PROCEDURES

FOR

MECHANICALLY GRADED LUMBER

SOUTHERN PINE INSPECTION BUREAU
PENSACOLA, FLORIDA

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GENERAL

These procedures address all forms of mechanically graded Southern Pine lumber, including Machine Stress Rated lumber, Machine Stress Rated Scaffold Plank, E-Rated Laminations, E-Rated Tension Laminations, Machine Stress Rated Tension Laminations, and Machine Evaluated Lumber.

Mechanically graded lumber is lumber that has been evaluated by ALSC Board of Review approved mechanical grading equipment. Mechanically graded lumber is distinguished from visually graded lumber in that each piece is nondestructively tested and marked to indicate a grade classification. Mechanically graded lumber is also required to meet certain visual requirements as set forth herein, and in addition, conform to all applicable provisions of current Southern Pine Inspection Bureau Grading Rules. Mechanically graded Southern Pine lumber conforming to these procedures is eligible for grade-marking.

The grade-mark on mechanically graded lumber indicates that the design value assignment system meets requirements of the grading agency's qualification and quality control procedures. The grade-mark will show the agency trademark, the mill name or number, the species identification, seasoning designation, and the grade classification. Additional requirements for the grade-mark are indicated in Section 3.0. To meet structural needs for engineered construction, a range of grade classifications is available. Depending on the mechanically graded product being produced, one or more design values will be included on the grade-mark: "E" designates the average edge Modulus of Elasticity of the grade in millions of pounds per square inch. Mechanical stress grading equipment is adjusted so that the output will average or exceed the "E" level shown on the grade-mark. "F_b" indicates the design value for extreme fiber stress in bending for edge loading, in pounds per square inch. "F_t" indicates the design value for tension stress parallel-to-grain, in pounds per square inch.

Strength property design values represent a 5% exclusion level of the property. Assigned design values have been reduced by the same factors applied to visually graded lumber in accordance with ASTM D245.

SCOPE

These Mechanically Graded Lumber Procedures consist of two parts. Part A specifies standard sizes, visual grade requirements, grade-marking and physical property requirements for mechanically graded lumber. Part A also contains standard grade designations and re-inspection provisions. Part B specifies minimum requirements for qualification and quality control. SPIB must verify compliance to these qualification requirements before production of mechanically graded lumber may commence. The quality control requirements are minimum procedures and the agencies have the right to call for an increase in the frequency of calibration, sampling and testing if individual circumstances warrant such an increase.

PART A – PRODUCT REQUIREMENTS FOR MECHANICALLY GRADED LUMBER

1.0 GENERAL

The following subsections apply to all forms of mechanically graded Southern Pine lumber, including Machine Stress Rated Lumber, MSR Scaffold Plank, E-Rated Laminations, E-Rated Tension Laminations, MSR Tension Laminations and Machine Evaluated Lumber.

1.1 Standard Sizes

Thickness		Width	
Nominal	Surfaced Dry	Nominal	Surfaced Dry
1"	3/4"	2"	1-1/2"
1-1/4"	1"	3"	2-1/2"
1-1/2"	1-1/4"	4"	3-1/2"
2"	1-1/2"	5"	4-1/2"
2-1/2"	2"	6"	5-1/2"
3"	2-1/2"	8" & wider	3/4" less than nominal
3-1/2"	3"		
4"	3-1/2"		
4-1/2"	4"		
5" & Thicker	1/2" Off Nominal		

Standard lengths are 6', 7', 8', 9', 10' and in multiples of 2' after 10'.

Note: MSR Scaffold Plank shall only be produced in a nominal 2" thickness and nominal widths of 8" and wider.

1.2 Moisture Content

Moisture Content limit is 19%, but if specified, or represented as kiln dried, the limit shall be 19% for such lumber designated "KD" or "KD19" and 15% for such lumber designated as "KD15".

2.0 VISUAL GRADING REQUIREMENTS

2.1 MSR

Mechanically stress rated lumber must be well manufactured and visually graded to limit certain characteristics even though the actual strength is not affected. All pieces shall be visually graded to assure that the characteristics affecting the strength are no more serious than the following limiting characteristics:

For MSR grades with an F_b of 1000 psi or greater:

- Checks: Seasoning checks not limited. Through checks at ends limited as splits.
- Manufacture: Standard F.
- Shakes: If through at ends limited as splits. Away from ends through heart shakes up to 2' long, well separated. If not through, single shakes may be 3' or up to 1/4 the length whichever is greater.
- Skips: Hit and miss, and in addition 5% of the pieces may be hit or miss or heavy skip not longer than 2'. (Reference SPIB Standard Grading Rule Book, para. 720(e), (f), and (g)).
- Slope of Grain: For machines not evaluating slope of grain, the assigned bending design value shall limit the slope of grain as follows:

0 – 1450 psi	:	1 in 8
1500 – 2050 psi	:	1 in 10
2100 & higher	:	1 in 12

  Machines that measure MOE by deflection indirectly evaluate slope of grain.
- Splits: Equal in length to 1-1/2 times the width of piece.
- Unsound Wood: Heart center streaks not over 1/3 the width or thickness.
- Wane: 1/3 the thickness and 1/3 the width full length, or equivalent on each face, provided that wane not exceed 2/3 the thickness or 1/2 the width for up to 1/4 the length. (reference SPIB Standard Grading Rule Book, para. 750)
- Warp: Light. (reference SPIB Standard Grading Rule Book, para. 752)
- Worm-Eaten Pitch: Regardless of the location, the worst-face measurement is limited to the allowable edge-knot size.

For machines not evaluating knots, knot holes, burls, distorted grain, and decay, when located partially or wholly at the edges of wide-faces, these defects shall be limited as determined by grade level qualification tests.

For MSR grades with an F_b less than 1000 psi:

- Checks: Seasoning checks not limited. Through checks at ends limited as splits.
- Manufacture: Standard F.
- Shakes: Surface shakes permitted. If through at edges or ends, limited as splits; elsewhere, through shakes 1/3 the length, scattered along the length.
- Skips: Hit or miss, with a maximum of 10% of the pieces containing heavy skips. (Reference SPIB Standard Grading Rule Book, para. 720(e) and (g))
- Slope of Grain: For machines not evaluating slope of grain, slope of grain is limited to 1 in 4. Machines that measure MOE by deflection indirectly evaluate slope of grain.
- Splits: Equal to 1/6 the length of the piece.
- Unsound Wood: Must not destroy the nailing edge. Heart center streaks are limited to 1/3 the cross section at any point along the length.
- Wane: 1/2 the thickness and 1/2 the width full length, or equivalent on each face, provided that wane not exceed 7/8 the thickness or 3/4 the width for up to 1/4 the length. (Reference SPIB Standard Grading Rule Book, para. 750)
- Warp: Medium. (Reference SPIB Standard Grading Rule Book, para. 752)
- Worm-Eaten Pitch: Regardless of the location, the worst-face measurement is limited to the allowable edge knot size.

For machines not evaluating knots, knot holes, burls, distorted grain, and decay, when located partially or wholly at the edges of wide faces, these defects shall be limited as determined by grade level qualification tests.

2.2 MSR Scaffold Plank

The grading of MSR Scaffold Plank shall be according to the following provisions, as well as the appropriate provisions in other paragraphs of the grading rules. MSR Scaffold Plank shall be dressed to standard dry size prior to machine stress rating and each piece shall be visually graded to assure that the characteristics affecting strength are no more serious than the limiting characteristics for each grade.

2400 F_b - 2.0E MSR Scaffold Plank
Characteristics permitted and limiting provisions shall be:

- Compression Wood: Prohibited if in readily identifiable and damaging form.
- Checks: Surface seasoning checks, not limited. Through checks at end limited as splits.
- Decay: In knots only.
- Knots: Knots, holes, burls or distorted grain shall not occupy more than 1/6 of the nominal cross section of the piece. Unsound knots limited to 1". Spike knots limited to the edge knot size, not extending across more than 1/3 of the width.
- Manufacture: Standard E.
- Pockets: Not limited.
- Shakes: On ends limited as splits if through. Away from ends heart shakes up to 2 feet long, none through. Ring shakes 1/4 width.
- Skips: hit and miss on any face in 10% of pieces.
- Slope of Grain: For machines not evaluating slope of grain, it shall be limited to 1:16.
- Splits: Equal in length to 1/2 the width of piece.
- Stain: Medium Stain.
- Wane: 1/4 the width, 1/4 the thickness, except 5% of the pieces may have wane ¼ width, 1/3 the thickness by 1/4 length.
- Warp: 1/2 medium, except very light twist.

2200F_b - 1.8E MSR Scaffold Plank
Characteristics permitted and limiting provisions shall be:

- Compression Wood: Prohibited if in readily identifiable and damaging form.
- Checks: Surface seasoning checks, not limited. Through checks at ends limited as splits.
- Decay: In knots only.
- Knots: Knots, holes, burls or distorted grain shall not occupy more than 1/5 of the nominal cross section of the piece. Unsound knots limited to 1" in 8" and 9" widths, 1-1/2" in 10" and 12" widths. Spike knots limited to the edge knot size, not extending across more than 1/3 of the width.
- Manufacture: Standard E.
- Pockets: Not limited.
- Shakes: On ends limited as splits if through. Away from ends heart checks up to 2 feet long,

none through. Ring shakes 1/3 width.

- Skips: Hit and miss on any face in occasional piece but heavy skip on narrow face permitted in 10% of pieces.
- Slope of Grain: For machines not evaluating slope of grain, it shall be limited to 1:14.
- Splits: Equal in length to the width of piece.
- Stain: Medium Stain.
- Wane: 1/4 the width, 1/4 the thickness except 5% of the pieces may have wane 1/3 the width, 1/2 the thickness for 1/4 the length.
- Warp: 1/2 medium, except very light twist.

2.3 E-Rated Laminations and E-Rated Tension Laminations

E-Rated Structural Laminations and E-Rated Tension Laminations must be well manufactured and visually graded to limit certain characteristics even though the actual strength is not affected. All pieces shall be visually graded to assure that the characteristics affecting the strength are no more serious than the following limiting characteristics:

- Checks: Seasoning checks not limited. Through checks at ends limited as splits.
- Knots: Knots may be sound, unsound or not firmly fixed. The cross-section area determines the knot size. Edge knots are limited to 1/2 the cross-section unless a more restrictive knot size is specified.
- Knotholes: Knotholes may be the same as knots permitted in the grade. Other holes are permitted if no more damaging in effect than the allowable knothole.
- Pitch or bark pockets: Medium scattered pitch or bark pockets are permitted. Pitch streaks shall not exceed 1/6 of the width.
- Shakes and Splits: Permitted if extending from wide faces into the thickness at an angle of 45 degrees or more from the wide face.
- Skips: Hit and miss, and in addition, 5% of the pieces may be hit or miss. (Reference SPIB Standard Grading Rule Book , para. 720(e), (f), and (g))
- Slope of Grain: For machines not evaluating slope of grain, the edge knot category shall limit the slope of grain as follows:

  1/3 and larger : 1 in 10
  1/4 and smaller : 1 in 12

  Machines that measure MOE by deflection indirectly evaluate slope of grain.
- Torn Grain: Medium torn grain. Spots of heavy torn grain around knot areas or equivalent.
- Wane: Not to exceed 1/4" deep by 1/4" wide unless a more restrictive requirement is specified.
- Warp: Light, unless a more restrictive requirement is specified. (Reference SPIB Standard Grading Rule Book, para. 752)
- Worm-Eaten Pitch: Regardless of the location, the worst-face measurement is limited to the allowable edge-knot size.

2.4 MSR Tension Laminations

MSR Tension Lams must meet the visual grading requirements for E-Rated Lams. In addition, MSR

Tension Lams must meet the edge knot requirements for MSR lumber.

2.5 MEL

Machine Evaluated Lumber must be well manufactured and visually graded to limit certain characteristics even though the actual strength is not affected. All pieces shall be visually graded to assure that the characteristics affecting the strength and appearance are no more serious than the following limiting characteristics:

For MEL grades with an F_b of 1000 psi or greater:

- Checks: Seasoning checks not limited. Through checks at ends limited as splits.
- Manufacture: Standard F.
- Shakes: If through at ends limited as splits. Away from ends, through heart shakes up to 2' long, well separated. If not through, single shakes may be 3' or up to 1/4 the length which ever is greater.
- Skips: Hit and miss, and in addition 5% of the pieces may be hit or miss or heavy skip not longer than 2'. (Reference SPIB Standard Grading Rule Book, para. 720(e), (f), and (g))
- Slope of Grain: For machines not evaluating slope of grain, the assigned bending design value shall limit the slope of grain as follows:

  1000 - 1450 psi : 1 in 8
  1500 - 2050 psi : 1 in 10
  2100 psi & higher: 1 in 12

  Machines that measure MOE by deflection indirectly evaluate slope of grain.
- Splits: Equal in length to 1-1/2 times the width of piece.
- Unsound Wood: Heart center streaks not over 1/3 the width or thickness.
- Wane: 1/3 the thickness and 1/3 the width full length, or equivalent on each face, provided that wane not exceed 2/3 the thickness or 1/2 the width for up to 1/4 the length. (Reference SPIB Standard Grading Rule Book, para. 750)
- Warp: Light. (Reference SPIB Standard Grading Rule Book, para. 752)
- Worm-Eaten Pitch: Regardless of the location, the worst-face measurement is limited to the allowable edge knot size.

For machines not evaluating knots, knot holes, burls, distorted grain, and decay, when located partially or wholly at the edges of wide faces, these defects shall be limited as determined by grade level qualification tests.

For MEL grades with an F_b less than 1000 psi:

- Checks: Seasoning checks not limited. Through checks at ends limited as splits.
- Manufacture: Standard F.
- Shakes: Surface shakes permitted. If through at edges or ends, limited as splits; elsewhere, through shakes 1/3 the length, scattered along the length.
- Skips: Hit or miss, with a maximum of 10% of the pieces containing heavy skips. (Reference SPIB Standard Grading Rule Book, para. 720(e) and (g))

- Slope of Grain: For machines not evaluating slope of grain, slope of grain is limited to 1 in 4. Machines that measure MOE by deflection indirectly evaluate slope of grain.
- Splits: Equal to 1/6 the length of the piece.
- Unsound Wood: Must not destroy the nailing edge. Heart center streaks are limited to 1/3 the cross section at any point along the length.
- Wane: 1/2 the thickness and 1/2 the width full length, or equivalent on each face, provided that wane not exceed 7/8 the thickness or 3/4 the width for up to 1/4 the length. (Reference SPIB Standard Grading Rule Book, para. 750)
- Warp: Medium. (Reference SPIB Standard Grading Rule Book, para. 752)
- Worm-Eaten Pitch: Regardless of the location, the worst-face measurement is limited to the allowable edge knot size.

For machines not evaluating knots, knot holes, burls, distorted grain, and decay, when located partially or wholly at the edges of wide faces, these defects shall be limited as determined by grade level qualification tests.

3.0 GRADE-MARKING REQUIREMENTS

If the lumber produced in conformance with these procedures is grade-marked, the mark shall contain the items for each product as indicated in the following table:

Item	MSR	MSR Scaffold Plank	E-Lam	E-Rated Tension Lam	MSR Tension Lam	MEL
Agency Identification	X	X	X	X	X	X
Seasoning Designation	X	X	X	X	X	X
Mill Identification	X	X	X	X	X	X
Species	X	X	X	X	X	X
"Machine Rated" or "MSR"	X	X			X	
"E-LAM"			X	X	X	
Grade Code						X
F_b rating	X	X			X	X
E rating	X	X	X	X	X	X
F_t rating	Optional			X	X	X
$F_{c//}$ rating	Optional				Optional	Optional
Specific Gravity	Optional		Optional	Optional	Optional	Optional

Note: "Optional" items may be required if a mill chooses to participate in additional quality control procedures.

4.0 DESIGN VALUES

4.1 General

4.1.1 Mechanically graded lumber allowable stress assignments shall be limited to the increments specified in the following table:

Mechanical Property	Increment
Modulus of Elasticity (MOE)	100,000 psi
Fiber Stress in Bending (F_b)	50 psi
Fiber Stress in Tension (F_t)	25 psi
Compression Parallel to Grain ($F_{c//}$)	25 psi
Compression Perpendicular-to-Grain ($F_{c\perp}$)	5 psi
Horizontal Shear (F_v)	5 psi

4.1.2 Determination of $F_{c\perp}$ and F_v by Controlling Specific Gravity
When a grade is qualified by test and quality controlled for specific gravity, the allowable compression perpendicular-to-grain value may be determined using the following equation:

$$F_{c\perp} = (2252.4 * SG_{OD}) - 480$$

Compression perpendicular-to-grain values determined from the equation above are based on a 0.04-inch deformation limit and are standard for most structures. Values at 0.02-inch deformation may be obtained with the following equation:

$$F_{c\perp(.02)} = (0.71 * F_{c\perp(.04)}) + 14.1$$

When a grade is qualified by test and quality controlled for specific gravity, the allowable horizontal shear value may be determined using the following equation:

$$F_v = (266.0 * SG_{OD}) + 40.0$$

4.2 MSR F_b-E Combinations and Design Values

Design Values for Machine Stress Rated Lumber
2" Thick or Less
Recommended Design Values in Pounds Per Square Inch

FiberStress in Bending "F_b" [1]	Grade	Modulus of Elasticity (million psi) "E"	Tension Parallel to Grain "F_t"	Compression Parallel to Grain "$F_{c//}$"
750	750f-1.4E	1.4	425	925
850	850f-1.4E	1.4	475	975
975	975f-1.6E	1.6	550	1450
1050	1050f-1.2E	1.2	450	1225
1050	1050f-1.6E	1.6	575	1500
1200	1200f-1.3E	1.3	600	1400
1200	1200f-1.6E	1.6	650	1550
1250	1250f-1.6E	1.6	725	1600
1350	1350f-1.4E	1.4	750	1600
1450	1450f-1.3E	1.3	825	1600
1500	1500f-1.5E	1.5	900	1650
1500	1500f-1.6E	1.6	900	1650
1500	1500f-1.7E	1.7	900	1650
1650	1650f-1.5E	1.5	1020	1700
1650	1650f-1.7E	1.7	1020	1750
1800	1800f-1.6E	1.6	1175	1750
1850	1850f-1.7E	1.7	1175	1850
1950	1950f-1.5E	1.5	1375	1800
1950	1950f-1.7E	1.7	1375	1800
2100	2100f-1.8E	1.8	1575	1875
2250	2250f-1.9E	1.9	1750	1925
2400	2400f-2.0E	2.0	1925	1975
2550	2550f-1.8E	1.8	1400	2000
2550	2550f-2.1E	2.1	2050	2025
2700	2700f-2.2E	2.2	2150	2100
2850	2850f-2.3E	2.3	2300	2150
3000	3000f-2.4E	2.4	2400	2200

Major Species Southern Pine:

E Level	F_v	$F_{c\perp}$	Specific Gravity
1.7 million psi and less:	175 psi	565 psi	0.55
1.8 million psi and less:	See paragraph 600.5 (a) of the current Grading Rules		
1.9 million psi and higher:	190 psi	805 psi	0.57

[1] The tabulated Extreme Fiber in Bending value "F_b" is applicable to lumber loaded on edge. When loaded flatwise, multiply by the following factors to increase this value:

Nominal Width (in.)	*4"*	*6"*	*8"*	*10"*	*12"*	*14"*
Factor	*1.1*	*1.15*	*1.15*	*1.2*	*1.2*	*1.2*

4.3 MSR Scaffold Plank Combinations and Design Values

Design Values for Machine Stress Rated Scaffold Plank
Nominal Sizes: 2" Thick, 8" and Wider
Recommended Design Values in Pounds Per Square Inch

Grade	Fiber Stress in Bending "Fb" [1]	Modulus of Elasticity (million psi) "E"
MSR Scaffold Plank 2400f-2.0E	2400	2.0
MSR Scaffold Plank 2200f-1.8E	2200	1.8

[1] The design values for MSR Scaffold Plank are recommended for flatwise use only and are for dry conditions of use (moisture content not to exceed19%). When qualified and controlled as specified in these procedures to meet the flexural requirements of Section 5.0, these values meet all requirements of ANSI A10.8 Safety Requirements for Scaffolds.

For wet conditions of use (where moisture content in service is greater than 19%) the above values shall be multiplied by the following adjustment factors:

F_b	E
0.85	0.90

4.4 MSR Tension Lamination Combinations and Design Values

MSR Tension Laminations have the same design values as the associated MSR grade. MSR Tension Lams also have an E-Lam grade associated with them. The E-Lam grade may be higher or lower than the grade E for the associated MSR grade.

4.5 MEL Combinations and Design Values

Design Values for Machine Evaluated Lumber
2" Thick or Less
Recommended Design Values in Pounds Per Square Inch

Grade Name	Fiber Stress in Bending "F_b" [1]	Tension Parallel to Grain "F_t"	Compression Parallel to Grain "$F_{c//}$"	Modulus of Elasticity (million psi) "E"
M-5	900	500	1050	1.1
M-6	1100	600	1300	1.0
M-7	1200	650	1400	1.1
M-8	1300	700	1500	1.3
M-9	1400	800	1600	1.4
M-10	1400	800	1600	1.2
M-11	1550	850	1675	1.5
M-12	1600	850	1675	1.6
M-13	1600	950	1675	1.4
M-14	1800	1000	1750	1.7
M-15	1800	1100	1750	1.5
M-16	1800	1300	1750	1.5
M-17 [2]	1950	1300	2050	1.7
M-18	2000	1200	1825	1.8
M-19	2000	1300	1825	1.6
M-20 [2]	2000	1600	2100	1.9
M-21	2300	1400	1950	1.9
M-22	2350	1500	1950	1.7
M-23	2400	1900	1975	1.8
M-24	2700	1800	2100	1.9
M-25	2750	2000	2100	2.2
M-26	2800	1800	2150	2.0
M-27 [2]	3000	2000	2400	2.1
M-28	2200	1600	1900	1.7
M-29	1550	850	1650	1.7
M-30	2050	1050	1850	1.7
M-31	2850	1600	2150	1.9
M-32	750	425	925	1.4
M-33	850	475	975	1.4
M-34	975	550	1450	1.6
M-35	1050	575	1500	1.6
M-36	1200	650	1550	1.6
M-37	1250	725	1600	1.6
M-38	1500	900	1650	1.6
M-39	1650	1020	1750	1.7
M-49	1850	1175	1850	1.7

Major Species Southern Pine:

E Level	F_v	$F_{c\perp}$	Specific Gravity
1.7 million psi and less:	175 psi	565 psi	0.55
1.8 million psi and less:	See paragraph 603.5 (b) of the current Grading Rules		
1.9 million psi and higher:	190 psi	805 psi	0.57

[1] The tabulated Extreme Fiber in Bending value "F_b" is applicable to lumber loaded on edge. When loaded flatwise, multiply by the following factors to increase this value:

Nominal Width (in.)	*4"*	*6"*	*8"*	*10"*	*12"*	*14"*
Factor	*1.1*	*1.15*	*1.15*	*1.2*	*1.2*	*1.2*

[2] Grade requires "$F_{c//}$" qualification and quality control.

4.6 LRFD Conversion Factors

The design values shown in Sections 4.2 through 4.5 are for use with Allowable Stress Design (ASD). Load and Resistance Factor Design (LRFD) is an alternative engineering method. The design values for LRFD, called reference resistance values, can be computed by multiplying the ASD design values by the conversion factors listed in the following table:

Extreme Fiber in Bending "F_b"	Tension Parallel to Grain "F_t"	Horizontal Shear "F_v"	Compression Perpendicular to Grain "$F_{c\perp}$"	Compression Parallel to Grain "$F_{c//}$"	Modulus of Elasticity "E"
2.54	2.70	2.88	2.08	2.40	1.00

These factors have been established in accordance with the procedures set forth in ASTM Standard D 5457. The reference resistance values derived using these factors are in units of psi (million psi for "E"). To obtain units of ksi, divide the reference resistance values in psi by 1000.

5.0 MECHANICAL PROPERTY REQUIREMENTS

5.1 General

Mechanically graded lumber is required to meet certain mechanical requirements. The following table indicates the properties for which qualification and daily quality control are required for each type of mechanically graded lumber:

Property	MSR	MSR Scaffold Plank	E-LAM	E-Rated Tension Lam	MSR Tension Lam	MEL
Average Edgewise E	X	X			X	X
Minimum Edgewise E	X	X			X	X
Average Long Span E			X	X	X	
Minimum Long Span E			X	X	X	
Bending Strength (MOR)	X	X			X	X
Tension Strength (UTS)	Optional	Optional	Optional	X	X	X
Compression Strength (UCS)	Optional	Optional	Optional	Optional	Optional	Optional
Specific Gravity[1]	Optional	Optional	Optional	Optional	Optional	Optional

[1] If a major species Southern Pine grade of 1.9E or greater is run in combination with one or more, equal or higher E grade(s), then specific gravity must be qualified and quality controlled for the lower grade(s), as determined by the agency.

Note: "Optional" items may be required if a mill chooses to participate in additional quality control procedures.

5.2 Average Edgewise MOE

The grade E (E_g) is the assigned average Modulus of Elasticity for each machine grade classification. The edge Modulus of Elasticity is determined under the following conditions:

Selection of Loaded Edge	random
Loading Location	third points
Span to Depth Ratio	21:1 where possible
Lengthwise Orientation	the piece shall be centered in the test span
Rate of Loading	maximum rate of stress of 16,000 psi per minute

The average edge Modulus of Elasticity ($\overline{E}$) of MSR lumber shall equal or exceed the grade E (E_g).

$$\overline{E} \geq E_g$$

5.3 Minimum E

The Minimum E (E_{min}) is the estimate of the lower fifth percentile of Modulus of Elasticity. For products with an assumed coefficient of variation for modulus of elasticity of 11%, including MSR, MSR Scaffold Plank, E-Lams, E-Rated Tension Lams, and MSR Tension Lams, the Minimum E value for each grade is assigned a value of 0.82 times the grade E (E_g).

$$E_{min} \geq 0.82E_g$$

For products with an assumed coefficient of variation for modulus of elasticity of 15%, including MEL, the Minimum E value for each grade is assigned a value of 0.75 times the grade E (E_g) unless tighter E variability control is applied.

$$E_{min} \geq 0.75E_g$$

5.4 Long Span E

The Long Span E (LS E) is the assigned average flat-wise long span modulus of elasticity for each machine grade classification. The LS E shall be determined under the following conditions:

Selection of Loaded Face	random
Loading Location	center point
Span to Depth Ratio	100:1 where possible, minimum of 80:1
Lengthwise Orientation	the piece shall be centered in the test span
Preload	5 pounds

The increment load should be sufficient to produce approximately 0.2 (in) deflection in a piece with an LS E of 2.0 million psi. The following loads are recommended:

Size	Load (lbs.)
2x4	10
2x6	10
2x8	15
2x10	15
2x12	20

The average Long Span E (LS E) of E-LAM lumber shall equal or exceed the grade E (E_g).

$$\bar{E} \geq E_g$$

Flatwise Modulus of Elasticity for MSR Scaffold Plank is determined under the same conditions as above.

5.5 Bending Strength (MOR)

The Modulus of Rupture (MOR) is the ultimate stress (expressed in pounds per square inch) of the extreme fibers during bending. It is determined from a formula and depends on maximum bending load, location of load in the span, depth of the member and length of the span. The edgewise Modulus of Rupture shall be determined as follows:

Selection of Loaded Edge	Random
Loading Location	third points
Span to Depth Ratio	21:1 where possible
Lengthwise Orientation	the maximum edge defect located between or as close to the load points as possible
Rate of Loading	maximum rate of stress of 16,000 psi per minute (reach proofload in not less than 15 seconds)

The lower fifth percentile estimate of the Modulus of Rupture for a grade of mechanically graded lumber (MOR 5th) when subjected to a short-term load shall equal or exceed 2.1 times the assigned fiber stress in bending for the grade (F_b):

$$P = \frac{F_b * b * d^2}{L} * 2.1$$

where:

P	=	Proofload (lb)
F_b	=	Design Value (psi)
b	=	base (in) perpendicular to load
d	=	depth (in) parallel to load
L	=	Test Span Length (in)

Appropriate Test Span Lengths for
Various Widths and Lengths of Lumber

Size	Lumber Length	Test Span Length
2x4	10' - 20'	73.5"
2x6	10' - 20'	115.5"
2x8	10' - 12'	115.5"
	14' - 20'	152.25"
2x10, 2x12	10' - 12'	115.5"
	14'	152.25"
	16' - 20'	185.0"

For MSR Scaffold Plank -The lower fifth percentile estimate of the Modulus of Rupture shall equal or exceed 2.6 times the assigned flatwise fiber stress in bending for the grade (F_b) adjusted for edge orientation, if tested on edge, according to the following table:

$$P = \frac{F_b * b * d^2}{L} * 2.6$$

For Edge F_b, multiply flat F_b by:

Size:	2x8	2x10	2x12
Factor:	0.870	0.833	0.833

5.6 Tension Strength (UTS)

The Ultimate Tensile Stress is determined from a formula and depends on the ultimate tensile load and the cross sectional area of the member. The Ultimate Tensile Stress shall be determined as follows:

Gauge Length (Interior Distance between Grips):	8' or longer when possible. Not less than 4'.
Orientation:	The maximum strength-reducing defect shall be positioned between the grips and, where possible, a minimum distance away from the grip equal to two times the nominal test specimen width. In no case shall it be located partially or wholly within the grip.
Rate of Loading:	Not to exceed 4000 psi per minute.

The lower fifth percentile estimate of the Ultimate Tensile Stress for a grade of mechanically graded lumber (UTS 5th) when subjected to a short-term load, shall equal or exceed 2.1 times the assigned fiber stress in tension for the grade (F_t):

$$P = F_t * b * d * 2.1$$

where: P = Proofload (lb)
F_t = Tension Design Value (psi)

b = thickness (in)
d = width (in)

5.7 Compression Strength (UCS)

The Ultimate Compressive Stress (UCS) is determined from a formula and depends on the ultimate compressive load and the cross sectional area of the member. The UCS shall be determined as follows:

Test Specimen	Cut from full-length members. Represents maximum strength-reducing characteristic.
Test Specimen Length	At least 2.5 times the greater cross sectional dimension. Maximum strength reducing characteristic shall be centered within the specimen length. Bearing surfaces shall be plane, parallel to each other and perpendicular to the long axis of the specimen.
Bearing Blocks	Designed to ensure load is uniformly applied over the full contact surfaces to prevent eccentric loading. At least one spherical bearing block shall be used.
Lateral Supports	May be either continuous or intermittent. Shall allow for specimen movement in the direction of the load application and provide minimal friction restraint.
Loading Rate	Load shall be applied at a rate such that the target load is achieved in approximately 1 minute.

The lower fifth percentile estimate of the Ultimate Compressive Stress for a grade of mechanically graded lumber (UCS 5th) when subjected to a short-term load, shall equal or exceed 1.9 times the assigned fiber stress in compression parallel to the grain for the grade ($F_{c//}$):

$$P = F_{c//} * b * d * 1.9$$

where:
P = Proofload (lb)
$F_{c//}$ = Compression Parallel Design Value (psi)
b = thickness (in)
d = width (in)

5.8 Specific Gravity

When the equations in Section 4.1.2 are used to assign $F_{c\perp}$, F_v, or an alternate specific gravity value, the mean specific gravity of the population of a grade of mechanically graded lumber shall be maintained at the level qualified.

The specific gravity shall be measured following the procedures of ASTM D2395, Method A, except for the tolerances listed below. The specific gravity for each specimen shall be determined at the moisture content at the time of test. The specific gravity value shall be converted to an oven dry weight and volume basis using ASTM D2395 Appendix X1. The table in Appendix C may be used

for many cases.

Specific Gravity shall be determined to the following specifications:

Specimen dimensions shall be measured to the nearest 0.01inch in thickness and width, and to the nearest 1/8 inch in length. Specimen weight shall be measured as either the full specimen weight or 1/2 weight using a calibrated weighing device measuring to at least the nearest 0.1 (lb). Moisture content shall be determined using a calibrated surface or pin type moisture meter adjusted for the species

$$SG_{test} = \frac{K * W}{(1 + \frac{MC_{test}}{100}) w * t * \ell}$$

where:

SG_{test} = Specific Gravity at OD weight and volume at time of test
K = a constant, 27.68 if W is in (lb), volume is in (in^3)
W = Weight of specimen, (lb)
MC_{test} = Moisture Content at time of test
w = width of piece, (in)
t = thickness of piece, (in)
ℓ = length of piece, (in)

When specific gravity is to be qualified, the specific gravity shall be determined for each specimen in the bending or tension sample.

When required, specific gravity shall be determined for all bending or tension daily quality control specimens in accordance with the above paragraphs.

6.0 REINSPECTION REQUIREMENTS

Complaints on mechanically graded lumber involving visual grade, size, working, tally or moisture content shall be governed by Inspection and Shipping provisions of the SPIB Standard Grading Rules. Complaints on the Modulus of Elasticity of mechanically graded lumber shall be in accordance with the basis of testing desired, provided the basis is specified in the contract of purchase and sale, or is mutually agreeable to buyer and seller. In the absence of a special agreement, the purchase, sale or shipment of mechanically graded lumber under these SPIB Mechanically Graded Lumber Procedures shall be construed as involving agreement to abide by the acceptance sampling procedures described below. Samples from the mechanically graded lumber under complaint shall be randomly selected using a procedure mutually agreed upon by the buyer and seller. The sample sizes and acceptance requirements are given in Table 1. The sample pieces shall be submitted to an independent, qualified laboratory authorized by SPIB and tested for edgewise MOE in accordance with Section 5.0. (Note: E-Rated Laminations and E-Rated Tension Laminations shall be tested for Long Span E instead of edgewise E.)

If the pieces tested conform to the requirements of Table 1, the average and minimum Modulus of Elasticity of the item qualifies as satisfactory in relation to compliance with purchase specifications

and for effecting settlement of the invoice between buyer and seller. If the pieces tested do not conform to the requirements of Table 1, the entire item shall become the property of the seller.

The expense of the inspection and testing costs shall be borne by the seller if the item tested does not conform to the specified requirements of these procedures, and by the buyer if the item tested conforms to the specified requirements, but the applicant for the inspection shall be responsible to the Bureau for the cost thereof.

TABLE 1. Acceptance Criteria for Mechanically Graded Lumber Re-inspections

Sample Size	Sample average must exceed this value	Maximum number of pieces which may be less than "Minimum E"
100	E_g - 0.318*s	8

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

where: E_g = the grade E
s = sample standard deviation, calculated as:
n = sample size = 100
x_i = each observation
$\bar{x}$ = average value

Minimum E = 0.82 * E_g for products with an assumed COV of 11%
= 0.75 * E_g for products with an assumed COV of 15%

Note: Both requirements in Table 1 must be met for acceptance.

PART B - PROCEDURES FOR QUALIFICATION AND QUALITY CONTROL

7.0 QUALIFICATION PROCEDURES

7.1 Scope

This document defines minimum procedures by which manufacturers may become qualified to produce and grade-mark mechanically graded lumber as described by the grading rules. The agency is responsible for qualification of each manufacturer.

7.2 Equipment and Personnel Requirements

7.2.1 Each facility shall have a written facility standard outlining quality control procedures. This standard must be approved by the agency prior to production (grademarking) and must be followed to retain qualification. Any changes to the facility standard must be approved by the agency.

7.2.2 The agency supervisor shall visit the facility to determine:

1) That the operation is capable of being operated within the requirements of the facility standard; and

2) Operating personnel shall be qualified by the quality control agency to conduct the mechanically graded lumber quality control program.

7.2.3 Each facility shall possess the static test equipment capable of testing the sizes and grades to be qualified. The accuracy of the facility's test equipment shall either be certified by the manufacturer or verified against the agency's calibrated test equipment. The tension gauge length and bending test span and load points shall be set to an accuracy of ± 1/16" of the required span.

7.2.4 The static bending test equipment shall be capable of measuring displacement to 0.001". The deflection of the wood is measured relative to the reaction supports.

7.2.5 Where unsupported overhangs create a flexural stress in the member, the calculation of MOR shall consider the effect due to the weight of the overhangs if to do otherwise results in non-conservative results.

7.3 Qualification Sample Selection

7.3.1 Before selecting the samples, the production machine shall have been properly calibrated and set for the size and machine grade or grades to be qualified. Grades shall be qualified in the grade combinations in which they are produced. Each size and grade category for which grade-marks are desired must be qualified.

For the mechanically graded lumber product being qualified, determine which properties are required to be tested (Reference Section 5.1). Based on the properties to be tested, determine the number of pieces to be selected. No piece may be tested for more than one

strength property. Pieces may be tested for one or more E measurements as well as a single strength property. The following table indicates the minimum sample sizes required for the various mechanically graded products:

Property	MSR	MSR Scaffold Plank	E-LAM	E-Rated Tension Lam	MSR Tension Lam	MEL
Bending (AVG E, MIN E, AVG LS E, MIN LS E, MOR)	53	53	53		53	53
Tension (UTS)				53*	53	53

* AVG LS E and MIN LS E are required, but the same 53 pieces may be used as used for UTS. Additional samples are required if optional properties are to be qualified (e.g. UTS or UCS). Specific gravity may be determined using the same pieces used to determine E.

7.3.3 If knots are not evaluated by the production machine, an edge knot size must be established that has the potential of being qualified. A knot size guide is 1/6 the width of the piece for grades 2100f and higher and 1/4 the width for grades less than 2100f.

7.3.4 Following machine rating, the agency supervisor shall randomly select pieces representative of each grade to be qualified. Including 10-30 additional pieces per grade during initial sample selection is recommended so that extras are available for replacement of pieces with over-sized edge knots, excess moisture, etc. Each piece shall meet the visual grading requirements as per Section 2.0. A higher-level visual grade requirement is permissible. Such requirements must be recorded on the qualification form and become a permanent part of the grade qualification.

7.3.5 Pieces with edge knots whose size are questionable must be included in the sample and the edge knot size determined later by measurement. If two or more grades are being qualified in combination, any downfall from a higher grade must be included in a lower grade.

7.4 Qualification Sample Testing

7.4.1 Mark the location of the edge characteristic visually judged to be the most strength reducing defect. Measure and record the maximum edge knot in each piece. Discard any piece exceeding the edge knot size as established in 7.3.3 above. Testing of each piece is to be done in sequence, layer by layer from the package of qualification sample lumber. Testing continues until the minimum sample size has been tested.

7.4.2 Moisture content shall be determined and recorded for each piece at time of test. Discard any piece exceeding the moisture content requirements.

7.4.3 If required, the edgewise Modulus of Elasticity shall be determined from a load/deflection relationship obtained below the proportional limit of the test piece in accordance with Section 5.2. The grade-mark or color mark on the sample shall be consistently placed to

either the tester's right or left and the machine spray facing the tester to provide random placement of edge defects with respect to loading in tension or compression.

7.4.4 If required, the Long Span E (LS E) shall be determined in accordance with Section 5.4.

7.4.5 If required, bending strength shall be determined in accordance with Section 5.5, by loading each piece to a level to be determined according to Appendix B for the machine grade being produced. If the test piece fails at any load value below the specified proofload, the MOR is recorded and also whether the failure was obviously initiated by a visual defect in the test piece. A partial failure in the lumber may be disregarded if the piece sustains the proofload without further damage.

7.4.6 If required, tension strength shall be determined in accordance with Section 5.6, by loading each piece to a level determined according to Appendix B for the machine grade being produced. If the test piece fails at any load value below the specified proofload, the UTS is recorded and also whether the failure was obviously initiated by a visual defect in the test piece. A partial failure in the lumber may be disregarded if the piece sustains the proofload without further damage.

7.4.7 If required, compression strength shall be determined in accordance with Section 5.7, by loading each piece to a level determined according to the equation in Section 5.7 for the machine grade being produced. If the test piece fails at any load value below the specified proofload, the UCS is recorded and also whether the failure was obviously initiated by a visual defect in the test piece. A partial failure in the lumber may be disregarded if the piece sustains the proofload without further damage.

7.4.8 If required, the specific gravity shall be determined in accordance with Section 5.8.

7.4.9 When the temperature of the wood is below 32°F, corrections to the strength properties and E may be necessary.

7.5 Analysis of Qualification Test Results

7.5.1 The results of the E and strength tests shall determine whether grade-marks may be issued for the item being qualified. The grade and size combination is considered qualified and grade-marks may be issued if the following requirements are met:

(a)	(b)	(c)
Mean E of the E Qualification Sample equals or exceeds:	Pieces with E less than "Minimum E" for the grade	Pieces with strength less than the required proofload (per property)
E_g - 0.04×10^6 psi	no more than 1	no more than 1

Note: Additional samples may be tested to qualify for minimum E or a strength property.

The following table presents required sample sizes and permitted failures:

Sample Size	Failures Permitted
78	2
102	3
125	4

7.5.2 If more strength failures are encountered than permitted in 7.5.1(c), the grade might still be qualified by utilizing the following procedures.

1) Determine how many failed pieces and passing pieces with a given knot size would have to be eliminated to qualify. Reduce the edge knot size to the new limit. Eliminate the pieces with edge knot sizes exceeding this new limit. Test an equal number of additional pieces in the same sequence as in 7.4.1.

2) If no additional strength failures are encountered, the grade may be qualified. Provided:
   - The number of strength failures in the new sample is rechecked and does not exceed the strength failure allowance.
   - The average E for the new sample is calculated and meets the E requirements.
   - The number of pieces in the new sample with an E less than the Minimum E for the grade is rechecked and meets the requirements.

7.5.3 If the test results do not meet the requirements of 7.5.1 (a), (b), and (c), or 7.5.2, the manufacturer may elect to qualify a lower grade for which these requirements are met, provided the visual requirements for the lower grade are the same. Alternatively, adjustments of the machine settings may be made, new samples selected and tested until requirements of 7.5.1 (a), (b), and (c) or 7.5.2 are satisfied.

8.0 FACILITY QUALITY CONTROL PROCEDURES

8.1 Scope

This section defines minimum quality control procedures to be followed by the facility to continuously maintain both the E and strength requirements of the grades being produced. Continuing use of grade-marks for mechanically graded lumber is made contingent upon the manufacturer following certain required minimum in-facility quality control procedures as set forth in this Section.

8.2 Machine and Test Equipment Calibration

8.2.1 Machine Calibration - The production machine shall be calibrated prior to the beginning of each production period and at approximately every four hours of machine operation, unless otherwise stated in the machine manufacturer's published operation manual. The manufacturer's machine operation manual is to be referenced within the Facility Standard and shall be available to the agency for review. Records of all calibration checks shall be

maintained.

8.2.2 Test Equipment Calibration

1) Bending - Bending proof loader calibration shall be verified daily using an aluminum bar with the test bench set for 2x4 or 2x6 measurements. Load cells shall be verified once per week using a load gauge that has been calibrated per paragraph 8.2.3. Readings shall be within 1% of the target value for the proving ring and aluminum bar, unless otherwise stated in the manufacturer's published operator's manual. If the precision cannot be met with both the proving ring and aluminum bar, no lumber shall be released for shipment until samples are tested with a proof loader meeting the required precision and the test results meet the quality control requirements.

2) Tension - Daily calibration of tension proofloaders refers to the calibration of electronic measuring devices using "shunt calibration". The tension proof loader must be calibrated once per year using a tension calibration link.

3) Compression - Daily calibration of compression proofloaders refers to the calibration of electronic measuring devices by the use of the "shunt calibration". Load cells must be calibrated once per week using a proof ring.

8.2.3 Certification of Load Gauge – A testing laboratory with standards traceable to the National Institute of Science and Technology shall calibrate the mill load gauges annually with no more than 18 months between calibrations. The laboratories testing equipment shall be calibrated in accordance with the current ASTM E-74 standard. ASTM E-74 considers bias and precision.

8.3 Quality Control Sampling

Immediately following qualification, intensive quality control sampling shall be performed on the grade or grade combinations qualified. From each of the first three (3) eight-hour (8hr.) shifts following the qualification four (4), five-piece samples shall be selected as specified below:

Count five (5) pieces of the grade being tested.

Select the next five (5) pieces of the grade tested as graded under production line conditions.

Repeat this process four (4) times at approximately equal intervals during the shift period.

For all subsequent quality control sampling for a given grade, a minimum of one (1) five (5)-piece sample shall be selected for each four (4) hour production period or for each significant portion of a production period.

8.4 Quality Control Sample Testing

Quality control tests shall be performed for each property, as required for the product being

produced (Reference Section 5.1). Tests shall be performed using the procedures described in Sections 5.2 through 5.8. Proofloads for bending and tension strength are presented in Appendix B. Results from these tests shall be entered on the Control Forms.

8.5 Analysis of Quality Control Test Results

Quality control, including sampling and testing shall utilize the Cumulative Sum (CUSUM) procedure or other approved system, and test results shall be recorded on Control Forms. CUSUM control constants are given in Appendix C. Separate CUSUM records shall be required for each grade produced. In some instances, a given grade may be run individually or in combination with other grades. In either case, one CUSUM record shall be maintained if a grade is run individually and another CUSUM record shall be maintained when a grade is run in combination with another grade.

8.5.1 In-Control

If tests show the process for the properties required for the mechanically graded product being produced to be in-control, all lumber represented by the sample is satisfactory for shipment.

8.5.2 Out-of-Control

Upon determining the production is out-of-control, all lumber represented by the sample shall be held pending results of confirmation tests as set forth below and in Appendix D:

The visual grade and moisture content shall be checked. The production machine shall be checked for basic calibration and accuracy of machine boundary settings. The static test equipment shall be checked for accurate calibration. Following lumber, machine and test equipment checks, the operator can 1) make no machine grade boundary adjustment, 2) make a single 3% or smaller machine grade boundary adjustment, or 3) make a machine grade boundary adjustment greater than 3% (Appendix D).

8.5.3 Summary of Steps in Out-of-Control

The operator may take a maximum of three (3) sets of six (6) five (5)-piece* samples in an attempt to bring the grade back into control. The operator may take one (1) set of six (6) five (5)-piece* samples in Step 1 and another two (2) sets of six (6) five (5)-piece* samples in Step 2. If the grade remains out-of-control after Step 1 and/or Step 2 is executed, then Step 3 is executed and the grade must be re-qualified.

** When UTS and/or UCS testing are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.*

STEP 1. No Machine Grade Boundary Adjustment
If no initial machine grade boundary adjustment is made, the operator shall select 30* pieces from production by choosing approximately every third (3rd) piece, sequentially numbered

in six (6) samples of five (5) pieces*. Tests shall be made in accordance with Section 8.4.

When control forms indicate in-control, after one (1) or more of the six (6) samples have been tested and evaluated, the production volume held pending completion of tests may be released for shipment and grade-marked production may continue.

If control forms indicate the process is still out-of- control, proceed to either Step 2 or Step 3.

STEP 2. Machine Grade Boundary Adjustment of 3% or Less.
If a single 3% or smaller machine grade boundary adjustment is made, the operator shall select 30* pieces representative of production following the modification by choosing approximately every third (3rd) piece, sequentially numbered in six (6) samples of five (5) pieces*. Tests shall be made in accordance with Section 8.4.

If after the machine grade boundary adjustment the control forms indicate in-control, after one or more of the six (6), five (5)-piece* samples have been evaluated the production volume held pending completion of tests may be released for shipment and grade-marked production may continue.

If the process remains out-of-control, the operator can select 30* additional pieces at the modified machine grade boundary settings or proceed to Step 3. These additional samples must be collected and tested in the manner described above. If the process remains out-of-control after these additional samples are tested, proceed to Step 3.

STEP 3. Machine Grade Boundary Adjustment of More than 3%.
If a machine grade boundary adjustment of more than 3% is made, all grade-marks on lumber held pending completion of tests shall be obliterated. The Quality Control agency shall be notified immediately.

This size-grade level must be requalified according to Section 7.3 through 7.5 before production can resume. After requalification, intensive sampling shall be performed in accordance with Section 8.4.

8.6 Machine Grade Boundary Adjustments

Qualified mill personnel may adjust machine grade boundary settings. The amount of the change and required testing vary, depending on the direction of the change, the current CUSUM value and the current machine settings.

8.6.1 Reducing Grade Boundary Settings

1) Current CUSUM = 0, Current settings = qualified settings.
   Reductions in grade boundary settings from the qualified settings are limited to 3% increments. After reducing the settings up to 3%, Intensive Sampling, at the rate of 2 samples every 4 hours for 3 shifts (12 samples) must be performed. Upon acceptance of the reduced settings, the new settings become the qualified settings.

2) Current CUSUM = 0, Current settings above qualified settings.
If current settings are above the qualified settings, they may be reduced to the qualified settings in any increment up to 6%, and no additional testing (Intensive Sampling) is required. Additional reductions may be taken after testing at least 12 samples at the first reduced settings. These 12 samples may be taken at the ordinary rate (1 sample every 4 hours for 6 shifts), or at an increased rate (Intensive Sampling).

If a single increment reduction of greater than 6%, but less than 10%, is desired, Intensive Sampling must be performed.

No reductions in grade boundary settings greater than 10% are permitted in a single increment.

3) No reductions in Grade Boundary settings are permitted when the CUSUM is positive (greater than 0).

8.6.2 Increasing the Grade Boundary Settings

1) Current CUSUM is less than Y.
If the current CUSUM is less than the Y value for grade being produced, and the process is not otherwise Out-of-Control, the grade boundary settings may be increased in any increment.

2) Current CUSUM is greater than Y.
If the current CUSUM is greater than Y, it is automatically set equal to the Z value and an Out-of-Control situation has occurred. Increases in grade boundary settings are permitted, but limited to 3% increments. Out-of-Control procedures must be followed.

8.6.3 Machine Controlled Grade Boundary Settings

1) Machines that are capable of monitoring and controlling the settings automatically may be set to adjust the settings to any increment above the qualified setting and then automatically adjust the settings towards the qualified setting, but not below.

2) Paragraph 8.6.2 2) applies.

8.7 Quality Control Record Keeping

Facility quality control records shall include:

- Machine and test equipment calibration checks,
- Machine settings and any changes thereto,
- Quality control tests, and
- Production stoppages occasioned by the quality control provisions with an explanation of the corrective action taken.

Records shall be retained for at least one year and be available, upon request, to the agency during

work hours.

8.8 Time Frame for Grade Qualifications

Grade or grade combination qualification tests shall become void when such grades or grade combinations have not been produced for a period of eighteen (18) months.

9.0 AGENCY QUALITY CONTROL

9.1 Qualification of Facilities

The agency is responsible for performing the analysis of grade/size qualification test results prior to issuance of grade-marks. The agency shall maintain a current list of qualified facilities including grades and sizes. The agency shall approve and maintain a record of tests performed to change qualified grade boundary settings in order to increase grade recovery or change the combination of grades being produced.

9.2 Verification of Test Equipment

At least annually the accuracy of facility test equipment shall be evaluated to verify the integrity of the deflection and load measuring apparatus. This requirement is separate from the annual calibration of the mill load gauge.

9.3 Mill Personnel

Upon initial plant qualification, the agency shall establish that mill personnel are informed on proper operating procedures required for the production of mechanically graded lumber as outlined in the agency's procedures for qualification and quality control.

9.4 Periodic Inspections

Following qualification mechanically graded lumber production of the operating facility shall be inspected by an agency supervisor at approximately monthly intervals to evaluate conformance to visual grade requirements and general manufacturing quality. The agency supervisor shall submit a report of the inspection to the inspected facility and to the agency. This report shall include a record of any production stoppages during the preceding month occasioned by an out-of-control situation in addition to indicating facility production conformance to agency visual grade rules. The agency shall keep on record for a minimum of three years the monthly reports furnished by the agency supervisor.

9.5 Quarterly Inspections

Following qualification, mechanically graded lumber production of the operating facility shall be inspected by an agency Quality Supervisor or technician at least quarterly to evaluate conformance to established requirements under the quality control procedure. The Quality Supervisor shall submit

a report of the inspection to the inspected facility and to the agency. If not previously covered in an inspection report since the last quarterly report, this report shall include:

- An analysis of the physical tests performed on representative mechanically graded lumber production.
- A record of the mill's weekly static tester calibration checks; and
- A record of the mill's maintenance of accurate and complete daily quality control tests.

This report shall also include a record of any production stoppages since the previous inspection occasioned by an out-of-control situation. The agency shall keep on record for a minimum of two (2) years the quarterly mill reports.

9.6 Periodic Tension Testing

For those facilities not monitoring tension strength on an on-going basis, the agency shall periodically assess the mechanically graded products for tension strength.

APPENDIX A - SHEAR CORRECTION FACTORS FOR E

In cases where the size and length of lumber results in a test span to depth ratio (l/d) less than 21, the following factors may be applied to E qualification and quality control test results.

Assumptions:

1/3 Point Loading*
Deflection measured at mid-point
E/G ratio of 16

l/d	Factor applied to Measured E
20	1.003
19	1.007
18	1.012
17	1.017
16	1.024
15	1.032
14	1.041
13	1.053
12	1.068
11	1.087
10	1.112

This table was derived from ASTM D 2915-17, Table X4.1, K factors for Adjusting Apparent Modulus of Elasticity of Simply Supported Beams.

APPENDIX B - PROOFLOADS

The equations used to determine the proofloads are as follows:

Bending	Tension
$P = \frac{F_b * b * d^2 * 2.1}{L}$	$P = F_t * b * d * 2.1$
P = Bending Proofload (lb) F_b = Bending Design Value (psi) b = base (in) (perpendicular to load) d = depth (in) (parallel to load) L = Test Span Length (in)	P = Tension Proofload (lb) F_t = Tension Design Value (psi) b = thickness (in) d = width (in)

Bending Proofload Tables: MSR and MEL
Minimum Required Load, pounds

Fb / Span	2x4	2x6			2x8				2x10				2x12				Fb
		8'	8'	10'-20'	8'	8'	10'/12'	14'/20'	8'	10'/12'	14'	16'/20'	8'	10'/12'	14'	16'/20'	
	73.5	73.5	90.42	115.5	73.5	90.42	115.5	152.25	90.42	115.5	152.25	185	90.42	115.5	152.25	185	
750	394	972	790	619	1690	1373	1075	816	2236	1750	1328	1093	3307	2589	1964	1616	750
850	446	1102	896	701	1915	1556	1218	924	2534	1983	1505	1238	3748	2934	2226	1832	850
900	473	1167	948	743	2027	1648	1290	979	2683	2100	1593	1311	3968	3107	2357	1939	900
975	512	1264	1027	804	2196	1785	1398	1060	2906	2275	1726	1420	4299	3365	2553	2101	975
1050	551	1361	1107	866	2365	1923	1505	1142	3130	2450	1859	1530	4630	3624	2749	2263	1050
1100	578	1426	1159	908	2478	2014	1577	1196	3279	2567	1947	1603	4850	3797	2880	2370	1100
1200	630	1556	1265	990	2703	2197	1720	1305	3577	2800	2124	1748	5291	4142	3142	2586	1200
1250	656	1621	1317	1031	2816	2289	1792	1359	3726	2917	2213	1821	5511	4315	3273	2694	1250
1300	683	1685	1370	1073	2928	2380	1864	1414	3875	3034	2301	1894	5732	4487	3404	2801	1300
1350	709	1750	1423	1114	3041	2472	1935	1468	4024	3150	2390	1967	5952	4660	3535	2909	1350
1400	735	1815	1475	1155	3154	2564	2007	1523	4173	3267	2478	2040	6173	4832	3666	3017	1400
1450	761	1880	1528	1196	3266	2655	2079	1577	4322	3384	2567	2112	6393	5005	3797	3125	1450
1500	788	1945	1581	1238	3379	2747	2150	1631	4471	3500	2655	2185	6614	5178	3928	3232	1500
1550	814	2009	1633	1279	3492	2838	2222	1686	4620	3617	2744	2258	6834	5350	4059	3340	1550
1600	840	2074	1686	1320	3604	2930	2294	1740	4769	3734	2832	2331	7055	5523	4190	3448	1600
1650	866	2139	1739	1361	3717	3021	2365	1794	4918	3850	2921	2404	7275	5695	4321	3556	1650
1800	945	2334	1897	1485	4055	3296	2580	1958	5365	4200	3186	2622	7936	6213	4713	3879	1800
1950	1024	2528	2055	1609	4393	3571	2795	2121	5813	4550	3452	2841	8598	6731	5106	4202	1950
2000	1050	2593	2108	1650	4505	3662	2867	2175	5962	4667	3541	2914	8818	6903	5237	4310	2000
2100	1103	2723	2213	1733	4731	3845	3010	2284	6260	4900	3718	3059	9259	7249	5499	4525	2100
2200	1155	2852	2318	1815	4956	4029	3154	2393	6558	5134	3895	3205	9700	7594	5761	4741	2200
2250	1181	2917	2371	1856	5069	4120	3225	2447	6707	5250	3983	3278	9921	7766	5892	4849	2250
2300	1208	2982	2424	1898	5181	4212	3297	2501	6856	5367	4072	3351		7939	6023	4956	2300
2350	1234	3047	2477	1939	5294	4303	3369	2556	7005	5484	4160	3424		8112	6154	5064	2350
2400	1260	3111	2529	1980	5406	4395	3440	2610	7154	5600	4249	3497		8284	6284	5172	2400
2550	1339	3306	2687	2104	5744	4669	3655	2773	7601	5950	4514	3715		8802	6677	5495	2550
2700	1418	3500	2845	2228	6082	4944	3871	2936	8048	6301	4780	3934		9320	7070	5818	2700
2750	1444	3565	2898	2269	6195	5036	3942	2991	8197	6417	4868	4006		9492	7201	5926	2750
2800	1470	3630	2951	2310	6308	5127	4014	3045	8346	6534	4957	4079		9665	7332	6034	2800
2850	1496	3695	3003	2351	6420	5219	4086	3099	8495	6651	5045	4152		9837	7463	6142	2850
3000	1575	3889	3161	2475	6758	5493	4301	3263	8942	7001	5311	4371			7856	6465	3000

Tension Proofload Tables: MSR and MEL
Minimum Required Load, pounds

Look up proofload based on the TENSION value associated with the grade being produced

Ft	2x4	2x6	2x8	2x10	2x12	Ft
425	4,690	7,360	9,710	12,380	15,060	425
450	4,960	7,800	10,280	13,110	15,950	450
475	5,240	8,230	10,850	13,840	16,830	475
500	5,510	8,660	11,420	14,570	17,720	500
575	6,340	9,960	13,130	16,750	20,380	575
600	6,620	10,400	13,700	17,480	21,260	600
650	7,170	11,260	14,840	18,940	23,030	650
700	7,720	12,130	15,990	20,400	24,810	700
725	7,990	12,560	16,560	21,120	25,690	725
750	8,270	12,990	17,130	21,850	26,580	750
800	8,820	13,860	18,270	23,310	28,350	800
825	9,100	14,290	18,840	24,040	29,240	825
850	9,370	14,730	19,410	24,770	30,120	850
900	9,920	15,590	20,550	26,220	31,890	900
950	10,470	16,460	21,700	27,680	33,670	950
1000	11,030	17,330	22,840	29,140	35,440	1000
1020	11,250	17,670	23,290	29,720	36,150	1020
1050	11,580	18,190	23,980	30,590	37,210	1050
1100	12,130	19,060	25,120	32,050	38,980	1100
1175	12,950	20,360	26,830	34,240	41,640	1175
1200	13,230	20,790	27,410	34,970	42,530	1200
1250	13,780	21,660	28,550	36,420	44,300	1250
1300	14,330	22,520	29,690	37,880	46,070	1300
1375	15,160	23,820	31,400	40,060	48,730	1375
1400	15,440	24,260	31,970	40,790	49,610	1400
1575	17,360	27,290	35,970	45,890	55,810	1575
1600	17,640	27,720	36,540	46,620	56,700	1600
1750	19,290	30,320	39,970	50,990	62,020	1750
1800	19,850	31,190	41,110	52,450	63,790	1800
1900	20,950	32,920	43,390	55,360	67,330	1900
1925	21,220	33,350	43,960	56,090	68,220	1925
2000	22,050	34,650	45,680	58,280	70,880	2000
2050	22,600	35,520	46,820	59,730	72,650	2050
2150	23,700	37,250	49,100	62,650	76,190	2150
2300	25,360	39,850	52,530	67,020	81,510	2300
2400	26,460	41,580	54,810	69,930	85,050	2400

APPENDIX C - CUSUM QUALITY CONTROL

This appendix includes instructions and sample quality control forms that are used to implement the CUSUM quality control process for monitoring the mechanical properties of mechanically graded lumber. Various sets of forms are available, depending on the type of production machine and which properties are being tested. The forms in this appendix are presented as an example of the CUSUM process.

Also included in this appendix are the forms and procedures used to implement the CUSUM quality control process for monitoring the average specific gravity of mechanically graded lumber.

The following table provides the CUSUM constants that are referred to in the instructions and used in the CUSUM process.

Values for use with CUSUM Forms						
Grade E x 10^6 psi	Designation	W		X	Y	Z
		MEL	MSR			
1.0	100	75	82	950	84	296
1.1	110	83	90	1050	103	314
1.2	120	90	98	1150	120	333
1.3	130	98	106	1250	141	356
1.4	140	105	115	1350	163	378
1.5	150	113	123	1450	186	402
1.6	160	120	131	1550	211	428
1.7	170	128	139	1650	236	455
1.8	180	135	147	1750	262	483
1.9	190	143	156	1850	288	511
2.0	200	150	164	1950	316	542
2.1	210	158	172	2050	344	574
2.2	220	165	180	2150	372	606
2.3	230	173	188	2250	400	638
2.4	240	180	197	2350	428	670

IN-PLANT QUALITY CONTROL
CUSUM INSTRUCTIONS for
AVERAGE E, MINIMUM E, MOR & UTS

CUSUM
Instructions

Sampling and testing procedures for in-plant quality control for mechanically graded lumber are given in Section 8.0 of the *SPIB Mechanically Graded Lumber Procedures*. Standard forms are available from SPIB for entering daily test results.

All properties normally tested for daily quality control must remain "in-control" at all times. The CUSUM constants (W, X, Y and Z) are found in Appendix C of the *SPIB Mechanically Graded Lumber Procedures.* Once the data for each property has been entered, the following instructions shall be used to determine process control.

AVG MOE

AVERAGE E, Directions for Entering CUSUM

1. If the sum is 0 or less, enter 0.
2. If the sum is less than Y but greater than 0, enter sum.
3. If the sum is Y or more, enter Z; the process is out-of-control.

MIN MOE

MINIMUM E, Directions for Entering Pieces below W

1. Enter total pieces below W
2. If the total is 1 or less, the process is in-control.
3. If the total is 2 or more, the process is out-of-control.

MOR or UTS

MOR, UTS or UCS, Directions for entering Failures
(These requirements apply to each property separately.)

1. Enter number of pieces failing below proofload.
2. If the total is 1 or less, the process is in-control.
3. If the total is 2 or more, the process is out-of-control.
4. If one piece fails in each of three consecutive five-piece samples, the process will be assumed out-of-control.

If an out-of-control situation arises, refer to the CUSUM OUT-OF-CONTROL INSTRUCTIONS.

SPIB Form #403

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Location: _____ Date: _____

MSR Quality Control f E Size

CUSUM FOR AVERAGE E	X:			Y:		Z:		
Date								
Shift / Time								
E Values / MC								
(3 digits)								
"								
"								
"								
Total								
Total								
Average (4 digits)								
Last CUSUM								
X								
Subtotal								
Average (from above)								
Sum								
CUSUM								
Minumum E	W=							
Pcs. Below W								
MOR Length: Prrofload	8':		10'-12':		14':		16'-20':	
Length								
Test Results								
"								
"								
"								
"								
Failures								
Machine Settings: AVG / E								
Machine Settings: LP / UTS								
Machine Settings: MOR								
In Comb. With								
OPERATOR:								
SUPERVISOR:								

SPIB Form 401

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Size: _____ Grade: _____

Location: _____ Fb: _____ E: _____ Ft: _____

Date	Date/Time											
This sheet to be used ONLY when this grade is produced in combination with:		CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading
		MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending
	E Values / MC										
Grade:	(3 digits)										
Grade:	"										
Grade:	"										
	"										
CUSUM CONSTANTS:	Total		# of MOR		# of MOR		# of MOR		# of MOR		# of MOR
	Total		Failures		Failures		Failures		Failures		Failures
X:	Average (4 digits)										
Y:	Last CUSUM		Tension		Tension		Tension		Tension		Tension
Z:	X										
	Subtotal										
Minimum E:	Average										
W:	Sum										
	CUSUM										
PROOFLOAD LEVELS: Bending		# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures
8':	Length:										
10'-12':	Settings E / AVG										
14':	UTS / LP										
16'-20':	MOR										
Tension:	Operator										
	Supervisor										

SPIB Form 402

INTENSIVE SAMPLING INSTRUCTIONS
for CUSUM Forms

CUSUM
I.S.

Intensive Sampling CUSUM forms shall be filled out after:

1) Any New Qualifications (SPIB Mechanically Graded Lumber Procedures, Section 8.3)

2) Downward adjustments (up to 3%) from original qualified grade boundary machine settings (SPIB Mechanically Graded Lumber Procedures, Section 8.6.1(a))

3) Downward adjustments (more than 6%, less than 10%) from grade boundary machine settings which have been previously raised above the original qualified settings. (SPIB Mechanically Graded Lumber Procedures, Section 8.6.1 and 8.6.3)

Intensive Sampling involves taking one 5-piece sample every 2 hours for 3 shifts, or until 12 samples (totaling 60 pieces) have been tested. Monitor all three categories (Average E, Minimum E, and MOR) using the values for W, X, Y, and Z in Appendix C of the SPIB Procedures for Mechanically Graded Lumber, following all other instructions for CUSUM procedures and requirements.

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Location: _____ Date: _____

MSR Quality Control f E Size

CUSUM FOR AVERAGE E	X:			Y:		Z:	
Date							
Shift / Time							
E Values / MC							
(3 digits)							
"							
"							
"							
Total							
Total							
Average (4 digits)							
Last CUSUM							
X							
Subtotal							
Average (from above)							
Sum							
CUSUM							
Minumum E	W=						
Pcs. Below W							
MOR Length:Prrofload	8':		10"-12":		14':		16"-20":
Length							
Test Results							
"							
"							
"							
"							
Failures							
Machine Settings AVG / E							
Machine Settings LP / UTS							
Machine Settings MOR							
In Comb. With							
OPERATOR:							
SUPERVISOR:							

INTENSIVE SAMPLING

SPIB Form 404

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Size: _____ Grade: _____

Location: _____ Fb: _____ E: _____ Ft: _____

Date	Date/Time											
This sheet to be used ONLY when this grade is produced in combination with:		CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading
		MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending
	E Values / MC										
Grade:	(3 digits)										
Grade:	"										
Grade:	"										
	"										
CUSUM CONSTANTS:	Total		# of MOR		# of MOR		# of MOR		# of MOR		# of MOR
	Total		Failures		Failures		Failures		Failures		Failures
X:	Average (4 digits)										
Y:	Last CUSUM		Tension		Tension		Tension		Tension		Tension
Z:	X										
	Subtotal										
Minimum E:	Average										
W:	Sum										
	CUSUM										
PROOFLOAD LEVELS: Bending		# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures
8':	Length:										
10'-12':	Settings E / AVG										
14':	UTS / LP										
16'-20':	MOR										
Tension:	Operator										
	Supervisor										

SPIB Form #405

INTENSIVE SAMPLING

OUT-OF-CONTROL INSTRUCTIONS
for CUSUM Forms

CUSUM
O.O.C.

1. Identify which property (AVG E, MIN E, MOR, UTS, etc.) resulted in the Out-of-Control situation.

2. EITHER: Pull six 5-piece* samples (30* pc's)
OR: Raise the machine settings no more than 3% and then pull six 5-pc samples*.

Note: IF MACHINE SETTINGS ARE RAISED MORE THAN 3% DURING AN OUT-OF-CONTROL SITUATION, THE GRADE MUST BE REQUALIFIED. PRODUCTION OF THAT GRADE STOPS UNTIL IT CAN BE REQUALIFIED.

** When UTS and/or UCS are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.*

Note: All properties normally tested for daily CUSUMs must be tested, regardless of which category caused the Out-of-Control situation. Only that category responsible for the Out-of-Control situation shall be evaluated using these specific Out-of-Control instructions. The other properties are evaluated using the daily CUSUM instructions.

3. Record the test data on the GREEN Out-of-Control CUSUM form.

AVG
MOE

<u>Out-of-Control for AVERAGE E:</u>

A) Copy the last CUSUM value from the daily, cream CUSUM form to the green Out-of-Control CUSUM form. THIS WILL BE THE Z VALUE. Begin testing the 5-pc samples.

i) When the Sum is Y or less, enter 0. The process is In-Control.
ii) When the Sum is greater than Y but less than Z, enter the Sum.
iii) When the Sum is greater than Z, enter Z.

B) If the CUSUM comes down to 0 , as in (i), production may continue and recording of test results is resumed on the cream forms.

C) If the CUSUM does not come down to 0, see Step 5, below.

MIN MOE

Out-of-Control for MINIMUM E:

A) All six 5-pc* samples must be tested before the process can be considered back in control. Record the number of pieces below W for each 5-pc* sample in the space provided on the green form.

B) If no more than two pieces fall below W in the 30* pieces tested, control is regained and production may continue.

C) If three or more pieces fall below W in the 30* pieces tested, the process is still Out-of-Control. See Step 5, below.

MOR or UTS

Out-of-Control for MOR, UTS or UCS (Proofload):

(Each property is evaluated separately. These instructions apply only to the property which caused the Out-of-Control situation.)

A) All six 5-pc* samples must be tested before the process can be considered back in control. Record the number of pieces below the required proofload for each 5-pc* sample in the space provided on the green form.

B) If no more than two pieces fail in the 30* tested pieces, production may continue.

C) If three or more pieces fail in the 30* tested pieces, the process is still Out-of-Control. See Step 5, below.

5. If the process is still Out-of-Control and the machine settings have not been raised, the settings may be raised no more than 3% and another six 5-pc* samples may be pulled. If the machine settings have already been raised, no further adjustment may be made, but another set of six 5-pc* samples may be pulled. Testing of the additional samples continues as above.

6. A maximum of three sets of six 5-pc* samples may be tested to regain control: one set before any machine adjustment and up to two sets after a single machine adjustment of no more than 3%.

7. Control is regained only if all properties are in control. If control is not regained, The facility supervisor should be called and production of mechanically graded lumber shall be stopped. Note the time and date of stoppage. Contact SPIB immediately. The grade must be requalified. The mechanically graded lumber produced between the last "in-control" test (prior to the first "out-of-control" test) and the production stoppage is off-grade. Grade-marks must be obliterated and the material regraded.

** When UTS and/or UCS are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.*

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Location: _____ Date: _____

MSR Quality Control f E Size

CUSUM FOR AVERAGE E X: Y: Z:

Date						
Shift / Time						
E Values / MC						
(3 digits)						
"						
"						
"						
Total						
Total						
Average (4 digits)						
Last CUSUM						
X						
Subtotal						
Average (from above)						
Sum						
CUSUM						
Minumum E W=						
Pcs. Below W						
MOR Length:Prrofload 8': 10"-12": 14': 16"-20":						
Length						
Test Results						
"						
"						
"						
"						
Failures						
Machine Settings AVG / E						
Machine Settings LP / UTS						
Machine Settings MOR						
In Comb. With						
OPERATOR:						
SUPERVISOR:						

OUT-OF-CONTROL

SPIB Form #407

SOUTHERN PINE INSPECTION BUREAU

Mill: _____ Size: _____ Grade: _____

Location: _____ Fb: _____ E: _____ Ft: _____

Date	Date/Time											
This sheet to be used ONLY when this grade is produced in combination with:		CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading	CUSUM for AVG E	Proof Loading
		MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending	MOE \ MC	Bending
	E Values / MC										
Grade:	(3 digits)										
Grade:	"										
Grade:	"										
	"										
CUSUM CONSTANTS:	Total		# of MOR		# of MOR		# of MOR		# of MOR		# of MOR
	Total		Failures		Failures		Failures		Failures		Failures
X:	Average (4 digits)										
Y:	Last CUSUM		Tension		Tension		Tension		Tension		Tension
Z:	X										
	Subtotal										
Minimum E:	Average										
W:	Sum										
	CUSUM										
PROOFLOAD LEVELS: Bending		# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures	# Pc's below W	# of UTS Failures
8':	Length:										
10'-12':	Settings E / AVG										
14':	UTS / LP										
16'-20':	MOR										
Tension:	Operator										
	Supervisor										

SPIB Form #408

OUT-OF-CONTROL

SPECIFIC GRAVITY QUALITY CONTROL

Specific gravity data shall be collected in accordance with Section 5.8 of the SPIB Mechanically Graded Lumber Procedures. The data shall be entered on the Specific Gravity Quality Control Form, shown on page C-10. The Specific Gravity value shall be converted to oven-dry weight and volume basis using the table or the equation given on page C-11.

The CUSUM constants (X, Y, and Z) for monitoring average specific gravity are provided in the following table:

Average Specific Gravity	X	Y	Z
0.55	0.530	0.075	0.161
0.56	0.540	0.077	0.164
0.57	0.550	0.079	0.166
0.58	0.560	0.084	0.171
0.59	0.570	0.085	0.172
0.60	0.580	0.087	0.174
0.61	0.590	0.090	0.177
0.62	0.600	0.092	0.179
0.63	0.610	0.096	0.183

Converting Specific Gravity to Oven-Dry Basis

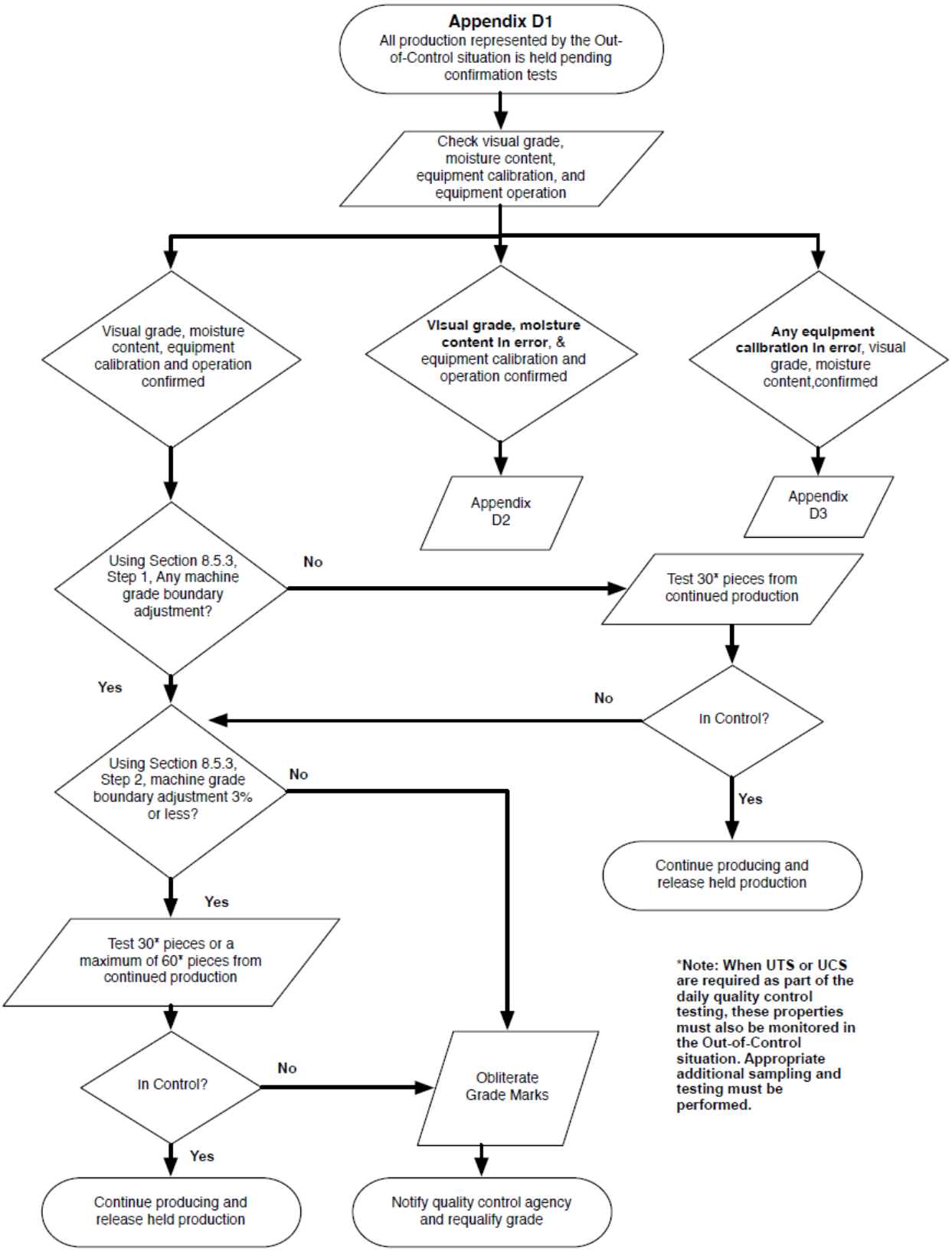
MC	Specific Gravity at Time of Test (based on volume at time of test)																MC
	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70	
7%	0.41	0.43	0.45	0.47	0.49	0.52	0.54	0.56	0.58	0.60	0.62	0.65	0.67	0.69	0.71	0.73	7%
8%	0.41	0.43	0.45	0.48	0.50	0.52	0.54	0.56	0.58	0.61	0.63	0.65	0.67	0.69	0.72	0.74	8%
9%	0.41	0.43	0.46	0.48	0.50	0.52	0.54	0.56	0.59	0.61	0.63	0.65	0.67	0.70	0.72	0.74	9%
10%	0.41	0.44	0.46	0.48	0.50	0.52	0.55	0.57	0.59	0.61	0.63	0.66	0.68	0.70	0.72	0.75	10%
11%	0.42	0.44	0.46	0.48	0.50	0.53	0.55	0.57	0.59	0.62	0.64	0.66	0.68	0.71	0.73	0.75	11%
12%	0.42	0.44	0.46	0.48	0.51	0.53	0.55	0.57	0.60	0.62	0.64	0.66	0.69	0.71	0.73	0.76	12%
13%	0.42	0.44	0.46	0.49	0.51	0.53	0.55	0.58	0.60	0.62	0.65	0.67	0.69	0.72	0.74	0.76	13%
14%	0.42	0.44	0.47	0.49	0.51	0.53	0.56	0.58	0.60	0.63	0.65	0.67	0.70	0.72	0.74	0.77	14%
15%	0.42	0.45	0.47	0.49	0.51	0.54	0.56	0.58	0.61	0.63	0.65	0.68	0.70	0.72	0.75	0.77	15%
16%	0.42	0.45	0.47	0.49	0.52	0.54	0.56	0.59	0.61	0.63	0.66	0.68	0.70	0.73	0.75	0.78	16%
17%	0.43	0.45	0.47	0.49	0.52	0.54	0.56	0.59	0.61	0.64	0.66	0.68	0.71	0.73	0.76	0.78	17%
18%	0.43	0.45	0.47	0.50	0.52	0.54	0.57	0.59	0.62	0.64	0.66	0.69	0.71	0.74	0.76	0.79	18%
19%	0.43	0.45	0.48	0.50	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.80	19%
20%	0.43	0.45	0.48	0.50	0.53	0.55	0.57	0.60	0.62	0.65	0.67	0.70	0.72	0.75	0.77	0.80	20%
21%	0.43	0.46	0.48	0.50	0.53	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.81	21%

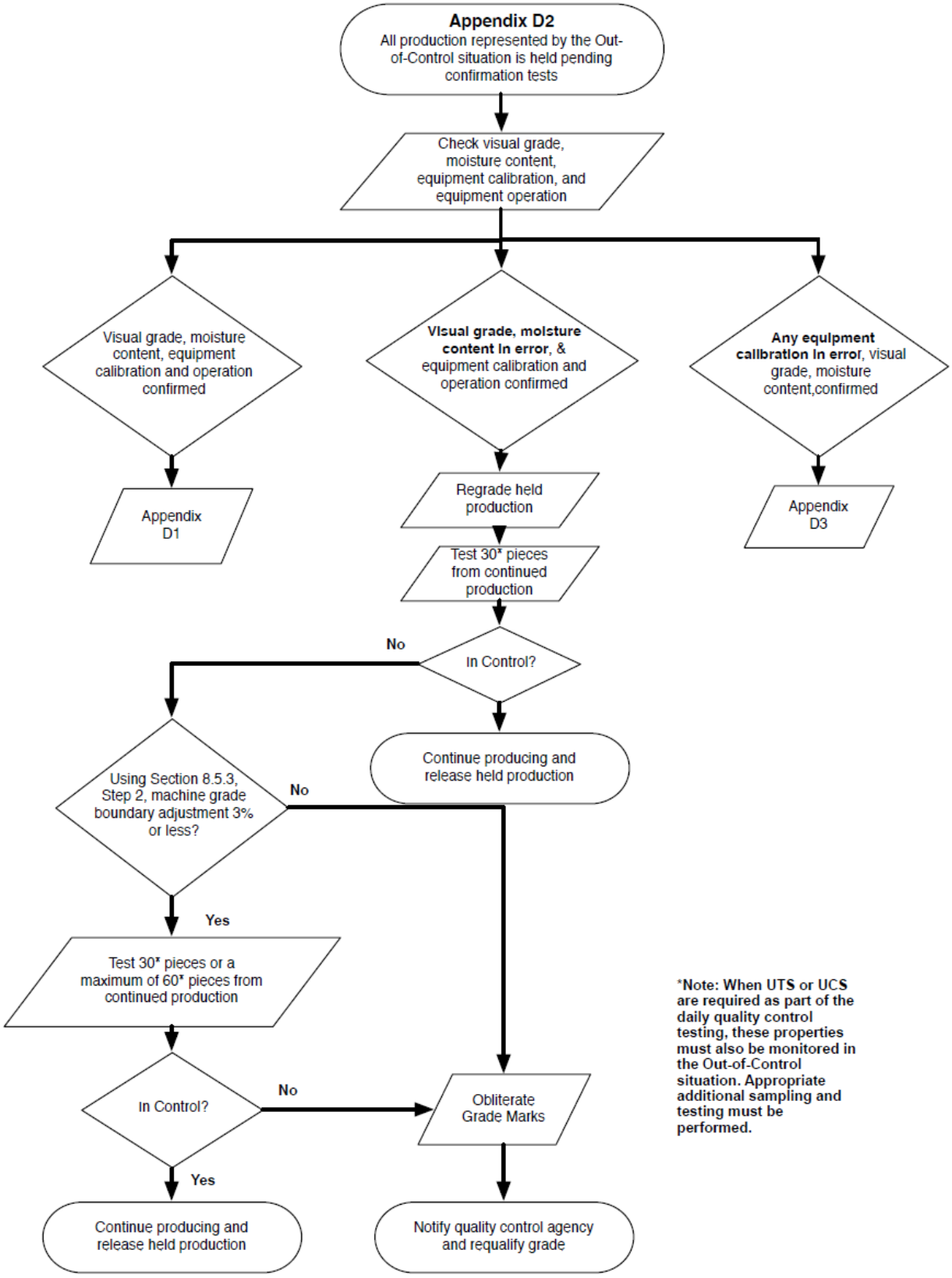
$$SG_{OD} = \frac{SG_{test}}{(1-(SG_{test}*MC*0.009)}$$

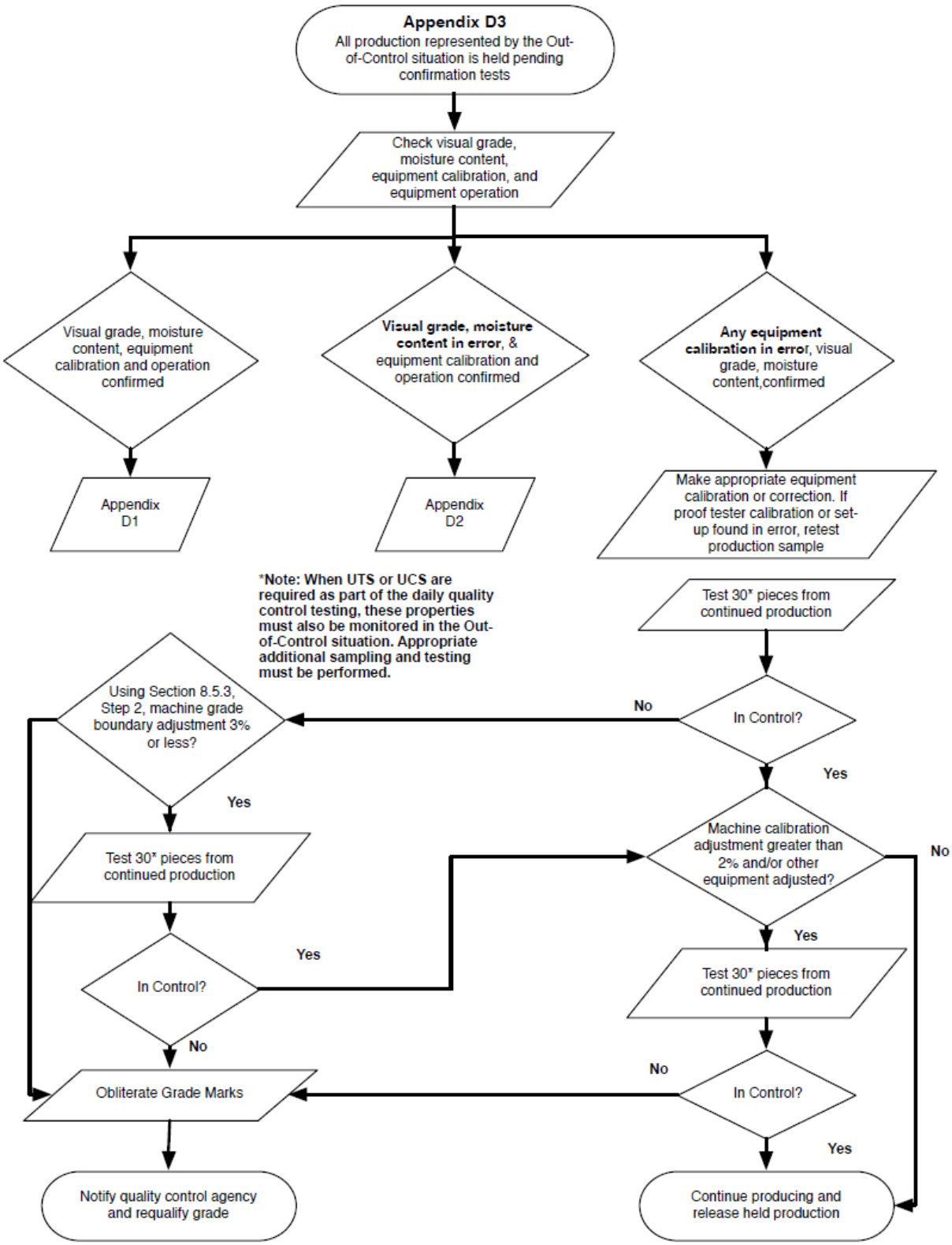
Per ASTM D2395

APPENDIX D - OUT-OF-CONTROL FLOWCHARTS

This Appendix includes three flowcharts, which describe the out-of-control procedures and tests required.


Appendix D1
All production represented by the Out-of-Control situation is held pending confirmation tests
Check visual grade, moisture content, equipment calibration, and equipment operation
Visual grade, moisture content, equipment calibration and operation confirmed
Visual grade, moisture content in error, & equipment calibration and operation confirmed
Any equipment calibration in error, visual grade, moisture content,confirmed
Appendix D2
Appendix D3
Using Section 8.5.3, Step 1, Any machine grade boundary adjustment?
No
Test 30* pieces from continued production
Yes
No
In Control?
Using Section 8.5.3, Step 2, machine grade boundary adjustment 3% or less?
No
Yes
Yes
Continue producing and release held production
Test 30* pieces or a maximum of 60* pieces from continued production
In Control?
No
Obliterate Grade Marks
Yes
Continue producing and release held production
Notify quality control agency and requalify grade
*Note: When UTS or UCS are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.


Appendix D2
All production represented by the Out-of-Control situation is held pending confirmation tests
Check visual grade, moisture content, equipment calibration, and equipment operation
Visual grade, moisture content, equipment calibration and operation confirmed
Visual grade, moisture content in error, & equipment calibration and operation confirmed
Any equipment calibration in error, visual grade, moisture content,confirmed
Appendix D1
Regrade held production
Test 30* pieces from continued production
Appendix D3
No
In Control?
Continue producing and release held production
Using Section 8.5.3, Step 2, machine grade boundary adjustment 3% or less?
No
Yes
Test 30* pieces or a maximum of 60* pieces from continued production
In Control?
No
Obliterate Grade Marks
Yes
Continue producing and release held production
Notify quality control agency and requalify grade
*Note: When UTS or UCS are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.


Appendix D3
All production represented by the Out-of-Control situation is held pending confirmation tests
Check visual grade, moisture content, equipment calibration, and equipment operation
Visual grade, moisture content, equipment calibration and operation confirmed
Visual grade, moisture content in error, & equipment calibration and operation confirmed
Any equipment calibration in error, visual grade, moisture content,confirmed
Appendix D1
Appendix D2
Make appropriate equipment calibration or correction. If proof tester calibration or set-up found in error, retest production sample
*Note: When UTS or UCS are required as part of the daily quality control testing, these properties must also be monitored in the Out-of-Control situation. Appropriate additional sampling and testing must be performed.
Test 30* pieces from continued production
In Control?
No
Yes
Using Section 8.5.3, Step 2, machine grade boundary adjustment 3% or less?
Yes
Machine calibration adjustment greater than 2% and/or other equipment adjusted?
No
Yes
Test 30* pieces from continued production
In Control?
Yes
Test 30* pieces from continued production
No
In Control?
No
Obliterate Grade Marks
Yes
Notify quality control agency and requalify grade
Continue producing and release held production

APPENDIX E - AGENCY FORMS

This Appendix includes example forms used by SPIB for Test Inspections and Grade Qualification (Qualification) Tests for MSR and MEL.

SPIB Mechanically Graded Lumber
TEST INSPECTION

1/4

Company: _____ Location: _____ Date: _____

MGR/SUPT: _____ Quality Supervisor: _____

Tested Grade			
Grade Name			
Edge Knot			
SETTINGS	CLT	AVG	
		LP	
	XLG	MOE	
		UTS	
		MOR	

Tested Grade		
Grade Name		
Edge Knot		
Thresholds	Ecoustic	
	A-Grader	
	LHG	
	Jenny Ray	
	E-Valuator	
	Timber Grader	

Size:		
Test Span:		
Gauge Length:		
	Required	Actual*
AVG E		
MOR PL		
UTS PL		
MIN E		

Grade Properties	Fb	E	Ft	Fc//	Fc	Fv

Pc	MC	MOE	MOR	Knot	Comments	MC	UTS	Knot	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

APPROVED CRITERIA: Please refer to TABLES 1 & 2, QUARTERLY TEST ACCEPTANCE CRITERIA, in Tab 2 of the SPIB MSR MANUAL.

SPIB Form #421

SPIB Mechanically Graded Lumber
QUALIFICATION FORM

Q

Company: _____ Location: _____ Date: _____

MGR/SUPT: _____ Quality Supervisor: _____

Grade Being Qualified			Produced With		
Grade					
Edge Knot					
SETTINGS	CLT	AVG			
		LP			
	XLG	MOE			
		UTS			
		MOR			

Grade Being Qualified			Produced With	
Grade				
Edge Knot				
Thresholds	Ecoustic			
	A-Grader			
	Timber Grade			
	LHG			
	E-Valuator			
	Jenny Ray			

Size:		
Test Span:		
Proofloader:		
Property: Bending/Tension		
	Required	Actual*
AVG E		
Proof Load		
MIN E		

Grade Properties	Fb	E	Ft	Fc//	Fc	Fv

Pc	MC	Knot	MOE	Load		Pc	MC	Knot	MOE	Load	
1						28					
2						29					
3						30					
4						31					
5						32					
6						33					
7						34					
8						35					
9						36					
10						37					
11						38					
12						39					
13						40					
14						41					
15						42					
16						43					
17						44					
18						45					
19						46					
20						47					
21						48					
22						49					
23						50					
24						51					
25						52					
26						53					
27											

SPIB Form #420

APPROVED CRITERIA:

1. Average E > (Grade E - .04 x 10_6)
2. # Failures < PL: # 1/53, 2/78, 3/102
3. # Pieces < Min E: # 1/53, 2/78, 3/102