BOARD FOOT CONTENT OF A LOG:

Board foot: this unit of measure is equivalent to a board 1 inch thick and 12 inches (1 foot) square, which contains 144 cubic inches of wood. The formula used to calculate the board foot content of a piece of rough, green, sawed lumber is:

\[
\text{Bdft} = \frac{\text{Thickness} \times \text{Width} \times \text{Length}}{12}
\]

For example, the board foot content of a board 1 inch thick, 12 inches wide, and 1 foot long is 1 board foot.

Similarly, a board 1 inch thick, 12 inches wide, and 12 feet long contains 12 board feet.

Board foot **log rules** decide how many board feet can be cut from round logs. Many log rules have been created to estimate board foot content of logs (well over a 100). Note, board foot volume is a man-made unit of measure; there is NO single correct answer, because it is NOT an absolute measurement like cubic foot volume.

**Log scaling** is the application of log rules to logs. **Mill tally** is the actual amount of board feet cut from a log at the mill.

- If the mill tally > log scale, then overrun occurs
- If the mill tally < log scale, then underrun occurs.
Assumption of Log Rules

1.) The log is a cylinder. The scaling cylinder is the cylinder defined from the small end of the log.

2.) Cut 1 inch boards.

3.) Some wood is lost to sawdust. This lost wood is called kerf.

4.) There are minimum board widths

5.) There are minimum board lengths.

6.) No defect.

To Maximize the Overrun (which is what the mill does):

1.) Improve the sawmill’s machinery.

2.) Optimize the material cut; e.g., make boards from slab material.

3.) Improve worker efficiency.

4.) Adapt to market conditions; old log rules cannot make specifications about today’s markets.

5.) Account for taper and defect.

LOG RULES

Types: 1.) Diagram Rules; e.g., Scribner

2.) Mathematical or Formula Rules; e.g., International \(\frac{1}{4}\) or Doyle
Scribner’s Log Rule

J.M. Scribner (circa 1846) drew pictures to scale by 1 inch scaling diameters, assuming 4 inch minimum width, 1 inch thick boards with ¼” of kerf. He then calculated width and thickness of board ends from his diagrams, assumed a 1 foot long log, and then developed his rule:

\[ BF = \sum \frac{W \times T \times L}{12}, \text{ for a 1 foot log} \]

Scribner dec C is Scribner board foot in tens.

Tabulated Scribner dec C scale can be found in Avery and Burkhart, page 386.

Example: Scaling diameter = 20 inches and log length = 16 feet. Board foot volume = 28 dec C

Scribner’s tables have been fit with regression to create an equation:

\[ \text{Scribner BF} = 0.79d^2 - 2d - 4 \]

Doyle’s Log Rule

Edward Doyle (circa 1825) assumed that 4 inches should be removed from the scaling diameter for slab material (2 inches per side). Basically, he was squaring up a round log. Doyle’s Rule under-estimates the board foot content for small logs and over-estimates board foot content for large logs. Why? In squaring the log, the 4
inch slab allowance is not adequate for large logs and is excessive for small logs. It works well for logs with scaling diameters between 26 and 36 inches.

Let’s derive Doyle’s formula:

**Slab Allowance:**
\[ BF = \frac{(d - 4)(d - 4) \cdot L}{12} = \frac{(d - 4)^2 \cdot L}{12} \]

**Kerf Allowance:** Make a 25 percent reduction for kerf
\[ BF = \frac{(d - 4)^2 \cdot L \cdot \frac{3}{4}}{12} = \left(\frac{d^2 - 8d + 16}{16}\right) L \]

**Final Formula:**
\[ BF = \left(\frac{d - 4}{4}\right)^2 \cdot L \]

**International ¼” Log Rule**

This log rule is considered to be the most accurate. It assumes a 4 foot long scaling cylinder, which better captures the taper of a log. Judson Clark created this rule in 1906, originally assuming 1/8” kerf and a ½” taper per 4 foot log section.

**Derivation of formula for a 4 foot cylinder:**

The volume for a cylinder is:  \( V = Ab \cdot L \)

1.)  \( V = 0.005454 \cdot d^2 \cdot 4 \text{ ft.} \cdot 12 \text{ bdf/ft}^3 = 0.262d^2 \text{ bdf.} \)

2.)  Deduct a 2.12 inch thick plank for slab, where width = d
\[ V = \frac{T \cdot L \cdot W}{12} = \frac{2.12'' \cdot 4'' \cdot d}{12} = 0.71d \text{ bdf} \]

3.)  Deduct 1/8 = 2/16” saw kerf and 1/16” shrinkage loss, for a total deduction of 3/16”. Thus, you lose 3/16” or 0.1875” to get a 1” board. So, the total reduction as a percentage would be:
4.) Our final formula for a 4 foot log is:

\[ V = (1 - 0.158) \times 0.262d^2 - 0.71d = 0.22d^2 - 0.71d, \] in a 4 foot section

5.) Derive the formula for a 16 foot log.

Basically, we will add up four, 4 foot sections to get the International BF scale for our 16 foot log. We will also assume ½” of taper per 4 foot section.

\[ \sum_{i=1}^{4n} V_i = 0.88d^2 - 1.52d - 1.36 \]

For 32 foot logs, just add up more 4 foot sections.

**Convert to ¼” kerf**

To convert the International 1/8” log rule to a ¼” log rule, simply use a multiplier based on a kerf deduction of ¼”. For the International ¼” log rule, our kerf deduction is now 5/16”. So,

\[ \text{Reduction} = \frac{5/16}{(1/16+5/16)} = 0.238 \]

Now, our multiplier is:
Multiplier = \( \frac{1 - 0.238}{1 - 0.158} \) = 0.905

Our International \( \frac{1}{4}'' \) log rule formulas are:

\[ V = 0.905(0.22d^2 - 0.71d), \]  for a 4 foot log section.

\[ V = 0.905(0.88d^2 - 1.521d - 1.36), \]  for a 16 foot log.

**Comparison of Log Rules**

The International \( \frac{1}{4}'' \) (and \( \frac{1}{8}'' \)) log rule is considered to be the most accurate of all the log rules. So, it is often used as the standard for comparison between log rules. Doyle underestimates the scale for logs less than 25 inches and overestimates the scale for logs greater than 35 inches; this rule does well for logs between 26 and 36 inches. Scribner underestimates the scale for all diameters, with the smaller log scales being more underestimated than those of the larger logs. Scribner becomes progressively more accurate for larger logs.

See section 6-8 on pages 120 and 121 in Avery and Burkhart for more details on the comparisons between log rules, especially Figure 6-3 on page 121.

**BOARD FOOT – CUBIC FOOT RATIOS**

Board foot / Cubic foot ratios are used to convert between the two units of volume measurement.

Theoretically, 12 board feet = 1 cubic foot of wood. Actually, the number varies depending on dib and taper. You get more board foot cut per unit cubic foot as the scaling cylinder increase (as dib increases). More taper tends to make the BF:CF ratio decrease. Why? Because cubic foot increases while board foot remains the same; so, the denominator of the ratio, BF/CF, increases while the numerator stays constant, which causes the ratio to decrease.
BF/CF RATIOS FOR 16 FOOT LOGS
by DIB and Taper

DOYLE AND CUBIC VOLUME COMPARISON
by DIB