

**Forest Service Handbook  
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**Forest Service Handbook 2409.11 – National Forest Log Scaling Handbook  
Chapter 20 – Defect-Deduction Methods**

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**Approved by:** Gregory Smith, For Joel Holtrop, Deputy Chief

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**Responsible Staff:**

**Last Change:** Amendment No. 7

**Superseded Document(s):** Entire Handbook, Title Page thru 247

**Digest:** Following is an explanation of the changes throughout the directive by section.

**10:** Corrects minor typographical and technical errors throughout the chapter. Substantive changes are as follows:

**13:** Clarifies in paragraph 1 that the standard unit for saw timber scaling will be in cubic foot log scale, although board foot log scale is used under certain circumstances.

**17.12:** Changes the caption in exhibit 02 to clarify direction to allow full trim in the length measurement and record in 2 foot multiples.

**17.18:** Adds new direction and an exhibit for length measurements on forked logs.

**17.2:** Clarifies scalers will notify the contracting officer when improper trim allowance is detected.

**17.3:** Adds direction on how to record logs that are further reduced to the lower 2 foot multiple, but the diameter increases to the next diameter class, the increased diameter will be recorded as the proper scaling diameter.

**17.33:** Adds a list of butt characteristics to assist in identifying butt cut logs.

**20:** Corrects minor typographical and technical errors throughout the chapter. There are no changes to the substantive direction in this chapter.

**30:** Corrects minor typographical and technical errors throughout the chapter. Substantive changes are as follows:

**33:** Establishes defect types and new deduction procedures for: Burls, Foreign Material, Pecky Rot, Pistol Butt Defect, Pitch Pockets, and Spiral Grain.

Slope of Grain, and Twist have been included in the Spiral Grain definition.

Barber Chair and Pull, Stump or Sliver has been included in the Breaks and Splits definition.

Bark Seam has been included in the Pitch Seam, Heart Check, Frost Crack definition.

Adds new direction and exhibits for crook defect deduction process.

Combines Knots, large and Knots, clusters into a single new defect type, Knots. Establishes new knot size limits and knot deduction guide.

Adds definition of massed pitch and clarification of when a deduction is necessary.

Adds clarification of scaling cylinder position when deducting for sweep.

Reformats and rennumbers entire section to conform to FSH 2409.11a - Cubic Scaling Handbook, chapter 20.

**40:** Corrects minor typographical and technical errors throughout the chapter. Substantive changes are as follows:

**44:** Changes caption from Stump Scaling to Timber Trespass. Provides direction for measurements to be performed by certified scalers and cruisers and requires coordination with Law Enforcement staff prior to beginning field work.

**44.1:** Changes caption from Timber Trespass to Stump Scaling.

**44.2:** Changes caption from Scaling when Stump and other Direct Evidence is lacking to Stump Cruising.

**44.3:** Established this code and recodes direction formerly at section 44.2 to this section.

**51:** Changes caption to selection of scaling locations. Changes responsibility for selection of scaling locations from District Ranger to Contracting Officer. Also removes direction on selecting truck-scaling locations.

**52:** Removes requirement for Forest Supervisor to develop additional safety specifications for scaling.

**53:** Removes the direction which discusses the need for the purchaser to keep government logs separate from private logs up to the point of scaling and for the use of distinctive marking between various sales.

**54.1:** Changes the direction for team scaling from "discouraged" to "must not be used." Also removes direction Regional Forester to authorize team scaling in limited situations. Changes the responsibility for taking corrective action when scalers to not perform to standard from District Ranger to Contracting Officer.

**54.2:** Removes direction on the benefits of mill visits and specific direction concerning various items to be observed while conducting a mill visit.

**55.2 - 55.4:** Removes obsolete direction, which referenced out of date equipment, processes and procedures.

**55.5:** Revises and recodes to section 55.2. Changes the responsibility for completing the Scaler Information Form from the Forest Service Representative to the Contracting Officer.

**55.61:** Removes section on standard scaling forms.

**55.62:** Recodes to section 553.

**55.63:** Recodes to section 55.4. Removes significant amount of instruction, including exhibit's 01 and 02, on how to fill in scaling sheets. Stresses the use of field data recorders to record scaling information.

**55.64 - 55.65:** Removes obsolete direction from handbook.

**56.1:** Removes obsolete from handbook.

**56.21:** Removes obsolete direction from handbook.

**56.22:** Recodes to section 56.1.

**56.3:** Removes obsolete direction from handbook.

**60:** Corrects minor typographical and technical errors throughout the chapter. Substantive changes are as follows:

**64:** Increases situations where Regional Foresters may deviate from established check scale standards.

**65:** Revises to require minimum check scale record and summary information. Removes outdated policy, procedures, and forms.

**70:** Reformats chapter.

**71:** Updates CFR reference.

**80:** Corrects minor typographical and technical errors throughout the chapter. Substantive changes are as follows:

**82:** Deletes previous documentation which was incomplete and adds reference to National Forest Cubic Scaling Handbook (FSH 2409.11a) for handbook direction.

**85:** Adds a cross reference on sample scaling to Forest Service Handbook 2409.11a, National Forest Cubic Scaling Handbook, chapter 50.

**85.5:** Recodes to section 86.1.

**85.6:** Recodes to section 86.2.

**87.42:** Establishes new direction for Fiber Scaling.

**Appendix:** Renames exhibits from "Table" to "Appendix." Removes Table 1A, Table VIII, Table IX - Exhibit A, Table XIV. Adds Appendix 15 - Factors for Computing Scribner decimal C Volumes and Appendix 16 - Scribner Decimal C Recorded Length and Segment Lengths.

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## 21 - General

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

- a. Squared-defect method.
- b. Pie cut method.
- c. Length-deduction method.
- d. Diameter-deduction method.

2. In applying any of the above methods, the loss is 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 must be considered lost, except as provided in chapter 70, sec. 73.

3. All methods must be used with judgment and skill. Knowledge of how defects actually cut out must be obtained from periodic mill visits. 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.

4. If defect calculations end in a fraction of 1/2 or more, raise the defect to the next whole number. If the fraction is less than 1/2, reduce the defect to the next lower whole number.

## 22 - Squared-Defect Method

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.<sup>1</sup> 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 chapter 70, section 75 and table XII in the appendix chapter for defect deductions applied with the International 1/4-Inch rule.

<sup>1</sup>Originally termed the (Forest Service) Standard 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 chapter.

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).

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 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 (sec. 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; for example, a 16x20 measurement can be read directly as an 18 x 18 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 (sec. 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. There may be occasional answer variances of 10 and 20 board feet from the figures in

table V (see appendix chapter). 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 1/4-Inch Decimal rule are available.

## 22.2 - Shortcut Procedure

1. For the Scribner Decimal C rule, the shortcut procedure for determining the squared-defect deduction may be stated by the following formula:

$$X = W \times H \text{ to the next higher } 10 \times L/16 \text{ to nearest } 10.$$

The defect dimensions used in this formula are identical to those which would be used in the preceding more complicated formula (sec. 22); 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.

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

3. In applying the shortcut procedure, remember these four easy steps:

- a. Measure both height and width of the defect, including the 1-inch allowance for waste.
- b. 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,  $10 \times 11 = 110$ , raise to 120 and drop the zero for 12.
- c. This is the deduction if the defect extended through a 16-foot log.
- d. Estimate the length of the defect in terms of 16 feet. If the estimate is 8 feet, take  $8/16$  or  $1/2$ , the originally calculated defect. If the estimate is 4 feet, deduct  $1/4$  of the 16-foot calculation. If the defect extends about 6 feet, use  $6/16$  or  $3/8$ . For a 20-foot length of defect, add  $1/4$  of the 16-foot calculation.

4. The following corrections should be made for larger defects:

- a. Add 10 board feet to the product of  $W \times H$  for defects squaring 13 to 16 inches, inclusive.



- b. Add 20 board feet to the product of W x H for defects squaring 17 to 21 inches, inclusive.

Using the same example as for the formula in section 22:

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

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

See chapter 70, section 75 for the shortcut procedure applicable to the International rule.

### 22.3 - Application of Squared-Defect Method

Scalers should acquire 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 chapter 70, section 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.

$$7 \times 10 = 70 \text{ to the next higher } 10 = 80$$

$$80 \times 8/16 \text{ or } 80/2 = 40$$

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.

$$14 \times 16 = 224 \text{ to the next higher } 10 = 230$$

Add 10 (size between 13 and 16 inches)

$$240 \times 8/16 \text{ or } 240/2 = 120$$

(Read on Coconino stick  $15 \times 15 \times 8' = 12$ ).

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.

$$9 \times 11 = 99 \text{ to the next higher } 10 = 100$$

$$100 \times 6/16 \text{ or } 38 \text{ to the nearest } 10 = 40$$

(Read on Coconino stick  $10 \times 10 \times 6' = 4$ ).

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 ch. 70, sec. 75 for International rule).

1. For logs 8 to 14 feet in length, defect dimensions must be taken at large end of defect (in Western regions).

Example 1: 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:

$$9 \times 11 = 99 \text{ to the next higher } 10 = 100$$

$$100 \times 14/16 = 88 \text{ to the nearest } 10 = 90$$

(Read on Coconino stick  $10 \times 10 \times 14' = 9$ )

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 must be used (in Western regions).

Example 2: 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:

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

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

$$7 \times 9 = 63 \text{ to the next higher } 10 = 70$$

$$70 \times 20/16 = 88 \text{ to the nearest } 10 = 90$$

(Read on Coconino stick  $8 \times 8 \times 20' = 9$ )

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 paragraphs 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 1: 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 2: 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

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

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

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

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.

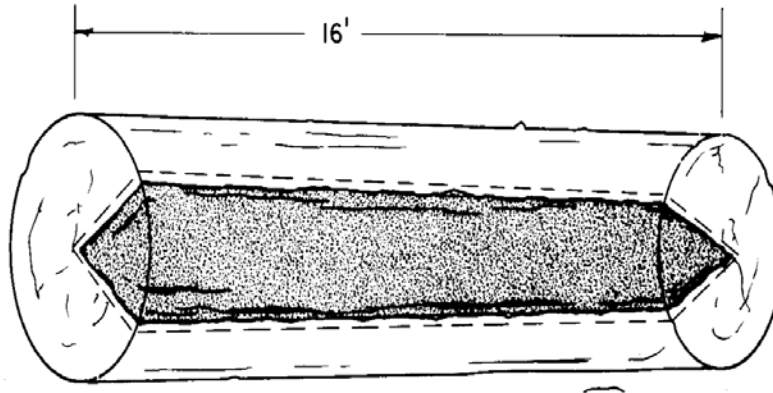
When the dimensions of end defects are averaged and the result is a fraction, round up to the next whole number, as  $(4 + 3) \div 2 = 4$ .

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.

**23 - Exhibit 01**  
**Pie Cut Method (deep lightning scar affecting 1/4 of log)**



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 1/4 of the circumference. The deduction is 1/4 of 280, which is 70 or 7 Decimal, and the net scale is 21 or 210 board feet.

This deduction method usually applies well to catfaces, fire scars, grubworm holes, and rotten knots. It is applicable 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 to deduct for defects which can be confined to a portion of the log length. Use this method when the squared defect deduction method equals or exceeds the scale of the affected log length. Use the scaling cylinder diameter to determine the scale of the affected log length. 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 (section 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.