GUIDELINES
for the
SCALING AND GRADING
of
HARDWOOD LOGS

SOLID APPALACHIAN HARDWOOD

AHC Appalachian Hardwood Center

2025 Edition

GUIDELINES
for the
SCALING AND GRADING
of
HARDWOOD LOGS

(For Domestic Applications Only)

Effective September 2019

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TABLE OF CONTENTS

INTRODUCTION

Log scaling and grading are integral components of hardwood sawmilling and effectively set the bar for generating mill profits or losses. The first formal efforts to establish standard log grading rules occurred during the early twentieth century, but never caught on.

Beginning in the 1940s the US Forest Service (USFS) implemented a major effort in hardwood log grading. Based on data gathered from individual logs and the lumber produced from those logs, the USFS developed and refined a standardized hardwood log grading system that was designed foremost to satisfy the day to day needs of the USFS in managing National Forests. With the final revisions of the USFS system occurring in 1966, no additional documented development has occurred and been sustained.

A limited number of competing hardwood log grading systems surfaced during the time frame of USFS system implementation, but did not take hold within or without the USFS. Beyond internal use of the system by the USFS, the system has seen widespread use by the research community, as a means of classifying logs for analysis purposes. There is little or no documented evidence that the USFS hardwood grading system has been adopted or even adapted for use by the hardwood industry. In fact, there is no universal hardwood log grading and scaling system used by the hardwood industry. Instead, the hardwood industry has informally gravitated to an ad hoc system that is primarily based on species, scaling diameter, and clear faces…resulting in a cornucopia of log grading and scaling rules that lack uniformity among and between hardwood mills.

The rules promulgated here represent a collaborative effort of Appalachian Hardwood Manufacturers, Inc. (AHMI), its members, and the Appalachian Hardwood Center at West Virginia University to develop a basic hardwood log grading and scaling system that reflects the reality of today's hardwood industry and that provides a level of uniformity in log grading and scaling that is lacking in the marketplace for hardwood logs.

Moving forward with this effort to develop an industry focused set of standard log grading and scaling rules it is perhaps useful to reference a quote from the originators of the USFS rules that is a relevant today as it was over 70 years ago. "…log grading must be viewed as a measure requiring gradual development and application rather than one lending itself to full perfection and universal adoption from the beginning" (Wollin and Vaughan (USFS), 1947).[1]

[1]Wollin, A. C. and C. L. Vaughan. 1947. Sawlog Grades for Hardwoods – Central States Studies. USFS Forest Products Lab, Madison, WI, No. D1699. 22pp.

GENERAL INSTRUCTIONS

1. Inspection, as defined in this guidebook, includes both the scaling (determination of log volume, in board feet) and grading (determination of log quality) of hardwood logs.
2. In order to maintain the necessary uniformity in inspection activities, inspectors are advised to study the guidelines contained herein carefully and apply them using their best judgment. At no time should an inspector use their personal opinion to supersede anything specifically stated in this guidebook.
3. Any exceptions to the guidelines are listed under each paragraph within the major headings of the Guidebook.
4. Logs should be properly manufactured according to the guidelines set forth herein. Miscut logs can, at the discretion of the mill, be classified as cull logs.
5. The guidelines contained herein are expressly intended for use in domestic US markets and for the manufacture of hardwood lumber in domestic US sawmills. At this time, the guidelines are NOT intended for use in purchasing or selling hardwood logs for export markets.
6. As these guidelines evolve it will be the responsibility of the AHMI Log Rules Committee, composed of active AHMI members and practitioners, to consider any proposed changes and determine the feasibility of adopting the proposed change(s).
7. Any active Member of the Association can submit a proposed guideline change or new guideline to the Log Grading Committee. These submissions can occur once a year by July 15. The proposals will be carefully considered by the Committee. If the proposal is approved by the Log Grading Committee, it is then debated and voted upon by the AHMI Board of Trustees. If approved by the Board of Trustees it becomes official and is included in the next printing of the Guidebook.

BEST PRACTICES

Log inspection occurs in a range of conditions in outdoor environments that include poor weather conditions, yard conditions that may not be conducive to the application of log inspection and a range of hazards that may occur at any time during the workday. As such, safety is an important consideration for those performing log inspection activities, and the mill must ensure a safe work environment that includes the proper personal protective equipment and safe interaction between the pieces of equipment involved in the unloading and movement of logs in the log yard.

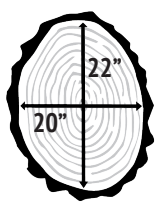
In order for the guidelines stated herein to be applied uniformly and accurately, it is important for mills to establish policies that enable the log inspection activities to function efficiently and effectively. Some of the ways to facilitate the log inspection function are:

1. Ensure that logs are not bunched tightly together for the inspectors when they are unloaded onto the yard. It is critically important for the inspector to observe the maximum surface of each log, minimizing the assumptions he/she must make, and thereby minimizing any grading and scaling errors.
2. Conduct log grading and scaling with a 2-person team so that log length can be accurately determined using a tape and end conditions can be visually assessed. A 2-person team, although requiring additional labor cost, can improve both inspection time and recognition of scaling and grading defects.
3. Avoid payment policies, such as payment at time of delivery, that force grading/scaling to occur in an environment where speed trumps accuracy.
4. Educate log inspectors about the manufacturing process so that they have a reasonably good understanding of how log defects impact both the breakdown of logs and the production of grade lumber.
5. Establish an in-house quality control system where loads of logs can be checked scaled and graded at random, to ensure log inspectors are adhering to the established log scaling and grading system.

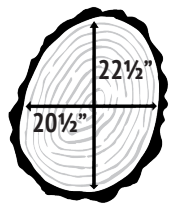
LOG SCALING

A. Scaling Diameter

1. Diameter measurement: Log diameter is measured on the small end of the log, inside the bark.
2. Method of measurement: Use two (2) measurements. Measure the shortest diameter (short way) then 90 degrees to the first measurement for the second measurement, then average the two diameters.
3. Rounding protocol: Round the average of the two (2) measurements up if the fraction is greater than 0.5 and round down if it is less than or equal to 0.5.
4. Measuring Different Log Shapes: Following are some examples of commonly occurring log shapes and how they should be measured.



DIAMETER = 21"



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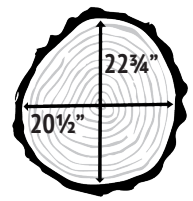

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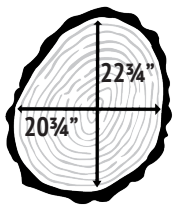
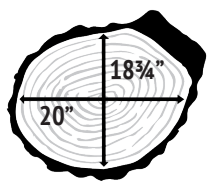
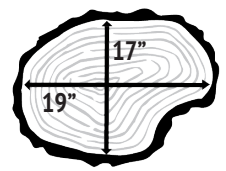


DIAMETER = 22"

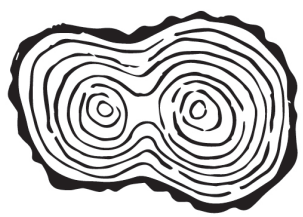


DIAMETER = 19"
KNOT OR BURL



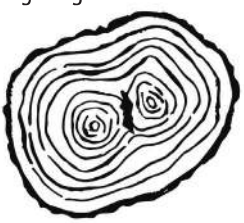
DIAMETER = 18"
DEPRESSION OR SPLIT

5. Double Hearts: A double heart occurs when the small end of the log contains 2 distinct piths/hearts and growth rings around each pith/heart.



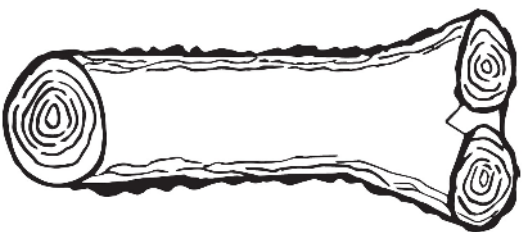
DOUBLE HEART

If the double heart does not contain a bark pocket, determine scaling diameter by taking a single measurement that bisects the end of the log between the two hearts. At the log inspector's discretion and depending on the flaring of the double heart, a length deduction can be taken (the length deduction can be either to an even or odd length…see section on Log Lengths for standard and other log lengths).



DOUBLE HEART CONTAINING A BARK POCKET

If the double heart contains a bark pocket between the two hearts or the flaring of the double heart is excessive, then move down the log toward the large end and estimate scaling diameter at the point where the flare begins. Adjust log length to the point where diameter is measured. For upper logs that do not contain significant taper, the large end diameter can be a suitable alternative for scaling diameter.



DOUBLE HEART CONTAINING THE FORK

With stems that actually contain the fork, reduce length to the nearest even foot below the fork and estimate the diameter at the new log length.

Note, remember that the log supplier is responsible for the existence of the double heart and should not be rewarded unnecessarily.

B. Log Length

1. Standard Log Lengths: 8, 10, 12, 14, and 16 feet.
2. Other Permissible Log Lengths: At the discretion of an individual mill, additional log lengths may be permissible and are limited to 6, 7, 9, 11, 13, and 15 feet.
3. Long Logs: Log lengths greater than 16 feet are permissible, but scaling must be handled through a mutually acceptable agreement between buyer and seller.

4. Trim Allowance: The target trim allowance is 4 – 6 inches. At the discretion of the individual mill, trim less than 4 inches can result in a length deduction of up to 2 feet (a deduction of 1 foot is at the discretion of the mill).

For excessive trim allowance, the mill may reduce length to the nearest standard length or at the discretion of the mill to "Other Log Lengths".

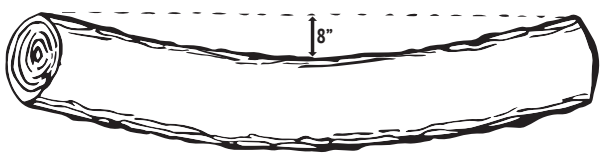
C. Scaling Defects

Dealing with scaling defects is the most difficult aspect of log scaling. The difficulty lies in how to determine the amount of volume (i.e., board footage) to deduct for each type of scaling defect.

The protocol followed here in adjusting for scaling defects is to take a deduction that ideally would not force more or less Overrun/Underrun than expected from a log without scaling defects of a given size (i.e., matching the defect deduction to the expected yield of lumber).

The most common methods for adjusting for scaling defects are rules-of-thumb that result in either a reduction in length or diameter of the log. The advantage of rules-of-thumb is that they are designed to speed up the scaling process, by avoiding complex calculations. Rules-of-thumb are used for making most scaling adjustments in this guidebook.

1. Scaling Defect Types: Sweep, crook, interior (holes, decay, doughty), sector (exterior holes, decay, doughty), shake, and splits.
2. Sweep:



   a. Sweep Measurement: Determine gross sweep of the log by measuring the departure from a straight line between the two end points of the log (the points of the U-shape sweep).

      If gross sweep is ⩾ 1/2 scaling diameter cull the log.

   b. For purposes of these guidelines, either a diameter or length rule-of-thumb deduction is permissible, and is applied at the sole discretion of the mill.

   c. Length Rule-of-Thumb: The deduction is determined by taking (Gross Sweep/3), ignoring the fraction and using the whole number as the length deduction.

d. Diameter Rule-of-Thumb: The deduction is determined by taking (Gross Sweep/4), ignoring the fraction and using the whole number as the diameter deduction.

e. When using the length deduction, the mill, at its discretion, may reduce length to the nearest standard length or nearest permissible log length.

3. Crook:

a. Crook Measurement: Determine gross crook of the log, by measuring the departure from a line extending along the side of the log opposite the crook and length of departure.

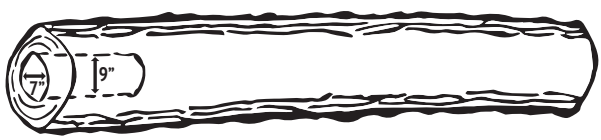
If the length of the crook is ⩾ 1/2 log length, deal with it as sweep.

b. Length Rule-of-Thumb: The deduction is determined by taking (Crook Length/3), ignoring the fraction and using the whole number as the length deduction.

When making the length deduction the mill, at its discretion, may reduce length to the nearest standard length or nearest permissible log length.

c. If the length and displacement of the crook are such that it appears no acceptable lumber can be sawn, at its discretion, the mill may cull the log.

4. Interior Defect:



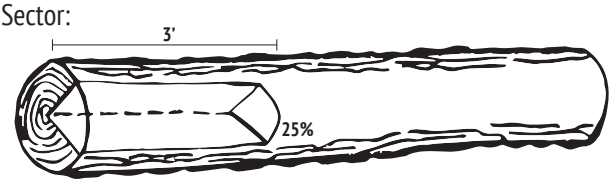
a. Interior Defect Measurement: Determine the width and height of the interior defect (hole, rot, doughty) and take the average of the two measurements as the diameter of the interior defect. Always round defect length up to the next foot.

If the diameter of the interior defect is such that it appears no lumber can be sawn, cull the log, or if defect diameter >= scaling diameter cull the log.

b. Rule-of-Thumb: The deduction is determined by taking (Defect Diameter/3), ignoring the fraction and using the whole number as a deduction in scaling diameter. Therefore, no deduction is taken for any interior defect that is less than 3 inches.

Because of the uncertainty in how any interior defect affects sound lumber to be sawn, the rule-of-thumb is applied to all interior defects regardless of the length of the defect.

5. Sector:



a. Sector Defect Measurement: Measure the length of the sector and estimate the portion of circumference of the log encompassing the sector.

b. Rule-of-Thumb: A length deduction is determined by (Sector Circumference (in %)/100)*(Sector Length)). Round up to the next foot if the fraction is >=0.5.

Example: Sector Circumference = 25%
Sector Length = 3 ft.
Length Deduction = 0.25 * 3 = 0.75
Round up to 1.0 foot for the length deduction

c. The mill, at its discretion, may reduce length to the nearest standard length or nearest permissible log length.

6. Ring Shake: A lengthwise separation of the growth rings in a log, which may or may not follow the line of annual growth rings.

a. Rule-of-Thumb: If the ring shake occurs less than or equal to 4 inches from the pith and is less than or equal to 50% of the circumference at that point, ignore the shake.

If the ring shake occurs less than or equal to 4 inches from pith and more than 50% of the circumference at that point, treat the ring shake as an interior defect.

If the ring shake occurs more than 4 inches from the pith treat it as an interior defect.

7. Spider/Heart Shake: Cracks emanating from near the edge of a log towards the center of the log or vice-versa.

a. Rule-of-Thumb: Estimate how deep the shake extends into the log and deduct log length in 2 foot increments (or 1 foot increments at the discretion of the mill).

8. Splits: Cracks/separation of wood that may or may not pass through the center of the log.
    a. Rule-of-Thumb: Estimate how deep the split(s) extend into the log and deduct log length in 2 foot increments (or 1 foot increments at the discretion of the mill).
9. Stain and Mineral: See "Other Considerations", paragraph A.

D. Log Rules for Determining Volume.

1. Acceptable Log Rules: Doyle, Scribner, Scribner Decimal C, and International.
2. Doyle Volume Table:

Doyle Log Rule											
Scaling Diameter (in)	Log Length (ft)										
	6	7	8	9	10	11	12	13	14	15	16
8	6	7	8	9	10	11	12	13	14	15	16
9	9	11	13	14	16	17	19	20	22	23	25
10	14	16	18	20	23	25	27	29	32	34	36
11	18	21	25	28	31	34	37	40	43	46	49
12	24	28	32	36	40	44	48	52	56	60	64
13	30	35	41	46	50	56	61	66	71	76	81
14	38	44	50	56	62	69	75	81	88	94	100
15	45	53	61	68	75	83	91	98	106	113	121
16	54	63	72	81	90	99	108	117	126	135	144
17	63	74	85	95	106	116	127	137	148	158	169
18	74	86	98	110	122	135	147	159	171	184	196
19	84	98	113	127	141	155	169	183	197	211	225
20	96	112	128	144	160	176	192	208	224	240	256
21	108	126	145	163	181	199	217	235	253	271	289
22	122	142	162	182	202	223	243	263	283	304	324
23	135	158	181	203	226	248	271	293	316	338	361
24	150	175	200	225	250	275	300	325	350	375	400
25	165	193	221	248	276	303	331	358	386	413	441
26	182	212	242	272	302	333	363	393	423	454	484
27	198	231	265	298	330	364	397	430	463	496	530
28	216	252	288	324	360	396	432	468	504	540	576
29	234	273	313	352	391	430	469	508	547	586	625
30	254	296	338	380	422	465	507	549	591	634	676

For those wishing to use the Doyle formula ($\{D-4\}^2\{L/16\}$ where D = Scaling Diameter and L = Log Length), that is acceptable. Note, some 1 bf discrepancies between published tables and the formula do exist and should be recognized when using the Doyle formula.

3. Scribner Volume Table:

Scribner Log Rule											
Scaling	Log Length (ft)										
Diameter (in)	6	7	8	9	10	11	12	13	14	15	16
8	9	11	12	13	15	17	19	20	22	23	25
9	13	16	18	20	23	25	27	29	32	34	36
10	18	21	24	27	30	33	37	40	43	46	49
11	24	28	32	36	40	44	48	52	56	60	64
12	29	34	40	44	49	54	59	64	69	74	79
13	36	42	48	54	61	67	73	79	85	91	97
14	43	50	57	64	72	79	86	93	100	107	114
15	53	62	71	80	89	98	107	116	125	133	142
16	59	69	79	89	99	109	119	129	139	149	159
17	69	81	93	104	116	127	139	150	162	173	185
18	80	93	106	119	133	146	160	173	187	200	213
19	90	105	120	135	150	165	180	195	210	225	240
20	105	122	140	157	175	192	210	227	245	262	280
21	114	133	152	171	190	209	228	247	266	285	304
22	125	146	167	188	209	230	251	271	292	313	334
23	141	165	188	211	235	259	283	306	330	353	377
24	151	176	202	227	252	277	303	328	353	378	404
25	172	200	229	258	287	315	344	372	401	430	459
26	187	219	250	281	313	344	375	407	439	469	500
27	205	239	274	308	342	376	411	445	479	513	548
28	218	254	291	327	363	399	436	472	509	545	582
29	228	266	305	343	381	419	457	495	533	571	609
30	246	287	328	369	411	452	493	534	575	616	657

4. Scribner Decimal C:

Scribner Decimal C Log Rule[1]											
Scaling	Log Lengh (ft)										
Diameter (in)	6	7	8	9	10	11	12	13	14	15	16
8	10	10	10	10	20	20	20	20	20	20	30
9	10	20	20	20	30	30	30	30	30	30	40
10	20	20	30	30	30	30	30	40	40	50	60
11	20	20	30	30	40	40	40	50	50	60	70
12	30	30	40	40	50	50	60	60	70	70	80
13	40	40	50	50	60	70	70	80	80	90	100
14	40	50	60	60	70	80	90	90	100	110	110
15	50	60	70	80	90	100	110	120	120	130	140
16	60	70	80	90	100	110	120	130	140	150	160
17	70	80	90	100	120	130	140	150	160	170	180
18	80	90	110	120	130	150	160	170	190	200	210
19	90	100	120	130	150	160	180	190	210	220	240
20	110	120	140	160	170	190	210	230	240	260	280
21	120	130	150	170	190	210	230	250	270	280	300
22	130	150	170	190	210	230	250	270	290	310	330
23	140	160	190	210	230	260	280	310	330	350	380
24	150	180	210	230	250	280	300	330	350	380	400
25	170	200	230	260	290	310	340	370	400	430	460
26	190	220	250	280	310	340	370	410	440	470	500
27	210	240	270	310	340	380	410	440	480	510	550
28	220	250	290	330	360	400	440	470	510	540	580
29	230	270	310	350	380	420	460	490	530	570	610
30	250	290	330	370	410	450	490	530	570	620	660

[1]Cassens, D. 2001. Log and Tree Scaling Techniques. Purdue University, Forestry and Natural Resources, FNR-191. 15pp.

5. International Volume Table:

International 1/4" Log Rule[1]											
Scaling Diameter (in)	Log Length (ft)										
	6[2]	7[2]	8	9	10	11	12	13	14	15	16
8	10	15	15	20	20	25	25	30	35	35	40
9	15	20	20	25	30	30	35	40	45	45	50
10	20	25	30	35	35	40	45	50	55	60	65
11	25	30	35	40	45	50	55	65	70	75	80
12	30	40	45	50	55	65	70	75	85	90	95
13	40	45	55	60	70	75	85	90	100	105	115
14	45	55	65	70	80	90	100	105	115	125	135
15	55	65	75	85	95	105	115	125	135	145	160
16	60	75	85	95	110	120	130	145	155	170	180
17	70	85	95	110	125	135	150	165	180	190	205
18	80	95	110	125	140	155	170	185	200	215	230
19	90	105	125	140	155	175	190	205	225	245	260
20	100	120	135	155	175	195	210	230	250	270	290
21	115	135	155	175	195	215	235	255	280	300	320
22	125	145	170	190	215	235	260	285	305	330	355
23	135	160	185	210	235	260	285	310	335	360	390
24	150	175	205	230	255	285	310	340	370	395	425
25	165	195	220	250	280	310	340	370	400	430	460
26	180	210	240	275	305	335	370	400	435	470	500
27	195	225	260	295	330	365	400	435	470	505	540
28	210	245	280	320	355	395	430	470	510	545	585
29	225	265	305	345	385	425	465	505	545	590	630
30	240	285	325	370	410	455	495	540	585	630	675

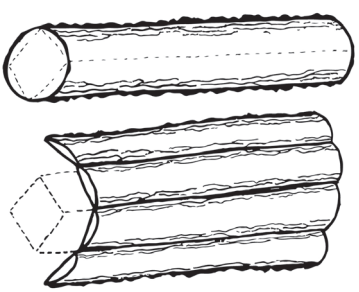
[1]Rast, E.D., D. L. Sonderman, and G. L. Gammon. 1973. A Guide to Hardwood Log Grading. USDA Forest Service, Northeastern Forest Experiment Station, General Technical Report NE-1. 32pp.

[2]Entries for 6- and 7- foot lengths are based on an equation from Grosenbaugh, L.R. 1952. Shortcuts for cruisers and scalers. USDA Forest Service, South. For. Exp. Sta., Occasional Paper 126.

LOG GRADING

A. Determine the species of the log.

B. Visually break the log surface into 4 equal sized faces (or sides).



C. Determine the number of clear faces as 4 (four), 3 (three), 2 (two), 1 (one), or 0 (zero).

D. Defects that result in a non-clear face: knots, seams, cracks, holes, bird peck, and decay.

Defects that occur entirely within the trim allowance can be ignored.

E. Log grades are determined based on scaling diameter (⩽10", 11", 12", 13", 14", 15", 16", and ⩾17") and clear faces (4, 3, 2, 1, and 0) for each species.

F. For purposes of this hardwood log grading system, grades are defined by the proportion of Select & Better lumber to be produced within that grade.

A recommended grade designation is Prime, Select+, Select, No. 1+, No. 1, No. 2+, No. 2, and No. 3, with the Prime grade yielding the highest percentage of Select & Better lumber, followed by Select, No. 1, and No. 2 yielding progressively less Select & Better lumber, and the No. 3 grade, yielding the lowest percentage of Select & Better lumber.

G. It is at the individual mill's discretion to specify additional restrictions on log grades, including length, end conditions, and butt log versus upper logs.

The following table illustrates the impact of scaling diameter and clear faces on log quality, within the context of lumber grade yields. For example, the largest scaling diameter and most clear faces will yield the highest proportion of Select & Better lumber and therefore the highest log grade. The smallest scaling diameter and fewest clear faces will yield the lowest proportion of Select & Better lumber and thereby the lowest log grade.

Scaling Diameter	Clear Sides/Faces				
	Most	→	→	→	Least
Largest	Highest Grade	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
↓	↘	↘	↘	↘	↓
Smallest	→	→	→	→	Lowest Grade

H. Following is a grading table based on the percentage of Select & Better yields and the empirical results from 4,000+ logs collected as part of sawmill studies in 6 Appalachian region states. Eight separate grades are recommended, based on the following average percentages of Select & Better yields produced in each grade:

Scaling Diameter	Clear Sides/Faces				
	4	3	2	1	0
≥17"	Prime	Select+	Select	No. 2+	No. 2
16"	Select+	No. 1+	No. 1	No. 2+	No. 3
15"	Select+	No. 1+	No. 2+	No. 2	No. 3
14"	Select	No. 1	No. 2+	No. 2	No. 3
13"	No. 1+	No. 2+	No. 2	No. 3	No. 3
12"	No. 2+	No. 2	No. 3	No. 3	No. 3
11"	No. 2+	No. 2	No. 3	No. 3	No. 3
≤10"	No. 3	No. 3	No. 3	No. 3	No. 3

Prime: ≥ 55.0%
Select+: ≥ 47.5% and < 55.0%
Select: ≥ 40.0 and < 47.5%
No. 1+: ≥ 32.5% and < 40.0%
No. 1: ≥ 25.0% and < 32.5%
No. 2+: ≥ 17.5% and < 25.0%
No. 2: ≥ 10.0 % and < 17.5%
No. 3: < 10%

I. As these hardwood log grading rules evolve, adjustments to the above table may be required and will require the accumulation of additional data.

OTHER CONSIDERATIONS

A. Certain conditions such as the existence of stain, mineral, gum, and excessive bird peck can negatively impact the production of higher grade lumber. For the purposes of this Guidebook, at this time, it is left to the mill's discretion to adjust log grade based upon the existence of these various conditions. It is recommended that reductions in grade are limited to no more than two reductions in grade for any given log.

B. Technical issues and questions regarding these guidelines should be directed to the Appalachian Hardwood Center at West Virginia University. Contact Dr. Curt Hassler at chasslerwv@gmail.com or phone at 304.282.5417. Or, general issues and questions can be directed to Tom Inman, President, Appalachian Hardwood Manufacturers, at info@appalachianhardwood.org or phone at 336.885.8315.

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