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# Standard Packing & Crating Requirements

***The standard for materials, design, construction, packing, and marking of wooden containers.***

**Department of Packaging Engineering**
**Applied Materials**

# Table of Contents

# 1. INTRODUCTION

## 1.1. Purpose

This document provides the minimum requirements when wood packaging and crating is the required or chosen product packaging type. This document applies to all export and import shipments, via all modes of transport, shipped to, within, from, or on behalf of Applied Materials. All internal and external suppliers must comply to the requirements specified in this document. Supplier to provide crate/package drawings for all level 1 parts (refer to 0250-00098). Drawings to have dimensioned layout, BoM and required markings. If the part or assembly is known to be a merge-in-transit, drop-ship or spares item, please contact Packaging Engineering for authorization to ship the crate directly to an Applied Materials customer.

## 1.2. Administration, Conflict and Deviations

Applied Materials Packaging Engineering is the owner of this document. Any conflicts from other documents and/or deviations from the requirements herein must be approved in writing from Applied Materials Packaging Engineering team prior to implementation. Special requests must be approved by Packaging Engineering, i.e., material substitutions, construction techniques, additional labeling, etc. Only the latest revision of this document must be referenced. A detailed released Applied Materials Packaging Engineering crate drawing will supersede this document even if the design, materials, and construction is not in full compliance with this specification.

## 1.3. Compliance

The requirements specified in this document are in addition to the supplier responsibilities per the agreement with Applied Materials. Supplier compliance to the requirements in this document will be enforced as a condition of purchase. Any packaging provided by the suppliers must not violate the local Government laws and regulations. To ensure conformance, all supplier packaging is subject to inspection. Primary suppliers are responsible to ensure that all their packaging material suppliers, who are sourcing to Applied Materials, meet the requirements in this document. Applied Materials reserves the right to audit and review the material quality at any time. Applied Materials reserves the right to take any or all the following actions:

1. Reject any shipment which is not in compliance with requirements.
2. Charge the supplier for any or all costs incurred from non-compliance including, but not limited to, damage, return, repair, repackaging, redelivery, fines, penalties, and duties.
3. Diminish or remove business from the supplier for non-compliance.
4. Remove from the list of Approved Suppliers any supplier that, after notice, repeatedly fails to comply with requirements.

Note: Suppliers can access the current revision through e-Supplier, Supplier Collaboration Vault (SCV), contact your CBM or Packaging_Engineering@amat.com to ensure current revision of this document is always used (http://spedsc/sites/edsc/SitePages/Welcome.aspx).

## 1.4. Safety

Packaging designs must meet SEMI S8 (Semiconductor Equipment and Materials International) standards. For any safety risk assessments, Applied Materials Packaging Engineering team must be consulted.

# 2. MATERIALS

The most common crate materials are listed in this section.

| Item | Material | Requirement |
|---|---|---|
| 1 | **All Materials** | All new crates must be manufactured with new material; unless the crate is approved for a recycle program. |
| 2 | **Material Deviation** | No material substitutions without written approval of Applied Materials Packaging Engineering. Contact packaging_engineering@amat.com to submit a request for deviation. |
| 3 | **Material Purchasing** | Material procurement is the responsibility of the party performing the packaging services. Applied Materials is not in any way responsible for procuring or providing any materials or supplies to packaging and crating companies, suppliers, or any other entity that performs packaging services. |
| 4 | **Wood Purchasing** | Applied Materials fully supports and endorses responsible forest management. All wood packaging (lumber, plywood, etc.) must therefore be derived from sustainably managed forests. Utilizing the equivalence or better standards from organizations such as FSC or PEFC to the Forest Stewardship Council (FSC), the Program for the Endorsement of Forest Certification (PEFC), or an equivalent or better standard. Information can be found on these organizations at www.fsc.org and www.pefc.org, respectively. |

| Item | Material | Requirement |
|---|---|---|
| **5** | **Wood Moisture** | Adhere to Applied Materials *0251-11462, Wood Packaging Moisture Content Requirements* to prevent negative effects of high-moisture wood (greater than 19%) such as decrease in strength and dimensional stability, compromised structural integrity, increased shipping costs, a reduction in fastener hold, pest infestation, fungal growth, decay, and poor package aesthetics. |
| **6** | **Wood Treatment** | Adhere to Applied Materials *0251-07660, Wood Packaging Phytosanitary Requirements*. Unprocessed raw lumber and solid wood used to support, brace, and package products for export shipment can serve as a pathway for the global spread of wood-boring insects that destroy living trees and devastate forests of the importing countries. It must therefore be treated and marked according to international regulations. |
| **7** | **Lumber Standard** | American Softwood Lumber Standard (Voluntary Product Standard PS-20) |
| **8** | **Lumber Grading Standard** | U.S. Western Lumber Grading Rules (latest edition); Western Wood Products Association (www.wwpa.org). |
| **9** | **Lower Density Lumber** | Lumber used in non-load-bearing and non-structure-critical applications, such as cleating, must be derived from coniferous (softwood) species of the Pinaceae Family having a lower density range (20-27lbs/$ft^3$). This typically includes spruces, pines, firs, and similar white woods. Grade #3 or higher is required. |
| **10** | **Higher Density Lumber** | Lumber used in loadbearing and structure-critical applications, such as shipping base components and joists, must be derived from coniferous (softwood) species of the Pinaceae Family having a higher density range (28-39lbs/$ft^3$). This typically includes Southern Yellow Pine, Doug-Fir, Larch, and Hemlock, but can include some spruces and pines. Grade #3, Standard, or higher is required. |

| Item | Material | Requirement |
|---|---|---|
| **11** | **Lumber Defects** | Applied Materials, and some of its Customers, regulate lumber flaws (manufactured and natural) beyond those allowed by the specified grade. Such flaws must be **completely removed (cut out) prior to use** unless otherwise specified.<br><br>**Bark:** No bark allowed.<br><br>**Decay:** Obvious areas of decay and rot are prohibited. Decay around or within knots limited by grade. Peck, honeycomb, and white speck limited by grade.<br><br>**Knot Holes/Loose Knots/Unsound Knots:** All types of knots are allowed per grade on purchased lumber. Knots must not negatively compromise manufacturability and structural strength in the final assembly (e.g., a knot hole on the end or edge of a board, nailing/screwing/bolts to or through knots, wane that prevents Klimp seating, etc.).<br><br>**Cavities/Holes:** Dense clusters of cavities or holes, such as pin holes and grub holes, that may be caused by or perceived as past or present insect infestation, are prohibited unless they can be hidden from visible sight in the final crate assembly.<br><br>**Compression Breaks:** All compression breaks as shown that are more than 1/3 the board width is prohibited. No more than two compression breaks are allowed per 8 linear feet.<br><br>**Splits/Checks/Shake:** All wood fiber separation produced by seasoning or other causes is to be regulated by grade. Such flaws must not severely compromise manufacturability and structural strength in the final assembly.<br><br>**Warp:** All warp (bow, crook, twist, cup) is to be regulated by grade. Any warp that interferes with intended assembly tolerances, manufacturability, and expected package performance is prohibited.<br><br>**Wane:** Allowed per grade. Wane must not negatively compromise manufacturability and structural strength in the final assembly.<br><br>**Stain:** Free of decay, mold, or any stains and discolorations not naturally associated with the lumber and its grade. |

| Item | Material | Requirement |
|---|---|---|
| **11** | **Lumber Defects (cont.)** | **Blue stain is not allowed for any shipments.** |
| **12** | **Plywood Standard** | Voluntary Product Standard PS1 (latest edition); American Plywood Association (www.apawood.org). Deviations must be approved by Packaging Engineering. |
| **13** | **Plywood Veneers** | The grain of each layer (veneer) in any sheet of plywood must be perpendicular to the grain of its adjacent layers and to the ends or edges of the plywood panel.<br><br>The proportion of wood with grain perpendicular to panel face grain shall be not less than 33% or more than 70% of the total panel thickness. The combined thickness of core veneers in panels having ≥4 plies shall be not less than 45% of the total panel thickness.<br><br>Face and back veneers must be derived from coniferous (softwood) species of the Pinaceae Family (Larch, Hemlock, Doug-Fir, True Fir, Spruce, Pine) having a density of 20-63lbs/$ft^3$. Core veneers can be derived from softwood species of the same density or from hardwood species with a density of 35-75lbs/$ft^3$.<br><br>Minimum Plies (Veneers): 1/4-3/8 Plywood (3); 1/2 Plywood (4); 3/4 Plywood (5); 1-1/8 Plywood (7). |
| **14** | **Plywood Grades** | All grades B and higher are prohibited. All grades below D are prohibited. Grade D is also limited to the back face of a plywood panel. The following can be used for any purpose:<br><br>**Exterior Plywood**: Minimum grades allowed are C-C Plugged (touch sanded) or C-C (sanded).<br><br>**Exposure 1 Plywood:** Minimum grades allowed are Underlayment C-D Plugged (touch-sanded), C-D Plugged (touch sanded), C-D/CDX (non-sanded), Structural I C-D (non-sanded), Structural I C-D Plugged (touch-sanded), and Structural I Underlayment C-D Plugged (touch-sanded).<br><br>Note: All veneers in Structural I plywood must be derived from the softwood species listed in section 2-13. |

| Item | Material | Requirement |
|---|---|---|
| **15** | **Floating Deck Foam Plank** | Extruded polyethylene foam plank, solid or laminated, 2 inch or 3 inches thick. Common densities utilized in floating decks include 1.7pcf, 2.2pcf, and 4.0pcf. Recycled/Reclaimed foam prohibited.<br><br>Foam surfaces must be skived (skin removed) when using contact adhesive, but this is not required when using hot melt adhesive.<br><br>For polyurethane foam please consult Packaging Engineering. |
| **16** | **Floating Deck Foam Plank Suppliers** | Polyethylene and polyurethane foam performance can vary depending on the manufacturer. Applied Materials has tested, approved, and requires the following foam from either global company:<br><br>**Sealed Air:** Ethafoam® solid plank; Stratocell® laminated plank (minimum 1/2" layers, 1" layers preferred); www.sealedair.com.<br><br>**Pregis:** PolyPlank® EXT solid plank; PolyPlank® LAM laminated plank (minimum 1/2" layers, 1" layers preferred); www.pregis.com.<br><br>• All other foam manufacturers need to be approved by Applied Materials Packaging Engineering<br><br>• For polyurethane foam please consult Packaging Engineering |
| **17** | **Floating Deck Foam Plank Adhesive** | **Contact Adhesive:** Must be solvent-based (water-based prohibited). Approved adhesives include LOKWELD 801, LOKWELD 831, 250 DEV, all manufactured by Ralph Wilson Plastics Company, Wilsonart International; www.wilsonart.com.<br><br>**Hot Melt Adhesive:** Approved adhesive includes HMT-1204 hot melt adhesive manufactured by Hot Melt Technologies; www.hotmelt-tech.com.<br><br>Contact Packaging_Engineering@amat.com for alternate adhesive approval. |
| **18** | **General Cushioning Foam Plank** | Polyethylene plank foam (as with floating decks) and/or polyurethane plank foam can and should be used when necessary to protect parts from shock and vibration, abrasion, and other damaging factors. Foam-lined crates and custom cushioning are two common uses. Plank foam thicknesses of 1-4". |

| Item | Material | Requirement |
|---|---|---|
| **19** | **Generic Light Cushioning & Void Fill** | Other light cushioning and void fill materials are allowed such as polyethylene and polyurethane foam sheeting (microfoam) and bubble wrap. **Inflatable packaging is to be used for void fill only. Foam packaging peanuts and instant foam (foam in place) are not allowed.** |
| **20** | **Moisture Vapor Proof Barrier Material** | Flexible, supported, heat sealable, aluminum foil laminate with an "as received" moisture vapor transmission rate ≤0.005g/100in$^2$/24hr. Material must comply with U.S. Military Specification MIL-PRF-131 Class 1 or Class 3 (Class 2 prohibited). Alternate materials may be acceptable if approved by Packaging Engineering |
| **21** | **Desiccant** | Non-dusting clay or silica gel, U.S. MIL-D-3464, Type II, or commercial equivalent. Eight (8) or sixteen (16) unit bags only. Recommended Manufacturers: Desiccare (www.desiccare.com) and Sud-Chemie (www.sud-chemie.com). |
| **22** | **Tarp Sheeting** | Poly tarp sheeting used to cover crate top panel or entire crate must be a minimum of 12-mil thick and preferably blue color. See appendix A. |
| **23** | **Fasteners** | **Bolts/Washers/Nuts/Lag Screws:** Minimum Grade 2 commercial zinc plated steel for all carriage bolts, hex head bolts, hex nuts, hex head lag screws, USS flat washers, and USS split lock washers. Higher grade and/or more corrosion resistant materials to be used as necessary or required.<br><br>**Nails:** Galvanized or hardened steel, round head, spiral (screw) or ring shank.<br><br>**Staples:** Galvanized steel, divergent tip (for cleated ply panels) or chisel point (general use), clear coated, 0.050" thick minimum.<br><br>**Klimp® Fasteners:** Reusable galvanized spring wire Klimp used to fasten cleated crate corners. Manufactured by Klimp Industries; www.klimpindustries.com. Alternate materials may be acceptable if approved by packaging engineering |
| **24** | **Steel Strapping** | Minimum 0.75 x 0.02" low-carbon solid steel. Wider and thicker material to be used as necessary with larger and heavier loads. |

| Item | Material | Requirement |
|---|---|---|
| **25** | **Vermiculite** | Vermiculite must be exfoliated, fine grade #3, CAS #1318-00-9. Used as an absorbent and cushion in packaging containing liquids. |
| **26** | **Brackets** | Shipping brackets must be manufactured from a minimum and equivalent to A-36 plate steel with black powder coat finish. Material thickness to be commensurate with expected shear and tensile forces during shipment. |
| **27** | **Labels** | Except for dangerous goods labels, all labels on crate exteriors must be waterproof coated, laminated or placed inside a clear plastic waterproof envelope. A shipping label containing the ship-to and ship-from addresses, crate weight, and crate dimensions, at a minimum, is required on the outside of each crate. Adhesive to be wood acceptable. |
| **28** | **Spray Adhesive** | Multipurpose spray adhesive used to adhere labels and devices to wood surfaces must be 3M Super 77 or equivalent. Manufacturer: 3M Corporation; www.3M.com. |
| **29** | **Document Envelope** | The envelope must be a clear front (with no printing), have a permanent adhesive backing, and be re-sealable. |
| **30** | **Monitoring Devices** | Required Manufacturer: Shockwatch a division of Spot See;<br>Impact Indicators: Low profile, disposable, tamperproof, serialized, field settable, and non-resettable Shockwatch®2 25G (yellow) and Shockwatch® 2 50G (red).<br>Tilt Indicator: Low profile, disposable, tamperproof, serialized, field-arm able, and non-resettable Tiltwatch® XTR. |

| Item | Material | Requirement |
|---|---|---|
| **31** | **Stenciling** | **Stencils to have** – clean edges, no fading, no overspray, no drips, no jagged edges, etc.…<br>Recommended Manufacturer: Marsh Shipping Supply Company (www.msscllc.com).<br>**Ink:** Marsh® K, Rolmark, or EFI (low VOC) stencil Ink. Black and red ink is required.<br>**Applicator:** Marsh® FR100 fountain roller (K stencil ink only) OR FR200 fountain roller (Rolmark stencil ink only). Roller sizes to be used are 1.50" and 3.00" wide.<br>**Solvent** (for clean-up): Marsh® K Solvent for K stencil ink and Rolmark solvent for Rolmark stencil ink. EFI ink only requires soap and water.<br>**Equipment:** Stencil-making equipment and template material is required to make stencils with text, numbers, and/or graphics. |

**Table 2-1-1: Packing & Crating Materials**

# 3. GENERAL REQUIREMENTS

## 3.1. Workmanship

- Crates must be free from imperfections and/or defects which may affect, utility, and/or which could result in personal injury.
- Crates must be free of defects beyond allowable material grade (see sections 2.9 thru 2.14).
- Crates must not have protruding or bent nails, staples, and screws.
- Cleats in the construction of cleated panels must be flush without gaps
- Footprints, dust and debris to be removed from all visible surfaces before crate cap is installed.

## 3.2. Fastening

- Unless otherwise specified, all components to be firmly secured in placed via bolting, nailing, gluing, and/or other adequate fastening methods.
- Nailing patterns must follow industry standard requirements.

- All bolts heads, except carriage bolt heads, must utilize a flat washer. All bolt tips (ends) must utilize a flat washer, a split lock washer, and a hex nut.
- All bolt holes must be drilled to a minimum of 1/16” diameter larger than the bolt diameter size.
- When utilizing lag screws for any purpose, lead holes must be drilled the entire length of the screw to prevent wood splitting. Lead holes for the threaded portion of the lag screws must be 1/16-1/8” less. Lead holes for the non-threaded portion must be the same diameter as the lag screw.

## 3.3. Storage

- Crates, or any component thereof, must not be stored outdoors or show signs of being exposed to moisture and weathering at time of crating.
- Stacking of crates, loaded or unloaded, please refer to 0250-00098.
- The supplier must store and transport all shipping bases in a manner that prevents any compression of their floating decks prior to use.

# 4. CRATE STYLE REQUIREMENTS

Though there are a host of crate styles that can be utilized in the crating industry, Applied Materials only allows and requires the specific styles stated in this section, or hybrids thereof. See subsequent sections for design and construction requirements.

## 4.1. Crate Style Selection Guideline

The below chart must be used to select the proper style of crate (Style A, B, C or D) given the known or estimated product size and weight. Note - Generally items under 100lbs do not require crating. Please refer to 0250-00098 or contact Packaging Engineering.

| **Product Size (L+W+D) (inches)** | **Product Weight (lbs.)** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **<250** | **250-1500** | **1500-3000** | **3000-6000** | **>6000** | **>10,000-20K** | **>20,001** |
| **0-50** | Style A or B | Style B | Style B | N/A | N/A | N/A | N/A |
| **51-100** | Style A or B | Style B | Style B | Style B | N/A | N/A | N/A |
| **101-200** | Style A or B | Style B | Style B | Style B or C | Style C | Style C | N/A |
| **201-300** | Style A or B | Style B | Style B or C | Style C | Style C | Style C | Style D |
| **> 300** | N/A | N/A | Style C | Style C | Style C | Style C | Style D |

**Table 4-1: Crate Style Selection**

### 4.1.1. General Crate Guidelines

- Minimum 3x4 Skids to be spaced ≥ 28.00 (minimum distance between skids for pallet jack entry).
- Solid lumber panels must be one piece (no splicing), minimum ¾" lumber, and are limited in size to a single board size.
- Solid plywood bottom panel must be one piece (no splices), minimum ¾" plywood, and is limited in size to a sheet of plywood.

- Solid plywood top panel must also be one piece (no splices) and is limited in size to a sheet of plywood.

| Minimum plywood thickness for the following solid (one-piece; non-cleated) panel sizes | |
|---|---|
| 3/8" plywood | For panels ≤ 24.00 wide and ≤ 48.00 long |
| ½" plywood | For panels > 24.00 but ≤36.00" wide and ≤ 72.00 long |
| ≥ 5/8" plywood | For panels > 36.00 but ≤ 48.00 wide and ≤ 96.00 long |

**Table 4-2: Minimum Plywood Thickness for Panel Sizes**

- Solid plywood side panels are prohibited (must be solid lumber or cleated plywood).
- Cleat size for cleated plywood panels – see section 7.3.
- Cleated bottom panel must use minimum ½" plywood. Cleated top panel and cleated side panels must be minimum ¼" plywood.
- Side panels must sit on top of bottom panel.
- There must be one or more removable panels allowing for easy product access and removal. No crates should be fully nailed closed.
- Top and/or side panels usually secured with wood screws to make it the removable panel, but multiple panels can be designed to be removable with the use of Klimps and/or wood screws. Reusable crates can also use link locks and Klimps.
- Cushioned plywood floating deck, foam-lining, custom cushion design, and/or generic cushioning is required on the interior for fragile product and parts and is not required if the crate is used for non-fragile and miscellaneous part consolidation (e.g., bagged and or boxed parts, etc.).
- Part must be immobilized in the crate with use of dunnage (void fill, foam, bracing, etc.).

## 4.2. Style A Crate

A style A is a two-way entry crate consisting of cleated plywood, solid lumber, and/or solid plywood panels. It has at least one removable panel (usually top) allowing for easy product access and removal. Interior cushioning and/or dunnage may be necessary to protect, block, and brace the part. This crate is like ASTM D6251 Style A (previously known as a Mil-601).

Note – Sometimes 4-way entry is required for transportation loading when crate length is greater than width of an ocean container or truck opening. Corrugated top cap or cleated corrugated panel crates are permitted under certain circumstances due to light weight of product and/or costs. Uses of these types of crates requires an engineering drawing, compression testing, a defined closure, and a banding method. Packaging Engineering must approve all crates using corrugated fiberboard in any part of the design.

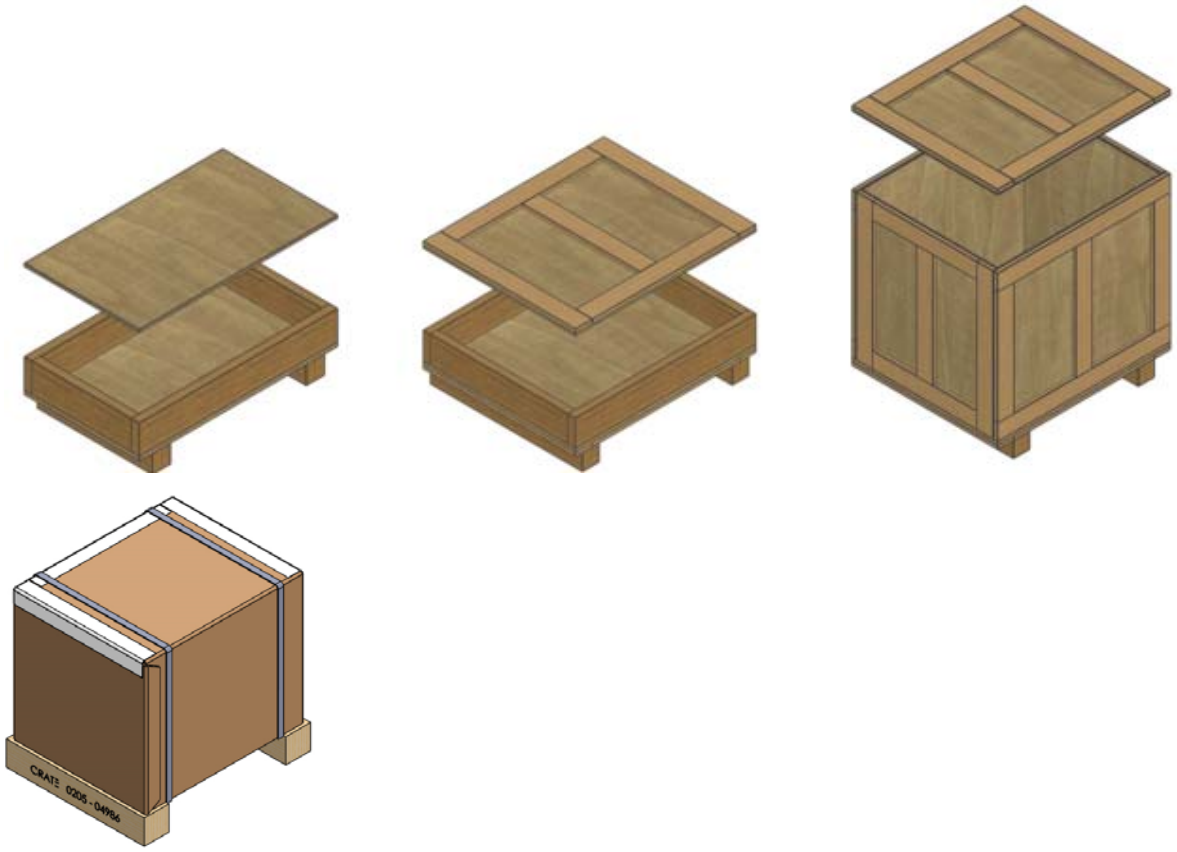


**Figure 4-1: Style A Crate Examples**

## 4.3. Style B Crate

A Style B crate consists of a two-way entry load-bearing lumber shipping base with drop-end style cleated plywood cap. At least one side or end panel is removable allowing for easy product access and removal. A cushioned plywood floating deck is required for fragile product and parts but is not required if the crate is used for non-fragile and miscellaneous part consolidation. This crate is like an ASTM D6251 Style A-Mod crate (previously known as a Mil-601 drop end).

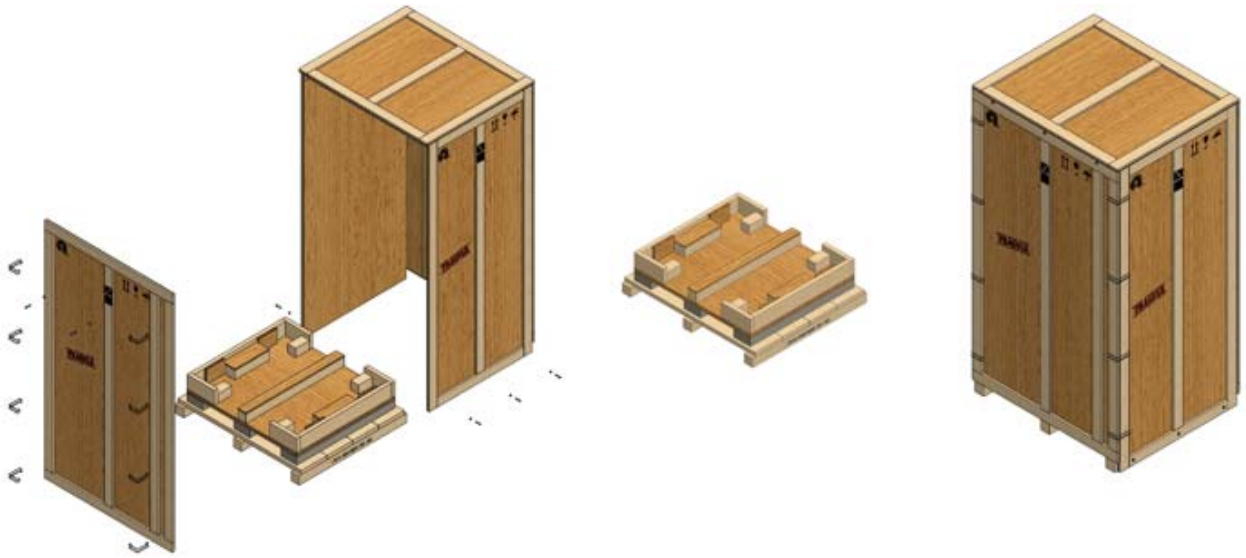


**Figure 4-2: Style B Crate Example**

## 4.4. Style C Crate

A Style C crate consists of a four-way entry load-bearing lumber shipping base with drop-end style cleated plywood cap. At least one side or end panel is removable allowing for easy product access and removal. A cushioned plywood floating deck is required for fragile product and parts but is not required if the crate is used for non-fragile and miscellaneous part consolidation. This crate is like an ASTM D6256 crate (previously known as a Mil-B-26195).

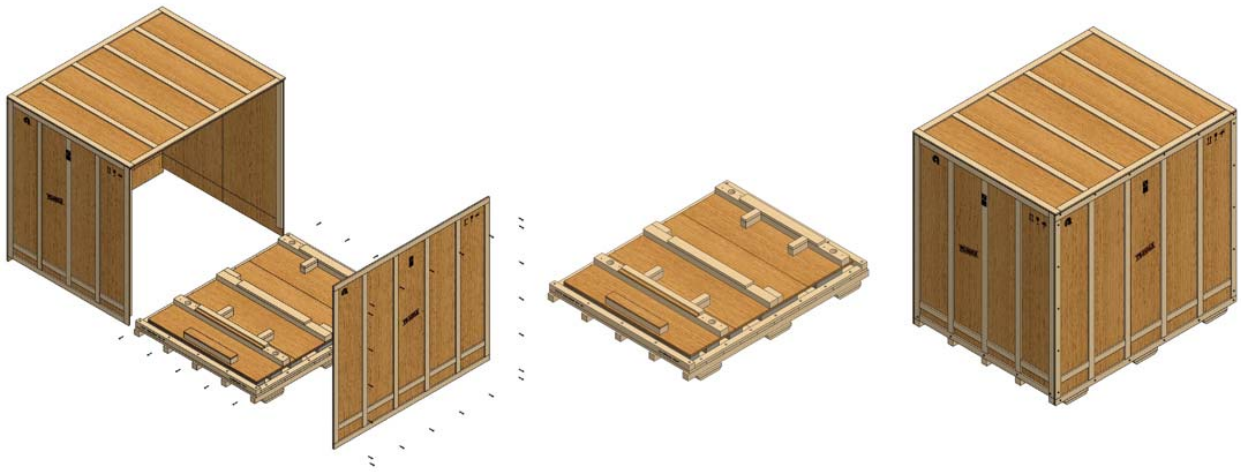


**Figure 4-3: Style C Crate Example**

## 4.5. Style D Crate

A Style D crate consists of a four-way entry load-bearing lumber shipping base with drop-end style cleated plywood cap; cleating is facing inside, plywood is facing outside the cap. The top panel is reinforced with joist lumber. At least one side or end panel is removable allowing for easy product access and removal. All panels are attached with screws. A cushioned plywood floating deck is required for fragile product and parts but is not required if the crate is used for non-fragile parts. Steel sling lift protectors (minimum 6mm thick), steel L-angle edge protectors (minimum 5mm thick) and steel L-angle reinforcement steel (minimum 9mm thick) is necessary for crates exceeding 15 tons. This style crate is primarily used for Display products. Please contact Packaging Engineering for guidance. This crate is like ASTM D7478 crate (previously known as a Mil-C-104).

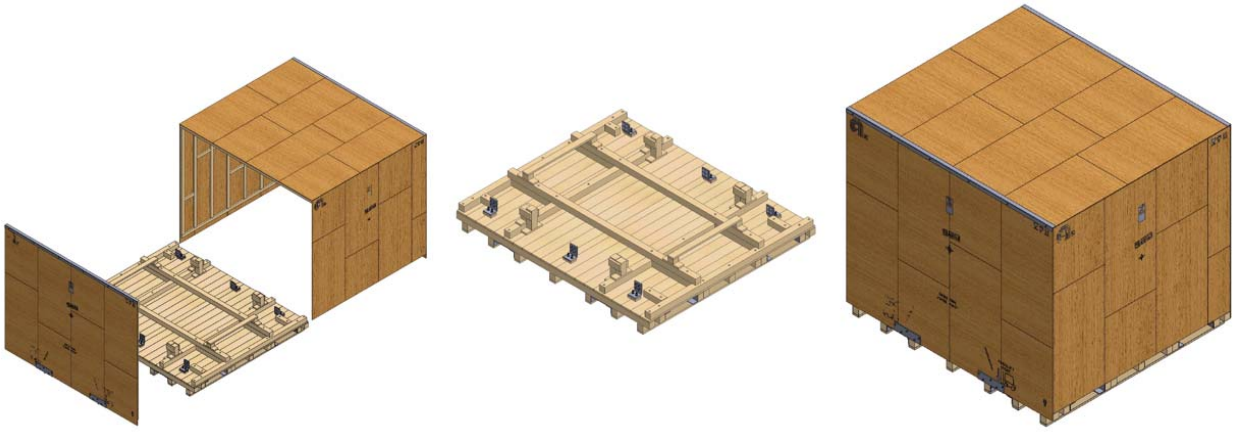


**Figure 4-4: Style D Crate Example**

**Figure 4-5: Steel Chain Lift Bracket**

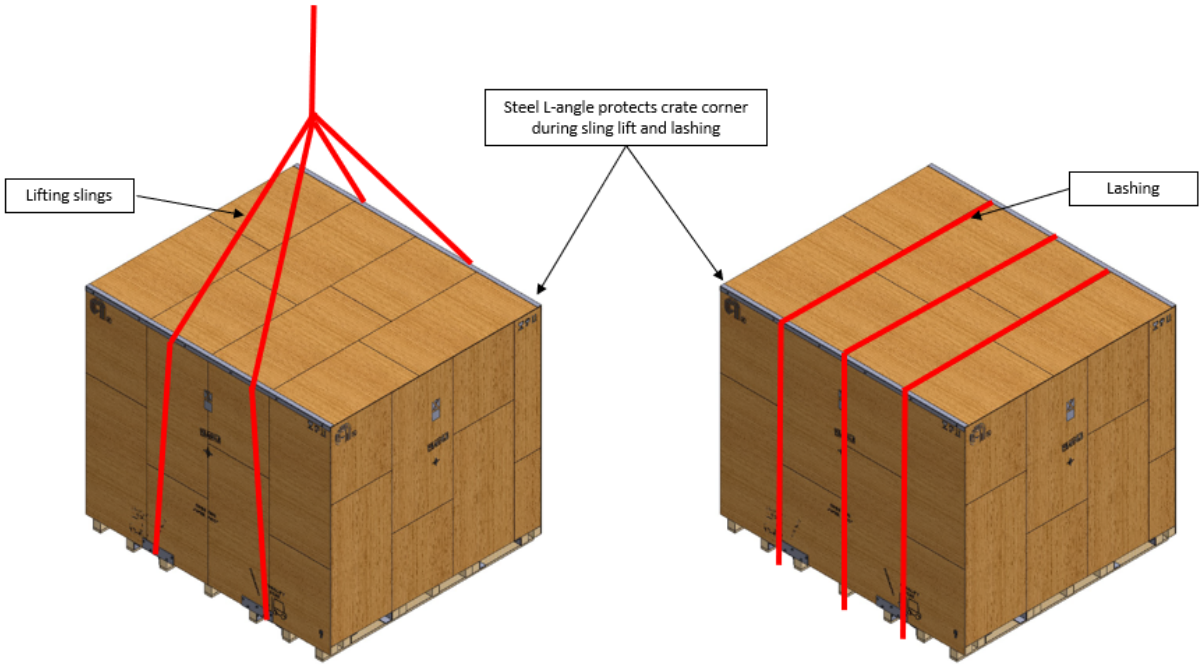



**Figure 4-6: L-Angle Steel on Crate Cap**

# 5. SHIPPING BASE DESIGN AND CONSTRUCTION

One major component of crate design is the shipping base. This section provides design and construction specifications for Style B, C and D shipping bases.

## 5.1. Generic Shipping Base Anatomy

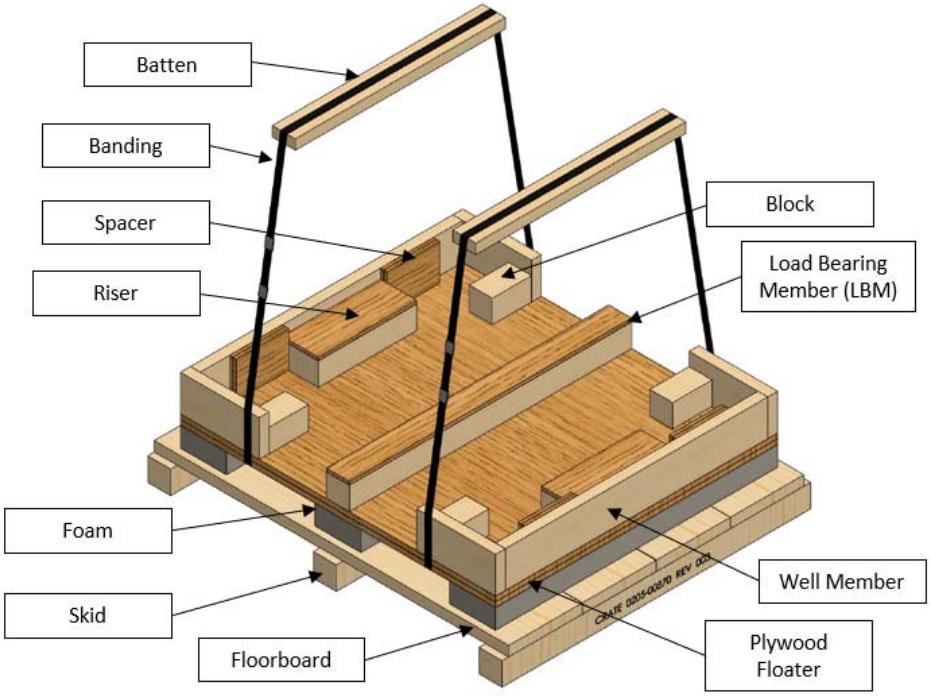



**Figure 5-1: Generic Shipping Base Anatomy - Style B Crate**

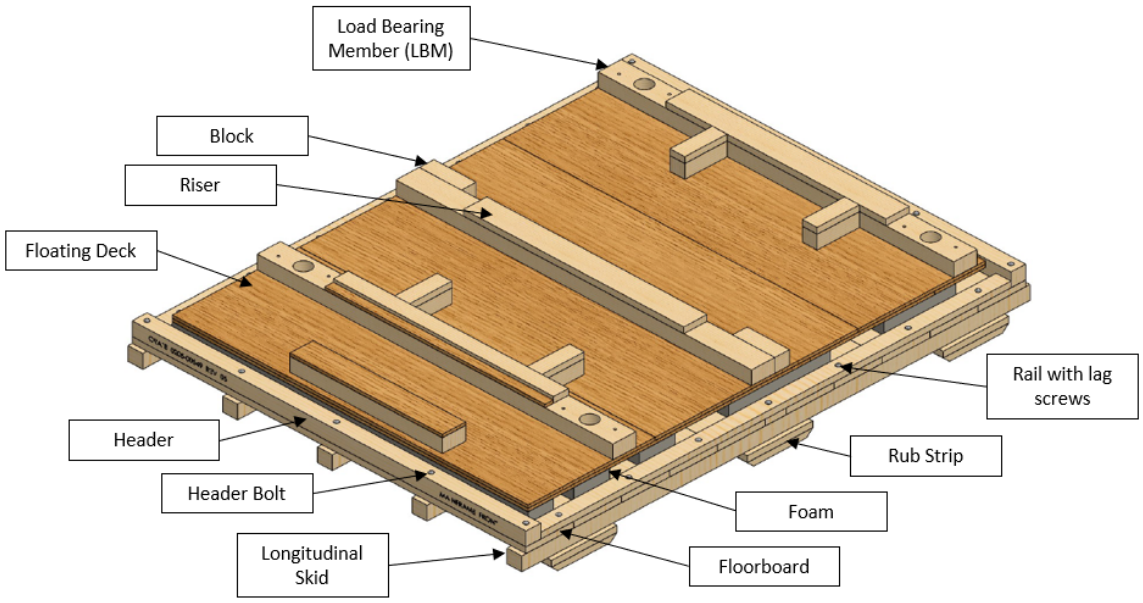



**Figure 5-2: Generic Shipping Base Anatomy - Style C Crate**

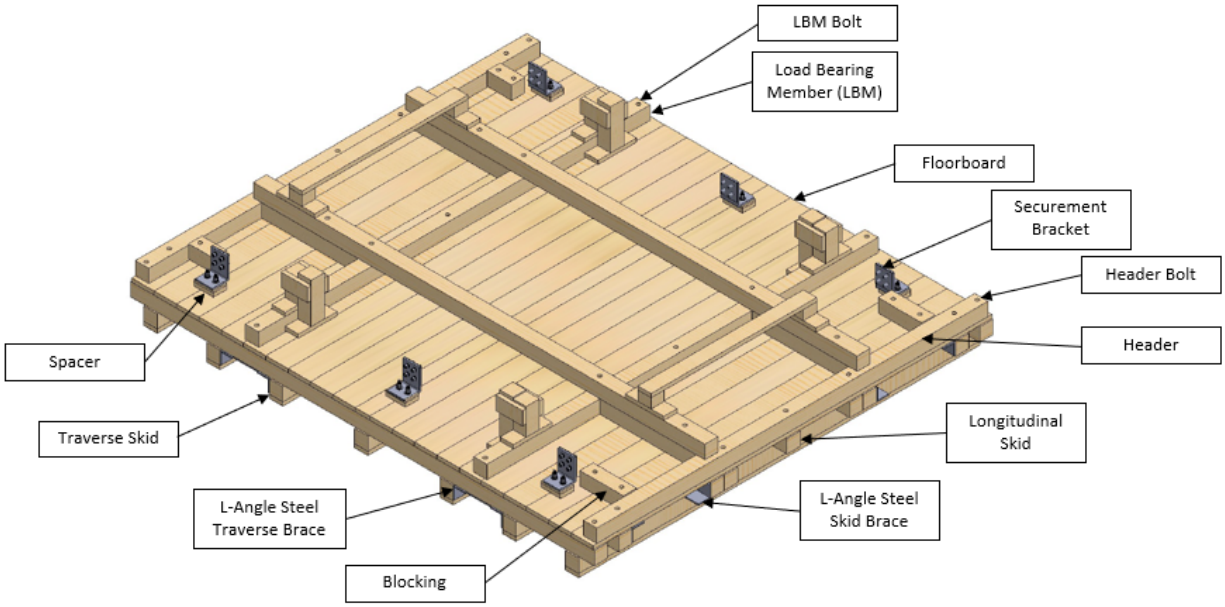



**Figure 5-3: Generic Shipping Base Anatomy - Style D Crate**

## 5.2. Rub Strips

- Rub strips required on crates with skid length $\geq$ 96.00”.
- Splicing of rub strips is prohibited.

- Rubs strips okay to use with 4 x 4, 4 x 6, 6 x 6, and 8 x 8 skids as required.
- Rub strips must consist of laminated 2 x 4 lumber (minimum width) to create access clearance for handling equipment.

| Product Weight | (Access) Ground Clearance |
|---|---|
| 2500lbs | ≥ 3.00” |
| 2500-20,000lbs | ≥ 3.00” |
| 20,000-40,000lbs | ≥ 4.50” |
| ≥ 40,000lbs | ≥ 5.50” |

**Table 5-1: Product Weight vs Ground Clearance**

- Outer rub strip width must be a crate panel width wider than the outer skids with the extra width protruding to the outside edge of the skid on which to rest the crate cap. Inner Rub strip width must match the width of the inner skids.
- Rub strips must be beveled from the ground 45-60° for 50% of their total height.
- All crates with rub strips must allow for a minimum of 3” clearance for material handling equipment.
- Rub strips must be positioned along each skid such that material handling locations provide optimum balance of the crate when lifted. End rub strips must be 4-8” in from ends. The distance between rub strips must be $\underline{\geq}$ 12.00” to allow for forklift access.
- All rub strips must be the following lengths

| **Rub strip Length** | **Skid Length** |
|---|---|
| 15.50” | ≥ 96.00 and < 146.50” |
| 23.50” | ≥ 146.50 and < 182.50” |
| 35.50” | < 182.50” |

**Table 5-2: Rub strip vs Skid Length**

- Rub strips must be secured to skids using minimum 10d (3.00” long) nails with a staggered nailing pattern shown in figure 5-3

## 5.3. Skids

- Splicing of skids is prohibited.
- Laminated plywood, 1x or 2x skids are prohibited unless written permission allowed from Packaging Engineering.
- All crates must have skids with minimum 3.5" in height to allow access for material handling equipment.
- All skids must be manufactured from

| Lumber Size | 3 x 4 | 4 x 4 | 4 x 6 | 6 x 6 | 8 x 8 |
|---|---|---|---|---|---|
| Product Weight | < 500lbs | 501 to 4500lbs | 4501 to 20,000lbs | 20,001 to 40,000lbs | 40,001 to 60,000lbs |

**Table 5-3: Lumber Size vs Product Weight**

Note: Any existing crate design drawings requiring 4 x 6 skids for product under 4500lbs can have the 4 x 6 skids replaced with an equal or greater number of 4 x 4 skids

- All skids must be nailed into from the inside (through bottom panel or floorboards).
- Beveling of skid ends is prohibited except on ASTM D6251 Style crates or skid-only shipments (no cap).
- Skids must not be warped such that floorboards do not lie within 1/4" flat on the skid.
- Skid spacing as follows -

| | |
|---|---|
| 3 or 4 x 4 skids | spaced on center from one another $\leq$ 30.00" |
| 4 x 6 skids | spaced on center from one another $\leq$ 41.00" for product weighing less than 6,000 pounds |
| | $\leq$ 28.00" for product weighing 6,000 -12,000 pounds |
| | $\leq$ 24.00" for product weighing 12,000-20,000lbs |
| All 6 x 6 skids | must be spaced $\leq$ 24.00" for product weighing 20,000-30,000lbs |
| | $\leq$ 20.00" for product weighing 30,000-40,000lbs |
| All 8 x 8 skids | must be spaced $\leq$ 24.00". |

**Table 5-4: Skid Size vs Spacing**

## 5.4. Floorboards

- Splicing of floorboards is prohibited.
- Floorboards must consist of nominal 2 x (width) lumber. Only one floorboard on any base shall be no less than 2.50" wide. All others must be ≥ 5.50" but ≤ 11.25" wide.
- Any warp in floorboards must not prevent the floorboards, once nailed in place, from resting flat on the skids ± 1/4" nor create a gap between floorboards >1/4".
- Floorboard top length edges must butt against one another on the top side of the shipping base with a gap no greater than 1/4". Floorboards must cover the entire span of skids to create a solid deck.
- All floorboards must be laid perpendicular to skids.
- The ends of floorboards must be flush with outer edge of outer skids ± 1/8".
- Floorboards must be secured to skids using minimum 10d (3.00" long) nails. Staggered nailing patterns for various widths of floorboards are specified below. Nailing patterns shown are only applicable to 4 x 4 and 4 x 6 lumber skids. Wider skids must utilize 3 rows of nails. All nails must be ≥ 0.75" from edge of floorboards and skids.

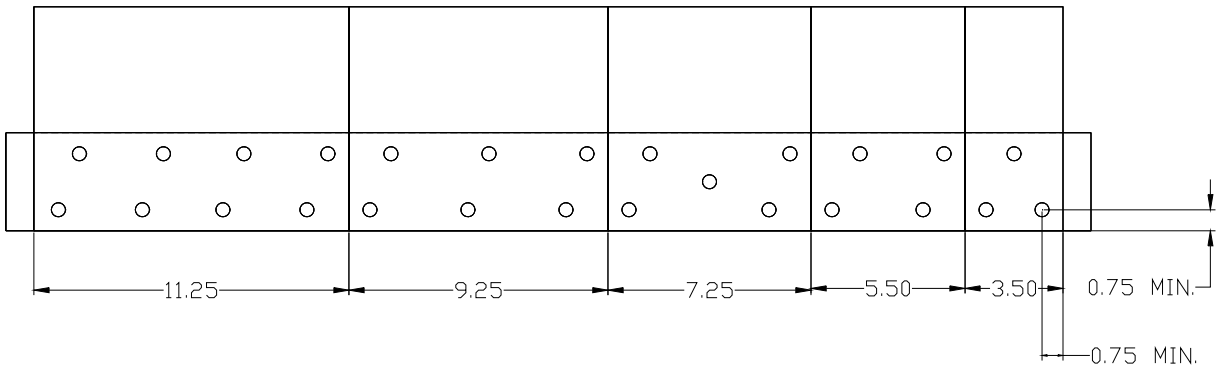



**Figure 5-4: Floorboard Staggered Nailing Pattern**

- Due to improper forklifting techniques, floorboards can become forcefully separated from the skids. The proper nailing techniques above should eliminate much of this for product up to 10,000lbs, at which time rails can be installed to keep this from happening. Enhanced floorboard securement techniques, in lieu of rails, can be used. Such techniques'/ can include additional nails, longer nails, adhesive, screws, or an adequate combination thereof.

## 5.5. Headers

- Splicing of headers is prohibited.

- Headers must be manufactured from minimum 3 x 4 lumber. Lumber size to be commensurate with product weight and span between skids. Heavier products and/or longer spans between adjacent skids will require larger headers.
- Headers are required on all crates when the product ≥ 3,000lbs.
- Headers must be flush with outside edges of floorboards ± 1/8".
- If a header is required, one header bolt must accompany each end of each skid. The header bolts must be installed at the mid-width of each skid and header. If a bolt cannot be centered due to the proximity of other hardware or bracket, please contact Packaging Engineering.
- Headers are to always be bolted in place to each skid. Nailing is prohibited except to hold the header in place prior to drilling. Hole diameter to match header bolt diameter.
- Header bolts must be carriage style bolts with a flat washer, split lock washer, and hex nut on the securing end. Bolt diameter to be minimum ½" up to a product weight of 20,000lb, 5/8" for 20,001-40,000lbs, and ¾" diameter for product 40,001-60,000lbs.
- Header bolts must point downward if rub strips exist. If rub strips are not present, the header bolts must point upward, and countersinking is required if bolt tips cause a safety hazard or interfere with product handling.

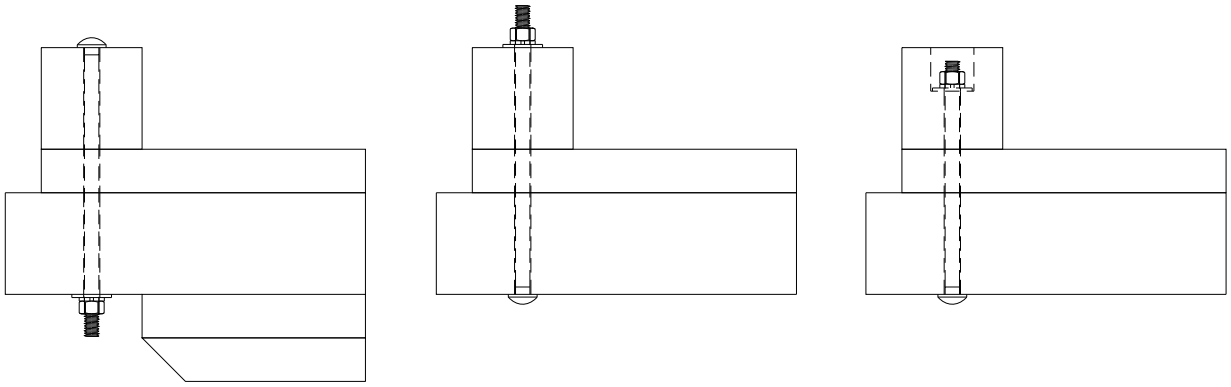


**Figure 5-5: Header Bolt Configurations**

## 5.6. Rails

- Splicing of rails is prohibited.
- All rails must be manufactured from 2 x 4 lumber may be ripped to >2.00" if necessary (e.g., if there is interference with floating deck).
- If space permits (no interference with floater), rails should be installed on shipping bases for product ≥ 10,000lbs only if necessary (see section 5.4).
- Rails must be secured with 3/8 x 5.00" lag screws starting 6.00" in from each end of the rail.

- Lag screw spacing on each rail must be

| |
|---|
| ≤24” for rails ≥3.00 wide |
| ≤20” for rails ≥2.50 and <3.00 wide |
| ≤16” for rails ≥2.00 and <2.50 wide |

**Table 5-5: Rail Lag Screw Spacing**

- Allowing for water drainage off the shipping base should be considered when installing rails.
- All rails must be pre-drilled 5/16” diameter 5.00” deep to accommodate each lag screw so as not to split the rails, floorboards, and skids during lag screw installation.

# 6. FLOATING DECK DESIGN AND CONSTRUCTION

Product that is considered fragile or more prone to damage from the shock and vibration inputs during transport and handling must be cushioned using a floating deck. Floating decks shall be designed by an experienced packaging professional with expertise in product/package shock and vibration testing and cushion design. A floating deck needs to be tested per ISTA standards to validate its performance; see testing section in 0250-00098. Any deviation requires approval from Packaging Engineering.

## 6.1. Objectives of Floating Deck

There are two primary objectives of a floating deck:

1) Extend deceleration time to absorb as much shock as possible and prevent the shock from transferring to the product at damaging levels.
2) Avoid vibration input amplification to the product caused by overlapping resonant frequencies between critical components of the product and the floating deck cushioning system. Ideally, the product natural frequencies should be 1 octave apart from the package/crate natural frequencies.

## 6.2. Cushion Type and Thickness

Polyethylene and polyurethane foams are most commonly used in floating deck designs. Foams come in various thickness’ and densities. Coiled steel springs imbedded strategically into the foam may improve cushion performance when foam by itself cannot achieve the desired results. Contact packaging_engineering@amat.com for assistance with these special designs.

Foam plank thickness for floating decks shall be >2 inches and < 5 inches. Thickness of foam can be varied based on product height but must not compromise the shock and vibration mitigation.

Ideally, there should be a minimum of 4 inches of void space between the product and the inside of all crate panels. Reductions in this clearance is possible and shall be proven through transit testing. Headspace between crate top panel (including joists if present) and product (including battens if present) should be a minimum of 1.5" unless otherwise authorized by Packaging Engineering.

Note: The lamination process of foam layers for laminated plank foam can only be done by the manufacturer during the manufacturing process.

| Good | Better | Best |
|---|---|---|
| Solid Plank PE | Laminated Plank PE (1/2" layers) | Laminated Plank PE (1" layers) |
| 2 inches | | 3 inches |

**Table 6-1: Foam Type and Thickness**

## 6.3. Foam Density and Static Loading

Lower density polyethylene foam plank (1.7pcf or 2.2pcf) provides excellent results and should be used as the default. Higher density foam plank should only be used when the required area of lower density foam exceeds the surface area of the floating deck (can't fit the required amount of foam under the deck).

The following static loading range must be used when using various polyethylene foam plank densities and thicknesses. The weight on the foam includes the product plus the floating deck weight itself. An average wood weight of 35lbs per cubic foot can be used to calculate floating deck weight. For polyurethane foam and/or metal springs please consult Packaging Engineering.

| PE Foam Density (pcf or lbs./ft$^3$) | PE Foam Static Loading (psi or lbs./in$^2$) | |
|---|---|---|
| | 3-Inch-Thick (best) | 2 Inch Thick (good) |
| **1.7 pcf** | 1.000 - 1.250 psi | 0.875 - 1.125 psi |
| **2.2 pcf** | 1.125 - 1.375 psi | 1.000 - 1.250 psi |
| **4.0 pcf** | 2.500 - 2.750 psi | 2.250 - 2.500 psi |
| **6.0 pcf** | 3.250 - 3.500 psi | 2.750 - 3.000 psi |
| **9.0 pcf** | 5.500 - 5.750 psi | 5.000 - 5.250 psi |

**Table 6-2: Foam Density and Static Loading**

## 6.4. Foam-to-Wood Bond

The foam-to-wood adhesive bond will be subjected to multiple G forces during crate handling and transport and must be strong enough to hold the floating deck in place without failure. Bond failure can lead to potential safety issues and product damage.

### 6.4.1. Minimum Bond Strength

The foam to wood bond strength shall be greater than the tear strength of the foam and wood yield strength.

### 6.4.2. Minimum Foam Area

Given the minimum foam-to-wood minimum bond strength requirements in section 6.4.1:

- The calculated $in^2$ ($cm^2$) of foam multiplied by 4.0lbs/$in^2$ (0.281Kg/$cm^2$) must always be greater than the total weight in lbs. (Kg) resting on top of the foam (product + floating deck assembly). Please contact Packaging Engineering for the polyethylene foam to wood bonding report or questions.

If this cannot be achieved, then other shock and vibration mitigating methods must be researched, tested, and/or employed for product that is deemed fragile. When a larger amount of high-density foam is utilized, the bonding surface area decreases exponentially, so designers must be careful to meet these minimum bonding surface area requirements.

### 6.4.3. Approved Adhesives for floating decks (and all foam to wood bonds)

- **Solvent-Based Contact Adhesive:** LOKWELD 801, LOKWELD 831, and 250 DEV. Ralph Wilson Plastics Company, Wilsonart International (www.wilsonart.com).
- **Hot Melt Adhesive:** HMT-1204. Hot Melt Technologies; www.hotmelt-tech.com.
- If the use of an alternative adhesive is desired, it must be tested and approved at the requestor's expense prior to implementation, unless certification of equivalency or better is provided to Packaging Engineering.

### 6.4.4. Application

#### 6.4.4.1. General Requirements

Regardless of the adhesive used, there are basic requirements that must be followed.

- All wood bonding surfaces must be relatively even and smooth with very minimal loose wood fibers, voids, unevenness, debris, dust, or any other characteristics that can compromise full bonding strength potential.
- Once the materials are bonded together, pressure must be applied to the bonds such that bonding surfaces fully contact one another without gaps.

- Application equipment must be properly suited for the task and be in good working condition.

#### 6.4.4.2. Solvent-Based Contact Adhesive

Solvent-based contact adhesive is applied in liquid form. Below are the requirements for applying the solvent-based contact adhesive.

- **Critical:** Foam must first be skived (outer skin planed off on both faces). Foam can be ordered this way, or it can be skived by the end user if they have skiving equipment.
- **Note:** It is recommended the bonding face of PE foam be skived to ensure the best bond to plywood or lumber.
- Adhesive must be **liberally** applied over 100% of each bonding surface (foam and wood)
- Adhesive must be allowed to properly set per the manufacturer's recommendations before any bonding of materials takes place.
- Adhesive must be applied according to the manufacturer's recommendations including, but not limited to, the use of proper safety equipment, minimum adhesive application temperature, maximum open time, and the use of proper application equipment.

#### 6.4.4.3. Hot Melt Adhesive

Hot melt adhesive is applied in semi-liquid form. Once applied, it immediately starts to cool and solidify, so the bonding of the foam and wood needs to occur quite quickly. Below are the requirements for applying the hot melt adhesive.

- **Note:** As opposed to using contact adhesive, the foam does not have to be skived when using hot melt adhesive. The application temperature of the hot melt adhesive, however, must be adequate to fully melt the outer skin of the foam.
- Adhesive must be **liberally** applied over 100% of each bonding surface (foam and wood) such that there is an adhesive build-up of at least .13in (or 3mm) above the foam and wood surfaces after all pores and cavities are filled.
- **Extremely Important**: Bonds must occur well within the adhesive open time (typically 45 second or less). If the hot melt cools too far, then the adhesive does not penetrate the pores of the materials and produce maximum bond strength. Construction methods and techniques may need to be adjusted accordingly.

## 6.5. Foam Placement and Layout

While calculating the correct amount of foam is very important, how it is laid out underneath the floating deck is quite significant as well. A poor foam layout can produce less than optimal shock and vibration mitigation, can contribute to excessive flexing and/or point compression of the deck under the weight of the product, and can create uneven foam compression and product tilt, to name a few side-effects.

- Foam must be absent from areas that are used to secure the product to the floating deck such as steel banding paths and bolting locations. The absent areas of foam must be enough in size to easily install the securement method without interference.
- The foam layout must consider the product's center of balance. The amount and placement of foam utilized underneath the floating deck must align with the weight distribution (center of balance) of the product across the floating deck.
- The foam layout must consider the product's center of gravity. Taller, smaller footprint products, or any product with a higher center of gravity, can cause product tilt or tip-over during inertial events. Oversizing the floating deck and/or placing a higher ratio of foam at the floating deck perimeter may be necessary.
- Foam must be well-distributed underneath the floating deck with emphasis on matching the product's center of gravity, and with placement directly underneath or near load-bearing members that distribute the product weight across the floating deck.
- Foam plank must be well-utilized such that scrap is minimized. Often, individual pieces of foam can be cut in widths and lengths that are multiples of the overall foam plank sheet (typically 48 x 108in or 1220 x 2745mm).
- The width of individual foam pieces must never exceed their thickness.
- A plywood splice joint on the bottom layer of the plywood deck must have a minimum of 2.00in (or 50mm) of foam on each side of the splice joint at the perimeter of the floating deck assembly. It is recommended this occur for at least 30% of the splice length.
- Foam must be located such that proper alignment of the floating deck to the foam is easily achieved during floating deck to shipping base assembly. Ideally, some amount of foam should be placed in all four corners and/or even with the plywood deck perimeter on all four sides to assist alignment.

## 6.6. Foam Splicing Limits for Scrap Foam

The number of individual foam pieces underneath a floating deck should be kept to a minimum. This generally results in less overall manufacturing cost. This practice, however, will produce fall-off (pieces of leftover foam) that may eventually need to be scrapped or recycled if it cannot be utilized. To better utilize this leftover plank foam and reduce cost, Applied Materials will allow **minimum 4 x 12in (or 100 x 300mm)** pieces of the same thickness to be put together (spliced) to substitute for what would have been a larger single piece of foam cushioning.

## 6.7. Plywood Deck

The main platform, or plywood deck, upon which the floating deck assembly is constructed, must be stiff enough so as not to bend and flex too much under the weight of the product. This is dependent primarily upon the overall plywood deck thickness and its construction.

### 6.7.1. Maximum Weight Capacity

Depending on product weight, total area of the plywood deck, and total thickness of the plywood deck, the following maximum weight capacity of the deck must not be exceeded:

| in (mm) | lbs./ft$^2$ (kg/m$^2$) | in (mm) | lbs./ft$^2$ (kg/m$^2$) | in (mm) | lbs./ft$^2$ (kg/m$^2$) |
|---|---|---|---|---|---|
| .750 (19) | 70 (342) | 1.375 (35) | 138 (674) | 2.000 (51) | 271 (1,323) |
| .875 (22) | 80 (391) | 1.500 (38) | 158 (771) | 2.125 (54) | 310 (1,514) |
| 1.00 (25) | 92 (449) | 1.625 (41) | 181 (884) | 2.250 (57) | 355 (1,733) |
| 1.125 (29) | 105 (513) | 1.750 (44) | 207 (1,011) | 2.375 (60) | 407 (1,987) |
| 1.250 (32) | 120 (586) | 1.875 (48) | 237 (1,157) | 2.500 (64) | 466 (2,275) |

**Table 6-3: Maximum Weight Capacity of Plywood Decks**

### 6.7.2. Layering and Minimum Thickness

The following requirements apply to plywood deck thickness in floating deck design.

- At least one layer of plywood is required for the floating deck, but two layers are required if installing barrier film (see section 8). This layer of plywood must always be a minimum of 3/4in (or 18-19mm) regardless of floating deck size or product weight.
- Only two layers of plywood can be used in a plywood deck. The top layer of plywood can never be thicker than the bottom layer, but the total thickness must meet requirements of section 6.7.1.
- When the bottom layer of a plywood deck is spliced, a top layer of plywood is required. The top layer of plywood must be of equal thickness to the bottom layer in this instance.

### 6.7.3. Plywood Sheet Sizes

A “full sheet” of plywood has minimum dimensions of 4 x 8ft (or 1220 x 2440mm). This is the most common size produced worldwide. Plywood is also available in less common and custom sizes, usually in additional increments of 12in (or 300mm). This may help to reduce overall cost by reducing the number of plywood splices required for larger plywood decks. Applied Materials expects that the overall lowest cost prevails in this respect.

### 6.7.4. Plywood Splice Joints

A plywood deck must be constructed of as few pieces as possible. Sheets of plywood that run full deck width and/or length should be used whenever possible. The maximum number of allowable splices in any given plywood deck layer, however, is specified in the table below:

| Plywood Deck Width | Plywood Deck Length | Max Splices Width | Max Splices Length |
|---|---|---|---|
| ≤ 48.00” | ≤ 96.00” | 0 | 0 |
| ≤ 48.00” | > 96.00 ≤ 144.00” | 0 | 2 |
| ≤ 48.00” | > 144.00 ≤ 192.00” | 0 | 3 |
| > 48.00 ≤ 96.00” | > 48.00 ≤ 96.00” | 1 | 0 |
| > 48.00 ≤ 96.00” | > 96.00 ≤ 144.00” | 1 | 2 |
| > 48.00 ≤ 96.00” | > 144.00 ≤ 192.00” | 1 | 3 |

**Table 6-4: Plywood Deck Maximum Splice Quantity**

### 6.7.5. Layer Configuration and Construction

How each plywood deck layer is configured and constructed plays a vital role in its overall strength and stiffness. Minimizing the quantity of splices and controlling the direction and location of splices is a major key in creating a solid foundation onto which the product will be loaded. Below are requirements.

- A single layer plywood deck must never be spliced (deck larger than a full sheet of plywood). When splicing is necessary, two overlapping plywood layers must be used.
- Splices in the top and bottom plywood layers that are running parallel to one another must never be aligned and must overlap ≥ 6.00in. If this cannot be achieved, the bottom and top layers must run perpendicular to one another.
- Any piece of plywood in either plywood deck layer must never be less than 2.00” wide. Such filler pieces (one in the bottom layer and one in the top layer) must be located at opposite sides of the plywood deck.
- When the length and width of a plywood deck/floating deck is equal, it is best to run the face grain of each layer perpendicular to one another to achieve maximum stiffness.

- Tongue & groove plywood is allowed in the construction of a plywood deck and can help to stiffen it. If used, the tongue and groove splice joint must be located on the interior of the plywood deck. The groove can be located at the plywood deck perimeter, but the tongue must never be located there.

### 6.7.6. Securement of Two Layers

It is very important that the top and bottom plywood layers of a plywood deck are properly and adequately secured together. The bottom layer is adhered to foam cushioning and the product is directly or indirectly secured to the top layer, so stresses occur during shipping and handling that can pull the two layers apart. To this end, the requirements below apply.

- Floating decks constructed of two plywood layers must have the two layers secured together such that gaps and delamination are absent between layers and across the entire floating deck. The upper and lower plywood layer perimeters must align with one another ±1/8”.
- When securing the top and bottom plywood decks to one another, always nail through the thinner layer into the thicker layer using divergent tip staples and/or screw or ring shank nails.
- Fasteners (nails and staples) must not protrude below the bottom layer of plywood (underside of floating deck) but must penetrate the thicker layer a minimum of 80% of its thickness.
- The heads of fasteners (nails and staples) must not penetrate the plywood surface more than 1/16”. Air pressure must be adjusted accordingly.
- Staple heads must be installed cross-grain ±60° to help prevent head pull-through.
- A minimum of one fastener (nail or staple) is required every 8.00” in both length and width directions beginning 1.00-3.00” in from the deck perimeter and corners.

### 6.7.7. Installing Moisture Barrier Film

It should be noted in this section that one method of installing barrier film (used to create the moisture barrier bag) on the underside of the product is by sandwiching it between the top and bottom plywood deck layers during the plywood deck construction. This method is discussed and detailed in section 8.

## 6.8. Other Floating Deck Components

While the plywood deck, detailed in the previous section, is the foundation of the floating deck, there can be many other wood components secured on top of the plywood deck that are sized and configured uniquely to an individual product with which they interface. The following are minimum requirements for floater design for crating Applied Materials' product.

- All floating deck components must be designed and positioned in such a manner that allows for safe and efficient equipment loading and unloading, and prevents equipment damage, particularly to the underside of equipment (gas lines, vents, casters, leveling feet, sheet metal flanges, etc.).
- **Load-bearing members, along with risers if necessary, must support the equipment off its casters and/or leveling feet whenever possible**. Do not remove casters or leveling feet from any frame or component without prior approval from Applied Materials. If this is not feasible, place the equipment on its casters or leveling feet and design a lumber well around the product.
- Floater components which have the product secured directly to them (such as load bearing members or blocking) must be minimum 3 x 4 lumber and must themselves be bolted to the plywood deck with bolt diameter $\geq$1/2" to ensure the product does not come loose from the floating deck. Bolt length must be such that the bolt tip protrudes below the plywood deck ≤ half the foam cushion thickness.
- Lumber well members, bracing, shipping brackets or alike must prevent all lateral movement of the equipment on its floating deck. Well members and bracing should consist of 2" nominal lumber. **The floating deck design must "capture" the product in the horizontal plane and prevent product shift during transportation.**
- Floating deck components must be designed and positioned in a manner that minimizes the potential for moisture barrier film to tear or puncture when the product is loaded onto its shipping base.
- All floating deck components must be adequately secured to the plywood deck with the proper type and quantity of fasteners. In general, components should be secured by installing the fastener through the underside of the plywood deck into the component on top of the floating deck. Toe-nailing the component into the plywood deck should be limited as much as possible.

# 7. CRATE CAP DESIGN AND CONSTRUCTION

The other major component of crate design is the crate cap made by assembling crate panels. This section will provide design and construction specifications for crate panels and caps. ***Note***: *In order to illustrate some common crate cap features, figure 7-1 does not show a removable panel with plywood panel stops.*

## 7.1. Generic Crate Cap Anatomy

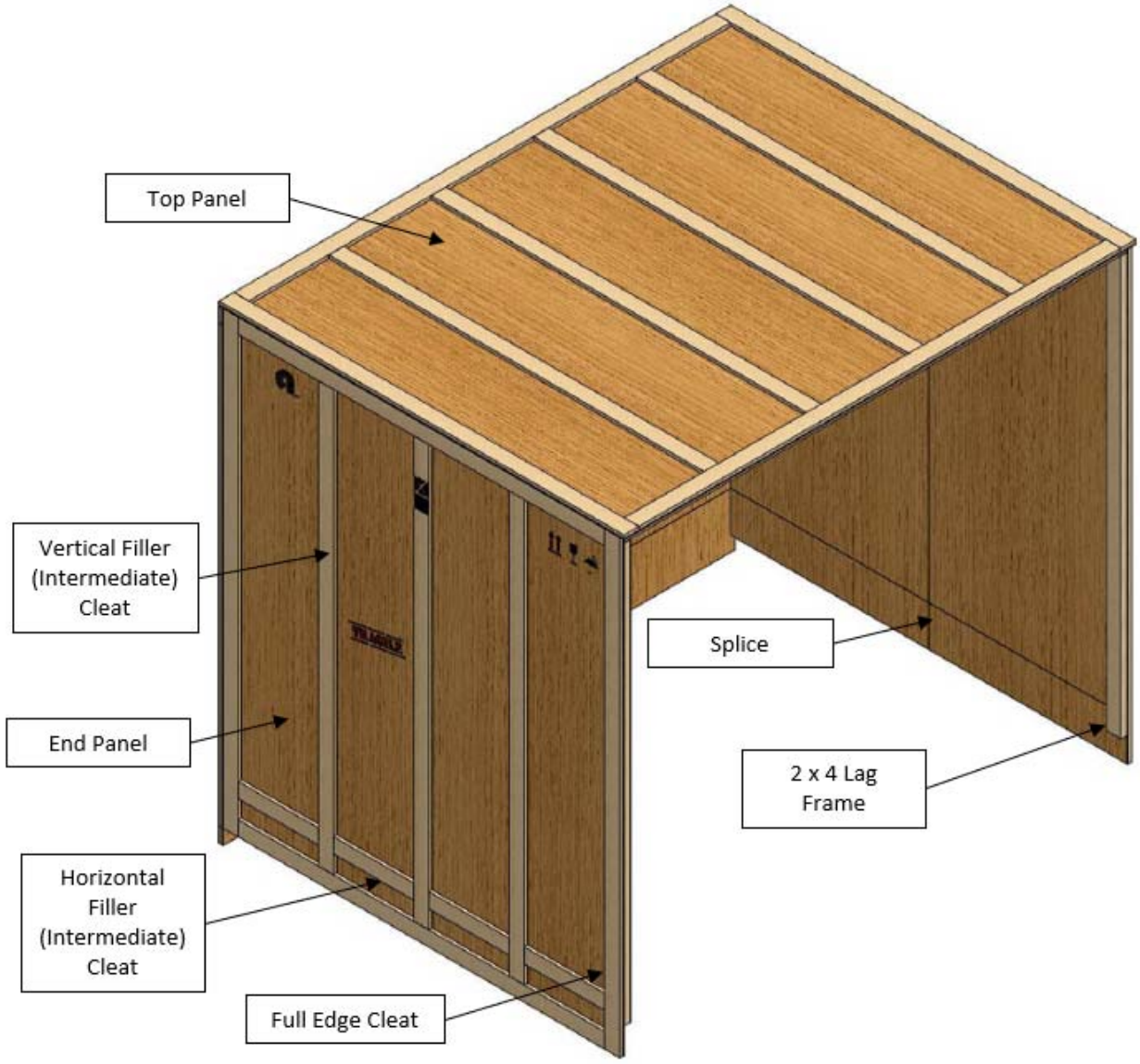



**Figure 7-1: Generic Crate Cap Anatomy**

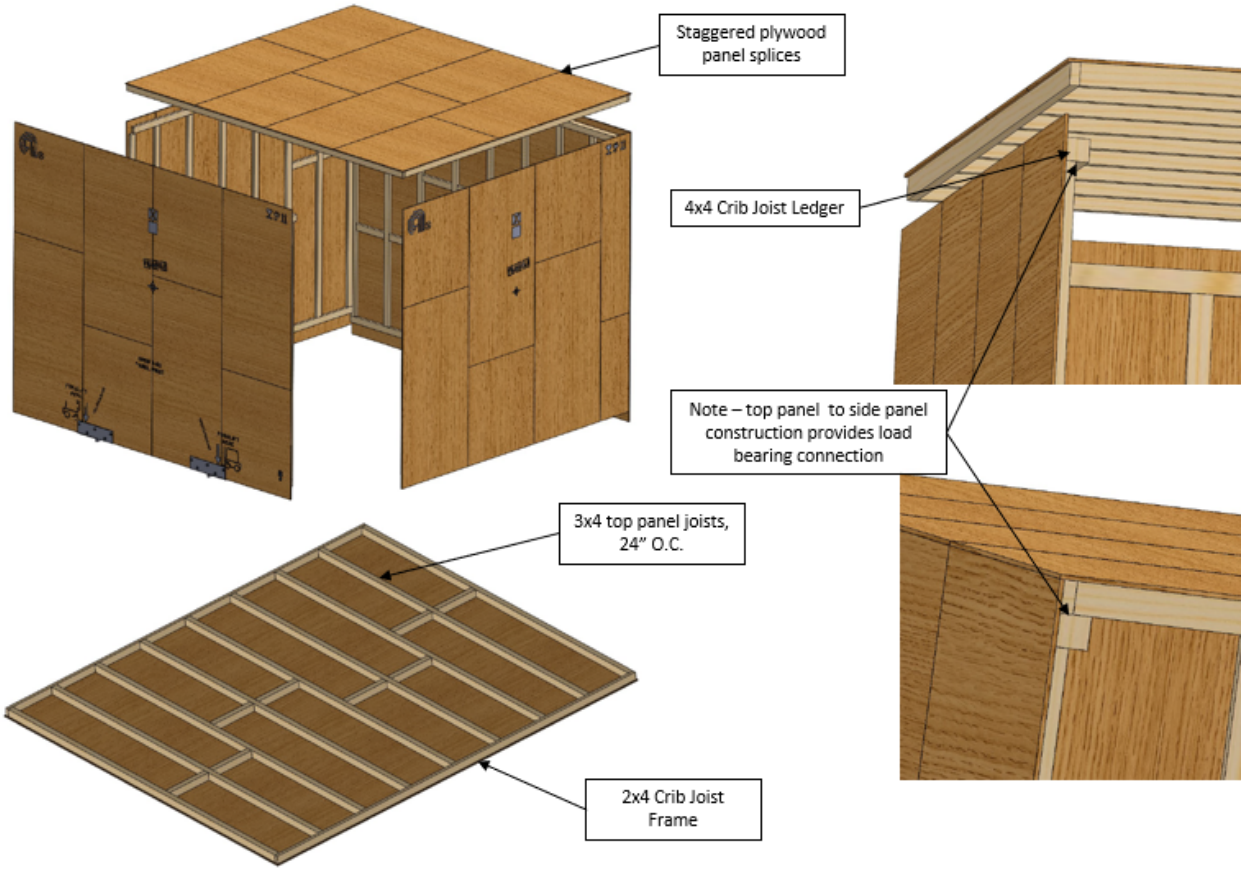



**Figure 7-2: Generic Style D Crate Cap Anatomy**

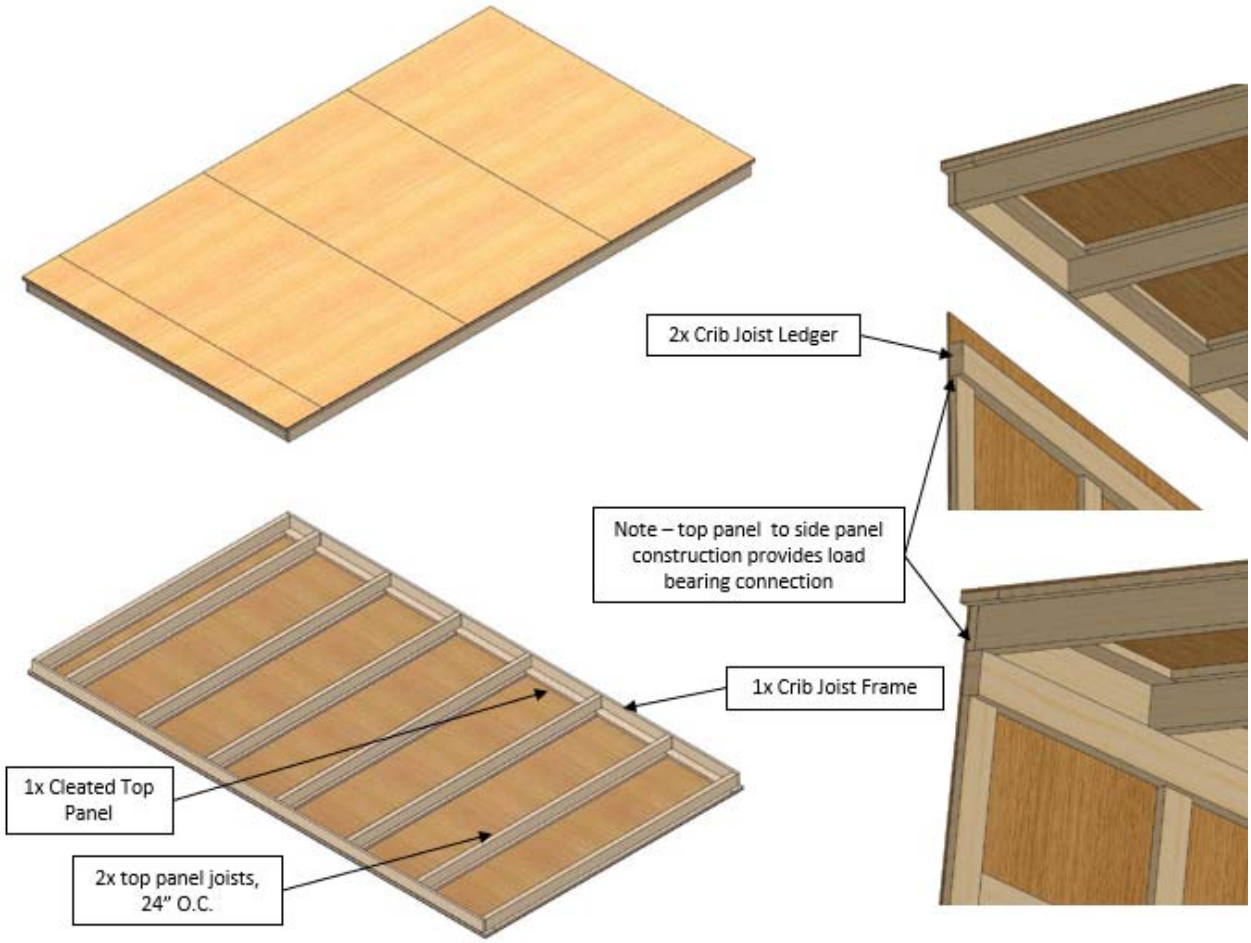



**Figure 7-3: Alternate Generic Style D Top Panel Anatomy**

## 7.2. General

- Plywood crate side panels without cleats are prohibited.
- When panels are assembled to form the crate cap, adjacent panel edges and corners must be flush with one another with no more than 1/8" allowable gap.

## 7.3. Cleats & Cleated Panels

- Cleats must not be spliced.
- Plywood cleating is allowed, must meet performance requirements equal or greater strength to lumber cleats and must follow dimensional lumber guidelines below.
- For cleated plywood panels the cleat size to panel size is -

| Cleat Size | Panel Size |
|---|---|
| 1 x 2 cleats | ≤ $4ft^2$ |
| 1 x 3 cleats | ≤ $12ft^2$ |
| 1 x 4 cleats | ≤ $56ft^2$ |
| 1 x 6 cleats | > $56ft^2$ |
| Cleating wider than 1 x 6, or nominal 2" cleating, must be used when necessary to enhance the panel rigidity and strength. | |

**Table 7-1: Cleat Size vs Panel Size**

- Adjacent cleat thickness in a panel must match within 1/16".
- Plywood sheathing must be stapled to the lumber cleating using divergent tip staples. Staple tips must not protrude outside the cleat surface. Staple length must be such that it penetrates the lumber cleating a minimum of 80% of the cleat thickness.
- Staple pattern into each cleat must consist of two staples at the end of each cleat followed by a staggered pattern every ≤ 4" with staples remaining .50-1.00" inward of cleat edge.
- The head of each staple must not penetrate the plywood surface more than 25% of the plywood thickness. Pneumatic staple gun air pressure must be adjusted accordingly.
- Cleats must be assembled in a manner that the wane is facing down and inward on edge cleats and facing downward on intermediate cleats to improve crate appearance.

- Unless otherwise specified in this document, the following table dictates the orientation and use of intermediate cleats. Filler and splice cleats are considered intermediate cleats. Center to center (C to C) dimension tolerance is ± ½".

| Panel Width | Panel Height | Intermediate Cleats |
|---|---|---|
| Edge Cleats ≤ 24" C to C | Edge Cleats ≤ 24" C to C | None |
| Edge Cleats ≤ 24" C to C | Edge Cleats ≥ 24" C to C | Horizontal |
| Edge Cleats ≥ 24" C to C | Edge Cleats ≤ 24" C to C | Vertical |
| Edge Cleats ≥ 24" C to C | Edge Cleats ≥ 24" C to C | Vertical |
| Cleat spacing ≤ 30.00" center to center (Style A only). | | |

**Table 7-2: Cleat Spacing Requirements**

## 7.4. Cleated Panel Sheathing

- Cleated plywood panels must be manufactured from minimum 1/4" plywood.
- When splicing plywood, the adjacent edges must be secured at the mid-width of a cleat with no splice gap greater than 1/8".
- Panels can be spliced at the mid-width of the edge cleats ± ¼". The remaining portion of the edge cleat must be filled with plywood of equal thickness.
- When horizontal splicing occurs on panels with a height greater than 96.00", the splices must be located toward the crate base.
- Best (highest grade) plywood face must be on the crate exterior.
- OSB (oriented strand board) panels are allowed for inbound shipments only and with approval from Packaging Engineering. OSB cannot be used for any customer shipment crates.

- The following table shows the maximum allowable plywood splices in any given crate panel. Splices at the cleat mid-width are not included.

| Panel Length | Vertical Splices | Panel Height | Horizontal Splices |
|---|---|---|---|
| ≤ 27.50” | 0 | ≤ 27.50” | 0 |
| > 27.50 ≤ 51.50” | 1 | > 27.50 ≤ 51.50” | 1 |
| > 51.50 ≤ 99.50” | 2 | > 51.50 ≤ 99.50” | 2 |
| > 99.50 ≤ 147.50” | 3 | > 99.50” | 3 |
| > 147.50 ≤ 195.50” | 4 | - | - |

**Table 7-3: Panel Plywood Maximum Splice Quantity**

## 7.5. Panel Configurations and Assembly

- For purposes of this document, the end panel is always considered the panel with the least width.
- Vertical edge cleats on end panels must run the full length of the panel height.
- Horizontal edge cleats on side panels must run the full length of the panel length.
- Edge cleats on top panels which run parallel to skids must run full length of the top panel.
- Caps must be nailed together with a minimum of 1 nail every 4 inches. Nail length must be minimum 2.5 times the thickness of the panel being nailed through.
- The individual and assembled panels must be configured as shown in Figure 7-4. The difference between the two illustrations is that a Style C end panel overlaps the side panels whereas a Style B end panel is overlapped by the side panels.

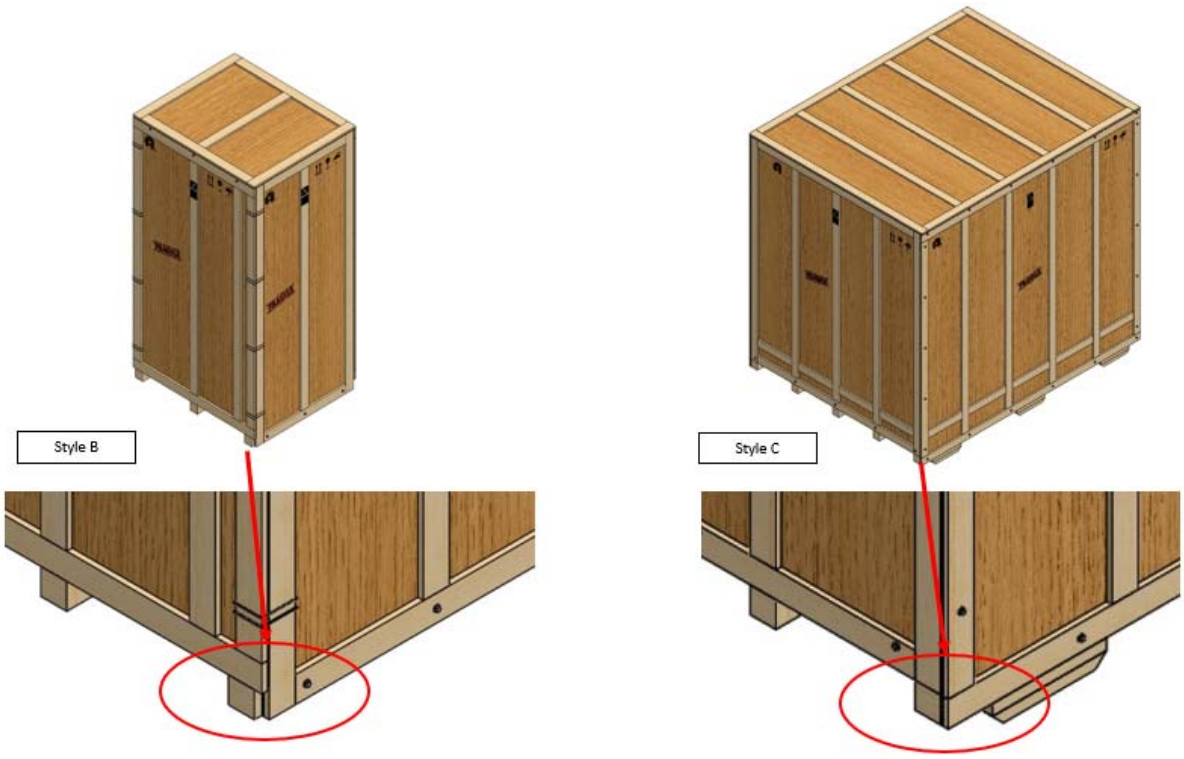



**Figure 7-4: Panel Configuration**

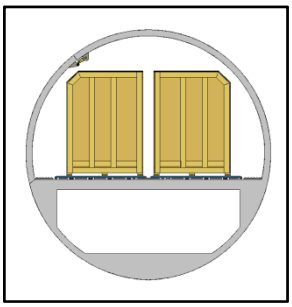
## 7.6. Top Panel

- Top panel to have cleats facing up for all crates except Style D crates.

## 7.7. Panel Stops and Lag Frames

- Panel stops and lag frames are used to position/stop and help secure removable crate panels. They must be utilized on all crates with removable panels and must cover the entire perimeter of the crate opening except the bottom of each style B and C crate.
- Panel stops must be made from ≥ 3/8” plywood and a strip width of ≥ 2.00”.
- Lag frame members must always be made from 2 x 4 lumber.
- Lag frames/panel stops on the top panel are not required on removable panels ≤ 30” wide.

## 7.8. Chamfered Crate Cap for Air Shipment



A chamfered cap may be required to optimize the cargo hold space inside a cargo aircraft. Chamfering a crate cap most often angles one top edge of a crate such that the crate will better fit within the circular confines of the aircraft. By doing so, freight can fit where it may have not if the crate was squared-off. It can significantly reduce air freight costs by allowing for side-loading (one aircraft pallet position) instead of center-loading (two aircraft pallet positions). Chamfering can only be done if the product inside the crate allows enough space to do so.

When shipping on a plane, the cost to ship a crate in a center-load position is greater than to ship in a side-load position. The images below show side loading versus center loading on a plane.

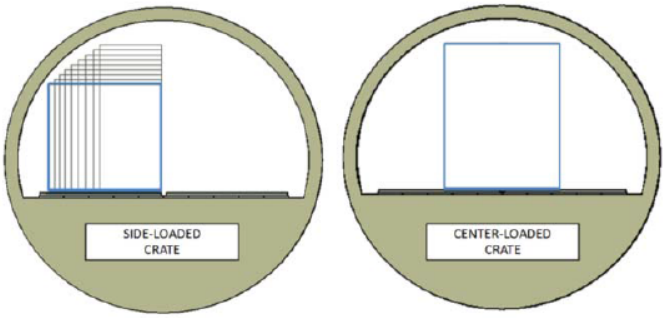



Figure 5: Side- & Center-Loaded Crate for Aircraft

**Figure 7-5: Air-Freight Crate Optimization Example From 0250-00098**

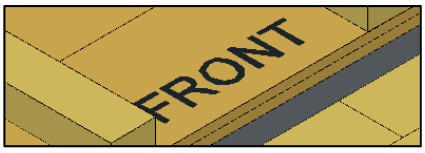
### 7.8.1. Specification Call-Out

Specifications that call-out a chamfered cap must possess the following three requirements:

1. Width (W) of chamfer (horizontal distance from side/end panel edge)
2. Height (H) of chamfer (vertical distance from side/end panel top edge)
3. Side of Chamfer (correlates with shipping base, see section 7.8.1)

Example: “Crate cap to be chamfered 12.00W x 12.00H on (front/rear) side for air shipment.”

### 7.8.2. Required Elements of a One-Side Chamfered Cap




1) **Identify Shipping Base:** Identify (stencil) the side of the shipping base that will correlate with the side of the chamfer (see section 7.8.1). **Important:** This is necessary when the crate cap is only chamfered on one side.
2) **Removable Panel:** The panel opposite the crate cap chamfer must be the removable panel.
3) **Tarping:** For chamfered crate caps, one solid piece of tarping is required over all top panels regardless of the non-existence of plywood splices. Tarp to hang down the side panels a minimum of 3".

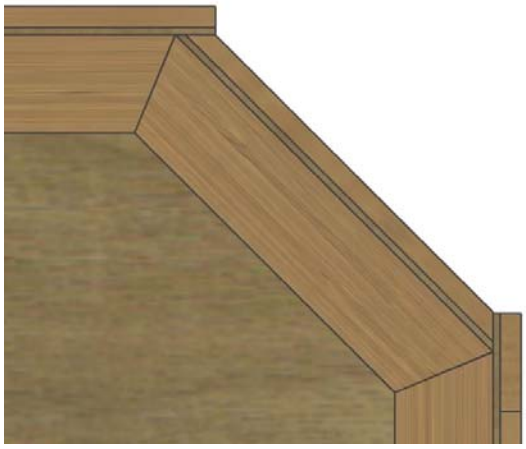


**Figure 7-6: Chamfered crate example (see Appendix B and C for more chamfering examples)**

# 8. CRATING REQUIREMENTS

## 8.1. Hazardous Materials

Hazardous materials must be packed and crated separately from non-hazardous materials. All hazardous materials/dangerous goods must be packaged, marked, and labeled per the applicable regulations: *CFR 49 Parts 106-180* (http://www.fhwa.dot.gov), *International Air Transport Association (IATA)* (http://www.iata.org), *International Maritime Dangerous Goods (IMDG)* (http://www.imo.org), and *International Civil Aviation Organization (ICAO)* (http://www.icao.int).

## 8.2. Ocean Crating

- Crates shipped inside a dry ocean container do not need any enhancement. The standard requirements within this document are enough. Crates shipped via an ocean flat rack or platform, however, the exposure to more frequent and severe handlings, and the exposure to moist and/or salty air, requires crate structural enhancements. **Note - All Display crating to be fully tarped with a 12mil minimum thickness tarp, preferably blue, heat welded if seamed together. See Appendix A.**
- Corrosion protection as required (see section 8.4 and 8.5).

### 8.2.1. Flat Rack or Platform (Non-Containerized)

- Full crating is required. Skid-only and open crate shipments are prohibited unless authorized in writing by Applied Materials.
- Crate cap (panels) must be constructed of minimum 1x6 (19x140mm) lumber cleats and minimum 1/2in (12mm) plywood. Cleats spaced a maximum of 30in (76cm) on center.
- Crate top panel to be reinforced with additional cleating and/or joists to prevent top panel sag and withstand slinging and stacking compression.
- All tarping to be 12 mil minimum thick, preferably blue, heat welded if seamed together.
- Top panel edge protection needs to be applied on top of tarping to avoid damage to the crate and tarp, see Figure 4-6.

### 8.2.2. Dry Ocean Container (Containerized)

- To lower the dew point inside the sealed ocean container and reduce the probability of condensation forming on the container ceiling and dripping onto the cargo, dry ocean container hanging desiccant bags should be utilized.

## 8.3. Crate Water Protection

### 8.3.1. General Crate Tarping

- No staples must be through the top of tarp.
- Staple length must not puncture through crate.
- Nails are prohibited for use in securing tarp to crate.
- All stencils required on the crate are also required on the tarp.
- Part supplier assumes responsibility of crate tarping done by all 3rd parties performing the tarping.
- Transportation providers shall follow their SOP/SOW when shipping on flat racks and flat-bed trailers regardless of Applied Materials crates that are already tarped.
- Add a 2.00” wide plywood strip at the bottom of the crate cap, example shown in Figure 8-2, for better securement of the tarp on all crates shipping by flat rack. Preferred plywood thickness is 0.50”. Not required for crates shipping in a dry ocean container. Add one poly band (1/2”) around center of crates shipping by flat rack. Attach 2” x 5” pieces of plywood over the poly banding on the end panels to keep the banding in place, 4 pieces of plywood required.
- Add 2.00” plywood strips to all folds in tarp to reduce water seepage. See figure 8-3.
- For crates > 150 lbs., attach Shock Watch and Tilt Watch to a plywood placard stapled/screwed over the tarping. Refer to Figure 8-2 or 0205-05335.
- Tarp must be pulled tight to crate to avoid fluttering during transportation which may lead to tearing. Refer to Figure 8-2 and 8-3.
- Tarp must be stapled to the side panel top cleats with a minimum of 1 staple every 4.00”.
- A tarped crate shipped by ocean flat rack and/or flatbed trailer must have top edge protection to avoid the tarp or crate from being damaged from lashing.
- See appendix A for tarp specifications.
- Crates shipping by ocean flat rack must be fully tarped.
- Crates shipping by air must have the top panel covered with tarp only if the top panel has splices.
- Crates using a fiber corrugated crate cap must be adequately protected from rain or ocean water. Please contact Packaging Engineering for guidance.
- Tarp must extend a minimum of 3.00” outside the perimeter of the top panel and be folded downward over the joint between the side panels and the top panel.

- Tarp is preferred to be one piece; all folds to be downwards so water does not collect. If a one-piece tarp is cost prohibitive then the crate can be covered in two pieces. See figure 8-1 and 8-2.

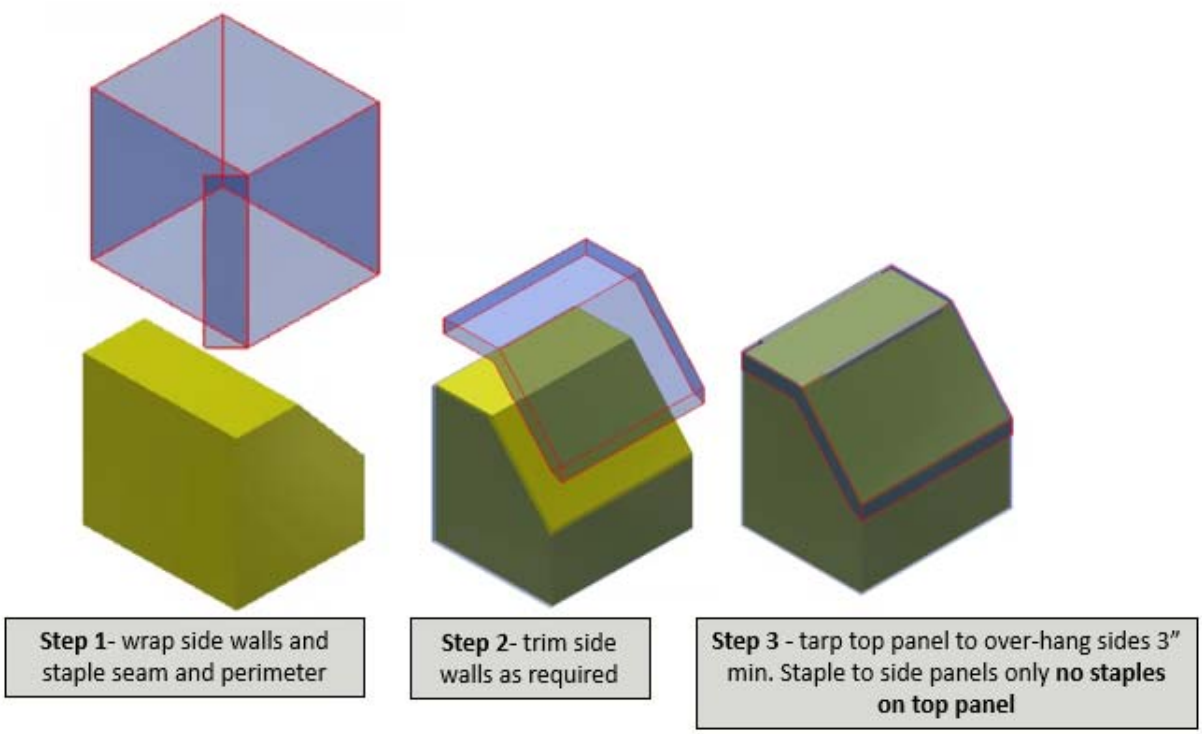



**Figure 8-1: Crate Tarping Example 1**


**Figure 8-2: Crate Tarping Example 2**

**Figure 8-3: Crate Tarping Example 3 - Plywood Strips Over Tarp Folds**

## 8.4. Moisture Barrier Bag (MBB) Installation

### 8.4.1. General

- Install barrier bags around all customer shipments, per SEMI E137, unless otherwise instructed. For inbound shipments or spares see 0250-00098 for MBB installation guidelines.
- Pad or otherwise protect all sharp edges both on the equipment and on the shipping base to prevent punctures or tears in barrier material.
- Excess air must be evacuated from inside the barrier bag prior to final sealing. Vacuum sealing is allowed but must not be done too far such that the barrier material is stressed from product contact—a tight vacuum is not required nor desired--holes and punctures are very detrimental to moisture protection. The better method is to evacuate excess air by stretch wrapping using at least one layer of stretch wrap. As with vacuum sealing, care must be taken not to apply excess pressure that could cause bag puncture or tear.
- Barrier bag seams must be completely heat sealed with a seal width $\geq$ 3/8”.

### 8.4.2. Sandwich in Floating Deck

In the case of a Style B or Style C crate, one method of installing barrier material on the underside of a product is to sandwich it between two plywood layers of a floating deck. This is done during the floating deck/plywood deck manufacturing process. It is the preferred method since it allows greater visibility when loading a product onto the floating deck and it prevents puncture and tear of the barrier material due to product contact and compression. Using this method, the barrier film must be installed throughout the entire plywood deck making sure to leave excess material (minimum 8.00”) for heat sealing operations with the top barrier bag. Moreover, the barrier film must be sandwiched between 4-mil poly sheeting enough to ensure that the barrier film does not directly contact any portion of the plywood deck perimeter.

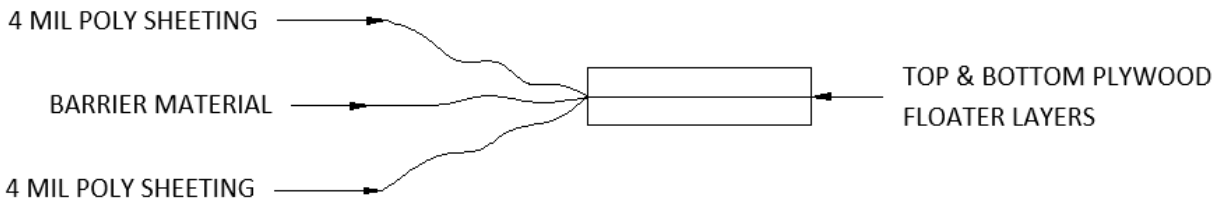



**Figure 8-4: Barrier Film Configuration in Floating Deck**

### 8.4.3. Drape Over Floating Deck

A second method of installing barrier film on the underside of a product for a style B or Style C crate is to drape it over the entire shipping base/floating deck. Though allowed, this technique is discouraged in lieu of sandwiching the barrier film between the floating deck plywood layers since it can create a safety hazard for those loading the product onto the shipping base and/or promote tearing and puncturing of the barrier film. When using this technique, the barrier film must be fully sandwiched between 4-mil poly sheeting to protect the barrier film. Ensure to leave enough excess barrier material and poly sheeting around the component for eventual heat-sealing operations. Prior to loading the equipment onto the shipping base, press the sheeting and barrier material into the base to prevent puncturing/tearing from the equipment or from the wood components of the floating deck itself.

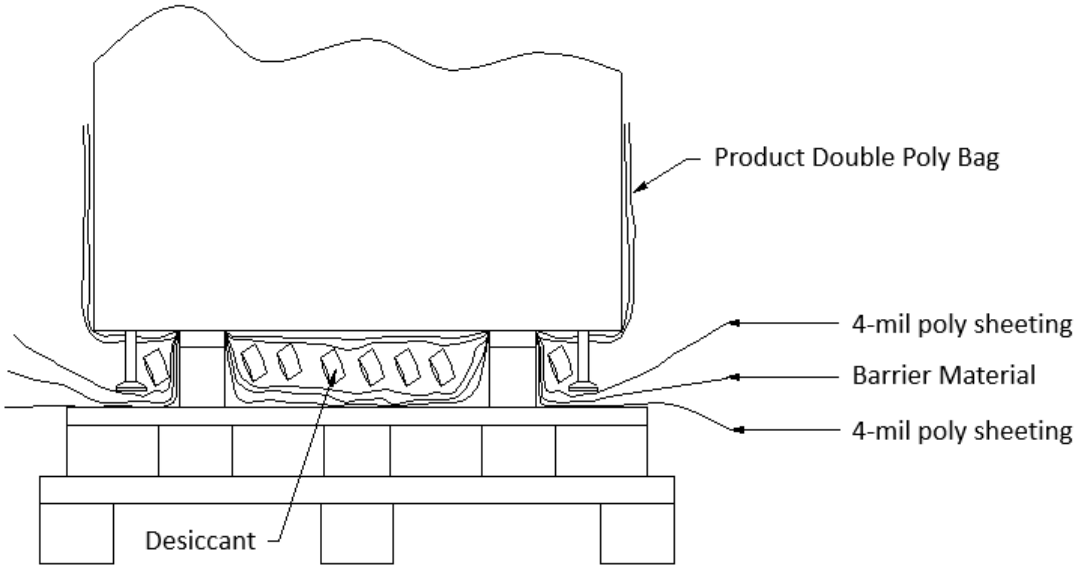



**Figure 8-5: Barrier Film Configuration Over Floating Deck**

## 8.5. Desiccant

- All barrier bagged equipment must have activated desiccant absorbent inserted between the product bagging and the moisture vapor barrier material. Distribute desiccant evenly around the equipment.
- Do not leave desiccant exposed to open air for more than 15 minutes prior to sealing the barrier bag.
- All desiccant containers must remain closed and sealed air-tight when not in use.
- Desiccant should be either 8- or 16-unit bags. It is best to use 8-unit bags when desiccant needs to be distributed over larger areas. This provides better coverage.

- Once a moisture vapor barrier bag is sealed, the environment inside the bag becomes independent from that on the exterior. Moisture inside the bag can only come from four sources once the bag is properly sealed – moisture in the trapped air, moisture penetrating the barrier film from outside, condensation, and hydroscopic materials (primarily wood) sealed inside the bag. By far, wood can be the largest source of moisture inside a sealed barrier bag. To this end, the following formulas must be used to determine the number of required desiccant units depending on if wood is sealed inside the barrier bag or not.

  **1) No Wood Sealed Within Barrier Bag:**

  Desiccant Units = Crate O.D. surface area ($in^2$) x .002 units/$in^2$ (includes crate bottom, i.e., 6-sided crate)

  **2) Wood Sealed Within Barrier Bag:**

  Desiccant Units = (Crate O.D. surface area ($in^2$) x .002 units/$in^2$) + ($Ft^3$ wood inside bag x UCF)

  Formula 2 requires users to know their beginning average wood moisture content as defined and measured in Applied Materials 0251-11462 Wood Packaging Moisture Content Requirements. When sealed inside a barrier bag, the maximum wood moisture content is 15%. At 10% MC, it is a non-factor (additional desiccant is not required to absorb wood moisture).

| **Units Required per $Ft^3$ of Wood Inside Barrier Bag** | | | | | | |
|---|---|---|---|---|---|---|
| Beginning Avg Wood MC | **15%** | **14%** | **13%** | **12%** | **11%** | **≤10%** |
| Units per Wood $Ft^3$ (UCF) | 106 | 84.8 | 63.6 | 42.4 | 21.2 | 0.0 |

**Table 8-1: Desiccant Units for Wood Moisture**

By using the proper number of units above inside a 100% sealed barrier bag, the relative humidity inside the barrier bag can be kept at 60% RH and below for 1 year which will prevent fungal growth and bare-metal corrosion. The lower the RH, the lower the dew point, as well, and thus less chance for condensation to occur.

Note: If a crate cap does not exist to calculate crate surface area (e.g., skid-only shipment), then simulate the calculation as if a crate cap did exist.

## 8.6. Product Loading

To avoid personal injury and/or product damage, good judgment must be utilized when loading the product onto its shipping base or into its crate. Guidelines may vary according to the supplier's safety standards and should take precedence over those guidelines listed below.

### 8.6.1. Mechanical Lift

- In general, all product greater than 65 pounds should be mechanically lifted (forklift, overhead crane, etc.) onto its shipping base or into its crate. Handler should adhere to their established safety procedures within their company.
- Always lift a product as instructed by the labeling on the outer bag. If labeling does not exist, utilize a best-known-method.
- When lifting on eyebolts, all eyebolts must be utilized in the lifting operation. Eyebolts should always be lifted at no greater than a 30° angle off vertical.
- When lifting with a forklift, care must be taken not to damage the product, especially those components near the fork blades such as casters, leveling feet, plumbing, fittings, framework, and panels. Looking and feeling underneath the equipment before lifting is highly recommended.
- When lifting a product, the lifting mechanism must be placed in such a manner that maximizes product stability when lifted. There should always be a minimum of two spotters, one on each side of the product, to assist the loading and positioning of the product onto its shipping base or into its crate.

## 8.7. Product Securement for Shipment

### 8.7.1. General

- All products must be crated in a manner which prevents product shifting during shipment.
- Components not suitable for securement to shipping bases (with or without floaters) must be placed in a container with a minimum of 2.00” of cushioning material between the product and the inside surfaces of the crate.

### 8.7.2. Banding

- Banding must be a minimum of .75 x .02” commercial steel strapping. Larger banding to be used based on load capacity
- Banding must always run $\leq$ 15° off vertical (perpendicular to floor).
- Banding must never be in direct contact with the product or product bagging.
- A minimum of two bands is required on all product requiring banding.
- Two banding clips per steel band must always be utilized.
- All banding must be taut with very limited flexibility.

- When banding to floating deck, banding must run under the floating deck. Moreover, banding must run underneath a lumber member on top of the floater so as not to rip through or flex the plywood and thus loosen the banding. A maximum of 1.00" thick polyethylene foam can be used under banding only in circumstances where lumber and/or plywood battens cannot be used due to product design or compromise to product protection.

### 8.7.3. Battens

- Stand-alone battens (single piece) must be manufactured from minimum 2 x 4 lumber. Batten assemblies (two or more pieces assembled into one unit), however, may be required to properly fit a product. If a batten assembly is required, other lumber and plywood sizes are acceptable if the assembly is robust in design.
- Lumber battens must be placed on top of a **flat, solid** surface of the product underneath the banding. The lumber battens must overhang the equipment by a minimum of .50" on each end.
- In order to distribute the banding compression force and prevent equipment damage, minimum 3/4" plywood battens must be used (in combination with lumber battens, if necessary) for equipment without solid framework or structure underneath the equipment's top surface. Plywood must overhang the equipment by a minimum of .50" on all sides.
- Whenever possible, battens must remain outside the barrier bag.

### 8.7.4. Product Handling and Securement Features

The product design itself can be, and often is, used to secure the product in its crate for shipment. Features such as fork tubes (through which lumber braces can run) and L-flanges with bolt holes that are bolted onto the bottom of the product (through which lag screws can run) are extremely useful and can provide a very adequate and safe means of securement. If such product features exist, they should be used, but only if they do provide adequate securement and safety, and do not damage the product.

### 8.7.5. Batten and Banding Illustrations

Figure 8-4 shows two methods of securing equipment to the crate with battens and banding. One to two layers of microfoam with a combined **maximum** thickness of 3/8" must be used between battens and the product. The lumber well around the bottom perimeter of the product is the best method, and preferred method, for preventing horizontal movement of the product during shipment. In both illustrations, the bands are running perfectly vertical and run under the floater around the well member or load bearing member.

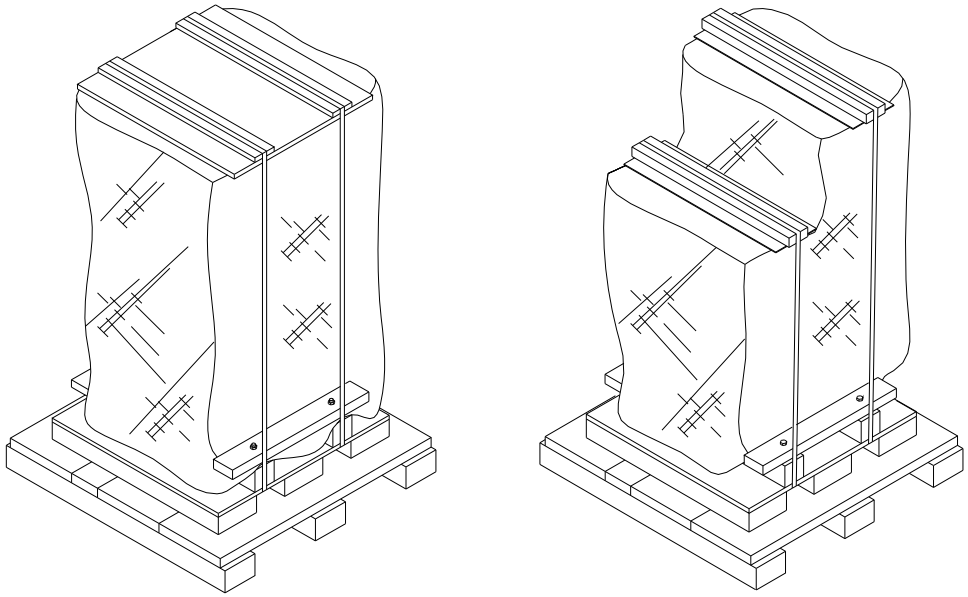


**Figure 8-6: Batten and Banding Examples**

### 8.7.6. Brackets

For product securement to its shipping base, custom steel brackets may be required which interface with some portion of the product design. All brackets must be manufactured from A-36 hot-rolled low carbon plate steel, must be cut with a laser or water jet, and must be powder coated with a black wrinkled finish.

## 8.8. Removable Panel Securement

Once the crate is manufactured and the product is loaded in the crate, closure of the removable panel is necessary to complete the crate. The following requirements must be met when securing the removable panel.

- Klimps can be utilized to secure the removable panel when the panel is $\leq$ 64 square feet. Klimps must be spaced 18-24" on center from one another.
- 3/8 x 3.00" lag screws must be utilized to secure removable panels > 64 square feet and must be spaced 18-24" on center from one another.
- A lead hole the length of the lag screw must be drilled prior to installation to prevent splitting
- A combination of Klimps and lag screws can be used, and in many instances, is required to secure the removable panel. If both are used, spacing does not change (18-24").

# 9. CRATE MARKING AND MONITORING

Crate "marking" consists of labeling and stenciling while "monitoring" refers to monitoring devices and instruments which detect and/or record shock, vibration, and/or tilt. Applied Materials desires to project a very recognizable and positive brand in the marketplace, so extra care must be taken to ensure the aesthetics of the crate exterior are superior and compliant to this section.

## 9.1. Shipping Scenarios

1) When shipping to an Applied Materials Customer, including supplier shipments on behalf of Applied Materials (pass-thru/dropship/merge-in-transit/distributed operations), full compliance with section 9 is required.
2) When shipping to an Applied Materials Spare Part Global Distribution Center (GDC) or Part Depot, compliance to section 9 is required. Note: In these instances, wood treatment for pests must always comply with Applied Materials *0251-07660, Wood Packaging Phytosanitary Requirements* since final shipping destination may require international transport.
3) Applied Materials' intra-company (facility-to-facility) shipments must comply with section 9 in full.
4) Suppliers shipping to an Applied Materials' manufacturing site are not required to adhere to section 9 except for a packing list and country of origin requirements (enabling shipment identification and receipt); However, it is highly recommended that this section be followed in full to enable proper crate handling during transport.

## 9.2. General Requirements

- All shipping labels must specify **Country of Origin (COO)**. All country of origin markings must be in accordance with the *U.S. Federal Trade Commission's "Made in USA" policy and Part 134 of the U.S. Customs Regulations (Title 19)*: (www.ftc.gov).
- All crate markings and devices, when checked for level, must not be off horizontal more than 1/4" for every 12.00" of rule unless otherwise specified.
- All crate surfaces underneath markings and devices must be free of dust, dirt, oils, markings, or any other substance which could reduce the level of adhesion or legibility.
- Prior to applying labels, envelopes, monitoring devices, and alike, **the entire crate surface area underneath these mediums must be liberally coated** with spray adhesive (3M Super 77 or equivalent) to prevent any level of label peeling or delamination, even if the medium already has an adhesive backing. **For maximum adhesion, allow adhesive to set for a minimum of 30 seconds but no more than 15 minutes before applying medium.**

- Some shorter and smaller crates can impose space limitations on their exterior. In these cases, the supplier should use a more suitable area on the crate; use all available crate surface area (including cleats and top panel, if absolutely necessary), and prioritize the markings and devices as such: **1)** Crate shipping label and packing list; **2)** Project/Identification # stencil; **3)** Shock/tilt indicators as required **4)** Handling symbol grouping stencil; **5)** Fragile stencil.

## 9.3. Return to Stock (RTS) Parts

**Applicable to Applied Materials only:** Often times, crated goods in stock at a manufacturing site's warehouse are sent out to the site's manufacturing work center for use. They are then unpackaged, not utilized for various reasons, and sent back to stock. Since the original packaging and crating have been removed, the RTS goods require crating again before going back into stock so they can be properly handled and protected. In these instances, the only markings required are the packing list, the crate shipping label, the project/identification # stencil, the center of balance/do not stack/top heavy stencils as required, and "RTS" in 2.00 high black letters in the upper left hand corner of each crate side panel. In the event the crated goods are pulled out of stock and shipped to the site's manufacturing work center again, the crate need not be marked and labeled any further. If shipped anywhere else outside the local area, the crate must be fully marked and labeled per section 9. At the very least, this would require the full removal of the "RTS" stencil.

## 9.4. Return to Vendor (RTV) Parts

**Applicable to Applied Materials only:** Crating for goods returned to a vendor or supplier from Applied Materials (for any reason) must comply with the full marking and labeling of section 9.

## 9.5. Center of Gravity Calculation

- Supplier is responsible for determining the method of calculation and marking all applicable crates with a center of gravity stencil per section 9.9, item J.

## 9.6. Labeling Requirements

- All crate label material must be poly (plastic) based except for dangerous goods/hazardous material labels. Vinyl is the preferred poly material.
- Label printing must be of laser printer quality and must be highly legible.
- Labels, and any other flexible medium such as packing list envelopes, must be smoothly applied to the crate surface without obvious creases or folds.

## 9.7. Stenciling Requirements

- Alphanumeric stencils must be of a plain/simple font and must be ≥3/4in (19mm) high as a default. Fonts that are intricate or too small cannot be easily read.

- Stencils must be cut with precision equipment (water jet, laser, sample table, stencil machine, etc.) such to help facilitate graphic aesthetics and quality.
- Stencil ink must be applied using a stencil ink roller. Stamping, brushing, and spraying painting are prohibited. Graphics can also be applied using a precision ink stamp.
- All stenciling must not appear faded in any way. The shade of color must be consistently dark throughout the graphic. Black is the default ink color unless otherwise shown or specified.
- Stencil lettering and graphics must be legible and in good readable condition.
- Stencil templates must be cleaned or replaced on a regular basis if their condition deteriorates the quality of the intended graphic.
- Stencil templates must be ≤1/16" thick for the roller to sufficiently fill in all areas of the stencil and maximize graphic quality at the edges.
- All stencils must sit flat during ink application to prevent blurring of the graphic's edges.

## 9.8. Monitoring Device Requirements

- Devices must not be triggered prior to shipment. If triggered, replace or re-set.
- Devices must not be in any potential path into which forklift tines, material handling equipment, or banding/strapping may travel.
- Devices on crate interiors must be placed where they are immediately visible once the crate is opened and when the moisture barrier bag and/or product are removed.
- Spray adhesive must be used underneath all shock and tilt indicator labels.
- See Section 9.9 item E for more information.

## 9.9. Marking and Monitoring Application

### A Applied Materials Logo Stencil

| P/N | Crate | Dimensions |
|---|---|---|
| 0205-02548 | All ≤ 37" High | 5.56 x 4.00" |
| (Scale 1.5X) | All 37-73" High | 8.34 x 6.00" |
| (Scale 2.0X) | All > 73" High | 11.13 x 8.00" |

**Required:** Locate in upper left corner of each side and end panel. If space between cleats does not permit specified size, default to next smaller size until it fits, **4 per crate.**

### B Fragile Stencil

| P/N | Crate | Dimensions |
|---|---|---|
| 0205-01930 | All ≤ 73" High | 8.00 x 2.31" |
| (Scale 1.5X) | All > 73" High | 12.00 x 3.50" |

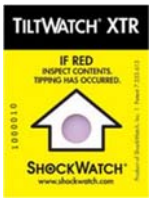
**Required:** Center on each side and end panel on a 10° angle (per stencil design). Vertically locate from middle (preferred) to upper half of each panel, **4 per crate.**


### C Horizontal Handling Symbol Grouping

| P/N | Crate | Dimensions |
|---|---|---|
| 0205-00606 | All ≤ 37" High | 3.00 x 8.25" |
| 0205-00605 | All > 37" High | 4.00 x 11.00" |

**Required:** This orientation takes priority over the vertical orientation if space permits between cleats. Locate on upper right corner of each side and end panel, **Up to 4 per crate**.

| D | Vertical Handling Symbol Grouping | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |  |
| 0205-00610 | All ≤ 37" High | 2.25 x 10.50" | |
| 0205-00609 | All > 37" High | 3.00 x 14.00" | |
| **Required (Alternate):** Locate on upper right corner of each side and end panel if space permits between cleats, **Up to 4 per crate**. | | | |

| E | Shock* / Tilt Indicators | | |
|---|---|---|---|
| **P/N** | | **Orientation** | |
| 3540-00225 |  | Vertical → |  |
| 3540-00285 |  | Horizontal → |  |

***Shock/Tilt indicator required only on crates >150lbs (68kg). All AGS crates not to have either indicator regardless of weight. Exceptions to this requirement may be dictated by the crate drawing or Packaging Engineering can waive the requirement via email on specific products, an SPS/ESW is not required.** Apply indicator(s) on the face of the front panel in the lower right corner. Apply the second indicator(s) on the adjacent panel to the left of the front panel in the lower left corner. Apply in the **vertical** orientation unless space limited. Avoid placing shock/tilt watch on the removeable panel. Ensure the indicators are securely attached. If crate is fully tarped, add a plywood placard on the outside of the tarp and apply the indicators. Refer to Figure 8-2: Crate Tarping Example 2.

## F Project Number/Identification Stencil

| P/N | Crate | Dimensions | |
|---|---|---|---|
| N/A | All | .75-2.00" High | **300475** (Above is Example Only) |

**Required:** Horizontally and vertically center unique project or I.D. number on top cleat of side and end panels, **4 per crate**

## G Air Ride Vehicle Required Stencil

| P/N | Crate | Dimensions | |
|---|---|---|---|
| N/A | As Required | .75-2.00" High | **AIR RIDE VEHICLE REQUIRED** |

The Air Ride Vehicle Required stencil should only be used as dictated by Applied Materials Engineering, Global Logistics, crate drawing, sales order or customer requirements.

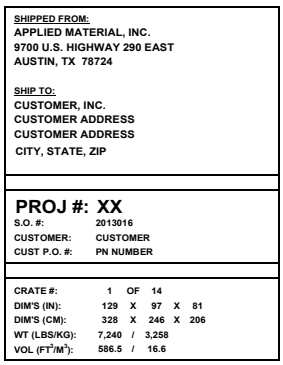
## H Shipping Label*

| Crate | Dimensions |
|---|---|
| All | 5.50 x 8.50" (Half Sheet) OR |
| | 8.50 x 11.00" (Full Sheet) |

**Required:** Label(s) to be clear (transparent) or paper printed and inserted in a waterproof sealable clear envelope. Both labels to be laser printed. Locate underneath or beside the Applied Materials logo stencil (or head high on tall crates) on the removable panel (if one exists), **1 per crate.**

If crate is fully tarped, place a second shipping label on the outside of the tarp.

Shipping label to contain, at minimum, ship-to and ship-from addresses, country of origin, crated weight, crate outside dimensions, crate volume, and any pertinent project information such as the project number, sales order number, and customer purchase order number. *For supplier inbound shipments, please refer to 0250-07710 Packaging Labeling Specification.


SHIPPED FROM:
APPLIED MATERIAL, INC.
9700 U.S. HIGHWAY 290 EAST
AUSTIN, TX 78724

SHIP TO:
CUSTOMER, INC.
CUSTOMER ADDRESS
CUSTOMER ADDRESS
CITY, STATE, ZIP

PROJ #: XX
S.O. #: 2013016
CUSTOMER: CUSTOMER
CUST P.O. #: PN NUMBER

CRATE #: 1 OF 14
DIM'S (IN): 129 X 97 X 81
DIM'S (CM): 328 X 246 X 206
WT (LBS/KG): 7,240 / 3,258
VOL ($FT^3/M^3$): 586.5 / 16.6

| I | Packing List/Documentation Envelope with TE Label | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |  |
| 0205-00720 | All > 37” High | 11.00 x 12.50” | |
| 0205-00721 | All ≤ 37” High | 6.50 x 11.00” | |
| 3540-00110 | 1 per Envelope | 2.00 x 3.38” | |
| **Required:** Place only on crate # 1 of multiple crate order. Locate directly underneath or beside Shipping Label when feasible, **1 per order.** | | | |

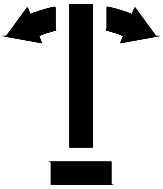
| J | Center of Gravity (CoG)* | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |  |
| N/A | All | 3.00 x 3.00” | |
| **Place CoG on crate, 4 per crate. If a stencil lands partially on a cleat it is okay to add material to increase the surface area for it.** *If CoG is unknown, 1. find center of balance 2. Apply CoG at center of balance and locate Z-axis at the following – | | | |
| < 37” locate at mid-height of crate | | | |
| ≥ 37 < 73” locate at +4” from mid-height of crate | | | |
| ≥ 73 < 120” locate at +8” from mid-height of crate | | | |
| ≤ 120” locate at +12” from mid-height of crate | | | |

| K | Do Not Stack Stencil | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |  |
| 0205-00602 | All ≥ 73” High | 3.00 x 6.50” | |
| **As Required:** Center horizontally on each side and end panel. Locate directly underneath the top cleat, **4 per crate**. | | | |

## L Top Heavy Stencil

| P/N | Crate | Dimensions |
|---|---|---|
| 0205-01094 | All ≥ 200 lbs. **and** ≥ 48" height **and** height ≥ 2X width | 5.00 x 6.00" |

**As Required:** Center horizontally on each side and end panel. Locate directly underneath the top cleat or underneath or next to the Do Not Stack symbol if one exists, **4 per crate**. If center vertical cleat exists, it is okay to offset stencil.



## M 25G Shock Indicator for Floating Decks

| P/N | Floating Decks | Dimensions |
|---|---|---|
| 3540-00223 | All | 1.69 x 1.69 |

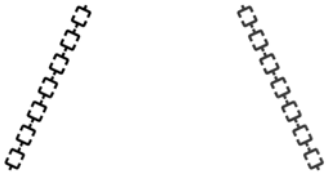
**As Required:** A 25G yellow Shockwatch®2 impact indicator is required on all floating deck assemblies. **Locate only on a <u>vertical</u> surface** out of the way of product loading area and material handling equipment paths such that it is immediately visible upon unpacking. If a vertical surface does not exist, or it does exist but is smaller than the indicator, add a wood block to the floating deck for the sole purpose of mounting the indicator. Use spray adhesive underneath each indicator. Install only upon final packing operation, **1 per floating deck assembly**.


## N Forklift Here - Left Side

| P/N | Crate | Dimensions |
|---|---|---|
| N/A | As Required | 1 |

**As Required:** Use on Style D crates or when specified by the customer. See Figure 9-5. If shown stencil cannot fit on crate, stencil FORKLIFT HERE and adjust font size as needed.

| O | Forklift Here - Right Side | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |   |
| N/A | As Required | 12.00 x 12.00” | |
| **As Required:** Use on Style D crates or when specified by the customer. See Figure 9-5. If shown stencil cannot fit on crate, stencil FORKLIFT HERE and adjust font size as needed. | | | |

| P | Chain Lift | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |  |
| N/A | As Required | 1.69 x 20.00” 60deg | |
| **As Required:** Use on Style D crates or when specified by the customer. See Figure 9-5. | | | |

| Q | Do Not Forklift | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** |   |
| N/A | As Required | 12.00 x 12.00” | |
| **As Required:** Use on crates when specified by the drawing. If stencil shown cannot fit on the crate, stencil DO NOT FORKLIFT and adjust font size as needed. | | | |

| R | Crate Part Number | | |
|---|---|---|---|
| **P/N** | **Crate** | **Dimensions** | **CRATE 0205-XXXXX** (Above is Example Only) |
| N/A | As Required | .75-2.00” High | |
| **As Required:** Use on Applied Materials crate drawings. Locate PN stencil on the bottom cleat side panels and crate base outer skids. See example in Figure 9-7. | | | |

| | |
|---|---|
| **Crate Style** | Style B |
| **Crate O.D.** | 31.25 x 28.75 x 30.00 in |
| **Product Weight** | 95lbs. |


**Figure 9-1: Example 1 - Crate Exterior Marking**

| | |
|---|---|
| **Crate Style** | Style B |
| **Crate O.D.** | 48.00 x 36.00 x 68.00 in |
| **Product Weight** | 1,400 lbs. |

**Figure 9-2: Example 2 - Crate Exterior Marking & Device Placement**

| | |
|---|---|
| **Crate Style** | Style C |
| **Crate O.D.** | 96.00 x 96.00 x 113.13 in |
| **Product Weight** | 6,700 lbs. |

**Figure 9-3:Example 3 - Crate Exterior Marking & Device Placement**

| | |
|---|---|
| **Crate Style** | Style B (Top Heavy) |
| **Crate O.D.** | 76.00 x 30.00 x 68.00 in |
| **Product Weight** | 2,100 lbs. |

**Figure 9-4: Example 4 - Crate Exterior Marking & Device Placement**

| | |
|---|---|
| **Crate Style** | Style D |
| **Crate O.D.** | 161.00 x 148.00 x 136.00 in |
| **Product Weight** | 60,750 lbs. |

**Figure 9-5: Example 5 - Crate Exterior Marking & Device Placement**

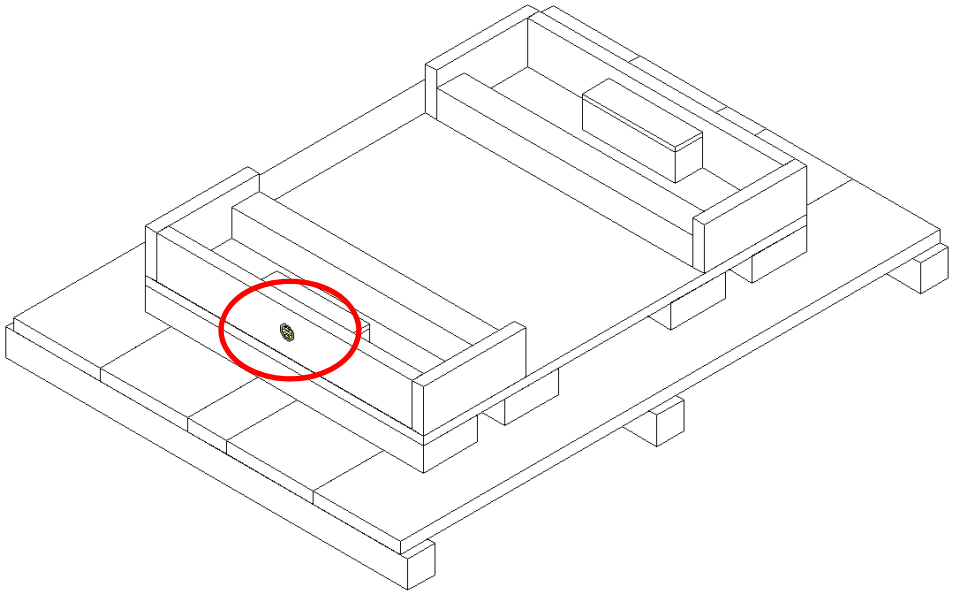


**Figure 9-6: Example 6 - Floating Deck 25G Shockwatch 2 Placement**

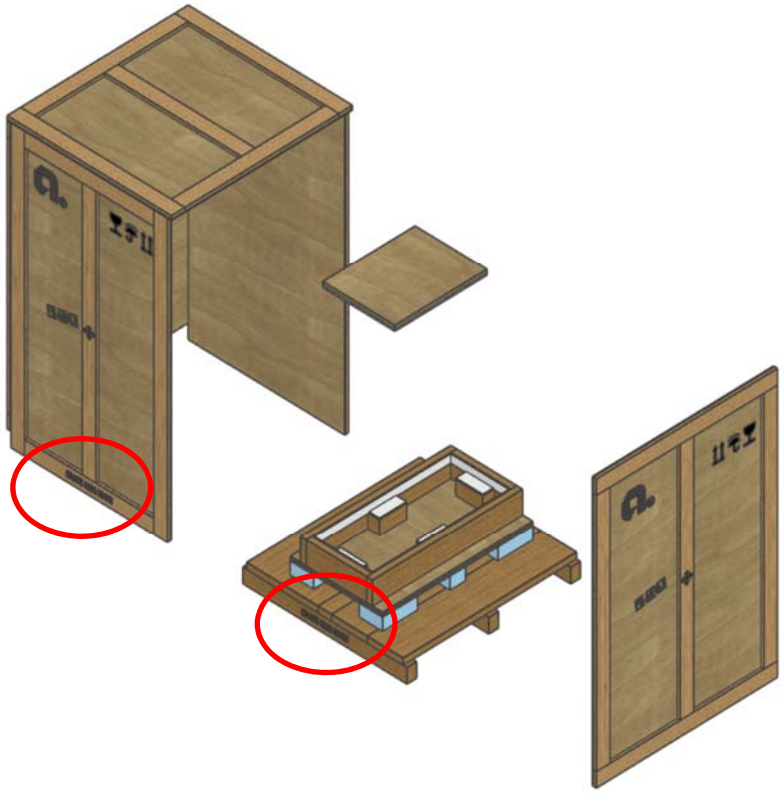


**Figure 9-7: Example 7 – Applied Materials Crate PN Stencil**

# 10. CRATING AND PACKING CHECKLIST

| Item | General Packing Requirements | Yes | No |
|---|---|---|---|
| 1 | When consolidating, packing, and crating multiple boxes and totes, place heavier items on the bottom and the lighter and more fragile items on the top. | | |
| 2 | Miscellaneous unboxed parts should be placed around and on top of boxes and totes or should be crated separately if such a packing method compromises product protection. | | |
| 3 | All totes and boxes must be placed into the crate in their upright position, not on their sides or upside-down. | | |
| 4 | Totes and boxes must not be stacked more than 3 high.<br>If containers on the bottom appear to be getting compressed, re-stack the items or separate the containers from one another. **Do not overpack the crates.** | | |
| 5 | Block, brace, void-fill, and/or cushion the boxes, totes, miscellaneous items, and pallet load to prevent excessive (2 or more inches) of movement inside the crate.<br>This can be achieved using plank foam, stretch wrap, wood, or other approved packing materials. **Scrap foam less than 144 square inches is prohibited as void fill**. | | |
| 6 | When packing small parts/orders, parts being sent to the same address can be crated together. All parts must be adequately immobilized and secured inside the crate.<br>Care must be taken to separate/cushion the parts in general, and from one another, such that product damage of any kind is prevented during packing and shipment. Bubble wrap and/or foam sheet cushioning is a versatile, inexpensive method for packaging small parts/order. | | |

*Continues next page*

| Item | General Packing Requirements | Yes | No |
|---|---|---|---|
| 7 | All parts/loads must be stable once the method for holding them in place is removed (removal of banding, brackets, stretch-wrap, etc.). | | |
| 8 | All crates with a floating deck **must not lean** after product is loaded; no more than ¼" foam compression delta from one side to the other is allowed. Foam must have uniform compression. | | |
| 9 | All crates with a floating deck must not show signs of delamination on the foam to wood bond. Use of a 4' or longer pry bar can be used to test the foam to wood bond strength. | | |
| 10 | All crated product must be poly bagged and not have signs of damage.<br>Product bagging is not the responsibility of contracted craters and should be returned to its origin if not bagged. **Bagged product which is received must not be cut open to access any handles or material handling devices without prior approval from the product owner.** | | |
| 11 | Dust and debris must be removed from all crates. | | |
| 12 | Excessive shoe prints, as well as other unspecified markings, must be removed from crates except for grade or heat-treated stamps. | | |
| 13 | No branding information is allowed. | | |
| 14 | All liquid items, such as ethylene glycol and deionized water, must be crated separately from other non-liquid product.<br>Like liquids must be placed into the same crate. Unlike liquids must be separately crated.<br>The product must be placed into vermiculite absorbent material. Must be shipped in dedicated crates. Liquid containers to be shipped up right to its opening. | | |
| 15 | Verify crate dimensions are correct for the mode of transportation. Contact Packaging Engineering for guidance. | | |

# 11. RECYCLING/RE-USING CRATES FOR SUSTAINABILITY

## 11.1. General Requirements

- Must emphasize on sustainability and waste reduction
- Requires an approved process map, detailing labor, timing, logistics, storage and refurbishment
- Reusable crates/cases must have a 0205- part number
- RFID tracking is preferred
- Key stake holder alignment – engineering, logistics, suppliers, sales and marketing
- Must have cost / ROI analysis
- Design for re-use – no nails or lag screws, use of link locks, router edges
- Possibility of using a case over a crate

## 11.2. Crate Recycle/Re-Use Markings

- SAVE CRATE FOR RE-USE – (.75-2.0" tall font / locate @ center bottom, all sides)
- RETURN TO <ADDRESS> – (.75-2.0" tall font / locate @ center bottom, all sides)

# 12. TERMINOLOGY

**Adhesive** - An organic substance that unites two or more surfaces to one another.

**Barrier Bag** – Moisture proof/resistant flexible material that has been formed into a bag by heat sealing sections of the material together.

**Batten** – A lumber component used under banding to secure the product within its crate.

**Blocking and Bracing** – A general term used to describe the process of stabilizing a load with a crate.

**C to C** – Center to center. The dimensional midpoint of one component to the midpoint of another component.

**Cleat** – A lumber material used to frame a crate panel which provides support and structure to that panel.

**Clinch Nail or Staple** – A nail or staple that is longer than the combined thickness of the wood it is driven into which is designed to strike a hard surface then bend back creating a hook at the tip side of the fastener.

**Crate** - A shipping container mostly constructed of lumber and/or plywood used to protect a product during shipment.

**Crate Cap** – Five panels (top, sides, and ends) secured to one another in a permanent or reusable manner.

**Crate Style** – A term used to identify the component and construction parameters of the crate.

**Decay** – A decomposition (rotting) of wood due to the action of wood destroying fungi.

**Delamination** – A visible separation of plies or layers of wood through the failure of the adhesive bond.

**Discoloration** – Stains in wood substances.

**Divergent Staple** – A crown head staple with legs that spread as it is driven into the wood.

**Drop End Panel** – A panel which extends to, and is flush with, the bottom of a skid upon cap installation.

**Edge Cleat** – A lumber component of a plywood panel that is located at the panel perimeter.

**Exterior Plywood** – Plywood which will retain its glue bond when repeatedly wetted and dried or otherwise subjected to the weather.

**Floating Deck (Floater)** – A multi-piece assembly of flexible foam and wood that is glued to the base of a crate used to isolate the product to mitigate shock and vibration to the product. A spring deck is also a type of floating deck and uses both foam and steel coil springs.

**Floorboard** – A lumber component of a shipping base that is used to make the top surface of the base.

**Grain** – The fibers in wood and their direction, size, arrangement, appearance, or quality.

**Header** – A lumber component placed at the end of each base that is bolted to each skid. Headers help to maintain shipping base squareness and add support for lifting or moving heavy crates from their ends.

**Heat Seal** – The process of sealing two layers of material together via the melting and subsequent cooling and bonding of their poly layers.

**Intermediate Cleat** - A lumber component of a plywood panel that is located on the interior of the panel. Common intermediate cleats are called splice cleats and filler cleats.

**Joint** – The common edge between two adjacent materials in the same plane.

**Klimp** – A reusable spring type fastener used to hold two cleated panels together.

**Knot** – A portion of a branch or limb that has become incorporated into a piece of lumber.

**Label** – A printed material which is attached to the crate to identify contents, ownership, and any number of instructions to the crate handler.

**Lag Frame** – Lumber components on the inside perimeter of the crate opening (removable panel side) used to lag screw the removable panel in place.

**Lead Hole** – A hole drilled into wood to prevent wood split upon the entry of a fastener into the hole.

**Load Bearing Member** – A lumber component used to distribute the product weight over a large area.

**Longitudinal Skid** – A lumber component running the entire length of the shipping base used to provide the primary strength and support to the base as well as a common fastening surface for base components. They are also used to create a gap between the ground and the floorboards when 4-way entry is not used.

**Lumber** - Any solid wood material that is primarily defined by its width & length.

**Major Module** – An Applied Materials term used to label product which is typically a heavy and/or large assembly, cabinet-like in nature, usually with casters and/or leveling feet.

**Mechanical Lift** – A non-manual (non-human) lifting process which utilizes a mechanical tool or mechanism for lifting.

**Moisture Content** – The weight of the water in wood expressed in percentage of the weight of the oven-dry wood.

**Moisture Vapor Barrier Material** – A multi-layer flexible material used to reduce or prevent the transfer of water molecules. It creates a moisture barrier between the environment and the product.

**Nailing Pattern** – The methodical and organized layout of nails in such a way as to maximize the securement of components to one another.

**Packing Process** – The process of loading the product inside the crate and performing the necessary operations to stabilize, isolate, brace, secure, and/or bag the product in preparation for shipment.

**Panel** – A lumber cleat and plywood assembly formed together to create a wall of a crate cap.

**Panel Stop** – A strip of plywood used to stop a removable panel from caving into the crate interior.

**Plugs** – Sound wood of various shapes used to replace defective portion of plywood veneers.

**Plywood** – A flat wood panel composed of an assembly of adhered layers of wood untied under pressure with each layer at right angles to each other.

**Rail** – A lumber component running the length of the shipping base on top of the floorboard ends used to maintain floorboard attachment to the skids upon lifting of the crate.

**Removable Panel** – A crate panel that be easily installed and uninstalled multiple times without any degradation to the crate. It is primarily used to allow for quick removal of the crate cap from around the product.

**Riser** – A component used to raise the product such that interference with the crate is eliminated.

**Rub Strip** – A lumber component secured to the bottom of a skid which allows the crate to be entered underneath by a forklift from all four sides. They can also serve as a ledge for the crate panel to rest upon. They also allow the crate to be pushed or pulled along the ground without the need for lifting the crate off the ground.

**Sanded Shop Plywood** – Plywood which has had its outer surfaces sanded to remove irregularities.

**Sandwich** – To place between.

**Shiner** – The exposed protruding tip of a fastener (e.g., nail, screw, etc.) through wood.

**Shipper** - Any shipper of product, including both Applied Materials and its suppliers.

**Shipping Base** – The lower portion of the crate on which its contents rest typically comprised of rub strips, skids, floorboards, headers, rails, and/or a floating deck.

**Shipping Bracket** – Any device, usually manufactured from steel, which is used to secure a product to its shipping base to immobilize it for shipment.

**Shock** - A sudden, severe, non-periodic excitation of an object or system.

**Skid** – A lumber component running the entire length of the shipping base used to provide the primary strength and support to the base as well as a common fastening surface for base components. They are also used to create a gap between the ground and the floorboards when rub strips are not used.

**Skid Racking** – The toppling over of skids due to skid width being less than skid depth.

**Splice** – The seam between which two components are joined.

**Split** – A separation of the wood through the piece to the opposite or adjoining surface due to the tearing apart of wood cells.

**Stencil** – A graphic design which is typically used to relay handling instructions of the crated product. A stencil is applied filling the design cut-out with a thin layer of ink.

**Tilt Indicator** – A small mechanical device that mounts to the surface of a crate to indicate if the crate has been tipped and/or to what degree it has been tipped.

**Wane** – Bark or lack of wood from any cause on the edge or corner of a piece of lumber.

**Warp** - Any deviation from a true or plane surface, including a bow, crook, cup, and twist, or any combination thereof, usually developed during drying.

**Well** – A configuration on a floating deck whereby lumber components surround the product on all sides to prevent product lateral movement during shipment.

# APPENDIX A – Tarpaulin Material Specification

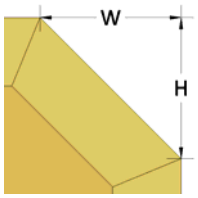
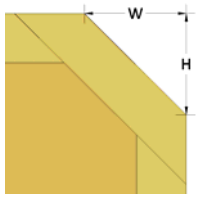
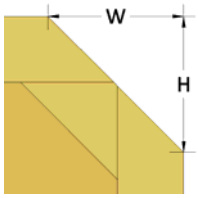
| Tarpaulin Material Specification | | | |
|---|---|---|---|
| **Material** | LDPE | **Color** | Blue |
| **Thickness** | 12mil (minimum) | **Width** | N/A |
| **Length** | N/A | **Density** | Warp: 16/ inch<br>Weft: 12/ inch |
| **Puncture Strength / Warp/Weft** | ≥ 52 kgf | **Water Permeability** | 0% |
| **Tearing Strength / Warp/Weft** | ≥ 21 kgf / ≥ 16 kgf | **Tensile Strength** | ≥ 168 kgf / ≥ 125 kgf |
| **Breaking Elongation / Warp/Weft** | ≥ 11.5% / ≥ 13% | **UV Exposure Appearance Test** | None |
| **UV Exposure Tensile Strength Test – WARP / WEFT** | ≥151.5 kgf / ≥ 115 kgf | **UV Exposure Retention Rate Test – WARP / WEFT** | ≥ 90% / ≥ 92% |

Notes:

1. The average thickness is the average of multi-point measurements
2. UV exposure test according to ASTM G154-16 Cycle 1. The time is 200 hrs., the conditions are as follows: (1) light source: UVA-340 92) Illumination intensity: 0.89W/m2/nm (3) Appropriate wavelength: 340nm (4) Cycle period 8 hrs. illumination (60C BPT), 4 hrs. condensation (50C BPT)
3. Strength retention rate formula: (tensile strength after illumination/tensile strength before illumination) X 100%

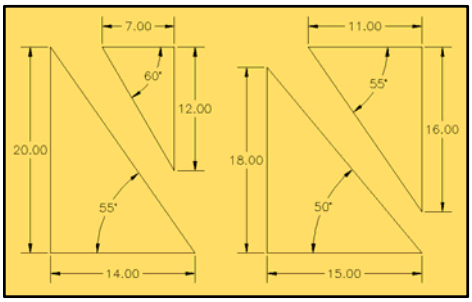
# APPENDIX B - CLEAT STRUCTURE

The edge cleat configuration at the panel chamfer location must be per the below requirement:

| Allowed (Mitered) | Allowed (Full Angle) | Prohibited |
|---|---|---|
|  |  |  |



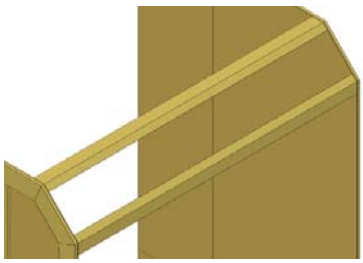
# APPENDIX C - CHAMFER ANGLES AND DIMENSIONS




To make chamfered cap design and manufacturer more efficient, it is strongly recommended that a chamfer of 45° be used whenever possible to produce a chamfer with equal width and height. If that cannot be done, then it is recommended that the chamfer width and height at least be specified to the nearest whole inch (or 25mm) that produces an angle of exactly a 5° increment to 45° so it is easier to ultimately determine cleat angle cuts. For example, the chamfer widths and heights in the call-outs in 7.8.1 all produce either a 45° angle or an angle that is a 5° increment to 45° (e.g., 14.00W x 20.00H = 55°, 7.00W x 12.00H = 60°, 11.00W x 16.00H = 55°, 15.00W x 18.00H = 50°).

4) **Mitered/Angled Edge Cleats on Chamfered Panels:** Equal angles to be cut on the edge cleats at the chamfer location (cleat miter angle = 1/2 total angle) or full angles whereby the chamfer edge cleat runs full length to the panel top and side edges (see section 7.8.2).

5) **Lumber Joists:** Strong lumber joists, angled (ripped lengthwise) to match the chamfer angles, must exist underneath the top chamfer panel joints. The Joists must be a minimum of 2x4 lumber, but increase in size (3x4, 4x4, 4x6, etc.) as necessary to prevent panel sag over longer spans. The joists must



be fastened to all panels to which they contact, including through the side panels into the joist end grain (1 fastener/in2 of joist end grain).

6) **Top Panel Cleats:** The top panel and top chamfer panel cleating must be configured such that longest cleats run the full length of the crate and rest on top of the side/end panels (the chamfered panels). This provides the best support for the top panel.

# APPENDIX D – WOOD SIZING CHART

| Boards | | Dimension Lumber | | Timbers | |
|---|---|---|---|---|---|
| Rough-Cut | S4S / Dry (19% MC) | Rough-Cut | S4S / Dry (19% MC) | Rough-Cut | S4S / Dry (19% MC) |
| Inch (mm) | Inch (mm) | Inch (mm) | Inch (mm) | Inch (mm) | Inch (mm) |
| 1 x 2 (25 x 50) | .75 x 1.50 (19 x 38) | 2 x 2 (50 x 50) | 1.50 x 1.50 (38 x 38) | 6 x 6 (150 x 150) | 5.50 x 5.50 (140 x 140) |
| 1 x 3 (25 x 75) | .75 x 2.50 (19 x 64) | 2 x 3 (50 x 75) | 1.50 x 2.50 (38 x 64) | 8 x 8 (200 x 200) | 7.25 x 7.25 (184 x 184) |
| 1 x 4 (25 x 100) | .75 x 3.50 (19 x 89) | 2 x 4 (50 x 100) | 1.50 x 3.50 (38 x 89) | 10 x 10 (250 x 250) | 9.25 x 9.25 (235 x 235) |
| 1 x 6 (25 x 150) | .75 x 5.50 (19 x 140) | 2 x 6 (50 x 150) | 1.50 x 5.50 (38 x 140) | 12 x 12 (300 x 300) | 11.25 x 11.25 (286 x 286) |
| 1 x 8 (25 x 200) | .75 x 7.25 (19 x 184) | 2 x 8 (50 x 200) | 1.50 x 7.25 (38 x 184) | | |
| 1 x 10 (25 x 250) | .75 x 9.25 (19 x 235) | 2 x 10 (50 x 250) | 1.50 x 9.25 (38 x 235) | | |
| 1 x 12 (25 x 300) | .75 x 11.25 (19 x 286) | 2 x 12 (50 x 300) | 1.50 x 11.25 (38 x 286) | | |
| | | 3 x 4 (75 x 100) | 2.50 x 3.50 (64 X 89) | | |
| | | 4 x 4 (100 x 100) | 3.50 x 3.5 (89 x 89) | | |
| | | 4 x 6 (100 x 150) | 3.50 x 5.50 (89 x 140) | | |

ALS/CLS rough-cut and surfaced dimensions are shown with their equivalent metric sizes.

Common lengths for Boards and Dimension Lumber are 8-20ft (2.4-6.1m) in 2ft (.6m) increments, while common lengths for Timbers are 8-24ft (2.4-7.3m) in 2-4ft (.6-1.2m) increments. Longer timber lengths are available but are typically a custom order.

Required Dimensional Tolerances of Surfaced and Dry Lumber: ±1/32in (or 1mm) for every 1.00in (or 25mm) of width or depth.

Timbers are usually sold “green” (>19% MC). Dimensions may thus be up to .50in (or 12mm) greater due to swelling of wood fibers. For design purposes, it is best to use the dry dimensions since dry lumber is required for packaging and crating.