

2012 NDS Changes

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Introduction

The 2005 Edition of the *National Design Specification*[®] (*NDS*[®]) for Wood Construction (*ANSI/AF&PA NDS-2005*) was recently updated. The updated standard designated *ANSI/AWC NDS-2012* was approved as an ANSI American National Standard on August 15, 2011 (Figure 1). The 2012 NDS was developed by the American Wood Council's (AWC) Wood Design Standards Committee and is referenced in the 2012 *International Building Code*.

Primary changes to the 2012 NDS are listed here and major issues are subsequently covered in more detail:

- Revised load and resistance factor design (LRFD) Format Conversion Factors (K_F) to provide numeric values of K_F rather than equations
- Incorporated LRFD K_F factors and resistance factors (ϕ) into NDS Chapter 2 and all material-specific chapters
- Incorporated a new equation for intermediate calculation of members subjected to bending in combination with axial compression with or without edgewise bending
- Removed sections on specification of glued laminated timber (glulam) and deflection
- Added two glulam adjustment factors: stress interaction factor and shear reduction factor
- Clarified applicability of existing glulam provisions for curved members, double-tapered and tapered straight beam members, and notching
- For poles and piles: updated design values per *ASTM D 2899*, moved design values to the *NDS Design Value Supplement*, and revised several adjustment factors
- Revised I-Joist beam stability factor to be more consistent with NDS Chapter 3
- Removed grade and construction factor for wood structural panels and clarified panel size factor applicability
- Referenced ANSI/TPI standard for design of assemblies utilizing metal connector plates
- Revised connection provisions and table headings and footers for consistency
- Clarified provisions for dowel bearing strength of wood structural panels for fastener diameters less than or equal to $\frac{1}{4}$ "
- Added provisions for post-frame ring shank nails
- Clarified how connection tip length is used for lateral load calculations
- Addressed perpendicular to grain outer row distance for fasteners accounting for expected glulam shrinkage
- Clarified provisions for applicability of split ring and shear plate connections in side grain and end grain; and relocated provisions for edge distance, end distance, and spacing

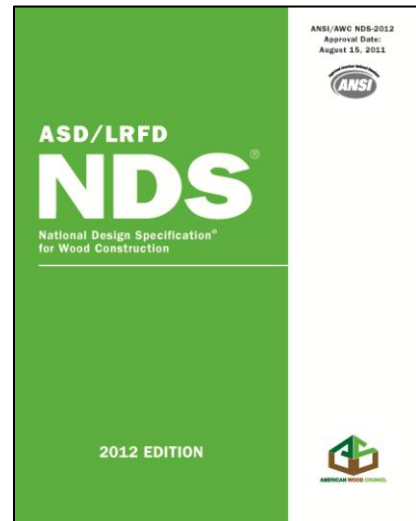


Figure 1 National Design Specification for Wood Construction, 2012 Edition

- Revised geometry factors for split rings and shear plates for reduced edge distance associated with glulam with faces as narrow as 3” and 5”
- Revised timber rivet capacity equations to allow proper application of the load duration factor and LRFD conversion factors
- Directly referenced *Special Design Provisions for Wind and Seismic (SDPWS-08)* and removed all other provisions in Chapter 14

LRFD

In Section 2.3.5, reference to the Format Conversion Factor, K_F , (LRFD only) is changed from Appendix N.3.1 to new Table 2.3.5. Similarly in Section 2.3.6, reference to Resistance Factors, ϕ , (LRFD only) is changed from Appendix N.3.2 to new Table 2.3.6 (Figure 2).

Table 2.3.5 Format Conversion Factor, K_F (LRFD Only)

Application	Property	K_F
Member	F_b	2.54
	F_t	2.70
	F_v, F_{rt}, F_s	2.88
	F_c	2.40
	$F_{c\perp}$	1.67
	E_{min}	1.76
All Connections	(all design values)	3.32

Table 2.3.6 Resistance Factor, ϕ (LRFD Only)

Application	Property	Symbol	Value
Member	F_b	ϕ_b	0.85
	F_t	ϕ_t	0.80
	F_v, F_{rt}, F_s	ϕ_v	0.75
	$F_c, F_{c\perp}$	ϕ_c	0.90
	E_{min}	ϕ_s	0.85
	All Connections	(all design values)	ϕ_z

Figure 2 LRFD format conversion factors and resistance factors.

The values in Tables 2.3.5 and 2.3.6 are based on Tables N1 and N2 respectively from Appendix N. Note that Table 2.3.5 (and revised Table N1) shows the numeric values of K_F directly. These numeric values are used to estimate the LRFD reference resistances because use of a constant/ ϕ equation format from *ASTM D5457-10 Standard Specification for Computing Reference Resistance of Wood Based Materials and Structural Connections for Load and Resistance Factor Design* has proven to be confusing. Table 2.3.5 includes a revised Format Conversion Factor for $F_{c\text{perp}}$ (revised from $K_F=2.08$ to $K_F=1.67$). This revision is necessary in order to be consistent with *ASTM D5457-10*.

Variables for the Format Conversion Factor, K_F , and the Resistance Factor, ϕ , in the applicability tables of NDS chapters 4, 5, 6, 7, 8, 9 and 10 have been replaced with specific values from Table 2.3.5 and Table 2.3.6, respectively (see Table 5.3.1 for an example). Specifying language in NDS sections 2.3.5 and 2.3.6 has been revised, as has the specifying language in each of the material chapters to reflect this change.

Intermediate Calculation for Combined Bending and Compression

A new equation 3.9-4 was added for intermediate calculation of members subjected to flatwise bending in combination with axial compression with or without edgewise bending. When a flatwise bending load is checked with the third term of the stress interaction equation, axial and edgewise bending interactions in the denominator can become negative. Occurrence of a negative value indicates an overstress. However, use of this negative term in the stress interaction equation overlooks overstress in flatwise bending and incorrectly reduces the overall interaction. While a check for overstress due to bending is a limiting condition of member design for bending per 3.3.1 of the *NDS*, an explicit check needs to be provided to clarify limitations on flatwise bending in *NDS* stress interaction equations. Similar modifications were made for built-up columns in Chapter 15 (equations 15.4-2 and 15.4-4).

Structural Glued Laminated Timber

Sections on specification of glued laminated timber (Section 5.1.4) and deflection (Section 5.4.3) were removed. Dry-use adhesives are not permitted in *ANSI/AITC A190.1 Structural Glued Laminated Timber*, removing the need to specify whether the glulam can be used in dry or wet service conditions. The specification of stress requirements and design values were removed for consistency with other *NDS* product chapters which do not contain similar requirements. Deflection information was redundant to provisions elsewhere in the standard including Section 3.5.

Provisions were added for two stress adjustment factors (see Figure 3). The stress interaction factor (Section 5.3.9) was added consistent with provisions of the *Timber Construction Manual* (TCM) used to adjust bending stress in tapered bending members. The shear reduction factor (Section 5.3.10), previously appearing in footnotes to glulam design values in the *NDS Design Value Supplement*, has been specifically defined as an adjustment factor applicable for shear design of other than prismatic beams (e.g. notched members, curved members, tapered members, design for radial tension, and shear design at connections).

Applicability of existing provisions was clarified for curved members (Section 5.4.1) and provisions for double-tapered and tapered straight beam members (Section 5.4.2 and Section 5.4.4) were added in lieu of referencing the *TCM* (Section 5.4.1).

Finally, notching provisions were clarified for glulam. Notches are not permitted on the top and bottom of the beam at the same location (Section 5.4.5).

Table 5.3.1 Applicability of Adjustment Factors for Structural Glued Laminated Timber

	ASD	ASD and LRFD										LRFD		
	only	Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor ¹	Volume Factor ¹	Flat Use Factor	Curvature Factor	Stress Interaction Factor	Shear Reduction Factor	Column Stability Factor	Bearing Area Factor	Format Conversion Factor	Resistance Factor
												K_F	ϕ	
$F_b' = F_b$ X	C_D	C_M	C_t	C_L	C_V	C_{fu}	C_c	C_I	-	-	-	2.54	0.85	λ
$F_t' = F_t$ X	C_D	C_M	C_t	-	-	-	-	-	-	-	-	2.70	0.80	λ
$F_v' = F_v$ X	C_D	C_M	C_t	-	-	-	-	-	C_{VT}	-	-	2.88	0.75	λ
$F_{rt}' = F_{rt}$ X	C_D	C_M	C_t	-	-	-	-	-	-	-	-	2.88	0.75	λ
$F_c' = F_c$ X	C_D	C_M	C_t	-	-	-	-	-	-	C_P	-	2.40	0.90	λ
$F_{c\perp}' = F_{c\perp}$ X	-	C_M	C_t	-	-	-	-	-	-	-	C_b	1.67	0.90	-
$E' = E$ X	-	C_M	C_t	-	-	-	-	-	-	-	-	-	-	-
$E_{min}' = E_{min}$ X	-	C_M	C_t	-	-	-	-	-	-	-	-	1.76	0.85	-

1. The beam stability factor, C_L , shall not apply simultaneously with the volume factor, C_V , for structural glued laminated timber bending members (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.

Figure 3 Adjustment factors for structural glued laminated timber.

Timber Poles and Piles

NDS Chapter 6 has been updated to address changes to ASTM standards for developing and adjusting round timber pile and round construction pole design values. Changes are summarized as follows:

- New design values for Table 6A Untreated Round Timber Piles and Table 6B Untreated Round Construction Poles were relocated from NDS Chapter 6 to the *NDS Design Value Supplement* (Figure 4).
- Section 6.3.5 “Untreated Factor” adjustment was changed to “Condition Treatment Factor” in recognition that new reference design values are now based on air dried condition.
- Section 6.3.9 “Critical Section” is changed to be consistent with changes to reference design values in *ASTM D2899 Standard Practice for Establishing Allowable Stresses for Round Timber Piles*.
- Section 6.3.11 “Single Pile Factor” adjustment was changed to “Load Sharing Factor” in recognition that new reference design values are now based on a single pile condition.

Table 6A Reference Design Values for Treated Round Timber Piles Graded per ASTM D25

(Tabulated design values are for normal load duration and wet service conditions. See NDS 6.3 for a comprehensive description of design value adjustment factors.)

Species	Design values in pounds per square inch (psi)						Specific Gravity ⁴
	Bending F_b	Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain F_c	Modulus of elasticity		
					E	E_{min}	
Pacific Coast Douglas Fir ¹	2,050	160	490	1,300	1,700,000	690,000	0.50
Red Pine ²	1,350	125	270	850	1,300,000	520,000	0.42
Southern Pine (Grouped) ³	1,950	160	440	1,250	1,500,000	600,000	0.55

1. Pacific Coast Douglas Fir reference design values apply to this species as defined in ASTM Standard D 1760. For connection design use Douglas Fir-Larch reference design values.

2. Red Pine reference design values apply to Red Pine grown in the United States. For connection design use Northern Pine reference design values.

3. Southern Pine reference design values apply to Loblolly, Longleaf, Shortleaf, and Slash Pines.

4. Specific gravity, G, based on weight and volume when oven-dry.

Table 6B Reference Design Values for Construction Poles Graded per ASTM D3200

(Tabulated design values are for normal load duration and wet service conditions. See NDS 6.3 for a comprehensive description of design value adjustment factors.)

Species	Design values in pounds per square inch (psi)						Specific Gravity ⁴
	Bending F_b	Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain F_c	Modulus of elasticity		
					E	E_{min}	
Pacific Coast Douglas Fir ¹	2,050	160	490	1,300	1,700,000	690,000	0.50
Lodgepole Pine	1,275	125	265	825	1,100,000	430,000	0.42
Ponderosa Pine	1,200	175	295	775	1,000,000	400,000	0.43
Red Pine ²	1,350	125	270	850	1,300,000	520,000	0.42
Southern Pine (Grouped) ³	1,950	160	440	1,250	1,500,000	600,000	0.55
Western Hemlock	1,550	165	275	1,050	1,300,000	560,000	0.47
Western Larch	1,900	170	405	1,250	1,500,000	660,000	0.49
Western Red Cedar	1,250	140	260	875	1,000,000	360,000	0.34

1. Pacific Coast Douglas Fir reference design values apply to this species as defined in ASTM Standard D 1760. For connection design use Douglas Fir-Larch reference design values.

2. Red Pine reference design values apply to Red Pine grown in the United States. For connection design use Northern Pine reference design values.

3. Southern Pine reference design values apply to Loblolly, Longleaf, Shortleaf, and Slash Pines.

4. Specific gravity, G, based on weight and volume when oven-dry.

Figure 4 Reference design values for timber poles and piles.

Prefabricated Wood I-Joists

NDS 7.3.5 regarding I-Joist Beam Stability Factor, C_L , was revised to be more consistent with provisions in Section 3.3.3 and to address confusion that currently exists with these provisions. A new section 7.3.5.1 was created that permits $C_L=1.0$ when the compression flange of an I-joist is supported throughout its length to prevent lateral displacement, consistent with the general requirements in 3.3.3.3. Additionally, a new section 7.3.5.2 was added that provides a method for designing the compression flange as an unbraced or partially braced column when the compression flange is not braced throughout its length. These provisions are consistent with 3.3.3.4.

Wood Structural Panels

The Grade and Construction Factor, C_G , was removed from Section 9.3.4 and Table 9.3.1 as this factor is no longer used by the wood structural panel industry. The *NDS Commentary* will also be updated to remove reference to C_G .

Additional wording is provided in *NDS* 9.3.4 to better clarify under what conditions the panel size factor, C_s , is required. *NDS Commentary* Table C9.3.4 Panel Size Factor is relocated and designated as *NDS* Table 9.3.4.

Dowel-type Fasteners

Provisions throughout *NDS* Chapter 11 have been revised to clarify intent and to add charging text utilizing a consistent format. Design value tables were also revised to use consistent and more descriptive table headings and table footnotes.

For lateral design value tables where penetration is an issue, footnotes clarify penetration basis of tabulated values and applicability of penetration adjustment to the table values only. The addition of penetration assumptions in the table titles are intentionally redundant with similar information in table footnotes to more clearly identify the reference penetration used for tabulated values.

Provisions for dowel bearing strength for wood structural panels were clarified as being applicable to fastener diameters of less than or equal to $\frac{1}{4}$ " (see 11.3.2.2) for consistency with supporting data. Commentary will be developed to address available guidance for larger diameter fasteners.

Provisions were added for post-frame ring shank nails manufactured in accordance with *ASTM F1667 Standard Specification for Driven Fasteners: Nails, Spikes, and Staples*. A withdrawal design (Section 11.2.3.3) equation for post-frame ring shank nails, based on research conducted at the Forest Products Laboratory including a 20% adjustment to account for effects of galvanized coatings, was added. Lateral design value tables (Table 11S and 11T), based on application of yield limit equations to standard properties for post-frame ring shank nails as noted in table footnotes, were also added.

Provisions were added to clarify how tip length is addressed in determination of bearing length used for lateral load calculations (Section 11.3.4). New provisions to specifically address length of tapered tip are based on analysis of reduced bearing present as the fastener diameter tapers to a point at the tip and the effect of tip length on lateral design values for small penetrations. Commentary will be developed to provide background for determination of new bearing length provisions for driven fasteners and the effect of tip length.

Provisions were also added to address the maximum perpendicular to grain distance for outermost fasteners in glulam based on moisture content and fastener type (Section 11.5.1.3) taking into account the expected shrinkage of glulam.

Split Ring and Shear Plate Connectors

NDS Section 12.3.2 was revised to clarify applicability of provisions to connections in side grain; and provisions for edge distance, end distance, and spacing (Section 12.3.3, 12.3.4, and 12.3.5) were relocated in the following sections:

- Section 12.3.2.1 combines requirements for geometry factors for parallel or perpendicular to grain loading (i.e. Section 12.3.3.1, 12.3.4.1, and 12.3.4.5).
- Section 12.3.2.2 clarifies requirements for connectors loaded at an angle to grain. Separate geometry factors for end and edge distance are to be calculated for the parallel and perpendicular components of the resistance. An equation and table for determining spacing requirements were added (Eq. 12.3-1 and Table 12.3.2.1).

Provisions were added to clarify applicability of requirements to connectors installed in end grain:

- Section 12.3.3 was revised to clarify that a single geometry factor is determined and applied to parallel and perpendicular components of the resistance.
- Section 12.3.3.1(a) clarifies that end distance provisions do not apply to connectors installed in end grain.
- For connectors in sloping surface of end grain, loaded parallel or perpendicular to axis of cut (Section 12.3.3.1b and 12.3.3.1c) an equation approach was added for determination of the geometry factor for greater consistency with the method used for side grain connections when transitioning from 0 degrees to 90 degrees and to remove a step function.
- Provisions were added to clarify requirements for connectors in sloping surfaces of end grain, loaded other than parallel or perpendicular to the axis of cut (Section 12.3.3.1d).

Geometry factors were revised to account for reduced edge distance associated with glulam with faces as narrow as 3" and 5" rather than 3.5" and 5.5" assumed previously (e.g. edge distances of 1.5" and 2.5" rather than 1.75" and 2.75"). Reduced values of the geometry factor were based on a re-evaluation of the original research and will be provided as background in *NDS Commentary*.

Timber Rivets

The constant in Equation 13.2-1 for parallel to grain reference timber rivet capacity, P_r , was changed from 280 to 188 and the constant in Equation 13.2-2 for perpendicular to grain reference timber rivet capacity, Q_r , was changed from 160 to 108. To allow proper application of the load duration factor and LRFD conversion factors to timber rivet connections, including those conditions limited by rivet strength rather than wood strength, these constants have been reduced to be consistent with other NDS connection values. Average ultimate values of P_r and Q_r have previously been divided by 3.36. Similarly, a correlating change was made in Chapter 10, Table 10.3.1 to remove footnote 4 which will permit application of the load duration factor when rivet capacity controls as well as when wood capacity controls.

The following sentence was added to Section 13.3.1: "The maximum distance perpendicular to grain between outermost rows of rivets shall be 12". This change parallels requirements in the new Table 11.5.1F specifying maximum spacing between outer rows of dowel-type fasteners in glulam connections.

NDS Supplement

The *NDS Supplement* incorporates several new species combinations and revisions to existing design values. Changes include:

- Revision of Table 1A Nominal and Minimum Dressed Sizes of Sawn Lumber to reflect new sizes for Timbers per Voluntary Product Standard *PS 20-10 American Softwood Lumber Standard*
- Reorganization and revision of Table 1B Section Properties of Standard Dressed Sawn Lumber to better distinguish between dimension lumber, Posts and Timbers, and Beams and Stringers; and reflect new sizes per *PS 20-10*
- Incorporation of new Coast Sitka Spruce and Yellow Cedar design values in Table 4A for dimension lumber
- Revision of Northern Species bending and tension design values in Table 4A
- Clarification of size factor adjustments for visually graded timbers in Table 4D
- Revision of Ponderosa Pine decking repetitive member design values in Table 4E
- Table 4F for non-North American species was revised to incorporate new design values for Douglas-fir from France and Germany and revised values for Norway Spruce and Scots Pine from the countries of Estonia, Latvia, and Lithuania
- Revision of glulam design values in Tables 5A, 5A Expanded, and 5B. Primary changes are to shear parallel to grain design values
- Addition of Tables 6A and 6B for Timber Poles and Piles
- Addition of specific gravity values for visually graded lumber, timbers, poles & piles

More Details

A comprehensive table listing section by section changes to the *NDS*, including modifications to Appendix material, is included as an appendix to this document.

Availability

The *2012 NDS* and *2012 NDS Supplement* is currently available for purchase in electronic format (PDF) only. Once the *NDS Commentary* and other support documents to be included in the *2012 Wood Design Package (WDP)* are updated, printed copies will be available for purchase. Check the AWC website (www.awc.org) for status updates on the *2012 WDP*. Once the *NDS Commentary* and other support documents are complete, those who purchased electronic versions of the *2012 NDS* and *2012 NDS Supplement* will receive those documents in electronic format at no additional charge.

Conclusion

The *2012 NDS* represents the state-of-the-art for design of wood members and connections. Its reference in the *2012 IBC* will make it a required design methodology in those jurisdictions adopting the latest building code. However, building officials are also apt to accept designs prepared in accordance with newer reference standards even if the latest building code has not been adopted in their jurisdiction. *IBC* 104.11 for alternate materials and design provides the authority having jurisdiction with that leeway.

Authors

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Appendix - 2012 NDS Summary of Changes

Section	Description
Chapter 1	<ol style="list-style-type: none"> 1) Added new section 1.1.1.3 to reference the <i>ANSI/TPI 1-07 Standard for Design of Metal Plate-Connected Wood Truss Construction</i> (see related changes to revise section 10.1.1.1, delete 10.2.1.6, delete “Metal Plate Connectors” in Table 10.3.1, and delete “Metal Connector Plates” and footnote 2 in Table 10.3.3). 2) Added and updated terms in 1.6 Notation that are used throughout the NDS.
Chapter 2	<ol style="list-style-type: none"> 1) In Section 2.3.5, reference to Format Conversion Factor, K_F, (LRFD Only) was changed from Appendix N.3.1 to new Table 2.3.5. Similarly in Section 2.3.6, reference to Resistance Factor, ϕ, (LRFD Only) was changed from Appendix N.3.2 to new Table 2.3.6. Variables for the Format Conversion Factor, K_F, and the Resistance Factor, ϕ, in the Applicability Tables of NDS chapters 4, 5, 6, 7, 8, 9 and 10 were replaced with specific values from Appendix N, Tables N1 and N2. Specifying language in NDS sections 2.3.5 and 2.3.6 was therefore revised, as was the specifying language in each of the material chapters to reflect this change. 2) Tables 2.3.5 and 2.3.6 are new and are based on Tables N1 and N2 respectively from Appendix N. Note that Table 2.3.5 (and revised Table N1) shows the numeric values of K_F directly. These values are used to estimate the reference resistances for design procedures outside the NDS and use of a constant/ϕ equation format from <i>ASTM D5457-10 Standard Specification for Computing Reference Resistance of Wood Based Materials and Structural Connections for Load and Resistance Factor Design</i> has proven to be confusing. 3) Table 2.3.5 includes a revised modification factor, K_F, for $F_{c\perp}$ from 2.08 to 1.67. This revision was necessary in order to be consistent with ASTM D5457-10.
Chapter 3	<ol style="list-style-type: none"> 1) Consistent with intent of Section 3.3.3.4, deleted the non-mandatory phrase “and/or lateral displacement” after stated requirements to “prevent rotation” at points of bearing. Support at points of bearing, either using torsional restraint or lateral support, to prevent rotation of bending members is consistent with the boundary conditions in the beam stability equation used in the NDS. It might also be noted that preventing rotation at points of bearing will also prevent lateral displacement at those locations and the additional phrase “and/or lateral displacement” provides no additional requirement. 2) Add new equation 3.9-4 to check the intermediate calculation for members subjected to flatwise bending in combination with axial compression with or without edgewise bending. When a flatwise bending load is checked with the third term of the stress interaction equation, the axial and edgewise bending interaction in the denominator can become a negative value. The occurrence of the negative value indicates an overstress. However, use of this negative term in the stress interaction equation overlooks the overstress in flatwise bending and incorrectly reduces the overall interaction. While a check for overstress due to bending is a limiting condition of member design for bending per 3.3.1 of the NDS, an explicit limit needs to be provided to clarify limitations on flatwise bending in NDS stress interaction equations (see related change in 15.4.1).

Section	Description
Chapter 4	<ol style="list-style-type: none"> 1) Heading for section 4.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) The adjustment factor table (Table 4.3.1), and changes to 4.3.14 (Format Conversion Factor, K_F) and 4.3.15 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2).
Chapter 5	<ol style="list-style-type: none"> 1) Heading for section 5.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) Description of laminations and standards sizes in Section 5.1.2 and 5.1.3 was clarified. The revised description clarifies the composition of a lamination. In Table 5.1.3, column headings clarify that dimensions represent the nominal width of laminations. 3) Sections on specification of glued laminated timber (Section 5.1.4) and deflection (Section 5.4.3) were removed. Dry-use adhesives are not permitted in <i>ANSI/AITC A190.1 Structural Glued Laminated Timber</i> removing the need to specify dry or wet service conditions. The specification of stress requirements and design values were removed for consistency with other NDS product chapters which do not contain similar requirements. Deflection information is redundant to information elsewhere including Section 3.5. 4) Provisions to reflect standard nomenclature used by the glued laminated timber (glulam) industry were updated for items such as member orientation, unbalanced lay ups, bending, compression perpendicular to grain, shear parallel to grain, and modulus of elasticity (Sections 5.2.2-5.2.7), radial compression (Section 5.2.9), volume factor (Section 5.3.6), and flat use factor (Section 5.3.7). 5) The adjustment factor table (Table 5.3.1), and changes to 5.3.14 (Format Conversion Factor, K_F) and 5.3.15 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2). In addition, two new stress adjustment factors (i.e. the stress interaction factor, C_L, and shear reduction factor, C_{vr}) were added to Table 5.3.1. 6) Provisions were added for two stress adjustment factors. The stress interaction factor (Section 5.3.9) was added consistent with provisions of the <i>AITC Timber Construction Manual (TCM)</i> used to adjust bending stress in tapered bending members. The shear reduction factor (Section 5.3.10), previously appearing in footnotes to glulam design value tables, is specifically defined as an adjustment factor applicable for shear design of other than prismatic beams (e.g. notched members, curved members, tapered members, design for radial tension, and shear design at connections). 7) Applicability of existing provisions was clarified for curved members (Section 5.4.1) and provisions for double-tapered and tapered straight beam members (Section 5.4.2 and Section 5.4.4) were added in lieu of referencing the TCM (Section 5.4.1). 8) Notch provisions were clarified. Notches are not permitted on the top and bottom of the beam at the same location (Section 5.4.5).

Section	Description
Chapter 6	<ol style="list-style-type: none"> 1) Heading for section 6.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) The adjustment factor table (Table 6.3.1), and changes to 6.3.12 (Format Conversion Factor, K_F) and 6.3.13 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2). 3) Chapter 6 has been updated to reflect design values based on changes to the reference ASTM standards. Changes are summarized as follows: <ol style="list-style-type: none"> a. New design values for Table 6A Untreated Round Timber Piles and Table 6B Untreated Round Construction Poles moved from Chapter 6 to the NDS Supplement. These new design values have been reviewed by the responsible parties and will be incorporated into the NDS Design Values Supplement. b. Section 6.3.5 “Untreated Factor” adjustment becomes “Condition Treatment Factor” – reference design values are now based on air dried condition. c. Section 6.3.9 “Critical Section” was changed to be consistent with changes to reference design values in D2899 <i>Standard Practice for Establishing Allowable Stresses for Round Timber Piles</i>. d. Section 6.3.11 “Single Pile Factor” adjustment becomes “Load Sharing Factor” – reference design values are now based on single pile condition.
Chapter 7	<ol style="list-style-type: none"> 1) Heading for section 7.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) The adjustment factor table (Table 7.3.1), and changes to 7.3.9 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2). 3) Revise 7.3.5 I-Joist Beam Stability Factor, C_L, to be more consistent with provisions in Section 3.3.3 and to address confusion that currently exists with these provisions. <ol style="list-style-type: none"> a) Created a new section 7.3.5.1 that permits $C_L=1.0$ when the compression flange of an I-joist is supported throughout its length to prevent lateral displacement, consistent with the general requirements in 3.3.3.3. b) Created a new section 7.3.5.2 that provides a method for designing the compression flange as an unbraced or partially braced column when the compression flange is not braced throughout its length. These provisions are consistent with 3.3.3.4.
Chapter 8	<ol style="list-style-type: none"> 1) Heading for section 8.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) The adjustment factor table (Table 6.3.1), and changes to 8.3.11 (Format Conversion Factor, K_F) and 8.3.12 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2).

Section	Description
Chapter 9	<ol style="list-style-type: none"> 1) Heading for section 9.1.1 was changed from “Application” to “Scope” for consistency with other chapters in the NDS. 2) The adjustment factor table (Table 9.3.1), and changes to 9.3.5 (Format Conversion Factor, K_F) and 9.3.6 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2). 3) Removed Grade and Construction, C_G, from Section 9.3.4 and Table 9.3.1 as this factor is no longer used by the wood structural panel industry. The Commentary will also be updated to remove the reference to Grade and Construction Factor, C_G. 4) Additional wording was provided in 9.3.4 to better clarify under what conditions the panel size factor, C_s, is required. Table C9.3.4 Panel Size Factor was relocated from the Commentary and designated Table 9.3.4.
Chapter 10	<ol style="list-style-type: none"> 1) A comparison of the metal connector plate provisions in NDS Chapter 10 found the provisions to be redundant and less specific to similar provisions in TPI 1-02. A series of changes to Chapter 10 revises section 10.1.1.1, deletes 10.2.1.6, deletes “Metal Plate Connectors” in Table 10.3.1, and deletes “Metal Connector Plates” and footnote 2 in Table 10.3.3 (see related changes to add new section 1.1.1.3 to reference the <i>ANSI/TPI 1-07 Standard for Design of Metal Plate-Connected Wood Truss Construction</i>). 2) The adjustment factor table (Table 10.3.1), and changes to 10.3.7 (Format Conversion Factor, K_F) and 10.3.8 (Resistance Factor, ϕ), was updated for LRFD (See summary of changes for Chapter 2). 3) Remove Table 10.3.1 Footnote 4 (pertaining to Timber Rivets) to address a change to the equations in Chapter 13 that eliminates the need for this footnote (See Chapter 13). 4) Revision to Table 10.3.3 to clarify which fastener types are defined by the particular category of Dowel-type fasteners. 5) Deletion of unnecessary note under C_g definition in 10.3.6 which explained that C_g doesn’t apply to timber rivet connections. Table 10.3.1 doesn’t indicate the C_g applying to timber rivets so the note is unnecessary.

Section	Description
Chapter 11	<ol style="list-style-type: none"> <li data-bbox="367 172 1435 220">1) 11.1.1 Scope was added for consistency with other chapters in the NDS. <li data-bbox="367 220 1435 378">2) Provisions were both added and revised to implement charging language for the Chapter and clarify applicability of the requirements. For example, Section 11.3.7 Common Connection Conditions was added to clarify where applicability of the tabulated connection values and required adjustment of table values is described. <li data-bbox="367 378 1435 640">3) Provisions throughout the chapter have been revised to clarify intent and utilize a consistent format. Examples include multiple references to Appendix L, description of terms, description of minimum penetration limitations and whether or not tip is included (e.g. Section 11.1.2), applicability of the clinched nail exception (Section 1.1.5.5), inclusion of withdrawal under other dowel-type fasteners (Section 11.1.7), and description of penetration for withdrawal and calculation of withdrawal value in pounds (e.g. Section 11.2.1.2). <li data-bbox="367 640 1435 903">4) Design value tables were revised to use consistent and more descriptive table headings and table footnotes (Tables 11.2A-C for withdrawal and Tables 11A-11R for lateral). For lateral design value tables where penetration is a factor, footnotes clarify penetration basis of table values and applicability of adjustment for penetration. The addition of penetration assumptions in the table titles are intentionally redundant with similar information in the table footnotes to more clearly identify the reference penetration used for the tabulated values. <li data-bbox="367 903 1435 1060">5) Provisions for dowel bearing strength for wood structural panels were clarified as being applicable to fastener diameters of less than or equal to ¼" (see 11.3.2.2) for consistency with supporting data. Commentary will be developed to address available guidance for larger diameter fasteners. <li data-bbox="367 1060 1435 1323">6) Provisions were added for post-frame ring shank nails in accordance with <i>ASTM F1667 Standard Specification for Driven Fasteners: Nails, Spikes, and Staples</i>. The withdrawal design (Section 11.2.3.3) equation is based on research conducted at the Forest Products Laboratory including a 20% adjustment to account for effects of galvanized coating. Lateral design value tables (Table 11S and 11T) were added based on application of the yield limit equations to standard properties for these nails as noted in the table footnotes. <li data-bbox="367 1323 1435 1585">7) Provisions were added to clarify how tip length is addressed in determination of bearing length used for lateral load calculations (Section 11.3.5). New provisions to specifically address length of tapered tip are based on an analysis of reduced bearing present as the fastener diameter tapers to a point at the tip and effect of tip length on lateral design values for small penetrations. Commentary will be developed to provide background for determination of new bearing length provisions for driven fasteners and effect of tip length. <li data-bbox="367 1585 1435 1722">8) Provisions were added to address perpendicular to grain distance for fasteners in glulam based on moisture content and fastener type (Section 11.5.1.3) taking into account the expected shrinkage of glulam.

Section	Description
Chapter 12	<ol style="list-style-type: none"> 1) 12.1.1 Scope was added for consistency with other chapters in the NDS. 2) The term “connector axis” was added to clarify use of split ring and shear plate connector provisions (Section 12.3.1.3 and Figure 12L). 3) Section 12.3.2 title was revised to clarify applicability of provisions to connections in side grain and provisions for edge distance, end distance, and spacing (Section 12.3.3, 12.3.4, and 12.3.5) were relocated in the following sections: <ol style="list-style-type: none"> a. Section 12.3.2.1 combines requirements for geometry factors for parallel or perpendicular to grain loading (i.e. Section 12.3.3.1, 12.3.4.1, and 12.3.4.5). b. Section 12.3.2.2 clarifies requirements for connectors loaded at an angle to grain. Separate geometry factors for end and edge distance are to be calculated for the parallel and perpendicular components of the resistance. An equation and table for determining spacing requirements were added (Eq. 12.3-1 and Table 12.3.2.1), rather than sending the designer to the TCM or the <i>Design Manual for TECO Timber Connector Construction</i> for a graphical method (See 12.3.5). 4) Provisions were added to clarify applicability of requirements to connectors installed in end grain: <ol style="list-style-type: none"> a. The title of Section 12.3.3 was revised. It was clarified that a single geometry factor is determined and applied to the parallel and perpendicular components of the resistance. b. Section 12.3.3.1(a) clarifies that end distance provisions do not apply to connectors installed in end grain. c. For connectors in sloping surface of end grain, loaded parallel or perpendicular to axis of cut (Section 12.3.3.1b and 12.3.3.1c) an equation approach was added for determination of the geometry factor for greater consistency with the method used for side grain connections when transitioning from 0 degrees to 90 degrees and to remove a step function. d. Provisions were added to clarify requirements for connectors in sloping surface of end grain, loaded other than parallel or perpendicular to the axis of cut (Section 12.3.3.1d). 5) Geometry factors were revised to account for reduced edge distance associated with glued laminated timbers with faces as narrow as 3” and 5” rather than 3.5” and 5.5” assumed previously (e.g. edge distances of 1.5” and 2.5” rather than 1.75” and 2.75”). Reduced values of the geometry factor were based on a re-evaluation of the original research and will be provided as background in NDS Commentary.

Section	Description
Chapter 13	<ol style="list-style-type: none"> 1) The heading and section number “13.1.1 Scope” was added to the chapter introduction for consistency with other chapters in the NDS. 2) The constant in Equations (13.2-1) for parallel to grain reference timber rivet capacity (P_r) was changed from 280 to 188 and the constant in (13.2-2) for perpendicular to grain reference timber rivet capacity (Q_r) was changed from 160 to 108. To allow proper application of the duration of load factor and LRFD conversion factors to timber rivet connections, including those conditions limited by rivet strength rather than wood strength, these constants have been reduced to be consistent with other NDS connection values. Average ultimate values of P_r and Q_r have previously been divided by 3.36. Similarly, a correlating change was made in Chapter 10, Table 10.3.1 to remove footnote 4 which will permit application of the load duration factor when rivet capacity controls as well as when wood capacity controls. 3) The following sentence was added to Section 13.3.1: “The maximum distance perpendicular to grain between outermost rows of rivets shall be 12”. This change parallels requirements in the new Table 11.5.1F specifying maximum spacing between outer rows of dowel-type fasteners in glulam connections.
Chapter 14	<ol style="list-style-type: none"> 1) Under 14.1 General, wording has been added to directly reference the <i>Special Design Provisions for Wind and Seismic (SDPWS-08)</i> and all other sections in Chapter 14 were removed.
Chapter 15	<ol style="list-style-type: none"> 1) Revise 15.3.3.1(b) [Nailed Built-up Columns] to clarify that nails need to penetrate all laminations - to the last outermost lamination. 2) Add new equations 15.4-2 and 15.4-4 to check the intermediate calculation for members subjected to flatwise bending in combination with axial compression with or without edgewise bending (see related change and summary in Chapter 3, Equation 3.9-4).
Chapter 16	<ol style="list-style-type: none"> 1) Revise 16.2.2 to clarify that required adjustments to reference design values must be taken before the beam stability and column stability factors are calculated. 2) In Table 16.2.2, editorially move rows to group the required adjustments for bending, including beam buckling, and compression, including column buckling.
Appendix E	<ol style="list-style-type: none"> 1) Revise Examples E.6, E.7, and E.8 to more clearly state what values are assumed for the adjustment factors. The Shear Reduction adjustment factor, C_{vr}, for glulam was incorporated in example E.6. Design values for glulam were updated in E.6 and design values for lumber were updated in E.7 per the NDS Design Values Supplement. 2) Revise Example E.8 by adding a check for $A_{critical}$ and adding Figure E5 to illustrate the calculation of $A_{critical}$ for a row of split ring connectors.
Appendix F	<ol style="list-style-type: none"> 1) Remove Footnote 1 in Table F1 (Appendix F) which indicates that the COV_E of 0.10 is an approximate value for glulam with six or more laminations. Results of glulam beam and column tests in accordance with <i>ASTM D 198 Standard Test Methods of Static Tests of Lumber in Structural Sizes</i> have indicated that the COV_E for glulam is less than 10%.

Section	Description
Appendix L	<ol style="list-style-type: none"> 1) References in Tables L1, L2, and L3 Footnote 1 have been updated to reflect new ANSI/ASME designations. 2) The dimension “L” is defined as “lag screw length” in Table L2 – previously the dimension had been shown in the figure but had not been specifically defined. Similarly definition of “S” has been changed from “unthreaded shank length” to “unthreaded body length” consistent with <i>ANSI/ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws</i>. 3) Additional footnotes have been added in Tables L3 and L4 to indicate that it is permitted to assume the length of the tapered tip is 2D – this is a correlation change with the new section 11.3.4.2 regarding dowel bearing length. 4) New table L5 was added for post-frame ring shank nails to coordinate with addition of provisions for lateral and withdrawal design provisions added in Chapter 11. 5) New Table L6 was added for standard cut washers as required in Section 11.1.2.3 for bolted connections.
Appendix N	<ol style="list-style-type: none"> 1) Table N1 has been revised to show the numeric value of the format conversion factor, K_F, directly for each property (see related change and summary in Chapter 2). 2) Tables N1 and N2 to change the Application for connections to “All Connections” and to change to the Property for connection to “(all design values)”. 3) Update load combinations in Table N3 to be consistent with <i>ASCE 7-10 Minimum Design Loads for Buildings and Other Structures</i>. Footnote 2 was also revised to reference ASCE 7-10.
NDS Design Values Supplement	<ol style="list-style-type: none"> 1) Revision of Table 1A Nominal and Minimum Dressed Sizes of Sawn Lumber to reflect new sizes for Timbers per Voluntary Product Standard <i>PS 20-10 American Softwood Lumber Standard</i>. 2) Reorganization and revision of Table 1B Section Properties of Standard Dressed Sawn Lumber to better distinguish between dimension lumber, Posts and Timbers, and Beams and Stringers; and reflect new sizes per <i>PS 20-10</i>. 3) Incorporation of new Coast Sitka Spruce and Yellow Cedar design values in Table 4A for dimension lumber. 4) Revision of Northern Species bending and tension design values in Table 4A. 5) Clarification of size factor adjustments for visually graded timbers in Table 4D. 6) Revision of Ponderosa Pine decking repetitive member design values in Table 4E. 7) Table 4F for non-North American species was revised to incorporate new design values for Douglas-fir from France and Germany and revised values for Norway Spruce and Scots Pine from the countries of Estonia, Latvia, and Lithuania. 8) Revision of glulam design values in Tables 5A, 5A Expanded, and 5B. Primary changes are to shear parallel to grain design values. 9) Addition of Tables 6A and 6B for Timber Poles and Piles. 10) Addition of specific gravity values for visually graded lumber, timbers, and poles and piles.