The PDS Pallet Specification Sheet provides complete details on pallet design, dimensions of all components, and specs for all materials used in construction.

Guide to the Pallet Design System® (PDS) Pallet Specification Sheet

**Pallet Design System Version 5.2**

**Customer:** identifies company for whom PDS design work was performed.

**Pallet ID:** identifies this particular pallet design, chosen by Customer or Preparer.

**Drawing Number, Specification Date, and Revision Info:** optional information to identify this particular specification.

**Classification:** identifies size and general design and construction of pallet:
- **Pallet Size** is listed as Length x Width.
- **Pallet-class** can be either Stringer-class or Block-class.
- **Deck-style** can be Single-Face, Double-Face Non-reversible, or Double-Face Reversible.
- **Entry-style** can be 2-way, partial 4-way, or full 4-way.
- **Use class** can be Reusable or Single-Use. **Manufacture class** can be New, Remanufactured, or Remanufactured/Combo.

**Pallet Treatments:** identifies whether Heat Treating or Fumigation is performed for ISPM-15 Compliance, and whether Conditioning (Drying) of pallet is performed after manufacture and assembly.

**Components:** for each component group, the style and type and the number and actual dimensions of each component are listed. The fastening schedule is shown graphically on the pallet drawings.

**Style:** Deck Styles include Deckboard and Panel.

**Type:** Deckboards can be New Lumber, Recycled Lumber, or Wood Composite (Panel Stips).

**Dimensions:** number and actual (average) dimensions of components at time of manufacture. Due to sawing variation, exact dimensions will vary from component to component within acceptable tolerances defined by the Uniform Standard for Wood Pallets (www.palletcentral.com).

**Special Manufacturing Features:** forklift entry notches, strapping notches and slots, and chamfers are specified within the component group receiving these manufacturing features.

**Spec Sheet Notes:** provides a place for the Preparer to input any additional or custom information to be displayed at the bottom of the Pallet Specification.

**Materials:** complete details are provided for all materials used in construction of the pallet, including Fasteners, New Lumber, Recycled Lumber, and Composite Panels.

**Fasteners:** Detailed Fastener Specifications are required in order to predict pallet performance. Pallet performance is highly dependent on the connections between components, which in turn are highly dependent on the fastener withdrawal resistance and fastener shear resistance in the connections.

**New Lumber:** New Lumber components are those produced from cants, rough-sawn lumber, or dimension lumber which has not previously been used.

- **Species Class:** Each PDS Species Class contains from one to several wood species. Species within each Class are either commonly used together without differentiation and/or they have similar mechanical properties.
- **Grade:** defines the Lumber Characteristic Restrictions permitted within the Pallet Component. Component Grades were developed to control structural and functional performance. PDS Component Grades include single grades (Select, Premium, Standard, Utility, and Economy), as well as mixed, or &BTR, grades (Premium &BTR, Standard &BTR, Utility &BTR, Economy &BTR). For single grades, all the components are of the quality defined by that grade. For &BTR grades, the minimum grade component is identified, but components of all higher grades are also included.
- **Lumber Mix:** PDS allows up to 5 different Species Classes and/or Grades within a single New Lumber Specification. This is necessary when a mixture of Species Classes is used for components.
- **Moisture Content** of the lumber components at time of manufacture and pallet assembly must be specified in PDS.

**Volume:** based on actual specified component dimensions. This is NOT the total volume of lumber required to produce pallet components, which would include saw kerf, end trim, and culling of below-grade material.

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**Pallet ID:** Stringer-Class Pallet Example

**Drawing Number:** 12245

**Specification Date:** April 1, 2011

**Revision Number:** R1

**Revision Date:** May 5, 2012

**Classification:** 48.0 x 48.0, Stringer-Class, Double-Face Non-Reversible, Partial 4-Way, Reusable, New Manufacture

**Pallet Treatments:** ISPM-15 Compliance, Heat Treatment (HT).

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**Components:**

- **Top Deck:**
  - **Number:** 625
  - **Type:** New Lumber
  - **Thickness:** 0.625 x 2.000
  - **Width:** 4.000
  - **Length:** 4.000
  - **Volume:** 42.5 ft³

- **Bottom Deck:**
  - **Number:** 625
  - **Type:** New Lumber
  - **Thickness:** 0.625 x 2.000
  - **Width:** 4.000
  - **Length:** 4.000
  - **Volume:** 27.3 ft³

**Materials:**

- **New Lumber:**
  - **Use Class:** Reusable
  - **Grade:** Premium &BTR
  - **Species Class:** Red Oak

**Notes:**

- **Prepared by:** identifies company licensed to use PDS and perform PDS design work. The Preparer understands the importance of correct pallet specification and construction and the effect on the pallet’s ability to protect and safely support Customer’s product during transport and storage.
- **Materials:** complete details are provided for all materials used in construction of the pallet, including Fasteners, New Lumber, Recycled Lumber, and Composite Panels.
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  - **Lumber Mix:** PDS allows up to 5 different Species Classes and/or Grades within a single New Lumber Specification. This is necessary when a mixture of Species Classes is used for components.
  - **Moisture Content** of the lumber components at time of manufacture and pallet assembly must be specified in PDS.

**Volume:** based on actual specified component dimensions. This is NOT the total volume of lumber required to produce pallet components, which would include saw kerf, end trim, and culling of below-grade material.
The PDS Unit Load Specification and Drawings identifies the pallet design and provides specifications for the containers and load stabilizers. Arrangement of containers on pallet, and overall weight and dimensions of Unit Load are shown.

**Guide to the Pallet Design System® (PDS)**

**Unit Load Specification and Drawings**

**Pallet Design System Version 5.2**

All dimensions in inches, weights in lbs.

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- **Entry-style** can be 2-way, partial 4-way, or full 4-way.
- **Use class** can be Multiple-Use or Limited-Use. **Manufacture class** can be New, Remanufactured, or Remanufactured/Combo.

**Pallet Treatments:** identifies whether Heat Treating or Fumigation is performed for ISPM-15 Compliance, and whether Conditioning (Drying) of pallet is performed after manufacture and assembly.

**2-D Unit Load Drawings: Side and End Views** show the entire Unit Load (pallet, containers, and load stabilizers) and overall dimensions.

**Container Type:** available types include Corrugated Box, Bags, Pails, Drums, Bulk Box, or Bulk Bag.

**Container Specifications:** style, material specifications, and dimensions of containers.

**Summary of number of containers and weight of Unit Load**

**Load Stabilizers:** style and type of materials used to secure containers to pallet and/or to offer further protection to containers.

**Prepared by:** identifies company licensed to use PDS and perform PDS design work. The Preparer understands the importance of correct pallet specification and construction and the effect on the pallet’s ability to protect and safely support Customer’s containers during transport and storage.

**Interface of Pallet and Containers:** 2-D Top View of Unit Load showing interface of bottom of containers with top deck of pallet.

**3-D Container Drawings:** provides perspective view and dimensions of the individual containers.

**3-D Unit Load Drawings:** provides perspective view of the entire Unit Load (pallet, containers, and load stabilizers).
Guide to the Pallet Design System® (PDS) Pallet Structural Analysis

**General Load Type** specifies the load model used in the Structural Analysis of the pallet. The **Safe Load Capacity** of the pallet is dependent on the Load Type. PDS contains several **General Load Types** which can be used to represent most common pallet loads.

**Weight of Actual Load**: if specified, PDS will display any **Safe Maximum Load** or **Maximum Load for Deflection Limit** less than the Actual Load in red.

**Load Weight Variability** indicates how much the weight of the load on each pallet may vary. If the pallet is used to support the same load each and every time, the variability is Low. If the pallet is used to support loads ranging from cotton bales to cans of soup, the variability is High. Since PDS uses a reliability-based engineering analysis, load variability affects the predicted safe load capacity.

**Service Environment**: Most shipping and handling environments are classified as a **Dry Service Environment**, in which the pallet is NOT continuously exposed to liquid water or extremely high humidity, and the wood will reach an Equilibrium Moisture Content (EMC) of 19% or less. **Wet Service Environments** are those in which the pallet is frequently or continuously exposed to liquid water or extremely high humidity, and the wood will reach an Equilibrium Moisture Content (EMC) greater than 19%.

**Racked Across Length** indicates the pallet is supported only at its ends, either in a rack system or conveyor.

**Span** is the distance between the supports in a rack system or conveyor.

**Racked Across Width** indicates the pallet is supported only at its edges, either in a rack system or conveyor.

**Shelf Support** indicates the pallet is completely supported by rigid shelving within a rack system.

**Forklift Support** indicates the pallet is lifted and transported while supported under the top deck by rigid forklifts. Unlike other storage support conditions, Forklift Support is assumed to be a short-term loading.

**Stacked Support** assumes the floor supports the bottom pallet in a stack. "Stacked 1 High Analysis" will always be provided. PDS can analyze the pallet when 2 or more Unit Loads are in a Stack, either in the warehouse or in shipping. The lowermost pallet has the highest stressed top deck. The second pallet up has the highest stressed bottom deck. PDS indicates which deck limits the safe load capacity.

**Lateral Collapse Resistance**: Lateral Collapse is a failure mode in stringer pallets characterized by lateral movement of the top vs. bottom deck, rotational failure of all stringer-deck connections, and collapse of stringers onto their sides. Handling equipment can no longer enter the pallet and product damage is likely. Lateral Collapse most frequently occurs during shipping when horizontal forces cause lateral movement and/or shifting of the load perpendicular to the stringers. Forces during handling of the pallet can also cause Lateral Collapse.

PDS estimates the HV Ratio, the ratio of Horizontal to Vertical Force required to cause Lateral Collapse. The Vertical Force is equal to the weight on the pallet. The handling environment supplies the Horizontal Force, either due to motion of the load during transit or mishandling by forklift. The greater the HV Ratio, the greater the Lateral Collapse Resistance.

**Deflection at Maximum Load**: PDS reports the pallet deflection at the safe load. The deflection in a loaded pallet will increase over time. Most of this increase will occur within the first few days, after which the rate of increase in deflection will subside. PDS estimates the deflection after 30 days.

**Critical Member**: The Critical Member is identified in the Pallet Structural Analysis Results for each Support Condition. The Critical Member is the component that is most highly stressed (compared to its strength) and which therefore limits the Safe Load Capacity of the pallet. If the pallet designer wishes to increase the safe load capacity of the pallet, he/she can do so most efficiently by increasing the strength of the Critical Member or making some other design change which decreases the stress in the Critical Member.

**Maximum Load for Deflection Limit**: If a Deflection Limit is specified, PDS will report the safe load to maintain this deflection limit if less than the safe load limited by pallet strength.

**User-Specified Deflection Limit**: If there is a known limit to how much pallet deflection can be tolerated in a handling system, either because of a fragile product on a pallet or deflection-sensitive handling equipment, this User-Specified Deflection Limit can be input.

If **Weight of Actual Load** was specified, PDS will display any **Safe Maximum Load** or **Maximum Load for Deflection Limit** less than the Actual Load in red.
Guide to the Pallet Design System® (PDS) Pallet Durability Analysis

The PDS Pallet Durability Analysis uses a computer simulation coupled with an engineering analysis to predict the Service Life, in terms of Handling Cycles, for the pallet described on the Pallet Specification Sheet under the Service Environment Conditions defined on this Pallet Durability Analysis sheet.

Service Environment Conditions:

Handling Environment Severity reflects the general handling and treatment of pallets in their service environment.

- **Rough Handling and Treatment** occurs in service environments using untrained or unskilled material handling personnel, cluttered or crowded handling areas, rapid and non-careful pallet handling, frequent manual handling and dropping of pallets, and non-fragile and relatively low-value loads.
- **Average Handling and Treatment** is the typical service environment using moderately skilled material handling personnel, reasonably well organized handling areas, moderately careful pallet handling, minimal manual handling and dropping of pallets, and somewhat damage-sensitive or relatively valuable loads.
- **Good Handling and Treatment** occurs in service environments using trained or skilled material handling personnel, automated handling systems, well organized handling areas, careful pallet handling at moderate speed, infrequent or careful manual handling, and fragile and relatively high-value loads.

Intended Service-Duty reflects the approximate unit load weight and determines the weight to be used in the handling cycle simulation.

- **Light-Duty Loads** uses 1000 lbs.
- **Medium-Duty Loads** uses 2000 lbs.
- **Heavy-Duty Loads** uses 3000 lbs.

The following assumptions regarding component repairs and replacements are used in the simulation and Pallet Service Life Analysis:

- **Connections** in boards can be repaired once without having to replace the board. A repaired connection is restored to 65% of its original damage resistance. In boards, only repairs to connections are allowed.
- A **replaced board** is restored to 100% of its original damage resistance, but its connections lose 10% with each replacement.
- The **number of times a board can be replaced** depends on the stringer width: boards can be replaced twice for stringer widths of 1.5 to 2 inches, once if stringer width is less than 1.5 inches, and three times if stringer width is greater than 2 inches. The same rule applies to block widths for block pallets.
- **Stringers** can be repaired **twice** without having to be replaced. They are restored to 65% of their original damage resistance when repaired, 100% when replaced. Stringers can be replaced one time.
- In the **Handling Cycle Simulation**, forces and impacts are distributed equally among the number of specific components (e.g., the two Top Leadboards, or four Corner Blocks), and so the **Damage Level** for all the components of that specific type will remain equal. Therefore, when a repair or replacement is required, all these specific components (e.g., both the Top Leadboards or all four Corner Blocks) must be repaired or replaced.

Each **Handling Cycle** assumes an average of 15 pallet handlings, with a handling defined as a single lifting, movement, and set-down of a pallet.

For **Reusable** pallets, the Handling Cycle Simulation proceeds until a specific component requires replacement but has already been replaced the allowed number of times. The **Predicted Service Life** is that number of Cycles.

For **Single-Use** pallets, which are not intended to be repaired or re-used, the Handling Cycle Simulation proceeds until a component requires repair or replacement. The **Predicted Service Life** is that number of Cycles.
Guide to the Pallet Design System® (PDS) 
Pallet Physical Property Analysis

The PDS Pallet Physical Property Analysis estimates the average Pallet Weight and the Dimensional Changes due to Wood Drying for the pallet described on the Pallet Specification Sheet.

### Average Pallet Weight At Manufacture

Average Pallet Weight is based on estimated component weights at specified moisture content. Pallet weights will decrease if lumber components lose moisture to reach equilibrium with the environment. Estimated Pallet Weights at 25%, 19%, 15%, and 12% MC are provided for reference (if less than MC at manufacture.)

### Dimensional Change due to Wood Drying

As wood dries below Fiber Saturation Point (about 28% MC), the wood fibers essentially pack tighter together. This results in a noticeable decrease in dimension across the grain, but only a tiny decrease along the grain. For lumber pallet components, the width and thickness dimensions will decrease slightly, but their length remains essentially the same.

While component dimensions may slightly decrease with drying, component strength and stiffness increases.

A general rule of thumb is a 1% decrease in width or thickness with a 5% decrease in MC (below Fiber Saturation Point).

### The Cellular Structure of Wood

The orientation of the cells across the width and thickness of lumber components is usually a combination of the tangential and radial direction.

PDS provides shrinkage measurements based on the average of tangential and radial shrinkage, with a (+/-) value based on the range possible for pure tangential or pure radial shrinkage.

The orientation of the cells across the width and thickness of lumber components is usually a combination of the tangential and radial direction.

PDS provides shrinkage measurements based on the average of tangential and radial shrinkage, with a (+/-) value based on the range possible for pure tangential or pure radial shrinkage.

The cellular structure of wood shrinks differently in two directions, based on the anatomy of the tree. Wood shrinks about twice as much tangentially as radially.
### Guide to the Pallet Design System® (PDS)

#### Pallet Production Order

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<thead>
<tr>
<th>Pallet Design</th>
<th>Materials</th>
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<tr>
<td>Order Number: 54321</td>
<td>Customer:</td>
</tr>
<tr>
<td>Production Date: December</td>
<td>Company Name of Customer</td>
</tr>
<tr>
<td>Delivery Date: December</td>
<td>Address of Customer</td>
</tr>
<tr>
<td>Number of Pallets: 1000</td>
<td></td>
</tr>
</tbody>
</table>

**Production Order Notes:**
- Provides a place to display any additional information or instructions for production staff.
- Optional information to identify this particular specification.

**Pallet ID:**
- Identification of this particular pallet design, chosen by Customer or Preparer.

**Drawing Number, Specification Date,** and **Revision Info:**
- Identification of this particular pallet design.

**Pallet Size:**
- Listed as Length x Width.

**Class:**
- Pallet-class (Stringer-class or Block-class)
- Deck-style (Single-Face, Double-Face Non-reversible, or Double-Face Reversible)
- Entry-style (2-way, partial 4-way, or full 4-way)

**Pallet Treatments:**
- Identifies whether Heat Treating or Fumigation is performed for ISPM-15 Compliance.

**Lumber:**
- Lumber ID plus Species, Grade, and Moisture Content for each component group is listed.

**Cut List:**
- A count for the total number of pieces of each component size (and Lumber ID) is provided – based on Number of Pallets to be Produced.

**Assembly Setup Data:**
- Locations of each component from end or edge of pallet are provided for use in setting up assembly jigs and machinery.

**Fastener Schedule:**
- Listed and shown graphically on the Pallet Drawings.

**Special Manufacturing Features:**
- Forklift entry notches, strapping notches and slots, and chamfers are specified within the component group receiving these manufacturing features.

**Coatings:**
- Identification of coatings used for ISPM-15 Compliance.

**Pallet ID:**
- Identification of this particular pallet design, chosen by Customer or Preparer.

**Drawing Number, Specification Date,** and **Revision Info:**
- Identification of this particular specification.