Technical Evaluation Report

TO ASSIST WITH CODE COMPLIANCE

Lamco Laminated Finger Jointed Lumber (LFL®) **TER No. 1211-01**

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Additional Listee:
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Product Name: onCENTER™ Advanced Framing Lumber (AFL)

DIVISION: 06 00 00 – WOOD, PLASTICS AND COMPOSITES
Section: 06 02 00 – Design Information
Section: 06 17 00 – Shop-Fabricated Structural Wood

1. **Product Lines Evaluated:**
   - **1.1.** Lamco LFL® (Laminated Finger Jointed Lumber) Structural Wood-Based Lumber or Advanced Engineered Lumber
   - **1.2.** BlueLinx onCENTER™ Advanced Framing Lumber (AFL)

2. **Applicable Codes and Standards:**[1]
   - **2.1.** *2006*, *2009* and *2012 International Building Code®* (*IBC*)
   - **2.2.** *2006*, *2009* and *2012 International Residential Code®* (*IRC*)
   - **2.3.** *2005 and 2010 National Building Code of Canada (NBC)*
   - **2.4.** *ASTM D5456 Standard Specification for Evaluation of Structural Composite Lumber Products*
   - **2.5.** *ASTM D5764 Standard Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products*
   - **2.6.** *Engineering Design in Wood* (*CAN/CSA 086-09*)
   - **2.7.** *2005 National Design Standard for Wood Construction* (*NDS*)

[1] Unless otherwise noted, code references are from the 2012 versions of the codes.

3. Performance Evaluation:

3.1. Lamco LFL® was tested and evaluated to determine its resistance properties, which are used to develop reference design values for allowable stress design (ASD) and limit states design (LSD). This Technical Evaluation Report (TER) examines Lamco LFL® for:

3.1.1. Use as an alternative material to that described in Chapter 23 of the *IBC*, in particular, compliance with the requirements noted in Section 2301.2 for ASD.

3.1.2. Compliance with Sections 2304 and 2308 of the *IBC* and Chapters 5, 6 and 8 of the *IRC* for conventional light-frame construction applications.

3.1.3. Use as an alternative material and method of construction in compliance with *IBC* Section 104.11 and *IRC* Section R104.11.

3.1.3.1. When used in an application that exceeds the limits of *IRC* Section R301, an engineered design shall be submitted in accordance with Section R301.1.3 and this TER.

3.1.4. Structural capacities in accordance with *IBC* Section 2303.1.9:

> **2303.1.9 Structural composite lumber.** Structural capacities for structural composite lumber shall be established and monitored in accordance with ASTM D 5456.

3.1.5. Structural capacity in accordance with *NBC* Parts 4 and 9 and *CAN/CSA 086-09*.

3.1.6. Fire-resistance properties of Lamco LFL® are evaluated with regard to equivalence to solid-sawn lumber in accordance with the *IBC*, *IRC* and *NBC*.

4. Product Description and Materials:

4.1. Lamco LFL® is manufactured by Produits Forestiers Lamco Inc. at its facility in Saint-Felicien, Quebec.

4.2. The product is made from Black Spruce #1&2 or MSR lumber. Short segments of the lumber are assembled with tongue and groove joints along the length of the members and finger joints across the width of the members.

4.3. All joints are adhered with a heat-resistant adhesive of phenol-resorcinol-formaldehyde (PRF).

4.4. The wood lumber properties and species, adhesive, manufacturing parameters, and finished product dimensions and tolerances are specified in the approved quality documentation and Lamco's in-plant manufacturing standard.

4.5. Material Availability:

4.5.1. Grades: 1.6E, 1.7E, 1.9E and 2.1E

4.5.2. Thickness: $1^{7}/_{16}$" (36.5mm) and $1^{1}/_{2}$" (38.1mm)

4.5.3. Width: 2½" to 16" (63.5-406mm)

4.5.4. Length: up to 32' 1" (9.8 m)

5. Applications:

5.1. Lamco LFL® is an alternative to sawn lumber for floor, roof and wall structural members.

5.2. Structural applications include use as beams, columns, headers, joists, rafters, chords and webs of trusses, I-joist flanges, rim boards and wall studs.

5.3. Lamco LFL® is used as an equivalent alternative to sawn lumber for use where fire resistance is required as follows:

5.3.1. Lamco LFL® with a minimum thickness of $1^{7}/_{16}$" may be used as an equivalent alternative to $1^{1}/_{2}$"-thick solid-sawn lumber in accordance with the *IBC*, *IRC* and *NBC*.

5.4. Design:

5.4.1. Design of Lamco LFL® is governed by the applicable code and the provisions for structural composite lumber (SCL) in *ANSI/AF&PA National Design Specification for Wood Construction* (*NDS*).

5.4.2. Cuts, notches and holes in structural members shall comply with the applicable building code for sawn lumber and this TER. For applications outside of the scope of the applicable code, consult the manufacturer's installation instructions or a Registered Design Professional.

5.4.3. Uniformly loaded beams may have holes bored in the member, provided such holes are entirely in the center $^1/_3$ of the member in both the length and depth dimensions.

5.4.4. For buildings constructed in accordance with *IBC* Section 2308, *Conventional Light-frame Construction*, and subject to the limitations therein, the following conditions apply:

5.4.4.1. Holes bored in joists shall not be within 2" (51 mm) of the top or bottom of the joist, and the diameter of any such hole shall not exceed $^1/_3$ the depth of the joist.

5.4.4.2. Notches in the top or bottom of joists shall not exceed $^1/_6$ the depth and shall not be located in the middle $^1/_3$ of the span.

5.4.4.3. In load bearing walls, Lamco LFL® is permitted to be cut or notched to a depth not exceeding 25% of its width.

5.4.4.4. In non-load bearing walls, Lamco LFL® is permitted to be cut or notched to a depth not exceeding 40% of its width

5.4.4.5. Holes bored into studs shall not exceed 40% of the stud width, and the edge of the boring shall be no closer than $^5/_8$" from the edge of the stud.

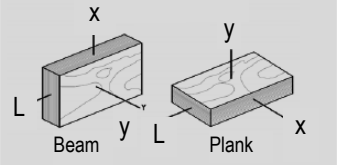
5.4.4.6. Holes shall not be located in the same section of the stud as a cut or notch.

5.4.5. Unless otherwise noted, adjustment of the design stresses for duration of load shall be in accordance with the applicable code.

5.4.6. The design provisions for wood construction noted in Section 2301.2 of the *IBC* and Section R301.1.3 of the *IRC* apply to Lamco LFL® for ASD, unless otherwise noted in this report. Allowable unit stresses for Lamco LFL® for dry conditions of use are specified in Table 1.

Grade	Bending, F_b (psi)	Tension, F_t (psi)	Compression, F_c (psi)		Horizontal Shear, F_v (psi)	Modulus of Elasticity, E ($x10^6$psi)	Modulus of Elasticity for Beam & Column Stability, E_{min} ($x10^6$psi)
	Beam[6,10]	Parallel-to-Grain	Parallel-to-Grain	Perpendicular-to-Grain	Beam	True[5]	
1.6E	1200	1300[7]	1600	425	135	1.6	0.793
1.7E	1800	1585[8]	1925	595	180	1.7	0.862
1.9E	2300	1800[8]	2190	675	205	1.9	0.968
2.1E	2300	2175[9]	2660	675	250	2.1	1.039

1. 1 psi = 0.00689 MPa or 1 MPa = 145 psi.
2. The reference design values in this table are applicable for the product used in dry, well-ventilated interior applications, in which the equivalent moisture content of sawn lumber is less than 16%. See Section 9.3.1 of this report.
3. The reference design values in this table are for normal load duration. Loads of longer or shorter duration shall be adjusted in accordance with the applicable code. Duration of load adjustments shall not be applied to $F_{c\perp}$, E or E_{min}.
4. Orientation nomenclature for Lamco LFL®.



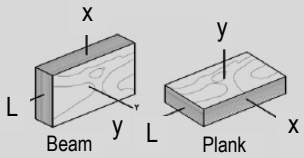
5. Using True (shear free) E, deflection is calculated as follows for uniformly loaded simple span beams:
   $\Delta = [5WL^4/(32Ebh^3)] + [12WL^2/(5Ebh)]$
   where: Δ = deflection in inches (mm)
   W = uniform load in lbs/in (N/mm)
   L = span in inches (mm)
   E = modulus of elasticity in psi (MPa)
   b = width of beam in inches (mm)
   h = depth of beam in inches (mm)
6. The bending values in these tables are based on a reference depth of 12" (305 mm). For other depths, the bending value for 1.6E grade shall be adjusted by a size factor adjustment of $(12/d)^{0.34}$, where d is measured in inches with a minimum depth of 2.5" (64 mm). For other depths of the 1.7E, 1.9E and 2.1E grades, the bending values shall be adjusted by a size factor adjustment of $(12/d)^{0.25}$ where d is measured in inches with a minimum depth of 2.5" (64 mm). Bending values are further limited to 2455 psi for 1.9E and 2795 psi for 2.1E grades. For flatwise bending, values are permitted to be increased by a factor of 1.1 for 2" thick and 4" and larger widths.
7. The tension, F_t value for the 1.6E grade is based on a reference length of 24". For lengths up to 24', multiply F_t by K_L. $K_L = (24/L)^{0.15}$, where L is the length in inches.
8. The tension, F_t values for 1.7E and 1.9E grades are based on a reference length of 88" (7'4"). For lengths greater than 88", multiply F_t by K_L. $K_L = (88/L)^{0.1335}$, where L is the length in inches.
9. The tension, F_t value for the 2.1E grade is based on a reference length of 88" (7'4"). For lengths greater than 88", multiply F_t by K_L. $K_L = (88/L)^{0.125}$, where L is the length in inches.
10. When structural members qualify as repetitive members in accordance with the applicable code, a 4% increase is permitted to F_b.

Table 1: Reference Design Values for Lamco LFL® (ASD)[1,2,3,4]

5.4.7. For compliance with the *NBC*, limit states design shall be in accordance with *CAN/CSA 086-09*. Specified Strength Values for Lamco LFL® for dry conditions of use are specified in Table 2.

Grade	Bending, F_b (MPa)	Tension, F_t (MPa)	Compression, F_c (MPa)		Horizontal Shear, F_v (MPa)	Modulus of Elasticity, E (MPa)	Modulus of Elasticity for Beam & Column Stability, E_{min} (MPa)
	Beam[6, 10]	Parallel-to-Grain	Parallel-to-Grain	Perpendicular-to-Grain	Beam	True[5]	
1.6E	14.25	16.41[7]	17.61	5.33	1.72	10,859	8,998
1.7E	22.71	20.19[8]	21.21	7.46	2.29	11,802	9,778
1.9E	29.27	22.95[8]	24.10	8.47	2.60	13,257	10,984
2.1E	29.27	27.69[9]	29.31	8.47	3.20	14,227	11,788

1. 1 psi = 0.00689 MPa or 1 MPa = 145 psi.
2. The reference design values in this table are applicable for the product used in dry, well-ventilated interior applications, in which the equivalent moisture content of sawn lumber is less than 16%. See Section 9.3.1 of this report.
3. The reference design values in this table are for normal load duration. Loads of longer or shorter duration shall be adjusted in accordance with the applicable code. Duration of load adjustments shall not be applied to $F_{c\perp}$, E and E_{min}.
4. Orientation nomenclature for Lamco LFL®.



5. Using True (shear free) E, deflection is calculated as follows for uniformly loaded simple span beams:
   $\Delta = [5WL^4/(32Ebh^3)] + [12WL^2/(5Ebh)]$
   where: Δ = deflection in inches (mm)
   W = uniform load in lbs/in (N/mm)
   L = span in inches (mm)
   E = modulus of elasticity in psi (MPa)
   b = width of beam in inches (mm)
   h = depth of beam in inches (mm)
6. The bending values in these tables are based on a reference depth of 12" (305 mm. For other depths, the bending value for 1.6E grade shall be adjusted by a size factor adjustment of $(12/d)^{0.34}$, where d is measured in inches with a minimum depth of 2.5" (64 mm). For other depths of the 1.7E, 1.9E and 2.1E grades, the bending values shall be adjusted by a size factor adjustment of $(12/d)^{0.25}$ where d is measured in inches with a minimum depth of 2.5" (64 mm). Bending values are further limited to 31.28 MPa for 1.9E and 35.61 MPa for 2.1E grades.
7. The tension, F_t value for the1.6E grade is based on a reference length of 24". For lengths up to 24', multiply F_t by K_L. $K_L = (24/L)^{0.15}$, where L is the length in inches.
8. The tension, F_t values for 1.7E and 1.9E grades are based on a reference length of 88" (7'4"). For lengths greater than 88", multiply F_t by K_L. $K_L = (88/L)^{0.1335}$, where L is the length in inches.
9. The tension, F_t value for the 2.1E grade is based on a reference length of 88" (7'4"). For lengths greater than 88", multiply F_t by K_L. $K_L = (88/L)^{0.125}$, where L is the length in inches.
10. When structural members qualify as repetitive members in accordance with the applicable code, a 4% increase is permitted to F_b.

Table 2: Specified Strengths for Lamco LFL® (LSD) [1,2,3,4]

5.4.8. Connections:

5.4.8.1. Lateral loads for nails, screws and bolts, and withdrawal loads for nails and screws, installed in Lamco LFL® shall be in accordance with the *NDS* and *CAN/CSA 086-09* for sawn lumber having a minimum specific gravity equal to that shown in Table 3.

5.4.8.2. Fastener spacing shall be as prescribed in the applicable code (for sawn lumber) unless specifically indicated in Table 3 or Table 4 or as prescribed in Part 11 of *NDS*.

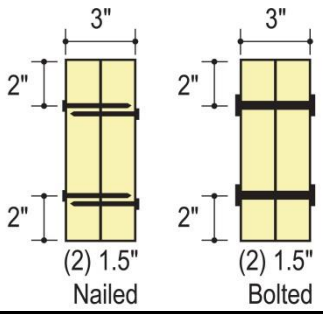
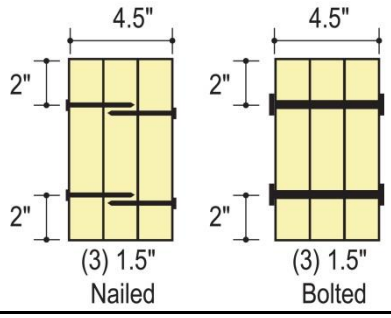
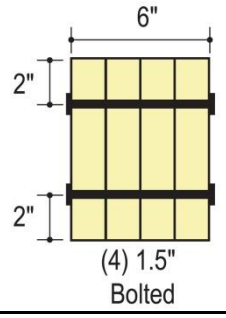
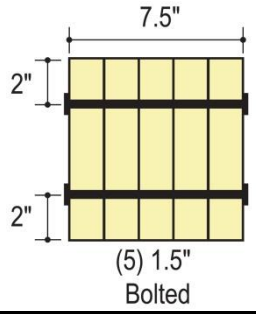
5.4.8.3. Other nail spacing for specific applications, such as prefabricated steel components or hangers, may be used. Nail spacing for these applications should follow what is specified and detailed in the proprietary catalogues for the specific gravities as defined in Table 3.

5.4.8.4. Allowable lateral loads for machine bolts installed perpendicular to the wide face of Lamco LFL® with loads applied parallel or perpendicular to the grain shall be as prescribed in the applicable code or in accordance with *NDS* for sawn lumber with the minimum specific gravity at least equivalent to that defined in Table 3.

Product	Fastener	Fastener Axis Location	Load Direction	Angle to Grain	Equivalent Specific Gravity for Design Purposes – Grade 1.6E	Equivalent Specific Gravity for Design Purposes – Grades 1.7E, 1.9E & 2.1E	Minimum Spacing
Lamco LFL®	Nails & Screws (<0.25" dia.)	Wide Face	Lateral	Any	0.44	0.44	Per Applicable Code for Solid-Sawn Material
		Narrow Face	Lateral	Any	0.44	0.44	
		X & Y Axes	Withdrawal	–	0.44	0.45	
	Bolts	Wide Face	Lateral	0 degrees	0.44	0.46	
		Wide Face	Lateral	90 degrees	0.42	0.42	
		Narrow Face	Lateral	0 degrees	0.39	0.39	

Table 3: Equivalent Specific Gravities & Minimum Fastener Spacing for Design of Mechanical Connections

5.4.8.5. Connection requirements for multiple member side-loaded beams are defined in the following assembly details and have the maximum uniformly distributed load carrying capacity as defined in Table 4.

Assembly A (2-ply Beam)	Assembly B (3-ply Beam)	Assembly C (4-ply Beam)	Assembly D (5-ply Beam)
			

Figures 1A-1D: Connection Requirements for Multiple Member Side-Loaded Beams

Assembly Detail (See Figure 1)	Allowable Load for Connection of Beams Loaded from One Side Only			Allowable Load (per side) for Connection of Beams Loaded from Both Sides[10]		
	2 Rows of 10d (0.148" x 3") Nails at 12" o.c.	3 Rows of 10d (0.148" x 3") Nails at 12" o.c.	2 Rows of ½" Bolts at 12" o.c.[3,7,8]	2 Rows of 10d (0.148" x 3") Nails at 12" o.c.	3 Rows of 10d (0.148" x 3") Nails at 12" o.c.	2 Rows of ½" Bolts at 12" o.c.[3,7,8]
A	415	625	650	210	310	325
B[9]	310	465	485	210	310	325
C	–	–	430	–	–	325
D[6]	–	–	405	–	–	325

1. Multiply the appropriate table value by:
   a. 1.5 for nails or bolts spaced at 8" o.c. per row
   b. 2 for nails or bolts spaced at 6" o.c. per row
   c. 3 for nails or bolts spaced at 4" o.c. per row
   d. 0.5 for bolts spaced at 24" o.c. per row
2. Determine the appropriate beam size required to support the load before determining the connection requirements.
3. Screws can be used in place of bolts, provided additional fasteners are used such that the sum of the screw capacities is equal to or greater than that of the ½"-diameter bolts. Refer to the screw manufacturer's literature.
4. Tabulated values assume adequate end distance, edge distance and spacing per Chapter 11 of *NDS*.
5. Tabulated values are for normal load duration. Adjustment of the design stresses for duration of load shall be in accordance with the applicable code or *NDS*, as applicable.
6. For beams greater than 4-plies wide, consult a Registered Design Professional for the attachment requirements.
7. A standard cut steel washer of minimum 0.118" thickness, with a minimum outside dimension of 1⅜", is required on each side of the beam between the wood and bolt head and nut.
8. Bolted connections assume full diameter bolts with bending yield strength (F_{yb}) of 45,000 psi and a SG of 0.42.
9. Nailing is required from both sides for 3-ply beams.
10. The allowable loads provided above for connection of beams loaded from both sides are the maximum that can be applied to each side of the beam.

Table 4: Connection Requirements & Allowable Uniform Loads for Multiple Member Side-Loaded Beams[1, 2, 4, 5, 10]

6. Installation:

6.1. Lamco LFL® shall be installed in accordance with the applicable code, the approved construction documents, this TER, the manufacturer's installation instructions, *NDS* and standard framing practice as applied to solid-sawn lumber.

6.1.1. If the manufacturer's installation instructions conflict with this report, the TER instructions supersede and should be used.

7. Test and Engineering Substantiating Data:

7.1. Test results and data by PFS for establishing the mechanical properties of Lamco LFL®.

7.2. *ASTM 5456*-08 – *Standard Specification for Evaluation of Structural Composite Lumber Products.*

7.3. *EN-14347 Timber Structures Structural Laminated Veneer Lumber Requirements*.

7.4. Some information contained herein is the result of testing and/or data analysis by other sources, which SBCRI relies on to be accurate as it undertakes its engineering analysis. SBCRI does not assume responsibility for the accuracy of data provided by other testing facilities, but relies on each source's accuracy and generally accepted engineering practices.

7.5. SBCRI relies on the codified design values of the *IBC*, and the basis of published code provisions, to undertake comparative equivalency testing and evaluation. SBCRI does not assume responsibility for the accuracy of the design values established in the building codes but relies on their accuracy and generally accepted engineering practices.

8. Findings:

8.1. *IBC* Section 104.11 and *IRC* Section R104.11 specifically state that:

> The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code.

8.2. When used in accordance with the manufacturer's installation instructions and this TER, Lamco LFL® complies with or is a suitable alternative to the requirements of *IBC* Chapter 23; *IRC* Chapters 5, 6 and 8; *NBC* Articles, 1.2, 4.3.11 and 9.23; and *CAN/CSA 086-09*.

9. Conditions of Use:

9.1. Lamco LFL® shall be installed in accordance with the applicable code, the approved construction documents, this TER and the manufacturer's installation instructions. If there is a conflict between this report and the manufacturer's instructions, this TER governs.

9.2. The manufacturer's published installation instructions shall be available at the jobsite at all times during installation.

9.3. Lamco LFL® complies with or is a suitable alternative to sawn lumber as permitted by the codes listed in Section 2, subject to the following conditions:

9.3.1. The service conditions for Lamco LFL® are dry conditions of use, for which the equilibrium moisture content must be less than 16%. Use in applications exceeding 16% moisture content is outside the scope of this TER.

9.3.2. The service conditions for Lamco LFL® with fire-retardant or preservative chemical treatments are outside the scope of this report.

9.3.3. Fastener design values shall be determined using equivalent specific gravities specified in Table 3 of this report.

9.3.4. Cutting and notching of Lamco LFL® is prohibited except where specifically permitted by the manufacturer's recommendations, this TER or where the effects of such alterations are specifically considered in the design of the member by a Registered Design Professional.

9.3.5. Increases for duration of load shall be in accordance with the limitations of the applicable building code for sawn lumber.

9.3.6. The product is considered acceptable for using the creep factors applicable to sawn lumber in accordance with the applicable building code.

9.3.7. Where use of Lamco LFL® qualifies as repetitive members as defined in *NDS*, an increase of 4% is permitted in allowable bending stresses.

9.3.8. Lamco LFL® may be cut to the specified length and width as appropriate for the application, provided the depth is no less than $2^{1}/_{2}$". The thickness may not be cut.

9.3.9. Minimum bearing length and anchorage of Lamco LFL® shall meet the requirements of Chapter 23 of the *IBC* or Division B, Article 9.23 of the *NBC*, and *CAN/CSA 086-09* for sawn lumber.

9.3.10. Lamco LFL® shall be fabricated by Produits Forestiers Lamco Inc. at its facility in Saint-Felicien, Quebec, with quality control inspections by an approved third-party quality control inspection agency.

9.4. Design

9.4.1. Lamco LFL® is designed using the same criteria as solid-sawn lumber in accordance with the most current version of *NDS*. Reference design values are shown in Table 1 and Table 2.

9.4.2. Building Designer

9.4.2.1. The Construction Documents shall be prepared by a Building Designer for the Building and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show, in detail, conformance to the building code.

9.4.2.2. The Construction Documents shall provide information sufficiently accurate and reliable to be used for facilitating the supply of Lamco LFL® and shall provide the following:

9.4.2.2.1. The location, direction and magnitude of all dead, live and lateral loads applicable to Lamco LFL®, and any other loads that are going to be applied to Lamco LFL®.

9.4.2.2.2. All foundation anchorage designs required to resist uplift, gravity and lateral loads.

9.4.3. Design loads shall not exceed the allowable loads as defined in this TER.

9.5. Construction Documents

9.5.1. Design calculations and details shall be furnished to the code official verifying that the material is used in compliance with this TER. The calculations must be prepared by a Registered Design Professional where required by the statutes of the jurisdiction in which the project is to be constructed.

9.5.2. Construction Documents shall contain the plans, specifications and details needed for the Building Official to approve such documents.

10. Identification:

10.1. Lamco LFL® is identified on each piece of lumber with a stamp noting the product manufacturer (Produits Forestiers Lamco Inc.) or listee, assigned plant number, product designation, grade, production lot (Julian calendar) and the quality control agency. Each lumber bundle is identified with the hour of production and the bundle number in this hour, the production lot (Julian calendar), the product manufacturer (Produits Forestiers Lamco Inc.), assigned plant number, product designation, grade and the quality control agency.

10.2. Where intended for use in fire-resistive construction, the designation “HRA” shall be included on the product marking.

10.3. Additional technical information and related TERs can be found at lamcoforest.com and from the SBC Research Institute (www.sbcri.info).

11. Review Schedule:

11.1. This TER is subject to periodic review and revision.

11.2. For information on the current status of this report, contact SBCRI.

Responsibility Statement

The information contained herein is a product, engineering or building code evaluation performed in accordance with the referenced building code, testing and/or analysis using generally accepted engineering practices. Product, design and code compliance quality control is the responsibility of the referenced company. Consult the referenced company for the proper detailing and application for the intended purpose. Consult your local jurisdiction or design professional to assure compliance with the local building code. Qualtim, Inc. (www.qualtim.com) and SBC Research Institute (www.sbcri.info) do not make any warranty, express or implied, or assume any legal liability or responsibility for the use, application of, and/or reference to opinions, findings, conclusions, or recommendations included in this report.

SBCRI is very careful to maintain the confidentiality of our clients' proprietary information and testing. SBCRI's doors are locked at all times. Qualtim staff must get clearance from Qualtim's President, Vice President or Director of R&D and Industry Projects before entering or taking any visitors into the SBCRI testing facility.

Appendix A:
Design Assumptions for Lamco LFL® Joist & Rafter Tables

SUPPORT REQUIREMENTS
Joists and rafters must have adequate support. Ridge beams must be installed at roof peaks with rafters bearing directly on the ridge beam or supported by hangers or framing anchors. Ceiling joists are not required when properly designed ridge beams are used. A ridge board may be substituted for a ridge beam when the roof slope equals or exceeds 3 in 12, except that ridge beams are required for cathedral ceilings. Ridge boards must be at least 1" nominal in thickness and not less than the depth of the cut end of the rafter. Rafters must be placed directly opposite each other, and ceiling joists must be installed parallel to the rafters to provide a continuous tie between exterior walls.

SPANS
The spans provided in these tables were determined on the same basis as those given in the code-recognized *Span Tables for Joists and Rafters* and *Wood Structural Design Data*, both published by AF&PA. Maximum spans were computed using Allowable Stress Design (ASD) and standard engineering design formulas for simple span beams with uniformly distributed gravity loads. The calculated spans assume fully supported members, properly sheathed and nailed on the top edge of the joist or rafter. Rafter spans do not include composite action of adhesive and sheathing. However, floor applications for joists do consider the effect of partial composite action. Listed spans also do not include checks for concentrated or partition loads that may be required by building codes for specific occupancy or use categories. Uplift loads caused by wind also have not been considered. Spans in the tables are given in feet and inches and are the maximum allowable horizontal span of the member from inside to inside of bearings. For sloping rafters, the span is also measured along the horizontal projection.

REFERENCE DESIGN VALUES
The reference design values used to determine the spans in the accompanying tables are as published in TER No. 1211-01: *Lamco Laminated Finger Jointed Lumber (LFL®).* Reference design values are based on normal load duration and dry service conditions.

ADJUSTMENT FACTORS
Reference design values must be multiplied by all applicable adjustment factors to determine adjusted design values. Adjusted design values are then used to calculate the maximum allowable span for a specified load condition. The adjustment factors used to develop the accompanying span tables are described below. For more information on adjustment factors, refer to *TER No. 1211-01* and NDS®, *National Design Specification® for Wood Construction*.

REPETITIVE MEMBER FACTOR, Cr – Bending design values, F_b, for the Lamco LFL® products listed in these tables are multiplied by the repetitive member factor, C_r = 1.04, when such members are in contact or spaced not more than 24" on-center, are not less than three (3) in number, and are joined by floor, roof or other load distributing elements adequate to support the design load.

LOAD DURATION FACTOR, C_D – Wood has the ability to carry substantially greater maximum loads for short durations than for long durations. Reference design values apply to the normal 10-year load duration. With the exception of modulus of elasticity, E and E_{min}, and compression perpendicular-to grain, $F_{c\perp}$, reference design values must be multiplied by the appropriate load duration factor, C_D. Floor joist and ceiling joist tables are based on the normal load duration, which implies C_D = 1.0. For rafters, the load duration factor, C_D, is typically either 1.15 for two-month snow loads or 1.25 for seven-day construction loads, or 1.6 for wind load. All rafter tables are labeled to indicate the load duration factor used. Rafter spans have been evaluated for wind loads up to and including V_{asd} = 110 mph (Exposure B, Mean Roof Height of 30') to determine that wind does not control design. For wind greater than V_{asd} = 110 mph, engineered design is required.

CALCULATIONS
The spans provided in these tables are limited to the minimum value calculated for the following design parameters using ASD:

- **BENDING (FLEXURE)**
- **DEFLECTION (BASED ON LIVELOAD)**
- **COMPRESSION PERPENDICULAR-TO-GRAIN**
- **SHEAR PARALLEL-TO-GRAIN (HORIZONTAL SHEAR)**

BENDING

Bending design values assume a fully supported member, properly sheathed and nailed on the top edge of the joist or rafter. The repetitive member factor, C_r, of 1.04 was included due to the assumption of the installation of at least three (3) joists or rafters spaced not more than 24" on-center. The load duration factor, C_D, has also been applied as appropriate.

DEFLECTION

Deflection may be the controlling factor in determining the member size required when appearance or rigidity is important. Control of floor vibration is another important reason to limit deflection. Deflection limits are expressed as a fraction of the span length in inches (l), and consider only live load in accordance with established engineering practice for the design of joists and rafters. The live load deflection ratio used to develop each table is listed.

COMPRESSION PERPENDICULAR-TO-GRAIN

The compression perpendicular-to-grain check used to develop these span tables assumes a 2.0" bearing length to account for the end of the joist or rafter bearing on a 2x4 wall with a $1^1/_2$" rim board applied along the outside edge of the wall. An additional check is required for shorter bearing lengths, such as for 1.5" ledgers.

SHEAR PARALLEL-TO-GRAIN (HORIZONTAL SHEAR)

All uniformly distributed loads within a distance from the inside face of each support equal to the depth of the member have been ignored for determining the maximum allowable span based on horizontal shear.

Floor Joists – 30 psf Live Load, 10 psf Dead Load, l/ 360 Deflection						Floor Joists – 30 psf Live Load, 15 psf Dead Load, l/360 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
$1^7/_{16}$" x $7^1/_4$"	1.6E	16-8	15-3	13-11	12-6	16-7	14-5	13-2	11-9
	1.7E	17-0	15-9	15-1	14-3	17-0	15-9	15-1	14-1
	1.9E	17-7	16-3	15-6	14-8	17-7	16-3	15-6	14-8
	2.1E	17-11	16-7	15-10	14-11	17-11	16-7	15-10	14-11
$1^7/_{16}$" x 9¼"	1.6E	20-10	18-8	17-1	15-3	20-4	17-7	16-1	14-5
	1.7E	21-4	19-9	18-10	17-9	21-4	19-9	18-10	17-5
	1.9E	22-0	20-4	19-5	18-3	22-0	20-4	19-5	18-3
	2.1E	22-5	20-9	19-9	18-7	22-5	20-9	19-9	18-7
$1^7/_{16}$" x 9½"	1.6E	21-4	19-1	17-5	15-7	20-10	18-0	16-5	14-9
	1.7E	21-10	20-3	19-3	18-2	21-10	20-3	19-3	17-10
	1.9E	22-7	20-10	19-10	18-9	22-7	20-10	19-10	18-9
	2.1E	23-0	21-3	20-3	19-1	23-0	21-3	20-3	19-1
$1^7/_{16}$" x $11^1/_4$"	1.6E	25-0	22-0	20-1	17-11	23-11	20-9	18-11	16-11
	1.7E	25-7	23-8	22-6	21-2	25-7	23-8	22-6	20-8
	1.9E	26-6	24-5	23-3	21-10	26-6	24-5	23-3	21-10
	2.1E	27-0	24-11	23-8	22-3	27-0	24-11	23-8	22-3
$1^7/_{16}$" x $11^7/_8$"	1.6E	26-4	23-0	21-0	18-9	25-0	21-8	19-10	17-8
	1.7E	26-11	24-10	23-8	22-3	26-11	24-10	23-8	21-8
	1.9E	27-10	25-8	24-5	23-0	27-10	25-8	24-5	23-0
	2.1E	28-5	26-2	24-11	23-5	28-5	26-2	24-11	23-5
$1^7/_{16}$" x 14"	1.6E	30-5	26-4	24-1	21-6	28-8	24-10	22-8	20-4
	1.7E	31-6	29-0	27-7	25-11	31-6	29-0	27-7	25-0
	1.9E	31-8	30-0	28-6	26-9	31-8	30-0	28-6	26-9
	2.1E	31-8	30-7	29-1	27-4	31-8	30-7	29-1	27-4
$1^7/_{16}$" x 16"	1.6E	31-8	29-5	26-11	24-1	31-8	27-9	25-4	22-8
	1.7E	31-8	31-8	31-3	29-5	31-8	31-8	31-3	28-2
	1.9E	31-8	31-8	31-8	30-4	31-8	31-8	31-8	30-4
	2.1E	31-8	31-8	31-8	30-11	31-8	31-8	31-8	30-11

Floor Joists – 30 psf Live Load, 10 psf Dead Load, l/ 480 Deflection						Floor Joists – 30 psf Live Load, 15 psf Dead Load, l/480 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	15-2	14-0	13-5	12-6	15-2	14-0	13-2	11-9
	1.7E	15-6	14-4	13-8	12-11	15-6	14-4	13-8	12-11
	1.9E	15-11	14-9	14-1	13-4	15-11	14-9	14-1	13-4
	2.1E	16-3	15-1	14-4	13-7	16-3	15-1	14-4	13-7
1 7/16" x 9 1/4"	1.6E	18-11	17-6	16-8	15-3	18-11	17-6	16-1	14-5
	1.7E	19-4	17-11	17-1	16-1	19-4	17-11	17-1	16-1
	1.9E	20-0	18-6	17-7	16-7	20-0	18-6	17-7	16-7
	2.1E	20-5	18-10	17-11	16-11	20-5	18-10	17-11	16-11
1 7/16" x 9 1/2"	1.6E	19-5	18-0	17-1	15-7	19-5	18-0	16-5	14-9
	1.7E	19-10	18-4	17-6	16-6	19-10	18-4	17-6	16-6
	1.9E	20-6	18-11	18-1	17-0	20-6	18-11	18-1	17-0
	2.1E	20-11	19-4	18-5	17-4	20-11	19-4	18-5	17-4
1 7/16" x 11 1/4"	1.6E	22-9	21-0	20-0	17-11	22-9	20-9	18-11	16-11
	1.7E	23-3	21-6	20-5	19-3	23-3	21-6	20-5	19-3
	1.9E	24-1	22-2	21-1	19-10	24-1	22-2	21-1	19-10
	2.1E	24-6	22-7	21-6	20-3	24-6	22-7	21-6	20-3
1 7/16" x 11 7/8"	1.6E	23-11	22-1	21-0	18-9	23-11	21-8	19-10	17-8
	1.7E	24-6	22-7	21-6	20-3	24-6	22-7	21-6	20-3
	1.9E	25-4	23-4	22-2	20-11	25-4	23-4	22-2	20-11
	2.1E	25-10	23-10	22-7	21-3	25-10	23-10	22-7	21-3
1 7/16" x 14"	1.6E	27-11	25-9	24-1	21-6	27-11	24-10	22-8	20-4
	1.7E	28-7	26-4	25-1	23-7	28-7	26-4	25-1	23-7
	1.9E	29-7	27-3	25-11	24-4	29-7	27-3	25-11	24-4
	2.1E	30-3	27-10	26-5	24-10	30-3	27-10	26-5	24-10
1 7/16" x 16"	1.6E	31-8	29-2	26-11	24-1	31-8	27-9	25-4	22-8
	1.7E	31-8	29-11	28-5	26-8	31-8	29-11	28-5	26-8
	1.9E	31-8	30-11	29-4	27-7	31-8	30-11	29-4	27-7
	2.1E	31-8	31-7	29-11	28-1	31-8	31-7	29-11	28-1

Floor Joists – 30 psf Live Load, 10 psf Dead Load, l/600 Deflection						Floor Joists – 30 psf Live Load, 15 psf Dead Load, l/600 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	14-1	13-0	12-5	11-9	14-1	13-0	12-5	11-9
	1.7E	14-4	13-4	12-8	12-0	14-4	13-4	12-8	12-0
	1.9E	14-10	13-9	13-1	12-4	14-10	13-9	13-1	12-4
	2.1E	15-1	14-0	13-4	12-7	15-1	14-0	13-4	12-7
1 7/16" x 9¼"	1.6E	17-7	16-3	15-6	14-8	17-7	16-3	15-6	14-5
	1.7E	18-0	16-8	15-10	14-11	18-0	16-8	15-10	14-11
	1.9E	18-7	17-2	16-4	15-5	18-7	17-2	16-4	15-5
	2.1E	18-11	17-6	16-8	15-8	18-11	17-6	16-8	15-8
1 7/16" x 9 1/2"	1.6E	18-0	16-8	15-11	15-0	18-0	16-8	15-11	14-9
	1.7E	18-5	17-1	16-3	15-4	18-5	17-1	16-3	15-4
	1.9E	19-0	17-7	16-9	15-10	19-0	17-7	16-9	15-10
	2.1E	19-5	17-11	17-1	16-1	19-5	17-11	17-1	16-1
1 7/16" x 11 1/4"	1.6E	21-1	19-6	18-7	17-6	21-1	19-6	18-7	16-11
	1.7E	21-7	19-11	19-0	17-11	21-7	19-11	19-0	17-11
	1.9E	22-4	20-7	19-7	18-5	22-4	20-7	19-7	18-5
	2.1E	22-9	21-0	20-0	18-10	22-9	21-0	20-0	18-10
1 7/16" x 11 7/8"	1.6E	22-2	20-6	19-6	18-5	22-2	20-6	19-6	17-8
	1.7E	22-9	21-0	19-11	18-10	22-9	21-0	19-11	18-10
	1.9E	23-6	21-8	20-7	19-5	23-6	21-8	20-7	19-5
	2.1E	24-0	22-1	21-0	19-9	24-0	22-1	21-0	19-9
1 7/16" x 14"	1.6E	25-11	23-11	22-9	21-5	25-11	23-11	22-8	20-4
	1.7E	26-7	24-6	23-3	21-11	26-7	24-6	23-3	21-11
	1.9E	27-6	25-3	24-0	22-7	27-6	25-3	24-0	22-7
	2.1E	28-1	25-10	24-6	23-0	28-1	25-10	24-6	23-0
1 7/16" x 16"	1.6E	29-5	27-1	25-9	24-1	29-5	27-1	25-4	22-8
	1.7E	30-2	27-9	26-4	24-9	30-2	27-9	26-4	24-9
	1.9E	31-3	28-8	27-3	25-7	31-3	28-8	27-3	25-7
	2.1E	31-8	29-3	27-10	26-1	31-8	29-3	27-10	26-1

Floor Joists – 40 psf Live Load, 10 psf Dead Load, l/360 Deflection						Floor Joists – 40 psf Live Load, 15 psf Dead Load, l/360 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	15-2	13-8	12-6	11-2	15-0	13-0	11-11	10-8
	1.7E	15-6	14-4	13-8	12-11	15-6	14-4	13-8	12-9
	1.9E	15-11	14-9	14-1	13-4	15-11	14-9	14-1	13-4
	2.1E	16-3	15-1	14-4	13-7	16-3	15-1	14-4	13-7
1 7/16" x 9 1/4"	1.6E	18-11	16-9	15-3	13-8	18-5	15-11	14-7	13-0
	1.7E	19-4	17-11	17-1	16-1	19-4	17-11	17-1	15-9
	1.9E	20-0	18-6	17-7	16-7	20-0	18-6	17-7	16-7
	2.1E	20-5	18-10	17-11	16-11	20-5	18-10	17-11	16-11
1 7/16" x 9 1/2"	1.6E	19-5	17-1	15-7	13-11	18-10	16-4	14-11	13-4
	1.7E	19-10	18-4	17-6	16-6	19-10	18-4	17-6	16-2
	1.9E	20-6	18-11	18-1	17-0	20-6	18-11	18-1	17-0
	2.1E	20-11	19-4	18-5	17-4	20-11	19-4	18-5	17-4
1 7/16" x 11 1/4"	1.6E	22-9	19-8	17-11	16-1	21-8	18-9	17-1	15-4
	1.7E	23-3	21-6	20-5	19-3	23-3	21-6	20-5	18-8
	1.9E	24-1	22-2	21-1	19-10	24-1	22-2	21-1	19-10
	2.1E	24-6	22-7	21-6	20-3	24-6	22-7	21-6	20-3
1 7/16" x 11 7/8"	1.6E	23-9	20-7	18-9	16-10	22-8	19-7	17-11	16-0
	1.7E	24-6	22-7	21-6	20-3	24-6	22-7	21-6	19-7
	1.9E	25-4	23-4	22-2	20-11	25-4	23-4	22-2	20-11
	2.1E	25-10	23-10	22-7	21-3	25-10	23-10	22-7	21-3
1 7/16" x 14"	1.6E	27-3	23-7	21-6	19-3	26-0	22-6	20-6	18-4
	1.7E	28-7	26-4	25-1	23-7	28-7	26-4	25-1	22-8
	1.9E	29-7	27-3	25-11	24-4	29-7	27-3	25-11	24-4
	2.1E	30-3	27-10	26-5	24-10	30-3	27-10	26-5	24-10
1 7/16" x 16"	1.6E	30-5	26-4	24-1	21-6	29-0	25-1	22-11	20-6
	1.7E	31-8	29-11	28-5	26-8	31-8	29-11	28-5	25-5
	1.9E	31-8	30-11	29-4	27-7	31-8	30-11	29-4	27-7
	2.1E	31-8	31-7	29-11	28-1	31-8	31-7	29-11	28-1

Floor Joists – 40 psf Live Load, 10 psf Dead Load, l/480 Deflection						Floor Joists – 40 psf Live Load, 15 psf Dead Load, l/480 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	13-9	12-9	12-2	11-2	13-9	12-9	11-11	10-8
	1.7E	14-1	13-0	12-5	11-9	14-1	13-0	12-5	11-9
	1.9E	14-6	13-5	12-10	12-1	14-6	13-5	12-10	12-1
	2.1E	14-9	13-8	13-1	12-4	14-9	13-8	13-1	12-4
1 7/16" x 9 1/4"	1.6E	17-2	15-11	15-2	13-8	17-2	15-11	14-7	13-0
	1.7E	17-7	16-3	15-6	14-8	17-7	16-3	15-6	14-8
	1.9E	18-2	16-10	16-0	15-1	18-2	16-10	16-0	15-1
	2.1E	18-6	17-1	16-4	15-4	18-6	17-1	16-4	15-4
1 7/16" x 9 1/2"	1.6E	17-8	16-4	15-7	13-11	17-8	16-4	14-11	13-4
	1.7E	18-1	16-8	15-11	15-0	18-1	16-8	15-11	15-0
	1.9E	18-8	17-3	16-5	15-5	18-8	17-3	16-5	15-5
	2.1E	19-0	17-7	16-8	15-9	19-0	17-7	16-8	15-9
1 7/16" x 11 1/4"	1.6E	20-8	19-1	17-11	16-1	20-8	18-9	17-1	15-4
	1.7E	21-2	19-6	18-7	17-6	21-2	19-6	18-7	17-6
	1.9E	21-10	20-2	19-2	18-1	21-10	20-2	19-2	18-1
	2.1E	22-3	20-7	19-7	18-5	22-3	20-7	19-7	18-5
1 7/16" x 11 7/8"	1.6E	21-9	20-1	18-9	16-10	21-9	19-7	17-11	16-0
	1.7E	22-3	20-6	19-6	18-5	22-3	20-6	19-6	18-5
	1.9E	23-0	21-2	20-2	19-0	23-0	21-2	20-2	19-0
	2.1E	23-6	21-7	20-7	19-4	23-6	21-7	20-7	19-4
1 7/16" x 14"	1.6E	25-5	23-5	21-6	19-3	25-5	22-6	20-6	18-4
	1.7E	26-0	23-11	22-9	21-5	26-0	23-11	22-9	21-5
	1.9E	26-11	24-9	23-6	22-1	26-11	24-9	23-6	22-1
	2.1E	27-5	25-3	24-0	22-7	27-5	25-3	24-0	22-7
1 7/16" x 16"	1.6E	28-10	26-4	24-1	21-6	28-10	25-1	22-11	20-6
	1.7E	29-6	27-2	25-10	24-3	29-6	27-2	25-10	24-3
	1.9E	30-7	28-1	26-8	25-1	30-7	28-1	26-8	25-1
	2.1E	31-2	28-8	27-2	25-7	31-2	28-8	27-2	25-7

Floor Joists – 40 psf Live Load, 10 psf Dead Load, l/600 Deflection						Floor Joists – 40 psf Live Load, 15 psf Dead Load, l/600 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	12-9	11-10	11-4	10-8	12-9	11-10	11-4	10-8
	1.7E	13-1	12-1	11-6	10-11	13-1	12-1	11-6	10-11
	1.9E	13-5	12-6	11-11	11-3	13-5	12-6	11-11	11-3
	2.1E	13-9	12-8	12-1	11-5	13-9	12-8	12-1	11-5
1 7/16" x 9 1/4"	1.6E	16-0	14-9	14-1	13-4	16-0	14-9	14-1	13-0
	1.7E	16-4	15-1	14-5	13-7	16-4	15-1	14-5	13-7
	1.9E	16-10	15-7	14-10	14-0	16-10	15-7	14-10	14-0
	2.1E	17-2	15-11	15-2	14-3	17-2	15-11	15-2	14-3
1 7/16" x 9 1/2"	1.6E	16-4	15-2	14-5	13-7	16-4	15-2	14-5	13-4
	1.7E	16-9	15-6	14-9	13-11	16-9	15-6	14-9	13-11
	1.9E	17-4	16-0	15-3	14-4	17-4	16-0	15-3	14-4
	2.1E	17-8	16-4	15-6	14-7	17-8	16-4	15-6	14-7
1 7/16" x 11 1/4"	1.6E	19-2	17-9	16-10	15-11	19-2	17-9	16-10	15-4
	1.7E	19-7	18-1	17-3	16-3	19-7	18-1	17-3	16-3
	1.9E	20-3	18-8	17-10	16-9	20-3	18-8	17-10	16-9
	2.1E	20-8	19-1	18-2	17-1	20-8	19-1	18-2	17-1
1 7/16" x 11 7/8"	1.6E	20-2	18-8	17-9	16-8	20-2	18-8	17-9	16-0
	1.7E	20-8	19-1	18-2	17-1	20-8	19-1	18-2	17-1
	1.9E	21-4	19-8	18-9	17-7	21-4	19-8	18-9	17-7
	2.1E	21-9	20-1	19-1	17-11	21-9	20-1	19-1	17-11
1 7/16" x 14"	1.6E	23-7	21-9	20-8	19-3	23-7	21-9	20-6	18-4
	1.7E	24-2	22-3	21-2	19-11	24-2	22-3	21-2	19-11
	1.9E	25-0	23-0	21-10	20-6	25-0	23-0	21-10	20-6
	2.1E	25-6	23-5	22-3	20-11	25-6	23-5	22-3	20-11
1 7/16" x 16"	1.6E	26-9	24-8	23-5	21-6	26-9	24-8	22-11	20-6
	1.7E	27-5	25-3	23-11	22-6	27-5	25-3	23-11	22-6
	1.9E	28-4	26-1	24-9	23-3	28-4	26-1	24-9	23-3
	2.1E	29-0	26-7	25-3	23-9	29-0	26-7	25-3	23-9

Floor Joists – 50 psf Live Load, 10 psf Dead Load, l/360 Deflection						Floor Joists – 50 psf Live Load, 20 psf Dead Load, l/360 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	14-1	12-6	11-5	10-2	13-4	11-7	10-6	9-5
	1.7E	14-4	13-4	12-8	12-0	14-4	13-4	12-7	11-3
	1.9E	14-10	13-9	13-1	12-4	14-10	13-9	13-1	12-4
	2.1E	15-1	14-0	13-4	12-7	15-1	14-0	13-4	12-7
1 7/16" x 9 1/4"	1.6E	17-7	15-3	13-11	12-6	16-4	14-2	12-11	11-6
	1.7E	18-0	16-8	15-10	14-11	18-0	16-8	15-7	14-0
	1.9E	18-7	17-2	16-4	15-5	18-7	17-2	16-4	15-5
	2.1E	18-11	17-6	16-8	15-8	18-11	17-6	16-8	15-8
1 7/16" x 9 1/2"	1.6E	18-0	15-7	14-3	12-9	16-8	14-5	13-2	11-10
	1.7E	18-5	17-1	16-3	15-4	18-5	17-1	16-0	14-4
	1.9E	19-0	17-7	16-9	15-10	19-0	17-7	16-9	15-10
	2.1E	19-5	17-11	17-1	16-1	19-5	17-11	17-1	16-1
1 7/16" x 11 1/4"	1.6E	20-9	17-11	16-5	14-8	19-2	16-7	15-2	13-7
	1.7E	21-7	19-11	19-0	17-11	21-7	19-11	18-6	16-7
	1.9E	22-4	20-7	19-7	18-5	22-4	20-7	19-7	18-5
	2.1E	22-9	21-0	20-0	18-10	22-9	21-0	20-0	18-9
1 7/16" x 11 7/8"	1.6E	21-8	18-9	17-2	15-4	20-1	17-5	15-10	14-2
	1.7E	22-9	21-0	19-11	18-9	22-9	21-0	19-5	17-5
	1.9E	23-6	21-8	20-7	19-5	23-6	21-8	20-7	19-5
	2.1E	24-0	22-1	21-0	19-9	24-0	22-1	21-0	19-8
1 7/16" x 14"	1.6E	24-10	21-6	19-8	17-7	23-0	19-11	18-2	16-3
	1.7E	26-7	24-6	23-3	21-8	26-7	24-6	22-5	20-1
	1.9E	27-6	25-3	24-0	22-7	27-6	25-3	24-0	22-7
	2.1E	28-1	25-10	24-6	23-0	28-1	25-10	24-6	22-8
1 7/16" x 16"	1.6E	27-9	24-1	21-11	19-8	25-9	22-3	20-4	17-1
	1.7E	30-2	27-9	26-4	24-4	30-2	27-8	25-3	22-7
	1.9E	31-3	28-8	27-3	25-7	31-3	28-8	27-3	25-6
	2.1E	31-8	29-3	27-10	26-1	31-8	29-3	27-10	25-6

Floor Joists – 50 psf Live Load, 10 psf Dead Load, l/480 Deflection						Floor Joists – 50 psf Live Load, 20 psf Dead Load, l/480 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	12-9	11-10	11-4	10-2	12-9	11-7	10-6	9-5
	1.7E	13-1	12-1	11-6	10-11	13-1	12-1	11-6	10-11
	1.9E	13-5	12-6	11-11	11-3	13-5	12-6	11-11	11-3
	2.1E	13-9	12-8	12-1	11-5	13-9	12-8	12-1	11-5
1 7/16" x 9 1/4"	1.6E	16-0	14-9	13-11	12-6	16-0	14-2	12-11	11-6
	1.7E	16-4	15-1	14-5	13-7	16-4	15-1	14-5	13-7
	1.9E	16-10	15-7	14-10	14-0	16-10	15-7	14-10	14-0
	2.1E	17-2	15-11	15-2	14-3	17-2	15-11	15-2	14-3
1 7/16" x 9 1/2"	1.6E	16-4	15-2	14-3	12-9	16-4	14-5	13-2	11-10
	1.7E	16-9	15-6	14-9	13-11	16-9	15-6	14-9	13-11
	1.9E	17-4	16-0	15-3	14-4	17-4	16-0	15-3	14-4
	2.1E	17-8	16-4	15-6	14-7	17-8	16-4	15-6	14-7
1 7/16" x 11 1/4"	1.6E	19-2	17-9	16-5	14-8	19-2	16-7	15-2	13-7
	1.7E	19-7	18-1	17-3	16-3	19-7	18-1	17-3	16-3
	1.9E	20-3	18-8	17-10	16-9	20-3	18-8	17-10	16-9
	2.1E	20-8	19-1	18-2	17-1	20-8	19-1	18-2	17-1
1 7/16" x 11 7/8"	1.6E	20-2	18-8	17-2	15-4	20-1	17-5	15-10	14-2
	1.7E	20-8	19-1	18-2	17-1	20-8	19-1	18-2	17-1
	1.9E	21-4	19-8	18-9	17-7	21-4	19-8	18-9	17-7
	2.1E	21-9	20-1	19-1	17-11	21-9	20-1	19-1	17-11
1 7/16" x 14"	1.6E	23-7	21-6	19-8	17-7	23-0	19-11	18-2	16-3
	1.7E	24-2	22-3	21-2	19-11	24-2	22-3	21-2	19-11
	1.9E	25-0	23-0	21-10	20-6	25-0	23-0	21-10	20-6
	2.1E	25-6	23-5	22-3	20-11	25-6	23-5	22-3	20-11
1 7/16" x 16"	1.6E	26-9	24-1	21-11	19-8	25-9	22-3	20-4	17-1
	1.7E	27-5	25-3	23-11	22-6	27-5	25-3	23-11	22-6
	1.9E	28-4	26-1	24-9	23-3	28-4	26-1	24-9	23-3
	2.1E	29-0	26-7	25-3	23-9	29-0	26-7	25-3	23-9

Floor Joists – 50 psf Live Load, 10 psf Dead Load, l/600 Deflection						Floor Joists – 50 psf Live Load, 20 psf Dead Load, l/600 Deflection			
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	11-10	11-0	10-6	9-11	11-10	11-0	10-6	9-5
	1.7E	12-1	11-3	10-9	10-1	12-1	11-3	10-9	10-1
	1.9E	12-6	11-7	11-0	10-5	12-6	11-7	11-0	10-5
	2.1E	12-9	11-9	11-3	10-7	12-9	11-9	11-3	10-7
1 7/16" x 9 1/4"	1.6E	14-10	13-9	13-1	12-4	14-10	13-9	12-11	11-6
	1.7E	15-2	14-0	13-4	12-7	15-2	14-0	13-4	12-7
	1.9E	15-8	14-6	13-9	13-0	15-8	14-6	13-9	13-0
	2.1E	16-0	14-9	14-1	13-3	16-0	14-9	14-1	13-3
1 7/16" x 9 1/2"	1.6E	15-2	14-1	13-5	12-8	15-2	14-1	13-2	11-10
	1.7E	15-7	14-5	13-8	12-11	15-7	14-5	13-8	12-11
	1.9E	16-1	14-10	14-2	13-4	16-1	14-10	14-2	13-4
	2.1E	16-5	15-1	14-5	13-7	16-5	15-1	14-5	13-7
1 7/16" x 11 1/4"	1.6E	17-10	16-5	15-8	14-8	17-10	16-5	15-2	13-7
	1.7E	18-3	16-10	16-0	15-1	18-3	16-10	16-0	15-1
	1.9E	18-10	17-4	16-6	15-7	18-10	17-4	16-6	15-7
	2.1E	19-3	17-9	16-10	15-10	19-3	17-9	16-10	15-10
1 7/16" x 11 7/8"	1.6E	18-9	17-3	16-5	15-4	18-9	17-3	15-10	14-2
	1.7E	19-2	17-8	16-10	15-10	19-2	17-8	16-10	15-10
	1.9E	19-10	18-3	17-4	16-4	19-10	18-3	17-4	16-4
	2.1E	20-3	18-8	17-9	16-8	20-3	18-8	17-9	16-8
1 7/16" x 14"	1.6E	21-10	20-2	19-2	17-7	21-10	19-11	18-2	16-3
	1.7E	22-5	20-8	19-7	18-6	22-5	20-8	19-7	18-6
	1.9E	23-2	21-4	20-3	19-1	23-2	21-4	20-3	19-1
	2.1E	23-8	21-9	20-8	19-5	23-8	21-9	20-8	19-5
1 7/16" x 16"	1.6E	24-10	22-10	21-9	19-8	24-10	22-3	20-4	17-1
	1.7E	25-5	23-5	22-3	20-11	25-5	23-5	22-3	20-11
	1.9E	26-4	24-2	23-0	21-7	26-4	24-2	23-0	21-7
	2.1E	26-11	24-8	23-5	22-0	26-11	24-8	23-5	22-0

Rafters – 20 psf Live Load, 10 psf Dead Load, l/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	19-8	17-10	16-10	15-5
	1.7E	20-3	18-4	17-3	16-1
	1.9E	21-0	19-1	18-0	16-8
	2.1E	21-6	19-7	18-5	17-1
1 7/16" x 9¼"	1.6E	25-1	22-10	21-2	18-11
	1.7E	25-10	23-5	22-1	20-6
	1.9E	26-10	24-4	22-11	21-3
	2.1E	27-5	24-11	23-6	21-10
1 7/16" x 9 1/2"	1.6E	25-9	23-5	21-7	19-4
	1.7E	26-6	24-1	22-8	21-0
	1.9E	27-7	25-0	23-7	21-10
	2.1E	28-2	25-7	24-1	22-5
1 7/16" x 11 1/4"	1.6E	30-6	27-3	24-10	22-3
	1.7E	31-5	28-6	26-10	24-11
	1.9E	31-8	29-8	27-11	25-11
	2.1E	31-8	30-4	28-7	26-6
1 7/16" x 11 7/8"	1.6E	31-8	28-6	26-0	23-3
	1.7E	31-8	30-1	28-4	26-3
	1.9E	31-8	31-3	29-5	27-4
	2.1E	31-8	31-8	30-2	28-0
1 7/16" x 14"	1.6E	31-8	31-8	29-10	26-8
	1.7E	31-8	31-8	31-8	31-0
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8
1 7/16" x 16"	1.6E	31-8	31-8	31-8	29-9
	1.7E	31-8	31-8	31-8	31-8
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8

Rafters – 20 psf Live Load, 15 psf Dead Load, l/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	19-8	17-6	16-0	14-4
	1.7E	20-3	18-4	17-3	16-1
	1.9E	21-0	19-1	18-0	16-8
	2.1E	21-6	19-7	18-5	17-1
1 7/16" x 9 1/4"	1.6E	24-9	21-5	19-7	17-6
	1.7E	25-10	23-5	22-1	20-6
	1.9E	26-10	24-4	22-11	21-3
	2.1E	27-5	24-11	23-6	21-10
1 7/16" x 9 1/2"	1.6E	25-4	21-11	20-0	17-11
	1.7E	26-6	24-1	22-8	21-0
	1.9E	27-7	25-0	23-7	21-10
	2.1E	28-2	25-7	24-1	22-5
1 7/16" x 11 1/4"	1.6E	29-1	25-3	23-0	20-7
	1.7E	31-5	28-6	26-10	24-11
	1.9E	31-8	29-8	27-11	25-11
	2.1E	31-8	30-4	28-7	26-6
1 7/16" x 11 7/8"	1.6E	30-5	26-4	24-1	21-6
	1.7E	31-8	30-1	28-4	26-3
	1.9E	31-8	31-3	29-5	27-4
	2.1E	31-8	31-8	30-2	28-0
1 7/16" x 14"	1.6E	31-8	30-3	27-7	24-8
	1.7E	31-8	31-8	31-8	30-5
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8
1 7/16" x 16"	1.6E	31-8	31-8	30-10	27-7
	1.7E	31-8	31-8	31-8	31-8
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8

Rafters – 30 psf Live Load, 10 psf Dead Load, l/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	17-2	15-7	14-8	13-4
	1.7E	17-8	16-1	15-1	14-0
	1.9E	18-4	16-8	15-8	14-7
	2.1E	18-10	17-1	16-1	14-11
1 7/16" x 9 1/4"	1.6E	21-11	19-11	18-4	16-4
	1.7E	22-6	20-6	19-3	17-11
	1.9E	23-5	21-3	20-0	18-7
	2.1E	24-0	21-10	20-6	19-0
1 7/16" x 9 1/2"	1.6E	22-6	20-5	18-8	16-9
	1.7E	23-2	21-0	19-9	18-4
	1.9E	24-1	21-10	20-7	19-1
	2.1E	24-8	22-5	21-1	19-7
1 7/16" x 11 1/4"	1.6E	26-8	23-7	21-6	19-3
	1.7E	27-5	24-11	23-5	21-9
	1.9E	28-6	25-11	24-4	22-7
	2.1E	29-2	26-6	24-11	23-2
1 7/16" x 11 7/8"	1.6E	28-2	24-8	22-6	20-2
	1.7E	28-11	26-3	24-9	23-0
	1.9E	30-1	27-4	25-9	23-10
	2.1E	30-10	28-0	26-4	24-5
1 7/16" x 14"	1.6E	31-8	28-3	25-10	23-1
	1.7E	31-8	31-0	29-2	27-1
	1.9E	31-8	31-8	30-4	28-2
	2.1E	31-8	31-8	31-0	28-10
1 7/16" x 16"	1.6E	31-8	31-7	28-10	25-9
	1.7E	31-8	31-8	31-8	30-11
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8

Rafters – 30 psf Live Load, 15 psf Dead Load, l/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	17-2	15-5	14-1	12-7
	1.7E	17-8	16-1	15-1	14-0
	1.9E	18-4	16-8	15-8	14-7
	2.1E	18-10	17-1	16-1	14-11
1 7/16" x 9 1/4"	1.6E	21-10	18-11	17-3	15-5
	1.7E	22-6	20-6	19-3	17-11
	1.9E	23-5	21-3	20-0	18-7
	2.1E	24-0	21-10	20-6	19-0
1 7/16" x 9 1/2"	1.6E	22-4	19-4	17-8	15-9
	1.7E	23-2	21-0	19-9	18-4
	1.9E	24-1	21-10	20-7	19-1
	2.1E	24-8	22-5	21-1	19-7
1 7/16" x 11 1/4"	1.6E	25-8	22-3	20-4	18-2
	1.7E	27-5	24-11	23-5	21-9
	1.9E	28-6	25-11	24-4	22-7
	2.1E	29-2	26-6	24-11	23-2
1 7/16" x 11 7/8"	1.6E	26-10	23-3	21-3	19-0
	1.7E	28-11	26-3	24-9	23-0
	1.9E	30-1	27-4	25-9	23-10
	2.1E	30-10	28-0	26-4	24-5
1 7/16" x 14"	1.6E	30-9	26-8	24-4	21-9
	1.7E	31-8	31-0	29-2	26-10
	1.9E	31-8	31-8	30-4	28-2
	2.1E	31-8	31-8	31-0	28-10
1 7/16" x 16"	1.6E	31-8	29-9	27-2	24-4
	1.7E	31-8	31-8	31-8	30-2
	1.9E	31-8	31-8	31-8	31-8
	2.1E	31-8	31-8	31-8	31-8

Rafters – 50 psf Live Load, 10 psf Dead Load, I/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	14-6	13-2	12-2	10-11
	1.7E	14-11	13-6	12-9	11-10
	1.9E	15-6	14-1	13-3	12-4
	2.1E	15-10	14-5	13-7	12-7
1 7/16" x 9 1/4"	1.6E	18-6	16-4	14-11	13-4
	1.7E	19-0	17-3	16-3	15-1
	1.9E	19-9	17-11	16-11	15-8
	2.1E	20-3	18-5	17-4	16-1
1 7/16" x 9 1/2"	1.6E	19-0	16-9	15-3	13-8
	1.7E	19-6	17-9	16-8	15-6
	1.9E	20-4	18-5	17-4	16-1
	2.1E	20-9	18-11	17-9	16-6
1 7/16" x 11¼"	1.6E	22-3	19-3	17-7	15-9
	1.7E	23-1	21-0	19-9	18-4
	1.9E	24-0	21-10	20-7	19-1
	2.1E	24-7	22-4	21-0	19-6
1 7/16 x 11 7/8"	1.6E	23-3	20-2	18-5	16-5
	1.7E	24-5	22-2	20-10	19-4
	1.9E	25-4	23-1	21-8	20-2
	2.1E	26-0	23-7	22-2	20-7
1 7/16" x 14"	1.6E	26-8	23-1	21-1	18-10
	1.7E	28-9	26-2	24-7	22-10
	1.9E	29-11	27-2	25-7	23-9
	2.1E	30-7	27-10	26-2	24-4
1 7/16" x 16"	1.6E	29-9	25-9	23-7	20-0
	1.7E	31-8	29-10	28-1	26-1
	1.9E	31-8	31-1	29-3	27-2
	2.1E	31-8	31-8	29-11	27-9

Rafters – 50 psf Live Load, 15 psf Dead Load, l/240 Deflection, CD = 1.15					
Size	**Grade**	**12"**	**16"**	**19.2"**	**24"**
1 7/16" x 7 1/4"	1.6E	14-6	12-10	11-9	10-6
	1.7E	14-11	13-6	12-9	11-10
	1.9E	15-6	14-1	13-3	12-4
	2.1E	15-10	14-5	13-7	12-7
1 7/16" x 9 1/4"	1.6E	18-2	15-9	14-4	12-10
	1.7E	19-0	17-3	16-3	15-1
	1.9E	19-9	17-11	16-11	15-8
	2.1E	20-3	18-5	17-4	16-1
1 7/16" x 9 1/2"	1.6E	18-7	16-1	14-8	13-2
	1.7E	19-6	17-9	16-8	15-6
	1.9E	20-4	18-5	17-4	16-1
	2.1E	20-9	18-11	17-9	16-6
1 7/16" x 11 1/4"	1.6E	21-4	18-6	16-11	15-1
	1.7E	23-1	21-0	19-9	18-4
	1.9E	24-0	21-10	20-7	19-1
	2.1E	24-7	22-4	21-0	19-6
1 7/16" x 11 7/8"	1.6E	22-4	19-4	17-8	15-10
	1.7E	24-5	22-2	20-10	19-4
	1.9E	25-4	23-1	21-8	20-2
	2.1E	26-0	23-7	22-2	20-7
1 7/16" x 14"	1.6E	25-7	22-2	20-3	18-1
	1.7E	28-9	26-2	24-7	22-4
	1.9E	29-11	27-2	25-7	23-9
	2.1E	30-7	27-10	26-2	24-4
1 7/16" x 16"	1.6E	28-7	24-9	22-7	18-6
	1.7E	31-8	29-10	28-1	25-1
	1.9E	31-8	31-1	29-3	27-2
	2.1E	31-8	31-8	29-11	27-9