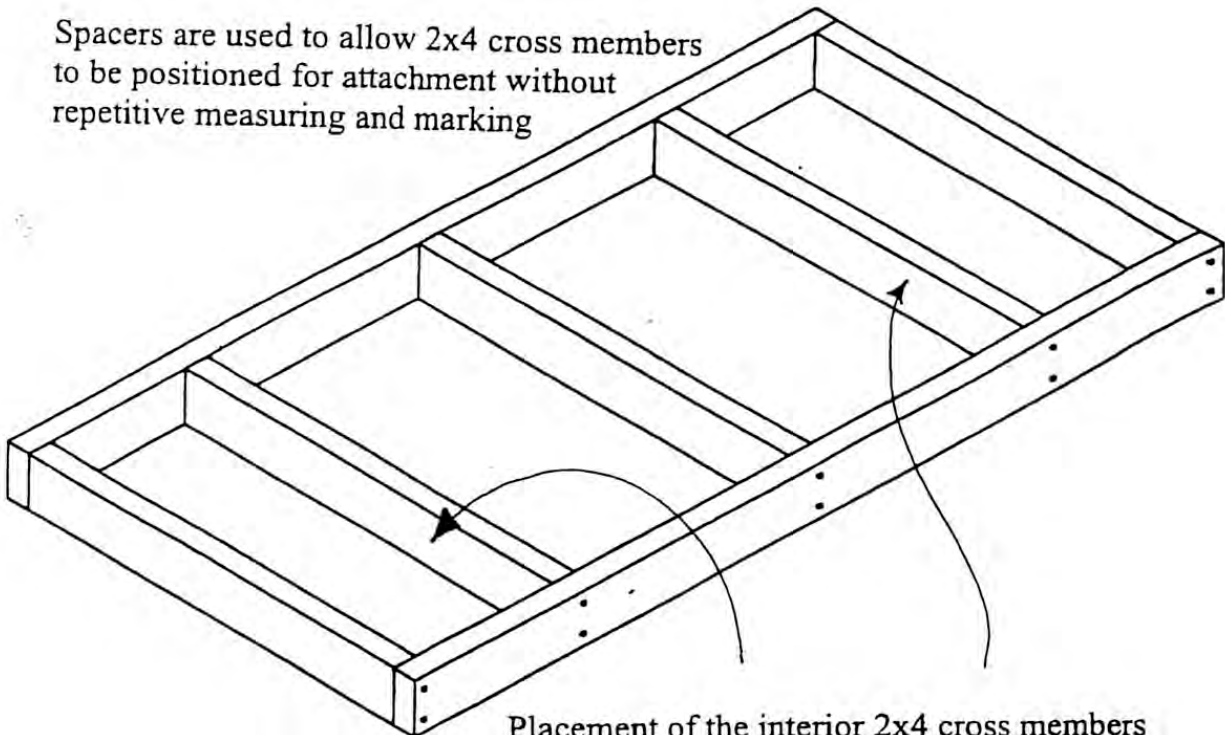
## Floor Joist Pallet Step 1





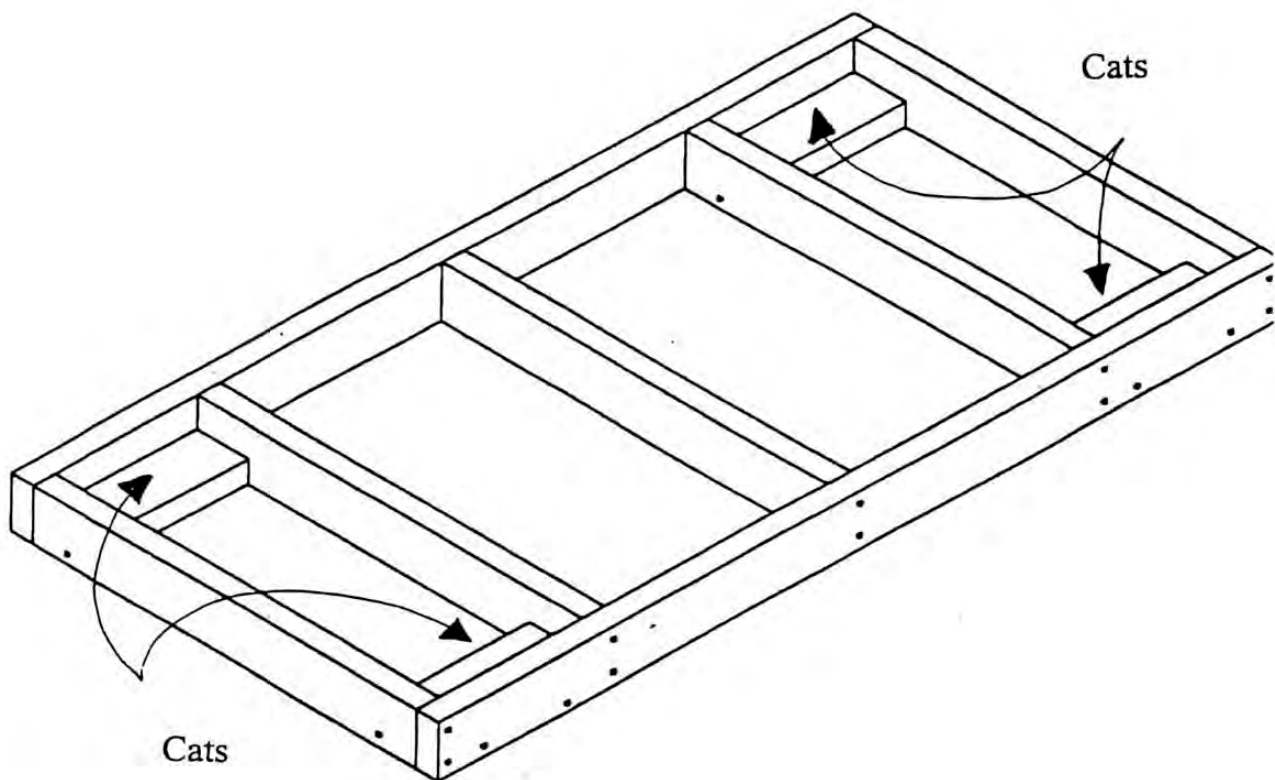
## Floor Joist Pallet Step 2

Spacers are used to allow 2x4 cross members to be positioned for attachment without repetitive measuring and marking

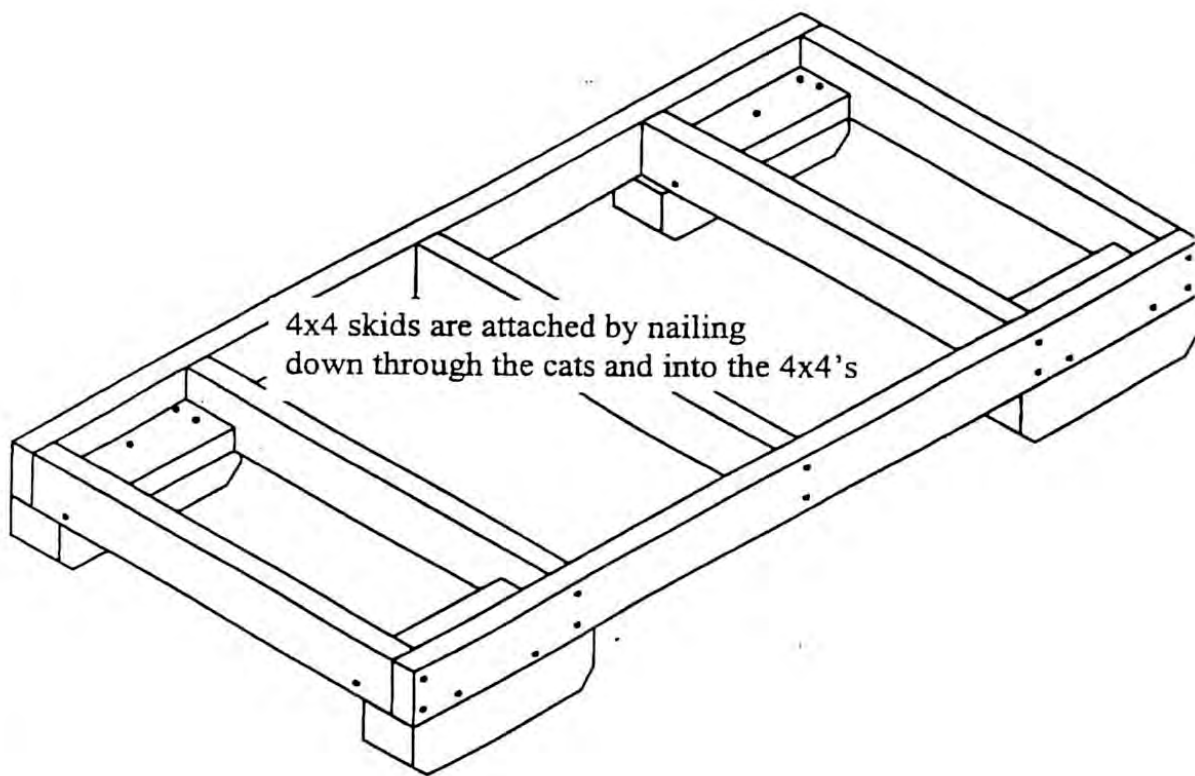


Placement of the interior 2x4 cross members has to accommodate the cats to which the 4x4 skids are attached.

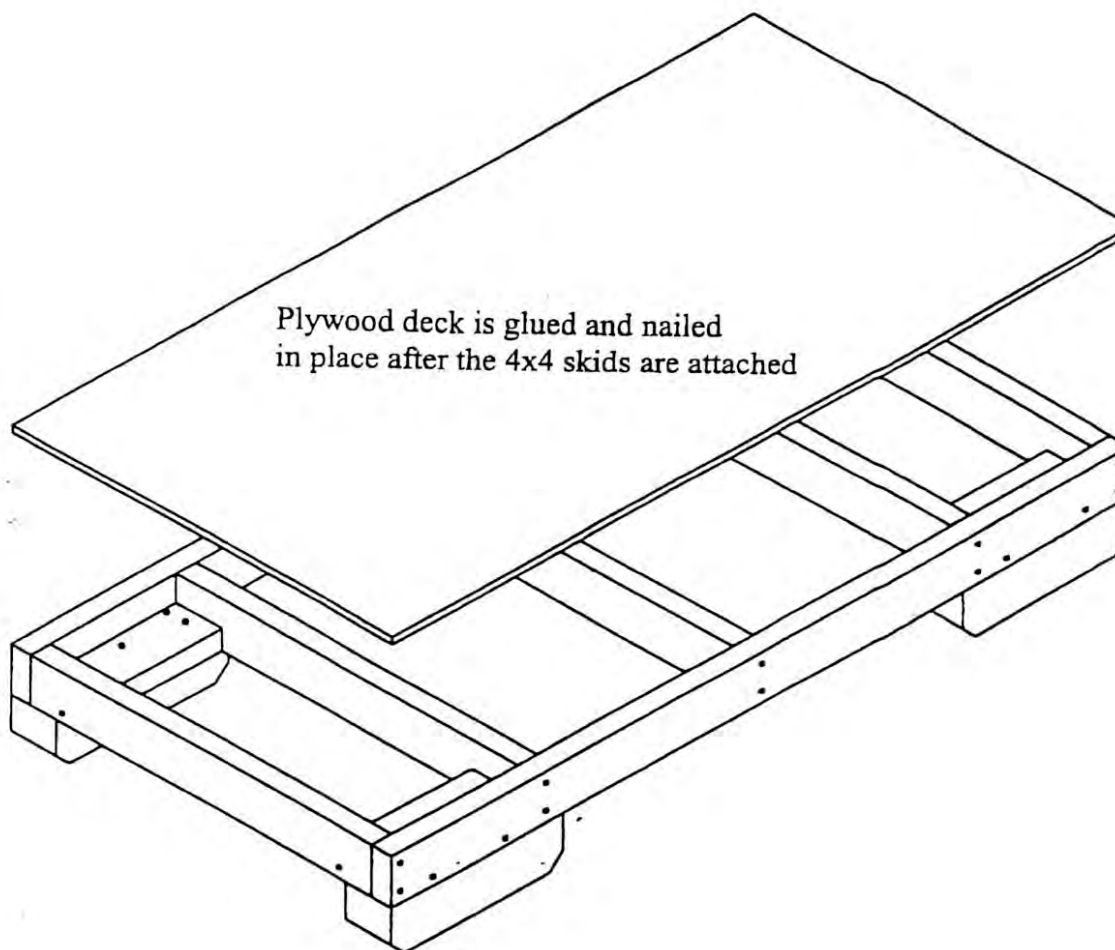
## Floor Joist Pallet Step 3



## Floor Joist Pallet Step 4

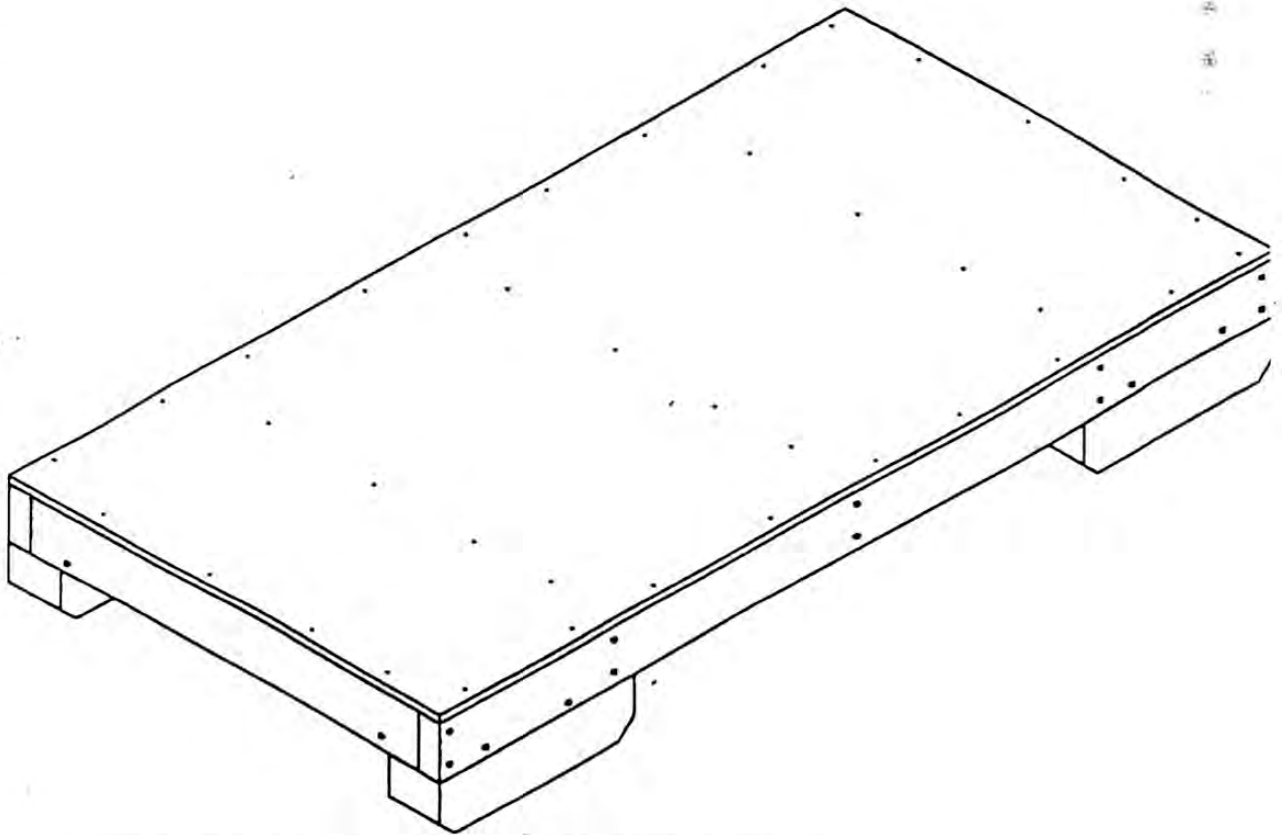


## Floor Joist Pallet Step 5





## Floor Joist Pallet Step 6



Trim edges of plywood deck flush with the 2x4 members  
This will facilitate the attachment of structures added to the pallet



## Custom 3-D Blanket

### Application:

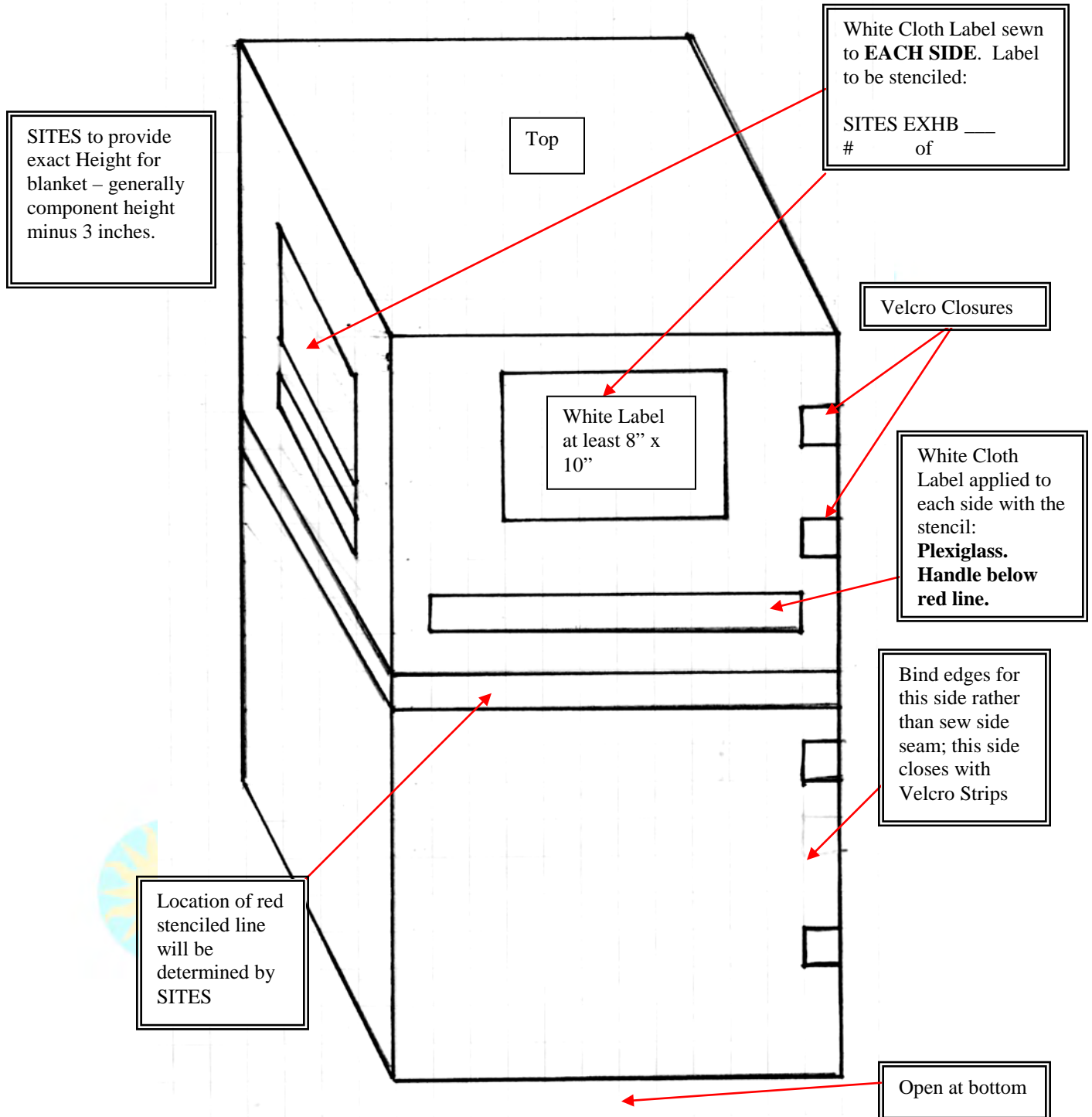
Blankets are used to protect exhibit elements in shipping for exhibition elements on pallets and elements which are fork lift or pallet jack accessible (such as large exhibition cases). The blanket materials should be soft enough to resist damaging the surface of the element and tough enough not to tear during shipment. Typical materials include a canvas outer layer and a moleskin inner layer or both layers of DREADNAUGHT® material, with a padded middle layer which is zig-zag, lock-stitched into place. Each custom blanket should be open at the bottom. All blankets should have at least one side open (see pattern and description) to assist in covering the element with the blanket.

Custom blankets are generally made by specialty companies. Contact the SITES Registrar to confirm your source before placing an order.



## Sample Custom 3-D Blanket

SITES will provide width and depth dimensions of the element. Vendor to calculate and to add appropriate allowances to those dimensions. The SITES Registrar may provide additional specifications for the label.



## Pallet with Blanket for Exhibition Element

### Materials:

Floor joist pallet  
Custom 3-D blanket  
½" or ¾" exterior grade AC fir plywood  
1" x 4" heat treated, solid pine or poplar battens  
2" x 2"s, poplar (blocks)  
Cushionaire®  
1 ½" x .086 common round wire nails with diamond points  
3" x .120 screw shank nails  
#8 washer head Robertson (square) drive screws, various lengths  
Carpenter's staples  
Hot melt glue  
Wood glue: Aliphatic-resin (yellow carpenter's glue) or polyvinyl-acetate (PVA white glue)

### Applications:

This type of crating is generally used for exhibition cases, which ship assembled having the acrylic bonnet attached to the base. If the appropriate dimensions, they are palletized and covered by custom padded blankets (toaster covers) with a cap at the top. Blocks on the pallet stop the case from shifting on its horizontal axis. The entire construct is strapped down to prevent motion on the vertical axis. This crating protects the acrylic, keeps the case from excessive vibration, and allows the pallet to be a buffer between the case and other crates. Once uncrated, the blanket is sandwiched between the cap and the pallet with the strap encircling everything in order to have a neat package for storage.

Remember, in general crated/palleted items should not exceed 6 ½" feet in height or 5 feet in width. The goal is to move them through a standard 7 foot double door without mullions using a pallet jack.

Contact SITES to see if this type of crating is appropriate for a specific element.

### Blocking:

Locator or register blocks for the case are made of poplar 2" x 2"s. The blocks are attached to the pallet around the outside perimeter of the case by Robertson drive screws. The blocks should snug up to the kick plate of the case. They are covered with Cushionaire® over the facing edge of the block (the side next to the piece), part of the sides of the block and the complete top of the block. Do not solely rely on the adhesive of the Cushionaire® for this to adhere; secure with hot melt glue and staples.





## **Caps, Blankets and Straps:**

See SITES Crating Specifications, p. 6, for construction of a crate panel, which serves as the cap for palletized floor cases.

See drawing of “Sample Custom 3-D Blanket,” p. 39.

The cap is made of a ½” or ¾” AC exterior plywood with 1” x 4” battens on the top of the cap, similar to a crate panel as outlined in the SITES Crating Specifications. The flat side of the cap rests on the top of the acrylic bonnet. Joints are glued and reinforced with nails. Acceptable glues are mentioned in the SITES crating specifications. For attaching battens to plywood panels, drive 1 ½” common round wire nails with diamond points through the batten and the plywood and crimp the exposed points back into the panel. This is best accomplished with a pneumatic nail gun on a steel faced worktable. Finishing nails are not acceptable for use. The cap should be 2” larger in all dimensions than the acrylic bonnet. The cap needs to be smaller than the pallet in length and width.

Notches are cut into the cap to accommodate the two webbing straps (webbing to be at least 1” in width) with saw tooth buckles. The notches should not extend to the edge of the acrylic top but allow at least 1” so the strap does not rub against the acrylic. Each strap is in two parts, one long and one short. The short piece has the buckle, and the long piece with the “tongue” comes over the top.

The straps are placed parallel to each other and run from the back of the pallet over the cap to the front of the pallet. The “tongue” of the strap is dipped in polyurethane or similar material to prevent fraying. The straps are hot glued and screwed to the sides of the pallet with washers and with Robertson screws with a shouldered head the appropriate length and size for the thickness of the belt and the pallet.

## **Exteriors and Stenciling:**

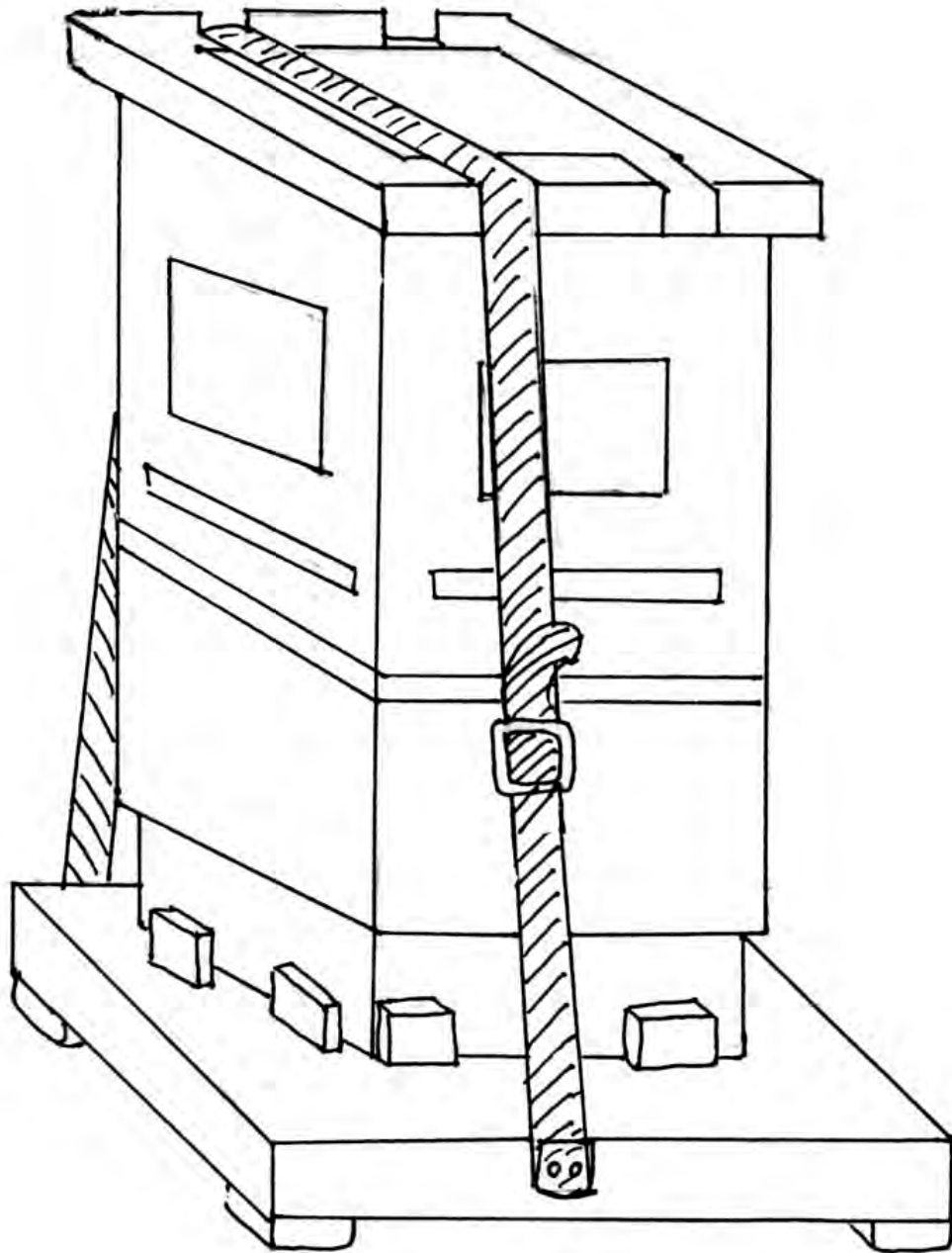
See SITES Crating Specifications, p. 8, for more details on these items.

Cap exteriors are sealed with two coats of clear, semi-gloss, water-based polyurethane or acrylic. Coating should cover all sides except the underside of the cap. Apply with either roller or sprayer. Allow drying before stenciling.

Follow the stenciling specifications in SITES Crate Specifications. SITES standard is HxWxD. SITES also asks that crated/palletized components be weighed. The exhibition number is to be marked on each disjoint part of the crate/pallet (lid, blanket, shell, etc.) and will be provided by the SITES Registrar.



## Pallet with Blanket for Exhibition Element



## Details for Pallet with Blanket for Exhibition Element

**Don't forget: the short piece has the buckle and the long piece has the "tongue".**

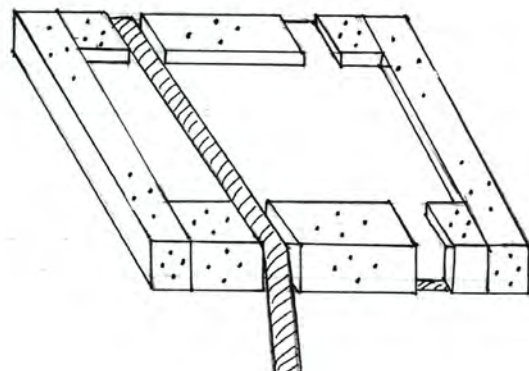
Make sure that the buckle is attached so that the strap can be removed.



The strap attaches with glue, screws and washers to the **SIDE** of the pallet.



The cap has the battens facing **UP**.  
If the battens face down, they can strike against the acrylic bonnet and damage it.



## Crating Odd Sized Items

Objects and exhibition furniture, especially cases and large panels, may be larger than a truck or museum door when packing in a traditional horizontal or vertical axis. Very narrow items crated separately, such as large paintings, may fit through the door, but don't have a large enough footprint to be stable. Be creative when planning the crates for these items – the use of diagonal braces or A-frames can allow these items to be handled with ease and be stable when shipped.

For example, this large and narrow framed object pictured below had dimensions of 95”H x 97”W x 3”D, which was too tall for many standard doors and also was not deep enough to rest safely. By attaching the entire crate to an A-frame on skids so the crate rested on the diagonal had a more stable depth of 48”, the item then was able to move through most doors and not require special strapping and bracing when shipped or stored.

**Crate with A-frame attached**



**Close-up view of A-frame**





## Crating Odd Shaped Items

If when crating an item, you cannot make adjustments to the crate itself to accommodate truck and door sizes or if the object itself is of an unusual shape, consider creating or modifying additional equipment to allow safe movement and handling. A crate doesn't just serve as protection during shipment; it often serves as a container for objects and exhibition structure during movement through museums and during installation. For installation, SITES prefers to have exhibit structures go straight from the crate to the wall or floor and objects go straight from the crate to where it will be displayed.

For example, pictured below is a modified refrigerator truck used to transport tall and heavy display cases through a standard double door and a standard passenger elevator. By using the truck, staff can tip the case get through doorways and into smaller spaces.



For another exhibition, the vitrines for object display separated from their bases for travel. However, because the method for connecting the vitrine to the base was a metal channel at the bottom of the vitrine, they could not be set flat on a surface. Since the objects traveled bracketed inside the vitrines, the vitrines had to remain upright at all times. The crate interior was especially fabricated for the channels. In addition, the crater constructed special dollies to support the vitrines during unpacking and movement in the exhibition area. The dollies and the crates were matched so that as the vitrine was removed, it could slide directly from the crate onto the dolly. The vitrine was then supported so it was stable on the dolly and the channel kept clear. Finally, the crater fabricated a special top for the crate so the dollies traveled safely and were immediately available for unpacking.

**Packed Vitrines**



**Vitrine on dolly**



**Packed Dollies**



## **Labels and markings for Crate Interiors**

### **General notes:**

SITES exhibitions are often installed and de-installed without a SITES staff member present. Our exhibitions go to a variety of non-traditional locations, including museums, libraries, schools, community centers and shopping malls. We have seen over the years that crate reports and checklists often do not make their way into the hands of those unpacking and repacking the crates. It is therefore very important that interior labels and markings are obvious, clear and easy to understand.



## **Crate Markings:**

Any disjoint internal crating structure which separates from the exhibition crate must be marked with the crate number, and also the checklist number if appropriate.

All disjoint internal crate structures should be marked “SAVE FOR REPACKING,” or “REPLACE IN CRATE FOR REPACKING.”

Any layers which need to be placed in a specific order must be marked by a number, with the lowest number at the bottom of the crate, and with an orientation mark, such as a black corner, so that the layer is always placed in the correct position.

Orientation marks for disjoint internal crate structures are necessary. Colored corners or stripes, cards, etc. are acceptable; the important thing is that they be permanent, visible and consistent. Don't use numbers or letters as they may be confused with checklist markings or crate markings.

If orientation marks do not clearly explain the method of repacking the structure, attach instructions to the interior of the crate. For example, the instructions for repacking a three sided structure, one side of which is acrylic, should say “PACK WITH ACRYLIC FACE DOWN ON THE VOLARA.” Trays for framed pieces should be labeled “PHOTOGRAPHS FACE UP.” When possible, use images for clarity.

When writing instructions, think about the best way to pack and unpack the crate. For example, if it works better to one element first, say so.

## **Checklist Labels and Markings:**

Always use the SITES checklist number to indicate the packing location of each element, both object and structure.

Every element with a distinct checklist number must have a corresponding crate location marked with that number. Same items are often not exactly the same size. SITES may provide a digital version of the exhibition checklist with case information and images, especially of objects. When possible, incorporate this information and images into the interior crating markings.

The checklist marking for individual elements should be immediately visible when the crate is opened so each piece can be quickly identified.

A list of all crate contents should be visible when the crate is opened. Whenever possible, this information should be posted inside on a crate wall and not on the crate lid or other disjoint part.

Markings to assist in repacking the item in its proper orientation are important. Consider clues such as “PACK BRACKET FACING OUT,” “PACK LABEL TO LABEL”, or “FRONT THIS SIDE.”



Labels and markings need to be permanent and indestructible. Tape or self-adhesive paper isn't sufficient for a long tour. Don't use mailing labels run off on a laser printer – the label will eventually peel off plywood, and the laser printing will smear. Instructions printed with a label maker on adhesive paper which is then covered with clear tape that adheres properly to plywood or ethafoam are preferred. Detailed instructions may be printed out on paper and secured in a heavy plastic document protector taped to the crate interior.

Use the largest font possible; boldface is preferred; sans serif, such as Arial, easier to read. 12 point is too small.

See next pages for a few samples of good labeling and interior marking.



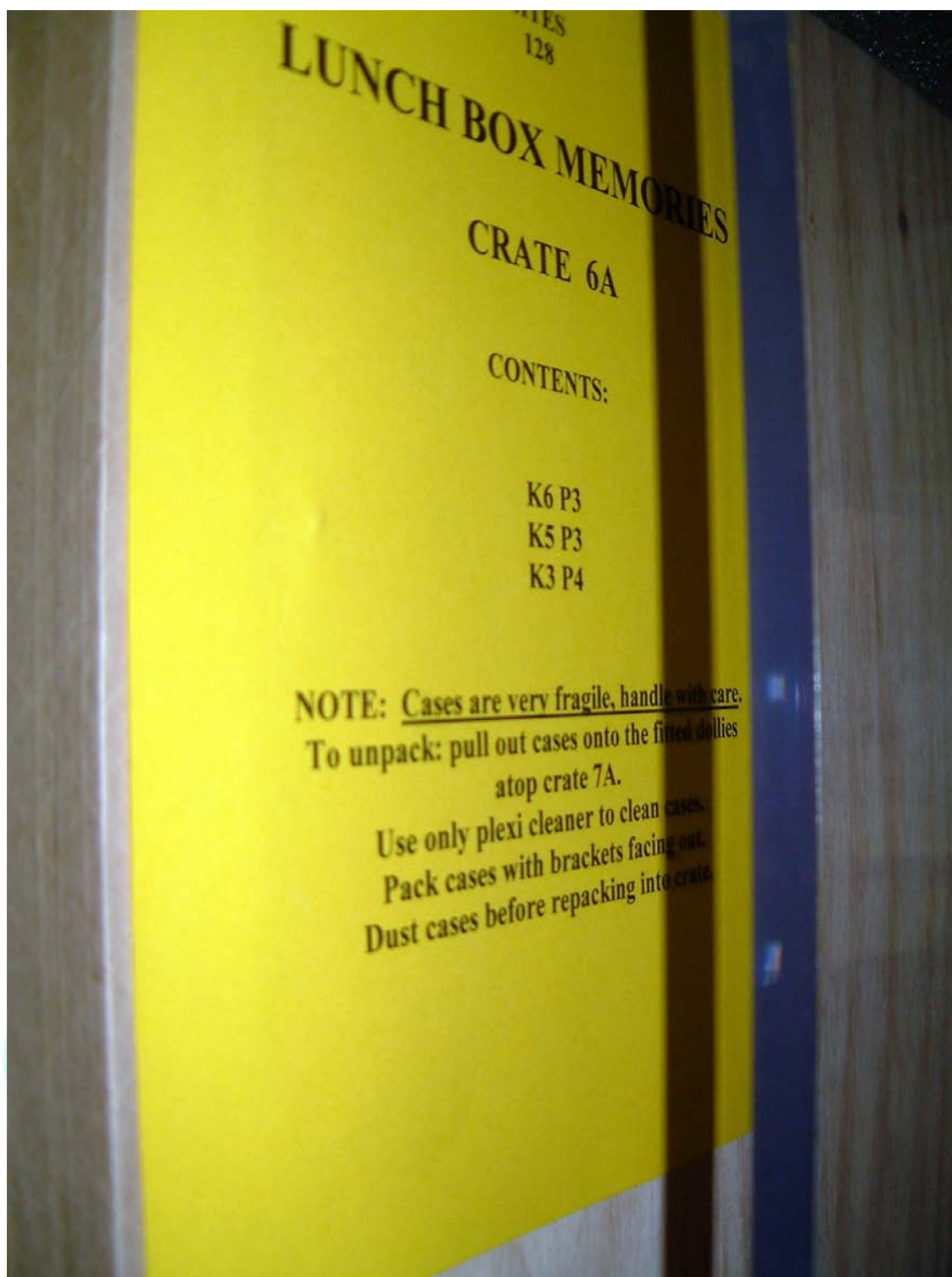


Sample crate showing markings of disjoint parts, clear view of labels while items are in crate, use of object photographs, unpacking directions, label type.





**Directions and checklist secured in a plastic document protector and properly adhered to the plywood.**



**Checklist numbers and orientation instructions are immediately visible upon opening the crate.**



**Put checklist numbers outside the cavity for each element (NOT underneath the element).**

**Checklist number visible  
when object is packed**

