



Purdue University
Forestry and Natural Resources

Quality Control in Lumber Purchasing: Hardwood Lumber Grades

By Daniel L. Cassens, Department of Forestry & Natural Resources

Most of the hardwood lumber purchased in North America for remanufacture into other products is graded according to the *Rules for the Measurement and Inspection of Hardwood and Cypress* published by the National Hardwood Lumber Association (NHLA)¹. Prices reported for hardwood lumber are directly tied to these grade rules. The rules are written with the volume user in mind. They are sometimes modified to better fit the needs of the buyer and seller. The original version of these rules was published in 1898 to help sellers and buyers establish a basis on which lumber at the producer's location could be sold without examination by the buyer. Through the years, the rules have been modified to better fit existing lumber supplies and end uses.

The NHLA grades for hardwood lumber appear complicated and difficult to apply upon initial inspection. However, for the most part, they are strictly mathematical and quantitative. The more subjective part of lumber grading is to determine what is and what is not a defect. With some practice, however, this too becomes more exact.

The objective of this publication is to provide a very abbreviated overview of the NHLA rules. It is intended for those individuals who must understand hardwood lumber grading concepts and terminology in order to purchase, sell, or use the material. It is not intended to teach someone how to become a professional lumber grader.

The rules are full of exceptions for different grades and species. Although extremely important in determining grade, few of these exceptions are covered here. The reader is encouraged to study the published rules book, as well as the *NHLA Inspection Training Manual*² to obtain a more detailed understanding.

Standard Terms and Grade Requirements

An understanding of a number of standard terms is essential in grading hardwood lumber. A few of the more important terms are defined in Table 1.

Hardwood lumber grades are generally based on the size and number of cuttings or individual pieces that can be obtained from a particular board when it is cut and used in a manufacturing process. Normally, manufacturers are interested in the amount of clear material available in a board, therefore, the cuttings are normally clear. However, sound cuttings are allowed in some of the lower grades, and this material is often used where appearance is not critical.

Table 2 is a summary of the requirements for the more common standard hardwood lumber grades. The grades are First and Seconds (FAS), FAS One Face (FIF), Selects, No. 1 Common, No. 2A Common, No. 2B Common, No. 3A Common, and No. 3B Common. Table 3 contains additional information for the FAS and FIF grades. The designation A means the cuttings are clear, whereas B indicates the cuttings are only required to be sound.

Lumber is generally graded from the poorest side of the piece. However, for FIF and the select grade, one side must grade FAS and the reverse side No. 1 Common. The reverse side of the cuttings are not required to be sound (see Table 1 for definition). The FIF grade is similar to the select grade, but it must be 6 inches wide. Special wane restrictions apply to each of these two grades.

Several factors are used to aggregate boards into different standard grade classes (Table 2). The easiest of these to apply is size. FAS lumber must be at least 6 inches wide and range from 8 to 16 feet long. The

Table 1. Definition of selected standard terms used in hardwood lumber grading¹.

| | |
|----------------------|---|
| Surface Measure (SM) | Width of the board in inches and fractions of inches times length in whole feet divided by 12. The surface measure is rounded to the nearest whole number. |
| Board Feet (BF) | Width of the board in inches times length in feet times the thickness in inches divided by 12 or it is equal to the SM times the thickness. |
| Cutting | A portion of a board obtained by cross-cutting, by ripping, or by both. Diagonal cuttings are not permitted. Note: In lumber grading the cuttings, are only visualized; no cross-cutting or ripping actually takes place. |
| Cutting Unit | One inch by one foot or 12 square inches of board surface. The unit is used to determine whether or not a board has enough clear surface to make a certain grade. The number of units in a cutting is equal to the width in inches and fractions of one inch times the length in feet and fractions of a foot. |
| Clear Face Cutting | A cutting having one clear face (ordinary season checks are admitted) and the reverse side sound (see below). |
| Sound Cutting | A cutting free from rot, pith, shake, and wane. Texture is not considered. It will admit sound knots, bird pecks, stain, streaks, or their equivalent, season checks not materially impairing the strength of the cutting, pin, shot, and spot worm-holes. Other holes ¼ inch or larger are admitted, but shall be limited as follows: one ¼ inch in average diameter in each cutting of less than 12 units; two ¼ inch or one ½ inch to each 12 units on one side only of a cutting. |

¹ Adapted from *Rules for the Measurement and Inspection of Hardwood and Cypress*. National Hardwood Lumber Association, Box 34518, Memphis, TN 38184-0518. 1998. 108 pp.

minimum size for lower grades is narrower and shorter. The next factor is the minimum size of cuttings allowed. For FAS, the cuttings must be at least 4 inches wide by 5 feet long, or 3 inches wide by 7 feet long. If the board does not have clear cuttings of at least this size, a lower grade must be considered.

Next, only a certain number of cuttings are allowed, depending on board size. For example, in FAS, the number of cuttings allowed is determined by dividing the surface measure (SM) by 4 and dropping all fractions.

Last, a certain percent of the board is required to be in clear face cuttings. For the FAS grade, this is 10/12; that is, at least 83-1/3 percent of the board is in the clear face cuttings. The number of cutting units in each cutting must be calculated. Fractions in 12th (e.g. 10/12) are used by graders so that the numerator of the fraction (10 in this case) when multiplied times the surface measure of the board gives the actual number of units required to make the grade.

The select and FIF grades had been priced separately - just somewhat less than FAS. Many operations are selling lumber such as select, and better, or FIF and better, at one price.

Steps in Grading a Board

There are several steps involved in grading a board. With practice, these steps become automatic. For instructive purposes, it is beneficial to go through each step.

The first step is to determine the species. Lumber is normally separated and sold based on species. Some species, such as oak, ash, birch, and others, are graded by the standard rule. (Note: plain red and white oak are graded standard except for a consideration on mineral stain). The unique characteristics of some species result in modifications of the rules. For example, in cherry, small knots or their equivalent not exceeding 1/8 inch in diameter shall be admitted in the cuttings. Gum streaks and spots are admitted without limit.

The second step is to determine the surface measure (SM) of the board. Surface measure is a measure of the surface area or size of the board. The surface measure is simply the width of the board in inches and fractions multiplied by the length in whole feet divided by 12. Fractions are rounded up or down to the nearest whole number. When the fraction is 1/2, it is rounded up one time and down the next time. The surface measure is used to determine the number of cuttings allowed.

Table 2. Standard hardwood lumber grades and their minimum requirements¹.

| | FAS ² | FIF ^{2,3} | Selects ³ | No. 1C | No.2 A No.2 B ⁴ | No.3A | No.3B |
|--|------------------------------|---|--|----------------------------------|-------------------------------------|---------------------------|--------------------------------------|
| Width | 6"+ | 6"+ | 4"+ | 3"+ | 3"+ | 3"+ | 3"+ |
| Length | 8'-16' | 8'-16' | 6'-16' | 4'-16' | 4'-16' | 4'-16' | 4'-16' |
| No. of cuttings allowed | $\frac{SM}{4}$ Not over 4 | $\frac{SM}{4}$ for FAS Side $\frac{SM + 1}{3}$ for No. 1 Com. Side | $\frac{SM}{4}$ for FAS Side $\frac{SM + 1}{3}$ for No.1 Com. Side | $\frac{SM + 1}{3}$ Not over 5 | $\frac{SM}{4}$ Not over 7 | No Limit | No Limit |
| Minimum size of cuttings | 4" x 5' 3" x 7' | 4"x5' or 3"x7' FAS Side 4"x2' or 3"x3' No.1C Side | 4"x5' or 3"x7' FAS Side 4"x2' or 3"x3' No.1 C Side | 4"x2' 3"x3' | 3"x2' | 3"x2' | 1½" or wider to contain 36 sq in |
| Yield amount req. in clear face cuttings | $\frac{10}{12}$ 83-1/3% | $\frac{10}{12}$ FAS Side $\frac{8}{12}$ No. 1Com. | $\frac{10}{12}$ FAS Side $\frac{8}{12}$ No. 1Com. | $\frac{8}{12}$ 66-2/3% | $\frac{6}{12}$ 50% | $\frac{4}{12}$ 33-1/3% | $\frac{3}{12}$ 25% sound cuttings |

¹ Adapted from *Rules for the Measurement and Inspection of Hardwood and Cypress*. 1998.

National Hardwood Lumber Association, Box 34518, Memphis, TN 38148-0518. 108 pp.

² See Table 3 for additional restrictions for the FAS and FIF grades.³ The reverse side of the cuttings for both the FAS and No. 1 common sides are not required to be sound for the grades of FIF and Selects⁴ The grade of No. 2A common requires clear face cuttings. No. 2B common meets all of the requirements of No. 2A, except that the cuttings are sound as defined in sound cuttings.

Lumber graders use a scale stick to quickly determine the surface measure (Figure 1).

Next, the poor side of the board is determined. The lumber grade is determined from the poor side of the piece, except for the Selects and FIF grades. The poor side is the side with the lower grade, or if both sides have been graded, it is the side with the least number of cutting units.

At this point, the grade of the board is assumed, and the board characteristics are compared to those given in Table 2. The first characteristic to determine is the number of cuttings permitted for the assumed grade. The number of cuttings is equal to the surface measure divided by the appropriate factor (four in the case of FAS). The larger the board, the greater the number of cuttings allowed. Some limits apply. An extra cutting is also allowed in some cases. This extra cutting allows a board to be placed in a higher grade, providing an increased yield can be achieved (Table 4).

The cuttings are then visually laid out on the board surface. The objective is to obtain the largest amount of surface area in the cuttings given the limited number

allowed and their minimum size. This step requires some skill. In the upper grades, the cuttings are generally required to be clear, and the reverse side of the cuttings are required to be sound.

Next, the number of clear face cutting units needed is calculated. The number of units needed depends on the size or surface measure of the board and the percent or fractional yield required by the grade. An FAS board measuring 12 inches wide by 12 feet long has a surface measure of 12 feet. Therefore, the number of units required is determined by multiplying the 12 feet of surface measure times 10, for the 10/12 clear face cuttings required for the FAS grades. Thus, 120 units are needed to make the grade. The board has a total of 144 units (12SM x 12).

The number of cutting units available in the cuttings that were visually laid out above is calculated. To calculate the number of units in each cutting, the width (in inches and fractions of an inch) is multiplied by the length (in feet and fractions of a foot). The number of units for each cutting is totaled. If the total exceeds the number required, the board meets the requirement for the

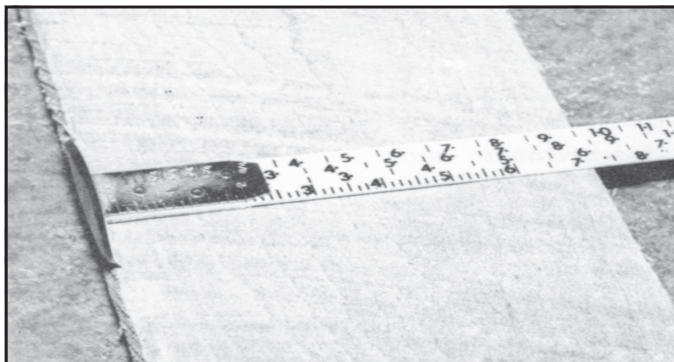


Figure 1. The standard tool in hardwood lumber grading is this scale stick which is used to obtain the surface measure of each board.

cutting units needed. If it does not, the next lower grade is considered.

Walnut is one of our more interesting species, and it is often purchased in small quantities. Every board is likely to be closely scrutinized. The grades for walnut and butternut vary substantially from the standard grades. FAS will admit pieces 6 and 7 feet long, as compared to the standard 8-foot length. The minimum width for FAS is 5 inches, as compared to the standard 6 inches. The minimum size cuttings is decreased in all of the grades. As a result, any particular grade in walnut and butternut will not yield the size and probably surface area of clear material, as compared to lumber graded with the standard rules.

Sales Code

The Rules for the Measurement and Inspection of Hardwood and Cypress contain a detailed section on sales code section and inspection regulations. It is stated in the sales code that this code is binding between buyer and seller only when it is specifically stated in the contract that it shall govern. The bulk of the code discusses good business practices, common sense, and the courtesies buyers and sellers should extend to each other if a long-term relationship is to exist. The sales code also discusses what options exist when a dispute over a lumber shipment develops.

A step-by-step explanation of the portion of the code dealing with a dispute has been developed and is indicated below.

1. The buyer unloads the lumber and has 14 days upon receipt to file a claim with the shipper. The lumber must remain intact, which means the buyer does not surface, trim, rip, dry, or otherwise alter the lumber he has purchased. In altering the lumber in any way, the buyer has forfeited any claim he has with the shipper.

2. If the buyer and seller agree that a national inspection is to be used for the basis for settlement, the following will apply.
 - a) If more than 20% of the footage ordered does not meet specifications of the order, the buyer can reject the entire shipment and be reimbursed for any freight paid. The supplier pays for the national inspection and actual labor costs or \$15 per thousand feet, whichever is less.
 - b) If at least 80% of the footage is in accordance with the invoice, then the money value of the lumber must be figured, using invoice prices and recognized prices not covered on the invoice. Recognized prices can be agreed upon using any of the market reports.
 - c) If the total value of the lumber is within 4% money value of the original invoice, the buyer loses the claim, accepts the lumber, pays the invoice, and charges for the national inspection.
 - d) If the difference between the national inspection and the original invoice is more than 4% money value, the seller loses the claim and pays for the national inspection and actual labor cost of \$15 per thousand feet, whichever is less. The buyer keeps and pays for all items on the national certificate, of the species and thickness ordered, at the invoice price or recognized differentials for grades not on the invoice. Other items are held for the shipper.



Figure 2. Typical hardwood lumber grading short courses emphasize hands-on experience.

Inspection Service

In addition to maintaining and publishing the hardwood and cypress inspection rules, the NHLA also offers an inspection service. Professional lumber graders employed by the NHLA are available to inspect lumber on a fee plus expenses basis. They are available upon request to both members and non-members.

Table 3. Additional restrictions for the FAS grade. With the exception of wane these same restrictions apply to the FAS side of both FIF and Selects grades¹.

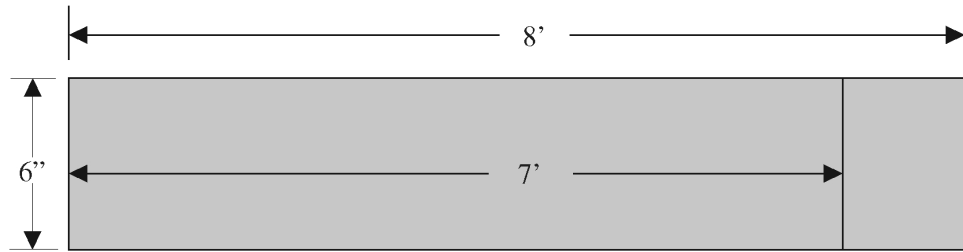
| | |
|-------------------|--|
| Pith | Pith is the soft textured tissue located in the very center of a cross section of a tree. If a board is cut from this portion of a tree or log, the pith will then appear along the length of the board. The length of pith in the FAS grade is limited. In total, it shall not exceed a number equal to the surface measure expressed in inches. Thus, a board with 12 feet of surface measure shall not contain more than 12 inches of pith. |
| Wane | For FAS, wane is allowed up to one-half the length on one or both edges. For FIF, the length of wane on the No.1 Common side is the same as FAS. In addition, the sum of the width of the wane from both edges cannot exceed 1/3 of the total width of the piece. For Selects, 6" and wider, wane is restricted on the No. 1 Common side just as for the No. 1 Common side of FIF. For 4" and 5" wide pieces, wane is restricted on both sides just as for the No. 1 Common side of FIF. |
| Splits | The maximum total length of splits is limited to twice the surface measure of the piece expressed in inches except when one foot or shorter. Splits may diverge up to one inch to the lineal foot, except when one foot or shorter. Splits shorter than one foot are not covered by this rule. |
| First Lineal Foot | Within one lineal foot from the ends of the boards of standard length there shall be 50% or more clear-face. And another 25% sound wood. The remaining 25% may contain defects, sound or unsound. |
| Knots | The average diameter of any knot shall not exceed in inches one-third the surface measure of the piece. |
| 97% Rule | This rule admits pieces 6 inches and wider of 6 feet to 12 feet surface measure that will yield 97% in two clear-face cuttings of any length, full width of the board. |

¹ Adapted from *Rules for the Measurement and Inspection of Hardwood and Cypress*. National Hardwood Lumber Association, Box 34518, Memphis, TN 38184-0518. 1998. 108 pp.

Table 4. The grade of some boards can be increased by taking an additional cutting. However, the board is required to yield more.

| Grade | FAS | No. 1C | No. 2A and 2B |
|--|--------------------|---------------|-------------------|
| SM needed to take one additional cutting | 6-15' SM | 3-10' SM | 2-7' SM |
| Additional yield required when taking one additional cutting | SM x 11 91-2/3% | SM x 9 75% | SM x 8 66-2/3% |

Grading of Sample Boards using Standard Grades



Good Side



Poor Side

1. Calculate the SM

$$SM = \frac{\text{width in inches} \times \text{length in feet}}{12} \text{ or } \frac{6'' \times 8'}{12} = 4$$

2. Number of cuttings permitted for FAS

$$\text{Number} = SM \div 4 \text{ or } 4 \div 4 = 1$$

3. Minimum cutting size for FAS

The minimum cutting size is 4 x 5 or 3 x 7

The 6 x 7 cutting shown qualifies

4. Calculate the number of units available

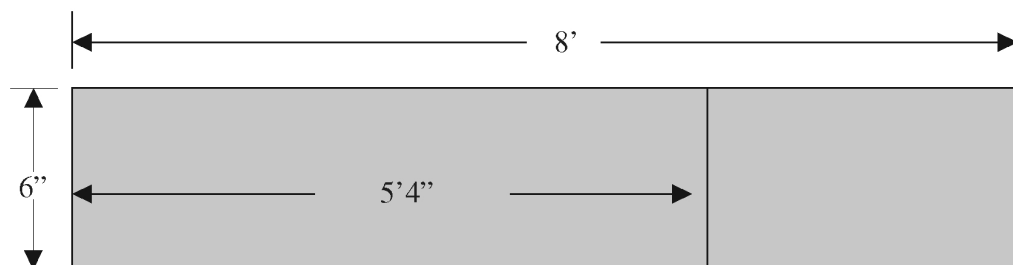
$$\text{Width in inches and fractions} \times \text{length in feet and fractions} \quad 6 \times 7 = 42 \text{ units}$$

5. Units needed for FAS is

$$SM \times 10 \text{ or } 4 \times 10 = 40$$

6. Board meets requirements for the FAS grade

Grading of Sample Boards using Standard Grades



Good Side



Poor Side

1. Calculate the SM

$$SM = \frac{\text{width in inches} \times \text{length in feet}}{12} \text{ or } \frac{6'' \times 8'}{12} = 4$$

2. Number of cuttings permitted for No. 1C

$$\text{Number} = SM + 1 \div 3 \text{ or } 5 \div 3 = 1$$

3. Minimum cutting size for No. 1C

The minimum size of cutting is 4 x 2 or 3 x 3

The 6 x 5 4 cutting shown qualifies

4. Calculate the number of units available

$$\text{width in inches and fractions} \times \text{length in feet and fractions} \quad 6 \times 5 \frac{4}{12} = 32 \text{ units}$$

5. Units needed for No. 1C

$$SM \times 8 \text{ or } 4 \times 8 = 32$$

6. Board just meets requirements for the No. 1 common grade

The graders will grade lumber as specified in written orders to them, using the NHLA rules as a basis. They will provide a certificate giving pertinent information about the parcel. The accuracy of the certificate is guaranteed by the NHLA. If a dispute over a lumber shipment arises, national inspectors can also be employed to grade the lumber, and the dispute should be settled based on the regulations given in the sales code if it applies.

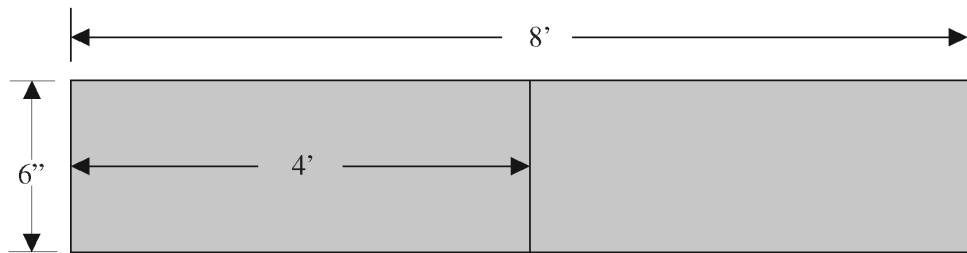
Training Programs

Numerous lumber grading short courses are offered around the country. These programs are about three days long and are sponsored by a university, government

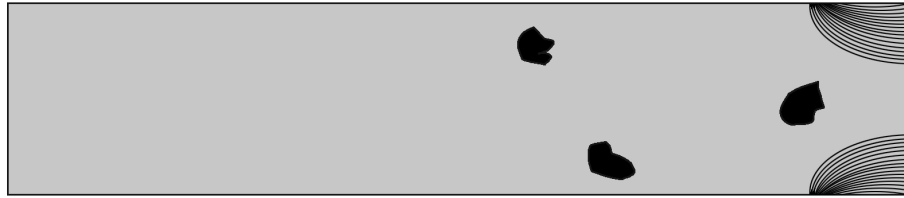
agency, or private company in cooperation with the NHLA. The instructor is usually, but not always, an NHLA inspector. For information on future programs, the NHLA should be contacted at 901-377-1818.

In the short course, some time is spent reviewing the rules, and the balance of time is spent in practice grading the boards (Figure 2). Thus, at the end of the program the registrant has a good understanding of the rules and should be able to accurately grade boards. However, he has not had time to develop the speed required in production situations. The NHLA offers an intensive 14-week training course at its headquarters in Memphis for those individuals who want more in-depth training.

Grading of Sample Boards using Standard Grades



Good Side



Poor Side

1. Calculate the SM

$$SM = \frac{\text{width in inches} \times \text{length in feet}}{12} \text{ or } \frac{6'' \times 8'}{12} = 4$$

2. Number of cuttings permitted for 2AC

$$\text{Number} = SM \div 2 \text{ or } 4 \div 2 = 2$$

3. Minimum cutting size for No. 2AC

The minimum size of cutting is 3 x 2

The 6 x 4 cutting shown qualifies

4. Calculate the number of units available

$$\text{width in inches and fractions} \times \text{length in feet and fractions } 6 \times 4 = 24 \text{ units}$$

5. Units needed for No. 2AC

$$SM \times 6 \text{ or } 4 \times 6 = 24$$

6. Board just meets requirements for the 2AC grade

References

¹ *Rules for the Measurement and Inspection of Hardwood and Cypress*. 1998. National Hardwood Lumber Association, Box 34518, Memphis, TN 38184-0518. 108 pp.

² NHLA Inspection Training Manual, NHLA, Box 34518, Memphis, TN 38184-0518. 103 pp.

³ The Rules Corner, in News published by the National Hardwood Lumber Association, Box 34518, Memphis, TN 38184-0518. No. 892, April 1990. Now called On Grade in Hardwood Matters.