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FOREST SERVICE HANDBOOK
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FSH 2409.11 - NATIONAL FOREST LOG SCALING HANDBOOK

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R. MAX PETERSON
Chief

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National Forest LOG SCALING HANDBOOK

FOREST SERVICE

U.S. DEPARTMENT OF AGRICULTURE

FOREWORD

The chief purpose of this handbook is to provide standard instructions for determining the volume of logs or other products cut from National Forest timber in cases where volume is determined after the timber is felled. The approved standards and uniform methods prescribed are primarily directed to Forest Service scalers to help them scale National Forest timber efficiently and accurately. Forest officers will follow these instructions in the administration of timber sales, timber trespass investigations, and free and administrative use.

Regional supplements will clarify local procedures and cover scaling of National Forest timber in Alaska and in the Douglas-fir region west of the Cascades.

John R. McGuire

JOHN R. McGUIRE
Chief, Forest Service

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CHAPTER 10 - THEORY AND PRINCIPLES OF SCALING

11 Theory of Scaling

Scaling is the determination of the gross and net volume of logs by the customary commercial units for the product involved; volume may be expressed in terms of board feet, cords, cubic feet, linear feet, or number of pieces. Scaling is not guessing; it is an art founded on applying specific rules in a consistent manner based on experienced judgment as to how serious certain external indicators of defect are in a specific locality.

The measuring standard used in scaling logs, called a log rule, is a table intended to show amounts of lumber which may be sawed from logs of different sizes under assumed conditions. At best, a log rule can only approximate salable manufactured volume because of constant changes in markets, machinery, manufacturing practices, and even the varying skill of individual sawyers. Thus a log rule is an arbitrary measure. Its application will not be varied according to the mill in which logs are sawed. The scaled volume of logs must be independent of variations in manufacture.

The difference between the volume of log scale and the actual volume of lumber sawed from the same logs is called "overrun" if the lumber tally exceeds log scale, or "underrun" if it is less.

There will generally be an overrun or an underrun when logs are scaled by a particular rule in a given locality and sawed by a mill. Basic assumptions in the log rules and assumptions in utilization practices cause overrun to vary with the size of the average log. Experience proves that this is true even for the International $\frac{1}{4}$-Inch rule, although not to the same degree as for the Scribner Decimal C rule. This fact does not change scaling practice. Overrun (or underrun) is estimated in the process of appraising National Forest timber for sale, and presumably by the purchaser in determining what prices he will bid. Overrun or underrun is not considered in log scaling, even though it is very important to any mill.

12 General Principles of Forest Service Scaling

*- The scaler must be familiar with Forest Service and Regional policy on scaling contained in the Forest Service Manual, instructions contained in this Handbook, and utilization and scaling specifications of the timber sale contract.

Forest Service scaling determines quantity rather than quality of the material. Unless the contract provides for payment on gross scale basis, all defects affecting recovery of sound volumes are deducted. No consideration is given to lumber grade recovery. -*

13 Commercial Units Used

1. National Forest timber is appraised, sold, and measured by customary commercial units for the products involved. Standard practice is to scale saw timber by a board-foot log scale, mining timbers by the piece or linear foot, telephone poles by the linear foot or the piece of stated length, piling by the linear foot, pulpwood by the solid cubic foot or cord, and fuelwood, shingle bolts, and similar material by the cord. Other units may be used when better adapted to local trade customs or local situations.

2. As a general rule, the measurement of National Forest timber is in the form in which the material leaves the woods rather than in the form of products. End-product measurement may only be used under special conditions approved by the Regional Forester. Products, such as telephone poles and fenceposts, are ordinarily finished for market at the stump, and are therefore usually measured or counted in their final form.

14 Authorized Log Rules

The Scribner Decimal C log rule, the International $\frac{1}{4}$-Inch log rule, the Forest Service International $\frac{1}{4}$-Inch Decimal log rule, or the Cubic Volume rule are *-authorized under 36 CFR 221.15 for uniform scaling-*

of saw timber.

With the exception of the Cubic Volume rule, all specified rules are board-foot rules. Each board-foot rule is a table showing an arbitrary estimate of the amount of lumber a log of given length and diameter can produce. Inasmuch as the tables for each rule have a different base, the scale of identical logs will differ according to the rule used.

1. The Scribner Decimal C rule is one standard rule for Forest Service saw log scaling. This rule rounds contents to the nearest 10 board feet. For example: Logs that according to the Scribner rule have volumes between 136 and 145 board feet are rounded to 140 board feet and shown as 14.

This rule is a diagram rule based on diagrams of circles. These diagrams (fig. 1) show in cross section the number of 1-inch boards the small end of a log will produce under assumed conditions.

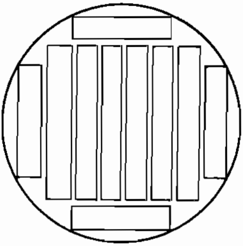

Figure 1. - Diagram showing the number of 1-inch boards that can be cut from a specific log.

Table II in the appendix shows the Scribner Decimal C rule volume of even- and uneven-length logs from 4 to 20 feet.

The Scribner Decimal C rule is used unless the advertisement and timber sale contract specify the International $\frac{1}{4}$-Inch rule, the Forest Service International $\frac{1}{4}$-Inch Decimal rule, or the Cubic Volume rule.

2. The International $\frac{1}{4}$-Inch rule is another standard Forest Service rule, which probably gives a closer lumber-volume estimate than other log rules in common use. This rule measures logs to the nearest 5 board feet. As the name implies, it allows for a saw kerf of one-fourth inch. It is a rule based on a formula applied to each 4-foot section of the log, and assumes a taper of one-half inch in each 4 feet. For practical purposes, the scaling cylinder becomes a part of a cone (a frustrum) with a taper of 2 inches in 16 feet. This rule generally results in a log scale relatively close to lumber tally when logs are sawed in a reasonably efficient mill. Table X in the appendix gives volumes for this rule.

3. The Forest Service International $\frac{1}{4}$-Inch Decimal log rule measures logs to the nearest 10 board feet as does the Scribner Decimal C log rule. Thus volumes are rounded off in the same manner. Table XI in the appendix gives volumes for this rule.

4. The Huber rule is one of the cubic volume rules in use. The formula for this rule is $V = A x L$. V is volume in cubic feet; A is the cross-section area in square feet at the middle of the log; and L is length in feet. Table XIV in the appendix gives the solid cubic contents of logs based on their average middle diameters.

*- 15 Species Identification

Since logs of different species may differ in stumpage rates and scaling specifications, the scaler's ability to identify logs by species is extremely important, although the logs may be mud- or snow-covered, weathered, or debarked. Species identity should be determined by bark characteristics, color, amount of sapwood and heartwood, presence of pitch, -*

*-and size and distribution of knots.

Regional Foresters should develop Regional guidelines as needed to aid in species identification.

16 Product or Piece Specifications

Forest Service timber sale contracts established estimated volumes, prices, and minimum tree and product or piece specifications. Contract provisions not only define tree and product or piece minimums, but also require the purchaser to vary log lengths to secure the greatest practicable utilization to the minimum top diameter specified in the contract. In entering the contract, purchaser agrees to pay for that material which equals or exceeds the contract minimums.

Contract terms also determine whether certain classes of material which do not meet the specifications may be removed at the rate of payment, if any, for this type of material. It is most important that the scaler adhere to the specifications in the contract. Regional Foresters may develop forms or procedures that will ensure that the scaler has the necessary contract information to properly scale any material required to be scaled which the purchaser may remove from the sale. -*

17 Log Measurements

17.1 Log Lengths

17.11 Maximum Scaling Lengths. A maximum scaling length of 20 feet is standard for the western Regions and Alaska; 16 feet is standard for the eastern Regions. Variation from the above standards may be authorized by the Regional Forester by special instructions included in Regional supplements.

The Scaler's Information Form will show maximum scaling length specified in the timber sale contract.

Unless otherwise specified, any further reference to maximum scaling length will be to the 20-foot standard. This may require the eastern Regions to issue special supplements.

17.12 How To Measure Lengths. Usually the first step in scaling a log (after positively identifying its species) is to measure its length. Satisfactory devices for length measurements include scale sticks, tapes, light bamboo poles, numbered markers on scaling platforms or mill decks, and known bunk distances on railroad cars. The method used depends on the type of scaling.

For stump cuts, measure lengths from a point at which the scaling cylinder emerges. For other cuts, make length measurements from the short side. Diagonal cutting or undercuts larger than normal industry practice are usually signs of poor bucking (codes 17.5, 42).

See "Breaks and Splits" in code 33 for measuring broken-end logs.

- 17.13 Length in Long Logs. When logs exceed the maximum scaling length, scale them as two or more segments as nearly the same 2-foot length as practicable. When it is necessary to divide a log into unequal lengths, make the butt segment(s) the longest. -

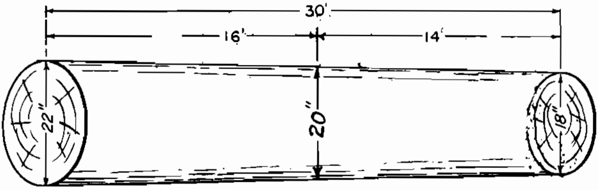

Figure 2. -How to divide a 30-foot log.

Figure 2 illustrates a 30-foot log divided into one 16-foot segment (large end) and one 14-foot segment (small end).

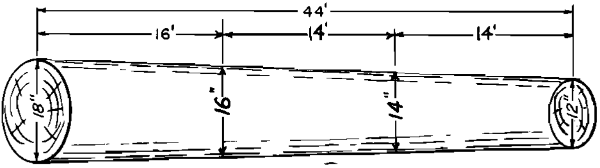

Figure 3. -How to divide a 44-foot log.

Figure 3 illustrates a 44-foot log divided into one 16-foot segment (large end) and two 14-foot segments.

Tables IA and IB in the appendix give the proper divisions of long logs for scaling purposes where maximum scaling lengths are 16 feet and 20 feet.

Table III in the appendix shows the division of long logs and the Scribner Decimal C volumes for the applicable taper.

17.14 Scaling $8\frac{1}{2}$-Foot Tie Logs. Scale tie logs cut $8\frac{1}{2}$ feet long (plus trim), up to and including 19 inches in diameter, as 8-foot logs. If diameters are 20 inches or larger, scale tie logs as 8 feet long plus one-half the difference between the scales of an 8-foot log and a 9-foot log. If half the difference is a fraction, use the next lower whole number.

Example: Scale a 14-inch tie log $8\frac{1}{2}$ feet long as an 8-fooot log with 60 board feet; scale a 17-inch tie log as an 8-foot log with 90 board feet. But scale a 20-inch tie log as:

$140 + \frac{(160-140)}{2} = 150$ board feed (record as 15); scale a 25-inch tie log as $230 + \frac{(260-230)}{2} =$ 245 board feet (record as 24).

17.15 Scaling Odd-Length Logs. Scale stick volumes are given for even 2-foot lengths. In the absence of tables or a special scale stick, scale odd-length logs by interpolating volumes, rounding 0.5 up or down to the nearest even volume.

Example: For a 15-foot log, use the volume halfway between those of 14- and 16-foot logs; then round results like 10.5 and 22.5 to 10 and 22 and results like 7.5 and 51.5 to 8 and 52.

*- 17.16 Scaling Short, Even-Length Logs. When scale sticks are not marked for 6-, 8-, and 10-foot lengths, use $\frac{1}{2}$ the volume for double the length and round 0.5 to the nearest even volume or obtain the volume from volume tables II, X, XI of the appendix.

17.17 Log Volumes, Board Feet. Regional Foresters may develop Regional guidelines to provide uniformity of log scale volumes. These guidelines will be based on Table II, Interpolation, or even length factors depending upon their applicability.

17.2 Trim Allowance. Logs are cut longer than standard lumber lengths because of the impossibility of bucking logs squarely and logging damage to log ends. This extra length is considered trim allowance and may vary between large and small timber, products to be sawed, and logging methods. Timber sale contracts list maximum allowances for trim in accordance with Regional standards. The Scaler's Information Form (code 55.5, ex. 1) should be used to inform the scaler of variations from normal trim allowances. -*

Contract trim allowances are normally the permissive maximums. Regularly tape-measure enough lengths to insure proper observance of trim. Scale logs overrunning the trim allowance to the next 1-foot scaling measure in length unless otherwise instructed. For example, if 6 inches is the contract trim allowance for logs 8 to 20 feet in length, a log measuring 20 feet 10 inches is scaled as a 21; one measuring 24 feet 10 inches, as a 24; but one measuring 25 feet 2 inches, as a 25-foot log; 32 feet 0 inches, as a 31; or 32 feet 2 inches, as a 32; 41 feet 2 inches as a 41. It is difficult to measure log lengths to the nearest inch. Be sure there is actually an overtrim before scaling to the next 1-foot length. After the scaling length and trim has been established, as above, divide logs into scaling segments in accordance with instructions in code 17.13 and tables IA and IB of the appendix.

Special cut lengths should be taken care of by contract modification and, except for different specifications, should not be a scaling problem.

Scalers should notify the District Ranger of any improper trim they detect. The District Ranger should notify the purchaser and take necessary action to obtain contract compliance (code 17.5).

*- 17.21 Special Trim Provision. When authorized by the Regional Forester, timber sale contracts may provide other provisions relating to trim such as a requirement that logs be scaled to the next lower foot.

17.3 Log Diameters. Good scaling requires accurate measurement of log diameters. The following systematic method of measurement will avoid bias:

1. Measure log diameters inside the bark at the small end of the log.

2. Measure through the true center of the log, not the center of the log as shown by the growth rings and pith. -*

*- 3. In measuring, avoid abnormal bumps and depressions if possible; otherwise, measure as though such conditions do not exist (fig. 5).

4. Where possible, read the scale stick directly from the end of the log, not obliquely from the side.

5. Take a pair of diameter measurements at right angles to each other. Measure the short axis first, then take the second measurement at right angles to the first measurement. This is an important technique.

6. Take diameter measurements to the nearest inch. Round exact $\frac{1}{2}$-inch measurements before averaging. Round up when it is one of a pair to be averaged. When both of a pair to be averaged fall on $\frac{1}{2}$-inch marks, round one up and one down. If the average diameter is on a $\frac{1}{2}$-inch; for example $23\frac{1}{2}$ inches, round down for the final scaling diameter; that is to 23 inches. -*

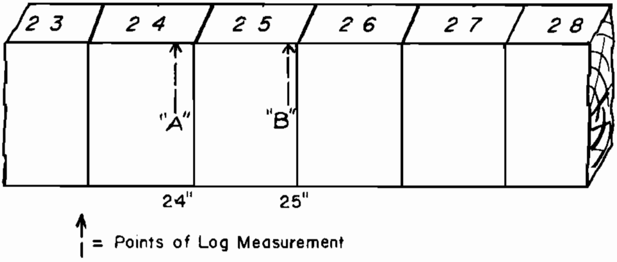

Figure 4.-Diameter measurements.

(Coconino scale stick)

Thus in figure 4, measurement "A" is read as 24 inches and measurement "B" as 25 inches. The average, (A + B) ÷ 2, is $24\frac{1}{2}$ inches. The one-half inch is dropped to a scaling diameter of 24 inches. Note, however, that had measurement "A" and /or measurement "B" coincided with the $\frac{1}{2}$-inch mark, the *-measurement would have resulted in a final scaling diameter 1 inch larger, or 25 inches.

<u>17.31 Diameter Determination of Crotched and Ill-Shaped Logs.</u> In scale-stick scaling, measure the diameter of the large end, unless it is a butt, and subtract taper to obtain the top diameter. Taper is generally abnormal on these types of logs. If the log is a butt cut, scaling diameter cannot be determined by subtracting taper. Instead, lay the scale stick across the log at the narrowest point below the swelling. Read the measurement carefully. In caliper scaling, measure the diameter at the narrowest point below the swelling. Remember to allow for bark (fig. 6). -*

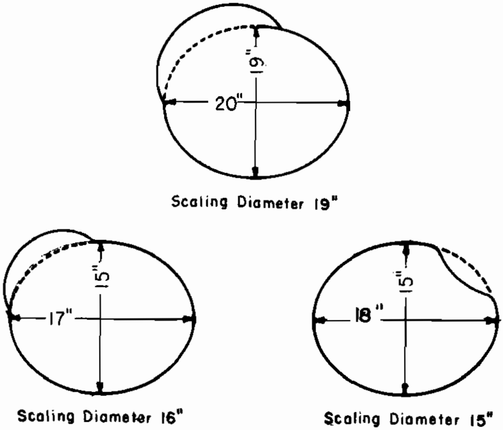

Figure 5. -How to measure logs with abnormal conditions and average the diameters.

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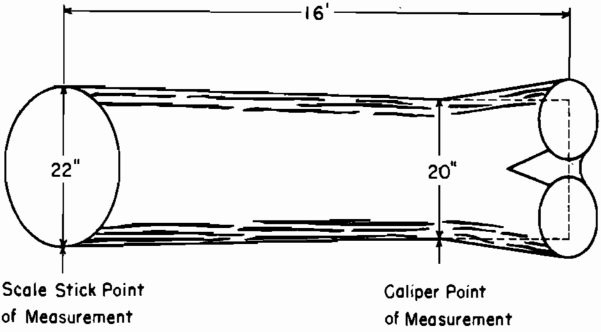

Figure 6.-Points of measurement for log with crotch.

Use the following methods to measure diameters of broken-end logs:

1. When the small end of a log other than a butt cut is broken, measure the large end. Reduce this measurement by the amount of estimated taper.
2. When the small end of a butt log is broken, lay the scale stick across the top of the small end. Read the measurement (inside bark) carefully.
3. When both ends of a log are broken, measure the same way as in item 2.

<u>17.32 Diameter Determination for Caliper Scaling.</u> Use average diameters in all types of scaling except caliper scaling in the woods. In this type of scaling, place the points of the calipers directly over the log. Be sure the points are on the widest portion on the -*

*-sides. Measure inside the bark if logs are scalped. If not, measure outside the bark and subtract twice the bark thickness from the reading.

17.4 Taper in Long Logs. Scaling diameters of the butt segments are determined by apportioning the taper of the long log. Except for butt logs, taper is the difference between the two end diameters. For butt logs, see code 17.43.

Taper is said to be even when it can be apportioned in an equal amount to each segment such as 4-inch taper in a 2-segment log can be apportioned 2-inches to each segment, and uneven when it cannot.

17.41 Distribution of Even Taper. Divide the taper by the number of segments, and add the taper per segment to the top diameter to obtain the diameter of the second segment. For a 3-segment log, add the taper per segment to the diameter of the middle segment. The resulting diameter should differ from the butt diameter by the taper per segment.

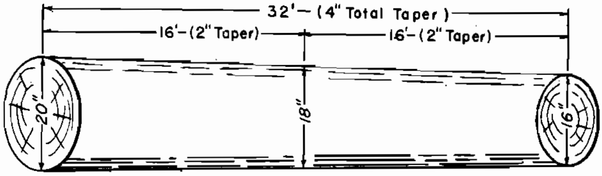

Figure 7. -How to distribute even taper in a 32-foot log. -*

*- Figure 7 illustrates a 32-foot log with end measurements of 16 and 20 inches or 4 inches total taper. Scale it as one 16-foot segment with a diameter of 16 inches and one 16-foot segment with a diameter of 18 inches (the middiameter).

Figure 8 illustrates a 46-foot log with end measurements of 16 and 22 inches (6 inches total taper or 2 inches per segment). Scale it as one 14-foot segment with a diameter of 16 inches (2 inches taper); one

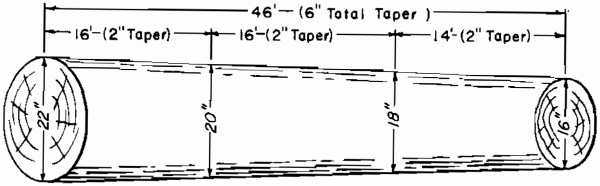

Figure 8. -How to distribute even taper in a 46-foot log.

16-foot segment with a diameter of 18 inches (2 inches taper); one 16-foot segment with a diameter of 20 inches (2 inches taper).

Table III in the appendix shows Scribner Decimal C volumes of long logs, 22 to 48 feet, for various total tapers.

<u>17.42 Distribution of Uneven Taper.</u> Scale logs with taper in uneven amounts, by applying the excess taper to the top segment(s). Trees naturally grow with increased taper in top logs, as a check of taper tables or of actual taper measurements will demonstrate. -*

*- The rule of distribution of taper in long logs is as follows:

1. For two-segment logs with taper not divisible by 2, add an inch and divide by 2. This is the amount of taper assigned to the top segment.

2. For three-segment logs, raise total taper to a number divisible by 3 and divide. This is the amount of taper assigned to the top segment. Distribute the remainder of the taper as in a two-segment log.

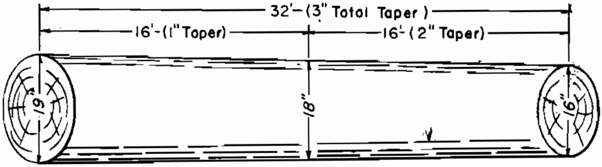

Figure 9. -How to distribute uneven taper in a 32-foot log.

Figure 9 illustrates a 32-foot log with end measurements of 16 and 19 inches (3 inches total taper). Scale it as one 16-foot segment with a diameter of 16 inches (2 inches of taper); one 16-foot segment with a diameter of 18 inches (1-inch taper to large end).

Figure 10 illustrates a 46-foot log with end measurements of 16 and 23 inches (7 inches total taper). Scale it as one 14-foot segment with a diameter of 16 inches (3 inches taper); one 16-foot segment with a diameter of 19 inches (2 inches taper); one 16-foot segment with a diameter of 21 inches (2 inches taper). -*

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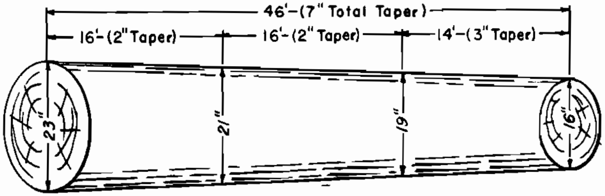

Figure 10. -How to distribute uneven taper in a 46-foot log.

17.43 Taper in Butt Logs. The taper in long logs which have the butt cut at one end cannot be determined in the same manner as for other logs. Average taper will be determined by local studies by species.

Uniform butt log tapers as determined by studies may be shown in the Long Log Table, Table III, appendix. Use of this table will be in accordance with instructions issued by the Regional Forester. In the absence of authorized taper tables, scale on the basis of actual taper. This may be determined by calipers or scale stick.

17.5 Measurements for Contract Specifications. As described in code 16, the timber sale contract establishes the specifications for scaling the products. The District Ranger is generally responsible for determining whether or not the material presented for scaling is in accordance with the terms of the contract. In the absence of any instructions to the contrary, the scaler will measure the logs according to contract specifications, allowing for defect in the logs as they are presented. -*

*- Occasionally, a purchaser will cut logs so that material in one product class is attached to material of another product class which may have a lower price, or may be removed free of charge. An example of this would be where a purchaser chooses to saw small diameter logs rather than buck, sort, and haul the smaller logs separately. That portion of the log which meets or exceeds the contract minimums would be scaled and charged for in the appropriate product class. The smaller portion of the log would be charged for at the rate for the appropriate product or removed free of charge depending upon contract specifications.

The scaler must be alert for operator actions which are not within contract specifications and report these actions to the Forest Service representative. When losses due to stump pull, breakage and damage, excessive trim, improper bucking, or poor top utilization begin to show up in scaling, the scaler will inform the Forest Service representative so that the latter may determine if administrative action is necessary. The scaler should not alter scaling practices until instructed to do so by the Forest Service representative. (code 42). -*

18 Scaling Cylinder in Logs

The scaling cylinder for the Scribner Decimal C rule is an imaginary cylinder extending the scaling length of the log with a diameter equal to the

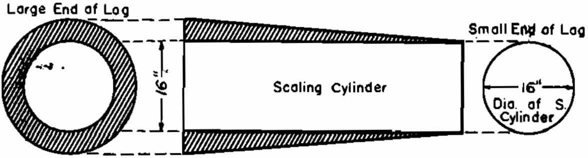

Figure 11.-The scaling cylinder of a log--Scribner Decimal C rule.

measured or small end of the log (fig. 11). Volumes given by the rule are the gross board-foot contents of this cylinder.

To visualize the scaling cylinder in a perfectly round log, picture the log in a giant lathe rotated against a knife until the entire log is peeled to the size of the small-end diameter. The cylinder of wood left is the scaling cylinder of that log. The part peeled off is outside the scaling cylinder. Make no deduction for defects in that portion of the log (figs. 12 and 13).

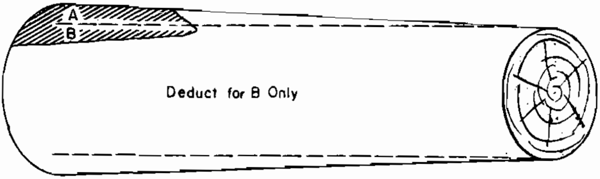

Figure 12. -Defect both inside and outside the scaling cylinder.

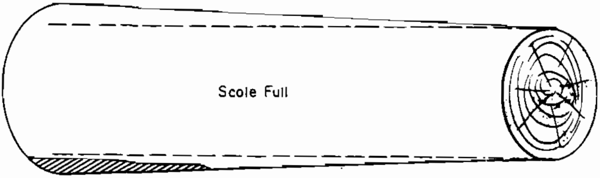

Figure 13. -Defect outside the scaling cylinder.

In the above description, note that the scaling cylinder is independent of the pith center of the tree. A good scaler learns to "see" the scaling cylinder when he deducts for defect.

The Scribner Decimal C rule also incorporates an allowance for slab and edgings, considered for practical purposes to be 1 inch inside the surface of the scaling cylinder (fig. 1). For this reason, no deduction should be made for minor surface defects or blemishes that can be eliminated in the slab or edgings.

For International $\frac{1}{4}$-Inch log rule or Forest Service International $\frac{1}{4}$-Inch Decimal log rule, refer to code 72.

CHAPTER 20 DEFECT-DEDUCTION METHODS

21 General

The following defect-deduction methods are approved for Forest Service scaling:

1. Squared-defect method.
2. Pie cut method.
3. Length-deduction method.
4. Diameter-deduction method.

In applying any of the above methods, the loss will be those portions of the boards (even feet in softwoods) from the scaling cylinder which must be trimmed off because of defect, provided that the remainder of each board has at least the minimum length of 6 feet and a minimum width of 4 inches for softwoods. If the remainder of any board is shorter or narrower than these limits, the entire board will be considered lost except as provided in code 73.

All methods must be used with judgment and skill. Knowledge of how defects actually cut out must be obtained from periodic mill visits. No formula, method, or rule will take the place of judgment in scaling. More than one defect-deduction method may be used in scaling one log. Good practice is to check one method of deduction against another for the same defect. Do not use rules of thumb.

22 Squared-Defect Method[1/]

Defects showing in one or both ends can often be treated as if sawn out in squares or rectangles. This deduction method is called the squared-defect method. It is generally the most accurate method of scaling interior defects.

For the Scribner Decimal C rule, the method may be stated by the following formula:

$$X = \frac{W'' \times H'' \times L'}{15}$$

See code 75 and table XII for defect deductions applied with the International $\frac{1}{4}$-Inch rule.

In the preceding formula, W'' and H'' represent end dimensions of the defect in inches plus an allowance (ordinarily 1 inch for each dimension) for waste, L' is the length of the defect in feet, and X is the contents of the defect in board feet after 20 percent is deducted for saw kerf. X is raised or lowered to the nearest 10. Deductions for the various sizes of rectangular and squared defects as computed by the formula are shown in tables IV and V in the appendix.

Example: A 16-foot log 21 inches in diameter has a gross volume of 300 board feet. The large end shows a spot of heart rot 5 inches square. The rot is estimated to go into the log 4 feet.
Stated in terms of the formula above:

$$\frac{6 \times 6 \times 4}{15} = \frac{144}{15} = 9.6 \text{ board feet.}$$

Rounded to the nearest 10, the amount deductible for defect is 10 board feet. Subtracted from the gross scale of 300, the net scale is 290 board feet (29 Decimal).

1/ Originally termed the (Forest Service) Standard Rule.

Scalers find it difficult and time consuming to use this formula in ordinary scaling. As a result, rules of thumb or rough estimates have often been used. Such rules of thumb and estimates are largely unnecessary. Forest Service scalers should use either a Coconino scale stick, or shortcut procedure with its simplified defect calculation.

22.1 Coconino Scale Stick

Defect deductions for squares up to 30 inches are read directly from Coconino-style scale sticks (code 55.2) for all log lengths. Defect deductions for odd or shorter lengths are determined by interpolation. Rectangular defects closely approaching squares are ordinarily converted to squares. This procedure is permissible in the smaller defects since in the Shortcut Procedure for the Scribner Decimal C rule (code 22.2) the products of 6x8 and 7x7 would both be raised to 50 board feet and the products of 10x12 and 11x11 would both be raised to 130. The variance in the readings can be extended to 4 inches without an appreciable difference in volumes; i.e., a 16x20 measurement can be read directly as an 18x18 square. Use of large rectangular measurements on both ends of a log, requiring averaging, increases computations and can induce errors. A more practicable method is measuring these defects as a square using the larger dimension, then averaging, squaring, and making a fractional estimate.

Small rectangular defects, as for checks and pitch seams, can generally be readily figured using the Shortcut Procedure (code 22.2). Where larger rectangular defects are involved such as 9 x 27, the 27 can be squared for the length of defect and this figure divided by 3, as 9 is a third of 27. Another example would be 13 x 26; square 26 for the length of defect and use half of this amount. Do not be concerned with occasional answer variances of 10 and 20 board feet from the figures in table V. These differences can creep into the figures through the single and double steps of raising or lowering Scribner volumes to the nearest Decimal C figure.

Coconino-style scale sticks marked according to the Forest Service International $\frac{1}{4}$-Inch Decimal rule are available.

22.2 Shortcut Procedure

For the Scribner Decimal C rule, the Shortcut Procedure for determining the squared-defect deduction may be stated by the following formula:
X=W x H to the next higher 10 x L/16 to nearest 10.

Defect dimensions used are identical to those which would be used in the preceding more complicated formula; however, the use of a divisor of 16 rather than 15 greatly simplifies computations for even-foot multiples of defect. Rounding the product of defect height times width to the next higher 10 effectively cancels the effect of the difference in divisors for defects up to and including 12 by 12 inches.

The procedure is particularly applicable to small rectangular defects such as checks and pitch seams.

In applying the Shortcut Procedure, remember the four easy steps:

1. Measure both height and width of the defect, including the 1-inch allowance for waste.

2. Multiply these two measurements, round off to the 10 next above, and drop the last zero. Raise results of multiplications that end in zero to the 10 next above. For example, 10 x 11=110, raise to 120 and drop the zero for 12.

3. This is the deduction if the defect extended through a 16-foot log.

4. Estimate the length of the defect in terms of 16 feet. If the estimate is 8 feet, take 8/16 or $\frac{1}{2}$ the originally calculated defect (in the example, $\frac{1}{2}$ of 12, or 6). If 4 feet, deduct $\frac{1}{4}$ of the 16-foot calculation (in the example, 3). If the defect extends about 6 feet, use 6/16 or 3/8 (in example, 4). For

a 20-foot length of defect, add $\frac{1}{4}$ of the 16-foot calculation (12 + 3, or 15, in example above).

The following corrections should be made for larger defects:

1. Add 10 board feet to the product of W x H for defects squaring 13 to 16 inches, inclusive.
2. Add 20 board feet to the product of W x H for defects squaring 17 to 21 inches, inclusive.

Employing the same example as for the more complex formula (code 22):

$$6 \times 6 = 36 \text{ to the next higher } 10 = 40$$

$$40 \times \frac{4}{16} \text{ or } \frac{40}{4} = 10 \text{ board feet (1 Decimal)}$$

See code 75 for the Shortcut Procedure applicable to the International rule.

22.3 Application of Squared-Defect Method

A good scaler acquires techniques for measuring defects in the ends of logs. Take measurements in pairs, each at right angles to the other as in diameter measurements. If defect is irregular more than one pair of measurements may be needed.

To allow for loss of sound material surrounding a defect, always measure end defects for "squaring out" and add an extra inch of loss in each dimension.

Consider lumber of even lengths only unless, as in some hardwood scaling, lumber of odd length is normally considered merchantable.

When the deduction indicated by the squared-defect method results in greater volume deduction than the log scale of the portion affected, use the length-deduction method.

The squared-defect method is best adapted to not more than two defects in a log end. Applying this method separately to more than two defects may cause errors in the several computations required.

See code 75 for exceptions when using the International rule.

22.4 Logs With Defect Showing on One End Only

If only one end of a log shows defect, check surface indications to determine how far it extends into the log. Surface indications for interior rots include conks, scars, catfaces, seams, or rotten knots. Look carefully for these on both ends and sides of a log. If a defect is found on one end, try to locate its source. Look the sides over thoroughly. If defect is found on a side, observe both ends carefully. The length of stump rot can often be determined by swells in the log, but not all swells mean rot. Breakage sometimes is an indication of weakness caused by interior rot. Examine the point of breakage for this possibility. When exterior indications are lacking, judgment alone must determine its length.

After the extent of the defect has been determined and the squared-defect method judged applicable, use either a Coconino-style scale stick or the Shortcut Procedure. Following are several examples of defect calculation using the Scribner Decimal C rule.

Example 1: A 16-foot log 21 inches in diameter has a gross scale of 300 board feet. Defect at one end measures 6 by 9 inches and is estimated to extend halfway into the log.

Adding 1 inch to each dimension for waste

7 x 10 = 70 to the next higher 10 = 80
80 x 8/16 or 80/2 = 40

The deduction is 40 or 4 Decimal and net scale is 26 or 260 board feet.

Example 2: A 20-foot log 36 inches in diameter has a gross scale of 1,150 board feet. Defect at one end measures 13 by 15 inches and is estimated to extend 8 feet into the log.

Adding 1 inch to each dimension for waste

14 x 16 = 224 to the next higher 10 = 230
Add 10 (size between 13 and 16 inches)
240 x 8/16 or 240/2 = 120

(Read on Coconino stick 15 x 15 - 8' = 12)
The deduction is 120 or 12 Decimal and net scale is 103 to 1,030 board feet.

Example 3: A 14-foot log 21 inches in diameter has a gross scale of 270 board feet. Defect in one end measures 8 by 10 inches and extends 6 feet into the log.
Adding 1 inch to each dimension for waste.

9 x 11 = 99 to the next higher 10 = 100
100 x 6/16 or 38 to the nearest 10 = 40

(Read on Coconino stick 10 x 10 - 6' = 4)
The deduction is 40 or 4 Decimal and net scale is 23 or 230 board feet.

When a defect shows at one end only of a log and is estimated to extend to a point within less than minimum lumber length of the other end, use the full length of the log as the defect length in making deduction. In western Regions the minimum lumber length is 6 feet for softwoods and normally 4 feet for hardwoods.

22.5 Logs With Same Defect Showing on Both Ends

Make careful examination of the log to determine if defects are connecting. If the defect is found to extend through the log and the squared-defect method is applicable, use either a Coconino-style scale stick or the Shortcut Procedure to determine the deduction. The average diameter of the defect will be used in making the deduction in 16-foot or longer logs.

Following are examples of defect calculation using the Scribner Decimal C rule and a 20-foot maximum scaling length. (See code 75 for International rule.)

1. For logs 8 to 14 feet in length, defect dimensions will be taken at large end of defect (in western Regions).

Example: A 14-foot log 21 inches in diameter has a gross scale of 270 board feet. End defects measure 8 by 10 inches and 4 by 6 inches.

Adding 1 inch for waste

9 x 11 = 99 to the next higher 10=100

100 x 14/16 =88 to the nearest 10=90

(Read on Coconino stick 10 x 10 - 14' = 9)

The deduction is 90 or 9 Decimal and net scale is 18 or 180 board feet.

- 2. For logs 16 to 20 feet in length, the average of the defect dimensions for both ends of the log will be used (in western Regions). -

Example: A 20-foot log 21 inches in diameter has a gross scale of 380 board feet. End defects measure 8 by 10 inches and 4 by 6 inches.

Add 1 inch for waste

$$\frac{9 + 5}{2} = 7 \quad \text{(H)}$$

$$\frac{11 + 7}{2} = 9 \quad \text{(W)}$$

7 x 9 = 63 to the next higher 10 =70

70 x 20/16 =88 to the nearest 10=90

(Read on Coconino stick 8 x 8 - 20'=9)

The deduction is 90 or 9 Decimal and net scale is 29 or 290 board feet.

3. For logs 22 feet and longer, treat each segment in the manner prescribed in 1 and 2.

a. For logs 22 to 28 feet in length, average the defect dimension at both ends to obtain the size of the defect at midpoint and run the larger end of the defect dimension through each segment.

Example: Defect extends through a 24-foot log that is scaled as two 12-foot segments. Defect, including waste allowance, measures 8 by 10 inches on the large end, 4 by 6 inches on the small end. The midpoint defect dimensions are 6 by 8 inches. For one segment, use 8 by 10 inches for deduction.

For the other segment, use the midpoint size, 6 by 8 inches.

b. For 30-foot logs, use large defect dimensions for the 14-foot segment and average defect dimensions for the 16-foot segment. See items a and c.

c. For logs 32 to 40 feet in length, average the defect dimensions at both ends to obtain the size of the defect at midpoint and then use average widths and heights of the defect as computed for each segment.

The procedure may be simplified and the same or a comparable answer obtained by an alternate method. This modification provides for use of the midpoint dimensions as the average defect dimensions for each log, but do not use it on marginal logs.

Example: Heart check on both ends of a 32-foot log measures (including waste) 2 by 10 inches and 2 by 4 inches. The midpoint measurements are 2 by 7.

Usual Deduction Method

$$\frac{2+2}{2} = 2 \qquad \frac{10+7}{2} = 9$$

2 x 9 = 18 to the next higher 10 = 20 board feet deduction for butt log.

$$\frac{2+2}{2} = 2 \qquad \frac{4+7}{2} = 6$$

2 x 6 = 12 to the next higher 10 = 20 board feet deduction for the top log.

Alternate Method

Use midpoint measurement.
2 x 7 = 14 to the next higher 10 = 20 board feet for the average deduction or 40 for the 32-foot log.

Do not use the alternate method when one segment of a long log is a cull or where other indicators cast doubt as to the uniformity of the defect.

When the dimensions of end defects are averaged and the result is a fraction, round up to the next whole number, as (4 + 3) ÷ 2 = 4.

In Regions where hardwoods comprise a significant part of the timber volume or where short logs are preponderant, Regional Foresters may prescribe different utilization standards and lengths for averaging defects.

23 Pie Cut Method

Where the defect is deep and V-shaped it can be enclosed in a sector of a circle. The deduction bears the same relation to the total scale as the sector bears to the circle. Estimates of 1/8, 1/4, 1/3, 1/2, or 2/3 are used. The deduction is the amount determined by the fraction of the scaling cylinder affected, times the scale of a log the same length as the defect and the same diameter as the log being scaled.

Example: A 16-foot log 20 inches in diameter has a gross scale of 280 board feet. A lightning scar running the entire length of the log has been burned out (fig. 14). It can be enclosed in a sector (pie cut) equaling $\frac{1}{4}$ of the circumference. The deduction is $\frac{1}{4}$ of 280, which is 70 or 7 Decimal, and the net scale is 21 or 210 board feet.

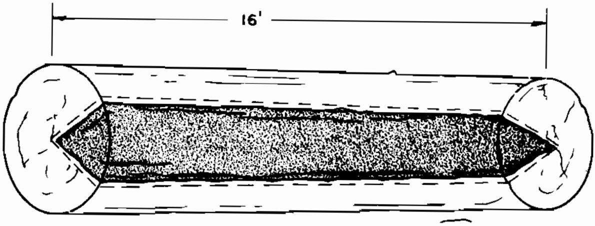

Figure 14. -Pie cut method (deep lightning scar affecting $\frac{1}{4}$ of log).

This deduction method usually applies well to catfaces, fire scars, grubworm holes, and rotten knots. It is applicabl e when the defect affects two-thirds or less of the scaling cylinder. To help determine the correct fraction to use, mark off the affected portion with a piece of keel. Remember to extend the defect the full length of the log if the sound portion would be less than minimum merchantable lumber length.

24 Length-Deduction Method

This method is useful when defects result in production of lumber shorter than the log length. It should be used when the deduction for squared defect for the length affected exceeds the scale for the log length involved. Such defects may include sweep, crook, fire scar, knot clusters, large burls and pitch spangles, breaks, crotch, massed pitch, and rot.

> Example: In a 16-foot log, 16 inches in diameter, scaling 160 board feet, with rot 12 inches in diameter affecting 4 feet of the log, the squared-defect deduction would be 50 board feet. As this deduction exceeds a 4-foot cut, or 40 board feet, use a length cut.

In use, this method is often combined with the pie cut method (code 23). For example, a deduction for a defect which affects one-half the scaling cylinder for 4 feet is equivalent to a 2-foot length cut.

25 Diameter-Deduction Method

A diameter cut means reducing the original diameter and scaling cylinder of a log. This method is used in deductions for sap rot, weather checks (when deductible), shallow catfaces, perimeter rings, and knots when they cause a loss of merchantable material.

Example: A log with sap rot measures 20 inches in diameter. The rotten sapwood is 1 inch thick on each side. Reduce the gross diameter of 20 inches by 2 inches for a net diameter of 18 inches. Net scale is that of an 18-inch log. (Show the difference between that net scale and the gross scale in the defect column.)

CHAPTER 30 LOG DEFECTS AND DEDUCTIONS

31 General

A scaling defect is defined as any unsound material or abnormal shape in a log that reduces its net volume. Defects are grouped in two common classes:

1. Natural Defects. Natural defects are those which exist in the log before the tree is felled. These may include all kinds of interior rot, rotten knots fire scars, catfaces, massed pitch, pitch rings and shake, pitch seams and checks, lightning scars, sweep, crook, massed grubworm holes, crotch, sap rot, weather checks (snags and windfalls), knot clusters, burls, and some types of large knots.

2. Logging Defects. Logging defects are those generally occurring after the tree is felled. They include mechanical defects, such as breakage, brooming, tractor damage, and loading damage. They also include other defects caused by poor logging practices, such as sap rot, weather checks, and damage caused by borers after trees have been cut.

Forest Service scaling ordinarily considers deductions for all natural defects and for breakage which is clearly unavoidable. The District Ranger must make the decision concerning permissible deductions for defects caused by allowing logs to remain in the woods. Where clearly not under the control of the operator to avoid them, the District Ranger will permit deductions for these defects. As provided in *-code 17.5., the scaler will deduct for defects in the logs as presented unless otherwise instructed. -*

32 Defect Types and Applicable Deduction Methods

Following is a tabulation of common types of defect and the defect-deduction method most applicable to each type. The types of defect and applicable procedures are discussed in code 33. Deduction methods are described in chapter 20.

Defect	Defect symbol (optional)	Deduction method: Diameter	Length	Pie-cut	Squared-defect
Barber chair	BK	----	----	x	x
Bark seam	PS	----	----	----	x
Break, straight	BK	----	----	x	x
Break, other	BK	----	x	----	-----
Burl, large	BL	----	x	x	-----
Catface, shallow	CF	x	----	----	-----
Catface, deep	CF	----	----	x	-----
Check, heart	CH	----	----	----	x
Check, weather	WC	x	----	----	-----
Crack, frost	FC	----	----	x	x
Crook	CR	----	x	----	-----
Crotch	Y	----	x	----	x
Fire scar	FS	----	x	x	-----
Knots, large	K	x	x	x	-----
Knot cluster	KC	----	x	x	-----
Knots, rotten	RK	----	----	x	x
Lightning scar	LS	x	x	x	x
Multiple defects	MD	----	x	x	x
Pitch, massed	MP	----	x	x	x
Pitch seam	PS	----	----	----	x
Pitch spangle, small	SP	----	----	----	x
Pitch spangle, large	SP	----	x	----	-----
Pull, stump or sliver	BK	----	----	----	x
Ring, pitch or shake	PR or SH	x	----	----	x
Rings, pitch or shake, multiple.	PR or SH	----	x	----	-----
Rot, conk	C	----	x	x	x
Rot, heart	R	----	x	----	x
Rot, sap	S	x	----	----	-----
Rot, stump	R	----	x	----	x
Stain[1]	------	----	----	----	-----
Sweep	SW	----	x	----	-----
Wormholes, massed, large.	WH	x	----	x	x

[1] Stain is not a defect by itself. If stain is accompanied by rot, refer to the appropriate rot.

The common rots and fungi found in saw logs are described in table IX in the appendix.

Descriptions of common defect types, with applicable deduction procedures, follow in alphabetical order. The Scribner Decimal C rule is used in examples. The same general scaling practices apply to the International rule.

Barber Chair. See Breaks and Splits.

Bark Seam. See Pitch Seam.

Breaks and Splits. Breaks and splits are mechanical defects which require special consideration. Modern-day logging, much of it in steep country, will generally result in some damage to the logs when felled, bucked, transported, and handled by various mechanical devices. In many instances this damage may result in a considerable loss of sound timber. Refer to codes 17.5 and 42 if abnormal amounts occur. Broken-end logs (shatter breaks) caused by falling, split or slabbed ends caused by poor bucking or falling, and slivers (stump pull) pulled from logs in falling are the most common types.

Breakage may occur regardless of what precautions are taken; or may result from improper bedding, felling trees across stumps, logs, rocks, or ridges. Accurate determination of the extent of lengthwise shattering is often difficult as it may be hidden by bark. Remove enough bark to insure inclusion of all of the defect in the deduction.

Buckers should usually leave some breakage in a log to avoid waste.

Lengths of broken-end logs are determined as follows:

1. Where the broken end is wholly or partly bucked, measure the log from saw cut to saw cut and make any required deduction (fig. 15).

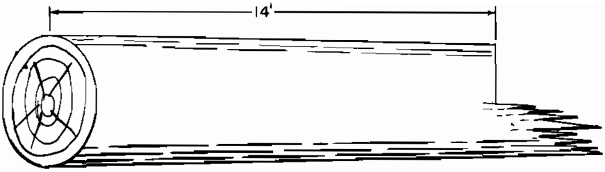

Figure 15. -Broken end partly bucked.

2. When only one end is bucked, determine the most applicable scaling length and make the required deduction (fig. 16).

3. When neither end is bucked, determine the applicable scaling length and make any required deduction for defect (fig. 17).

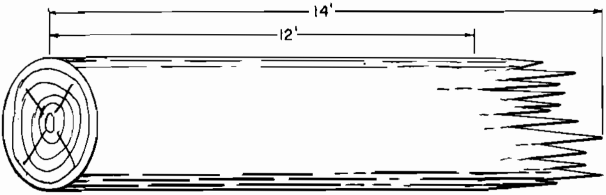

Figure 16. -Broken end not bucked.

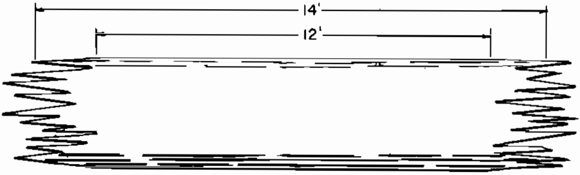

Figure 17. -Broken both ends, neither bucked.

The following deduction procedure should be used to simplify and standardize treatment of broken-end logs:

1. Logs under 16 inches. If a quarter to a half of the end section within the scaling cylinder is gone, deduct half the length affected (fig. 18). If more than half the end section is gone, consider the entire end lost and deduct for the full length affected (fig. 19).

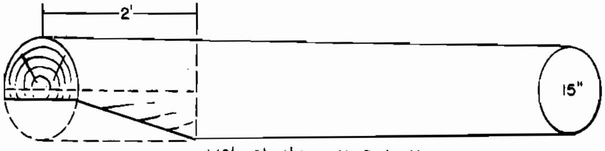

Figure 18.-End break. Small log deduction when half or less of log end is broken ($\frac{1}{2}$ x 2'= 1' length deduction).

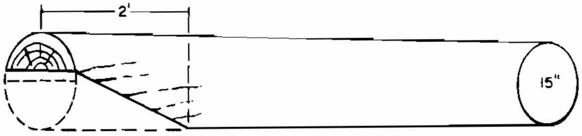

Figure 19.-End break. Small log deduction when over half of log end is broken (2' length deduction).

2. Logs 16 inches and over. When any portion of the end section is broken, use a combination of pie-cut and length deduction. See figures 20 and 21.

Falling and bucking breaks are generally avoidable, but may be caused by rot, by heavy leaning trees

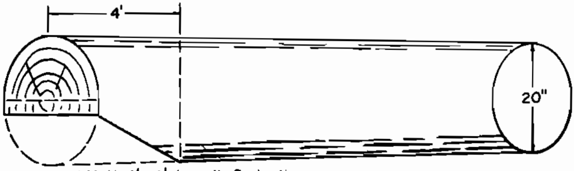

Figure 20. -End break. Large log deduction when half or less of log end is broken.

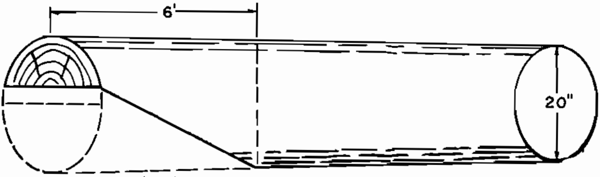

Figure 21. -End break. Large log deduction when over half of log end is broken.

on steep slopes, or by some factor not readily apparent to the scaler. Deductions for these defects are generally made by the squared-defect method (fig. 22). Refer to code 41.2 for scaling of chunks and slabs.

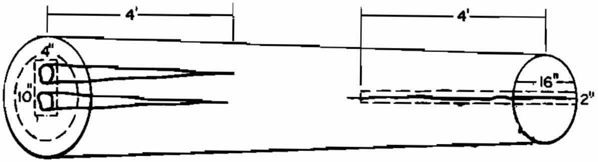

Figure 22. -Left, stump pull-squared-defect method. Right, bucker break (straight)-squared-defect method.

Burls. See Knot Clusters and Burls.

Catface. Scars or wounds, often caused by falling objects scraping against a tree, are generally called catfaces. When shallow in depth and removable with the slab, they need no deduction. When they penetrate deeper intothe log, use the pie-cut method.

For catfaces similar to sap rot, determine how much of the surface of the scaling cylinder is affected and apply a diameter cut.

Figure 23 illustrates a 16-foot log with a deep and partially grown-over catface. The defect is 10 feet long and is confined to a quarter section of the log. The diameter at the small end of the log is 17 inches. The gross scale of a 10-foot log, 17 inches in diameter, is 120 or 12 Decimal. The deduction for defect would be $\frac{1}{4}$ of 12 or 3.

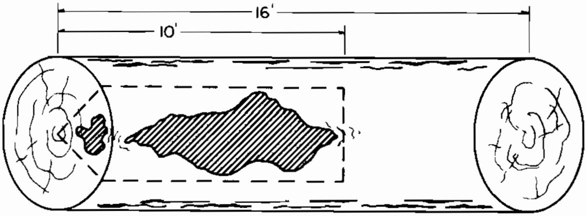

Figure 23. -Catface-Pie-cut method.

Figure 24 illustrates a 16-foot log with a catface extending the entire length. The catface is 2 inches deep and covers 1/3 the circumference. The small diameter of the log is 15 inches and the gross scale 140 or 14. The defect is determined by subtracting the scale of an 11-inch log (diameter of core) from the gross scale and dividing by 3. $(14-7) \div 3 = 2$.

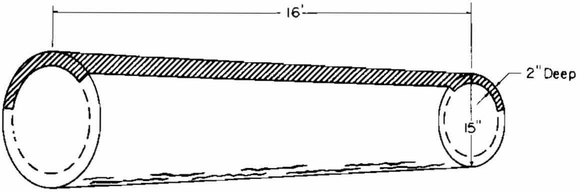

Figure 24. -Catface-Diameter-deduction method.

Watch for massed pitch, wormholes, and rot in conjunction with catface. If ants are present, they are usually an indication of a deep dry rot somewhere within the log.

Check, Heart. See Pitch Seam, Heart Check, Frost Crack.

Check, Weather. Also known as wind and sun checks. They occur (1) in logs left in the woods or cold decks for an extended period before scaling and (2) in dead trees (snags). Make no deductions for logs that weather check when left in the woods (by the option of the purchaser) or in cold decks. However, make deductions for such logs if the purchaser was not responsible for the condition of the logs as in sales of right-of-way logs already piled, or logs resold to a new purchaser. Instructions to scalers should cover proper procedures when this condition occurs.

Figure 25 illustrates a 32-foot log cut from a live tree. End dimensions are 24 and 28 inches, respectively. Weather checks occurred after the tree was felled and bucked in a right-of-way clearing. Such checks usually are about twice the depth at the ends of a log than elsewhere. If these weather checks are deductible (that is, not due to delay in removal by the purchaser), deduct as follows:

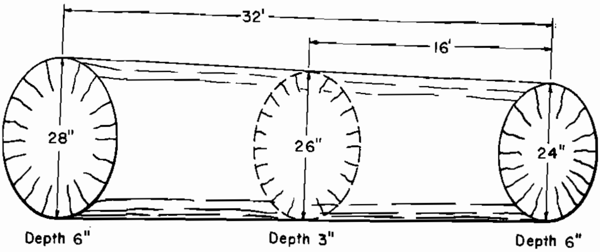

Figure 25. -Weather checks-diameter-deduction method.

*- 1. For top segment.

a. Measure the small end diameter of the 32-foot log (24 inches in the illustration).

b. Measure one-half of the depth of the checks on the small end (3 inches) and multiply by 2 for both sides of the segment (6 inches); this is the gross diameter deduction. -*

c. Reduce the diameter of the segment (24 inches) by 6 inches to obtain a net diameter of 18 inches. The net scale then is that of a 16-foot log 18 inches in diameter, 210 board feet or 21.

*- 2. For butt segment. In the top segment the gross diameter deduction was 6 inches or a net scale of a log 6 inches less than the diameter at the small end. Do the same thing with the butt segment, but use the midpoint diameter of the long log.

a. Find the midpoint diameter by use of the taper in the long log. In the illustration the taper is 4 inches from butt to top. Thus the midpoint diameter is 26 inches.

b. Reduce the segment diameter by 6 inches for a net diameter of 20 inches. The net scale then is that of a 16-foot log 20 inches in diameter, 280 board feet or 28. -*

Where only a fraction of the log surface or end is affected and the checks are deep, use the pie cut method, as shown in figure 14. Where (1) only a fraction of the log surface or end is affected and (2) the checks are confined to the outer surface and are deductible use a percentage or fraction of a diameter deducted for the length affected (fig. 24). -*

Weather checks found in logs cut from dead trees often are different from those described previously. These checks usually occur before a tree is felled. The depth of the checks in the sides of logs and at midpoint are about as deep as those in the ends. However, because of moisture retained in butts of standing trees, checks in the large end of a butt log may not be as deep as those in the top.

Weather checks often penetrate to the heart of dead logs. If the log is straight grained, consider the possibility of cutting lumber between the checks. But if spiral grained, the log may be a cull for saw timber. By mill visits, determine the seriousness of weather checks. The statements above are guides to help in making deductions.

<u>Crack, Frost.</u> (See Pitch Seam, Heart Check, Frost Cracks.)

<u>Crook.</u> A crook in a log is a sudden curve or bend from a straight line. One type is found in logs from upper portions of trees. Snow or falling trees that break off tops of other trees can cause this defect. Before a new leader starts, rot and black massed pitch may enter the wound. The new leader may die, leaving a large sucker-type dead knot (fig. 26). Breakage may occur at this point due to weakness caused by cross grain. Normal deduction for the log illustrated should be a 2-foot-length cut, since 6-foot lumber can be recovered from the small end of the log. Had the section been less than 6 feet in length, a deduction for this complete portion of log would be necessary.

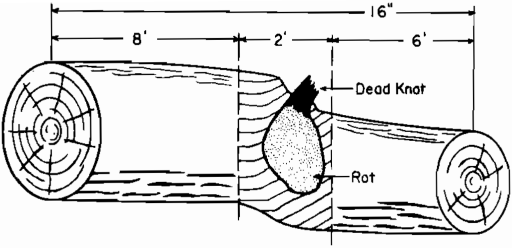

Figure 26. -Crook (caused by snow break or other leader damage) - length deduction method.

Another type of crook occurs in the large end of butt logs. It may locally be called "churn" or "pistol butt." This is caused by young trees having been pushed over by snow or forced to grow outward from steep slopes. Later these trees assume a natural position and grow upward but retain a crook or "hook" in the butt. Loss caused by this defect often is confined to a 2- or 4-foot section.

Figure 27 illustrates a 16-foot log with crook in the butt end. To deduct for this defect, measure the length of the crook and determine what fraction of this length is affected. In the illustration, $\frac{1}{2}$ the log will produce 14-foot lumber and $\frac{1}{2}$ the log will produce 12-foot lumber. No 16-foot lumber can be obtained. The net scale is determined by deducting 3 feet from the 16-foot log.

In deductions for crook, consider the loss in squaring up the ends of uneven-length lumber. Also consider unmerchantable cross-grained lumber that may result from this defect.

Crotch. A crotch is the point in a tree where it forks into two or more leaders or stems. Proper bucking can eliminate much of the defect. Usually the loss occurs from a bark seam, split, or cross grain in the end of such logs. Loss may occur from

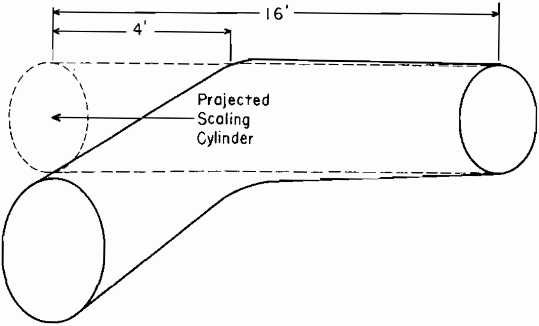

Figure 27. -Crook-length deduction.

flat sides often characteristics of a crotch condition (fig. 28. A deduction of 1 or 2 feet in length is often made for this type of defect, but the actual deduction

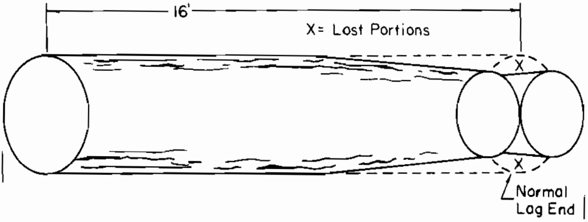

Figure 28. -Crotch log with characteristic flat sides.

depends on observation of loss during mill visits. It may be sufficient merely to square out the bark seam. Amount of deduction depends on the point of bucking. See figure 29 and code 17.32 for method of measuring diameters of crotched logs.

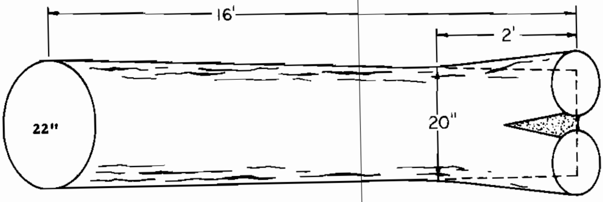

Figure. 29.-Crotch log.

Fire Scar. Fire scars are usually found only in butt logs, but occasionally extend into the second 16-foot log. In some species this defect may be accompanied by massed black or red pitch; sometimes by weather checks and wormholes or rot. Part of the scar at the top end may be healed over; consider possible defect here in measuring its length within the scaling cylinder. Mill visits will show how fire scars affect recovery of lumber from local species, timber of different ages, and scars of different ages. Fire scars may also be called catfaces. (See catface.)

Figure 30 illustrates a 16-foot log with fire scar extending 8 feet from the butt. Fire scars of this type always have a part of the defect outside the scaling cylinder (not deductible) and therefore appear more serious than they are actually.

Use a combination of pie cut and length of defect. First, estimate what part of the end of the scaling cylinder is affected, then what length is lost by defect. In the illustration half of the cross section of the scaling cylinder might be affected for 8 feet in length. Deduct $\frac{1}{2}$ of the 8 feet or 4 feet in length. Net scale is that of a log 12 feet long.

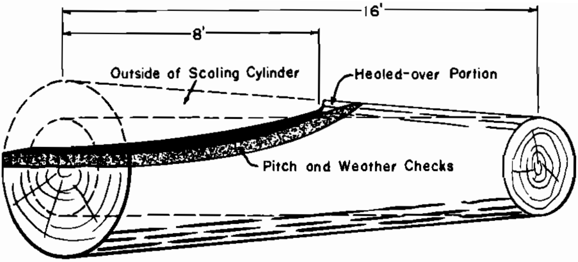

Figure 30. -Fire scar in butt log-combination pie and length of defect method.

Knots, Large.

1. Knots are normally a lumber-grade (quality) defect and will not be considered in scaling. However, on occasion, knots are so large and/or numerous that they will cause weaknesses in the lumber and an actual volume loss. Deductions for knots will only be allowed when this actual volume loss will occur. "Roughness" caused by knots does not automatically create a need for defect deductions.

2. Volume loss is more often the result of conditions created by dead knots than live knots of the same size. Live knots taper internally immediately, whereas dead knots do not taper until they reach the last growth ring before the limb died. Volume loss generally occurs in the outer portion or "collar" of a log (fig. 31).

3. Following are some conditions under which volume loss due to knots may occur:

a. Large knots in whorls.

b. Unusually large knots.

c. Grain distortion caused by adventitious bud swellings around larger knots.

d. Several large knots on the same face.

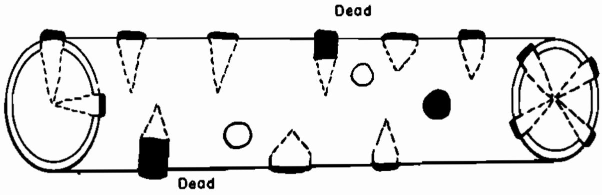

Figure 31. -Collar of rough log-diameter-deduction method.

4. Actual loss from knots should be ascertained by mill visits. Loss from whorls of large knots as in item 3a above will usually be included in a 1-foot-length deduction for each major complete whorl. Loss from unusually large knots can normally be determined by a combination pie cut and length cut, whereas loss from conditions mentioned in item 3c and 3d above will generally occur in the outer portion of the log which might include part, all, or more than the sap ring.

5. Table VIII, Knot Guide to Merchantability and Deductions in the appendix may be used if found to be locally applicable.

Knot Clusters and Burls.

1. Knot clusters grow in two distinct types. One type consists of a group of small limbs developed from adventitious buds. It does not affect the volume of lumber produced and is not treated as a defect. The other type consists of a group of larger limbs, often with a large dead limb in the center that penetrates deeply into the log. It may cause breakage in lumber produced. This second type commonly occurs in Douglas-fir and larch. Often massed pitch and twisted or disrupted grain occur in connection with such knots. When these will cause a loss in the volume of lumber produced, a deduction should be made. The extent of loss from this cause can be best determined by mill visits.

2. When knot clusters cover about one-fourth of the circumference of a log, make a length deduction to cover the volume loss in the affected portion (one-fourth the length of the cluster within the scaling cylinder). Usually 1 foot per major cluster is sufficient. If the clusters are so close together as to prevent the manufacture of merchantable-length lumber between them, apply the pie-cut method for the portion of the length affected.

Figure 32 illustrates a log where knot clusters are so close to the log end as to prevent the recovery of merchantable-length lumber. When this occurs, increase the deduction accordingly.

3. Burls are dome-shaped growths of various sizes sometimes found on tree trunks. At times they penetrate into logs as far as their height above the log surface. Treat burls the same as item 2 above.

4. Massed pitch, twisted grain, and sometimes a large limb may cause breakage in lumber similar to

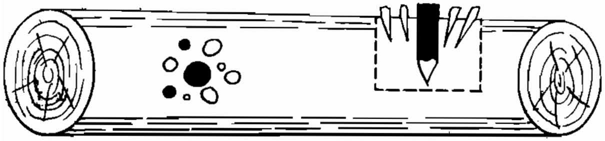

Figure 32. -Knot clusters-combination pie-cut and length-deduction method.

that caused by knot clusters. If observations during a mill visit so indicate, make the deduction as for knot clusters (fig. 32). Note, however, that defects which prevent recovery of standard-length lumber should be extended.

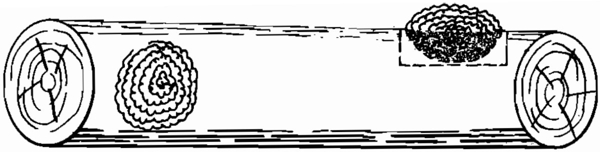

Figure 33. -Burls-combination pie-cut and length-deduction method.

5. Numerous small burls or pitch scabs occasionally are found on Douglas-fir and other logs. Massed pitch and pitch rings sometimes occurring beneath these burls may cause a loss in the outer portions of logs. A diameter deduction for this defect equal to the depth and portion affected as for sap rot may be equitable but should be checked, and not applied automatically (fig. 34). The figure shows areas of defect only. Deductions should include all loss of standard-length lumber.

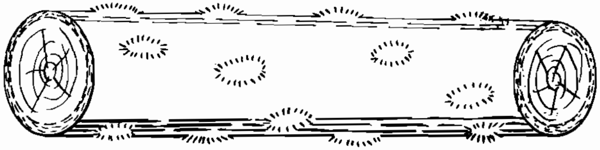

Figure 34. -Numerous small burls or pitch scabs-diameter-deduction method.

Knots, Rotten. In some species and areas, rotten knots indicate interior rot. Rot may follow the knot into the log, then spread out one or both ways. The length of this spread varies with species, age, and locality. When rot shows on one or both ends, make deductions using the pie cut method for the length affected (fig. 35). Logs with rotten knots and no end indications are a challenge to any scaler. Visit local mills to establish a pattern for making deductions for this defect.

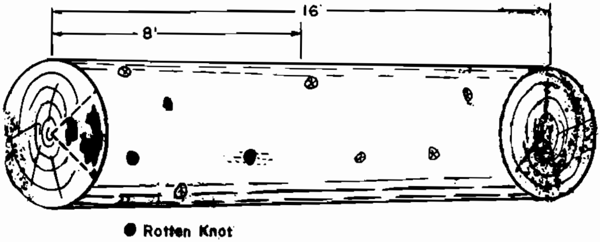

Figure 35. -Rot in log end caused by rotten knots pie cut method.

Lightning Scar. The spiral effect of lightning scars, sometimes with shatter, massed pitch, wormholes, and weather checks, presents a difficult scaling problem. The degree of spiral and volume loss varies. Give consideration to short-length lumber the log will produce.

The following alternate method may be used for the more difficult problems:

1. Determine degree of spiral over the entire log (as $\frac{1}{4}$, 1/3, $\frac{1}{2}$, 2/3). Consider recovery of short-length lumber and taper.
2. Obtain gross scale of the log.
3. Measure depth of scar. Include massed pitch and other defects if present.
4. Double the scar depth (for both sides, sec. A) and subtract from log diameter (fig. 36). This result is diameter of section B.

Some logs have shallow scars on all sides that are deep enough to cause some loss in the scaling cylinder. Treat this defect the same as sap rot by making a diameter deduction.

Use the pie cut method (fig. 14) when lightning scars are deep and affect one face.

Multiple Defects. More than two types of defect may occur in ends and sides of logs. To apply one or more deduction methods to each defect is often difficult and time consuming, and may result in erroneous deductions. The best method is usually to combine a pie cut with the length of defect method on such logs. In some cases, the squared-defect method may be applicable.

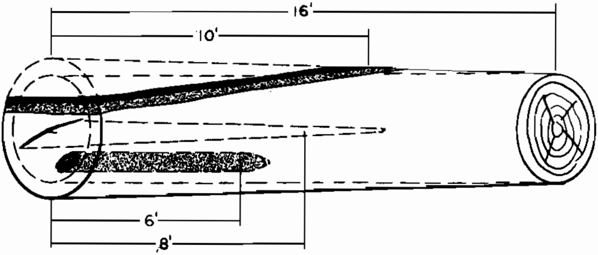

Figure 37. -Multiple defects-combination pie cut and length of defect method.

Figure 37 illustrates a 16-foot, 24-inch butt log with multiple defects in the large end. First estimate what fraction of the scaling cylinger is affected. About two-thirds is affected to some extent. Next, estimate the average length of the defects.

Example: Fire scar 10 feet, rot 6 feet, heart check 8 feet, making an average of 8 feet. The deduction then is 2/3 of 8 feet, or a 6-foot-length deduction.

Pitch, Massed. Often massed pitch occurs in connection with fire scars and may extend beyond the scar at the top end. It is considered in the deduction for this defect. Occasionally pine butt logs show such a heavy accumulation of pitch in the large ends that it makes the wood unmerchantable. Make a deduction for this only when mill visits show that it causes an actual volume loss. Make a length cut if most of the log end is affected. Use the pie-cut method or the squared-defect method if only a portion is affected.

Pitch Seam, Heart Check, Frost Cracks.

1. A heart check is an opening or separation across the log heart at right angles to the annual rings. When filled with pitch, it is called a pitch seam. Frost cracks are similar to heart checks, except that they are usually visible in the bark and extend from the outside of the log to the heart. Often these defects run farther lengthwise than do pitch rings. Normally make deductions for seams, checks, and frost cracks by the squared-defect method.

A word of caution in measuring the width of this type of defect; Search for "breakouts" or branches from the main check or seam. These are sometimes difficult to see, especially when ends are wet.

Figure 38 illustrates a 16-foot butt log with a heart check in the large end. Top diameter of the log is 21 inches. The actual height of the check is 23 inches, but do not add an inch for waste to this dimension. Use 21 inches (the diameter of the scaling cylinder) for the height and 3 inches for the width.

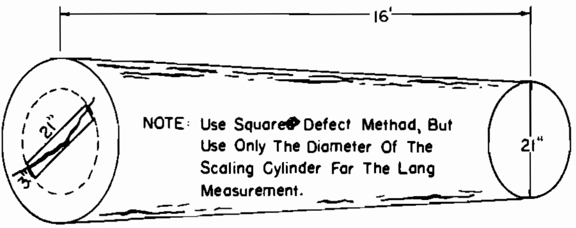

Figure 38. -Heart check-squared-defect method.

The width measurement includes the 1 inch allowed for waste. The estimated depth of penetration in the log is 8 feet. The squared-defect method (code 22.4) then gives 3 by 21=63 or a deduction of 7 for a 16-foot length. One-half of this gives 4 (Decimal), the deduction for 8 feet of penetration.

2. When the check shows on both ends and apparently extends straight through the log without twisting, deduct as for heart rot: For 16- to 20-foot logs, average the end defect dimensions. For logs shorter than 16 feet, use the large end dimensions unless the Regional Forester prescribes otherwise. For logs longer than 20 feet, follow the deduction rules described under code 22.5. This includes the use of the alternative method explained under code 22.5, item 3c.

Figure 39 illustrates a 32-foot butt log with heart check showing on both ends and in the same position. Small diameter of the 32-foot log is 23 inches, and midpoint diameter 25 inches. End dimensions of the defect in the 32-foot log are 2 by 15 inches and 3 by 25 inches, respectively, including waste. When dimensions of 15 and 25 inches are averaged the midpoint dimension is 20 inches.

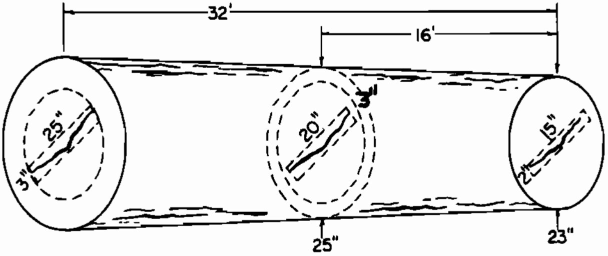

Figure 39. -Heart check in 32-foot log-squared-defect method.

*-Use 3 inches for the estimated width at the midpoint. For the butt segment, average 3 by 20 inches and 3 by 25 inches; result, 3 by 23 inches. For the top segment, average 2 by 15 inches and 3 by 20 inches; result, 3 by 18 inches. The squared-defect method (code 22.5) then gives the following deductions: Butt segment, 3 x 23=69 or 70 or 7. Top segment,

3 x 18=54 or 60 board feet (6 Decimal). -*

3. Deductions for two cross-checks are made as explained in item 2 preceding. But in measuring height of the second check, do not include any part of the first check measured (fig. 40). Diagram at right angles.

4. Deductions for more than two cross-checks *-(called multiple checks or spangle) are usually made using the squared-defect method unless the defect is large and results in a length-deduction. Some re- -* covery might show between the ends of the checks. "Give and take" when squaring out this type of defect. In figure 41, note that some recovery appears inside the square (the "give" area). This is offset by the loss in the check ends outside the square (the "take" area).

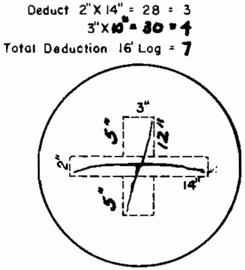

Figure 40. -Method for making deductions for cross-checking.

5. Heart checks and pitch seams showing on both ends of a log at different angles indicate twist. Obviously the loss here is greater than when the check is straight. The twist causes the production of short-length lumber, some of it less than 6 feet. Consider the amount of twist when deducting for this defect. If the twist is 45°, use 1.5 times the deduction for a straight check. If the twist is 90°, double the deduction for a straight check.

On one log end, place a small stick in the bark parallel to the check. This helps determine if any twist is present when you are at the other end.

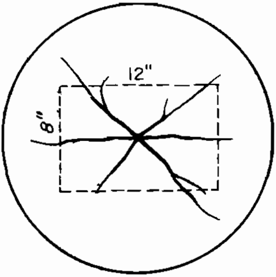

Figure 41. -Method for making deduction for multiple checks and pitch spangles. Squared-defect method.

Figure 42 illustrates a 16-foot log with a 2- by 20-

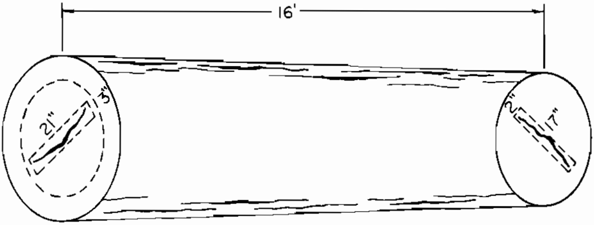

Figure 42. -Heart check with 90° twist. Squared-defect method.

inch heart check showing on the butt end. The same check at the top end is 1 by 16 inches, but shows a 90° twist. After adding 1 inch for waste and averaging the defects (3 by 21 and 2 by 17), the squared-defect method (code 22.5) gives 3 x 19=57, or a deduction of 6 for a 16-foot log with a straight check. Adjusting for the 90° twist, the actual deduction for the log will be 6 x 2 or 12.

Figure 43 illustrates a 32-foot log with a heart check showing on both ends. End measurements of the defect are 3 by 21 inches and 2 by 12 inches, including waste. The check on the top end indicates a 90° twist from that showing on the butt end. By using the squared-defect method (code 22.5), the defect is computed as follows:

*- Average end defects (3 by 21 and 2 by 12 inches) to obtain dimensions of defect in the center of the log (3 by 17 inches).

Determine defect for each scaling length by averaging end defects and adjusting for twist (45 degrees in each segment).

3 by 21 and 3 by 17 average 3 by 19 inches.

3 x 19=57 or a deduction of 6 for the 16-foot length for the butt segment if the check was straight. Adjusting for the twist, the actual deduction for the butt segment will be 6 x 1.5, or 9.

3 by 17 and 2 by 12 average 3 by 15 inches.

3 x 15=45 or a deduction of 5 for the 16-foot length of the top segment if the check was straight. Adjusting for the twist, the deduction for the top segment will be 5 x 1.5 or 8. The total defect deduction for the 32-foot log is 17. -*

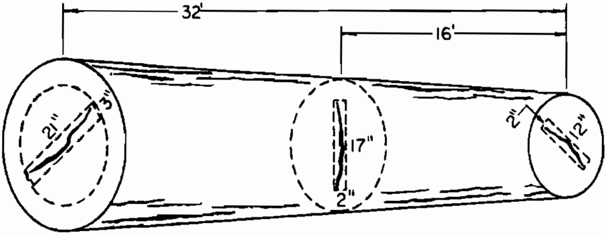

Figure 43. -Heart check with 90° twist in 32-foot log; 45° twist in 16-foot log. Squared-defect method.

6. When logs are exposed to the sun and wind for an extended period, weather or seasoning checks often occur in the ends. The scaler must learn to detect this type because he makes no deduction for them (see Checks, Weather). Such checks often increase in length due to weather. Use a thin wire or knife blade on doubtful checks to determine the type. Look for sawdust in checks. Sometimes this is an indication of a natural heart check.

7. For multiple frost cracks, see Pitch Spangle.

Pitch Spangle. When more than two pitch seams occur in the large ends of butt logs, the defect is called a pitch spangle. Douglas-fir and western larch are species commonly affected. Breakouts from the seams often occur. Sometimes pitch rings occur in connection with pitch seams. Defect of this type causes heavy loss in lumber manufacture. Sometimes a part of the defect extends into the second log.

Make length-cut deductions for pitch spangles in the butt 16-foot log when the size of the spangle approaches the scaling diameter. For other logs, use the squared-defect mehtod, as you would for multiple checks. See figures 41 and 44.

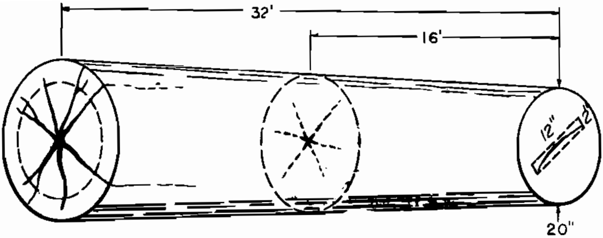

Figure 44. -Pitch spangle deductions in 32-foot log. Butt segment; length-deduction method. Top segment; length-deduction method for large end; squared-defect method for small end.

Figure 44 illustrates a 32-foot, 20-inch log with pitch spangle. The entire scaling cylinder is affected because the seams extend beyond its edges. Some defect shows on the small end of the 32-foot log indicating the defect is greater at the 16-foot point but not so great as in the butt end. In the illustration the butt 16-foot segment is highly defective, more than 50 percent. If the contract merchantability clause specifies 50 percent, this log is cull. If 33 1/3 percent, this log may be marginally merchantable.

If mill visits indicate that pitch spangle cuts out this way, treat the top 16-foot log as follows: Judge the large end defect as 50 percent of the scaling cylinder and the length of penetration as 8 feet. Deduct half of the 8 feet affected or 4 feet for the large end. For the small end, apply the squared-defect method and use 8 feet for the length. Compute the deduction for each, add, and then compute the net scale of the log.

Refer to examples included under Pitch Seam, Heart Check, Frost Cracks for alternate procedures for determining the volume of a top log.

<u>Pull, Stump or Sliver.</u> (See Breaks and Splits.)

<u>Rings, Pitch and Shake.</u>

1. Ring shake defect is the separation of one or more annual rings sufficient to cause a volume loss in manufacture. This separation is known as a pitch ring when it becomes filled with pitch, often a characteristics of species like Douglas-fir and larch.

2. Shake ring defects follow the annual rings. Sometimes they stop where knots start, for knots tend to hold the annual rings together. On some logs the length of pitch rings is shown by a narrow scar or pitchy seam running lengthwise in the bark. A scaler must look closely at log ends to locate rings and determine their size and shape. He should bear in mind that a ring that opens wide may have deep penetration into the log and that numerous rings may penetrate deeper than one or two rings. Make no deductions for rings outside the scaling cylinder, but rings in the large end of logs that enter the scaling cylinder will need defect deductions. It is important for the scaler to make sawmill visits to develop judgment in making ring shake deductions.

3. The need for considering the number of rings, ring location, ring class, ring taper, and the scale of any solid core often makes pitch and shake rings a complex scaling problem.

4. The basic procedure for scaling pitch and shake rings is to square the defect and replace a sound core. Rings are measured and averaged for size in the same manner as log diameters (code 17.3).

This rule in formula is:

Logs to 14 feet inclusive: $(\text{large ring} + 1)^2 - (\text{core ring scale})$

Logs 16 to 20 feet inclusive: $(\text{average ring} + 1)^2 - (\text{core ring scale})$

<u>Example 1:</u> A 14-foot log 21 inches in diameter has an 8-inch shake ring showing in the large end (fig. 45). The defect extends an estimated 8 feet.

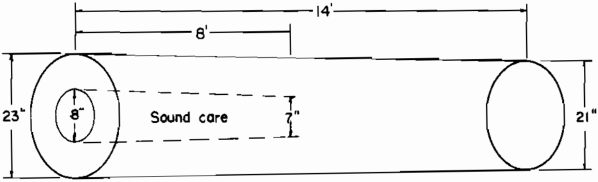

Figure 45. -Shake ring in large end.

Using the shortcut procedure (code 22.4), deduct as follows:

9 x 9≂81 to the next higher 10≂90 board feet

90 x 8/16≂45 to the nearest 10≂50 board feet

Replace 7-inch core (allow 1-inch taper), 8 feet long

Deduction≂50 - 10 or 40 board feet (4 Decimal)

(This is easy to compute with the Coconino scale stick.)

Example 2: A 16-foot log (fig. 46) has a 6-inch shake ring showing at the small end and an 8-inch shake ring showing at the large end. Adding 1 inch for waste and averaging the defect (code 22.5): 8 x 8≂64 to the next higher 10=70 board feet

Replaced 6-inch log≂20 board feet

Deduction≂70 - 20 or 50 board feet (5 Decimal)

(This is easy to compute with the Coconino scale stick.)

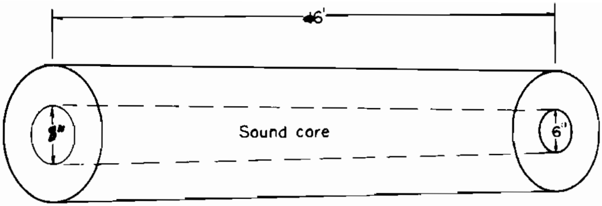

Figure 46. -Shake ring in both ends.

5. Following are instructions for varying the above procedure in accordance with the circumstances encountered.

a. For one-quarter rings, use the squared-defect method as for checks and do not consider core.

b. For a half ring, take half the deduction for a full ring for the length affected.

c. For a three-quarter ring, take three-quarters of the deduction for a full ring for the length affected.

d. When 2 full rings are not more than 2.5 inches apart, measure diameter of the outside ring. Add 1 inch. Apply squared-defect method for gross deduction. Reduce this by the scale of a log with a diameter of the inner ring.

e. When 2 full rings are over 2.5 inches apart, measure diameters of both rings. Compute separately as per preceding examples and add deductions together.

<u>Example 3:</u> A 16-foot log (fig. 47) has 6-inch and 16-inch shake rings showing at the small end and 8-inch and 18-inch rings showing at the large end. Adding 1 inch for waste and averaging the defect (code 22.5):

18 x 18 =324 + (Code 22.2) to the next higher 10 = 330 + 20 (For 17" to 21" squares)=350
Replaced 16-inch log =160
Deduction for large ring=350 - 160 or 190 (19 Decimal)

8 x 8=64 to the next higher 10=70
Replaced 6-inch log=20
Deduction for small ring 70 - 20 or 50 (5 Decimal)
Total deduction 240 board feet or 24
(This is easy to compute with the Coconino scale stick.)

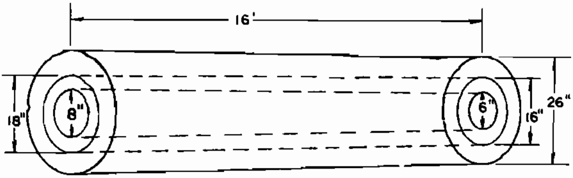

Figure 47.-Two full rings over 2.5 inches apart.

f. When multiple rings occur with no recovery between them, square the overall defect and allow for the scale of any inside log surrounded by the rings.

g. For a full or partial ring 2.5 inches or less from the outside at the top end, a perimeter ring, *-deduct by the diameter deduction method for the portion of the circumference and length affected.

Example 4: A 16-foot log 21 inches in diameter (fig. 48) has a 22-inch shake ring showing in the large end. The defect extends an estimated 8 feet to where the estimated ring diameter is 19 inches. It is thus a perimeter ring at this point and a diameter reduction is used. An 8-foot log 21 inches in diameter scales 150 board feet; an 8-foot log 19 inches in diameter scales 120 board feet. The deduction is 30 board feet or 3. -*

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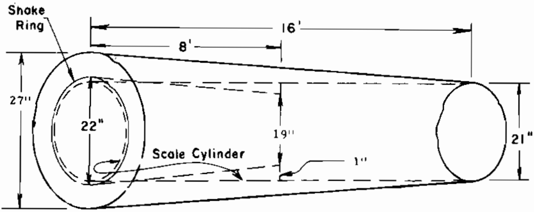


Figure 48. -Perimeter deduction in stump cut. -*

h. Make a length deduction if deductions by the squared-defect method exceed the log scale of the part affected.

i. Do not replace the core in determining the defect when the core is too small (normally less than *-6 inches) to yield standard-sized lumber. -*

6. The scaler must remember to follow instructions for application of the squared-defect method (code 22.3) in determining which measurements to use. He should also be aware that ring defects follow annual rings and taper, and remember to treat each core as a new scaling cylinder.

7. A Pitch and Shake Ring Deduction Table for 16-, 18-, and 20-foot logs with rings showing on both ends (table VI in the appendix) can be used instead of making the several calculations normally required. The table is for use in scaling with the Scribner Decimal C rule and provides for taper up to 8 inches.

8. Breakouts from a shake ring sometimes occur. These numerous short radial seams usually are found in a "collar" on the outside of the ring. Obtain the average length of the seams. If 2.5 inches or less (the collar thickness) follow the deduction rule as explained in the preceding item 5. If seams are over 2.5 inches long, determine how much of the collar is affected-a third, half, or all-and use the multiple-ring rule as explained in item 5.

9. Sometimes pockets occur in annual rings. In some softwood species they are called pitch pockets.

In some hardwood species they are referred to as gum pockets. Usually there is a separation present but the pockets are too short to cause a volume loss. Make no deduction for these pockets unless they are long enough to square out for a deduction of 10 board feet or are so numerous as to cause an actual loss in lumber recovery.

10. In white fir and hemlock a combination of ring and radial shake is common in some areas. The combination often requires a length deduction. Frost cracks, splits, or seams on the outside of the log often indicate the extent or condition.

Rot, Conk. Sometimes this rot is called red ring or honeycomb rot. In eastern species it is known as red rot. (Should not be confused with red rot of ponderosa pine-Polyporus anceps. See table IX, appendix.) In incipient stages it is commonly referred to as "firm red heart." This defect varies in color from purple and light red in early stages to dark brown in mature stages. In the early stages the wood is only stained and requires no deduction. In later stages, the wood breaks down to form a honeycomb appearance. Patches of white substance called "white pocket" appear. These white pockets indicate that the wood is broken down and that a deduction is required.

Deductions for conk rot are particularly difficult. Any one of several methods may apply. Effects of the fungus appear to vary with species, soil, altitude, and climatic conditions. Mill visits and experience are essential for a scaler to interpret what conk indicators mean in the timber he is scaling. Record guides applicable to timber from specific areas.

Generally the point of deepest penetration of conk rot is where a fruiting body or conk enters the log. Here the rot most commonly takes the shape of a crescent. Occasionally it may be in the form of one or more full rings. These may roughly parallel growth rings. When conk stain or conk rot shows in log ends, look with care for conks on the log. Use a spud to dig into swollen spots, punk knots, and black limbs. Size of conks is sometimes helpful in determining the extent of rot in some species. Recognize where conks have broken away from logs by punky, yellowish-brown material in the holes where the conks were attached.

Make deductions for white pocket (conk) using the squared-defect method if the defect occurs as a spot in one end. If $\frac{1}{4}$ to $\frac{1}{2}$ of one end is defective, make a pie-cut deduction of the scaling cylinder affected for the estimated length.

A good plan while on a mill visit is to make a rough chart guide such as that shown in exhibit A (appendix) for conk rot deductions. Use such a chart only for areas and species where it is proved to be applicable by repeated mill visits. Note the average length of rot spread from the last visible indicator.

WARNING: The effects of conk rot are variable. Widespread or uniform use of one chart without essential local modifications and repeated checks could result in erroneous scaling.

Rot, Heart. Sometimes called center, circular, dry, or red, this rot is found in logs cut from any position in trees. In color it ranges from light brown in early stages to reddish brown in its advanced stage. Fruiting bodies are usually missing by the time the log is ready to scale. This decay is characterized as brittle, dry, crumbly, sometimes with cubical patches and usually with white feltlike layers between the patches.

Use the full estimated length of heart rot because it does not taper like stump rot. Make deductions by the squared-defect method for most heart rot.

Example 1: Figure 49 illustrates a 16-foot log with a heart rot extending full length through the log. The defect including allowance for waste

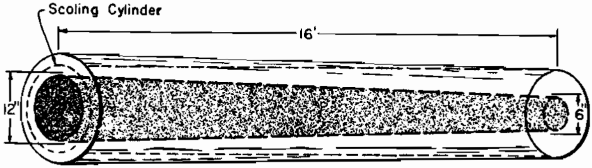


Figure 49. -Heart rot both ends-squared-defect method.

measures 12 by 12 inches on one end, 6 by 6 inches on the other. Average of these end dimensions is 9 by 9 inches. Using the squared-defect method (code 22.5), deduct as follows: 9 x 9=81 to the next 10=90 (9 Decimal).

Example 2: Figure 50 illustrates a 16-foot log with heart rot extending 8 feet into the log. The defect including waste allowance measures 10 by 10 inches on the end showing. The squared-defect method gives 10 x 10=100 to the next 10=110 (11 Decimal). Take ½ of 11 or a 6 deduction for this log.

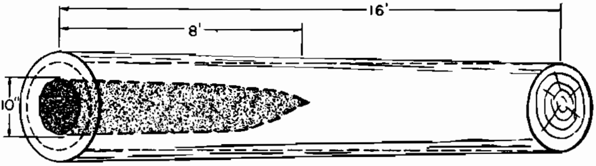


Figure 50. -Heart rot one end only-squared-defect method.

Use the length-deduction method where the diameter of heart rot equals or approaches the diameter of the scaling cylinder (code 24). Any regional variance from the instructions above should be based on a local guide developed during mill visits. Refer to Rot, Conk, and exhibit A, appendix.

Rot, Sap.

1. Sapwood on logs cut from dead trees, either snags or windfalls, often is in advanced stages of decay. If rotten sap extends over both the length and circumference of the log and the sapwood is still in place, the gross or outside diameter will be measured directly and the average diameter determined just as for green logs. When the rotten sapwood has sloughed away, the gross or outside diameter will be determined by measuring the sound wood within the sapwood and adding thereto the estimated thickness of the rotten sapwood.

To obtain net scale, determine the average diameter of the sound cylinder inside the rotten sapwood (or surface checks) and treat it as a special scaling cylinder, considering any other defects that may be present. The difference between the gross scale of the outer scaling diameter and the net scale of the inner scaling diameter will be the deduction if no other defects are present.

Example: A 16-foot log, 24 inches in diameter at the small end, has a gross scale of 40. If the average thickness of rotten sapwood is 2 inches (fig. 51), the net scale of the log will be that of a 16-foot log 20 inches in diameter, or 28.

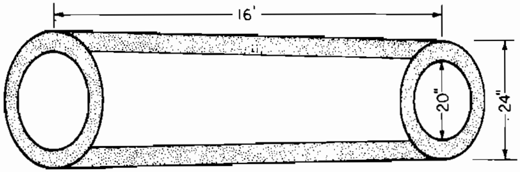


Figure. 51. -Sap rot-diameter-deduction method.

2. When portions of the length or circumference of the sap are sound, the full log diameter including sap will be the scaling diameter and the defect deduction will be treated as follows:

Example: A 16-foot log, 24 inches in diameter at the small end, has a gross scale of 40. If the rotten sapwood is confined to the side which was lying on the ground and averaged 2 inches rotten sapwood for 1/3 the circumference for the full length of the log (fig. 52) the net scale of the log would be 36, derived as

$$40 - \left(\frac{40 - 28}{3}\right) = 36$$

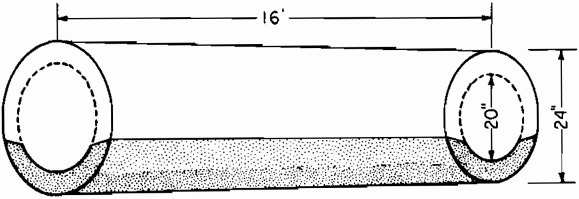


Figure 52. -Sap rot on one side-diameter-deduction method.

3. Examine logs with dead sapwood carefully. Rot may extend into the heart in the form of pockets. In fire-killed or down timber these pockets may be on one side only. This material should be looked over with care. Use the Hallin hammer or other type of spud to help determine the extend of rot. Deductions for these associated rots should usually be determined by the pie-cut method. See code 23 and figure 14.

4. Occasionally the top end of a sap-rotted log shows a deep rot penetration for a short length only. Make a length deduction for this portion and a diameter deduction for the remainder.

- 5. Check merchantability specifications of the timber sale contract (code 16). Some contracts may state that logs with the sapwood decayed will be scaled inside the sapwood. In such cases the sapwood, like the bark, is disregarded in scaling. Gross scale in such a case refers to the heartwood only. Other contracts may provide for scaling such logs "gross," in which case the gross scale is the only recorded volume. -

Rot, Stump. Often called butt or ground rot, it is found only in the butt portion of trees as the name implies. Color varies from light brown to dark reddish brown. Swelling on the outside of a log may be an indication of defect length but not always so. Where swellings do indicate rot, decay seldom extends far beyond such swelling. The rot may be either blunt or conical. Splits on the side of a log, sometimes due to weakness caused by rot, aid in estimating decay length. Mill visits are the best way to find out whether the local stump rot is generally blunt or conical. It may be desirable to develop a local chart guide of the type shown by exhibit A, appendix.

The length of penetration of stump rot seldom exceeds 16 feet and most commonly runs 2 to 8 feet. If mill visits show that the rot is generally blunt at the end, the amount of defect will be determined in the same manner as heart rot. If the rot is conical in shape, the amount of standard-length lumber which will be recovered along the taper of the rot must be considered. See figures 53 and 54. Use the squared-defect method unless the size of the defect is so large as to approach the diameter of the scaling cylinder and a length cut is indicated.

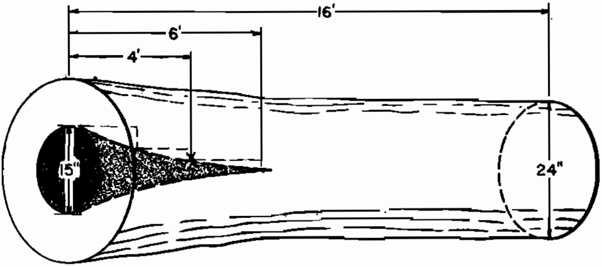


Figure 53. -Stump rot-squared-defect method.

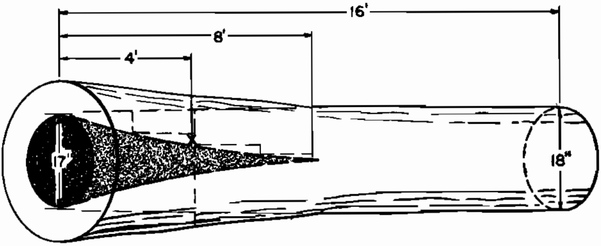


Figure 54. -Stump rot-Length-deduction method.

Example 1: Figure 53 illustrates a 16-foot, 24-inch log with stump rot averaging 14 inches in diameter. Visible swelling in the log indicates total length is 6 feet. Because of the cone shape of stump rot, not all of the 6-foot portion is lost. At the point where the rot penetrates deepest, the log will not produce longer than 10-foot lumber, but along the sides of the rot cone within the scaling cylinder, it should produce 12- and possibly some 14-foot lumber. Average the defect length. In this example use 4 feet as the average length. The squared-defect method (code 22.4) gives 15 x 15=225 + 10 raised to the next 10=240 (24 Decimal), the deduction if the defect extended 16 feet. The average length, however, is 4 feet, $\frac{1}{4}$ the length of the log, or a deduction of 6.

Example 2: Figure 54 illustrates a 16-foot, 18-inch log with stump rot averaging 16 inches in diameter. The size of this defect is so large as to approach the diameter of the scaling cylinder and calls for a length deduction. In the type of stump rot illustrated, a 4-foot-length cut should equal the loss from rot. The difference in scale between a log 12 feet in length and 18 inches in diameter and one 16 feet is 5, the proper deduction for this log.

Stain. Stain normally affects quality of lumber recovery rather than quantity. Generally stains are blue or brown. No deduction is made when the stain is firm and light in color, but deduction is made when stain is associated with actual rot and there is a breakdown of the wood. When to make a deduction for stain in some species is difficult to know. Examine dark stain for rot, weather checks, or wormholes. Brown spots are generally an indication of actual rot. See Rot, Sap.

Earlier stages of actual breakdown of wood can be determined frequently by driving the corner of a sharp handax bit, or Hallin hammer, into the end of a log and twisting. If fibers break across, the wood is weakened. Fibers of firm sound wood will cut clean and pull straight out rather than tear or break across.

The significance of mineral stain and firm blackheart varies in different areas. Become familiar with any local guides concerning these indicators.

Sweep. Sweep compared with crook is less abrupt and more continuous. Sweep is often long enough to affect more than one segment. Varying the bucking *-lengths of logs will often reduce the loss due to sweep. Report poor bucking practices to the District Ranger. Scalers will deduct for sweep in logs by scaling as -* presented unless otherwise instructed (code 17.5).

Make deductions for sweep as follows:

1. Measure the length of the log affected by sweep.

2. Deduct the fraction of this length lost in sawing, considering standard length lumber recovery.

3. Make a length deduction accordingly.

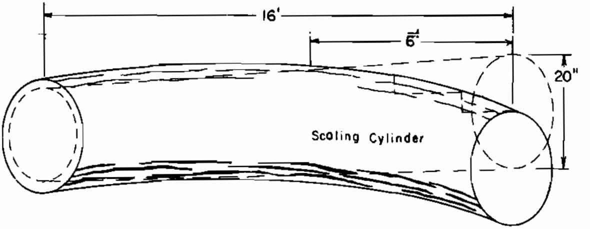


Figure 55. -Sweep.

Figure 55 illustrates a 16-foot, 20-inch log with sweep affecting 6 feet of the scaling cylinder. It is estimated that one-third of the affected area will be lost in sawing. In this case a 2-foot-length deduction is made.

An alternative or "Grosenbaugh empirical formula" method to deduct for sweep (table VII in appendix) may be used in eastern Regions when authorized by the Regional Forester. It is also useful as a check on the application of the other method, when calculations are recorded, or when speed is not required in scaling.

$$\text{(Cull) Percent} \quad \frac{\text{Maximum departure minus 1 inch for each 8 feet in length}}{\text{Diameter}}$$

Example: Figure 56 shows a 20-inch log, 16 feet long, with sweep. Imagine a straight line drawn between the centers of the ends of the log, like a bowstring. The true center of the log, like a bow, bends away from this line a maximum of 5 inches. (Except for logs with butt swell, a close approximation can be gained from a measurement along the sides, as shown.) Deduct 2 inches from the 5 inches, leaving 3 inches. Divide the 3 inches by the diameter of the log (20 inches). The answer is a 15-percent deduction from the gross scale (28) of the log. This is approximately 4.

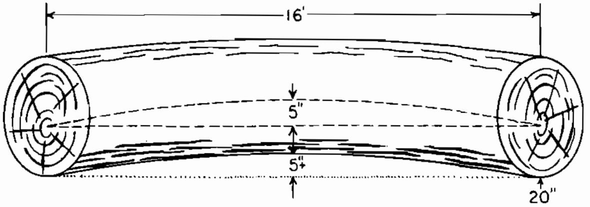


Figure 56. -Alternative method of calculating sweep deduction.

Sweep in combination with an interior defect such as rot or shake is likely to cause a cull log (fig. 57).

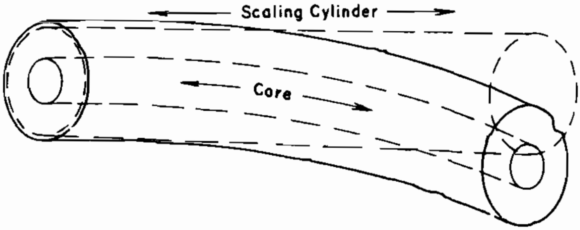


Figure 57. -Sweep in combination with shake.

Wormholes. Wormholes are classed as pin size, not over 1/16 inch in diameter; small, not over $\frac{1}{4}$ inch in diameter; and large, over $\frac{1}{4}$ inch in diameter. Pin and small wormholes are caused by different kinds of beetles; large wormholes by wood borers or grubs. Wormholes are common in logs cut from snags and in some down timber. When found in sap rot, the deduction for rot will also include any deduction for wormholes. When found in connection with catfaces and fire and lightning scars, include wormholes in the measurements of those defects.

Make deductions only for large (grub) wormholes when they are massed and this condition causes an actual loss of volume. Generally use the pie-cut deduction method (fig. 58). The diameter-deduction method may occasionally be applied when wormholes are uniformly distributed around the log.

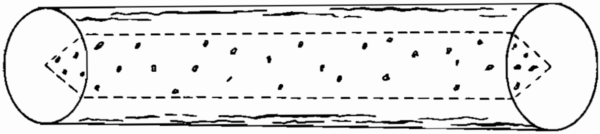


Figure 58. -Grubworm holes-pie-cut method.

CHAPTER 40 SPECIAL SCALING PROBLEMS

*- 41 Logs Not Meeting Utilization Specificiations

41.1 Because of Defect

Cull logs are logs which do not meet utilization standards for net scale as a percent of gross scale under the terms of the contract. Such logs may or may not contain some merchantable material. Usually the removal of cull logs from the sale area is by the option of the purchaser. If cull logs are removed as a product specified in the contract, record the log as a cull and show the gross scale in the defect column (code 55.63). If cull logs are being removed from the sale area as a product not specified in the contract, inform the District Ranger. In such cases, the product, shall be appraised, rates established, and instructions to the scaler (ex. 1, code 55.5) revised.

41.2 Chunks, Slabs, and Small Logs.

1. A chunk is a piece of wood in log form which measures less than the contract minimum length. Chunks may originate from long butting, bucking out defects, failure to vary log length, or breakage. When chunks result from purchasers' carelessness -*

*-or waste of what would have been standard material, as determined by the Forest Service representative for the sale, chunks may be scaled. Some timber sale contracts provide that products removed which do not meet the utilization standards because of size or net scale will be paid for at the same rates as standard timber. Therefore, under this type of contract if a chunk is not cull because of defect, it will be scaled if it is removed from the sale area. Also see code 42.

2. Slabs are portions of logs created when a log splits lengthwise. The preceding statements about chunks also apply to the treatment of slabs.

3. Scale slabs and chunks in the same manner as other logs. When slabs approximate one-half the original log, determine the gross volume as one-half the volume of a full log with the same dimensions. If pieces are not round, take square or rectangular measurements and determine the volume in the same manner as defect volumes are obtained by use of Coconino-scale stick or shortcut procedure (code 22). Deduct for any remaining defect.

4. Logs with top diameters smaller than the contract minimum will be measured at the top diameter specified in the contract when there would be a volume loss if scaled as presented. See also code 17.5. An exception to this would be when timber sale contracts provided for the scaling of material which has a diameter smaller than the contract minimum and is to be converted to board feet measure. In such cases, the Regional Forester will issue special instructions and approved volume tables.

5. Except for utilization scaling in the woods (code 42) the minimum volume that will be recorded for any piece is 10 board feet, or 1 decimal C., unless otherwise specified by the timber sale contract. -*

42 Utilization Scales
(See also code 17.5)

*- Timber sale contracts provide for the greatest practicable utilization of the included timber. Product specifications normally include minimum length, diameter, and net board feet. When material meeting the product specifications has been left in the woods, the Forest Service representative should promptly notify the purchaser in writing either to remove the material or, if the volume is not excessive and payment in lieu of removal is provided in the contract, that unless this material is removed by a certain date a utilization scale will be made of this unutilized volume. The scale should also include sound material wasted in tops, chunks not fully utilized, and excessive sound material left in long butts. Good judgment in determining the material to be scaled is needed.

Make utilization scales in cutover areas during or as soon after logging as practical. Timber sale men with scaling certification should make these utilization scales to prevent later controversy.

Paint utilizable material to help identify it for removal. Scale this material at the time it is painted and stamped. These logs should not then be rescaled when they later pass the scaling station. Mark cull logs "Cull" or "C" with crayon or paint and stamp "US" on both ends. When only one segment of a long log is culled, mark that end "Cull" and show the length. For example, on a 32-foot log with only one segment culled, show as "Cull/16."

Some examples of poor utilization are:

1. A cull log under the terms of the sale agreement due to defect, which would have met contract specifications if the end containing the major portion of the defect had been cut off (fig. 59). -*

*-

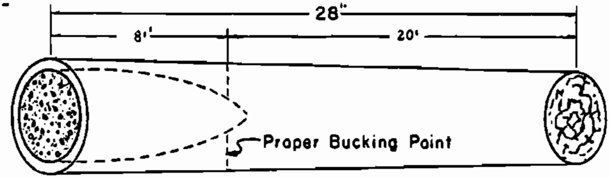


Figure 59. -Improperly bucked long log.

2. A log left in the woods because its top diameter is smaller than the sale-contract minimum, although it would equal minimum specifications if cut shorter.

3. Excessive sound material showing on one end of a defective log which, if properly bucked, should have been included on the adjacent log.

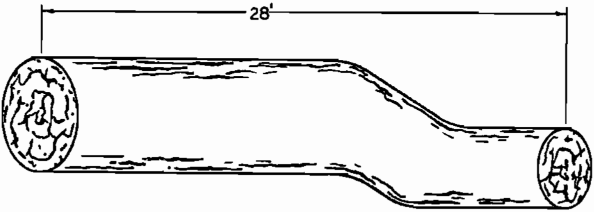


Figure 60. -Improper bucking.

4. Sound material wasted in bucking-out defects, breaks, or crooks which could have been utilized if bucking had been done correctly (fig. 60).

5. Tree not bucked so as to avoid excessive sweep deduction.

6. Material with a larger diameter than the minimum left in a top when proper bucking would have included this material in the adjacent log. -*

7. Improper long butting. Long butts should only
-include material which would be cull by itself because-
of defect. Since stump rot usually tapers to a point, long-butting becomes excessive when it attempts to eliminate all the stump rot. -*

8. Defective material that contains at least one-third or one-half scale, depending on the contract minimum.

9. High stumps.

A timber sale officer needs the following to make utilization scales in the woods: A scale stick or calipers for measuring diameters and for volumes; a 50-foot tape for measuring lengths; a 6-foot steel tape for measuring diameters in difficult places; a can of paint for marking unutilized material and culls; a Hallin hammer or equivalent; and a scalebook. He should completely cover the cutover areas.

Scale, stamp, and number as in a regular scale all material in a utilization scale. Record the volume of this material by location under a separate heading marked "Utilization scale." Report such scale on cutting reports marked as above and fully explain under "Remarks."

In adjustment-factor scaling, such material as
*-previously described, which would be utilization scaled, should be considered utilizable even when wrongly bucked.

It is the responsibility of the contractor to comply with the contract and vary log lengths to utilize the tree fully. When excessive waste occurs, a utilization scale will be made of all material wasted in tops, long butts, breaks, or otherwise not utilized. Unless the contract provides otherwise, a minimum volume of 10 board feet (1 Decimal) will be charged per piece, since the length and scale of the original segment had been reduced by an unknown amount. -*

Scalers make a utilization scale when (1) they are instructed by the District Ranger to scale improperly bucked logs to obtain the greatest practicable utilization (code 17.5), and (2) they scale logs with excessive trim allowance to the next foot in length (code 17.2) They should identify such logs by marking an "X" or some other symbol in the scalebook log-number column opposite the log scaled. Prior notification of a purchaser is desirable but is not always necessary. However, the purchaser should be informed of this standard procedure. Also see code 31.

43 Scaling Debarked Logs

In some situations, logs can be presented for scaling after the bark has been removed. This may present the following problems:

1. Reduction in the scaling diameter, if any, by mechanical debarking and loss of wood fibers. This is generally no problem with hydraulic barkers. A volume-adjustment factor might be agreed upon if a study showed loss in scaling volume after debarking. Also see code 17.5.
2. Destruction of defect side indicators. This is more than compensated for by the removal of slime and dirt in the debarking process. Also the mill deck cutoff saw provides fresh end cuts.
3. Removal of species indicators, especially where large price differentials exist between species. This may be offset by arranging to paint or brand the species on the log ends before debarking or by presorting logs by species.
4. Removal of brand indicators. Procedures are similar to those outlined above.

In summary, there may be problems but also good reasons to accept debarked log scaling if proper precautions are taken to identifv species and ownership.

44 Stump Scaling

Stump scales are made when logs are removed from the woods before being scaled and cannot be later scaled, as is often the case in timber trespass cases. Following is the suggested procedure for obtaining volume.

1. Locate the top of the tree and measure the diameter at the point where the last log was bucked.

2. Measure the distance from the stump end to the top and convert this distance to number of logs. Consider trim. Holes in the ground often help to locate where the butt rested; sawdust helps to show the length of logs.

3. Measure the stump diameter; stamp and number the stump. Establish the d. b. h. (diameter breast high) from this measurement by comparison with adjacent trees or tested tables. Consider numbering with aluminum tag.

4. Obtain d. i. b. (diameter inside bark) at the top of the first 16-foot log by use of d. b. h. and average form class for stand. Volume tables based on d. b. h. and number of logs are sometimes used.

5. By use of local taper tables, establish the diameter of all the logs obtained in step 2.

6. Record length and diameters of these logs, identified by the stump number. Consider trim. Make deductions for defect on the basis of what you see in the stump, top, or any cull logs left. Record lengths according to the common bucking practice for the area.

<u>Example:</u> (16-foot maximum scaling length.)
Top diameter-8 inches.
Distance from stump end to top-86 feet.
Number of logs-four 16-foot, one 10-foot, and one 8-foot log.
Stump diameter-30 inches; d. b. h. 26 inches.
Average form class-80; 80 percent of 26 inches = 21 inches d. i. b. at top of first 16-foot log.
Taper from 8-inch top to 21 inches (diameter of first log) is 13 inches. This provides the following diameters for all logs: 21, 19, 16, 13, 11, and 8 inches.
Record-16-21, 16-19, 16-16, 16-13, 10-11, and 8-8, with a total scale of 85.

7. Number and stamp "US" on each stump and top to indicate that logs have been scaled.

When it is difficult to locate tops, volume can be obtained by use of local tables showing relationship of stump diameter to d. b. h. and stand height.

44.1 Timber Trespass

Procedure under timber trespass is the same as in code 44 with this exception; deduct for defect using the best data available for like timber.

Merchantable volume left in tops, in high stumps, and in unused logs is scaled and recorded separately. Stamp "US" on each stump and top, and number each for future identification.

Where the top cannot be identified, reduce the stump diameter to d.b.h. Obtain the scale by applying the d.b.h. and estimated height to the best volume table for the locality and species. When heights can be checked on trees bordering the cutting, this procedure may be used in place of the stump scale outlined in code 44, if the results are judged more accurate.

Use extreme care in scaling trespass timber, especially by a stump scale, and keep complete accounts and legible notes of the method used. This information may be needed as legal evidence in court.

*-44.2 Scaling When Stumps and Other Direct Evidence Is Lacking

If a trespass, or other unauthorized cutting, is discovered after the stumps have been disturbed by clearing, site preparation, or similar activities, indirect methods must be used to determine actual volume. In some cases, cruise or compartment examination data will be available for the area. If so, it should be used to the extent possible. The usual situation, however, will be that there is no existing data for the area. The approved method for determining volume will be a cruise on similar timber using the most recent aerial photos of the cut timber as a basis for selecting a similar stand. Other stand attributes, such as species distribution, elevation, aspect, and site index should be as close as possible to the cut timber. The selected stand should then be cruised using approved Regional standards for tree-measurement sales. -*

45 Special Sectional Problems

Special sectional problems such as scaling sinkers, jackpots, etc., which have minor general significance in the scaling of National Forest timber will be included in Regional supplements.

CHAPTER 50 GENERAL SCALING REQUIREMENTS

51 Selection of Places for Scaling

The District Ranger is responsible for selection of scaling locations. Determination of the scaling location shall consider (1) the need for proper scale under safe working conditions with minimum expense to the Government and the purchaser, and (2) adequate provisions for check scaling. Scaling on mill decks or in other locations where conditions for adequate check scaling are questionable should only be provided when formally requested by the purchaser and approved by the Regional Forester.

Practice economy in scaling insofar as possible, but remember that losses from poor scaling caused by inadequate tools, platforms, or training can quickly exceed apparent savings. Consider in advance the most desirable scaling plan in large sales and make provisions for it in the sale contract. In small sales the frequency of scaling must be adapted to reasonable requirements.

Consider the following when selecting truck-scaling locations:

1. Safe location off main highways. Insure sufficient "tail" space for all trucks during peak periods. Provide areas of adequate width and length for scaling.
2. Possibility of future timber sales requiring a site closer to a mill.
3. Length of use and future need of station (portable or permanent station).
4. Present and potential volume to move through the station.
5. Number of scalers needed to handle the workload.

52 Safety in Scaling

The varied hazards present in all types of scaling require the scaler to be safety minded at all times. FSH 6109.13, Health and Safety Code, provides information on good safety practices to follow in all types of scaling. Each scaler should have a copy of that handbook at his station.

Forests should provide properly located and designed scaling platforms, with ladders and swing or drop planks at all truck-scaling stations. They should require adequate lighting on scaling stations and on mill decks.

Following is a partial list of safety rules for scalers:

1. Do not jump off loads to the ground or platform.
2. Place signs strategically at each station requiring truck driver to stop motor, set brakes, and not to tighten or move binders during the scaling. Maintain these signs in readable and effective condition. (paper signs, form 0-80, are available from Central Supply.)
3. Do not scale while binders are being moved or when logs are unsafely loaded or do not have binders on them. Hold up the load until the hazard is removed. A purchaser is obligated by terms of the contract to provide safe scaling conditions.
4. Wear suitable clothing for the job, including hardhat and rubber-calked boots or crepe-soled shoes for walking on logs.
5. Do not walk between logs in the woods or on a mill deck.
6. Measure log lengths from the uphill side of the log.
7. Watch for snags and "widowmakers" at or near landings.
8. Do not stand close to a tractor while it is dropping a load of logs.
9. Stand clear of flying chokers when a tractor pulls out of a landing.

10. Require poles and saplings to be pulled out of the landing immediately. They are easily snagged in chokers and are hazardous.

11. Keep clear of the loading area while trucks are being loaded. Watch for pulled hooks.

53 Requirements of Purchaser

Purchasers may be required to present, assemble, or hold logs for scaling in the manner prescribed by the Forest Service. Special requirements are usually covered by the sale contract. Methods of scaling should consider safety, efficiency of scaling, provisions for check scales, and the operating needs of the purchaser.

When timber is cut on both Government and private lands, purchasers must keep logs separated up to the point of scaling, or they must put a specified, distinctive mark on logs from private lands. Unbranded logs will be considered as Government logs chargeable at the highest contract price unless acceptable proof to the contrary is presented. Logs from different Government sales should also have a distinctive stamp or brand. These requirements are often necessary to enable scalers to distinguish between logs from different sale areas. This is especially important if different prices apply to the same species in those sales.

54 Scaler Qualifications and Proficiency Requirements

54.1 General

In many areas the scaler makes the final determination of volume of National Forest products removed from sale areas. He must be trained, equipped with good tools, and have the ability and skill to measure length and diameters systematically and accurately. He must be able to detect defect and use skill and good judgment in making deductions and in other phases of the job. He must properly identify species because of the different stumpage values involved.

A scaler's accuracy is determined by check scale. Specific standards for satisfactory scaling are established. These are listed in FSM 2443.54 and in code 64 of this handbook. Any check scale showing unsatisfactory scaling by a scaler indicates the need of corrective action. This is the responsibility of the District Ranger.

The ability of a scaler to identify logs by species is extremely important. Wide differences in value result in variations in merchantability specifications by species. Species identity should be determined by bark characteristics, color and amount of sapwood and heartwood, presence of pitch, and the size and distribution of knots.

54.2 Mill Visits To Develop Judgment

A proficient scaler must know how defects extend into logs and must keep that knowledge current. The best way for him to acquire skill and judgment in making defect deductions is to see defective logs opened on the saw carriage and note the losses caused by various defects.

In a mill visit the scaler should concern himself primarily with peculiarities of defects in timber from certain localities, and not quality, just as he avoids scaling to include certain grades of lumber and exclude other grades.

Defect in timber changes with localities, sites, and species. Thus, the scaler should make scheduled periodic mill visits to observe sawing of logs similar to those he must scale. By this means he can correctly maintain his judgment and proficiency.

Mill visits should be considered part of the routine of the scaler's initial and followup training.

Benefits received from mill visits are many. There are no rigid guides to fit all conditions, but the following guides will make the scaler's visits more beneficial:

1. A new scaler should spend the equivalent of a full day at a reasonably efficient mill. A mill cutting timber similar to the kind the scaler will scale is preferable. An experienced scaler of demonstrated proficiency and training ability should accompany him.

2. Choose periods when the species desired is being cut.

3. Become acquainted with the mill foreman and pondman.

4. Request permission to select logs in the pond with a variety of defects.

5. Request that these be sent into the mill interspersed with other logs.

6. Scale these logs as facilities permit, using approved deduction methods.

7. Observe cutting and give particular attention to the depth to which defect penetrates into the scaling cylinder. Try to determine (1) if any logs scaled as culls contain the contract minimum amount of sound material, (2) if any logs scaled as merchantable were actually culls, and (3) bucking practices for long and/or defective logs.

8. Where possible follow boards from some logs through the edger and trimmer to the green chain. Observe any volume loss that may occur at these points. Note any deductible material remaining in the low-grade lumber. Likewise note any volume loss of merchantable material trimmed to increase grade.

9. Visit planer to observe final stage in lumber production.

10. Make periodic return visits to mill when breaks in scaling permit.

55 Scaling Equipment

55.1 General

All scaling equipment must be kept serviceable and safe to use.

55.2 Scale Sticks

The most important piece of equipment used by a scaler is a scale stick. This is used for measuring diameters, lengths, and the dimensions of defects and for determining the scale. Scale sticks recommended for scaling National Forest logs and their advantages are as follows:

1. Coconino.

a. This is the most convenient to use of all scale sticks. Its principal faces are marked with lines at the $\frac{1}{2}$-inch locations. This arrangement helps in measuring diameters to the nearest inch. Board-foot volumes (Scribner Decimal C rule) are also marked on the principal faces.

b. Squared-defect figures (shown in smaller, red figures adjacent to the volume figures) are useful for quick defect deductions. They are especially useful for scaling long logs as two or more segments where tapered defect is involved.

2. Faulkner. This scale stick has one side and and two edges identical with the Coconino-scale stick. The usual 6-, 8-, 10-foot side, however, is marked for scaling 32-foot logs with 2-, 3-, and 4-inch taper. Volumes for such logs are shown directly on the scale stock. Use this stick where a large percentage of logs is 32 feet long.

Both the Coconino- and Faulkner-scale sticks are available either with the T-head or with spud, in 3- and 4-foot lengths. The Coconino form marked according to the Forest Service International $\frac{1}{4}$-Inch Decimal rule is available.

Other types of scale sticks are in use, but those mentioned above are considered better because of the advantages listed. All scale sticks should receive the care and maintenance given an important piece of equipment. Figures on the scale stick must be kept legible. Dirty or pitch-covered scale sticks should be cleaned by use of solvent. If this does not work, the faces may be quickly renewed by scraping the stick lightly with a paint scraper and then applying plastic or durable lacquer finish to protect the stick. Keep it clean by wiping with a kerosene-soaked rag, or by using waterless hand cleaners.

55.3 Hallin Hammer

Another piece of necessary equipment is a Hallin-type hammer. One end of this hammer forms a "US" brand for log stamping. The other end consists of a sharp edge called a spud. Scalers should use this spud, or an equivalent device to locate and identify defect in the ends and sides of logs. Its use is essential on logs with ends that are muddy, dusty, caked over, casehardened from exposure to the hot sun, or discolored, and for locating rotten knots, conks, and other exterior defects. It can be carried in a leather case attached to the belt so that the hands are free. An ax or hatchet may be substituted in some areas.

55.4 Other Equipment (Except Scalebook and Scaler's Information Form)

For woods scaling where most logs after being bucked remain in tree position, calipers are used. These may be of the sliding-finger-on-a-bar type or the "ice-tongs" type known as Coeur d'Alene calipers.

For accurate length measurements and for checking trim allowances, a 50-foot steel tape with end hook should be carried.

On trucks or in decks, certain logs because of their position cannot be measured with a scale stick. A 6-foot-or-longer steel-tape rule makes accurate diameter measurements possible and should always be provided scalers facing these problems.

In all types of scaling, a scalebook or scalesheets for recording log length, diameter, net scale, and defect is standard equipment.

A hardhat for head protection is a good safety precaution and is essential in many locations.

Scaling platforms are an essential part of a scaler's equipment for truck scaling. Their use provides easy and safe access to and from loads and a reliable method for measuring log lengths. (Inscribe 2-foot marks on the platform, both ways from center.) Portable platforms, made of either lumber or prefabricated steel, are serviceable.

A copy of this handbook, keel, pencil and holders, adding machine, Pitch and Shake Ring Deduction Chart, and a copy of FSH 6109.13, Health and Safety Code, should be available.

Well-lighted office facilities with heat where necessary should be provided.

55.5 Scaler's Information Form

Each region shall provide a standard form for informing scalers of contract scaling requirements for each sale. Complete these forms prior to the need for scaling. Scalers should keep them at their scaling stations for handy references. A sample of this form (exhibit 1) follows on page 90.

55.6 Scalebooks and Scalesheets

- 55.61 Standard Types. The Regional Forester is authorized to issue standard scaling forms and instructions for recording log measurements and scale extensions. The following instructions illustrate the use of a typical scalesheet which is to be compiled manually. Regional instructions may modify these instructions. Since automatic data processing may be used to compile scale data, it is important that the scaler follow instructions. -

Exhibit 1

SCALER'S INFORMATION FORM

Complete and give to scaler for each sale on which he works.

SALE DESIGNATION:

________________ ________________FOREST

________________ ________________DISTRICT

________________ ________________Date

Contract logger:_____ Coop. Scaling Agreement No. ________

____

SPECIFICATIONS

Minimum scaling length ________________
Minimum scaling diameter ________________
Net scale in % of gross ________________
Minimum net scale ________________
Maximum scaling length ________________

MAXIMUM TRIM:

Log numbering required: Yes______ No______.
Log removal permit required: Yes______ No______.
Log branding required: Yes_____ No____ Brand___.
Number of carbon copies of scale required:_______.
Truck tickets required: Yes_______ No______.
Daily time report: Yes___ No__ Daily record of volume scaled: Yes _____ No_______.
Daily summary of volume by species for operator: Yes_________ No________.
Maximum overtime authorization is ______ hours per pay period.

LOGS UNMERCHANTABLE DUE TO SIZE SHALL BE SCALED AND PAID FOR IF REMOVED.
FIRM BLUESTAIN IS NOT A DEFECT.
UNMARKED LOGS PRESENTED FOR SCALING SHALL BE SCALED AS NATIONAL FOREST LOGS. AT HIGHEST RATE FOR SPECIES ON SALES YOU SCALE FOR THE SAME PURCHASER.

SCALEBOOKS ARE AN OFFICIAL RECORD AND MUST BE KEPT NEAT, ACCURATE, AND SECURE.

KNOW YOUR SAFETY RULES
WORK SAFELY AT ALL TIMES

Prepared by ______________

Approved by ______________

55.62 Accountability. Regional Foresters issue instructions for scalebook accountability, and for the place and system of storage for completed books and series numbered scalesheets. Keep these records for the required number of years after the sale is closed.

55.63 Recording.

1. Enter scale records directly into one of the approved scalebooks or on approved scalesheets. Regional Foresters may approve recording in temporary scalebooks in unusual circumstances. These may be in cases when to do otherwise might greatly increase costs or seriously inconvenience the purchaser. Transfer such temporary scale records to the regular scalebook as soon as practicable. Then permanently attach the record to the book page on which the entries are made.

Scalebook records are a written proof of a scaler's job qualifications. These records are viewed by his supervisor and checked by auditors. Practice care in maintaining these records. Accuracy is a "must" in:

a. Recording the correct species.
b. Extending scale.
c. Adding scalebook pages or looseleaf sheets.
d. Posting to journal pages.
e. Adding journal pages.
f. Transferring totals from one book or sheet to another.

Advance payments for stumpage are required in timber sales. Errors might require an unnecessary payment or might result in an underpayment. Scalers must help prevent such situations by being accurate in their recordkeeping.

Well-written figures free from pitch and dirt reduce errors and make the job of auditing easier and quicker. Protect the book when scaling. Fill in all required spaces. This helps remove doubt as to the correct scale and assists in auditing.

2. Forest Service scaling requires a full record or written picture of each log scaled. Scalebooks and scalesheets provide space for recording lengths, diameters, net scale, and defect (amount and kind).

Record length and diameter first in scaling. Record the amount and kind of defect and the net scale. The net scale and defect volume total must equal the gross scale of the log.

It is a good practice to record log lengths specifically checked for trim in even feet and inches; viz, 16'6", 20'7", 32'16", 34'0". Extensions would show the scale of a 16' log, a 21' log, a 33' log, and a 33' log, if the trimming allowance is 6'.

Forest Service scaling requires the recording of diameters in all types of scaling. However, in certain mill-deck scaling locations the speed of the operation makes this impracticable. Also, logs here are immediately cut up and diameters serve no useful purpose for check scaling. In certain specific locations, Regional Foresters may waive the requirement for recording diameters. Each such waiver shall be documented in the sale folder. Use the scaler's information form to inform him.

3. The use of volumes based on taper provides an accurate and convenient way to record long logs in one entry. See table III in the appendix, showing volumes (Decimal C) for long logs scaled on 20-foot-maximum scaling length basis. The use of taper volumes on the Faulkner-scale stick permits the same, but for 32-foot logs only. Scalers should record logs so that a check scaler can reconstruct his work without guessing. In scaling logs longer than the maximum scaling length, the top diameter, length, taper, and defect affect the correct scale.

Following are methods for recording long logs:

a. Record measurements for the long log. Add the net scale for each segment and record the sum as one log.

b. Record measurements for the long log. Read the total scale in cubic feet directly from table XIV in the appendix and record as one log.

c. Record separately the measurements of each segment of a long log. Enter brackets or tick marks in the left-hand margin to identify the long log. Record scale for each segment.

4. A good practice to insure that correct diameters based on taper are used is to record both end measurements. Use the trial entry column in Scalebooks, forms 2400-33 and 2400-30, for these. On other books use a slash mark in the diameter column to provide space for both diameters. For butt logs, use an "X", or similar symbol, for the stump end.

A reminder to make deductions on defective logs: As soon as defect is seen in a log, record the symbol (code 32) in the defect column.

5. Record cull logs by "cull" in the species column and the gross amount and symbol in the defect column.

Where cull logs are sold at a separate stumpage price, record their scale in a special column headed "Cull."

6. Forest officers are cautioned about confusing board feet with tens of board feet. A volume total of 156,780 feet is recorded as 156.78 Mb.m. Make sure the decimal point is properly located.

7. To record scale in the proper species column, if the species is other than the one usually shown in the first column (as pine), the following method has proved helpful:

Place a dash in, or draw a line through, the unused column(s) over to the correct species column. Record the scale in the column at the end of the drawn line. See exhibits 2 and 3 in this code.

Exhibit 2

Long Logs Recorded as 1 Log (20-foot maximum length basis)

Log No.	Lgth.	Diam.	Species					Defect amount and kind
			P	D	W	A	C	
1	32	20 / 16	35	----	----	----	----	2 Cr
2	32	X / 25	----	89	----	----	----	12 FS
3	20	12 / 10	----	----	7	----	----	
4	36	15 / 10	----	----	----	12	----	5 CF
5	24	24 / 20	----	46	----	----	----	
6	42	X / 18	----	64	----	----	----	
7	42	16 / 11	----	----	25	----	----	

Exhibit 3

Long Logs Recorded by Segments (optional) (16-foot maximum scaling length)

Log No.	Lgth.	Diam.	Species					Defect amount and kind
			P	D	W	A	C	
[1	16	13	8	----	----	----	----	2 R
[2	16	15	14	----	----	----	----	
3	12	12	------	----	6	----	----	
[4	14	18	------	----	----	16	----	3 Bk
[5	16	20	------	----	----	24	----	4 R, FS
[6	16	12	5	----	----	----	----	3 R
[7	16	14	cull	----	----	----	----	11 R
[8	8	10	------	----	----	----	3	
[9	10	12	------	----	----	----	4	1 Bk
10	16	14	------	----	9	----	----	2 Sh

Brackets show segments of long logs. See code 32 for list of optional standard defect symbols.

55.64 Checking Scalebooks. A check of log extensions means a check of the net log scale and the figures showing how it was derived. Check the gross scale minus defect against the net scale in accordance with Regional Forester's instruction.

Extension checks are generally the responsibility of the District Ranger, since his personnel are usually more familiar with the log rule. As in check scaling, they should be made more intensively for the scaler who has not established a reputation for accuracy.

Check all page totals 100 percent. Use adding machines for totaling the individual page columns. Identify the totals by writing the species and page number on the tape. Then check the figures on the tape against those in the book. Finally attach the tapes to the scalebook or scalesheets for audit.

55.65 Journal.

1. Forms are in the back of scalebooks for the scale and number of logs from individual pages. The scaler may use these, or a larger form may be kept at the office, to summarize information for cutting report preparation. Where looseleaf scalesheets are used, a looseleaf journal is recommended.

2. Check journal transfers and summary totals 100 percent. These totals are the final figures used in charging the purchaser for timber. They usually represent large volumes and large amounts of money. Item 3 describes one method for checking them.

3. After totaling the species volume columns in the journal, add all individual page totals, using an adding machine. Then check these totals against the grand totals in the journal. If these two sets of totals disagree, check the page totals on the tape against those transferred to the journal. Any errors will be quickly detected. Do the same for the number of logs.

56.1 General (FSM 2443.34)

56.2 Numbering and Stamping Logs.

56.21 Numbering. The numbering of all logs presented for scaling is desirable if time, size of logs, and conditions of scaling make the requirement practicable, and if subsequent identification is needed for accountability or check scaling. When logs are scaled in units of a carload, truckload, raft, etc., log-removal permits, truck tickets, or similar identification for accountability purposes may be acceptable in lieu of numbering, if separate scale reports are made for each unit, and if adequate check scales may be obtained by sampling such units. The need for numbering, or for other means of accountability, may be precluded when scaling under certain conditions, but the practice of numbering should be followed in all cases of stump or utilization scale. Specific requirements for numbering logs presented by the purchaser for scaling will be established by the Regional Forester.

56.22 Stamping. Forest Service scalers will normally stamp logs which they have scaled with the symbol "US" as evidence that the logs have been scaled and to assist in accountability control. Specific requirements will be established by the Regional Forester.

56.3 Accounting for National Forest Logs While Scaling

Piece-count checks are normally required in scaling National Forest logs to account for all logs leaving the woods. In truck, car, cold-deck, landing, and water scaling, make these checks while scaling. Scalers need a different system of checking for each of the various kinds of scaling.

When scaling on trucks or cars, count the logs on each load and check this against the number scaled and recorded. Make a log count after scaling each load just before releasing the truck or leaving the car.

In landing scaling, count the logs of each "turn" or pile before leaving it. In cold-deck scaling, periodically lay out the decks in a pattern; then scale, count, and check each log in the pattern.

CHAPTER 60 CHECK SCALING

61 Purpose

The purpose of check scaling is to make and keep accurate and uniform the scale of all National Forest timber. This is done by checking the scaler's work and determining sources of errors.

The check scaler should always keep in mind the need for additional training of the scaler and note his weaknesses if any. Does he need help in taking measurements, in defect detection and deductions, or in recording? Is he the wrong man for the job? Check scales can bring these things to light. They also provide information for taking steps to improve the scaling job. Systematic check scaling is a necessary part of timber sale administration.

62 Frequency

Standards for check scale frequency are difficult to set. However, the more frequent the check scales, the simpler it is to solve a situation that might result when they are unsatisfactory. A satisfactory check scale usually establishes as final the volume scaled to that date.

Minimum standards for check scaling are established by the Regional Forester with approval by the Chief. The following factors deserve consideration:

1. New scalers.

2. Volume scaled.

3. Result of last check.

4. Amount of defect. The more defective the timber, the more difficult the scaling job. Chances of error and variation in scale are more common. Make check scales more frequently in heavily defective timber.

5. Change in defect. Normally fewer checks are needed where sound timber is scaled. But if conditions vary and units of defective timber are presented, visit such scaling locations more frequently.

6. Variation in scaling load. The frequency of check scales should be increased when a scaler moves from a light-load station to a heavy-load station.

7. Changes in species. These may require more frequent training and checking until the scaler becomes familiar with appearances of defects and their effect in the new species.

63 Procedure

Check scaling should be done by the most experienced scalers. Regions should establish more than one check scaling position where the check scaling load is heavy. This provides a good opportunity for training scalers for Regional check scaler positions.

Most Forest Service Regions recognize two primary check scaler positions, (1) Forest and (2) Regional. More experienced scalers on a Ranger District often will need to check scale to meet the necessary frequency standards.

1. Forest Check Scaler. Normally held responsible by the Forest Supervisor for assisting Rangers in training and checking all men scaling on the forest.

2. Regional Check Scaler. Normally responsible for technical control for all scaling within a Region. He should conduct Regional scaler-training sessions, check scale to settle controversies, and check area and forest check scalers.

Check scale as far as practicable under conditions similar to those under which the original scale was made. Wherever possible, check soon after the original scale and without the scaler's knowledge. In mill deck scaling and often in truck scaling, it may be necessary to check scale at the time logs are scaled. Note any effort by the scaler to change his way of scaling. Usually any serious change can be detected.

Normally a check scale includes at least 200 short logs (16 to 20 feet and under) or at least 100 long logs. Sample the species and defect situation as fairly as possible. Individually analyze more complex scaling situations and increase the number of logs check scale if necessary.

If possible make check scales independent of the scaler, but when check scales are made with the scaler's knowledge, first put him at ease. Explain that Forest Service check scales are made to keep the scale of all logs accurate and uniform. When the comparison of figures shows the need, training should follow. Conscientious scalers will welcome check scales because of the help they provide.

When check scaling inexperienced scalers, compare results before leaving the area. Attempt to eliminate any weaknesses found. Note in the scalebook all important variances in measurements, defect deductions, and defect missed. Where logs checked are still available, return with the scaler and point out these variances to him. Be sure he is using proper methods of measurement and deduction.

64 Standards

The following standards are guides to satisfactory scaling:

Check scale percent of defect in logs checked	Standard
Up to 10	Within 2 percent of check scale.
11 to 20	Within 3 percent of check scale.
Over 20	Within 5 percent of check scale.

The comparative accuracy of individual scalers can be more closely ascertained by considering a variance of 1 percent in gross scale as the acceptable standard and allowing in net scale 0.2 (two-tenths) percent variance for each percent of defect up to a maximum of 5 percent total variance.

65 Records and Reports

Exhibits 1, 2, and 3 at the end of this code are samples of a check scale record book, summary, and supplement. The use of these will standardize check scale reports. Several Regions have similar forms in looseleaf booklets. The coverholder is slightly larger, with inside pockets on both sides. Sheets are "bound" in the cover with several rubberbands. The cover provides a firm base for recording and protects the sheets from pitch and dirt.

A check scale by species often becomes necessary, especially where check scales may form the basis of adjustments. A separate check scale summary sheet can be prepared for each species or price-group when necessary.

Exhibit 1

COMPARATIVE INDIVIDUAL LOG SCALE

____________ NATIONAL FOREST

SCALER ____________

INSPECTOR ____________

SPECIES AND LOG NO.	LENGTH		DIAMETER		DEFECT. KIND AMOUNT
	INSP.	SCALER	INSP.	SCALER	

TOTAL (THIS PAGE)	REMARKS:
TOTAL BROUGHT FORWARD	
GRAND TOTAL	

CHECK MADE WITH / WITHOUT (CROSS OUT ONE) KNOWLEDGE OF SCALER.

____

____

____

DATE ____________ PAGE __ OF __ PAGES

SOUND LOGS		DEFECTIVE LOGS			
NET SCALE		GROSS SCALE		NET SCALE	
INSP.	SCALER	INSP.	SCALER	INSP.	SCALER

Exhibit 2

CHECK SCALE SUMMARY

__________, California

Date __________

__________ NATIONAL FOREST

on __________, 19__ __________ (Name of Check Scaler) Check Scaled __________ (Name of Scaler)

__________ (Number) logs were checked at the __________ (landing) (cold deck) (mill deck) (on trucks) (other) The results follow

LOGS CHECKED WITH KNOWLEDGE OF SCALER

NUMBER AND CLASS	GROSS DEC. C				NET DEC. C			
	INSPECTOR	SCALER	DIFFERENCE	PERCENT	INSPECTOR	SCALER	DIFFERENCE	PERCENT
( ) Sound logs								
( ) Defective logs								
( ) Total logs								

Cull percent of logs check scaled equals $\frac{\text{Inspector Gross} - \text{Inspector Net}}{\text{Inspector Gross}}$ equals __________ %

LOGS CHECKED WITHOUT KNOWLEDGE OF SCALER

NUMBER AND CLASS	GROSS DEC. C				NET DEC. C			
	INSPECTOR	SCALER	DIFFERENCE	PERCENT	INSPECTOR	SCALER	DIFFERENCE	PERCENT
( ) Sound logs								
( ) Defective logs								
( ) Total logs								

Cull percent of logs check scaled equals $\frac{\text{Inspector Gross} - \text{Inspector Net}}{\text{Inspector Gross}}$ equals __________ %

Error Guide:

SOUND LOGS	1 %
TO 10 % DEFECTIVE	2 %
11 TO 20 % DEFECTIVE	3 %
OVER 20% DEFECTIVE	5 %

__________ (Signature)

__________ (Date)

(SEE ATTACHED SUPPLEMENT)

Exhibit 3

SUPPLEMENT TO CHECK SCALE SUMMARY
(IN-SERVICE ONLY)

________________ FOREST

NAME OF SCALER ________________________ DATE OF CHECK ________

CHECKED BY ______________________________________

1. ACCOMPANIED BY ________________________________
2. SCALER'S EXPERIENCE ____________________ SEASONS, MONTHS
3. DATE OF LAST FOREST CHECK SCALE ____________________
4. FOREST CHECK SCALES ARE/ARE NOT MEETING FREQUENCY STANDARDS ____________________________
5. SCALER HAS HAD __________ DAYS/HOURS IN SAWMILL THIS SEASON
6. UNSATISFACTORY CHECK DISCUSSED WITH:

   __________________________ __________________
   NAME TITLE

7. LOG ACCOUNTABILITY SATISFACTORY YES ______ NO ______
8. SAFETY: FACILITIES SATISFACTORY ____________________
   PROCEDURE SATISFACTORY ____________________
9. LOG BRANDING: YES ______ NO ______
10. LOG LENGTHS MEASURED: YES ______ NO ______
11. STAMPING SATISFACTORY: YES ______ NO ______
12. NUMBERING SATISFACTORY: YES ______ NO ______
13. TRAINING ______ DAYS THIS SEASON: IS TRAINING SUFFICIENT ______
14. TOLD RESULTS OF CHECK SCALES: ________________________

Explanation of unsatisfactory items and proposed remedies:

CHAPTER 70 USE OF INTERNATIONAL LOG RULES

71 Policy

Regulation S-15 authorizes use of the International $\frac{1}{4}$-Inch rule if specified in the timber sale contract and advertisement. The use of this rule generally results in a log scale more nearly equal to the lumber tally. This is particularly true if logs are sawed in an efficient mill.

The use of the Forest Service International $\frac{1}{4}$-Inch Decimal rule is also authorized under Regulation S-15, Administration of Sales.[1] This rule is applied the same as the International $\frac{1}{4}$-Inch rule. The principal difference is that volumes are rounded to the nearest 10 board feet. Regional Foresters may authorize the use of either of these log rules on any saw timber sale.

Use the same general scaling practices with these rules including defect deductions, as with the Scribner Decimal C rule. Differences in detail are explained below.

Table X in the appendix gives the board foot contents of logs 4 to 20 feet long based on the International $\frac{1}{4}$-Inch rule. Table XI in the appendix gives those based on the Forest Service International $\frac{1}{4}$-Inch Decimal rule.

72 Scaling Cylinder in International Rule

The International $\frac{1}{4}$-Inch rule is based on a formula applied to each 4-foot section of the log and an assumed taper of $\frac{1}{2}$ inch in each 4 feet (2 inches in 16 feet). Thus the International scaling cylinder differs from that used with the Scribner Decimal C rule. For practical purposes, assume that the scaling cylinder becomes a frustrum of a cone with a taper of 2 inches in 16 feet. See figures 61, 62, and 63 and compare them with figures 11, 12, and 13, code 18.

1/ By amendment of the Secretary, in Federal Register of Nov. 13, 1953 (36 CFR 221.15).

The International $\frac{1}{4}$-Inch rule considers a 1-inch collar for slab, as does Forest Service practice with

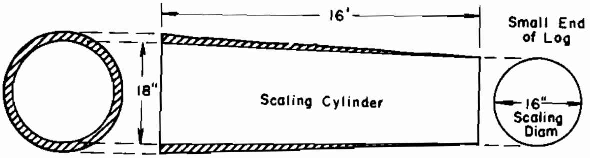


Figure 61. -Scaling cylinder for International rule.

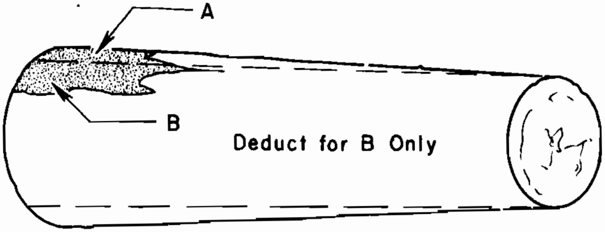


Figure 62. -Defect both inside and outside the scale cylinder.

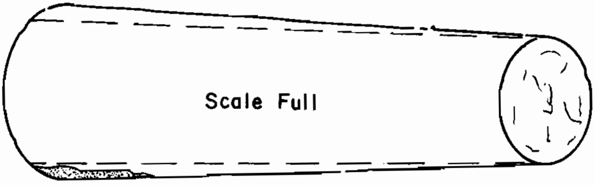


Figure 63. - Defect outside the scaling cylinder.

the Scribner Decimal C rule. For sap rot and similar side defects, use of the tapered scaling cylinder results in larger deductions in comparision to deductions by the Scribner rule with its nontapered scaling cylinder.

73 Mill Overrun

Normally where the International $\frac{1}{4}$-Inch rule is used, log scale will closely correspond to lumber tally. The rule considers a minimum board of 2 board feet. Inch lumber is considered if 3 inches wide by 8 feet long or any other combinations of dimensions making 2 board feet, down to 12 inches wide by 2 feet long. If a mill does not practice such good utilization, an underrun could result.

74 Log Lengths

In Forest Service scaling, logs as long as 20 feet are scaled as one log by the International $\frac{1}{4}$-Inch rule and the Forest Service International $\frac{1}{4}$-Inch Decimal rule; that is, if studies show that local timber does not greatly exceed the assumed taper of 2 inches in 16 feet. Where logs from 16 to 20 feet long average 3 inches or more taper in 16 feet, use the maximum scaling length of 16 feet. Where this condition exists, the timber sale contract should stipulate the maximum scaling length.

Example: With the International $\frac{1}{4}$-Inch rule, a 16-inch log, 20 feet long, scales 235 board feet. If this log has the taper assumed in the log rule, the large-end diameter is $18\frac{1}{2}$ inches. But if this log were typical and had a large-end diameter of 19 3/4 inches, there would be 3-inch taper in 16 feet.

To scale railroad ties cut $8\frac{1}{2}$ feet long, scale an $8\frac{1}{2}$-foot log as an 8-foot log unless the difference between the scale of an 8- and a 9-foot log is 10 board feet. If so, add 5 feet to the scale of the 8-foot log.

If the difference is 15 feet or more, add half the difference. But use the next lower 5 feet where half the difference does not fall on a 5-foot interval. (Half of 15 is $7\frac{1}{2}$; use 5.)

<u>Example 1:</u> Scale a 10-inch, $8\frac{1}{2}$-foot log as an 8-foot log, with 30 board feet.
<u>Example 2:</u> Scale a 15-inch, $8\frac{1}{2}$-foot log as an 8-foot log with 75 board feet, plus 5 feet (half the difference between the scale of an 8- and a 9-foot log), or 80 board feet.
<u>Example 3:</u> Scale a 17-inch, $8\frac{1}{2}$-foot log as an 8-foot log with 95 board feet plus 5 feet (half the difference between the scale of an 8- and a 9-foot log (15 feet) rounded down to the nearest 5 feet) or 100 board feet.

75 Defect Deductions

The International $\frac{1}{4}$-Inch rule and the Forest Service International $\frac{1}{4}$-Inch Decimal rule allow 1/16 inch for shrinkage in addition to the $\frac{1}{4}$ inch for saw kerf. The net effect is to give a squared-defect deduction formula almost identical to the "shortcut" one used with the Scribner rule. The basic formula is:

$$\frac{\text{Height in inches x width in inches x length in feet}}{16}$$

However, with the International $\frac{1}{4}$-Inch rule, round the product of height by width to the nearest 5; with the Forest Service International $\frac{1}{4}$-Inch Decimal rule, round to the nearest 10, above or below.

When defects extend all the way through a log, use their average dimensions. Do this because the International $\frac{1}{4}$-Inch rule is based on the use of short and narrow material.

For sap-rot and side-defect deductions, see discussion in code 72.

Also refer to tables XII and XIII in the appendix, showing defect allowances under the International

$\frac{1}{4}$-Inch log rule and the Forest Service International $\frac{1}{4}$-Inch Decimal log rule.

CHAPTER 80 OTHER FORMS OF MEASUREMENT

81 Cord Measure

81.1 Definitions

1. A cord is a unit of measure that expresses the volume of stacked wood. It differs from the board foot and cubic foot units because it is not a measure of the individual bolt or piece in terms of solid-wood content.
2. A standard cord is a pile of stacked wood measuring 8 feet long, 4 feet high, and 4 feet wide. The standard cord contains 128 cubic feet. The actual solid wood content is generally 100 cubic feet or less. Forest Service scalers will measure in terms of 128 cubic feet of stacked wood. Reduce the total cubic feet occupied to cords by dividing by 128.
3. A long cord contains a greater volume of wood than the standard cord. This unit measures 8 feet long and 4 feet high with a width greater than 4 feet. A long cord may consist of pieces that exceed 4 feet in length. Often a long cord is 8 feet by 4 feet by 5 feet. Pulpwood is often sold by this unit.
4. A short cord is a unit smaller than the standard cord and is usually used for fuelwood less than 4 feet long. For fuelwood, a rick is a pile 8 feet long, 4 feet high, and 1 foot wide, or 4 ricks per cord. Fuelwood cut to a 16-inch length will stack three ricks per cord.
5. The volume in cords may be calculated by measuring length, height, and width in feet and tenths, calculating the cubic volume and dividing by 128. The scale of 48-inch wood can be converted to any other length by applying converting factors listed below.

Length in inches	Percent of 48-inch scale
36	75
38	79
40	83
42	87
44	92
46	96
50	104
52	108
54	112
56	117
58	121
60	125

Example: Find the contents of a stack of wood 38 feet long, average height of 52 inches, and 40 inches wide which would be 5.11 cords if it were 48-inch wood. Multiply 5.11 by 0.83, the converting factor for 40-inch wood. Answer: 4.24 standard cords.

6. Regional Foresters may specify the use of other methods of cordwood measurement if better adapted to local conditions. In lieu of measuring of stacked wood, tree or sample tree measurement, weight, or other measurement may result in lower scaling cost without sacrifice in accuracy.

7. A sound cord contains only the merchantable pieces or bolts of a standard stacked cord. Merchantable pieces or bolts are defined in each timber sale permit or contract. Gross cubic foot measurement is reduced to net cubic measurement usually by applying the percentages of unmerchantable material. Since sound and net standard cord are synonymous, use of the term "sound cord" is largely obsolete. A cord of shingle bolts usually measures 8 feet by 4 feet by 4 1/3 feet.

8. "Rough wood" is the term used to designate wood with bark in contrast to smooth or peeled wood,

which is wood with the bark removed. Sales contracts are normally on a rough wood basis, and if measurements of peeled wood must be made, volume must be increased by an amount determined to be equitable for the material involved.

81.2 Measuring Stacked Wood

1. Measure stacks of wood accurately. Record length to the nearest foot, height to the nearest inch or tenth of foot. It is permissible to allow up to a maximum of 1 inch per foot of height to compensate for settling where long transportation to consumer is involved. The equitable settlement factor, if any, should be determined on the basis of documented tests, and not merely assumed.
2. If stacks are standing on slopes, measure the length parallel to the slope and the height at right angles to this plane. If end stakes are used here, obtain the length by measuring at a point half the distance between the top and bottom. Otherwise measure at enough places to obtain a fair average. Measure the height at several places to obtain the true average.
3. Check piece lengths sufficiently to make sure they do not regularly overrun those specified in the sale contract. If they do, follow the procedure outlined under code 42.

81.3 Stamping or Painting and Numbering

Regional Foresters may issue special instructions for stamping, painting, and numbering. Straight lines made with a paint gun are most effective. Household bluing in a paint gun produces a good mark that does not interfere with pulp production. Otherwise stamp or paint both ends and top of each stack. Number each stack. Enter the measurements and contents of each stack of each stack opposite its number in the scalebook. Indicate whether rough wood, hand peeled, or machine peeled.

81.4 Check Measurements

Minimum standards for check measurements are established by the Regional Forester with approval by the Washington Office. In the absence of specific Regional standards, make check measurements as instructed in Chapter 60, Check Scaling. Follow the same procedure as to frequency of checks, methods, reports, and action.

82 Cubic Foot Measurement

82.1 Definition

Cubic foot measurement is the measurement of volume in cubic units. National Forest timber sales will seldom use cubic foot measurement in log scaling. However, the following instructions may occasionally be helpful. An acceptable form of cubic-foot measurement is to convert cubic feet into cords by a suitable converting factor stipulated in the contract. Tree measurement or cruising may be greatly assisted by use of approved cubic volume tables.

82.2 Log Measurement Method

Take two measurements: (1) The average midpoint diameter of the log in inches inside the bark, and (2) total length in feet. Measure diameters as instructed in code 17.3. For accurate measurements, use calipers for diameters and a tape for lengths.

One way to obtain midpoint diameters is to measure both small and large log-end diameters and divide by 2. As with long logs (code 17.4), assign any odd inch of taper to the upper log (and increase the diameter of the lower log by the amount of taper in the top one). For butt logs, or where the method above is inconvenient, measure inside and outside bark at small end. Caliper the middiameter and add the taper measurement (from the outside bark measurements at the small end to the midpoint) to the diameter inside bark at the small end.

Round lengths to the nearest foot above or below the actual measurement. If the length is halfway between feet, record to the next lower foot.

> Examples: A log measures 32 feet 8 inches; record as 33. A log measures 32 feet 4 inches; record as 32. A log measures exactly 32 feet 6 inches; record as 32 . Measure pieces exceeding 40 feet in length as two logs; those exceeding 80 feet, as three logs; each in as equal lengths as possible. When pieces are measured as two or more logs, record the length, diameter, and volume of each segment separately. Enclose all segments of a piece in brackets or use tickmarks beneath the segment numbers designating the ends of the piece to show which segments make up one long log.

82.3 Defect Deduction

Make defect deductions in cubic feet in accordance with the general saw timber deduction methods for defects that reduce the cubic volume of the log. Deduct from the total log cubic volume the volume in cubic feet of unmerchantable material.

There is no allowance for saw kerf in cubic measurement. The 20-percent reduction used in board foot deductions with the Scribner rule does not apply. Thus the deductible volume by formula is (H" x W" x L')/144.

Following is a suggested way to apply this formula:

1. Always consider every defect as extending through a 12-foot log.

2. Convert the defect-height figure from inches to tenths of feet.

3. Multiply those tenths of feet by the width in inches for the defect extending through a 12-foot log.

4. Calculate the actual deduction in relation to the 12-foot length.

> Example: A log 24 feet long with a 14-inch diameter contains 26 cubic feet gross. Rot defect in this log measures 4 inches high x 9 inches wide. Four inches is equivalent to 0.3 feet. Multiply

0.3 x 9 2.7 or 3 cubic feet for a 12-foot length. If the defect extends into the log only 6 feet, the deduction then would be half of 3 or 1.5 or 2. For a defect extending into the log 18 feet, deduction is 1.5 x 3 or 5 cubic feet. The gross scale of 26 minus 5=21 cubic feet, the net volume of the log.

Unless the appraisal is based on lumber conversion make no deductions for sweep, shake, break, crotches, or knots. Deduct for unsound material affecting the merchantability of the end product of the sale upon which the appraisal was based.

82.4 Check Measurements

Refer to code 81.4.

83 Linear Measurements

83.1 Definition

Linear measurement involves the measurement of length only.

Posts, piling, fence poles, converter poles, telephone and power poles, hop poles, stulls, mine timbers, and lagging may be sold by the linear foot. Length and strength are often more important than the volume they contain. Timber sale contracts should specify the minimum length and diameter(s) of sticks classed as merchantable for each product. Contracts under which higher prices are charged for products cut from larger materials should set maximum lengths and diameters. For cedar poles and other products, the dimensions of material planned for each product should be specified.

Wherever necessary, similar specifications should cover the amount and kinds of defect admissible in products sold by the linear foot; also the character of the material considered merchantable for the purpose. This is especially important for valuable products like telephone and power poles, which often require the best grades of timber. Use Forest Service specifications when available. Otherwise, use current commercial specifications of associations of local pole dealers or other associations.

83.2 Measurement Method

Where pieces are cut in uniform standard lengths, make periodic measurements to check the bucker's work. When several products are cut in the same sale, make a similar current check of the diameter(s) of linear-foot material. Also check periodically when prices depend upon both diameter(s) and length.

The standard trim allowance for telephone poles is 1 inch for each 5 feet of length. Regional Foresters may authorize greater allowances for specific products if local conditions require such action. Make utilization measurements for lengths with excessive trim as outlined in code 17.2. Sale contracts should specify trimming allowances for other classes of material where advisable. Sale contracts also may specify the equivalent in board feet versus linear feet. This facilitates the use of a flat stumpage rate per board foot. As standard practice, however, it is preferable to require payment on a linear foot or piece basis.

83.3 Numbering and Stamping or Painting

Regional Foresters may establish procedures for numbering and stamping or painting. In the absence of Regional instructions, number each pile of material measured. Do this with posts, fence poles, hop poles, converter poles, lagging, and other material which is small and of low value. Enter the number of pieces in each pile and their linear-foot contents opposite the pile number in the scalebook. Number and stamp or paint large pieces equivalent in value to saw logs, such as telephone and power poles, piling, and stulls. Enter the length of each piece opposite its number in the scalebook.

83.4 Check Measurements

See code 81.4.

83.5 Combined Linear and Diameter Measurements

Sometimes top diameters as well as lengths affect the market value of products like telephone and power poles and stulls. Where this happens, use a schedule of stumpage rates for the various lengths and sizes. In such sales, accurately measure the diameter(s) of each piece. Average diameters to the nearest inch unless otherwise agreed upon. Number every piece and record it in a scalebook as with saw logs.

84 Counting

84.1 Procedure

Standard practice of the Forest Service is to count ties sold by the piece. Ties are also counted in sales where their board foot contents are specified in the sale contract. Where ties are scaled, follow the instructions under scaling. Count poles, posts, lagging, Christmas trees, etc., when sold by the piece.

Contract requirements should conform to the local market specifications of products concerned. Designate clearly by special contract clauses the maximum and minimum piece sizes to be counted rather than scaled. Include specifications as to defect or class of material necessary to establish precisely what timber is merchantable for those products.

84.2 Numbering and Stamping or Painting

Stamp or paint each piece of mine timbers, ties, posts, or poles counted. Painting helps identify the pieces counted. Christmas trees are usually counted and recorded by size classes.

Number each pile of material with crayon even though immediate removal is planned. Record number of pieces opposite the number of the pile in the scalebook.

84.3 Check Measurements

See code 81.4.

85 Sample Scaling

85.1 Introduction

Sample scaling is a practical method of final volume determination which should be considered especially whenever material to be presented for scaling approaches uniformity. This method of scaling is most applicable in large sales of small, low-valued material where the cost of measuring every unit is excessive for the benefit derived. By reducing unit variation through stratification, sample scaling can be adapted to most scaling problems. Accuracy is obtained through the application of statistical methods and procedures.

85.2 Background Needed

Statisticians are available at most Stations and Regional Offices to provide assistance to Forest Officers in analyzing individual problems and sampling needs. A Forest Officer does not need an intimate knowledge of statistical methods to use sample scaling; however, it is desirable that he understand the basic concepts so that he can properly describe the problem to the statistician. In addition, all individuals concerned in sample scaling should understand that the sampling intensity does not include any check on the accuracy of scaling and that sample scaling demands the maintenance of a high standard of scaling proficiency. USDA Agriculture Handbook 232, "Elementary Forest Sampling," issued December 1962, is recommended as a reference.

85.3 Factors To Consider

The three factors which will determine the sample size in any sample scaling problem are: (1) The desired accuracy at a prescribed level of probability, (2) the total number of sampling units in the population, and (3) the variation among sampling units. The first of these will normally be established by Regional standards and will largely depend on value. The Intermountain Forest and Range Experiment Station's Research Note 14, "What Is an Acceptable Allowable Error and Sample Size in Sample Log Scaling or Tree Measuring" (December 1954) is a ready reference for use in correlating values with sampling needs.

The number of units available for sampling can usually be obtained from the cruise after the unit to be used and the desired stratification have been determined. Units will normally be either individual logs or loads of logs. Stratification by species, defect, log diameters, log length, size of truck, etc., may be desirable to reduce the variation within the sample. The sampling period need not coincide with the duration of the sale. Annual (or shorter) accounting and sampling periods are desirable.

Variation among sampling units can be caused by all of the factors mentioned in the preceding paragraph. Such factors as (1) elapsed time since cutting; (2) green versus salvage; (3) mud, snow, and ice; (4) date of cutting; and (5) site, topography, and aspect should also be considered. A liberal, but experienced, estimate of the anticipated variation may be used in determining the initial sampling rate. This variation can then be checked after a representative sample of the units has been scaled.

85.4 Problem Solution and Application

Once the desired accuracy and the number and variation of sampling units have been established, the required sample size can readily be determined by conventional statistical procedures most applicable to the case in question. The Intermountain Forest and Range Experiment Station's Research Note 48, "Truck Load Sample Scaling To Adjust Company Scale" (November 1957), shows the statistical procedure used to determine sampling needs in this common usage of sample scaling.

After computing the required sample size, a sampling scheme can be worked out for selecting logs or loads to be scaled in an unbiased, random fashion during the sampling period. The final adjustment is then based on all the sample loads.

85.5 Scaling by Weight

Scaling by weight is an adaptation of sample scaling. When used, the most common procedure is to weigh all units and convert the weights obtained to board feet by use of a converting factor based upon the scale to weight ratio of a representative sample.

In this code a model problem is presented to illustrate the determination of sample sizes needed for two accuracy levels and various population sizes. In this example, the following is the composition of the actual sale.

	Volume (MMB.F.)	Stumpage rate per M	Logs per MB.F.
Lodgepole pine---	50	$2.10	21
Spruce----------	24	5.25	14

Complete log scaling on this sale would have been very costly. Weight scaling, with converting factors determined from sample loads, proved to be effective and economical. Stratification was limited to species. Following are weights and scales of five representative loads of lodgepole pine logs.

Weight scaling; loads of lodgepole pine logs

Date	Ticket No.	Net weight	Gross scale	Defect	Net scale	Board feet per lb.
1962						
May 15--	10	32,380	2,650	50	2,600	0.080
May 25--	35	26,880	2,610	80	2,530	.094
June 6---	50	40,270	4,780	170	4,610	.114
June 13--	72	28,590	2,590	20	2,570	.090
June 24--	100	31,730	2,890	120	2,770	.087

The variation among load-converting factors and resulting sampling rates for each species were determined from 35 representative loads.

The last table in this code shows the number of loads required in the sample to achieve sampling accuracies of either 2 percent or 5 percent at the 95-percent probability level for various total number of loads. The data are based on the coefficient of variation for this particular timber sale and are not intended as a general guide.

Weight scaling: sample loads needed for given sampling accuracies and populations

Population size for sampling period in loads	Loads required in sample			
	Lodgepine pine		Spruce	
	2 percent accuracy	5 percent accuracy	2 percent accuracy	5 percent accuracy
500---------	74	12	189	44
1,000-------	80	12	232	46
1,500-------	82	12	252	47
2,000-------	83	12	263	47
2,500-------	83	12	270	48
3,000-------	84	12	300	48

Bark, stumps, limbs, or other material not readily measured otherwise may be sold by weight, normally with the ton as the unit. Obtain records of the actual weights whenever possible, for example, when the products are weighed by common carrier agents. Truck scales must be reliable. If the long ton of 2,240 pounds is used instead of the standard ton, specify this in the sale agreement.

APPENDIX

CONTENTS

TABLE IA.--Standard division of long logs for scaling--16-foot maximum scaling length

Length (feet)	Division of log--segment lengths in feet		
	Bottom	Middle	Top
17----------------	9	---------	8
18----------------	10	---------	8
19----------------	10	---------	9
20----------------	10	---------	10
21----------------	11	---------	10
22----------------	12	---------	10
23----------------	12	---------	11
24----------------	12	---------	12
25----------------	13	---------	12
26----------------	14	---------	12
27----------------	14	---------	13
28----------------	14	---------	14
29----------------	15	---------	14
30----------------	16	---------	14
31----------------	16	---------	15
32----------------	16	---------	16
33----------------	12	-------11	10
34----------------	12	12	10
35----------------	12	12	11
36----------------	12	12	12
37----------------	13	12	12
38----------------	14	12	12
39----------------	14	13	12
40----------------	14	14	12

In this table any log length and segment division will be used as the overtrim scaling length for the preceding length.

TABLE IB.--Standard division of long logs for scaling--20-foot maximum scaling length.

Length (feet)	Division of log--segment lengths in feet		
	Bottom	Middle	Top
21	11	---------	10
22	12	---------	10
23	12	---------	11
24	12	---------	12
25	13	---------	12
26	14	---------	12
27	14	---------	13
28	14	---------	14
29	15	---------	14
30	16	---------	14
31	16	---------	15
32	16	---------	16
33	17	---------	16
34	18	---------	16
35	18	---------	17
36	18	---------	18
37	19	---------	18
38	20	---------	18
39	20	---------	19
40	20	---------	20
41	14	14	13
42	14	14	14
43	15	14	14
44	16	14	14
45	16	15	14
46	16	16	14
47	16	16	15
48	16	16	16
49	17	16	16
50	18	16	16

In this table any log length and segment division will be used as the overtrim scaling length for the preceding length.

TABLE II.—*Scribner Decimal C log rule—4- to 20-foot logs*

[Board-foot volumes in tens—no taper considered]

Diameter (inches)	Log lengths in feet															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
6	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1	2	2	2	2
7	.5	.5	.5	1	1	1	1	2	2	2	2	2	3	3	3	3
8	.5	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3
9	1	1	1	2	2	2	3	3	3	3	3	3	4	4	4	4
10	1	1	2	2	3	3	3	3	3	4	4	5	6	6	6	7
11	1	2	2	2	3	3	4	4	4	5	5	6	7	7	8	8
12	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	10
13	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	12
14	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	14
15	4	4	5	6	7	8	9	10	11	12	12	13	14	15	16	18
16	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
17	5	6	7	8	9	10	12	13	14	15	16	17	18	20	21	23
18	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	27
19	6	8	9	10	12	13	15	16	18	19	21	22	24	25	27	30
20	7	9	11	12	14	16	17	19	21	23	24	26	28	30	31	35
21	8	10	12	13	15	17	19	21	23	25	27	28	30	32	34	38
22	8	10	13	15	17	19	21	23	25	27	29	31	33	35	38	42
23	9	12	14	16	19	21	23	26	28	31	33	35	38	40	42	47
24	10	13	15	18	21	23	25	28	30	33	35	38	40	43	45	50
25	11	14	17	20	23	26	29	31	34	37	40	43	46	49	52	57

TABLE II.—*Scribner Decimal C log rule—4- to 20-foot logs*—Continued

Diameter (inches)	Log lengths in feet															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
26	12	16	19	22	25	28	31	34	37	41	44	47	50	53	56	62
27	14	17	21	24	27	31	34	38	41	44	48	51	55	58	62	68
28	15	18	22	25	29	33	36	40	44	47	51	54	58	62	65	73
29	15	19	23	27	31	35	38	42	46	49	53	57	61	65	68	76
30	16	21	25	29	33	37	41	45	49	53	57	62	66	70	74	82
31	18	22	27	31	36	40	44	49	53	58	62	67	71	75	80	89
32	18	23	28	32	37	41	46	51	55	60	64	69	74	78	83	92
33	20	24	29	34	39	44	49	54	59	64	69	73	78	83	88	98
34	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	100
35	22	27	33	38	44	49	55	60	66	71	77	82	88	93	98	109
36	23	29	35	40	46	52	58	63	69	75	81	86	92	98	104	115
37	26	32	39	45	51	58	64	71	77	84	90	96	103	109	116	129
38	27	33	40	47	54	60	67	73	80	87	93	100	107	113	120	133
39	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	140
40	30	38	45	53	60	68	75	83	90	98	105	113	120	128	135	150
41	32	39	48	56	64	72	79	87	95	103	111	119	127	135	143	159
42	33	42	50	59	67	76	84	92	101	109	117	126	134	143	151	168
43	35	43	52	61	70	79	87	96	105	113	122	131	140	148	157	174
44	37	46	56	65	74	83	93	102	111	120	129	139	148	157	166	185
45	38	47	57	66	76	85	95	104	114	123	133	143	152	161	171	190
46	39	49	59	69	79	89	99	109	119	129	139	149	159	169	178	198
47	41	52	62	72	83	93	104	114	124	134	145	155	166	176	186	207
48	43	54	65	76	86	97	108	119	130	140	151	162	173	184	194	216
49	45	56	67	79	90	101	112	124	135	146	157	168	180	191	202	225
50	47	58	70	82	94	105	117	129	140	152	164	175	187	199	211	234

Table II.—*Scribner Decimal C log rule—4- to 20-foot logs*—Continued

Diameter (inches)	Log lengths in feet															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
51	48	61	73	85	97	110	122	134	146	158	170	183	195	207	219	243
52	50	63	76	89	101	114	127	139	152	165	177	190	202	215	228	253
53	52	66	79	92	105	118	132	145	158	171	184	197	210	224	237	263
54	54	68	82	96	109	123	137	150	164	177	191	205	218	232	246	273
55	56	71	85	99	113	127	142	156	170	184	198	212	227	241	255	283
56	59	73	88	103	118	132	147	162	176	191	206	220	235	250	264	294
57	61	76	91	107	122	137	152	167	183	198	213	228	244	259	274	304
58	63	79	95	110	126	142	158	174	189	205	221	237	252	268	284	315
59	65	81	98	114	131	147	163	180	196	212	229	245	261	278	294	327
60	67	84	101	118	135	152	169	186	203	220	237	253	270	287	304	338
61	70	87	105	123	140	158	175	193	210	228	245	263	280	298	315	350
62	72	90	108	127	145	163	181	199	217	235	253	271	289	307	325	362
63	74	93	112	131	149	168	187	205	224	243	261	280	299	317	336	373
64	77	96	116	135	154	174	193	213	232	251	270	290	309	329	348	387
65	79	99	119	139	159	179	199	219	239	259	279	299	319	339	358	398
66	82	103	123	144	164	185	206	226	247	268	288	309	329	350	370	412
67	85	106	127	148	170	191	212	233	254	275	297	318	339	360	381	423
68	87	109	131	153	175	197	219	240	262	284	306	328	350	371	393	437
69	90	113	135	158	180	203	226	248	271	294	316	339	361	384	406	452
70	93	116	139	163	186	209	232	256	279	302	325	349	372	395	419	465
71	96	120	144	167	192	215	240	263	287	311	335	359	383	407	430	478
72	98	123	148	173	197	222	247	271	296	321	345	370	395	419	444	493
73	101	127	152	178	203	229	254	280	305	330	356	381	406	432	457	508
74	104	130	157	183	209	236	261	288	314	340	366	393	418	445	471	523
75	107	134	161	188	215	242	269	296	323	350	377	404	430	458	484	538

TABLE II.—*Scribner Decimal C log rule—4- to 20-foot logs*—Continued

Diameter (inches)	Log lengths in feet															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
76	110	138	166	194	221	249	277	304	332	360	387	415	443	470	498	553
77	114	142	171	199	228	256	285	313	341	369	398	426	455	483	511	568
78	117	146	176	205	234	263	293	322	351	380	410	439	468	497	527	585
79	120	150	180	211	240	271	301	331	361	391	421	451	481	511	541	602
80	123	154	185	216	247	278	309	340	371	402	432	464	494	526	556	618
81	127	158	190	222	254	286	317	349	381	413	444	476	508	540	572	635
82	130	163	196	228	261	293	326	358	391	424	456	489	521	554	586	652
83	134	167	201	234	268	301	335	368	401	434	468	501	535	568	601	668
84	137	171	206	240	275	309	343	378	412	446	481	515	549	584	618	687
85	140	175	210	246	281	316	351	386	421	456	491	526	561	596	631	702
86	143	179	215	251	287	323	359	395	431	467	503	539	575	611	646	718
87	147	184	221	258	295	332	368	405	442	479	516	553	589	626	663	737
88	150	188	226	264	301	339	377	414	452	490	527	565	603	640	678	753
89	154	192	231	270	308	347	385	424	462	501	539	578	616	655	693	770
90	157	196	236	275	315	354	393	433	472	511	551	590	629	669	708	787
91	161	201	241	282	322	362	402	443	483	523	563	604	644	684	725	805
92	164	205	246	288	329	370	411	452	493	534	575	616	657	698	740	822
93	167	209	251	293	335	377	419	461	503	545	587	629	671	713	755	838
94	171	214	257	300	343	386	428	471	514	557	600	643	685	728	771	857
95	175	218	262	306	350	394	437	481	525	569	612	656	700	744	788	875
96	178	223	268	313	357	402	446	491	536	581	625	670	715	759	804	893
97	182	227	273	319	364	410	455	501	546	592	637	683	728	774	819	910
98	185	232	278	325	371	418	464	511	557	603	650	696	743	789	836	928
99	189	236	284	331	379	426	473	521	568	614	653	710	757	805	852	947
100	193	241	289	338	386	434	482	531	579	627	675	724	772	820	869	965

TABLE II.—*Scribner Decimal C log rule—4- to 20-foot logs*—Continued

Diameter (inches)	Log lengths in feet															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
101	196	246	295	344	393	443	492	541	590	639	688	738	787	836	885	983
102	200	251	301	351	401	452	502	552	602	652	702	753	803	853	903	1003
103	204	256	307	358	409	461	512	563	614	665	716	768	819	870	921	1023
104	208	261	313	365	417	470	522	574	626	678	730	783	835	887	939	1043
105	212	266	319	372	425	479	532	585	638	691	744	798	851	904	957	1063
106	216	271	325	379	433	488	542	596	650	704	758	813	867	921	975	1083
107	221	276	331	387	442	497	553	608	663	718	773	829	884	939	995	1105
108	225	281	337	394	450	506	563	619	675	731	788	844	900	956	1013	1125
109	229	286	344	401	459	516	573	631	688	745	803	860	917	975	1032	1147
110	233	291	350	408	467	525	583	642	700	758	817	875	933	992	1050	1167
111	237	297	356	416	475	535	594	654	713	772	832	891	951	1010	1070	1188
112	241	302	362	423	483	544	604	665	725	785	846	906	967	1027	1088	1208
113	246	307	369	431	492	554	615	677	738	800	861	923	984	1046	1107	1230
114	250	313	375	438	501	563	626	688	751	814	876	939	1001	1064	1127	1252
115	254	318	382	446	509	573	637	700	764	828	891	955	1019	1082	1146	1273
116	259	324	389	454	519	584	648	713	778	843	908	973	1037	1102	1167	1297
117	264	330	396	462	528	594	660	726	792	858	924	990	1056	1122	1188	1320
118	268	336	403	470	537	605	672	739	806	873	940	1008	1075	1142	1209	1343
119	273	341	410	478	547	615	683	752	820	888	957	1025	1093	1162	1230	1367
120	278	347	417	487	556	626	695	765	834	904	973	1043	1112	1182	1251	1390

TABLE III.—*Long logs, volume according to taper, maximum scaling length 20 feet*

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	22-foot logs (1 10- and 1 12-foot segment)								24-foot logs (2 12-foot segments)							
	Taper in inches (difference between diameters of 2 ends)															
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16
6	3	3	4	4	5	7	8	10	3	3	4	4	5	7	8	10
7	3	4	4	5	7	8	10	12	4	5	5	6	8	9	11	13
8	5	5	6	8	9	11	13	14	5	5	6	8	9	11	13	14
9	6	7	9	10	12	14	15	17	6	7	9	10	12	14	15	17
10	7	9	10	12	14	15	17	19	7	9	10	12	14	15	17	19
11	10	11	13	15	16	18	20	22	10	11	13	15	16	18	20	22
12	12	14	16	17	19	21	23	26	13	15	17	18	20	22	24	27
13	15	17	18	20	22	24	27	29	16	18	19	21	23	25	28	30
14	18	19	21	23	25	28	30	32	20	21	23	25	27	30	32	34
15	21	23	25	27	30	32	34	37	23	25	27	29	32	34	36	39
16	24	26	28	31	33	35	38	40	26	28	30	33	35	37	40	42
17	28	30	33	35	37	40	42	46	30	32	35	37	39	42	44	48
18	31	34	36	38	41	43	47	50	34	37	39	41	44	46	50	53
19	36	38	40	43	45	49	52	56	39	41	43	46	48	52	55	59
20	40	42	45	47	51	54	58	61	44	46	49	51	55	58	62	65
21	44	47	49	53	56	60	63	65	48	51	53	57	60	64	67	69
22	49	51	55	58	62	65	67	70	53	55	59	62	66	69	71	74
23	53	57	60	64	67	69	72	76	58	62	65	69	72	74	77	81
24	59	62	66	69	71	74	78	80	64	67	71	74	76	79	83	85
25	66	70	73	75	78	82	84	88	71	75	78	80	83	87	89	93
26	72	75	77	80	84	86	90	91	78	81	83	86	90	92	96	97
27	78	80	83	87	89	93	94	100	85	87	90	94	96	100	101	107
28	82	85	89	91	95	96	102	105	90	93	97	99	103	104	110	113
29	87	91	93	97	98	104	107	115	95	99	101	105	106	112	115	123
30	94	96	100	101	107	110	118	121	102	104	108	109	115	118	126	129
31	99	103	104	110	113	121	124	128	108	112	113	119	122	130	133	137
32	105	106	112	115	123	126	130	136	114	115	121	124	132	135	139	145
33	109	115	118	126	129	133	139	144	119	125	128	136	139	143	149	154
34	116	119	127	130	134	140	145	151	126	129	137	140	144	150	155	161
35	124	132	135	139	145	150	156	160	135	143	146	150	156	161	167	171
36	135	138	142	148	153	159	163	169	146	149	153	159	164	170	174	180
37	144	148	154	159	165	169	175	178	157	161	167	172	178	182	188	191
38	151	157	162	168	172	178	181	186	164	170	175	181	185	191	194	199
39	160	165	171	175	181	184	189	194	174	179	185	189	195	198	203	208
40	170	176	180	186	189	194	199	205	185	191	195	201	204	209	214	220
41	180	184	190	193	198	203	209	214	196	200	206	209	214	219	225	230
42	189	195	198	203	208	214	219	224	206	212	215	220	225	231	236	241
43	198	201	206	211	217	222	227	233	216	219	224	229	235	240	245	251
44	207	212	217	223	228	233	239	245	225	230	235	241	246	251	257	263
45	214	219	225	230	235	241	247	253	233	238	244	249	254	260	266	272
46	223	229	234	239	245	251	257	263	243	249	254	259	265	271	277	283
47	234	239	244	250	256	262	268	274	254	259	264	270	276	282	288	294
48	243	248	254	260	266	272	278	284	265	270	276	282	288	294	300	306
49	252	258	264	270	276	282	288	295	275	281	287	293	299	305	311	318
50	263	269	275	281	287	293	300	306	286	292	298	304	310	316	323	329

Refer to code 17.33 for scaling of butt logs.

TABLE III.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	26-foot logs (1 12- and 1 14-foot segment)								28-foot logs (2 14-foot segments)							
	Taper in inches (difference between diameters of 2 ends)															
	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16
6	3	3	4	5	6	8	9	11	3	3	4	5	6	8	9	11
7	4	5	6	7	9	10	12	14	4	5	6	7	9	10	12	14
8	5	6	7	9	10	12	14	16	5	6	7	9	10	12	14	16
9	7	8	10	11	13	15	17	19	7	8	10	11	13	15	17	19
10	8	10	11	13	15	17	19	22	9	11	12	14	16	18	20	23
11	11	12	14	16	18	20	23	25	12	13	15	17	19	21	24	26
12	14	16	18	20	22	25	27	30	15	17	19	21	23	26	28	31
13	17	19	21	23	26	28	31	34	18	20	22	24	27	29	32	35
14	21	23	25	28	30	33	3[illegible]	38	22	24	26	29	31	34	37	39
15	25	27	30	32	35	38	40	44	26	28	31	33	36	39	41	45
16	28	31	33	36	39	41	45	47	30	33	35	38	41	43	47	49
17	33	35	38	41	43	47	49	54	35	37	40	43	45	49	51	56
18	37	40	43	45	49	51	56	60	40	43	46	48	52	54	59	63
19	42	45	47	51	53	58	62	66	45	48	50	54	56	61	65	69
20	48	50	54	56	61	65	69	72	51	53	57	59	64	68	72	75
21	52	56	58	63	67	71	74	76	56	60	62	67	71	75	78	80
22	58	60	65	69	73	76	78	82	62	64	69	73	77	80	82	86
23	63	68	72	76	79	81	85	90	68	73	77	81	84	86	90	95
24	70	74	78	81	83	87	92	94	75	79	83	86	88	92	97	99
25	78	82	85	87	91	96	98	103	84	88	91	93	97	102	104	109
26	85	88	90	94	99	101	106	107	92	95	97	101	106	108	113	114
27	92	94	98	103	105	110	111	118	99	101	105	110	112	117	118	125
28	97	101	106	108	113	114	121	125	104	108	113	115	120	121	128	132
29	103	108	110	115	116	123	127	136	110	115	117	122	123	130	134	143
30	111	113	118	119	126	130	139	142	119	121	126	127	134	138	147	150
31	117	122	123	130	134	143	146	151	126	131	132	139	143	152	155	160
32	124	125	132	136	145	148	153	160	133	134	141	145	154	157	162	169
33	129	136	140	149	152	157	164	170	139	146	150	159	162	167	174	180
34	137	141	150	153	158	165	171	177	147	151	160	163	168	175	181	187
35	147	156	159	164	171	177	183	188	158	167	170	175	182	188	194	199
36	159	162	167	174	180	186	191	198	171	174	179	186	192	198	203	210
37	170	175	182	188	194	199	206	210	183	188	195	201	207	212	219	223
38	178	185	191	197	202	209	213	219	191	198	204	210	215	222	226	232
39	189	195	201	206	213	217	223	229	203	209	215	220	227	231	237	243
40	201	207	212	219	223	229	235	241	216	222	227	234	238	244	250	256
41	212	217	224	228	234	240	246	252	228	233	240	244	250	256	262	268
42	223	230	234	240	246	252	258	265	239	246	250	256	262	268	274	281
43	234	238	244	250	256	262	269	275	251	255	261	267	273	279	286	292
44	244	250	256	262	268	275	281	288	262	268	274	280	286	293	299	306
45	253	259	265	271	278	284	291	298	272	278	284	290	297	303	310	317
46	264	270	276	283	289	296	303	310	284	290	296	303	309	316	323	330
47	275	281	288	294	301	308	315	322	296	302	309	315	322	329	336	343
48	287	294	300	307	314	321	328	336	308	315	321	328	335	342	349	357
49	299	305	312	319	326	333	341	348	321	327	334	341	348	355	363	370
50	310	317	324	331	338	346	353	361	334	341	348	355	362	370	377	385

Refer to code 17.33 for scaling of butt logs.

TABLE III.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	30-foot logs (1 14- and 1 16-foot segment)								32-foot logs (2 16-foot segments)							
	Taper in inches (difference between diameters of 2 ends)															
	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16
6	4	4	5	7	8	9	11	12	5	5	6	8	9	10	12	13
7	5	6	8	9	10	12	13	16	6	7	9	10	11	13	14	17
8	6	8	9	10	12	13	16	18	7	9	10	11	13	14	17	19
9	9	10	11	13	14	17	19	21	10	11	12	14	15	18	20	22
10	11	12	14	15	18	20	22	25	13	14	16	17	20	22	24	27
11	13	15	16	19	21	23	26	29	15	17	18	21	23	25	28	31
12	17	18	21	23	25	28	31	35	18	19	22	24	26	29	32	36
13	19	22	24	26	29	32	36	38	21	24	26	28	31	34	38	40
14	24	26	28	31	34	38	40	43	25	27	29	32	35	39	41	44
15	28	30	33	36	40	42	45	50	30	32	35	38	42	44	47	52
16	32	35	38	42	44	47	52	54	34	37	40	44	46	49	54	56
17	37	40	44	46	49	54	56	62	39	42	46	48	51	56	58	64
18	43	47	49	52	57	59	65	69	45	49	51	54	59	61	67	71
19	49	51	54	59	61	67	71	76	52	54	57	62	64	70	74	79
20	54	57	62	64	70	74	79	82	58	61	66	68	74	78	83	86
21	60	65	67	73	77	82	85	88	63	68	70	76	80	85	88	91
22	67	69	75	79	84	87	90	95	71	73	79	83	88	91	94	99
23	73	79	83	88	91	94	99	104	78	84	88	93	96	99	104	109
24	81	85	90	93	96	101	106	109	86	90	95	98	101	106	111	114
25	90	95	98	101	106	111	114	118	96	101	104	107	112	117	120	124
26	99	102	105	110	115	118	122	124	105	108	111	116	121	124	128	130
27	106	109	114	119	122	126	128	136	113	116	121	126	129	133	135	143
28	112	117	122	125	129	131	139	143	119	124	129	132	136	138	146	150
29	119	124	127	131	133	141	145	156	127	132	135	139	141	149	153	164
30	128	131	135	137	145	149	160	164	137	140	144	146	154	158	169	173
31	136	140	142	150	154	165	169	174	145	149	151	159	163	174	178	183
32	142	144	152	156	167	171	176	184	152	154	162	166	177	181	186	194
33	149	157	161	172	176	181	189	196	158	166	170	181	185	190	198	205
34	158	162	173	177	182	190	197	204	168	172	183	187	192	200	207	214
35	169	180	184	189	197	204	211	217	180	191	195	200	208	215	222	228
36	184	188	193	201	208	215	221	229	195	199	204	212	219	226	232	240
37	197	202	210	217	224	230	238	242	210	215	223	230	237	243	251	255
38	205	213	220	227	233	241	245	252	219	227	234	241	247	255	259	266
39	218	225	232	238	246	250	257	264	232	239	246	252	260	264	271	278
40	232	239	245	253	257	264	271	278	247	254	260	268	272	279	286	293
41	245	251	259	263	270	277	284	291	261	267	275	279	286	293	300	307
42	257	265	269	276	283	290	297	304	274	282	286	293	300	307	314	321
43	270	274	281	288	295	302	309	317	288	292	299	306	313	320	327	335
44	281	288	295	302	309	316	324	331	300	307	314	321	328	335	343	350
45	292	299	306	313	320	328	335	343	311	318	325	332	339	347	354	362
46	305	312	319	326	334	341	349	357	325	332	339	346	354	361	369	377
47	318	325	332	340	347	355	363	372	339	346	353	361	368	376	384	393
48	331	338	346	353	361	369	378	386	353	360	368	375	383	391	400	408
49	344	352	359	367	375	384	392	401	367	375	382	390	398	407	415	424
50	359	366	374	382	391	399	408	416	382	389	397	405	414	422	431	439

Refer to code 17.33 for scaling of butt logs.

TABLE III.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	34-foot logs (1 16- and 1 18-foot segment)								36-foot logs (2 18-foot segments)							
	Taper in inches (difference between diameters of 2 ends)															
	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16
6	5	5	6	8	10	11	13	15	5	5	6	8	10	11	13	15
7	6	7	9	11	12	14	16	19	6	7	9	11	12	14	16	19
8	7	9	11	12	14	16	19	21	7	9	11	12	14	16	19	21
9	10	12	13	15	17	20	22	25	10	12	13	15	17	20	22	25
10	14	15	17	19	22	24	27	30	14	15	17	19	22	24	27	30
11	16	18	20	23	25	28	31	34	17	19	21	24	26	29	32	35
12	19	21	24	26	29	32	35	39	20	22	25	27	30	33	36	40
13	23	26	28	31	34	37	41	44	24	27	29	32	35	38	42	45
14	27	29	32	35	38	42	45	49	29	31	34	37	40	44	47	51
15	32	35	38	41	45	48	52	56	34	37	40	43	47	50	54	58
16	37	40	43	47	50	54	58	61	39	42	45	49	52	56	60	63
17	42	45	49	52	56	60	63	70	45	48	52	55	59	63	66	73
18	48	52	55	59	63	66	73	77	51	55	58	62	66	69	76	80
19	55	58	62	66	69	76	80	86	58	61	65	69	72	79	83	89
20	62	66	70	73	80	84	90	93	65	69	73	76	83	87	93	96
21	68	72	75	82	86	92	95	98	72	76	79	86	90	96	99	102
22	75	78	85	89	95	98	101	107	80	83	90	94	100	103	106	112
23	83	90	94	100	103	106	112	118	87	94	98	104	107	110	116	122
24	92	96	102	105	108	114	120	123	97	101	107	110	113	119	125	128
25	102	108	111	114	120	126	129	134	108	114	117	120	126	132	135	140
26	112	115	118	124	130	133	138	140	118	121	124	130	136	139	144	146
27	120	123	129	135	138	143	145	153	127	130	136	142	145	150	152	160
28	126	132	138	141	146	148	156	162	133	139	145	148	153	155	163	169
29	135	141	144	149	151	159	165	177	142	148	151	156	158	166	172	184
30	146	149	154	156	164	170	182	186	154	157	162	164	172	178	190	194
31	154	159	161	169	175	187	191	197	163	168	170	178	184	196	200	206
32	162	164	172	178	190	194	200	209	171	173	181	187	199	203	209	218
33	168	176	182	194	198	204	213	221	178	186	192	204	208	214	223	231
34	178	184	196	200	206	215	223	231	188	194	206	210	216	225	233	241
35	192	204	208	214	223	231	239	245	202	214	218	224	233	241	249	255
36	208	212	218	227	235	243	249	258	220	224	230	239	247	255	261	270
37	223	229	238	246	254	260	269	274	236	242	251	259	267	273	282	287
38	233	242	250	258	264	273	278	285	246	255	263	271	277	286	291	298
39	247	255	263	269	278	283	290	298	261	269	277	283	292	297	304	312
40	263	271	277	286	291	298	306	314	278	286	292	301	306	313	321	329
41	278	284	293	298	305	313	321	329	294	300	309	314	321	329	337	345
42	291	300	305	312	320	328	336	345	308	317	322	329	337	345	353	362
43	306	311	318	326	334	342	351	359	323	328	335	343	351	359	368	376
44	319	326	334	342	350	359	367	376	337	344	352	360	368	377	385	394
45	330	338	346	354	363	371	380	389	349	357	365	373	382	390	399	408
46	345	353	361	370	378	387	396	405	364	372	380	389	397	406	415	424
47	360	368	377	385	394	403	412	421	380	388	397	405	414	423	432	441
48	375	384	392	401	410	419	428	437	396	405	413	422	431	440	449	458
49	391	399	408	417	426	435	444	454	413	421	430	439	448	457	466	476
50	406	415	424	433	442	451	461	471	430	439	448	457	466	475	485	495

Refer to code 17.33 for scaling of butt logs.

TABLE 111.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	38-foot logs (1 18- and 1 20-foot segment)								40-foot logs (2 20-foot segments)							
	Taper in inches (difference between diameters of 2 ends)															
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16
6	5	5	6	9	10	12	14	16	5	5	6	9	10	12	14	16
7	6	7	10	11	13	15	17	21	6	7	10	11	13	15	17	21
8	7	10	11	13	15	17	21	23	7	10	11	13	15	17	21	23
9	11	12	14	16	18	22	24	27	11	12	14	16	18	22	24	27
10	14	16	18	20	24	26	29	33	15	17	19	21	25	27	30	34
11	18	20	22	26	28	31	35	38	18	20	22	26	28	31	35	38
12	21	23	27	29	32	36	39	44	22	24	28	30	33	37	40	45
13	25	29	31	34	38	41	46	49	26	30	32	35	39	42	47	50
14	31	33	36	40	43	48	51	55	32	34	37	41	44	49	52	56
15	36	39	43	46	51	54	58	63	38	41	45	48	53	56	60	65
16	41	45	48	53	56	60	65	68	43	47	50	55	58	62	67	70
17	48	51	56	59	63	68	71	78	50	53	58	61	65	70	73	80
18	54	59	62	66	71	74	81	86	57	62	65	69	74	77	84	89
19	62	65	69	74	77	84	89	95	65	68	72	77	80	87	92	98
20	69	73	78	81	88	93	99	104	73	77	82	85	92	97	103	108
21	76	81	84	91	96	102	107	110	80	85	88	95	100	106	111	114
22	85	88	95	100	106	111	114	120	89	92	99	104	110	115	118	124
23	92	99	104	110	115	118	124	131	97	104	109	115	120	123	129	136
24	102	107	113	118	121	127	134	137	107	112	118	123	126	132	139	142
25	114	120	125	128	134	141	144	150	119	125	130	133	139	146	149	155
26	124	129	132	138	145	148	154	156	130	135	138	144	151	154	160	162
27	135	138	144	151	154	160	162	171	141	144	150	157	160	166	168	177
28	141	147	154	157	163	165	174	180	149	155	162	165	171	173	182	188
29	150	157	160	166	168	177	183	197	158	165	168	174	176	185	191	205
30	163	166	172	174	183	189	203	207	171	174	180	182	191	197	211	215
31	172	178	180	189	195	209	213	220	181	187	189	198	204	218	222	229
32	181	183	192	198	212	216	223	233	190	192	201	207	221	225	232	242
33	188	197	203	217	221	228	238	247	198	207	213	227	231	238	248	257
34	199	205	219	223	230	240	249	258	209	215	229	233	240	250	259	268
35	213	227	231	238	248	257	266	272	224	238	242	249	259	268	277	283
36	233	237	244	254	263	272	278	289	244	248	255	265	274	283	289	300
37	249	256	266	275	284	290	301	306	262	269	279	288	297	303	314	319
38	260	270	279	288	294	305	310	318	273	283	292	301	307	318	323	331
39	276	285	294	300	311	316	324	333	290	299	308	314	325	330	338	347
40	294	303	309	320	325	333	342	351	309	318	324	335	340	348	357	366
41	311	317	328	333	341	350	359	368	327	333	344	349	357	366	375	384
42	325	336	341	349	358	367	376	385	342	353	358	366	375	384	393	402
43	342	347	355	364	373	382	391	400	359	364	372	381	390	399	408	417
44	356	364	373	382	391	400	409	419	375	383	392	401	410	419	428	438
45	369	378	387	396	405	414	424	434	388	397	406	415	424	433	443	453
46	385	394	403	412	421	431	441	451	405	414	423	432	441	451	461	471
47	402	411	420	429	439	449	459	469	423	432	441	450	460	470	480	490
48	419	428	437	447	457	467	477	488	441	450	459	469	479	489	499	510
49	436	445	455	465	475	485	496	506	459	468	478	488	498	508	519	529
50	454	464	474	484	494	505	515	526	477	487	497	507	517	528	538	549

Refer to code 17.33 for scaling of butt logs.

Table III.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	42-foot logs (three 14-foot segments)										44-foot logs (two 14- and one 16-foot segments)									
	Taper in inches (difference between diameters of 2 ends)																			
	1	2–3	4	5–6	7	8–9	10	11–12	13	14–15	1	2–3	4	5–6	7	8–9	10	11–12	13	14–15
6	5	5	6	7	9	11	13	15	18	20	6	6	7	9	11	12	15	16	20	22
7	6	7	9	10	13	14	17	19	23	25	7	8	11	12	14	16	18	21	25	27
8	8	9	11	13	15	17	21	23	26	29	9	11	13	14	17	18	23	25	28	31
9	11	12	15	16	20	22	25	27	32	34	13	14	16	18	21	24	27	29	34	37
10	14	16	19	21	24	26	30	33	37	40	16	17	21	22	26	28	32	35	40	44
11	19	20	23	25	29	31	36	38	43	46	20	22	24	27	31	33	38	41	47	49
12	23	25	29	31	35	38	42	45	50	52	25	26	31	33	37	40	45	49	53	56
13	28	30	34	36	41	43	48	51	56	60	29	32	36	38	43	46	52	54	60	65
14	34	36	40	43	47	50	56	58	64	66	36	38	42	45	50	54	59	62	69	71
15	40	42	47	49	55	58	62	66	71	76	42	44	49	52	59	61	66	71	76	82
16	46	49	54	57	62	64	71	73	81	85	48	51	57	61	65	68	76	78	87	91
17	54	56	61	64	69	73	78	83	89	93	56	59	65	67	73	78	83	89	95	100
18	61	64	70	72	79	81	88	92	100	103	64	68	73	76	84	86	94	98	107	110
19	69	72	77	81	85	90	98	102	107	109	73	75	81	86	90	96	104	109	114	117
20	78	80	86	88	97	101	107	110	117	121	81	84	91	93	103	107	114	117	125	130
21	85	89	95	100	106	110	118	120	128	133	89	94	100	106	112	117	125	128	137	142
22	95	97	104	108	117	120	126	130	139	141	100	102	110	114	124	127	134	139	148	151
23	103	108	117	121	128	130	138	143	148	153	108	114	123	128	135	138	147	152	158	162
24	115	119	127	130	136	140	148	150	157	158	121	125	134	137	144	149	157	160	166	168
25	128	132	139	141	148	153	157	162	167	174	134	139	146	149	157	162	167	171	177	185
26	140	143	148	152	159	161	170	171	183	187	147	150	156	161	168	171	179	181	194	198
27	150	152	158	163	169	174	180	187	193	202	157	160	167	172	179	183	190	198	204	215
28	157	161	170	172	182	183	192	196	210	213	165	170	179	182	191	193	203	207	223	227
29	167	172	179	184	187	194	203	212	216	221	176	181	189	193	197	205	214	225	230	235
30	181	183	190	191	203	207	217	220	232	239	190	193	199	201	214	218	230	234	246	254
31	190	195	201	208	213	222	232	237	248	254	200	204	211	219	224	235	246	251	263	270
32	202	203	211	215	231	234	243	250	265	271	211	213	222	226	244	248	257	265	281	288
33	209	216	227	236	243	248	264	270	279	284	219	227	238	249	257	262	279	286	296	302
34	224	228	241	244	258	265	274	280	290	297	235	239	254	258	272	280	290	297	308	316
35	239	248	260	265	275	281	292	297	311	315	250	261	274	279	290	297	309	315	330	334
36	261	264	272	279	290	296	308	315	325	331	274	278	286	294	306	313	326	334	344	351
37	276	281	293	299	312	317	330	334	346	352	290	295	308	315	329	335	349	353	366	373
38	289	296	309	315	326	333	343	349	360	366	303	311	325	332	344	352	362	369	381	388
39	308	314	326	331	344	348	359	365	378	384	323	330	343	349	363	367	379	386	400	407
40	327	333	344	351	360	366	379	385	395	402	343	350	362	370	379	386	400	407	418	425
41	345	350	362	366	379	385	395	401	414	420	362	368	381	385	399	406	417	424	437	445
42	361	368	379	385	395	401	413	420	432	439	379	387	398	405	416	423	436	443	457	464
43	380	384	394	400	412	418	431	437	450	457	399	403	414	421	434	441	454	462	475	483
44	395	401	413	419	431	438	450	457	470	477	414	421	434	441	454	461	475	482	496	504
45	411	417	429	435	448	454	467	474	488	495	431	438	451	458	471	479	492	500	515	524
46	429	435	447	454	466	473	487	494	507	515	450	457	470	477	491	498	513	521	536	544
47	447	453	466	472	486	493	506	513	528	535	469	476	489	497	511	519	533	542	557	566
48	465	472	485	492	505	512	526	534	548	556	488	495	510	517	531	539	555	563	579	587
49	485	491	504	511	525	532	547	554	569	577	508	516	529	537	552	561	576	585	600	609
50	504	511	525	532	546	554	568	576	591	599	529	536	551	559	575	583	599	607	623	632

Refer to code 17.33 for scaling of butt logs.

TABLE III.—*Long logs, volume according to taper, maximum scaling length 20 feet*—Continued

[Scribner Decimal C rule—board feet in tens]

Top diam. (in.)	46-foot logs (1 14- and 2 16-foot segments)										48-foot logs (3 16-foot segments)									
	Taper in inches (difference between diameters of 2 ends)																			
	1	2–3	4	5–6	7	8–9	10	11–12	13	14–15	1	2–3	4	5–6	7	8–9	10	11–12	13	14–15
6	7	7	8	10	12	13	17	18	22	24	8	8	9	11	13	14	18	19	23	25
7	8	9	12	13	16	18	20	23	26	28	9	10	13	14	17	19	21	24	27	29
8	10	12	15	16	19	20	24	26	30	33	11	13	16	17	20	21	25	27	31	34
9	15	16	18	20	22	25	29	31	35	38	16	17	19	21	23	26	30	32	36	39
10	18	19	22	23	28	30	33	36	42	46	20	21	24	25	30	32	35	38	44	48
11	21	23	26	29	32	34	40	43	49	51	23	25	28	31	34	36	42	45	51	53
12	27	28	32	34	39	42	47	51	55	58	28	29	33	35	40	43	48	52	56	59
13	30	33	38	40	45	48	54	56	62	67	32	35	40	42	47	50	56	58	64	69
14	38	40	44	47	52	56	61	64	72	74	39	41	45	48	53	57	62	65	73	75
15	44	46	51	54	61	63	69	74	80	86	46	48	53	56	63	65	71	76	82	88
16	50	53	59	63	68	71	80	82	90	94	52	55	61	65	70	73	82	84	92	96
17	58	61	68	70	77	82	86	92	99	104	60	63	70	72	79	84	88	94	101	106
18	67	71	77	80	87	89	98	102	112	115	69	73	79	82	89	91	100	104	114	117
19	77	79	84	89	94	100	109	114	119	122	80	82	87	92	97	103	112	117	122	125
20	84	87	95	97	108	112	119	122	131	136	88	91	99	101	112	116	123	126	135	140
21	93	98	105	111	117	122	131	134	143	148	96	101	108	114	120	125	134	137	146	151
22	105	107	115	119	130	133	140	145	155	158	109	111	119	123	134	137	144	149	159	162
23	113	119	129	134	141	144	154	159	165	169	118	124	134	139	146	149	159	164	170	174
24	127	131	140	143	151	156	164	167	174	176	132	136	145	148	156	161	169	172	179	181
25	140	145	153	156	164	169	175	179	186	194	146	151	159	162	170	175	181	185	192	200
26	154	157	163	168	176	179	188	190	203	207	160	163	169	174	182	185	194	196	209	213
27	164	167	175	180	188	192	199	207	214	225	171	174	182	187	195	199	206	214	221	232
28	173	178	188	191	200	202	213	217	232	236	180	185	195	198	207	209	220	224	239	243
29	185	190	198	202	207	215	223	234	240	245	193	198	206	210	215	223	231	242	248	253
30	199	202	209	211	223	227	240	244	257	265	208	211	218	220	232	236	249	253	266	274
31	210	214	220	228	234	245	257	262	274	281	219	223	229	237	243	254	266	271	283	290
32	220	222	232	236	255	259	268	276	294	301	230	232	242	246	265	269	278	286	304	311
33	229	237	249	260	268	273	292	299	310	316	238	246	258	269	277	282	301	308	319	325
34	246	250	265	269	285	293	304	311	322	330	256	260	275	279	295	303	314	321	332	340
35	261	272	287	292	304	311	323	329	345	349	272	283	298	303	315	322	334	340	356	360
36	287	291	300	308	320	327	341	349	360	367	298	302	311	319	331	338	352	360	371	378
37	304	309	322	329	344	350	365	369	383	390	317	322	335	342	357	363	378	382	396	403
38	317	325	340	347	360	368	379	386	399	406	331	339	354	361	374	382	393	400	413	420
39	338	345	359	365	380	384	397	404	419	426	352	359	373	379	394	398	411	418	433	440
40	359	366	379	387	397	404	419	426	437	444	374	381	394	402	412	419	434	441	452	459
41	379	385	399	403	418	425	436	443	457	465	395	401	415	419	434	441	452	459	473	481
42	397	405	417	424	435	442	456	463	478	485	414	422	434	441	452	459	473	480	495	502
43	418	422	433	440	454	461	475	483	497	505	436	440	451	458	472	479	493	501	515	523
44	433	440	454	461	475	482	497	504	519	527	452	459	473	480	494	501	516	523	538	546
45	451	458	472	479	493	501	515	523	538	547	470	477	491	498	512	520	534	542	557	566
46	471	478	492	499	514	521	536	544	561	569	491	498	512	519	534	541	556	564	581	589
47	491	498	512	520	534	542	558	567	582	591	512	519	533	541	555	563	579	588	603	612
48	511	518	533	540	556	564	580	588	605	613	533	540	555	562	578	586	602	610	627	635
49	531	539	554	562	577	586	602	611	627	636	554	562	577	585	600	609	625	634	650	659
50	554	561	576	584	601	609	626	634	652	661	577	584	599	607	624	632	649	657	675	684

Refer to code 17.33 for scaling of butt logs.

TABLE IV.—*Deductions for squared defects from solid board-foot contents, based on formula*[1]

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches[2]	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16[3]	17[3]	18[3]	19[3]	20[3]
2×2	------	------	------	------	------	------	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3×3	------	0.5	0.5	0.5	0.5	0.5	.5	.5	.5	1	1	1	1	1	1	1	1
4×4	0.5	.5	.5	1	1	1	1	1	1	1	1	2	2	2	2	2	2
5×5	.5	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3
6×6	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5
7×7	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7
8×8	2	2	3	3	3	4	4	5	5	6	6	6	7	7	8	8	9
9×9	2	3	3	4	4	5	5	6	6	7	8	8	9	9	10	10	11
10×10	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13
11×11	3	4	5	6	6	7	8	9	10	10	11	12	13	14	15	15	16
12×12	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19
13×13	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	23
14×14	5	7	8	9	10	12	13	14	16	17	18	20	21	22	24	25	26
15×15	6	8	9	10	12	14	15	16	18	20	21	22	24	26	27	28	30
16×16	7	9	10	12	14	15	17	19	20	22	24	26	27	29	31	32	34

[1] Formula is: $\dfrac{\text{Width of defect in inches} \times \text{height in inches} \times \text{length in feet}}{15}$

Derivation: $X = \dfrac{W \times H \times L}{12} \times \dfrac{80}{100} = \dfrac{W \times H \times L}{15}$

$\dfrac{80}{100}$ represents contents in board feet less 20 percent for saw kerf.

[2] This is the measurement of the defect including 1-inch allowance for waste.

[3] Use average widths and heights for both ends of defect.

Table IV.—*Deductions for squared defects from solid board-foot contents, based on formula* [1]—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches [3]	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16 [3]	17 [3]	18 [3]	19 [3]	20 [3]
17×17	8	10	12	13	15	17	19	21	23	25	27	29	31	33	35	37	39
18×18	9	11	13	15	17	19	22	24	26	28	30	32	35	37	39	41	43
19×19	10	12	14	17	19	22	24	26	29	31	34	36	39	41	43	46	48
20×20	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53
21×21	12	15	18	21	24	26	29	32	35	38	41	44	47	50	53	56	59
22×22	13	16	19	23	26	29	32	35	39	42	45	48	52	55	58	61	65
23×23	14	18	21	25	28	32	35	39	42	46	49	53	56	60	63	67	71
24×24	15	19	23	27	31	35	38	42	46	50	54	58	61	65	69	73	77
25×25	17	21	25	29	33	38	42	46	50	54	58	63	67	71	75	79	83
26×26	18	23	27	32	36	41	45	50	54	59	63	68	72	77	81	86	90
27×27	19	24	29	34	39	44	49	53	58	63	68	73	78	83	87	92	97
28×28	21	26	31	37	42	47	52	57	63	68	73	78	84	89	94	99	105
29×29	22	28	34	39	45	50	56	62	67	73	78	84	90	95	101	107	112
30×30	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120

See footnotes on preceding page.

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2×3	-----	-----	-----	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1
4	-----	0.5	0.5	.5	.5	.5	.5	.5	.5	.5	.5	1	1	1	1	1	1
5	0.5	.5	.5	.5	.5	.5	.5	1	1	1	1	1	1	1	1	1	1
6	.5	.5	.5	.5	.5	.5	1	1	1	1	1	1	1	1	1	2	2
7	.5	.5	.5	.5	.5	1	1	1	1	1	1	1	1	2	2	2	2
3×4	.5	.5	.5	.5	.5	.5	1	1	1	1	1	1	1	1	1	2	2
5	.5	.5	.5	.5	1	1	1	1	1	1	1	2	2	2	2	2	2
6	.5	.5	.5	1	1	1	1	1	1	2	2	2	2	2	2	2	2
7	.5	.5	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3
8	.5	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3
9	.5	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	4
10	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4
11	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4
4×5	.5	.5	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3
6	.5	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3
7	.5	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4
8	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4
9	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5
10	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	5	5
11	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6
12	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6
13	1	2	2	2	3	3	3	4	4	5	5	5	6	6	6	7	7

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5×6	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4
7	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	5
8	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	5	5
9	1	2	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6
10	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7
11	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	7
12	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8
13	2	2	3	3	3	4	4	5	5	6	6	6	7	7	8	8	9
14	2	2	3	3	4	4	5	5	6	6	7	7	7	8	8	9	9
15	2	2	3	4	4	4	5	6	6	6	7	8	8	8	9	10	10
16	2	3	3	4	4	5	5	6	6	7	7	8	9	9	10	10	11
6×7	1	1	2	2	2	3	3	3	3	4	4	4	4	5	5	5	6
8	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6
9	1	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7
10	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8
11	2	2	3	3	4	4	4	5	5	6	6	7	7	7	8	8	9
12	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10
13	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10
14	2	3	3	4	4	5	6	6	7	7	8	8	9	10	10	11	11
15	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	11	12
16	3	3	4	4	5	6	6	7	8	8	9	10	10	11	12	12	13
17	3	3	4	5	5	6	7	7	8	9	10	10	11	12	12	13	14
18	3	4	4	5	6	6	7	8	9	9	10	11	12	12	13	14	14
19	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	15
20	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	16
21	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17
22	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18

Table V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of— 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7×8	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	7
9	2	2	3	3	3	4	4	5	5	5	6	6	7	7	8	8	8
10	2	2	3	3	4	4	5	5	6	6	7	7	7	8	8	9	9
11	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10
12	2	3	3	4	4	5	6	6	7	7	8	8	9	10	10	11	11
13	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	12	12
14	3	3	4	5	5	6	7	7	8	8	9	10	10	11	12	12	13
15	3	4	4	5	6	6	7	8	8	9	10	10	11	12	13	13	14
16	3	4	4	5	6	7	7	8	9	10	10	11	12	13	13	14	15
17	3	4	5	6	6	7	8	9	10	10	11	12	13	13	14	15	16
18	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17
19	4	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18
20	4	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	19
21	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
22	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21
23	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21
24	4	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22
8×9	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10
10	2	3	3	4	4	5	5	6	6	7	7	8	9	9	10	10	11
11	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12
12	3	3	4	4	5	6	6	7	8	8	9	10	10	11	12	12	13
13	3	3	4	5	6	6	7	8	8	9	10	10	11	12	12	13	14
14	3	4	4	5	6	7	7	8	9	10	10	11	12	13	13	14	15
15	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	16
16	3	4	5	6	7	8	9	9	10	11	12	13	14	15	15	16	17
17	4	5	5	6	7	8	9	10	11	12	13	14	15	15	16	17	18
18	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19
19	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	4	5	6	7	9	10	11	12	13	14	15	16	17	18	19	20	21

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
8×21	4	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22
22	5	6	7	8	9	11	12	13	14	15	16	18	19	20	21	22	23
23	5	6	7	9	10	11	12	13	15	16	17	18	20	21	22	23	25
24	5	6	8	9	10	12	13	14	15	17	18	19	20	22	23	24	26
25	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27
26	6	7	8	10	11	12	14	15	17	18	19	21	22	24	25	26	28
27	6	7	9	10	12	13	14	16	17	19	20	22	23	24	26	27	29
28	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30
29	6	8	9	11	12	14	15	17	19	20	22	23	25	26	28	29	31
30	6	8	10	11	13	14	16	18	19	21	22	24	26	27	29	30	32
9×10	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	11	12
11	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13
12	3	4	4	5	6	6	7	8	9	9	10	11	12	12	13	14	14
13	3	4	5	5	6	7	8	9	9	10	11	12	12	13	14	15	16
14	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17
15	4	4	5	6	7	8	9	10	11	12	13	14	14	15	16	17	18
16	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19
17	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	21	22
19	5	6	7	8	9	10	11	13	14	15	16	17	18	19	21	22	23
20	5	6	7	8	10	11	12	13	14	16	17	18	19	20	22	23	24
21	5	6	8	9	10	11	13	14	15	16	18	19	20	21	23	24	25
22	5	7	8	9	11	12	13	15	16	17	18	20	21	22	24	25	26
23	6	7	8	10	11	12	14	15	17	18	19	21	22	23	25	26	28
24	6	7	9	10	12	13	14	16	17	19	20	22	23	24	26	27	29

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
9×25	6	8	9	10	12	14	15	16	18	20	21	22	24	26	27	28	30
26	6	8	9	11	12	14	16	17	19	20	22	23	25	27	28	30	31
27	6	8	10	11	13	15	16	18	19	21	23	24	26	28	29	31	32
28	7	8	10	12	13	15	17	18	20	22	24	25	27	29	30	32	34
29	7	9	10	12	14	16	17	19	21	23	24	26	28	30	31	33	35
30	7	9	11	13	14	16	18	20	22	23	25	27	29	31	32	34	36
10×11	3	4	4	5	6	7	7	8	9	10	10	11	12	12	13	14	15
12	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	16
13	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	16	17
14	4	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	19
15	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
16	4	5	6	7	9	10	11	12	13	14	15	16	17	18	19	20	21
17	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	22	23
18	5	6	7	8	10	11	12	13	14	16	17	18	19	20	22	23	24
19	5	6	8	9	10	11	13	14	15	16	18	19	20	22	23	24	25
20	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27
21	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28
22	6	7	9	10	12	13	15	16	18	19	21	22	23	25	26	28	29
23	6	8	9	11	12	14	15	17	18	20	21	23	25	26	28	29	31
24	6	8	10	11	13	14	16	18	19	21	22	24	26	27	29	30	32
25	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33
26	7	9	10	12	14	16	17	19	21	23	24	26	28	29	31	33	35
27	7	9	11	13	14	16	18	20	22	23	25	27	29	31	32	34	36
28	7	9	11	13	15	17	19	21	22	24	26	28	30	32	34	35	37
29	8	10	12	14	15	17	19	21	23	25	27	29	31	33	35	37	39
30	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11×12	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18
13	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	18	19
14	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21
15	4	6	7	8	9	10	11	12	13	14	15	16	18	19	20	21	22
16	5	6	7	8	9	11	12	13	14	15	16	18	19	20	21	22	23
17	5	6	7	9	10	11	12	14	15	16	17	19	20	21	22	24	25
18	5	7	8	9	11	12	13	15	16	17	18	20	21	22	24	25	26
19	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	26	28
20	6	7	9	10	12	13	15	16	18	19	21	22	23	25	26	28	29
21	6	8	9	11	12	14	15	17	18	20	22	23	25	26	28	29	31
22	6	8	10	11	13	15	16	18	19	21	23	24	26	27	29	31	32
23	7	8	10	12	13	15	17	19	20	22	24	25	27	29	30	32	34
24	7	9	11	12	14	16	18	19	21	23	25	26	28	30	32	33	35
25	7	9	11	13	15	16	18	20	22	24	26	28	29	31	33	35	37
26	8	10	11	13	15	17	19	21	23	25	27	29	31	32	34	36	38
27	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
28	8	10	12	14	16	18	21	23	25	27	29	31	33	35	37	39	41
29	9	11	13	15	17	19	21	23	26	28	30	32	34	36	38	40	43
30	9	11	13	15	18	20	22	24	26	29	31	33	35	37	40	42	44
12×13	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21
14	4	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22
15	5	6	7	8	10	11	12	13	14	16	17	18	19	20	22	23	24
16	5	6	8	9	10	12	13	14	15	17	18	19	20	22	23	24	26
17	5	7	8	10	11	12	14	15	16	18	19	20	22	23	24	26	27
18	6	7	9	10	12	13	14	16	17	19	20	22	23	24	26	27	29
19	6	8	9	11	12	14	15	17	18	20	21	23	24	26	27	29	30
20	6	8	10	11	13	14	16	18	19	21	22	24	26	27	29	30	32

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
12×21	7	8	10	12	13	15	17	18	20	22	24	25	27	29	30	32	34
22	7	9	11	12	14	16	18	19	21	23	25	26	28	30	32	33	35
23	7	9	11	13	15	17	18	20	22	24	26	28	29	31	33	35	37
24	8	10	12	13	15	17	19	21	23	25	27	29	31	33	35	36	38
25	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
26	8	10	12	15	17	19	21	23	25	27	29	31	33	35	37	40	42
27	9	11	13	15	17	19	22	24	26	28	30	32	35	37	39	41	43
28	9	11	13	16	18	20	22	25	27	29	31	34	36	38	40	43	45
29	9	12	14	16	19	21	23	26	28	30	33	35	37	39	42	44	46
30	10	12	14	17	19	22	24	26	29	31	34	36	38	41	43	46	48
13×14	5	6	7	8	10	11	12	13	15	16	17	18	19	21	22	23	24
15	5	6	8	9	10	12	13	14	16	17	18	20	21	22	23	25	26
16	6	7	8	10	11	12	14	15	17	18	19	21	22	24	25	26	28
17	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	29
18	6	8	9	11	12	14	16	17	19	20	22	23	25	27	28	30	31
19	7	8	10	12	13	15	16	18	20	21	23	25	26	28	30	31	33
20	7	9	10	12	14	16	17	19	21	23	24	26	28	29	31	33	35
21	7	9	11	13	15	16	18	20	22	24	25	27	29	31	33	35	36
22	8	10	11	13	15	17	19	21	23	25	27	29	31	32	34	36	38
23	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
24	8	10	12	15	17	19	21	23	25	27	29	31	33	35	37	40	42
25	9	11	13	15	17	20	22	24	26	28	30	32	35	37	39	41	43
26	9	11	14	16	18	20	23	25	27	29	32	34	36	38	41	43	45
27	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	44	47
28	10	12	15	17	19	22	24	27	29	32	34	36	39	31	44	46	49
29	10	13	15	18	20	23	25	28	30	33	35	38	40	43	45	48	50
30	10	13	16	18	21	23	26	29	31	34	36	39	42	44	47	49	52

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
14×15	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28
16	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30
17	6	8	10	11	13	14	16	17	19	21	22	24	25	27	29	30	32
18	7	8	10	12	13	15	17	18	20	22	24	25	27	29	30	32	34
19	7	9	11	12	14	16	18	20	21	23	25	27	28	30	32	34	35
20	7	9	11	13	15	17	19	21	22	24	26	28	30	32	34	35	37
21	8	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37	39
22	8	10	12	14	16	18	21	23	25	27	29	31	33	35	37	39	41
23	9	11	13	15	17	19	21	24	26	28	30	32	34	36	39	41	43
24	9	11	13	16	18	20	22	25	27	29	31	34	36	38	40	43	45
25	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	44	47
26	10	12	15	17	19	22	24	27	29	32	34	36	39	41	44	46	49
27	10	13	15	18	20	23	25	28	30	33	35	38	40	43	45	48	50
28	10	13	16	18	21	24	26	29	31	34	37	39	42	44	47	50	52
29	11	14	16	19	22	24	27	30	32	35	38	41	43	46	49	51	54
30	11	14	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56
15×16	6	8	10	11	13	14	16	18	19	21	22	24	26	27	29	30	32
17	7	8	10	12	14	15	17	19	20	22	24	26	27	29	31	32	34
18	7	9	11	13	14	16	18	20	22	23	25	27	29	31	32	34	36
19	8	10	11	13	15	17	19	21	23	25	27	28	30	32	34	36	38
20	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
21	8	10	13	15	17	19	21	23	25	27	29	32	34	36	38	40	42
22	9	11	13	15	18	20	22	24	26	29	31	33	35	37	40	42	44
23	9	12	14	16	18	21	23	25	28	30	32	34	37	39	41	44	46
24	10	12	14	17	19	22	24	26	29	31	34	36	38	41	43	46	48
25	10	12	15	18	20	22	25	28	30	32	35	38	40	42	45	48	50

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15×26	10	13	16	18	21	23	26	29	31	34	36	39	42	44	47	49	52
27	11	14	16	19	22	24	27	30	32	35	38	40	43	46	49	51	54
28	11	14	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56
29	12	14	17	20	23	26	29	32	35	38	41	44	46	49	52	55	58
30	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
16×17	7	9	11	13	15	16	18	20	22	24	25	27	29	31	33	34	36
18	8	10	12	13	15	17	19	21	23	25	27	29	31	33	35	36	38
19	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	39	41
20	9	11	13	15	17	19	21	23	26	28	30	32	34	36	38	41	43
21	9	11	13	16	18	20	22	25	27	29	31	34	36	38	40	43	45
22	9	12	14	16	19	21	23	26	28	31	33	35	38	40	42	45	47
23	10	12	15	17	20	22	25	27	29	32	34	37	39	42	44	47	49
24	10	13	15	18	20	23	26	28	31	33	36	38	41	44	46	49	51
25	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53
26	11	14	17	19	22	25	28	31	33	36	39	42	44	47	50	53	55
27	12	14	17	20	23	26	29	32	35	37	40	43	46	49	52	55	58
28	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
29	12	15	19	22	25	28	31	34	37	40	43	46	49	53	56	59	62
30	13	16	19	22	26	29	32	35	38	42	45	48	51	54	58	61	64
17×18	8	10	12	14	16	18	20	22	24	27	29	31	33	35	37	39	41
19	9	11	13	15	17	19	22	24	26	28	30	32	34	37	39	41	43
20	9	11	14	16	18	20	23	25	27	29	32	34	36	39	41	43	45
21	10	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48
22	10	12	15	17	20	22	25	27	30	32	35	37	40	42	45	47	50
23	10	13	16	18	21	23	26	29	31	34	36	39	42	44	47	50	52
24	11	14	16	19	22	24	27	30	33	35	38	41	44	46	49	52	54

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
17×25	11	14	17	20	23	26	28	31	34	37	40	42	45	48	51	54	57
26	12	15	18	21	24	27	29	32	35	38	41	44	47	50	53	56	59
27	12	15	18	21	24	28	31	34	37	40	43	46	49	52	55	58	61
28	13	16	19	22	25	29	32	35	38	41	44	48	51	54	57	60	63
29	13	16	20	23	26	30	33	36	39	43	46	49	53	56	59	62	66
30	14	17	20	24	27	31	34	37	41	44	48	51	54	58	61	65	68
18×19	9	11	14	16	18	21	23	25	27	30	32	34	36	39	41	43	46
20	10	12	14	17	19	22	24	26	29	31	34	36	38	41	43	46	48
21	10	13	15	18	20	23	25	28	30	33	35	38	40	43	45	48	50
22	11	13	16	18	21	24	26	29	32	34	37	40	42	45	48	50	53
23	11	14	17	19	22	25	28	30	33	36	39	41	44	47	50	52	55
24	12	14	17	20	23	26	29	32	35	37	40	43	46	49	52	55	58
25	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
26	12	16	19	22	25	28	31	34	37	41	44	47	50	53	56	59	62
27	13	16	19	23	26	29	32	36	39	42	45	49	52	55	58	62	65
28	13	17	20	24	27	30	34	37	40	44	47	50	54	57	60	64	67
29	14	17	21	24	28	31	35	38	42	45	49	52	56	59	63	66	70
30	14	18	22	25	29	32	36	40	43	47	50	54	58	61	65	68	72
19×20	10	13	15	18	20	23	25	28	30	33	35	38	41	43	46	48	51
21	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53
22	11	14	17	20	22	25	28	31	33	36	39	42	45	47	50	53	56
23	12	15	17	20	23	26	29	32	35	38	41	44	47	50	52	55	58
24	12	15	18	21	24	27	30	33	36	40	43	46	49	52	55	58	61
25	13	16	19	22	25	28	32	35	38	41	44	48	51	54	57	60	63
26	13	16	20	23	26	30	33	36	40	43	46	49	53	56	59	63	66
27	14	17	21	24	27	31	34	38	41	44	48	51	55	58	62	65	68

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of— 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
19×28	14	18	21	25	28	32	35	39	43	46	50	53	57	60	64	67	71
29	15	18	22	26	29	33	37	40	44	48	51	55	59	62	66	70	73
30	15	19	23	27	30	34	38	42	46	49	53	57	61	65	68	72	76
20×21	11	14	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56
22	12	15	18	21	23	26	29	32	35	38	41	44	47	50	53	56	59
23	12	15	18	21	25	28	31	34	37	40	43	46	49	52	55	58	61
24	13	16	19	22	26	29	32	35	38	42	45	48	51	54	58	61	64
25	13	17	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67
26	14	17	21	24	28	31	35	38	42	45	49	52	55	59	62	66	69
27	14	18	22	25	29	32	36	40	43	47	50	54	58	61	65	68	72
28	15	19	22	26	30	34	37	41	45	49	52	56	60	63	67	71	75
29	15	19	23	27	31	35	39	43	46	50	54	58	62	66	70	73	77
30	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
21×22	12	15	18	22	25	28	31	34	37	40	43	46	49	52	55	59	62
23	13	16	19	23	26	29	32	35	39	42	45	48	52	55	58	61	64
24	13	17	20	24	27	30	34	37	40	44	47	50	54	57	60	64	67
25	14	18	21	24	28	32	35	38	42	46	49	52	56	60	63	66	70
26	15	18	22	25	29	33	36	40	44	47	51	55	58	62	66	69	73
27	15	19	23	26	30	34	38	42	45	49	53	57	60	64	68	72	76
28	16	20	24	27	31	35	39	43	47	51	55	59	63	67	71	74	78
29	16	20	24	28	32	37	41	45	49	53	57	61	65	69	73	77	81
30	17	21	25	29	34	38	42	46	50	55	59	63	67	71	76	80	84

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
22×23	13	17	20	24	27	30	34	37	40	44	47	51	54	57	61	64	67
24	14	18	21	25	28	32	35	39	42	46	49	53	56	60	63	67	70
25	15	18	22	26	29	33	37	40	44	48	51	55	59	62	66	70	73
26	15	19	23	27	31	34	38	42	46	50	53	57	61	65	69	72	76
27	16	20	24	28	32	36	40	44	48	51	55	59	63	67	71	75	79
28	16	21	25	29	33	37	41	45	49	53	57	62	66	70	74	78	82
29	17	21	26	30	34	38	43	47	51	55	60	64	68	72	77	81	85
30	18	22	26	31	35	40	44	48	53	57	62	66	70	75	79	84	88
23×24	15	18	22	26	29	33	37	40	44	48	52	55	59	63	66	70	74
25	15	19	23	27	31	34	38	42	46	50	54	58	61	65	69	73	77
26	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
27	17	21	25	29	33	37	41	46	50	54	58	62	66	70	75	79	83
28	17	21	26	30	34	39	43	47	52	56	60	64	69	73	77	82	86
29	18	22	27	31	36	40	44	49	53	58	62	67	71	76	80	84	89
30	18	23	28	32	37	41	46	51	55	60	64	69	74	78	83	87	92
24×25	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
26	17	21	25	29	33	37	42	46	50	54	58	62	67	71	75	79	83
27	17	22	26	30	35	39	43	48	52	56	60	65	69	73	78	82	86
28	18	22	27	31	36	40	45	49	54	58	63	67	72	76	81	85	90
29	19	23	28	32	37	42	46	51	56	60	65	70	74	79	84	88	93
30	19	24	29	34	38	43	48	53	58	62	67	72	77	82	86	91	96

TABLE V.—*Deductions for rectangular defects, from solid board-foot contents*—Continued

[Scribner Decimal C log rule—board feet in tens]

End dimensions, inches	Deductions for defect length, in feet, of—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
25×26	17	22	26	30	35	39	43	48	52	56	61	65	69	74	78	82	87
27	18	22	27	32	36	40	45	50	54	58	63	68	72	76	81	86	90
28	19	23	28	33	37	42	47	51	56	61	65	70	75	79	84	89	93
29	19	24	29	34	39	44	48	53	58	63	68	72	77	82	87	92	97
30	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
26×27	19	23	28	33	37	42	47	51	56	61	66	70	75	80	84	89	94
28	19	24	29	34	39	44	49	53	58	63	68	73	78	83	87	92	97
29	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	96	101
30	21	26	31	36	42	47	52	57	62	68	73	78	83	88	94	99	104
27×28	20	25	30	35	40	45	50	55	60	66	71	76	81	86	91	96	101
29	21	26	31	37	42	47	52	57	63	68	73	78	84	89	94	99	104
30	22	27	32	38	43	49	54	59	65	70	76	81	86	92	97	103	108
28×29	22	27	32	38	43	49	54	60	65	70	76	81	87	92	97	103	108
30	22	28	34	39	45	50	56	62	67	73	78	84	90	95	101	106	112
29×30	23	29	35	41	46	52	58	64	70	75	81	87	93	99	104	110	116

TABLE VI.—*Deductions for pitch and shake rings showing on both ends of logs, with various amounts of ring taper*[1]

[Scribner Decimal C rule—board feet in tens]

Inside diameter of ring, small end of log	Ring taper in log											
	1 or 2 inches			3 or 4 inches			5 or 6 inches			7 or 8 inches		
	16 ft.	18 ft.	20 ft.	16 ft.	18 ft.	20 ft.	16 ft.	18 ft.	20 ft.	16 ft.	18 ft.	20 ft.
6	5	6	7	7	8	9	9	10	11	11	13	14
7	6	7	8	8	9	10	10	12	13	12	14	16
8	8	9	10	10	12	13	12	14	16	15	17	20
9	9	11	12	11	13	15	14	16	19	17	20	22
10	9	11	12	12	14	16	15	18	19	18	21	23
11	11	12	15	14	16	18	17	19	22	20	23	26
12	13	15	16	16	18	20	19	22	24	23	26	29
13	14	16	18	17	20	22	21	24	27	25	28	31
14	16	18	20	20	22	25	24	26	29	28	30	34
15	17	19	21	21	23	25	25	27	30	29	32	35
16	19	21	23	23	25	28	27	30	33	31	35	39
17	21	22	25	25	27	30	29	32	36	34	37	42
18	22	24	26	26	29	32	31	34	38	35	39	44
19	23	26	29	28	31	35	32	36	41	37	42	47
20	24	27	30	28	32	36	33	38	42	39	44	48
21	26	29	33	31	35	39	37	41	45	42	47	52
22	28	31	35	34	37	41	39	43	48	45	49	55
23	29	33	36	34	39	43	40	45	50	46	52	58
24	32	36	40	38	42	47	44	49	55	50	56	62
25	32	35	40	38	42	48	44	49	55	50	56	63
26	34	38	43	40	45	50	46	52	58	53	60	66
27	35	39	44	41	46	52	48	54	60	54	62	68
28	38	43	47	45	51	55	51	59	63	58	67	73
29	42	48	52	48	56	60	55	64	70	62	72	80
30	43	50	54	50	58	64	57	66	74	65	74	82

[1] Example: A 16-foot log has a ring 10 inches in diameter in the top end and 14 inches in the butt end. Thus with a 4-inch taper, a 10-inch ring diameter, and a 16-foot length, the deduction is 12.

Instructions for Use of Pitch and Shake Ring Deduction Table

1. Measure rings at both ends to obtain taper.
2. Refer to table. Use small end ring and proper taper column for deduction.
3. When 2 full rings are over 2½ inches apart, measure diameter of both rings, refer to the proper columns for deductions. Add deductions together.

Supplementary Instructions

For rings showing on one end only, use squared-defect method and replace volume of core.

For logs shorter than 16 feet, use the large end ring and the Coconino scale stick.

When 2 full rings are not more than 2½ inches apart, measure diameter of the outside ring. Add 1 inch. Apply squared-defect method for gross deduction. Reduce this by the scale of a log with a diameter of the inner ring.

When multiple rings occur with no recovery between them, square the overall defect and allow for the scale of any inside log surrounded by rings.

For a full or partial ring 2½ inches or less from the outside at the top end (perimeter ring), deduct as for sap rot.

TABLE VII.—*Deduction for absolute sweep* [1]

Sweep in logs [2]		Percent deduction for logs with small end D.i.b. (inches) of—									
8 ft. long	16 ft. long	8	10	12	14	16	18	20	22	24	26
In.	*In.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
2	3	12	10	10	5	5	------	------	------	------	------
3	4	25	20	15	10	10	10	10	10	10	10
4	5	40	30	25	20	20	15	15	15	15	10
5	6	50	40	35	30	25	20	20	20	15	15
6	7	------	50	40	35	30	30	25	25	20	20
7	8	------	------	50	45	40	35	30	30	25	25
8	9	------	------	60	50	45	40	35	30	30	25
9	10	------	------	------	------	50	45	40	35	35	30
10	11	------	------	------	------	55	50	45	40	40	35
11	12	------	------	------	------	------	------	55	50	50	40

[1] Grosenbaugh formula (16-foot logs):

$$\text{Percent sweep} = \frac{\text{Absolute sweep (inches)} - 2}{\text{D.i.b. small end}}$$

[2] Interpolate for other lengths.

Refer to code 33, Sweep.

TABLE VIII.—*Knot guide to merchantability and deductions*[1] (*to be used only if locally applicable*)

[For knots over 4 inches in diameter and with less than 2 feet average spacing between them[2]]

Log size (inches)	Faces affected	Merchantable if knots are—		Log diameter deductions	
		Mostly live	Mostly dead	Mostly live	Mostly dead
	Number			*Inches*	*Inches*
Up through 18	4	No	No		
	3	Yes	No	3	
	2	Yes	Yes	2	3
	1	Yes	Yes	0	1
19 and larger	4	Yes	Yes	3	4
	3	Yes	Yes	2	3
	2	Yes	Yes	1	2
	1	Yes	Yes	0	0

[1] Primarily for upper logs of wolf-type trees of coniferous species characterized by large and often dead knots, such as found in Douglas-fir and western larch. Generally not applicable to pines and hardwoods.

[2] Measure knots for size at log surface just above any swelling. Measure spacing between knots from inside limb edges and above any swelling.

TABLE IX.—*Twelve common rots and fungi in saw logs*

1. *Fomes pini*

Common name.—Conk rot, red ring rot; sometimes called honeycomb rot, particularly in pine and larch.

Hosts.—Western white, ponderosa, lodgepole, whitebark, limber pine; Engelmann spruce; western hemlock; sugar pine; mountain hemlock; white, alpine, Shasta red fir; Douglas-fir; western redcedar; western larch.

General form.—Trunk rot rarely acting as butt rot. Generally patchy. Enters through dead branch stubs, rarely through wounds. The rot column is roughly conical in both directions from area of greatest decay in trunk. Often as patchy ring- or crescent-shaped areas not uniformly attacking the heartwood except in very advanced stages.

The rot column may extend from a few feet to entire tree length.

Characteristics.—Heart rot in resinous trees, heart rot or sap rot in trees with little or no resin. Rot in early stages reddish color in split section with small white patches mingled with pitted areas and in advanced stages ring-scaled. Delignifying rot, converting wood to cellulose; white pocket rot.

External signs.—Typical fruiting bodies or conks of fungus on log. Indications at old branch whorls, either by swells or by brownish punky substance, that fruiting bodies have dropped off. Soundings made on trunk to detect punkiness indicating decay. Punk knots or blind conks.

Fruiting body.—Sometimes called ring-scale fungus, brown shell fungus. Fruiting body is hoof or shell shape, perennial, hard, woody, upper surface dark brown, rough, hairy when young, with concentric raised zones, substance brown, pores usually large and round, pore layer stratified.

2. *Polyporus schweinitzii*

Common name.—Red-brown butt rot. Stump or ground rot.

Hosts.—Western white, ponderosa, lodgepole, whitebark, limber pine; Douglas-fir; grand, white, alpine, Shasta red fir; western redcedar; Engelmann spruce.

General form.—A uniform circular butt rot; a wound fungus. The rot column is generally conical from base of tree upward. Uniform, usually not advancing beyond first log. The rot column may extend from roots to 8 to 12 feet up into first log. Usually not more than 5 or 6 feet upward.

Characteristics.—Uniform heart rot of butt of tree, also enters roots. Rot in the early stage is light reddish brown; typical stage is reddish brown, pronounced cubical, crumbly, brittle when dry; occasionally with thin resinous crusts of white feltlike material (mycelium), odor of turpentine. Carbonizing rot.

External signs.—Typical fruiting bodies of the fungus on the ground near the tree (often partly covered by debris), sometimes found as bracket fungus issuing from injuries at base of the tree (never high up on the trunk). Indications of brown rot in the exposed roots. Soundings on the basal portion of the tree and exposed roots. Indications of typical rot.

Fruiting body.—Sometimes called velvet-top or cowdung fungus. Fruiting body annual, stem short, dark brown, covered with stiff hairs, flesh brown, soft and spongy when fresh, brittle when dry, pores large when young, becoming torn with age. Attached to the roots near the base of the tree or directly on the base of the tree.

3. Echinodontium tinctorium

Common name.—Brown stringy rot; rust-red stringy rot.

Hosts.—Alpine, white, grand fir; western, mountain hemlock. Of economic importance only on true firs and hemlocks. Shasta red fir; Engelmann spruce.

General form.—A uniform circular trunk rot, entering through branch stubs and wounds. The rot column is roughly conical in both directions from area of greatest decay. Very uniform in occupying most or all of the heartwood. The rot column may extend from a few feet to entire tree length, depending upon the degree of infection.

Characteristics.—Uniform heart rot, confined to given trees almost entirely. Rot in early stages: wood spongy yellow stained; typical stage: soft stringy, often separating along the annual rings, brownish to rusty red in color, knots show deep rusty red color. Sawed surface of cross section pitted, broken, stringy with reddish brown discolorations, often hollow rotted, carbonizing rot; viz, reducing cellulose, producing dark-colored decay.

External signs.—Typical fruiting bodies of the fungus on the tree. Indications at branch whorls either by swells or by deep rust red punk knots that fruiting bodies had dropped off. Large number of dead branch stubs accompanied by pronounced swells of whorls. Deep rusty red color in old branch stubs. Soundings made on trunk.

Many injuries. such as logging scars. fire scars. frost cracks, blazes, etc., are indications of typical rot.

Fruiting body.—Sometimes called Indian paint fungus, fruiting body perennial. hard and woody. gray or black above with concentric growth zones, substance brick red, lower surface covered with hard sharp spines when mature.

4. Fomes pinicola

Common name.—Brown crumbling rot.

Hosts.—Attacks all the important conifers. but principally western larch; western, mountain hemlock; alpine, grand fir: Douglas-fir (dead): Shasta red, white fir; especially Sitka spruce and hemlock in Alaska.

General form.—A uniform circular trunk rot; a wound fungus. The rot column is generally uniform and conical. The rot column usually occupies entire heartwood of tree on the portion of the tree infected. Rarely extending beyond the first log length.

Characteristics.—Uniform heart rot found principally in dead. standing. and down timber. occasionally acting as heart rot in living trees by gaining entrance through injuries. In early stages rot is light brown: typical stage, reddish brown, cubical, crumbly and brittle when dry, white feltlike layers of mycelium between cubical patches. Felt patches larger. thicker, and nonresinous as compared to those of velvet-top fungus. Carbonizing rot.

External signs.—Typical "red belt" fruiting bodies of the fungus on the tree. Typical rot at old branch stubs. Soundings made on the trunk. Indications of typical rot.

Fruiting body.—Sometimes called red-margin Fomes; red-belt Fomes. Fruiting body. perennial. hard, woody, flat or hoof-shaped, surface smooth. furrowed gray or black with resinous crust, margin white or reddish. substance whitish or wood colored, pores in layers.

5. Polyporus sulphureus

Common name.—Brown cubical rot; reddish-brown heart rot.

Hosts.—Attacks most all of the important conifers but principally ponderosa, western white pine; Douglas-fir: western larch; Shasta red fir; Engelmann spruce; white fir.

General form.—This is a uniform circular butt and trunk rot. A wound fungus.
The rot column is generally uniform and conical.
The rot column usually occupies the entire heartwood of the tree at point of greatest infection. Usually a butt rot, rarely extending beyond the first log length.
Characteristics.—Uniform heart rot. Rot in early stages light brown, typical stage, dark reddish brown. brittle dry. crumbly. not pronounced cubical. with thick felty mycelial masses in clefts, arranged star-shaped in cross section. Carbonizing rot.
External signs.—Typical fruiting bodies of the fungus on the tree. Soundings made on the trunk. Indications of typical rot.
Fruiting body.—Sometimes called sulfur fungus. Fruiting structure annual. broad, with several parts one above another, smooth, zoned, lemon yellow to orange, white when old, flesh white, crumbly when dry, pores small, sulfur yellow.

6. *Fomes officinalis*

Common name.—Reddish-brown heart rot: brown trunk rot.
Hosts.—Attacks all important conifers but principally western larch; ponderosa, sugar pine; white, Shasta red fir; Douglas-fir; Engelmann spruce.
General form.—Trunk rot. Wound fungus.
The rot column is generally uniform and conical.
The rot column usually occupies the entire heartwood of the tree in advanced stages. Most commonly occupies upper portion of merchantable timber; rarely a typical butt rot.
Characteristics.—Uniform heart rot. Rot in early stages light brown; typical stage, dark reddish brown, brittle dry, crumbly with thin felty mycelial masses in clefts. Carbonizing rot.
External signs.—Typical fruiting bodies of the fungus on the tree. the principal means of distinction between rots of this species and that of sulfur fungus. Soundings made on the trunk. Indications of typical rot.
Fruiting body.—Also known as *Fomes laricis* (chalky quinine fungus). Perennial hoof-shaped, sometimes cylindrical, snow white, substance white soft. bitter to the taste. pores small, white arranged in layers.

7. Poria weirii

Common name.—Yellow laminated rot.

Hosts.—Western redcedar and eastern arborvitae. Douglas-fir.

General form.—Butt rot. Uniform circular rot. Wound fungus.

The rot column is generally uniform and conical.

The rot column may extend from roots to 5 to 8 feet up into first log, often causing hollow butts. Rarely throughout entire pole length in old trees.

Characteristics.—Uniform heart rot. Rot yellow color, decays springwood, separating annual rings. In advanced stages brown, felty, mycelium between layers. Carbonizing rot.

External signs.—Typical fruiting bodies of the fungus on the tree (in the root crotches, often cementing the forest debris about the roots into a punky mass). Soundings at base of tree and exposed root spurs.

Fruiting body.—Sometimes called brown cedar Poria. Fruiting structure flat growing, inconspicuous, perennial, stratified, substance brown. Grows in root crotches and underside of down trees and logs.

8. Fomes annosus

Common name.—White spongy rot.

Hosts.—Western white, ponderosa, lodgepole, whitebark, limber pine; Engelmann spruce; western, mountain hemlock; Shasta red, alpine, grand, white fir; Douglas-fir; western redcedar; western larch.

General form.—Butt rot. Uniform circular. Pathogenic: can attack the cambium layer.

The rot column is generally conical and uniform, filling heartwood and part or all sapwood.

The rot column may extend from roots to 6 or 8 feet into first log; sometimes much higher in hemlock. Soon producing hollow butts.

Characteristics.—Uniform sap rot and heart rot of butt. Rot in early stages, ranging from lilac to reddish color; typical stage in whitish areas separated by smaller areas of sound wood, not prominently pitted, occasionally with black dots in center of white areas, in last stages annual rings separated; finally wet spongy. Fine felty masses (mycelium) under bark scales. Delignifying rot.

External signs.—Typical fruiting bodies of the fungus in root crotches usually covered by litter or duff. Resin flow at base of tree and exposed roots. Soundings at base of tree and exposed roots.

Fruiting body.—Sometimes called root Fomes. Fruiting body woody, usually thin and irregular, with a smooth brown crust, perennial; substance white or pale yellowish, pores small stratified and white. Found in the root crotches or under litter, not easily seen.

9. *Pholiota adiposa*

Common name.—Mottled rot; yellow heart rot.

Hosts.—Alpine, grand, white, Shasta red fir; western, mountain hemlock; Engelmann spruce; western white pine. Usually of most importance on the true firs.

General form.—Trunk rot. Uniform circular.

The rot column is generally conical in heartwood.

The rot column may extend from stumps to entire merchantable tree length. Usually confined to the first two log lengths. Sometimes localized in a single log.

Characteristics.—Uniform heart rot, principally of trees with little or no resin. Rot in early stages a light yellow stain; typical stage, yellow or honey color, brownish streaks, yellowish to light tan or white felty masses running across grain, breaking up in the last stages and separating annual rings, finally becoming hollow rotted. Carbonizing rot.

External signs.—Typical fruiting bodies of the fungus on the tree. Soundings made on the trunk. Indications of typical rot.

Fruiting body.—Sometimes called scaly Pholiota or yellow cap fungus. Fruiting body annual, mushroom type, appearing in clusters, yellow on upper surface, sticky when wet, stem yellow, gills yellowish to brown.

10. *Ceratostomella* species

Common name.—Blue stain.

Hosts.—Especially ponderosa, southern yellow, lodgepole, whitebark, limber pine; Engelmann spruce; western hemlock; but all soft and hard woods are affected.

General form.—Sap stain. Since the bluing fungus does not attack the cell walls except to a negligible extent and feeds only upon the cell contents, blued wood is not weakened. This has been determined by comparative mechanical tests on stained and unstained wood. But high moisture content and warm weather, which promote the development of the bluing fungus, are highly favorable to the development of true wood-destroying fungi. The fact that blued wood may soon show evidences of decay when put in service is due to the true wood-destroying fungi and not to the bluing fungus. Although the strength of blued wood is not impaired by the color, the wood may be objectionable in places where color is a factor.

NOTE: Certain other discolorations of sapwood are produced by fungi belonging to the molds, of which the green mold on fruits or in certain cheeses is an example. Such stains are usually superficial and may be planed off. They are difficult to distinguish by visual inspection from the true blue stain.

Characteristics.—Blue or bluish gray or black color of the sapwood, rarely in the heartwood, color usually most intense in the rays, causing it to appear in streaks in early stages. Due to the character of the wood, conifers are more susceptible than hardwoods. Fruiting body of the bluing fungus not readily seen. When the color is so dense that it is almost black, small bristles with a bulbous base may be seen with a hand lens. The color, depending upon the weather conditions, usually appears very rapidly in trees killed by bark beetles or fire, or in piled logs cut from green trees. Lumber in yards may blue very rapidly if not properly piled or treated. Blue color is due to the reflection to the surface of the wood of the colored mycelium in the wood cells. The wood itself is not stained by the true bluing fungus.

External signs.—"Blued" sapwood. Blued streaks extending from the sap into the heartwood of some logs. Dead and dying trees, killed by bark beetles, fire, or various other agents, are very susceptable to blue stain.

Fruiting body.—Sometimes called Bluing fungus. Fruiting body small, black, with long appendages, can best be seen with hand lens, appears on surface of boards or on wood of logs beneath bark.

11. Polyporus amarus

Comon name.—Pocket dry rot.

Hosts.—Incense-cedar.

General form.—Trunk rot. The rot column usually occupies entire heartwood, not common in butt portion.

Characteristics.—In early stage, pocket dry rot appears as a faint yellowish-brown discoloration of the heartwood. Later elongated pockets with pointed ends develop, longer than broad, from ½ inch to 12 inches. Wood broken down into a dark brown friable residue. Pockets confined to the heartwood of the main trunk or bases of large limbs. Pockets seldom form in exposed heartwood, are sparse near large open wounds.

External signs.—Typical fruiting bodies on the tree, rare. Open borings or shot-hole cups replace conks. Large open fire wounds are indicators of this rot in most locations.

Fruiting body.—Half bell-shaped or somewhat hoof-shaped, 4 to 8 inches wide, buff to tan on top, bright sulfur-yellow underneath, darkens in age to chalky tan, soft and moist when fresh, firm and dry when old.

12. Polyporus anceps

Common name.—Western red rot; red ray rot.

Host.—Ponderosa pine.

General form.—Heart rot. Fungus does not require conspicuous entrance courts such as wounds, fire scars, or dead tops. Enters only through recently dead, bark-covered branches. Requires moisture to sustain attack. The rot column extending to heartwood is invaded longitudinally by a localized infection in the form of a decay column from a knot. Radial and tangential spread is initially slow; may spread through entire tree length but affects mostly logs from middle portion.

Characteristics.—Wood decayed in irregular streaks or pockets. In early stage of decay, heartwood reddish to dark brown. Discolored areas, often fan-shaped, radiate out from the log center, resemble spokes of a wheel or may be isolated anywhere in heartwood. In advanced stage, heartwood is whitish or grayish in color. Rotted wood consists of soft white strands of cellulose intermixed with less rotted wood particles, often wet and soggy, usually in log center, often surrounded by the fanlike areas of an early stage. In longitudinal section, incipient decay often appears as several separate discolored areas. In advanced stage, appears continuous. Decay entering through knots may be concentrated in the pith cavity.

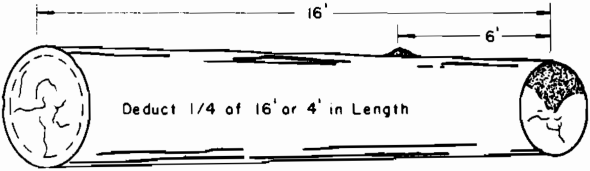
External signs.—Limited. Fruiting bodies rarely formed on trees and then only on dead bark-covered branches. No swollen knots.

Fruiting body.—Fruiting bodies found mostly on decaying dead material in contact with the ground.

EXHIBIT A

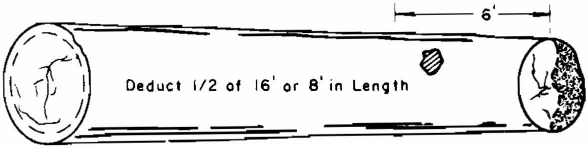
Example of Local Chart Guide for Conk Rot for One Species

1



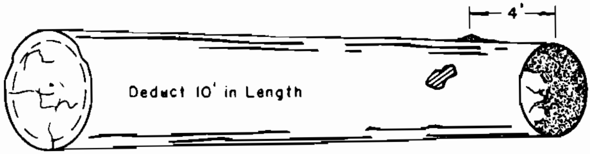
One-fourth of Scaling Cylinder, One End Only

2



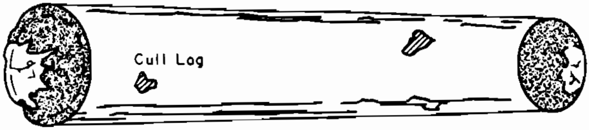
One-half of Scaling Cylinder, One End Only

3



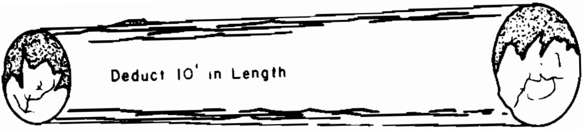
Over Half of Scaling Cylinder, One End Only

4



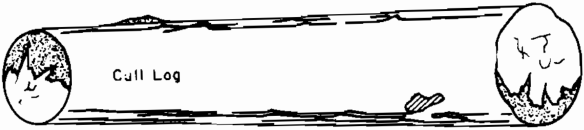
Over Half of Scaling Cylinder, Both Ends

5



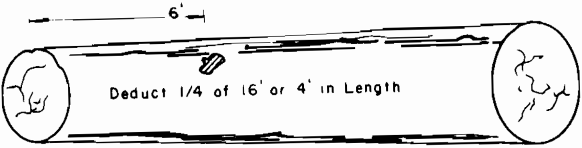
Less Than One-half of Both Ends Affected With One Conk Show

6



One-half of Both, But Opposite, End Affected

7



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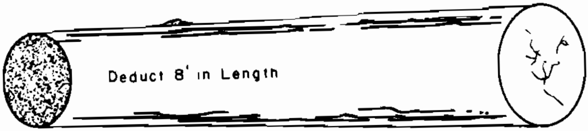

9

Table X.—*International ¼-Inch log rule* [1]

Diameter (inches)	Volume (board feet) according to length, in feet—								
	4	5	6	7	8	9	10	11	12
5	------	------	5	5	5	5	5	5	10
6	5	5	5	5	10	10	10	10	15
7	5	5	10	10	10	15	15	15	20
8	10	10	10	15	15	20	20	25	25
9	10	15	15	20	20	25	30	30	35
10	15	15	20	25	30	35	35	40	45
11	15	20	25	30	35	40	45	50	55
12	20	25	30	40	45	50	55	65	70
13	25	30	40	45	55	60	70	75	85
14	30	40	45	55	65	70	80	90	100
15	35	45	55	65	75	85	95	105	115
16	40	50	60	75	85	95	110	120	130
17	45	60	70	85	95	110	125	135	150
18	55	65	80	95	110	125	140	155	170
19	60	75	90	105	125	140	155	175	190
20	65	85	100	120	135	155	175	195	210
21	75	95	115	135	155	175	195	215	235
22	80	105	125	145	170	190	215	235	260
23	90	115	140	160	185	210	235	260	285
24	100	125	150	175	205	230	255	285	310
25	110	135	165	195	220	250	280	310	340
26	120	150	180	210	240	275	305	335	370
27	130	160	195	225	260	295	330	365	400
28	140	175	210	245	280	320	355	395	430
29	150	185	225	265	305	345	385	425	465
30	160	200	245	285	325	370	410	455	495
31	170	215	260	305	350	395	440	485	530
32	185	230	280	325	375	420	470	520	570
33	195	245	295	345	400	450	500	555	605
34	210	260	315	370	425	480	535	590	645
35	220	280	335	390	450	510	565	625	685
36	235	295	355	415	475	540	600	665	725
37	250	315	375	440	505	570	635	700	770
38	265	330	400	465	535	605	670	740	810
39	280	350	420	490	565	635	710	785	855
40	295	370	445	520	595	670	750	825	900
41	310	385	465	545	625	705	785	870	950
42	325	405	490	575	655	740	825	910	995
43	340	430	515	600	690	780	870	955	1,045
44	355	450	540	630	725	815	910	1,005	1,095
45	375	470	565	660	755	855	955	1,050	1,150

[1] Values as published by H. H. Chapman, extended by formula: $V=(0.22D^2-0.71D)\times.905$ for 4-foot section. Taper allowance: ½ inch per 4 feet lineal.

Diameter (inches)	Volume (board feet) according to length, in feet—							
	13	14	15	16	17	18	19	20
5	10	10	10	10	15	15	15	15
6	15	15	20	20	20	25	25	25
7	20	25	25	30	30	35	35	40
8	30	35	35	40	40	45	50	50
9	40	45	45	50	55	60	65	70
10	50	55	60	65	70	75	80	85
11	65	70	75	80	85	95	100	105
12	75	85	90	95	105	110	120	125
13	90	100	105	115	125	135	140	150
14	105	115	125	135	145	155	165	175
15	125	135	145	160	170	180	195	205
16	145	155	170	180	195	205	220	235
17	165	180	190	205	220	235	250	265
18	185	200	215	230	250	265	280	300
19	205	225	245	260	280	300	315	335
20	230	250	270	290	310	330	350	370
21	255	280	300	320	345	365	390	410
22	285	305	330	355	380	405	430	455
23	310	335	360	390	415	445	470	495
24	340	370	395	425	455	485	515	545
25	370	400	430	460	495	525	560	590
26	400	435	470	500	535	570	605	640
27	435	470	505	540	580	615	655	690
28	470	510	545	585	625	665	705	745
29	505	545	590	630	670	715	755	800
30	540	585	630	675	720	765	810	860
31	580	625	675	720	770	820	870	915
32	620	670	720	770	825	875	925	980
33	660	715	765	820	875	930	985	1,045
34	700	760	815	875	930	990	1,050	1,110
35	745	805	865	925	990	1,050	1,115	1,175
36	790	855	920	980	1,045	1,115	1,180	1,245
37	835	905	970	1,040	1,110	1,175	1,245	1,315
38	885	955	1,025	1,095	1,170	1,245	1,315	1,390
39	930	1,005	1,080	1,155	1,235	1,310	1,390	1,465
40	980	1,060	1,140	1,220	1,300	1,380	1,460	1,540
41	1,030	1,115	1,200	1,280	1,365	1,450	1,535	1,620
42	1,085	1,170	1,260	1,345	1,435	1,525	1,615	1,705
43	1,140	1,230	1,320	1,410	1,505	1,600	1,695	1,785
44	1,195	1,290	1,385	1,480	1,580	1,675	1,775	1,870
45	1,250	1,350	1,450	1,550	1,650	1,755	1,855	1,960

TABLE X.—*International ¼-Inch log rule*—Continued

Diameter (inches)	Volume (board feet) according to length, in feet—								
	4	5	6	7	8	9	10	11	12
46	390	490	590	690	795	895	995	1,100	1,200
47	410	515	620	725	830	935	1,040	1,150	1,255
48	430	535	645	755	865	975	1,090	1,200	1,310
49	445	560	675	790	905	1,020	1,135	1,250	1,370
50	465	585	705	820	940	1,060	1,185	1,305	1,425
51	485	610	735	855	980	1,105	1,235	1,360	1,485
52	505	635	760	890	1,020	1,150	1,285	1,415	1,545
53	525	660	795	925	1,060	1,195	1,335	1,470	1,605
54	545	685	825	965	1,100	1,245	1,385	1,530	1,670
55	565	710	855	1,000	1,145	1,290	1,440	1,585	1,735
56	590	740	890	1,040	1,190	1,340	1,495	1,645	1,800
57	610	765	920	1,075	1,230	1,390	1,550	1,705	1,865
58	635	795	955	1,115	1,275	1,440	1,605	1,770	1,930
59	655	820	990	1,155	1,320	1,490	1,660	1,830	2,000
60	680	850	1,025	1,195	1,370	1,545	1,720	1,895	2,070

Diameter (inches)	Volume (board feet) according to length, in feet—							
	13	14	15	16	17	18	19	20
46	1,305	1,410	1,515	1,620	1,730	1,835	1,940	2,050
47	1,365	1,475	1,585	1,695	1,805	1,915	2,030	2,140
48	1,425	1,540	1,655	1,770	1,885	2,000	2,115	2,235
49	1,485	1,605	1,725	1,845	1,965	2,085	2,205	2,330
50	1,550	1,675	1,795	1,920	2,045	2,175	2,300	2,425
51	1,615	1,745	1,870	2,000	2,130	2,265	2,395	2,525
52	1,680	1,815	1,945	2,080	2,215	2,355	2,490	2,625
53	1,745	1,885	2,025	2,165	2,305	2,445	2,590	2,730
54	1,815	1,960	2,100	2,245	2,395	2,540	2,690	2,835
55	1,885	2,035	2,185	2,330	2,485	2,640	2,790	2,945
56	1,955	2,110	2,265	2,420	2,575	2,735	2,895	3,050
57	2,025	2,185	2,345	2,510	2,670	2,835	3,000	3,165
58	2,100	2,265	2,430	2,600	2,770	2,935	3,105	3,275
59	2,170	2,345	2,515	2,690	2,865	3,040	3,215	3,390
60	2,250	2,425	2,605	2,785	2,965	3,145	3,325	3,510

TABLE XI.—*Forest Service International ¼-Inch Decimal rule*

[Board-foot volumes in tens]

Diameter (in.)	Volume according to log length, in feet																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
5	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2
6	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3
7	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4
8	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5
9	1	1	2	2	2	3	3	3	4	4	4	5	5	6	6	6	7
10	1	2	2	2	3	3	4	4	5	5	6	6	6	7	8	8	9
11	2	2	3	3	4	4	5	5	6	6	7	7	8	9	9	10	11
12	2	3	3	4	4	5	6	6	7	8	8	9	10	10	11	12	13
13	3	3	4	5	5	6	7	8	8	9	10	11	12	12	13	14	15
14	3	4	5	5	6	7	8	9	10	11	12	13	14	15	16	17	18
15	4	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20
16	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23
17	5	6	7	8	10	11	12	14	15	16	18	19	21	22	24	25	27
18	5	7	8	10	11	12	14	15	17	18	20	22	23	25	27	28	30
19	6	8	9	11	12	14	16	17	19	21	22	24	26	28	30	32	33
20	7	8	10	12	14	16	17	19	21	23	25	27	29	31	33	35	37
21	7	9	11	13	15	17	19	21	23	26	28	30	32	34	37	39	41
22	8	10	13	15	17	19	21	24	26	28	31	33	35	38	40	43	45
23	9	11	14	16	19	21	24	26	28	31	34	36	39	42	44	47	50
24	10	13	15	18	20	23	26	28	31	34	37	40	42	45	48	51	54
25	11	14	16	19	22	25	28	31	34	37	40	43	46	49	53	56	59
26	12	15	18	21	24	27	30	34	37	40	43	47	50	54	57	60	64
27	13	16	19	23	26	30	33	36	40	43	47	51	54	58	62	65	69
28	14	17	21	25	28	32	36	39	43	47	51	55	58	62	66	70	74
29	15	19	23	26	30	34	38	42	46	50	55	59	63	67	71	76	80
30	16	20	24	28	33	37	41	45	50	54	59	63	67	72	77	81	86
31	17	22	26	30	35	39	44	49	53	58	63	67	72	77	82	87	92
32	18	23	28	33	37	42	47	52	57	62	67	72	77	82	87	93	98
33	20	25	30	35	40	45	50	55	61	66	71	77	82	88	93	99	104
34	21	26	32	37	42	48	53	59	64	70	76	82	87	93	99	105	111
35	22	28	34	39	45	51	57	63	68	74	81	87	93	99	105	111	118
36	23	30	36	42	48	54	60	66	73	79	85	92	98	105	111	118	124
37	25	31	38	44	50	57	64	70	77	84	90	97	104	111	118	125	132
38	26	33	40	47	53	60	67	74	81	88	95	103	110	117	124	132	139
39	28	35	42	49	56	64	71	78	86	93	101	108	116	123	131	139	146
40	29	37	44	52	59	67	75	82	90	98	106	114	122	130	138	146	154

See note at end of table, p. 181.

TABLE XI.—*Forest Service International ¼-Inch Decimal rule*—Continued

[Board-foot volumes in tens]

Diameter (in.)	Volume according to log length, in feet—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
41	31	39	47	55	62	71	79	87	95	103	111	120	128	137	145	154	162
42	32	41	49	57	66	74	83	91	100	108	117	126	135	144	152	161	170
43	34	43	51	60	69	78	87	96	105	114	123	132	141	151	160	169	179
44	36	45	54	63	72	82	91	100	110	119	129	138	148	158	168	177	187
45	37	47	57	66	76	86	95	105	115	125	135	145	155	165	175	186	196
46	39	49	59	69	79	89	100	110	120	131	141	152	162	173	183	194	205
47	41	51	62	72	83	94	104	115	126	137	147	158	169	181	192	203	214
48	43	54	65	76	87	98	109	120	131	143	154	165	177	188	200	212	223
49	45	56	67	79	90	102	114	125	137	149	161	172	184	196	209	221	233
50	47	58	70	82	94	106	118	130	143	155	167	180	192	205	217	230	243
51	49	61	73	86	98	111	123	136	149	161	174	187	200	213	226	239	253
52	50	63	76	89	102	115	128	141	155	168	181	195	208	222	235	249	263
53	53	66	79	93	106	120	133	147	161	175	188	202	216	230	245	258	273
54	55	68	82	96	110	124	139	153	167	181	196	210	225	239	254	269	284
55	57	71	86	100	114	129	144	159	173	188	203	218	233	248	264	279	294
56	59	74	89	104	119	134	149	165	180	195	211	226	242	258	274	289	305
57	61	77	92	108	123	139	155	171	186	203	219	235	251	267	284	300	316
58	63	79	95	112	128	144	160	177	193	210	226	243	260	277	294	311	328
59	66	82	99	116	132	149	166	183	200	217	234	252	269	287	304	322	339
60	68	85	102	120	137	154	172	189	207	225	243	260	278	296	315	333	351
61	70	88	106	124	142	160	178	196	214	233	251	269	288	307	325	344	363
62	73	91	109	128	146	165	184	203	221	240	259	278	297	317	336	356	375
63	75	94	113	132	151	171	190	209	229	248	268	288	307	327	347	367	387
64	77	97	117	136	156	176	196	216	236	256	277	297	317	338	359	379	400
65	80	100	121	141	161	182	202	223	244	265	286	306	327	349	370	391	412
66	82	103	124	145	166	188	209	230	251	273	295	316	337	360	382	403	425
67	85	107	128	150	171	193	215	237	259	281	304	326	348	371	393	416	439
68	88	110	132	154	177	199	222	244	267	290	313	336	359	382	405	429	452
69	90	113	136	159	182	205	229	252	275	299	322	346	370	393	417	441	465
70	93	117	140	164	187	211	235	259	283	308	332	356	380	405	430	454	479
71	96	120	144	169	193	218	242	267	292	317	342	367	392	417	442	468	493
72	99	124	149	174	199	224	249	275	300	326	351	377	403	429	455	481	507
73	101	127	153	179	204	230	256	282	309	335	361	388	414	441	468	495	521
74	104	131	157	184	210	237	264	290	317	344	371	399	426	453	481	508	536
75	107	134	161	189	216	243	271	298	326	354	382	410	438	466	494	522	551
76	110	138	166	194	222	250	278	307	335	363	392	421	449	478	507	537	566
77	113	142	170	199	228	257	286	315	344	373	403	432	461	491	521	551	581
78	116	146	175	204	234	264	293	323	353	383	413	443	474	504	535	565	596
79	119	149	180	210	240	270	301	332	362	393	424	455	486	517	549	580	611
80	122	153	184	215	246	277	309	340	372	403	435	467	499	531	563	595	627

See note at end of table, p. 181.

TABLE XI.—*Forest Service International ¼-Inch Decimal rule*—Continued

[Board-foot volumes in tens]

Diameter (in.)	Volume according to log length, in feet—																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
81	125	157	189	221	252	285	317	349	381	414	446	479	511	544	577	610	643
82	129	161	194	226	259	292	325	358	391	424	457	491	524	558	592	625	659
83	132	165	199	232	265	299	333	367	400	435	460	503	537	572	606	641	675
84	135	169	203	238	272	306	341	376	410	445	489	515	550	586	621	657	692
85	138	173	208	243	278	314	349	385	420	456	492	528	564	600	636	672	709
86	142	178	213	249	285	321	358	394	430	467	504	540	577	614	651	688	726
87	145	182	219	255	292	329	366	403	440	478	516	553	591	629	667	705	743
88	149	186	224	261	299	337	375	413	451	489	528	566	605	643	682	721	760
89	152	190	229	267	306	345	383	422	461	501	540	579	618	658	698	738	777
90	155	195	234	273	313	352	392	432	472	512	552	592	633	673	714	755	795
91	159	199	239	280	320	360	401	442	482	524	565	606	647	688	730	772	813
92	163	204	245	286	327	369	410	452	493	535	577	619	661	704	746	789	831
93	166	208	250	292	334	377	419	462	504	547	590	633	676	719	763	806	849
94	170	213	256	299	342	385	428	472	515	559	603	647	691	735	779	824	868
95	174	217	261	305	349	393	438	482	526	571	616	661	706	751	796	841	887
96	177	221	267	312	357	402	447	492	538	583	629	675	721	767	813	859	906
97	181	227	273	318	364	410	457	503	549	596	642	689	736	783	830	877	925
98	185	232	278	325	372	419	466	513	561	608	656	704	751	799	848	896	944
99	189	236	284	332	379	428	476	524	572	621	669	718	767	816	865	914	963
100	193	241	290	339	387	436	486	535	584	634	683	733	783	833	883	933	983
101	197	246	296	346	395	445	496	546	596	646	697	748	798	850	901	952	1003
102	201	251	302	353	403	454	505	557	608	659	711	763	814	867	919	971	1023
103	205	256	308	360	411	463	516	568	620	673	725	778	831	884	937	990	1043
104	209	261	314	367	419	473	526	579	632	686	740	793	847	901	955	1010	1064
105	213	266	320	374	428	482	536	590	644	699	754	809	863	919	974	1029	1086
106	217	272	326	381	436	491	546	602	657	713	769	824	880	936	993	1049	1105
107	221	277	333	388	444	501	557	613	670	726	783	840	897	954	1012	1069	1127
108	225	282	339	396	453	510	567	625	682	740	798	856	914	972	1031	1089	1148
109	230	287	345	403	461	520	578	637	695	754	813	872	931	991	1050	1110	1169
110	234	293	352	411	470	529	589	648	708	768	828	888	948	1009	1070	1130	1191
111	238	298	358	418	479	539	600	660	721	782	843	905	966	1028	1089	1151	1213
112	243	304	365	426	487	549	611	673	734	797	859	921	983	1046	1109	1172	1235
113	247	309	372	434	496	559	622	685	748	811	874	938	1001	1065	1129	1103	1257
114	251	315	378	442	505	569	633	697	761	826	890	955	1019	1084	1149	1215	1280
115	256	320	385	450	514	579	644	709	775	840	906	972	1037	1104	1170	1236	1302
116	260	326	392	458	523	589	656	722	788	855	922	989	1056	1123	1190	1258	1325
117	265	332	399	466	532	600	667	735	802	870	938	1006	1074	1143	1211	1280	1348
118	270	338	406	474	542	610	679	747	816	885	954	1024	1093	1162	1232	1302	1372
119	274	343	413	482	551	621	690	760	830	900	971	1041	1111	1182	1253	1324	1395
120	279	349	420	490	560	631	702	773	844	916	987	1059	1130	1202	1274	1347	1419

NOTE: International ⅛-inch rule volumes computed electronically to 4 decimals, rounded to nearest tenth board foot. This volume multiplied by 0.905 for ¼-inch rule volumes, recorded to 1 decimal, rounded to nearest 10 board feet. Volumes that could be influenced by the rounding to a tenth in the ⅛-inch calculations were recalculated, using all decimals. Decimal volumes thus are the same as if all decimals had been used in the calculations.

Volumes are as calculated from the basic equation for the volume of a 4-foot section; i.e., volume $= 0.22\ (D^2) - 0.71\ D$).

Volumes for sections 8, 12, 16, and 20 feet were obtained by allowing ½-inch taper for each 4 feet of length and totaling the volumes for the sections. For other log lengths between 4 and 20 feet, linear interpolation was used.

Board feet = $\frac{W'' \times H'' \times L'}{16}$ or $\frac{(D'')^2 L'}{16}$ (for Circular Defect)

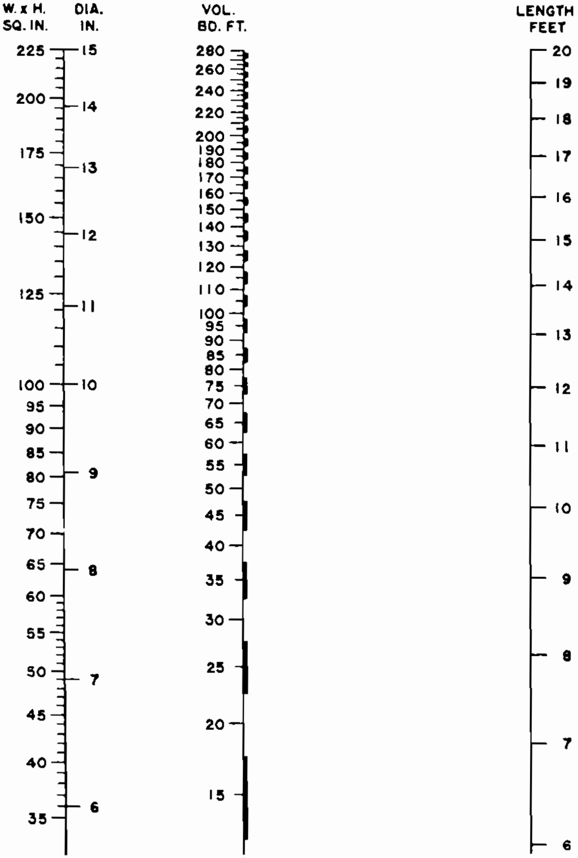

TABLE XII.—*Defect allowance chart—International ¼-Inch log rule*

Instructions for Use of Defect Allowance Chart

1. Measure width and height of defect in inches. Add 1 inch to each to allow for waste.
2. Multiply width by height.
3. Measure or estimate length of defect.
4. Place straightedge through product of W×H (left line) and length (right line).
5. Read deduction, to nearest 5 board feet, on center line.

For example, if a defect measured 7'' by 8'' by 10', the deduction would be determined by holding the straightedge through 72 on the left line $(7+1)\times(8+1)$ and 10 on the right line. The deduction, center line intersection, is 45 board feet.

Shortcut method: Width of defect in inches × height in inches = deduction if defect extends through a 16-foot log. Otherwise take proper proportion, round to *nearest* 5 bd. ft. (or 10 bd. ft. if scaling by Forest Service International ¼-Inch Decimal rule).

TABLE XIII.—*Defect allowances—for optional use*

[Forest Service International ¼-Inch Decimal log rule—board-feet in tens]

Length (feet)	Squared end defect [1]												
	10	20	30	40	50	60	70	80	90	100	110	120	130
1	0	0	0	0	0	0	0	1	1	1	1	1	1
2	0	0	0	0	1	1	1	1	1	1	1	1	2
3	0	0	1	1	1	1	1	2	2	2	2	2	2
4	0	1	1	1	1	1	2	2	2	3	3	3	3
5	0	1	1	1	2	2	2	3	3	3	3	4	4
6	0	1	1	2	2	2	3	3	3	4	4	5	5
7	0	1	1	2	2	3	3	4	4	4	5	5	6
8	1	1	2	2	2	3	4	4	5	5	6	6	7
9	1	1	2	2	3	3	4	5	5	6	6	7	7
10	1	1	2	2	3	4	4	5	6	6	7	7	8
11	1	1	2	3	3	4	5	6	6	7	8	8	9
12	1	2	2	3	4	4	5	6	7	8	8	9	10
13	1	2	2	3	4	5	6	7	7	8	9	10	11
14	1	2	3	3	4	5	6	7	8	9	10	10	11
15	1	2	3	4	5	6	7	8	8	9	10	11	12
16	1	2	3	4	5	6	7	8	9	10	11	12	13

[1] Width (inches) × height (inches), rounded to nearest 10. Round a product ending in 5 to the next higher 10.

TABLE XIV.—*Solid cubic contents of logs*

* HUBER RULE—*

Length (feet)	Contents (cubic feet) according to middle diameter, in inches—															
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
4	0.25	0.25	0.5	1	1	1	2	2	3	3	4	4	5	6	6	7
5	.25	.5	.5	1	1	2	2	3	3	4	5	5	6	7	8	9
6	.25	.5	1	1	2	2	3	3	4	5	6	6	7	8	9	11
7	.25	.5	1	1	2	2	3	4	5	5	6	7	9	10	11	12
8	.5	.5	1	2	2	3	4	4	5	6	7	9	10	11	13	14
9	.5	1	1	2	2	3	4	5	6	7	8	10	11	13	14	16
10	.5	1	1	2	3	3	4	5	7	8	9	11	12	14	16	18
11	.5	1	1	2	3	4	5	6	7	9	10	12	13	15	17	19
12	.5	1	2	2	3	4	5	7	8	9	11	13	15	17	19	21
13	.5	1	2	3	3	5	6	7	9	10	12	14	16	18	20	23
14	.5	1	2	3	4	5	6	8	9	11	13	15	17	20	22	25
15	.5	1	2	3	4	5	7	8	10	12	14	16	18	21	24	27
16	1	1	2	3	4	6	7	9	11	13	15	17	20	22	25	28
17	1	1	2	3	5	6	8	9	11	13	16	18	21	24	27	30
18	1	2	2	4	5	6	8	10	12	14	17	19	22	25	28	32
19	1	2	3	4	5	7	8	10	13	15	18	20	23	27	30	34
20	1	2	3	4	5	7	9	11	13	16	18	21	25	28	32	35
21	1	2	3	4	6	7	9	11	14	16	19	22	26	29	33	37
22	1	2	3	4	6	8	10	12	15	17	20	24	27	31	35	39
23	1	2	3	5	6	8	10	13	15	18	21	25	28	32	36	41
24	1	2	3	5	6	8	11	13	16	19	22	26	29	34	38	42
25	1	2	3	5	7	9	11	14	16	20	23	27	31	35	39	44
26	---	---	---	5	7	9	11	14	17	20	24	28	32	36	41	46
27	---	---	---	5	7	9	12	15	18	21	25	29	33	38	43	48
28	---	---	---	5	7	10	12	15	18	22	26	30	34	39	44	49
29	---	---	---	6	8	10	13	16	19	23	27	31	36	40	46	51
30	---	---	---	6	8	10	13	16	20	24	28	32	37	42	47	53
31	---	---	---	6	8	11	14	17	20	24	29	33	38	43	49	55
32	---	---	---	6	9	11	14	17	21	25	29	34	39	45	50	57
33	---	---	---	6	9	12	15	18	22	26	30	35	40	46	52	58
34	---	---	---	7	9	12	15	19	22	27	31	36	42	47	54	60
35	---	---	---	7	9	12	15	19	23	27	32	37	43	49	55	62
36	---	---	---	7	10	13	16	20	24	28	33	38	44	50	57	64
37	---	---	---	7	10	13	16	20	24	29	34	40	45	52	58	65
38	---	---	---	7	10	13	17	21	25	30	35	41	47	53	60	67
39	---	---	---	8	10	14	17	21	26	31	36	42	48	54	61	69
40	---	---	---	8	11	14	18	22	26	31	37	43	49	56	63	71

Length (feet)	Contents (cubic feet) according to middle diameter, in inches—													
	19	20	21	22	23	24	25	26	27	28	29	30	31	32
4	8	9	10	11	12	13	14	15	16	17	18	20	21	22
5	10	11	12	13	14	16	17	18	20	21	23	25	26	28
6	12	13	14	16	17	19	20	22	24	26	28	29	31	34
7	14	15	17	18	20	22	24	26	28	30	32	34	37	39
8	16	17	19	21	23	25	27	29	32	34	37	39	42	45
9	18	20	22	24	26	28	31	33	36	38	41	44	47	50
10	20	22	24	26	29	31	34	37	40	43	46	49	52	56
11	22	24	26	29	32	35	37	41	44	47	50	54	58	61
12	24	26	29	32	35	38	41	44	48	51	55	59	63	67
13	26	28	31	34	38	41	44	48	52	56	60	64	68	73
14	28	31	34	37	40	44	48	52	56	60	64	69	73	78
15	30	33	36	40	43	47	51	55	60	64	69	74	79	84
16	32	35	38	42	46	50	55	59	64	68	73	79	84	89
17	33	37	41	45	49	53	58	63	68	73	78	83	89	95
18	35	39	43	48	52	57	61	66	72	77	83	88	94	101
19	37	41	46	50	55	60	65	70	76	81	87	93	100	106
20	39	44	48	53	58	63	68	74	80	86	92	98	105	112
21	41	46	51	55	61	66	72	77	83	90	96	103	110	117
22	43	48	53	58	63	69	75	81	87	94	101	108	115	123
23	45	50	55	61	66	72	78	85	91	98	105	113	121	128
24	47	52	58	63	69	75	82	88	95	103	110	118	126	134
25	49	55	60	66	72	79	85	92	99	107	115	123	131	140
26	51	57	63	69	75	82	89	96	103	111	119	128	136	145
27	53	59	65	71	78	85	92	100	107	115	124	133	142	151
28	55	61	67	74	81	88	95	103	111	120	128	137	147	156
29	57	63	70	77	84	91	99	107	115	124	133	142	152	162
30	59	65	72	79	87	94	102	111	119	128	138	147	157	168
31	61	68	75	82	89	97	106	114	123	133	142	152	162	173
32	63	70	77	84	92	101	109	118	127	137	147	157	168	179
33	65	72	79	87	95	104	112	122	131	141	151	162	173	184
34	67	74	82	90	98	107	116	125	135	145	156	167	178	190
35	69	76	84	92	101	110	119	129	139	150	161	172	183	195
36	71	79	87	95	104	113	123	133	143	154	165	177	189	201
37	73	81	89	98	107	116	126	136	147	158	170	182	194	207
38	75	83	91	100	110	119	130	140	151	162	174	187	199	212
39	77	85	94	103	113	123	133	144	155	167	179	191	204	218
40	79	87	96	106	115	126	136	147	159	171	183	196	210	223

Table XIV.—*Solid cubic contents of logs*—Continued

Length (feet)	Contents (cubic feet) according to middle diameter, in inches—													
	33	34	35	36	37	38	39	40	41	42	43	44	45	46
4	24	25	27	28	30	32	33	35	37	38	40	42	44	46
5	30	32	33	35	37	39	41	44	46	48	50	53	55	58
6	36	38	40	42	45	47	50	52	55	58	61	63	66	69
7	42	44	47	49	52	55	58	61	64	67	71	74	77	81
8	48	50	53	57	60	63	66	70	73	77	81	84	88	92
9	53	57	60	64	67	71	75	79	83	87	91	95	99	104
10	59	63	67	71	75	79	83	87	92	96	101	106	110	115
11	65	69	73	78	82	87	91	96	101	106	111	116	121	127
12	71	76	80	85	90	95	100	105	110	115	121	127	133	138
13	77	82	87	92	97	102	108	113	119	125	131	137	144	150
14	83	88	94	99	105	110	116	122	128	135	141	148	155	162
15	89	95	100	106	112	118	124	131	138	144	151	158	166	173
16	95	101	107	113	119	126	133	140	147	154	161	169	177	185
17	101	107	114	120	127	134	141	148	156	164	171	180	188	196
18	107	113	120	127	134	142	149	157	165	173	182	190	199	208
19	113	120	127	134	142	150	158	166	174	183	192	201	210	219
20	119	126	134	141	149	158	166	175	183	192	202	211	221	231
21	125	132	140	148	157	165	174	183	193	202	212	222	232	242
22	131	139	147	156	164	173	183	192	202	212	222	232	243	254
23	137	145	154	163	172	181	191	201	211	221	232	243	254	265
24	143	151	160	170	179	189	199	209	220	231	242	253	265	277
25	148	158	167	177	187	197	207	218	229	241	252	264	276	289
26	154	164	174	184	194	205	216	227	238	250	262	275	287	300
27	160	170	180	191	202	213	224	236	248	260	272	285	298	312
28	166	177	187	198	209	221	232	244	257	269	282	296	309	323
29	172	183	194	205	217	228	241	253	266	279	292	306	320	335
30	178	189	200	212	224	236	249	262	275	289	303	317	331	346
31	184	195	207	219	231	244	257	271	284	298	313	327	342	358
32	190	202	214	226	239	252	265	279	293	308	323	338	353	369
33	196	208	220	233	246	260	274	288	303	317	333	348	364	381
34	202	214	227	240	254	268	282	297	312	327	343	359	376	392
35	208	221	234	247	261	276	290	305	321	337	353	370	387	404
36	214	227	241	254	269	284	299	314	330	346	363	380	398	415
37	220	233	247	262	276	291	307	323	339	356	373	391	409	427
38	226	240	254	269	284	299	315	332	348	366	383	401	420	439
39	232	246	261	276	291	307	324	340	358	375	393	412	431	450
40	238	252	267	283	299	315	332	349	367	385	403	422	442	462

Table XIV.—*Solid cubic contents of logs*—Continued

Length (feet)	Contents (cubic feet) according to middle diameter, in inches—													
	47	48	49	50	51	52	53	54	55	56	57	58	59	60
4	48	50	52	55	57	59	61	64	66	68	71	73	76	79
5	60	63	65	68	71	74	77	80	82	86	89	92	95	98
6	72	75	79	82	85	88	92	95	99	103	106	110	114	118
7	84	88	92	95	99	103	107	111	115	120	124	128	133	137
8	96	101	105	109	113	118	123	127	132	137	142	147	152	157
9	108	113	118	123	128	133	138	143	148	154	159	165	171	177
10	120	126	131	136	142	147	153	159	165	171	177	183	190	196
11	133	138	144	150	156	162	169	175	181	188	195	202	209	216
12	145	151	157	164	170	177	184	191	198	205	213	220	228	236
13	157	163	170	177	184	192	199	207	214	222	230	239	247	255
14	169	176	183	191	199	206	214	223	231	239	248	257	266	275
15	181	188	196	205	213	221	230	239	247	257	266	275	285	295
16	193	201	210	218	227	236	245	254	264	274	284	294	304	314
17	205	214	223	232	241	251	260	270	280	291	301	312	323	334
18	217	226	236	245	255	265	276	286	297	308	319	330	342	353
19	229	239	249	259	270	280	291	302	313	325	337	349	361	373
20	241	251	262	273	284	295	306	318	330	342	354	367	380	393
21	253	264	275	386	298	310	322	334	346	359	372	385	399	412
22	265	276	288	300	312	324	337	350	363	376	390	404	418	432
23	277	289	301	314	326	339	352	366	379	393	408	422	437	453
24	289	302	314	327	340	354	368	382	396	411	425	440	456	471
25	301	314	327	341	355	369	383	398	412	428	443	459	475	491
26	313	327	340	355	369	383	398	414	429	445	461	477	494	511
27	325	339	354	368	383	398	414	429	445	462	478	495	513	530
28	337	352	367	382	397	413	429	445	462	479	496	514	532	550
29	349	364	380	395	411	428	444	461	478	496	514	532	551	569
30	361	377	393	409	426	442	460	477	495	513	532	550	570	589
31	373	390	406	423	440	457	475	493	511	530	549	569	589	609
32	386	402	419	436	454	472	490	509	528	547	567	587	608	628
33	398	415	432	450	468	487	506	525	544	564	585	605	627	648
34	410	427	445	464	482	501	521	541	561	582	603	624	646	668
35	422	440	458	477	497	516	536	557	577	599	620	642	665	687
36	434	452	471	491	511	531	552	573	594	616	638	661	683	707
37	446	465	485	505	525	546	567	588	610	633	656	679	702	726
38	458	478	498	518	539	560	582	604	627	650	673	697	721	746
39	470	490	511	532	553	575	598	620	643	667	691	716	740	766
40	482	503	524	545	567	590	613	636	660	684	709	734	759	785

TABLE XV.—*Standard converting factors*

Product	Assumed dimensions	Equivalent in board feet
Cord, standard	4 by 4 by 8 feet	500
Cord, long	4 by 5 by 8 feet	625
Cord, shingle bolts	4 by 4 by 8 feet	600
Cord, small material (averaging less than 5 inches middle diameter in the round).	do	333⅓
Cord, short	4 by 3 by 8 feet	375
Cord, short, small material.	do	250
Load (small, irregular pieces that can not be ricked).	4 by 4 by 8 feet	333⅓
Tie, standard	7 by 9 inches by 8 feet	35
Do	7 by 8 inches by 8 feet	30
Do	6 by 6 inches by 8 feet	20
Tie, narrow gage	7 by 8 inches by 6½ feet	25
Do	6 by 7 inches by 6½ feet	20
Do	6 by 6 inches by 6½ feet	15
Pole (telephone) or piling	8 inches by 45 feet	200
Do	8 inches by 40 feet	150
Do	8 inches by 35 feet	100
Do	7 inches by 60 feet	280
Do	7 inches by 50 feet	200
Do	7 inches by 40 feet	100
Do	7 inches by 35 feet	80
Do	7 inches by 30 feet	60
Do	7 inches by 25 feet	50
Do	5 inches by 25 feet	30
Cubic foot	13.6 inches by 1 foot	6
Linear foot	10 inches by 1 foot	3
Linear foot (long piling)	80 to 125 feet by 6 inches.	5½
Derrick pole	7 inches by 30 feet	60
Derrick set (11 pieces)		480
Post, fence	6 inches by 7 feet	7
Do	5 inches by 7 feet	5

Product	Assumed dimensions	Equivalent in board feet
Post, split	18 inches circumference by 7 feet.	6
Brace, fence	4 inches by 6 feet	2
Stake, fence	3 inches by 5 feet	1
Stay, fence	2 inches by 6 feet	½
Rail, fence (split)	20 inches circumference by 16 feet.	15
Pole, fence	4 inches by 20 feet	10
Pole (12 pieces)	4 inches by 16 feet	100
Pole, converter	4 inches by 20 feet	10
Prop	6 inches by 10 feet	10
Lagging (6 pieces)	3 inches by 6 feet	10

CONVERTING FACTORS

For convenience in preparing statistics, such as reports of timber cut and sold, and for price determinations in sales of products for which prices have not been established by the Chief, it is necessary to convert other products than sawtimber into feet board measure. Regional Foresters will establish converting factors by Forests for these purposes. It is often possible and desirable to establish a converting factor for all standard-gage hewn ties cut on a given Forest based on the size of the average tie; and similar factors are often applicable to groups of sizes of telephone poles, piling, or posts. Standard conversion factors established by Regional Foresters will not be inconsistent with this table, which will be used in the absence of approved local tables.

Table XVI.—*Board-foot contents of standard lumber and timber sizes*

End dimensions (inches)	Volume (board feet) according to length, in feet—							
	10	12	14	16	18	20	22	24
1 by 2	1⅔	2	2⅓	2⅔	3	3⅓	3⅔	4
3	2½	3	3½	4	4½	5	5½	6
4	3⅓	4	4⅔	5⅓	6	6⅔	7⅓	8
5	4⅙	5	5⅚	6⅔	7½	8⅓	9⅙	10
6	5	6	7	8	9	10	11	12
7	5⅚	7	8⅙	9⅓	10½	11⅔	12⅚	14
8	6⅔	8	9⅓	10⅔	12	13⅓	14⅔	16
10	8⅓	10	11⅔	13⅓	15	16⅔	18⅓	20
12	10	12	14	16	18	20	22	24
14	11⅔	14	16⅓	18⅔	21	23⅓	25⅔	28
16	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32
18	15	18	21	24	27	30	33	36
20	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40
1¼ by 4	4⅙	5	5⅚	6⅔	7½	8⅓	9⅙	10
6	6¼	7½	8¾	10	11¼	12½	13¾	15
8	8⅓	10	11⅔	13⅓	15	16⅔	18⅓	20
10	10	12½	14 7/12	16⅔	18¾	20⅚	22 11/12	25
12	12½	15	17½	20	22½	25	27½	30
1½ by 4	5	6	7	8	9	10	11	12
6	7½	9	10½	12	13½	15	16½	18
8	10	12	14	16	18	20	22	24
10	12½	15	17½	20	22½	25	27½	30
12	15	18	21	24	27	30	33	36
2 by 3	5	6	7	8	9	10	11	12
4	6⅔	8	9⅓	10⅔	12	13⅓	14⅔	16
6	10	12	14	16	18	20	22	24
8	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32
10	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40
12	20	24	28	32	36	40	44	48
14	23⅓	28	32⅔	37⅓	42	46⅔	51⅓	56
16	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64
2½ by 12	25	30	35	40	45	50	55	60
14	29⅙	35	40⅚	46⅔	52½	58⅓	64⅙	70
16	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80
3 by 4	10	12	14	16	18	20	22	24
6	15	18	21	24	27	30	33	36
8	20	24	28	32	36	40	44	48
10	25	30	35	40	45	50	55	60
12	30	36	42	48	54	60	66	72
14	35	42	49	56	63	70	77	84
16	40	48	56	64	72	80	88	96

Table XVI.—*Board-foot contents of standard lumber and timber sizes*—Continued

End dimensions (inches)	Volume (board feet) according to length, in feet—							
	10	12	14	16	18	20	22	24
4 by 4	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32
6	20	24	28	32	36	40	44	48
8	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64
10	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80
12	40	48	56	64	72	80	88	96
14	46⅔	56	65⅓	74⅔	84	93⅓	102⅔	112
5 by 8	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80
6 by 6	30	36	42	48	54	60	66	72
8	40	48	56	64	72	80	88	96
10	50	60	70	80	90	100	110	120
12	60	72	84	96	108	120	132	144
14	70	84	98	112	126	140	154	168
16	80	96	112	128	144	160	176	192
8 by 8	53⅓	64	74⅔	85⅓	96	106⅔	117⅓	128
10	66⅔	80	93⅓	106⅔	120	133⅓	146⅔	160
12	80	96	112	128	144	160	176	192
14	93⅓	112	130⅔	149⅓	168	186⅔	205⅓	224
10 by 10	83⅓	100	116⅔	133⅓	150	166⅔	183⅓	200
12	100	120	140	160	180	200	220	240
14	116⅔	140	163⅓	186⅔	210	233⅓	256⅔	280
16	133⅓	160	186⅔	213⅓	240	266⅔	293⅓	320
12 by 12	120	144	168	192	216	240	264	288
14	140	168	196	224	252	280	308	336
16	160	192	224	256	288	320	352	384
14 by 14	163⅓	196	228⅔	261⅓	294	326⅔	359⅓	392
16	186⅔	224	261⅓	298⅔	336	373⅓	410⅔	448
18	210	252	294	336	378	420	462	504
16 by 16	213⅓	256	298⅔	341⅓	384	426⅔	469⅓	512
18	240	288	336	384	432	480	528	576
20	266⅔	320	373⅓	426⅔	480	533⅓	586⅔	640
18 by 18	270	324	378	432	486	540	594	648
20 by 20	333⅓	400	466⅔	533⅓	600	666⅔	733⅓	800
22 by 22	403⅓	484	564⅔	645⅓	726	806⅔	887⅓	968
24 by 24	480	576	672	768	864	960	1,056	1,152
26 by 26	563⅓	676	788⅔	901⅓	1,014	1,126⅔	1,239⅓	1,352
28 by 28	653⅓	784	914⅔	1,045⅓	1,176	1,306⅔	1,437⅓	1,568
30 by 30	750	900	1,050	1,200	1,350	1,500	1,650	1,800

TABLE XVI.—*Board-foot contents of standard lumber and timber sizes*—Continued

End dimensions (inches)	Volume (board feet) according to length in feet—					
	28	32	34	36	38	40
8 by 8	149⅓	170⅔	181⅓	192	202⅔	213⅓
10	186⅔	213⅓	226⅔	240	253⅓	266⅔
12	224	256	272	288	304	320
14	261⅓	298⅔	317⅓	336	354⅔	373⅓
10 by 10	233⅓	266⅔	283⅓	300	316⅔	333⅓
12	280	320	340	360	380	400
14	326⅔	373⅓	396⅔	420	443⅓	466⅔
16	373⅓	426⅔	453⅓	480	506⅔	533⅓
12 by 12	336	384	408	432	456	480
14	392	448	476	504	532	560
16	448	512	544	576	608	640
14 by 14	457⅓	522⅔	555⅓	588	620⅔	653⅓
16	522⅔	597⅓	634⅔	672	709⅓	746⅔
18	588	672	714	756	798	840
16 by 16	597⅓	682⅔	725⅓	768	810⅔	853⅓
18	672	768	816	864	912	960
20	746⅔	853⅓	906⅔	960	1,013⅓	1,066⅔
18 by 18	756	864	918	972	1,026	1,080
20 by 20	933⅓	1,066⅔	1,133⅓	1,200	1,266⅔	1,333⅓
22 by 22	1,129⅓	1,290⅔	1,371⅓	1,452	1,532⅔	1,613⅓
24 by 24	1,344	1,536	1,632	1,728	1,824	1,920
26 by 26	1,577⅓	1,802⅔	1,915⅓	2,028	2,140⅔	2,253⅓
28 by 28	1,829⅓	2,090⅔	2,221⅓	2,352	2,482⅔	2,613⅓
30 by 30	2,100	2,400	2,550	2,700	2,850	3,000

TABLE XVII.—*Board-foot contents of railroad ties*

[To nearest whole board foot, with no deduction for kerf]

End dimensions (inches)	Length (feet)		
	6½ [1]	8 [2]	8½
6 by 6	20	24	26
6 by 7	23	28	30
6 by 8	26	32	34
7 by 7	27	33	35
7 by 8	30	37	40
7 by 9	--------	42	45

[1] Narrow gage railroad.
[2] Standard gage railroad.

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