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.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallet Size</td>
<td>Listed as Length x Width.</td>
</tr>
<tr>
<td>Pallet-class</td>
<td>Can be either Stringer-class or Block-class.</td>
</tr>
<tr>
<td>Deck-style</td>
<td>Can be Single-Face, Double-Face Non-reversible, or Double-Face Reversible.</td>
</tr>
<tr>
<td>Entry-style</td>
<td>Can be 2-way, partial 4-way, or full 4-way.</td>
</tr>
<tr>
<td>Use class</td>
<td>Can be Multiple-Use or Limited-Use.</td>
</tr>
<tr>
<td>Manufacture class</td>
<td>Can be New, Remanufactured, or Remanufactured/Combo.</td>
</tr>
</tbody>
</table>

PDS can use either U.S. Customary Units (inches, lbs) or S.I. Units (mm, kg).

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

Pallet ID: identification of this particular pallet design, chosen by Customer or Preparer.

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

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: 2D Top View of Unit Load showing interface of bottom of containers with top deck of pallet.

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

Summary of number of containers and weight of Unit Load.

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).

Container Type: Corrugated Box

- Box Style: Regular Slotted Container (RSC) #321
- Outside Dimensions: Length: 400, Width: 300, Depth: 200
- Weight per Box: 20 kg
- Number of boxes per layer: 10
- Total Weight of Unit Load: 500 kg
- Total Height of Load: 1009 mm

Load Stabilizers:

- Horizontal Straps: Type: Plastic
- Perpendicular Straps: Type: Plastic
- Perpendicular Straps: Type: Plastic
- Corner Protectors: Type: Plastic
- Top Edge Protectors: Type: Plastic

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

Pallet ID: identification of this particular pallet design, chosen by Customer or Preparer.

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.
**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.

**Custom Load Type** (optional) specifies the type of tertiary containers (corrugated boxes, shipping bags, pails, bulk boxes, bulk bags) plus any load stabilizers (stretch wrap, strapping) for the unitized loads. The **Safe Load Capacity** and Deflection will be adjusted based on performance of this custom unit load.

**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 bolls 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) greater than 19%. 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) less 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 a 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. A 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 lowernest 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.

**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.

**Maximum Load for Deflection Limit**: If a Deflection Limit is specified, PDS will display any Safe Maximum Load or Maximum Load for Deflection Limit less than the Actual Load in red.

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.

**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.

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**Pallet Design System Version 5.2**

**Customer**: [Name]  
**Prepared by**: National Wooden Pallet and Container Association  
**Pallet Specification**: www.palletcentral.com
Guide to the Pallet Design System® (PDS) Pallet Durability Analysis

Pallet Design System Version 5.2
Pallet Durability Analysis

Customer: Company Name of Customer
Prepared by: Pallet Professional and NWPCA Member
PDS License: 50 Printed: November 15, 2015

Pallet ID: Block Class Pallet Example
Drawing Number: 12345-6 Specification Date: 11/12/2015
Classification: 2000 x 1800, Block Class, Double Face, Reversable, New Manufacture
Pallet Treatments: SPF-15 Compliance, Heat Treatment (HT), Conditioning, Kiln Dried, 15% EMC

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, 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 use 1000 lbs.
- Medium-Duty Loads use 2000 lbs.
- Heavy-Duty Loads use 3000 lbs.

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.
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- Good Handling and Treatment occurs in service environments using trained or skilled material handling personnel, 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 use 1000 lbs.
- Medium-Duty Loads use 2000 lbs.
- Heavy-Duty Loads use 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.

ForReusable 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.

Results from Handling Cycle Simulation

<table>
<thead>
<tr>
<th>Pallet Components</th>
<th>Cycles To First Repair</th>
<th>Cycles To First Replacement</th>
<th>Number of Times Replaced</th>
<th>Limits Pallet Service Life</th>
<th>Relative Component Damage during Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Leadboards</td>
<td>2</td>
<td>9</td>
<td>10</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Top Interior Boards</td>
<td>(4)</td>
<td>11</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Top Centerboard</td>
<td>(1)</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Perimeter-based Oner Boards</td>
<td>(2)</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perimeter-based Pallet Boards</td>
<td>(3)</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior Top Stringer Boards</td>
<td>(2)</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Top Stringer Boards</td>
<td>(1)</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corer Blocks</td>
<td>(4)</td>
<td>6</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Blocks</td>
<td>(2)</td>
<td>15</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Blocks</td>
<td>(2)</td>
<td>15</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center Block</td>
<td>(1)</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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.

### Pallet Design System Version 5.2
Pallet Physical Property Analysis

**Customer:**
Company Name of Customer

**Prepared by:**
Pallet Professional and NWPCA Member

**Pallet ID:** Block-Class Pallet Example
**Drawing Number:** 12345-A
**Specification Date:** 11/13/2015
**Classification:** 1200 x 1000, Block-Class, Double-Face Non-Reversible, Full 4-Way, Reusable, New Manufacture
**Pallet Treatments:** ISPM-15 Compliance, Heat Treatment (HT), Conditioning, Kiln Dried - 15% EMC

<table>
<thead>
<tr>
<th>Component</th>
<th>Original Dimension</th>
<th>Shrinkage from Manufacture to 15% MC</th>
<th>Shrinkage from Manufacture to 15% MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Deckboards</td>
<td>18 mm Thickness 95 mm Width</td>
<td>0.4 mm (+/- 0.1 mm)</td>
<td>0.5 mm (+/- 0.2 mm)</td>
</tr>
<tr>
<td></td>
<td>145 mm Width</td>
<td>2.0 mm (+/- 0.6 mm)</td>
<td>2.9 mm (+/- 0.6 mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0 mm (+/- 0.9 mm)</td>
<td>4.4 mm (+/- 1.3 mm)</td>
</tr>
<tr>
<td>Top Stringers</td>
<td>18 mm Thickness 95 mm Width</td>
<td>0.4 mm (+/- 0.1 mm)</td>
<td>0.5 mm (+/- 0.2 mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0 mm (+/- 0.6 mm)</td>
<td>2.9 mm (+/- 0.6 mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.6 mm (+/- 0.9 mm)</td>
<td>4.4 mm (+/- 1.3 mm)</td>
</tr>
<tr>
<td>Blocks</td>
<td>95 mm Height</td>
<td>2.0 mm (+/- 0.6 mm)</td>
<td>2.9 mm (+/- 0.6 mm)</td>
</tr>
<tr>
<td>Bottom Deckboards</td>
<td>18 mm Thickness 95 mm Outer Board Width</td>
<td>0.4 mm (+/- 0.1 mm)</td>
<td>0.5 mm (+/- 0.2 mm)</td>
</tr>
<tr>
<td></td>
<td>95 mm Pallet Board Width</td>
<td>2.0 mm (+/- 0.6 mm)</td>
<td>2.9 mm (+/- 0.6 mm)</td>
</tr>
<tr>
<td></td>
<td>90 mm Pallet Board Width</td>
<td>1.9 mm (+/- 0.5 mm)</td>
<td>2.7 mm (+/- 0.8 mm)</td>
</tr>
</tbody>
</table>

Average Pallet Weight

- **At Manufacture:** 25 kg
- **At 25% MC:** 24 kg
- **At 19% MC:** 23 kg
- **At 15% MC:** 23 kg
- **At 12% MC:** 22 kg

### Dimensional Change due to Wood Drying

**Width Shrinkage**

- **Top Deckboards:**
  - 0.4 mm (+/- 0.1 mm)
  - 2.0 mm (+/- 0.6 mm)
  - 3.0 mm (+/- 0.9 mm)
- **Top Stringers:**
  - 0.4 mm (+/- 0.1 mm)
  - 2.0 mm (+/- 0.6 mm)
  - 2.6 mm (+/- 0.9 mm)
- **Blocks:**
  - 2.0 mm (+/- 0.6 mm)
- **Bottom Deckboards:**
  - 0.4 mm (+/- 0.1 mm)
  - 2.0 mm (+/- 0.6 mm)
  - 1.9 mm (+/- 0.5 mm)

**Thickness Shrinkage**

- **Top Deckboards:**
  - 0.5 mm (+/- 0.2 mm)
- **Top Stringers:**
  - 0.6 mm (+/- 0.6 mm)
- **Blocks:**
  - 0.6 mm (+/- 0.9 mm)
- **Bottom Deckboards:**
  - 0.5 mm (+/- 0.2 mm)
  - 0.6 mm (+/- 0.9 mm)

### Notes

- **Average Pallet Weight At Manufacture** 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.)

- If lumber components lose moisture to reach equilibrium with the environment, they also decrease slightly in cross section. The estimated dimensional change is reported as Shrinkage and is provided for Manufacture to 19% MC and Manufacture to 15% MC (if less than MC at manufacture.)

- 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.

- The orientation of the cells across the width and thickness of lumber components are 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.

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).