Forest Service Handbook
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Forest Service Handbook 2409.11a – National Forest Cubic Scaling Handbook
Chapter 20 - Cubic Log Scaling Rules

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Approved by: Frederick L. Norbury, Associate Deputy Chief, NFS

Date approved: November 2, 2004

Responsible Staff:

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Superseded Document(s): Entire chapter 20

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

20: Reorganizes and makes minor corrections in spelling, punctuation, format and style throughout the chapter. Substantive changes are as follows:

21.13: Adds direction in paragraph 2 regarding the calculation of volume for butt logs 50 feet and longer.

21.3: Removes the term “merchantable logs” from the caption.

21.31: Changes the caption from “squared area method” to “squared area deduction method.” Adds direction for measuring fractional logs.

21.32: Adds direction for measuring slabs and chunks.

21.4: Adds list of physical characteristics indicative of butt logs.

22.2: Clarifies that a minimum deductible defect volume of 0.2 cubic feet is necessary before rounding. Clarifies rounding procedures when manually calculating and how to use computer precision in software applications.

Table of Contents

The cubic log scaling system was developed and tested by representatives of the Forest Service, Bureau of Land Management, Bureau of Indian Affairs, State agencies, industry and third party scaling bureaus.

The rules in this chapter apply only to logs intended to be manufactured into lumber or veneer. Scaling rules for other products are given in other chapters of this Handbook.

21 - Log Measurements and Determining Gross Cubic Foot Volume

Sections 21.1 through 21.4 set forth the basic procedures for measuring and recording log length and log diameters. Specific instructions are provided on how to measure the dimensions of broken end logs, forked logs, and logs with a small end diameter less than the contract minimum. Instructions are also given in section 21.5 for calculating the gross cubic foot volume of logs.

21.1 - Basic Rules for Measuring Log Length, Determining Recorded Log Length and Log Segmenting

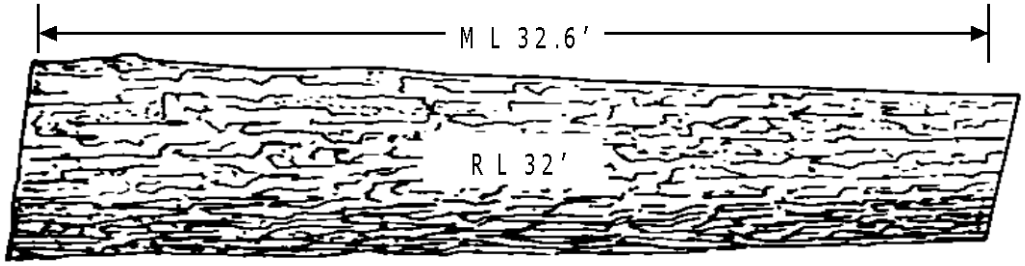
Log lengths are measured to 0.1 foot (measured length), but are recorded in whole numbers (recorded length) according to the following rules. The recording rules are based on a maximum segment length of 20 feet and a maximum trim allowance of 0.5 foot per segment. Segmenting occurs when the measured log length exceeds 20 feet plus trims allowance. Segmenting is necessary because longer logs are not accurately represented by the volume formula.

21.11 - Measuring Log Length

Determine measured log length by measuring to 0.1 foot, the shortest distance between the applicable points at the log ends. Measure short side to short side (ex. 01 and ex. 02). Disregard undercuts in measuring the length of butt logs (ex. 03). Measure length on partially bucked logs from saw cut to saw cut (ex. 04 and ex. 05).

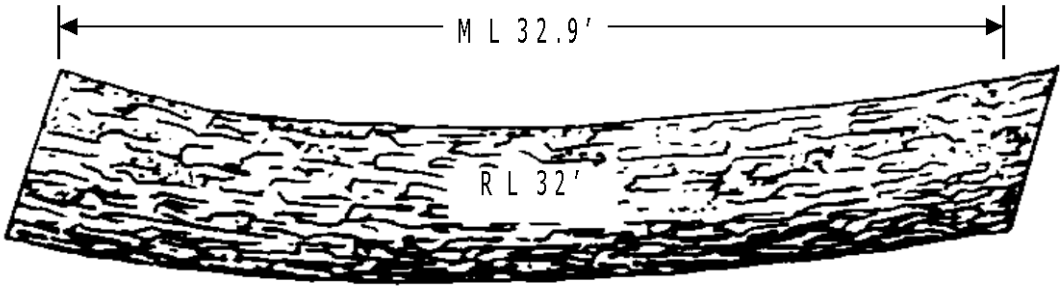
21.11 - Exhibit 01

Length Measurement of Second Cut Log



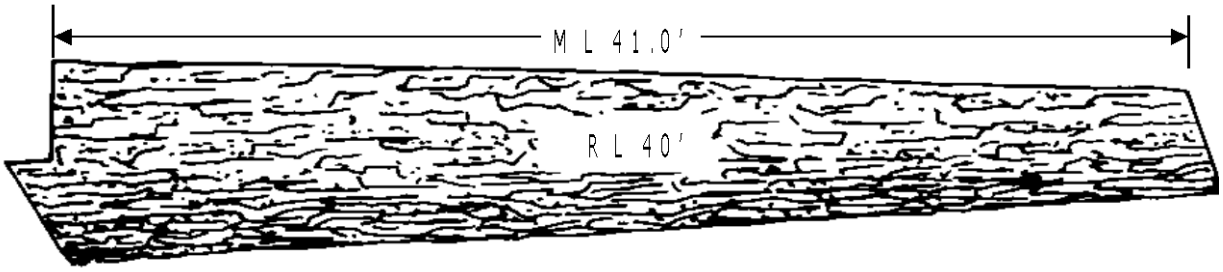
21.11 - Exhibit 02

Length Measurement of Log With Sweep or Crook



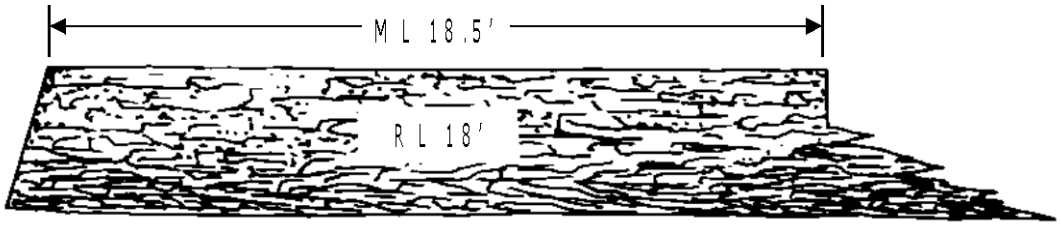
21.11 - Exhibit 03

Length Measurement Of Butt Log



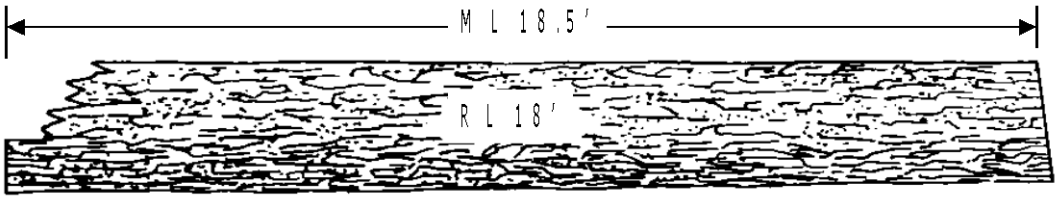
21.11 - Exhibit 04

Length Measurement of Log With Break and Partial Saw Cut



21.11 - Exhibit 05

Length Measurement of Log Bucked Through the Break



21.12 - Determining Recorded Log Length and Log Segments

Determine recorded log length from the measured log length, considering the allowable trim for the log being scaled. The allowable maximum trim is 0.5 foot per segment, unless the timber sale contract specifies otherwise. Record the length of logs overrunning allowable trim to the next one-foot length. For example, a log measuring 16.7 feet is 0.2-foot overtrim and is recorded as 17 feet. A log measuring 33.0 feet is recorded as 32 feet, but one measuring 33.1 feet is recorded as 33 feet.

Log volume is determined (sec. 21.5) and log defect is assessed (sec. 22) by log segment. Determine the number of segments, segment lengths, and segment position within the log from the recorded log length in accordance with the following rules:

1. Divide logs exceeding the maximum segment length of 20 feet into two or more segments.

2. Divide even length logs into two or more even length segments of equal length, if possible. Otherwise, make the large end segment(s) the longest.

3. Divide odd length logs, 21 - 39 feet recorded length, into two segments. One segment will be an even length and the other an odd length. Make the large end segment longer.

4. Divide odd length logs, 41 - 59 feet recorded length, into three segments. One segment will be an odd length and the other two segments will be even lengths. Make the even length segments equal length. The odd length segment will never be more than one foot longer or shorter than the even length segments. Make the large end segment(s) the longest.

Appendix 1 in chapter 60 lists the segment lengths for logs 21-80 feet in recorded length.

The rules for recording log length for one-, two-, and three-segment logs follow with examples.

One-segment logs measure 20.5 feet or less. Record lengths to the nearest foot. For measurements equal to or less than 0.5 feet, record the next lower foot. For measurements over 0.5 feet, record the next higher foot.

Example:

Measured Length (feet)	Recorded Length (feet)
14.0	14
16.5	16
16.3	16
16.6	17

Two-segment logs measure 20.6 feet through 41.0. Logs measuring 20.6 through 22.0 feet have a recorded length of 21 feet. Logs measuring 22.1 feet through 41.0 feet, record the next lower foot.

Example:

Measured Length (feet)	Recorded Length (feet)	Segment Lengths (feet)	
		Small End	Large End
20.8	21	10	11
21.1	21	10	11
32.3	32	16	16
33.0	32	16	16
34.5	34	16	18
34.7	34	16	18
35.0	34	16	18
41.0	40	20	20

Three-segment logs measure 41.1 feet through 61.5 feet. Record lengths as follows:

Measured Length (feet)	Recorded Length (feet)	Segment Lengths (feet)		
		Small End	Middle	Large End
41.1-42.5	41	13	14	14
42.6-43.5	42	14	14	14
43.6-44.5	43	14	14	15
44.6-45.5	44	14	14	16
45.6-46.5	45	14	15	16
46.6-47.5	46	14	16	16
47.6-48.5	47	15	16	16
48.6-49.5	48	16	16	16
49.6-50.5	49	16	16	17
50.6-51.5	50	16	16	18
60.6-61.5	60	20	20	20

21.13 - Recording Lengths for Butt Logs 50 Feet and Longer

In the absence of taper tables, butt logs with a recorded length of 50 feet and longer require an additional measured diameter at the top of the butt segment on three-segment logs, and at the midpoint (top of second segment) on four-segment logs.

Volume for butt logs 50 feet and longer can be calculated accurately as long as the scaling program (or scale ticket), allows for the recording of the third diameter measurement (or appropriate taper allocations are used), and for defect deductions by segment. The result is a unique taper being applied to the butt segment and actual taper being applied to the remaining segments. Depending on the data recorder (or scale ticket) being used, logs may or may not need to be divided and recorded separately.

21.2 - Length Determination of Logs with Broken Ends

Broken-ended logs require special attention. In all cases, measure length to a point where wood fiber balances voids and record length to the nearest lower even two-foot multiple.

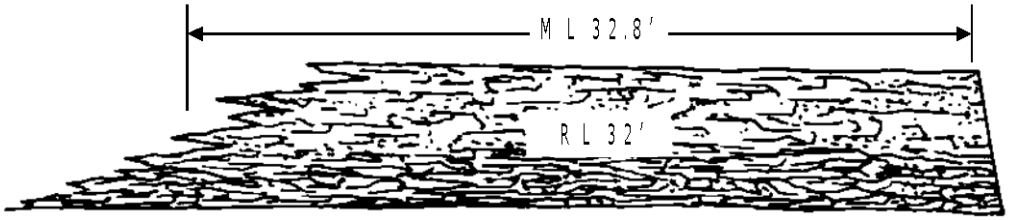
On logs with one broken end, measure from the bucked end to a point at the broken end where wood fiber balances the voids. Record to the nearest lower even two-foot multiple, as illustrated in exhibits 01 and 02.

21.2 - Exhibit 01

Length Measurement of Log With One End Broken

21.2 - Exhibit 02

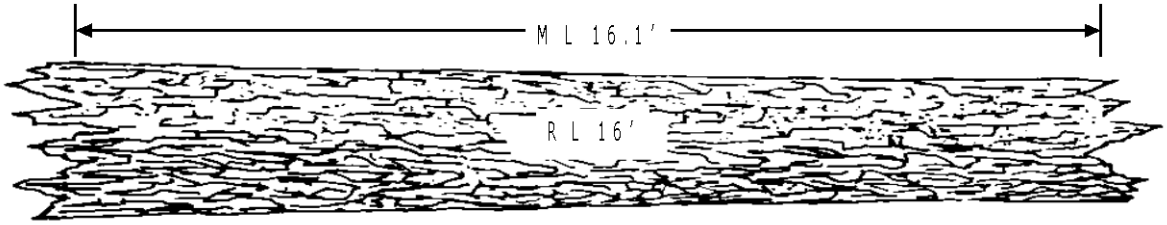
Length Measurement of Log With an Angled Break at One End



When both log ends are broken, locate the measurement point at one end where wood fiber balances the voids (ex. 03). Measure to the other end where wood fiber balances the voids and record to the nearest lower, even, two-foot multiple.

21.2 - Exhibit 03

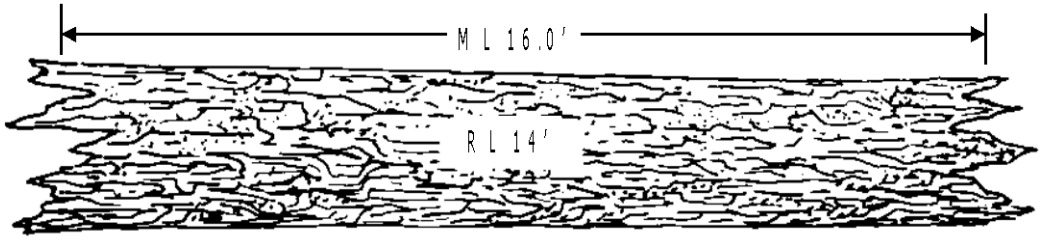
Length Measurement of Log With Both Ends Broken



If the length measurement falls exactly on a foot mark, such as 16.0 or 15.0, record the nearest lower even, two foot multiple (ex. 04).

21.2 - Exhibit 04

Length Measurement of Log With Both Ends Broken and Length Measurement Exactly on Foot Mark

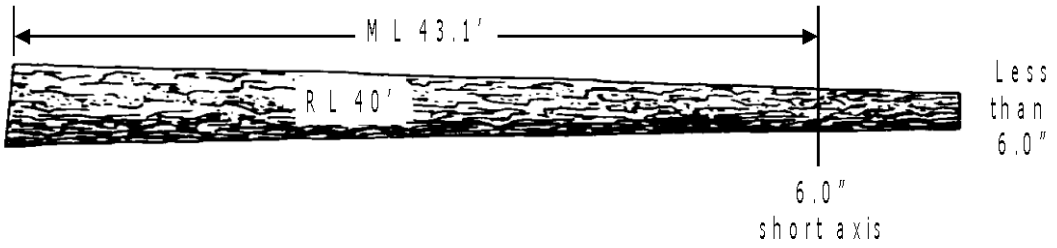


21.21 - Length Determination When Top Diameter Inside Bark (DIB) is Less Than Contract Minimum

A log may be presented for scaling that has a top diameter less than the contract minimum. The first step in measuring length, in this case, is to locate the contract minimum diameter by searching from the small end toward the large end of the log. The point of contract minimum diameter for measuring length is based on one measurement, inside bark, across the short axis of the log. Allow full trim in the length measurement and record the length in an even two-foot multiple. Upon establishing the length, measure the small end diameter to be recorded as described in section 21.3. In exhibit 01, for example, the measured length to a 6.0-inch minimum diameter is 43.1 feet. Allowing for full trim the recorded length is 40 feet.

21.21 - Exhibit 01

Top DIB Less Than Contract Minimum

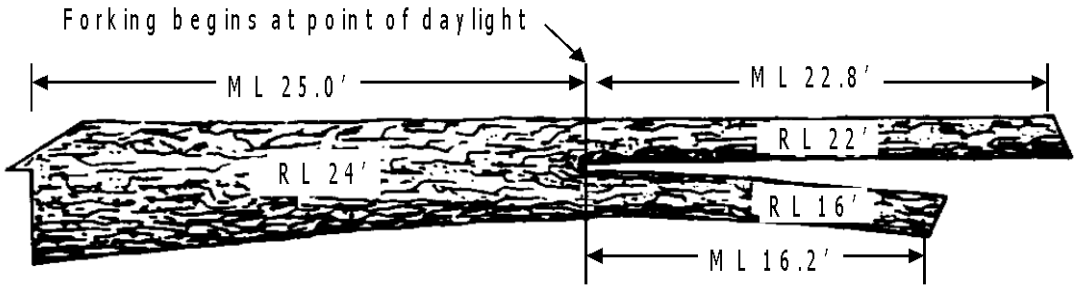


21.22 - Length Determination of Forked Logs

When a forked log is presented for scaling, record each fork, and the section below the fork, only if the fork or section meets the contract minimum piece specifications. Do not record substandard forks or sections unless specified on the scaler information form. Measure the length of any qualifying section or fork from the large end to the small end. Forking begins at the point of daylight. On the piece below the fork, allow full trim and record the length to the nearest lower, even, two-foot multiple. Record the remaining lengths to the nearest lower, even two-foot multiple (ex. 01 through ex. 04).

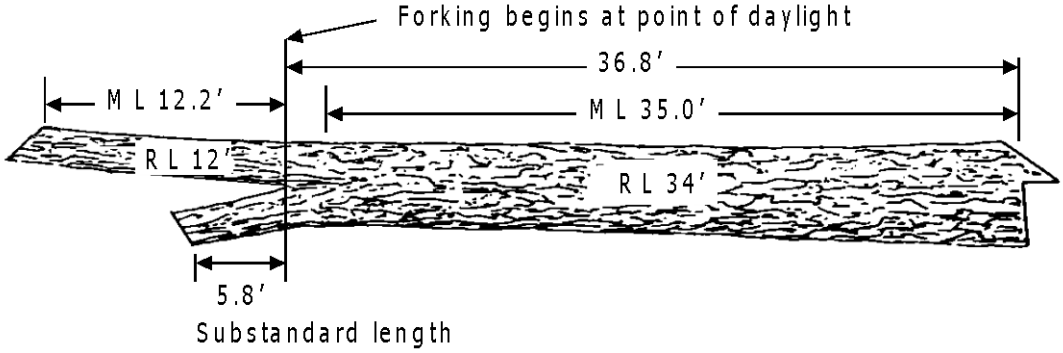
21.22 - Exhibit 01

Forked Log With Two Merchantable Forks



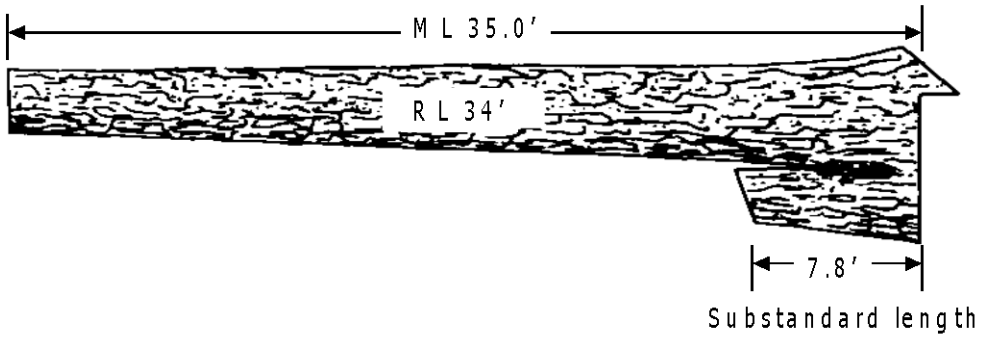
21.22 - Exhibit 02

Forked Log With One Substandard Fork



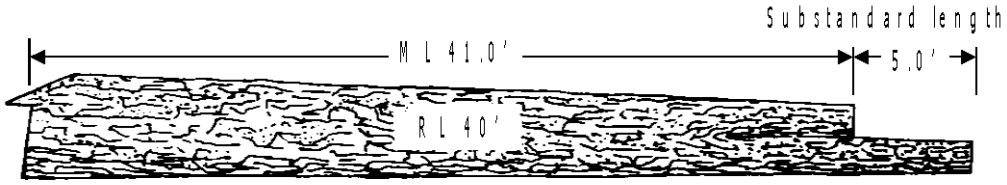
21.22 - Exhibit 03

Forked Log With a Substandard Fork at Butt End



21.22 - Exhibit 04

Forked Log With a Substandard Fork at Top End



21.3 - Measuring Log Diameters

An accurate measurement of log diameters is essential. Diameters are required at each end of the log. Butt logs with a recorded length of 50 feet and longer require an additional measured diameter along the log if approved taper tables are not available (sec. 21.13).

Use the procedure below for measuring log diameters:

1. Measure log-end diameters inside bark.

2. Measure through the geometric (true) center of the log-end cross-section.

3. Avoid measuring over stem abnormalities, such as bumps and depressions, if possible. Otherwise, measure as if such conditions were absent.

4. Read the measurement device straight-on, not from the side.

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

6. Measure diameters to the nearest inch. Round exact one-half inch measurements before averaging:

   a. When one measurement is on the half-inch mark, round up.

   b. When both measurements fall on half-inch marks, round one up and one down before averaging.

7. Average the two measurements. When the average of the two measurements is not a whole number, round down for the final scaling diameter.

8. When a portion of the log-end is missing, reconstruct the missing portion to determine the original round log scaling diameter.

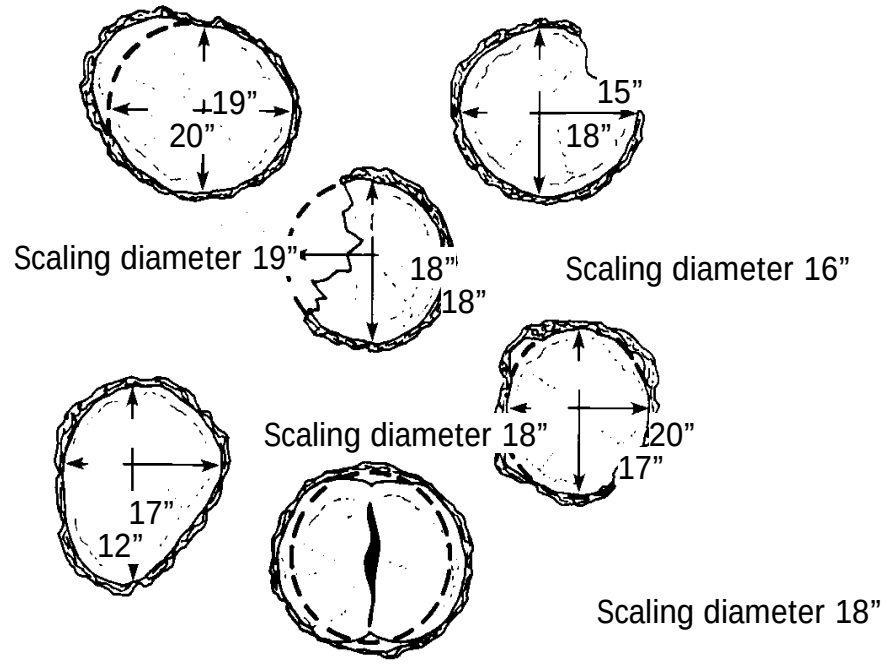
9. When a portion of a log has been broken or slabed from a whole log, measure the piece as a slab or chunk (sec. 21.32). The piece must meet minimum contract specifications or the piece is considered substandard.

10. When a portion of the log-end is missing and the missing portion affects the entire length of the piece or does not allow 6-foot lumber recovery, measure the piece as a slab or chunk (sec. 21.32).

11. When a log has been split or manufactured approximately in half, measure the piece as a fractional log (sec. 21.31).

21.3 - Exhibit 01

Log Ends With Abnormal Conditions And Irregular Shapes

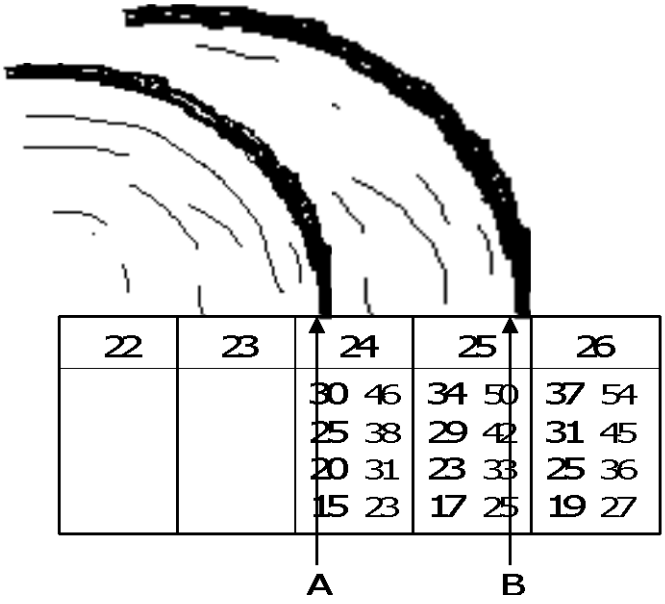


Measure smallest
diameter below fork

When using a scale stick, inch graduations are on the half-inch mark. Read each measurement as shown in exhibit 02.

21.3 - Exhibit 02

Reading Scale Stick



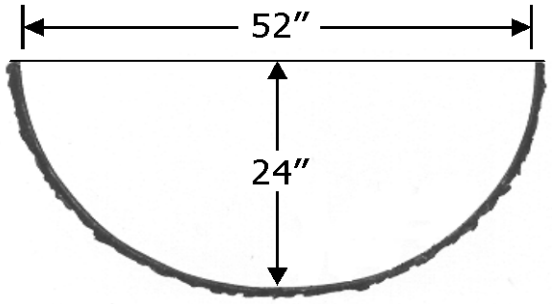
Measurement "A" is read as 24 inches and measurement "B" as 25 inches.

21.31 - Measuring Fractional Logs

A fractional log is defined as a log that has been split or manufactured approximately in half. Reconstruct the whole log gross diameter and determine cubic foot volume using the Cubic Foot Log Volume Appendix 2 in chapter 60. Record the diameter that most closely equals one-half the whole log gross volume as the fractional log gross scaling diameter. Take a long side width and short side height measurement, dropping all fractions. Measurements shall not be taken at points less than 5" thick. Double the height measurement. Average the width and height measurements to determine the approximate whole log gross diameter. Determine the whole log cubic foot volume. Record the diameter that most closely equals one-half the whole log gross volume as the fractional log gross scaling diameter.

21.31 - Exhibit 01

Cross-Section of Fractional Log



Gross measurements: 52" width, 24" height, and 16' length

Double the height: 24" x 2 = 48"

Whole log gross diameter: 52"+ 48" = 100" ÷ 2 = 50"

Log has 2" taper.

Whole log gross volume: 50" x 52" x 16' = 227.1 ft^3

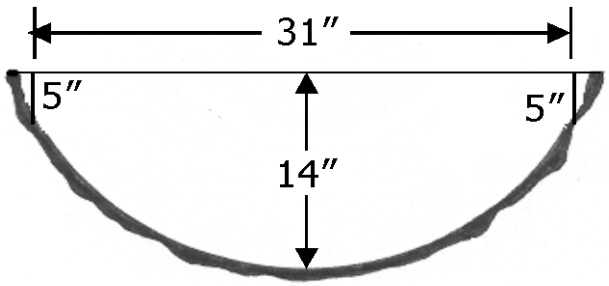
227.1 ÷ 2 = 113.55 ft^3

35" x 37" x 16' = 113.2 ft^3 which most closely equals one-half the whole log gross volume

Fractional log gross scaling diameter = 35"

21.31 - Exhibit 02

Cross-Section of Fractional Log



Gross measurements: 31" width, 14" height, and 16' length

Double the height: 14" x 2 = 28"

Whole log gross diameter: 31"+ 28" = 59" ÷ 2 = $29\frac{1}{2}$ " or 29"

Log has 3" taper.

Whole log gross volume: 29" x 32" x 16' = 81.4 ft^3

81.4 ÷ 2 = 40.7 ft^3

20" x 23" x 16' = 40.5 ft^3 this most closely equals one-half the whole log gross volume

Fractional log gross scaling diameter = 20"

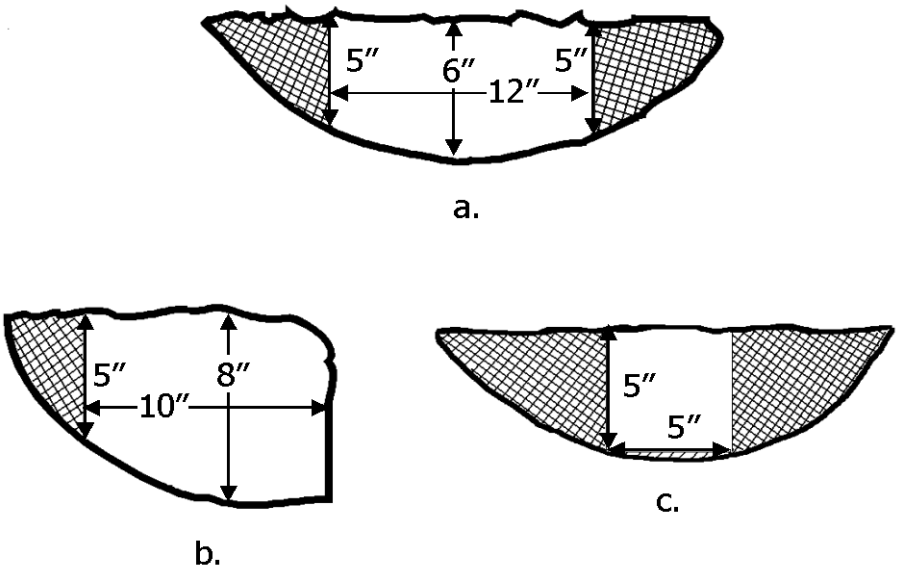
21.32 - Measuring Slabs and Chunks

Slabs and chunks are defined as a portion of a log that has been broken or slabbed from a whole log or when a portion of the log-end is missing and the missing portion affects the entire length of the piece or does not allow 6-foot lumber recovery. Convert the end area of a slab or chunk to a circular equivalent, which is recorded as the gross scaling diameter.

Determine the average width and average height measurements. Take measurements dropping all fractions. Measurements shall not be taken at points less than 5" thick. Average the width and height measurements to determine the circular equivalent. The gross scaling diameter must meet contract minimum specifications or the piece is considered substandard.

21.32 - Exhibit 01

Measuring Slabs and Chunks



The shaded areas are less than 5 inches thick and are not included in the measurement.

Example a: Gross measurements: 5" + 6" + 5" = 16" ÷ 3 = $5\frac{1}{3}$" or 5" average height, 12" width
5" + 12" = 17" ÷ 2 = $8\frac{1}{2}$" or 8" gross scaling diameter

Example b: Gross measurements: 5" + 8" = 13" ÷ 2 = $6\frac{1}{2}$"or 6" average height, 10" width
6" + 10" = 16" ÷ 2 = 8" gross scaling diameter

Example c: Gross measurements: 5" height, 5" width
5" + 5" = 10" ÷ 2 = 5" gross scaling diameter

21.33 - Tools Used in Measuring Diameters

Common tools used to measure log diameters include scale sticks, hand tapes and calipers. Scale sticks with one inch graduations at half inch points allows direct readings to the nearest inch on bucked ends. A hand tape is useful for measuring diameters of recessed logs on a truck. Calipers are useful for measuring diameters at points along the log other than at bucked ends, such as logs with broken ends, butt diameters, crotched, and forked logs.

21.34 - Measuring Bark Thickness and Determining Inside Bark Diameter Using Calipers

Measure bark thickness in tenths of inches. Take two representative bark measurements if possible, otherwise, double the single bark thickness.

Using calipers, measure outside bark diameter in tenths of inches. Take two diameter measurements at right angles to each other. Measure the short axis first; take the second measurement at right angles to the first. Average the measurements.

To determine inside bark diameter, subtract bark thickness from outside bark diameter and round to the nearest inch. Results ending in 0.5 or below are rounded to the next lower inch and 0.6 or above to the next higher inch. For example, round 15.5 to 15 inches and 15.6 to 16 inches.

21.4 - Determining the Large End Diameter of Butt Logs

Measure inside bark at four feet above the large end or estimate by applying an average taper to the small end diameter. For butt logs, taper is the difference between the small end diameter and the large end diameter taken inside bark, at four feet above the large end. Average taper (for any grouping of species, log size, and locality) is determined by special studies authorized by the Regional Forester (sec. 04.2).

See section 21.13 regarding additional diameters required on butt logs 50 feet and longer in recorded length.

Use a caliper when measuring the large end diameter of butt logs.

When in doubt, there are several physical characteristics whose absence or presence can assist the scaler in determining whether or not a log is a butt log. Physical characteristics that are indicative of butt logs are: butt flare (excessive taper), flutes, paint marks, absence of limbs, thicker bark, undercut/hinge/stump pull, and shear or circular saw marks left by mechanical fellers. The application of good scaler judgment while considering the above physical characteristics will help the scaler to determine whether or not a log in question is a butt log.

21.41 - Measuring Diameters on Crotched or Irregularly Shaped Log Ends

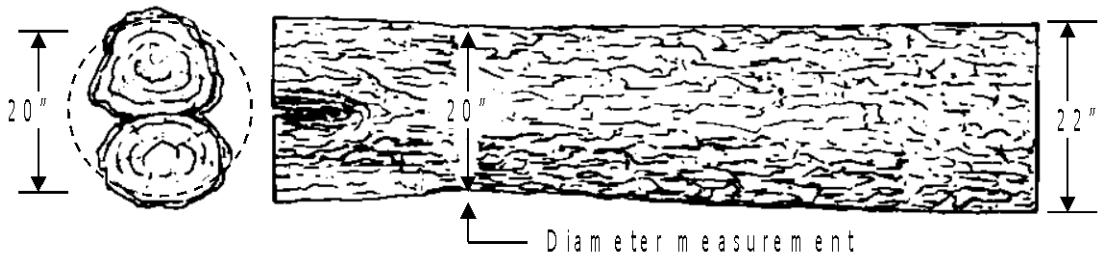
If the log end is irregular due to abnormalities such as scar, swelling, or crotch (so that the diameter cannot be measured normally), use one of the methods below. Refer to section 22.41c for measuring logs with missing sapwood.

1. Measure the diameter with calipers, above or below the abnormality. Adjust outside bark measurements for bark thickness (sec. 21.34). Exhibit 01 illustrates the procedure for crotched logs.

2. Measure the log end with the normal diameter, then add or subtract the estimated taper to determine the diameter of the abnormal log end.

21.41 - Exhibit 01

Diameter Measurement Points On a Crotched Log



21.42 - Measuring Diameters on Forked Logs

Measure diameters on forked logs at points along the log other than log ends with a caliper or other appropriate tool. See section 21.22 for examples of diameter measurement points on forked logs. Adjust outside bark measurements for bark thickness.

21.43 - Measuring Diameter on Logs with Broken Ends

Use one or more of the following methods to determine diameters of logs with broken end(s):

1. Use calipers or lay a tape or scale stick across the top of the log above or below the broken area. Record the measured diameter inside bark.

2. Measure the large end diameter. Reduce this measurement by the estimated taper to obtain the small end diameter.

3. Measure the small end diameter. Add the estimated amount of taper to this measurement to obtain the large end diameter.

21.44 - Determining Intermediate Diameters of Multi-Segment Logs

Determine intermediate diameters of multi-segment logs by apportioning the taper of the log. Taper is the difference between the two end diameters. Taper is even when it can be apportioned in an equal amount to each segment and uneven when it cannot.

21.44a - 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 three-segment log, add the taper per segment to the top diameter of the middle segment. The resulting diameter should differ from the large end diameter by the taper per segment.

Exhibit 01 illustrates a 32-foot log with end measurements of 16 and 20 inches (4 inches total taper or 2 inches per segment). Scale it as one 16-foot segment with diameters of 16 and 18 inches (2 inches taper); and one 16-foot segment with diameters of 18 inches and 20 inches (2 inches taper).

21.44a - Exhibit 01

Distribution of Even Taper in a 32-Foot Log

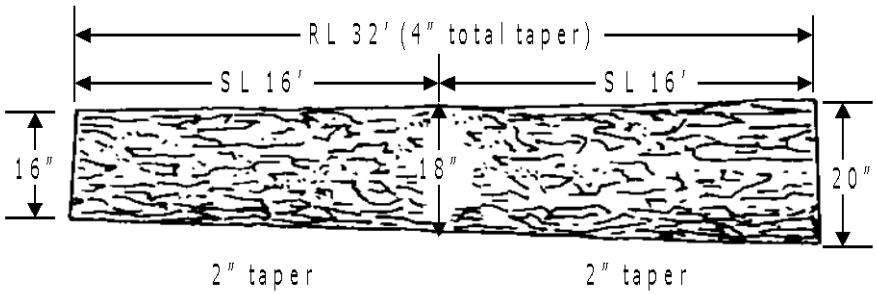
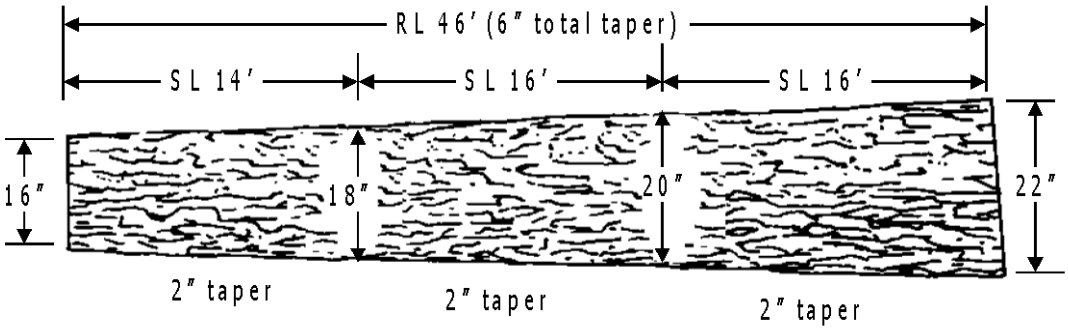


Exhibit 02 illustrates a 46-foot log with end measurements of 16 and 22 inches (6 inches total taper or 2 inches per segment). Scale it as one 14-foot segment with diameters of 16 and 18 inches (2 inches taper); one 16-foot segment with diameters of 18 and 20 inches (2 inches taper); and one 16-foot segment with diameters of 20 and 22 inches (2 inches taper).

21.44a - Exhibit 02

Distribution of Even Taper in a 46-Foot Log



21.44b - Distribution of Uneven Taper

Scale logs with uneven taper by applying the excess taper to the top segment(s). Trees naturally grow with increased taper in top logs.

The rule of distribution of uneven taper in multi-segment logs is as follows:

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

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

Exhibit 01 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 diameters of 16 and 18 inches (2 inches of taper); and one 16-foot segment with diameters of 18 and 19 inches (1-inch taper to large end).

21.44b - Exhibit 01

Distribution of Uneven Taper in a 32-Foot Log

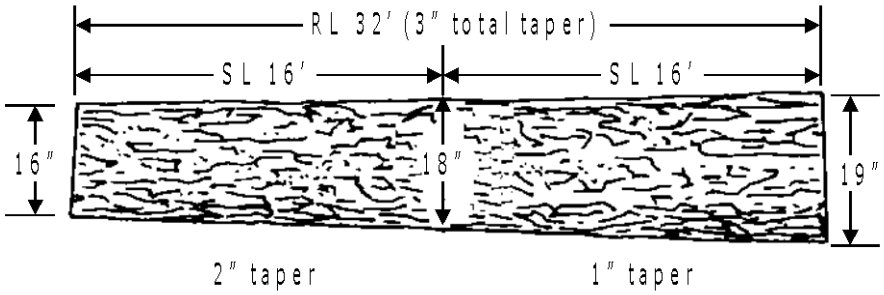
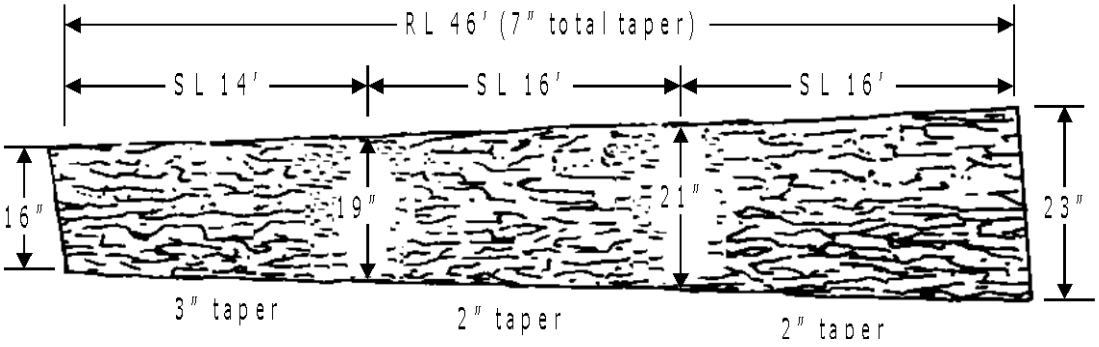


Exhibit 02 illustrates a 46-foot log with end measurements of 16 and 23 inches (7 inches total taper). Scale it as one 14-foot segment with diameters of 16 and 19 inches (3 inches taper); one 16-foot segment with diameters of 19 and 21 inches (2 inches taper); and one 16-foot segment with diameters of 21 and 23 inches (2 inches taper).

21.44b - Exhibit 02

Distribution of Uneven Taper in a 46-Foot Log



21.5 - Determining Gross Cubic Volume of Logs

Use the Smalian formula to determine gross log volume. Calculate volume for each segment. The volume of multi-segment logs is the sum of the segment volumes.

Calculate and record volume to the nearest 0.1 cubic foot. Round calculated volumes ending in 0.05 cubic foot or more up to the next 0.1 cubic foot.

Using the Smalian formula:

$$Volume\ in\ cubic\ \ feet\ (\ ft^3\ ) = 0.002727\ (\ D^2 + d^2\ )SL$$

Where:

D = Large end diameter (inches)
d = Small end diameter (inches)
SL = Segment length (feet)

Two examples of volume calculations follow in exhibits 01 and 02.

21.5 - Exhibit 01

Example Calculation for a One Segment Log

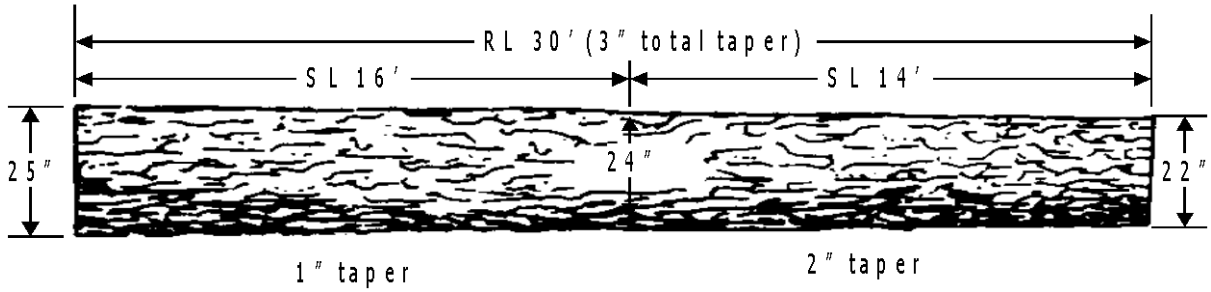
Given:

D = Large end diameter = 17 inches
d = Small end diameter = 15 inches
RL = Recorded length = 16 feet (one segment)
SL = Segment length = 16 feet

$$\begin{aligned} Volume\ (\ ft^3\ ) &= 0.002727\ (\ D^2 + d^2\ )\ SL \\ &= 0.002727\ (\ 17^2 + 15^2\ )\ 16 \\ &= 0.002727\ (289 + 225)\ 16 \\ &= 0.002727\ x\ 514\ x\ 16 \\ &= 0.002727\ x\ 8{,}224 \\ &= 22.4\ ft^3 \end{aligned}$$

21.5 - Exhibit 02

Example Calculation for a Two-Segment Log



Given:

D = Large end diameter = 25 inches
d = Small end diameter = 22 inches
RL = Recorded length = 30 feet (two segments)
SL = 16 foot large end segment and 14 foot small end segment.

Large end segment:

D = 25 inches
d = 24 inches
SL = 16 feet

$$Volume\ (ft^3) = 0.002727\ (D^2 + d^2)\ SL$$
$$= 0.002727\ (25^2 + 24^2)\ 16$$
$$= 0.002727\ (625 + 576)\ 16$$
$$= 0.002727 \times 1{,}201 \times 16$$
$$= 0.002727 \times 19{,}216$$
$$= 52.4\ ft^3$$

Small end segment:

D = 24 inches
d = 22 inches
SL = 14 feet

$$Volume\ (ft^3) = 0.002727\ (D^2 + d^2)\ SL$$
$$= 0.002727\ (24^2 + 22^2)\ 14$$
$$= 0.002727\ (576 + 484)\ 14$$
$$= 0.002727 \times 1{,}060 \times 14$$
$$= 0.002727 \times 14{,}840$$
$$= 40.5\ ft^3$$

Total log volume = 52.4 + 40.5 = 92.9 ft^3

21.51 - Determining Log Volume by Table Look-Up

Gross log volume can also be determined by table look-up using the Cubic Foot Log Volume Appendix 2 in chapter 60. The table includes user instructions.

21.52 - Calculating Trim Volume

Trim is not included in the calculation of gross cubic foot volume of saw and veneer logs. However, trim volume may need to be known to account for the total cubic foot volume in a segment or log. Trim volume for one segment can be closely estimated by the following formula:

$$Trim\ volume\ (\ ft^3\ ) = \frac{trim\ length}{segment\ length}\ x\ segment\ gross\ volume$$

Using the example from section 21.5, exhibit 01:

Trim = 0.5 feet
Segment length = 16 feet
Segment gross volume = 22.4 ft^3

$$Trim\ volume = \frac{0.5}{16.0}\ x\ 22.4 = .0313\ x\ 22.4 = 0.7\ \ ft^3$$

Trim volume for a batch of logs can be estimated by the following formula:

$$Trim\ \ volume\ (\ ft^3\ ) = \frac{average\ \ trim\ \ length}{average\ \ segment\ \ length}\ \ x\ \ total\ \ gross\ \ volume\ of\ \ all\ \ logs$$

Example:

Average trim = 0.5 feet
Average segment length = 15.2 feet
Total gross volume (5 logs) = 107.1 ft^3

$$Trim\ volume = \frac{0.5}{15.2}\ x\ 107.1 = .0329\ x\ 107.1 = 3.5\ \ ft^3$$

22 - Assessing Defect and Defect Deduction Methods

22.1 - Assessing Defect in Logs

Defect is any unsound wood or abnormal shape in a log that reduces the amount of volume available for the manufacture of lumber or veneer. The first step in assessing a log for defect is to determine if the log, or segment within the log, is merchantable. Instructions for cull log determination are provided in section 22.5.

22.11 - Sources of Defects

There are two sources of scaling defects, natural and logging.

1. Natural Defects. Natural defects exist in the log before the tree is felled. These may include all kinds of interior rot, rotten knots, fire scars, cat faces, lightning scars, massed wormholes, bark seams, crotch, sap rot, and grain distortion.

2. Logging Defects. Logging defects generally occur when or after the tree is felled. They may include defects such as breakage, tractor damage, loading and unloading damage.

22.12 - Defect Categories

There are two categories of defects, fiber and product.

1. Fiber defects result in complete loss of wood fiber for any primary (lumber or veneer) or secondary product (chips). Types of fiber defect are:

   a. Void. No wood is present.

   b. Soft rot. Rot not useable for primary or secondary products.

   c. Char. Burned wood, charcoal.

   d. Massed pitch. Wood impregnated with pitch.

   e. Shatter. When part of the log is broken to the extent it cannot be mechanically debarked.

   f. Foreign material. When foreign material cannot be removed it renders the log a safety hazard or may damage equipment when the log is manufactured.

2. Product defects reduce the amount of lumber or veneer that can be manufactured from a log. Types of product defects include:

   a. Break. Partial or complete break in a log.

   b. Checks. Internal or surface cracks in a log.

c. Pitch ring or shake ring. Separation of growth rings with or without pitch.

d. Spangle. Radial checks.

e. Firm rot. Rot firm enough to be manufactured into secondary products.

f. Crook. Severe curve in a log.

g. Sweep. Continuous curve in a log.

h. Knots. Very large and/or closely spaced knots.

i. Grain distortion. Common types of grain distortion are spiral grain, twist, slope of grain, and cross grain.

22.13 - Determining Extent of Defect in Logs

When defect shows in only one end of a log, check for surface indicators to determine how far the defect extends into the log. Surface indicators for interior rots include conks, scars, cat faces, seams, or rotten knots. Swell in the butt can be an indication of the extent of stump rot or spangle, but not all swells indicate defect. Breakage is sometimes an indication of weakness caused by interior rot. Carefully examine the point of breakage for this possibility. When exterior indications are lacking, use judgment to assess the extent of interior rot.

22.2 - Basic Defect Deduction Rules

Use the following basic defect deduction rules when applying any of the four defect deduction methods described in section 22.3. These rules apply to logs intended to be manufactured into lumber or veneer.

1. Record defect volume to the nearest 0.1 cubic foot. For example, 0.23 is recorded as 0.2, 1.78 is recorded as 1.8, and 3.55 as 3.6.

2. Record any single occurring defect only when that defect meets a minimum volume of 0.2 cubic feet before rounding.

3. When calculating manually use four decimal places for unrounded figures. Examples in this Handbook use rounded volumes from tables in the Appendix, which can result in slightly different defect volumes compared to computer precision rounding. Use computer precision in software applications.

4. Consider the following when determining defect:

a. A minimum board size is 1 inch x 4 inches x 6 feet.

b. The maximum segment length is 20 feet.

c. Consider the extent of defect length in two-foot multiples.

d. Consider defect shape (cylinder, cone) in determining average defect length.

5. Use actual defect dimensions in determining defect volume.

6. When computing average defect dimensions, round calculations ending in 0.5 to the nearest even whole number. For example, round 6.5 to 6 and 9.5 to 10.

7. Deduct for defects on log ends, such as stump pull, only to the extent that the defect exceeds 0.3 feet in length.

8. Stain by itself is not a defect.

9. More than one defect deduction method may be applicable when assessing a single defect. Check one method of deduction against another and use the method that deducts the least volume. Do not use rules of thumb.

10. More than one defect deduction method may be used to deduct for multiple defects in a log.