A COLLECTION OF LOG RULES

U.S.D.A. FOREST SERVICE
GENERAL TECHNICAL REPORT
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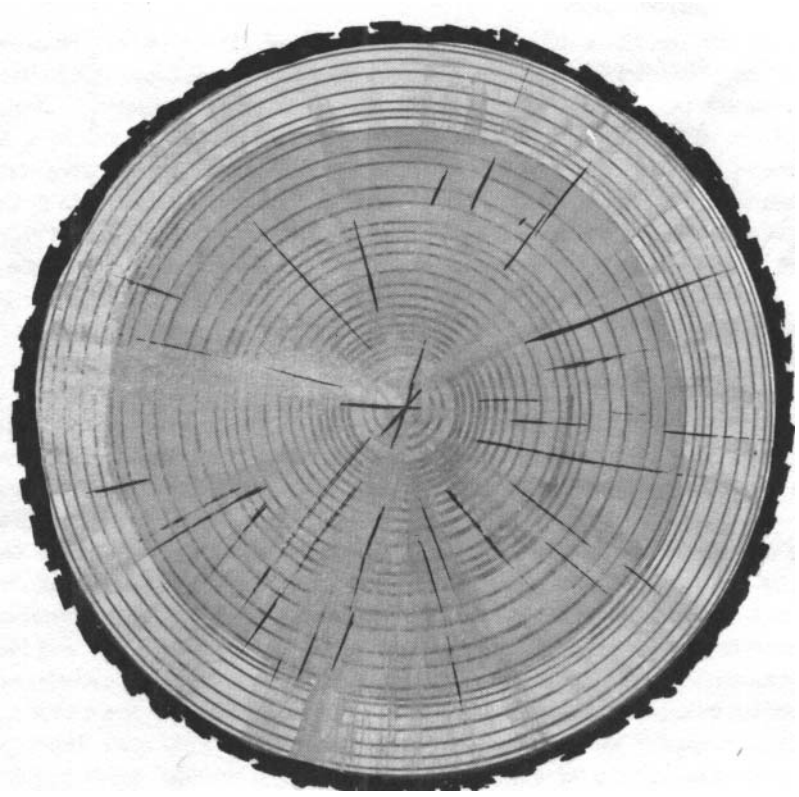

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WIS.

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A COLLECTION OF LOG RULES

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U.S. Department of Agriculture

INTRODUCTION

A log rule may be defined as a table or formula showing the estimated net yield for logs of a given diameter and length. Ordinarily the yield is expressed in terms of board feet of finished lumber, though a few rules give the cubic volume of the log or some fraction of it. Built into each log rule are allowances for losses due to such things as slabs, saw kerf, edgings, and shrinkage.

At first glance, it would seem to be a relatively simple matter to devise such a rule and having done so that should be the end of the problem. But it would seem so only to those who are unfamiliar with the great variations in the dimensions of lumber which may be produced from a log, with variations in the equipment used in producing this lumber and the skills of various operators, and finally, with the variations in the logs. All of these have an effect on the portion of the total log volume that ends up as usable lumber and the portion that becomes milling residue.

Historically the lumber industry has consisted of a number of independent marketing areas or even of separate companies. Since no industrial organization or government agency had control over the measurement of logs, each district or even individual buyers could devise a rule to fit a particular set of operating conditions. The result is that in the United States and Canada there are over 95 recognized rules bearing about 185 names. In addition, there are numerous local variations in the application of any given rule.

Basically, there are three methods of developing a new log rule. The most obvious is to record the volume of lumber produced from straight, defect-free logs of given diameters and lengths and accumulate such data until all sizes of logs have been covered. These "mill scale" or "mill tally" rules have the virtue of requiring no assumptions and of being perfectly adapted to all the conditions prevailing when the data were obtained. Their disadvantage, aside from the amount of record keeping required, is that they may have been produced in such a restricted set of conditions that the values are not applicable anywhere else.

The second method is to prescribe all of the pertinent conditions, e.g., allowance for saw kerf and shrinkage, thickness and minimum width and length of boards, taper assumptions, etc., and then to draw diagrams in circles of various sizes, representing the sawing pattern on the small end of a log. These "diagram rules," of which the Scribner is an example, will be good or bad, depending on how well the sawmilling situation fits the assumptions used in producing the diagrams.

The third basic procedure is to start with the formula for some assumed geometric solid and then make adjustments to allow for losses in saw

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

kerf, slabs, edgings, and so forth. These are referred to as "formula rules" and as is the case for any type of rule, their applicability will depend on how well the facts fit all of the assumptions.

The development of a rule may involve more than one of these procedures. Thus, the step-like progression of values in a mill-tally or diagram rule may be smoothed out by fitting a regression equation. Or the allowance to be used for slabs and edgings in a formula rule may be estimated from mill-tally data.

Finally, there are the "combination" rules such as the Doyle-Scribner which uses values from the Doyle Rule for small logs and from the Scribner Rule for large logs. The aim, of course, is to take advantage of either the best or the worst features of the different rules.

This publication lists and describes all of the log rules that the author has encountered in the course of answering inquiries about the various rules. Most of the information was obtained from over 200 references listed in the Appendix, with the bulk of it attributable to the writings of H. C. Belyea, Austin Cary, H. H. Chapman, H.S. Graves, H.E. McKenzie, and J. M. Robinson. Although log rules are no longer as big an issue as they once were, they are an important element in the history of forestry and the lumbering industry and it seemed desirable to bring together under one cover, all of the material that had been accumulated.

The existing data on log rules is scattered, incomplete, and often contradictory, hence, there are undoubtedly numerous errors and omissions in this work. The author would greatly appreciate receiving corrections or additions from readers. Particularly needed are complete tables of values for the various mill-scale and diagram rules.

SYMBOLOGY

Unless otherwise indicated,

D = The diameter in inches, inside bark, at the small end of the log.

D_m = The diameter in inches, inside bark, at the middle of the log.

L = The length of the log in feet.

BF = Volume in board feet.

CF = Volume in cubic feet.

Figure 1.--Relative scale value for 16-foot logs according to various board-foot log rules (International 1/4-Inch = 100).

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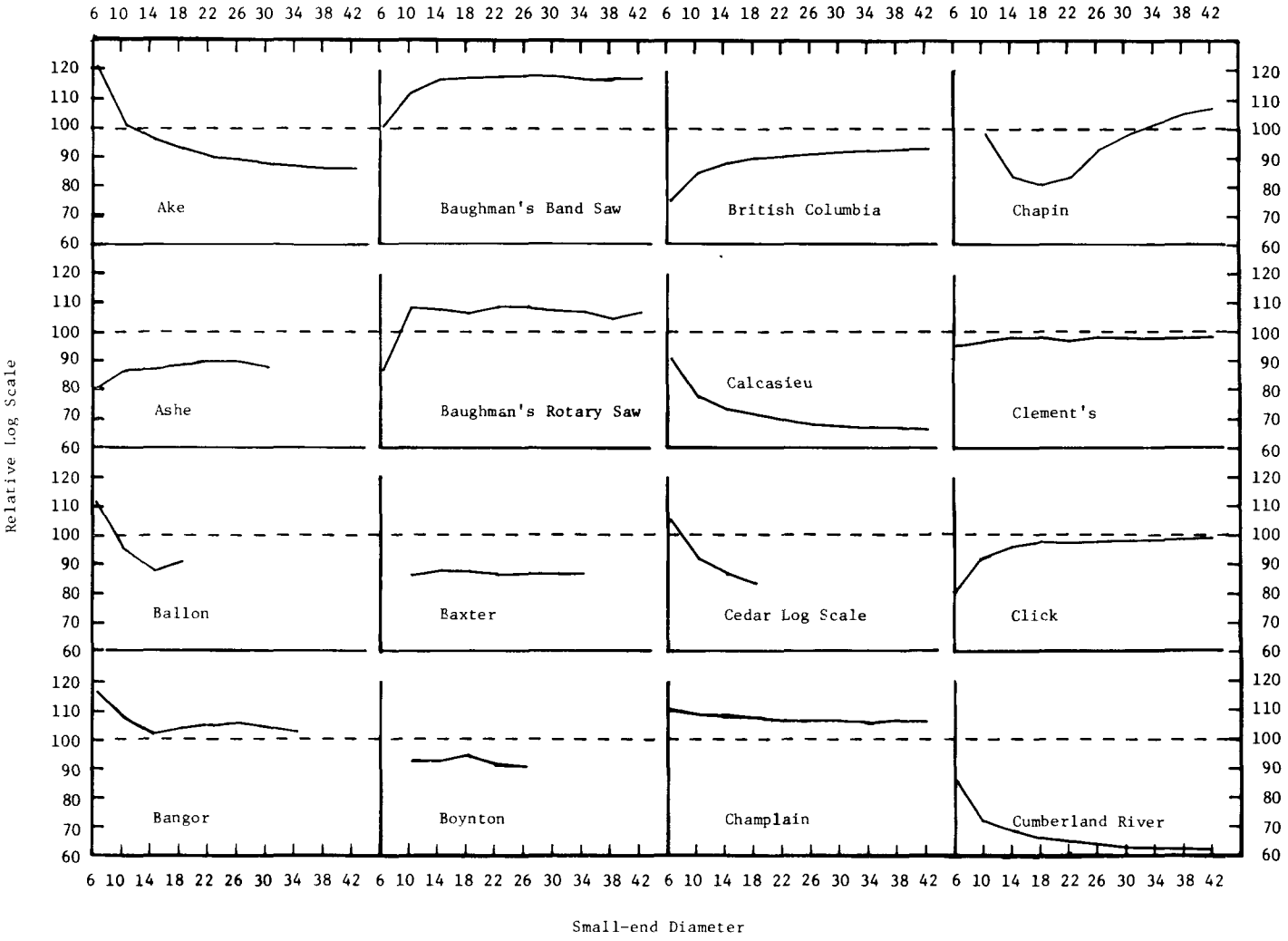
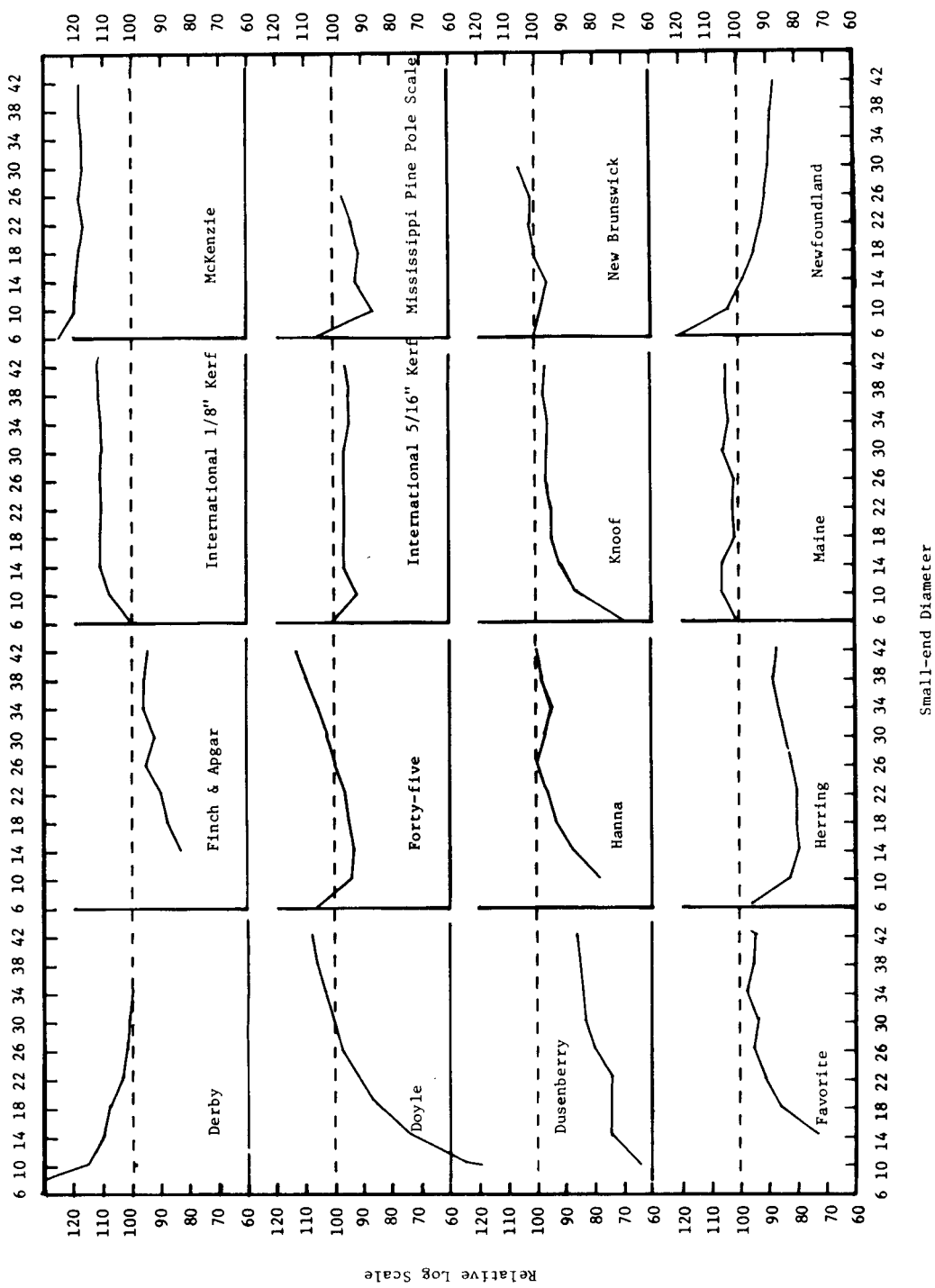
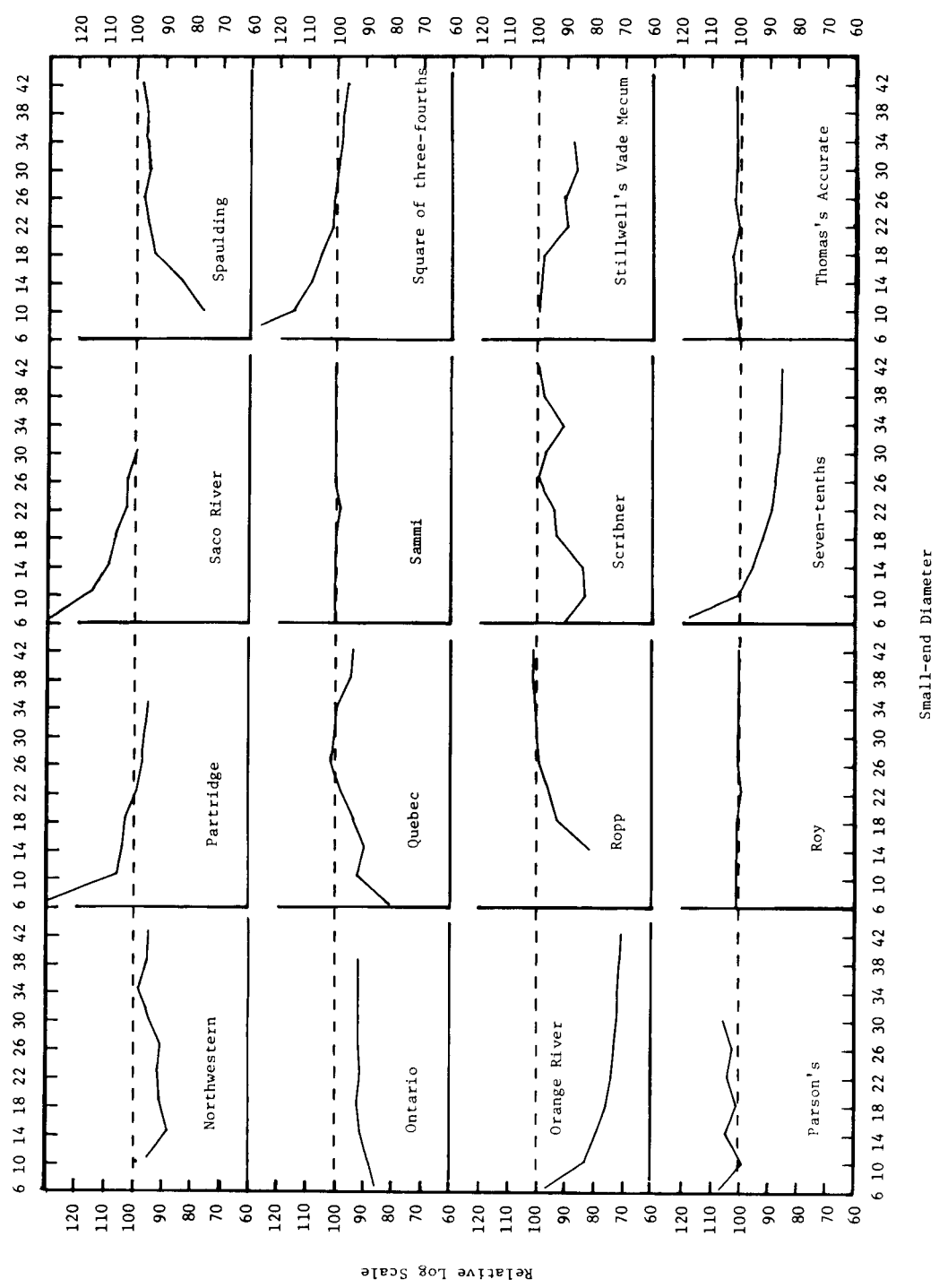



Relative Log Scale
Small-end Diameter
Derby
Finch & Apgar
International 1/8" Kerf
McKenzie
Doyle
Forty-five
International 5/16" Kerf
Mississippi Pine Pole Scale
Dusenberry
Hanna
Knoof
New Brunswick
Favorite
Herring
Maine
Newfoundland


Relative Log Scale
Small-end Diameter
Spaulding
Saco River
Square of three-fourths
Sammi
Stillwell's Vade Mecum
Scribner
Thomas's Accurate
Seven-tenths
Partridge
Quebec
Ropp
Roy
Northwestern
Ontario
Orange River
Parson's

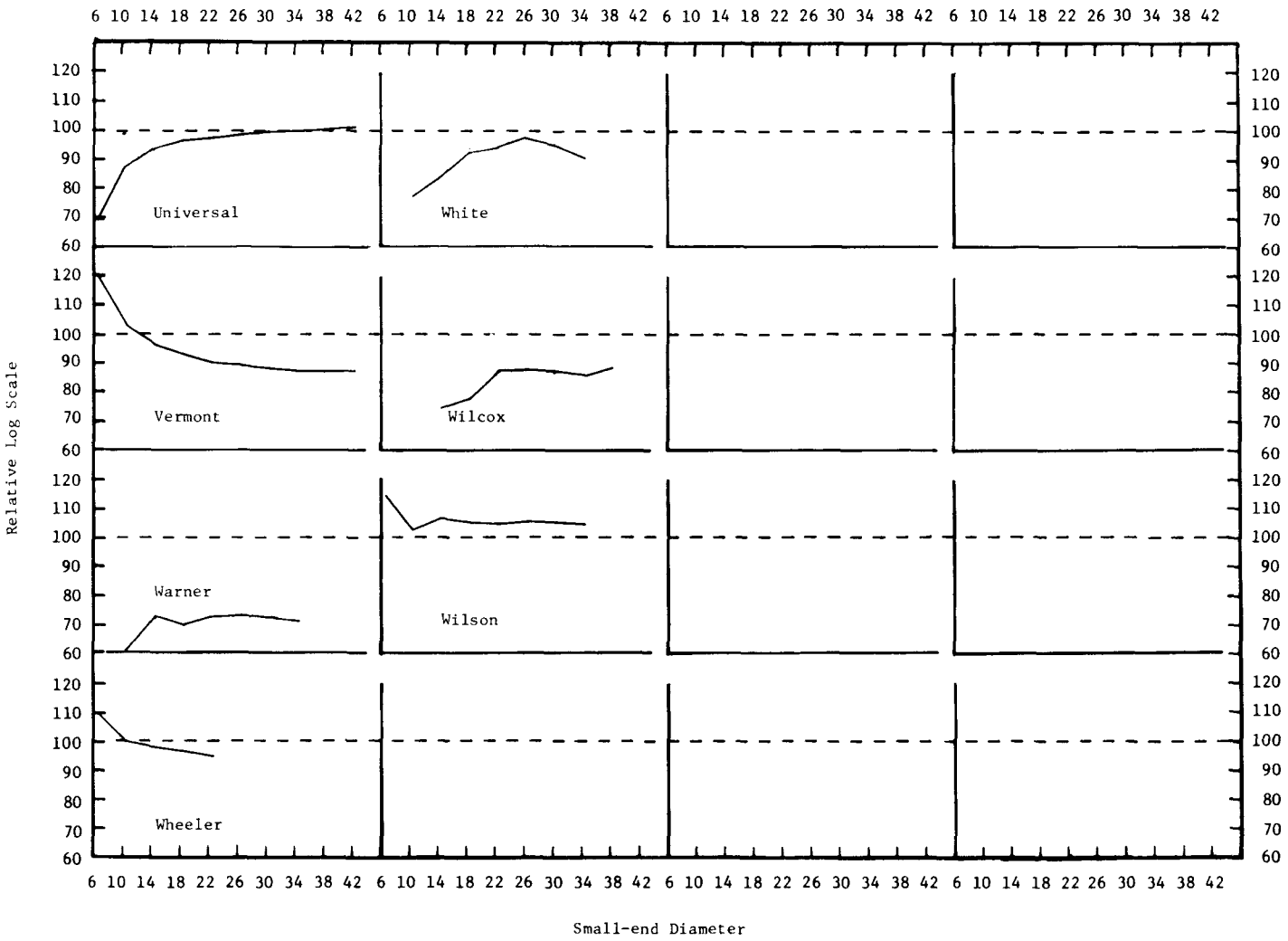
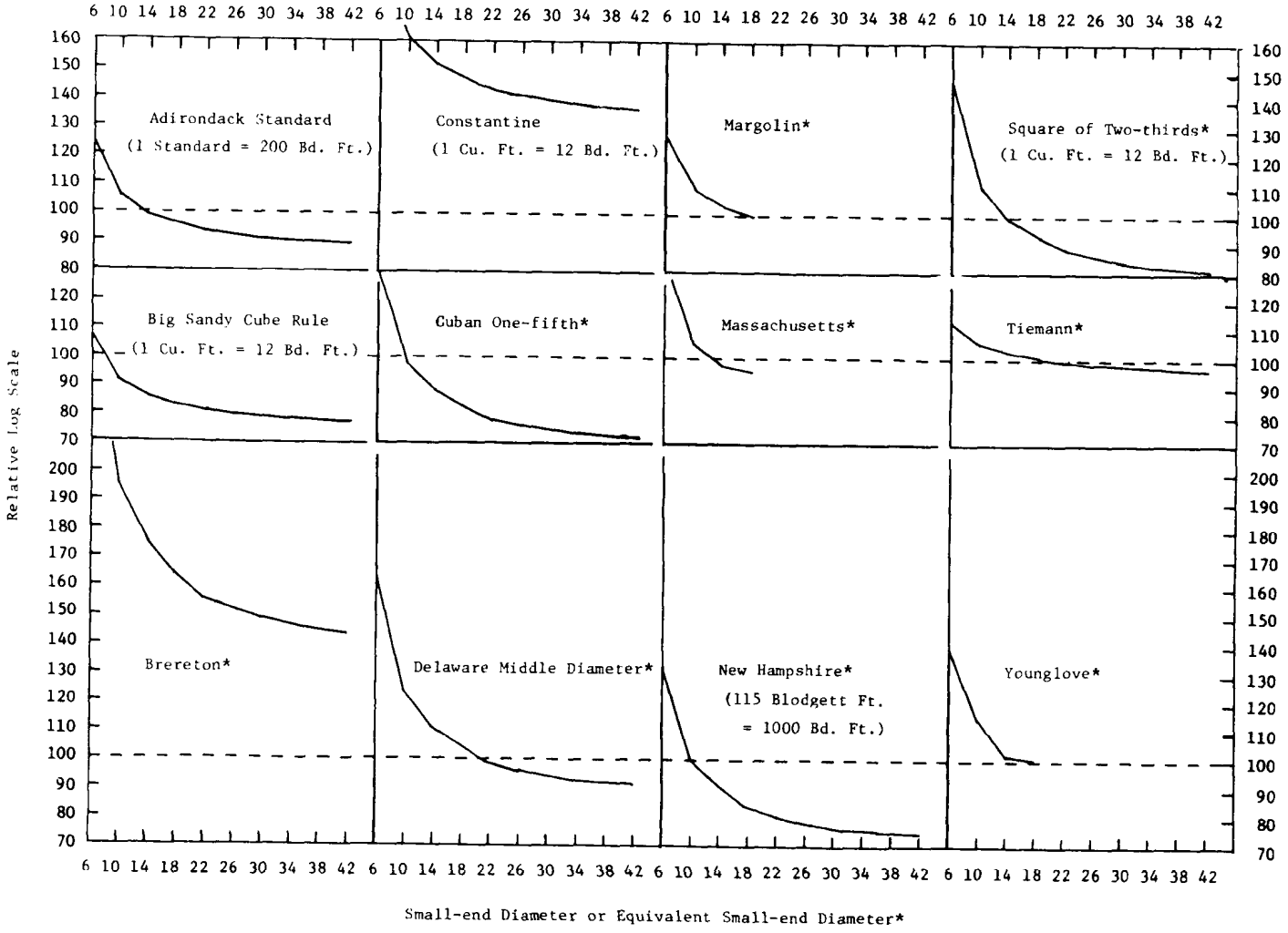

6 10 14 18 22 26 30 34 38 42
120
110
100
90
80
70
60
Universal
White
Vermont
Wilcox
Warner
Wilson
Wheeler
Relative Log Scale
Small-end Diameter

Figure 2.--Relative scale value for 16-foot logs according to various cubic volume rules or rules specifying the use of mid-point or average end diameter (International 1/4-inch = 100). *Small-end diameter has been increased by 1-inch to calculate the volume by rules requiring mid-point or average end diameter. M 140 670



SECTION I

LOG RULES OF UNITED STATES AND CANADA

In this section the log rules used in United States and Canada are listed and described in alphabetic order. For a number of rules, reference is made to the formula given by McKenzie. The three general types of formula which H. E. McKenzie used to approximate the values of many rules are discussed in detail under the" McKenzie Rule" (page 26) and it is suggested that the reader go over this section before examining the other rules.

The second section starting on page 41 describes some of the lumber measures that are sometimes confused with log rules, some general log volume formulae, and a few of the log rules used outside of North America.

Adirondack Market --See Adirondack Standard,

Adirondack Standard (and other rules based on "Standards")

In a number of early rules, the volume of a given log or group of loge was expressed in terms of the number of "standard" logs of equivalent cubic volume. Thus, if the standard was defined to be a log d inches in diameter and ℓ feet in length, then for a given log D inches in diameter and L feet in length the volume in number of standards would be,

$$\text{"Standards"} = \frac{D^2 L}{d^2 \ell}$$

One of the better known and more persistent of these rules was the Adirondack Standard which is generally attributed to Norman Fox who lumbered in the Sacandaga and upper Hudson watershed of northern New York from 1814 to 1821.

The Adirondack Standard was defined as a log 13 feet long and 19 inches in diameter at the small end. The volume of any log then would be,

$$\text{"Adirondack Standards"} = \frac{D^2 L}{4693}$$

The volume of the Adirondack Standard (ignoring taper) is 25.6 cubic feet or roughly one-third of a cord. It was usually regarded as equalling 200 board feet though Defebaugh (69)[2] says that the Hudson River Boom Association allowed 186 board feet per standard.

The Adirondack Standard was also called the Adirondack Market , Dimick Standard , Glens Falls Standard , and Nineteen-Inch Standard . Cary (44) referred to it as the New York Standard but there were two other standard rules (Twenty-Two-Inch Standard and Twenty-Four-Inch Standard) that carried this name.

The Adirondack Standard was one of a number of "standard" rules. In 1863, Maxfield Sheppard published his "Tables for Sawlogs" (179) in which the volumes of logs of various dimensions were shown in terms of "standard" logs 12 feet long with small-end diameters of 15, 16, 19, 20, 21, and 22 inches plus one for a standard 13 feet long and 19 inches in diameter. In Canada, Crown Timber Regulation lf, 1866, applicable to "Upper" and "Lower" Canada assessed dues on the basis of a standard sawlog 13-1/2 feet long and 20 inches in least diameter (162). Roy (169) states that among the units of measurement used in Quebec between 1865 and 1890 was a "standard" log 17 inches in diameter and 16 feet long which was later considered the equivalent of 200 board feet.

The Saranac Standard , used along the Saranac River of northern New York, was based on a log of 22 inches in diameter and 12 feet long, which was equivalent to 250 board feet. It was also called the Twenty-Two-Inch Standard or the New York Twenty-Two-Inch Standard and was apparently the same as the Canadian Twenty-Two-Inch Standard .

The Quebec Standard was a log 20 inches in diameter and 12 feet long and five standards were

[2] Underlined numbers in parentheses refer to literature cited at the end of this report.

assumed to be equivalent to 1,000 board feet. This rule is ascribed to Norman Fox (author of the Adirondack Standard) who moved to Canada sometime after 1821. It should be noted that the term "Quebec Standard" was also used to describe a quantity of lumber (see Section II).

Another "standard" rule used in Canada was the Canadian Twenty-One-Inch Standard based on a log 21 inches in diameter and 12 feet long.

The Twenty-Four-Inch Standard used in parts of Canada, New York, and New England was a log 24 inches in diameter and 12 feet long--equivalent to about 300 board feet. Graves and Ziegler (88) report that logs were sometimes scaled by the Doyle Rule and the total number of board feet divided by 300 to determine the number of standards. The Twenty-Four-Inch Standard is also called the New York Twenty-Four-Inch Standard .

The New Hampshire Rule , which is discussed in greater detail later, is based on a rather unusual standard--l6 inches in diameter and 1 foot long. This is taken to equal 1 cubic foot (though it is actually about 1.396 cubic feet) which is called a "Blodgett Foot."

The term "standard" has also been applied as a lumber measure as for example in the Gothenburg Standard, Quebec Standard, and Petrograd (St. Petersburg) Standard. These are discussed briefly in Section II.

References--13, 16, 27, 43, 44, 47, 69, 71, 80, 86, 88, 114, 162, 169, 179.

Ake Rule

This rule was used locally in Clearfield County, Pa. It is identical to the Seven-Tenths Rule used in southwest Georgia.

$$BF = (.7D)^2\left(\frac{L}{12}\right) = .04083D^2L$$

McKenzie's (134) formula for the Ake Rule is:

$$BF = (1 - .376)\ \frac{\pi D^2 L}{48}$$

Rules that are similar to or the same as the Ake Rule are the Clearfield County Rule and the Clearfield Rule .

References--16, 47, 86, 134.

Alberta Rule

This is actually the International 5/16-Inch Log Rule but it is often called the Alberta Rule because it was made the official rule of that province in 1957 (by Order-in-Council 263/57).

As in all versions of the International Rule, the basic formula is for 4-foot sections.

$$BF = .19D^2 - .61D$$

The formulae for lengths over 4 feet are derived by assuming 1/2 inch of taper every 4 feet. Thus, for a 16-foot log the formula becomes

$$BF = .76D^2 - 1.31D - 1.18$$

It should be noted that the tables for this rule issued by the Alberta Department of Lands and Forests show the volumes to the nearest board foot rather than to the nearest 5 feet as is the case with the International 1/8-Inch and 1/4-Inch Rules.

Robinson (162) states that at one time the International 1/4-Inch Rule may also have been called the Alberta Rule.

References--113, 162.

Alberta Cubic Foot Log Rule

Robinson (162) states that, according to a provincial regulation in 1962, when timber is scaled in cubic feet the Alberta Cubic Foot Log Rule shall be used. This is based on Smalian's Formula

$$CF = \frac{\pi\left(D_1^2 + D_2^2\right)L}{1{,}152}$$

where: D_1 and D_2 are the diameters (in inches) at the ends of the log,

Reference--162.

Apgar Rule --See Finch and Apgar Rule.

Arkansas Rule --See Doyle Rule,

Ashe Rule

The results of a mill scale study of loblolly pine made by W. W. Ashe in 1915. It is not known whether these tables were ever used in practical log scaling.

Reference--8.

Ballon Rule

A modified version of the Scribner Rule used around 1888 by M.E. Ballon and Son of Becket, Mass. It was used mainly on small hardwoods. Chapman (47) refers to a Ballou Rule, but this was probably a misprint.

References--47, 86, 88, 164.

Bangor Rule

This is a diagram rule which is said to give values that are slightly higher and more consistent than the Maine Rule. Belyea (13) and also Graves and Ziegler (88) state that the Maine and Bangor are one and the same. Young (202) states that in the eastern part of the state the Maine Rule is called the Bangor Rule, but that there is also a distinct Bangor Rule which is seldom used.

Daniels (65) gives the following formula for approximating the volume of 12-foot logs by the Bangor Rule:

$$BF = .62D^2 - 1.1D - 1$$

McKenzie (134) expressed the Bangor Rule

$$BF = \left[(1 - .258)\frac{\pi D^2}{48} - .5\right]L$$

The Bangor Rule is also called the Miller Rule and the Penobscot Rule .

References--13, 47, 65, 88, 134, 202.

Baughman's Rule

A diagram rule which assumes l-inch boards with a minimum width of 4 inches and with one board placed at the center of the log. The rule neglects taper, shrinkage, and normal crook, and includes fractional inches on the width of boards rather than dropping them to the whole inch, It is said to be too perfect, giving a higher volume than can ordinarily be obtained from the log.

There are two forms of the rule; one for a saw kerf of 1/8 inch which is called Baughman's Band Saw Rule, and one for 1/4-inch saw kerf which is called Baughman's Rotary Saw Rule.

McKenzie (134) approximated these rules by the formulae:

$$BF\ (1/8\text{-in. kerf}) = (1 - .10)\frac{\pi(D - 1)^2 L}{48}$$

$$BF\ (1/4\text{-in. kerf}) = (1 - .19)\frac{\pi(D - .87)^2 L}{48}$$

The rule is attributed to H.R.A. Baughman of Indianapolis, Ind., and is said to have originated around 1905.

In a sawmill operator's manual published by Jackson Lumber Harvester, Inc. (6) there is a table labeled "Rotary Log Scale" which is actually Baughman's Rotary Saw Rule. Because of this the rule has sometimes been called either the Rotary Rule or Jackson's Rule .

References--6, 47, 86, 134.

Baxter Rule

Although Belyea (16) states that this is a mill scale rule, other authorities claim that it is a formula rule. It is said to make insufficient allowance for slabs and an over-allowance for sawdust, equivalent to a saw kerf of about 1/2 inch. Because of this the rule should over-scale small logs and underscale large ones. This is just the reverse of the Doyle Rule which has a large allowance for slabs and allows too little for sawdust, thereby underscaling small diameter logs and overscaling the large ones.

Actually, although the Baxter Rule gives values that are lower than those given by most rules for logs over 18 inches in diameter, the values given for smaller logs are not far above those given by the Scribner Rule or the Quebec Rule and are considerably below those given by the Maine, New Brunswick, and International 1/4-Inch Rules.

Clark (53) has noted that the Baxter Rule gives an allowance for taper in scaling logs 18 feet long and over--one of the few rules to do so.

The formula given by McKenzie (134) for the Baxter Rule is,

$$BF = (1 - .338)\frac{\pi(D - 1)^2 L}{48}$$

References--16, 47, 52, 53, 86, 134.

Beaumont Rule --See Herring Rule.

Beeman Rule --See Doyle Rule.

Big Sandy Cube Rule

The Big Sandy Cube Rule, which was used along the Ohio River, is actually a "standard" rule. It is based on the assumption that it requires a log 18 inches in diameter at the small end to produce a timber 1 foot square and each foot of length gives 1 cubic foot of volume. According to Graves and Ziegler (88) , the local phraseology is, "An 18-inch log will cube once." The formula for cubic foot volume by this rule is:

$$CF = \frac{D^2L}{324}$$

This is sometimes converted to board feet by multiplying by 12.

The Two-Thirds Cubic Foot Rule has exactly the same formula and is sometimes called the Big Sandy Cube Rule, but in the Two-Thirds Rule the diameter is measured at the middle of the log rather than at the small end.

Other names for this rule are Cube Rule , Cube Rule of the Ohio River , Ohio River Rule , and Goble Rule .

References--47, 86, 88.

Blodgett Rule --See New Hampshire Rule.

Boynton Rule

This a local rule devised about 1899 by D.J. Boynton of Springfield, Vt. It is said to have been made up of values taken from the Scribner and Vermont Rules and checked by mill tallies.

McKenzie's (134) formula for approximating the values of this rule is,

$$BF = \left[(1 - .350)\ \frac{\pi D^2}{48} - .67\right]L$$

References--47, 86, 134.

Braniff Rule

The results of mill scale studies of lumber sawed from yellow-poplar, yellow birch, and beech were published by Braniff (24) in 1906. Similar tables for Vermont hardwoods were produced by Bailey and Heald (9) in 1914. Ashe (8) published the results of mill scale studies on loblolly pine in 1915 (see Ashe Rule). Though all of these could be regarded as mill scale log rules, there is no evidence that any of them were ever used as such.

References--8, 9, 24.

Brereton Rule

This rule was devised by Bernard Brereton for use in the Douglas-fir and redwood regions. It is also used extensively in the export and import trade. It is basically a cubic volume rule with multiplication by 12 for conversion to board feet. Thus,

$$BF = 0.06545 D_a^2 L$$

where: D_a = The average of the two end diameters.

This is identical to the Constantine Rule except for the use of average end diameter rather than the diameter at the small end of the log.

For the benefit of shippers, the following conversion factors are given:

Hoppus Cubic Feet = 0.06545 (Brereton Board Feet)
Brereton Board Feet = 15.279 (Hoppus Cubic Feet)
Cubic Meters = Brereton Board Feet/424
Japanese Koku = Brereton Board Feet/120
One Petrograd Standard = Brereton Board Feet/1,980

On the North Island of New Zealand volumes of logs are sometimes determined by measuring the mid-point diameter and using the Adams Table which has values identical to those of the Brereton Rule.

References--27, 29, 33, 76, 132, 194.

British Columbia Rule

Most mensuration textbooks state that this is a diagram rule which was reduced to formula form before being used very extensively. However, Robinson (162) reproduced copies of official correspondence which seems to indicate that the formula and diagrams appeared at the same time and that the diagrams may have been used either to derive or verify the formula. Ker (113) states that the rule assumes a 3/8-inch saw kerf and the production of l-inch-thick boards without turning of the log. Board widths were in multiples of 2 inches with a minimum width of 4 inches (though

Chapman says that the minimum width was 3 inches). The formula defining this rule is,

$$BF = (1 - 3/11)\ \frac{\pi(D - 1.5)^2 L}{48}$$

Two simplified formulae given by Ker (113) provide very close approximations:

$$1)\quad BF = (D - 1.5)^2\ \frac{L}{21}$$

$$2)\quad BF = (D - 1)\ (D - 2)\ \frac{L}{21}$$

The basic rule is used for logs up to 40 feet in length. Logs 42 to 80 feet in length are scaled as two logs, each half the measured length. The small-end diameter of the second section is assumed equal to D + 1 for logs 42 to 50 feet long, D + 2 for logs 52 to 60 feet long, etc. (i.e. an increase of 1 inch in small-end diameter for every 10 feet of length over 40. Logs over 80 feet are scaled in 40-foot sections plus remainder, with a taper allowance of 1 inch for every 10 feet.)

The rule has been in use on the British Columbia coast since about 1895. In 1902 it became the official rule in the province west of the Cascades and this was extended to the rest of the province (except the Peace River Block) in 1915. In 1972 it was replaced as the official rule by the British Columbia Firmwood Cubic Scale (72).

References--3, 13, 44, 47, 72, 86, 113, 132, 134, 145, 146, 162.

British Columbia Cubic Scale

In 1946, a statute made board foot or cubic foot measurement optional, and for cubic volume specified the use of the British Columbia Cubic Scale which is based on Smalian's Formula. The formula for the British Columbia Cubic Scale is,

$$CF = \frac{\pi\left(D_1^2 + D_2^2\right)L}{1{,}152}$$

where: D_1 and D_2 are the diameters in inches at the ends of the log.

This is, of course, identical to the Alberta Cubic Foot Rule.

Robinson (162) indicates that earlier (1921) British Columbia statutes specified the use of average-end diameter or mid-point diameter in calculating cubic volume rather than the average-end area as prescribed by Smalian's Formula.

Dobie (72) refers to this as the British Columbia Lumber Cubic Scale and notes that it has now been replaced as an official rule by the British Columbia Firmwood Cubic Scale described below.

References--72, 113, 145, 146, 162.

British Columbia Firmwood Cubic Scale

Starting in 1972, both the British Columbia Cubic Scale and the British Columbia Board Foot Scale have been superseded by the British Columbia Firmwood Cubic Scale, which is now the only log scale in official use in the province.

The Firmwood Cubic Scale, like the B.C. Cubic Scale, is based on Smalian's Formula. It differs from that rule in permitting scaling deductions only for pathological defects, charred wood, and cat-face. The deduction for pathological defects includes wood that is not firm, e.g., wood that falls away when scraped with the hook of a scale stick. In addition, the permissible deductions are smaller under the Firmwood Scale. Deductions not permitted under the new rule are sweep, crook, shake, check, and split. According to Dobie (72), another difference is that in Firmwood, logs are scaled to the nearest lower foot of length rather than to the lower even foot as was done in applying the B.C. Cubic Scale.

In measuring butt diameter of flared logs, flare is discounted under the new rule and diameter is estimated by taking the normal taper of the log into account.

Reference--72.

British Columbia Lumber Cubic Scale --

See British Columbia Cubic Scale

Brubaker Rule

Mentioned by Chapman (47). No further information.

Calcasieu Rule

This rule, once used in Louisiana, was originally published by Irvine and Irvine, 725 Ryan Street, Lake Charles, La. It is a cubic volume formula multiplied by a constant for conversion to board

feet.

$$BF = 1.01 \frac{(D^2L)}{32}$$

The rule gives absurdly low values for large logs. Graves (87) uses the name Calcasieu Standard Log Rule .

References--47, 87.

California Rule --See Spaulding Rule.

Canadian Twenty-One-Inch Standard --
Discussed under Adirondack Standard.

Canadian Twenty-Two-Inch Standard --
Discussed under Adirondack Standard.

Carey Rule

This rule was used in Massachusetts and gives values about the same as those of the Wilson Rule. It is a mill scale rule for round-edged lumber, 1 inch thick. For 12-foot logs, Daniels (66) gave the following values:

Diameter (inches)	6	8	12	16	20	30
Board feet	18	33	78	143	227	536

For approximating the Carey Rule, McKenzie (134) gave the following formula:

$$BF = (1 - .193) \frac{\pi(D - 1)^2 L}{48}$$

Chapman (47) claims that this is a caliper rule (i.e., diameter is measured at the center of the log) but neither Daniels nor McKenzie indicated whether their values were for diameters measured at the middle or the end of the log.

References--47, 66, 86, 134.

Cedar Log Scale

This rule was adopted and published by the Aromatic Red Cedar Association and the National Cedar Chest Association (666 Lake Shore Drive, Chicago). The values are given by the equation,

$$BF = \frac{D^2L}{27}$$

This is identical to the Square of Two-Thirds Rule except that the latter rule specifies diameter measurement at the mid-point of the log.

Champlain Rule

The Champlain Rule was devised by A. L. Daniels (65) of Vermont in 1902. The formula is,

$$BF = (.62832D^2 - D) \frac{L}{12}$$

McKenzie (134) approximated the rule by the formula,

$$BF = (1 - .20) \frac{\pi(D - .8)^2 L}{48}$$

Graves (86) says that Daniels devised two rules of thumb which give nearly the same result as the Champlain Rule.

$$BF \text{ (for 12-foot logs)} = \left(\frac{5D}{8} - 1\right) D$$

$$BF \text{ (for 19-foot logs)} = (D - 1)^2$$

Daniels' explanation of the development of the rule is as follows:

The cubic-foot volume of a perfect log (cylinder) with a top diameter inside bark of D would be,

$$CF = \left(\frac{\pi D^2}{4}\right)\left(\frac{L}{144}\right) = .7854 \frac{D^2L}{144}$$

If it is assumed that 1 cubic foot is equal to 12 board feet, the formula becomes,

$$BF = \left(.7854 \frac{D^2L}{144}\right)(12)$$

which is the same as the Constantine Rule.

Now, if a 1/4-inch saw kerf and slash sawing (i.e., without turning the log) is assumed, then the loss in sawdust when sawing l-inch boards would be one-fifth of the contents of the log. Therefore, four-fifths' of the volume is recovered and the formula becomes:

$$BF = (4/5)\left(.7854\ \frac{D^2L}{144}\right)(12) = .62832\ \frac{D^2L}{12}$$

Next it is assumed that the loss in slabs and edgings is proportional to the surface of the log which is in turn, proportional to the diameter and length. To determine the relationship between log surface and surface wastage, Daniels used evidence provided by sawyers and scalers, checking these data by diagrams. He concluded that the surface waste on perfect logs is equivalent to a 1-inch board of width equal to the diameter of the log. Therefore, the deduction would be DL/12, making the formula,

$$BF = .62832\ \frac{D^2L}{12} - \frac{DL}{12}$$

$$= (.62832\ D^2 - D)\ \frac{L}{12}$$

The premises on which the Champlain Rule is based have two primary deficiencies. First, the rule makes no allowance for normal crook, knots, and other blemishes and the allowance for slabs is too small. As a result, the values given for short logs are too high. The second flaw is that no allowance is made for taper, and on long logs this more than offsets the first deficiency arid results in values that are too low.

Chapman (47) reports that Daniels, realizing that the allowance for slabs was too small, increased that allowance and produced what is known as the Universal or Daniels Universal Rule.

References--18, 47, 65, 66, 86, 134.

Chapin Rule

This is a mill scale rule developed about 1883 which is said to be the most erratic of all rules. Chapman (47) says that it was made up by selecting values from existing rules to suit the author.

References--47, 86, 88.

Clarks International Rule --See International 1/8-Inch Rule.

Clearfield Rule --See Ake Rule.

Clearfield County Rule --See Ake Rule.

Clement's Rule

This was devised in 1904 by C. J. Clement of Portland, Oreg. In words the rule is, "multiply half the diameter by half the circumference, then subtract half the circumference. The remainder will be the total amount of feet board measure, in a 16-foot log." (47). In formula form

$$BF = .7854\ (D^2 - 2D)\ \frac{L}{16}$$

As an approximation to this, John C. Sammi (170) of the New York State College of Forestry proposed the following rule of thumb for 16-foot logs:

$$BF = .8D\ (D - 2)$$

The Sammi Rule itself, which was developed independently, also gives results that are fairly close to those of the Clement's Rule.

References--47, 54, 87, 170.

Click's Rule

A rule devised by A. G. Click of Elkin, N.C., in 1909. Graves' (87) expression of the rule is: "From the square of the diameter deduct 2-1/2 diameters and multiply the remainder by 1/2 the length of the log and cut off the right hand figure." In formula form,

$$BF = (D^2 - 2.5D)\ \frac{L}{20}$$

with the decimal portion dropped.

The formula which McKenzie (134) used to approximate Click's Rule is,

$$BF = (1 - .236)\ \frac{\pi(D - 1.25)^2L}{48}$$

The rule is supposed to give the volume from sawing 1-inch boards averaging 6 inches in width using a 1/4-inch saw kerf.

References--l2, 47, 87, 134.

Columbia River Rule --See Spaulding Rule.

Columbia River Taper Rule

Rapraeger (152) indicates that the Columbia River Taper Rule was devised by E. I. Karr while he was manager of the Columbia River Scaling and Grading Bureau. It is said to be a modification of the Spaulding Rule and differs from it in that long logs are built up from 12- to 14-foot sections by applying taper. It apparently is not extensively used.

References--l52,203.

Connecticut River Rule --See Doyle Rule.

Constantine Rule

This rule merely takes the cubic volume of a log D inches in diameter and L feet in length and multiplies this by 12 for conversion to board feet.

$$BF = \frac{\pi D^2 L}{48}$$

Graves (86) says that a "practical" log rule is sometimes made from the Constantine Rule by deducting a third or fourth of the indicated volume to allow for saw kerf and other waste.

Chapman (47) says that the rule is used to measure the volume of veneer logs.

Contrary to the above, Brereton (27) says that it is a system of measurement used on the New York market for square-hewed foreign woods, chiefly mahogany and cedar. "From first class hewed timber there is deducted 2 inches of width from one face and 1 inch of width from the other face at right angles to it. This deduction being made to straighten the log and remove axe marks. The face measurements are then used to compute the cubic contents of the log. If the log is defective, the contents are reduced by one half, "

References--27, 47, 86, 134.

Cock Rule --See Square of Three-Fourths Rule.

Cooley Rule --See Square of Three-Fourths Rule.

Crooked River Rule -- See Square of Three-Fourths Rule

Cuban One-Fifth Rule

In this rule, girth is measured at the mid-point of the log and a board foot-cubic foot ratio of slightly over 6 is assumed.

$$BF = \left(\frac{\text{Girth at mid-point in inches}}{5}\right)^2 \left(\frac{L}{12}\right)$$

Chapman (47) reports that in practice, fractional inches of fifth-girth are dropped as follows:

Girth	'Square'
50, 51, or 52	10 x 10
53 or 54	11 x 10
55, 56, or 57	11 x 11
58 or 59	12 x 11

The formula expressed in terms of the diameter (D_m) at the mid-point of the log is,

$$BF = .0329 D_m^2 L$$

The rule is used primarily in the imported hardwood trade.

Reference--47.

Cube Rule --See Big Sandy Cube Rule.

Cumberland River Rule

This is a cubic foot rule which was used for hardwood logs in the Mississippi Valley and tributaries and to some extent in other areas (e.g. Massachusetts and Michigan). The rule gives a generous over-run to the buyer. This was considered justified by the fact that in scaling river-driven logs most of the defects were hidden in the water and loggers were even known to spike the logs to make sure the defects would be under water.

The Cumberland River Rule, like the Square of Two-Thirds Rule, deducts one-third of the diameter and squares the remainder. It differs from that rule in that one-fifth of the squared stick volume is deducted for saw kerf. Logs are usually scaled at the small end but long logs may sometimes be scaled at the middle.

For cubic volume the formula would be

$$CF = \left(\frac{4}{5}\right)\left(\frac{2D}{3}\right)^2 \frac{L}{144} = \frac{D^2L}{405}$$

For board-foot volumes, McKenzie (134) gave the formula,

$$BF = (1 - .548)\ \frac{\pi D^2}{48}\ L$$

The Evansville Rule and Third and Fifth Rule are other names that have been used for this rule.

References--47, 86, 134, 166.

Daniels Rule --See Universal Rule.

Daniels Universal Rule --See Universal Rule.

Davant Rule --See discussion of Davant Extension under the Herring Rule,

Delaware Middle Diameter Rule

As the name indicates, this is another one of the few log rules which specifies measurement at the middle of the log rather than at the small end. The most common form of the rule is for 12-foot logs.

$$BF = \frac{D_m^2}{2}$$

Other lengths are calculated on a proportional basis, so the general formula would be

$$BF = \frac{D_m^2 L}{24}$$

The rule was frequently used in Maryland and Delaware. It is sometimes used as a rule of thumb for sweetgum and loblolly pine logs and very often, small-end diameter is used in place of the intended mid-point diameter.

Because of its use in Maryland the rule is sometimes known as the Eastern Shore Rule .

References--60, 195.

Derby Rule

The formula used by McKenzie (134) to describe this rule is,

$$BF = (1 - .279)\ \frac{\pi D^2 L}{48}$$

The rule was once used in Massachusetts but there is some confusion as to its origin. Chapman (47) described it as "an obsolete rule based on a cubic foot formula." Belyea (16), on the other hand, called it a diagram rule. McKenzie (134) noted that the original values were slightly erratic which would be expected of a diagram rule.

The other names by which this rule is known, Holden Rule , Robison Rule , and Holden and Robinson Rule suggest that it was probably used by a company of that name.

References--16, 47, 86, 134.

Dimicks Standard --See Adirondack Standard.

Dovicio's Rule

George Thomson of Iowa State University reports that a log scale table with this name is used in southeast Iowa by a sawmill operator named Dovicio. The values are identical to those of the Doyle-Scribner Rule.

Doyle Rule

This is one of the most widely used and roundly cursed log rules in existence. It is, or has been, that statute rule in Arkansas (replaced by Scribner in 1901), British Columbia (1884-1895), Florida, Louisiana (replaced by Scribner-Doyle in 1914), and Ontario (until 1952). It is not so widely used where timber is large or where Federally owned timber is involved, but in all other areas there is probably more sawlog volume measured by Doyle than by all other rules combined. Its primary characteristic and the main reason for its popularity, at least with buyers, is that it gives a very large over-run on small logs.

The formula for the Doyle Rule is usually written,

$$BF = (D - 4)^2\ \frac{L}{16}$$

The formula used by McKenzie (134) in his analysis of the rule is,

$$BF = (1 - .045)\ \frac{\pi(D - 4)^2 L}{48}$$

Diameter should be measured inside bark at the small end of the log, but there are numerous local modifications. Some scalers measure at the middle of the log, some include one bark, some both barks, and some measure inside bark "plus a thumb." Occasionally sweep is disregarded and a fairly common practice is to give logs under 7 inches in diameter a scale equal to their length. Most of these variants seem to be rough attempts to compensate for the notorious underscaling of small logs.

The primary weakness of the Doyle Rule is that the allowance for slabs and edgings (4 inches) is far too large for small logs and too small for large logs. Most studies have shown that the allowance for surface wastage is proportional to diameter and length, rather than a constant. The second fault of the rule is that it allows only about 4.5 percent of the log volume for sawdust and shrinkage whereas most rules make an allowance of anywhere from 10 to 30 percent. Finally, the rule makes no allowance for log taper, a deficiency that it has in common with most other rules.

Harold C. Belyea (15 , 16 ,) has published some interesting studies of the history of the Doyle and the Scribner Rules. The second edition of "The Improved Pocket Reckoner for Timber, Plant, Boards, Saw Logs, Wages, Board, and Interest" by Edward Doyle was published in 1837 in Rochester, New York. In this publication are tabulated the board foot contents of logs as given by the Doyle Rule. Values are shown for logs 10 to 25 feet in length and for small-end diameters from 12 to 36 inches. The first edition of Doyle's pocket reckoner was published in 1825. Although it very likely contained that same table, this cannot be verified as there are no known copies of the original.

After the Scribner Rule was introduced in 1846, it largely supplanted the less reliable Doyle. However, as Belyea has shown, a rather odd turn of events resurrected that "hoary old sinner of a log rule." Some time around 1872 to 1875, J. M. Scribner sold the copyrights and rights of royalty for his original work to the publisher George W. Fisher. Prior to this Fisher had also acquired the copyright and stereotype plates of Doyle's Ready Reckoner. Then in 1876 Fisher published "Scribner's Lumber and Log Book" which was nearly identical to the original Scribner publication even to the extent of listing Scribner as the author, But, in place of the Scribner Rule there was a table of values identical to the Doyle Rule which had been out of print for over 20 years. Because of this publication, the Doyle Rule was often referred to as the New Scribner Rule or, more simply, the New Rule . In 1879 when the province of Ontario adopted a rule for the measurement of logs taken from Crown lands and for log purchases on private lands the enabling act read, "to follow the table values of the new rule as published in Scribner's Lumber and Log Book." Thus, the Doyle Rule has also been known as the Ontario Rule though it has since been replaced by another rule of that name.

This new publication of the Doyle Rule had some minor differences from the original rule. However, one not so minor difference was that in place of small-end diameter inside bark, the average of the two end diameters was to be used with an allowance for bark of 1/10 to 1/12 the circumference (an impossibly large allowance). There is little evidence that this procedure ever was widely used in practice but there are infrequent references to the Mid-Doyle Rule .

Other rules that are similar to, or the same as, the Doyle are: Arkansas Rule , Beeman Rule , Moore Rule , Moore and Beeman Rule , Connecticut River Rule , St. Croix Rule , Thurber Rule , and Vannoy Rule . Because of its publication in Scribner's Lumber and Log book the Doyle Rule has even been called the Scribner Rule!

Duff (76) reports that in the Ohakune District of New Zealand, logs were scaled according to the Moore or Ohakune Table which was based on the Doyle Rule.

References--13, 15, 16, 17, 39, 44, 47, 48, 50, 55, 61, 73, 76, 86, 88, 102, 124, 132, 134, 136, 140, 162.

Doyle-Baxter Rule

Doyle underscales small logs and Baxter underscales large ones; put them both together and they spell profit! In this combination rule the values for logs up through 20 inches in diameter are those of the Doyle Rule and Baxter values are used for all logs larger than this. Belyea (16) reports that the rule once had considerable use in

Pennsylvania.

References--16, 47.

Doyle-Scribner Rule

This is another combination rule, using Doyle values for logs up through 28 inches in diameter and Scribner values for larger logs. At one time it was the official scale of the National Hardwood Lumber Association of St. Louis and was known as the Universal Standard Log Scale (5). The justification often given for this rule is that the large over-run compensated for losses in defective timber.

References--5, 44, 47, 86, 178.

Drew Rule

This rule was devised in 1896 by Fred Drew of Port Gamble, Wash, (Rapraeger (152) says Port Angeles). It was constructed from diagrams checked against mill tallies and the values are said to have been reduced to allow for hidden defects. The rule was designed for logs 12 to 60 inches in diameter and 20 to 48 feet in length with taper ignored.

The Drew Rule did not fit any of McKenzie's (134) three standard types. His formula for approximating the values is,

$$BF = \left[1 - (.450 - .003D)\right] \frac{\pi D^2}{48} L$$

For 12-foot logs, A. L. Daniels' (65) formula for approximating the "Drew of Puget Sound Rule" is,

$$BF = .615D^2 - 4.125D + 29$$

In 1898, the Drew Rule was designated as the statute rule for the state of Washington but apparently was seldom used there.

It is sometimes known as the Puget Sound Rule .

References--16, 47, 65, 74, 86, 134, 149, 152.

Dusenberry Rule

This is a mill scale rule made up originally for white pine by a Mr. May in 1835 and adopted by the Dusenberry-Wheeler Company of Portville, N.Y. It was widely used on the Allegheny waters of Pennsylvania.

The rule is based on 1-1/8-inch boards with a few 1-1/2-inch and 2-inch pieces and allows for a saw kerf of 7/16 inch. It is said to be a very consistent rule but due to the large saw kerf it underscales Scribner by 15 to 20 percent.

Two other spellings given for the name are Dusenbury and Duesenberry.

References--47, 86, 134.

Eastern Shore Rule --See Delaware Middle Diameter Rule.

Evansville Rule --See Cumberland River Rule.

Excelsior Rule --See Finch and Apgar Rule.

Fabian's Rule --See Maine Rule.

Fairbanks Rule --See Partridge Rule.

Favorite Rule --See Lumberman's Favorite Rule.

Fifth-Girth Method

This is a cubic volume formula with measurement made at the middle of the log rather than the end.

$$CF = \left(\frac{\text{Mid-point girth in feet}}{5}\right)^2 (2L)$$

No mention is made of an allowance for bark, implying that measurement must be made inside bark or on peeled logs.

Duff (76) reports that a table based on the Fifth-Girth formula was used in New Zealand at one time.

References--47, 76, 86.

Finch Rule --See Finch and Apgar Rule.

Finch and Apgar Rule

There is disagreement as to whether this rule is based on mill scale studies or diagrams. In either case, the rule is based on a 5/16-inch saw kerf, gives low values, and is quite erratic. It was published in 1887 in the Excelsior Lumber and Log Book and Rapid Reckoner (2).

The formula given by McKenzie (134) is,

$$BF = \left[(1 - .280) \frac{\pi D^2}{48} - 2.5 \right] L$$

The rule is also referred to as the Finch Rule , Apgar Rule , and Excelsior Rule .

References--2, 47, 86, 134.

Forty-Five Rule

This rule was devised around 1870 and was used in New York State. It is based on an inaccurate rule-of-thumb formula. Graves (86) describes the rule as follows: "For a 24-inch log multiply the square of the diameter by the length of the log and the result by 45, then point off three places. For every variation of 2 inches in diameter from the standard 24-inch log, add or subtract one from the number 45 in the formula according as the diameter is larger or smaller than 24 inches." Expressed in formula form

$$BF = \frac{(66 + D) D^2 L}{2,000}$$

McKenzie's (134) formula for the rule is,

$$BF = \left[1 - (.496 - .00763D) \right] \frac{\pi D^2}{48} L$$

References--5, 47, 86, 134.

French's Rule

Chapman (47) reports that this rule was used around Los Angeles and gives the following formula for approximating the values:

$$BF = .522 \left(\frac{\pi D_m^2}{48} \right) L$$

This was also known as the Los Angeles Rule .

Reference--47.

Glens Falls Standard --See Adirondack Standard.

Goble Rule --See Big Sandy Cube Rule.

Hallock and Lewis B. O. F. Rule

Attempts to produce a diagram log rule have, in the past, required a number of simplifying assumptions. For example, it is usually specified that only 1-inch lumber will be produced, that live sawing will be used, that the pith will either be centered in a board or on a saw cut, and that fractional board widths will be accepted or will be cut back to a whole inch or to even inches. One or, at most, two saw kerfs will be considered and log taper will be ignored except that the application of the rule may be limited to short sections. Also, the diagrams have usually been drawn only for each whole inch and the resulting yields are then assumed to represent the average of all yields for a 1-inch class.

Recently, however, Hallock and Lewis (93 , 94 ,) have discarded the tools of the draftsmen and done their diagraming with an electronic computer. Their aim was to study the placing of the first saw cut so as to maximize the yield from a log of a given diameter-- i.e., to pick the best opening face (B. O. F.) for that log. The computer program they produced would then be coupled with automatic measuring devices and setworks to solve a problem that has baffled sawmillers for many years. But incidental to their main objective, they produced what must be the very ultimate in diagram log rules.

With this program they can examine for a log of any given diameter and degree of taper and for a given set of production restrictions, the yield that can be obtained by several alternative sawing procedures. That system which gives the maximum yield in either board feet or dollars can then be selected. Some of the production conditions that may be arbitrarily specified are as follows:

1. Width of saw kerf.
2. Shrinkage during drying.
3. Planing allowance.
4. Allowance for sawing variation.
5. The thickness of either dry finished or green lumber.
6. The width of either dry finished or green lumber.

7. Minimum acceptable lumber dimensions.
8. Acceptance of wane according to National Grading Rules.

In addition, the program can be biased towards the production of a given mix of sizes and will examine the possibility of increasing the yield by reducing the length of a piece and getting greater width because of taper. The sawing methods which can currently be examined are,

1. Live sawing with centered flitch.
2. Live sawing with centered sawline.
3. Live sawing with variable-face opening.
4. Cant sawing with centered cant.
5. Cant sawing with variable-face opening.

The Reverend Scribner would be green with envy!

References--92, 93, 94.

Hanna Rule

Chapman (47) reports that this rule was developed by John S. Hanna of Lock Haven, Pa., in 1885. The rule covers diameters of 8 to 50 inches and follows Scribner values quite closely. Comparing the two rules, the Hanna appears to bean attempt to smooth out some of the irregularities of the older rule.

For approximating the volume of 12-foot logs, A. L. Daniels gives the formula,

$$BF = (.61D^2 - 1.7D - 6)$$

McKenzie's (134) formula for this rule is,

$$BF = \left[(1 - .266)\ \frac{\pi D^2}{48} - 2\right] L$$

This formula applies approximately to logs 12 to 42 inches in diameter. Although Chapman reported that the Hanna Rule was an attempt to smooth out the values of the Scribner Rule, McKenzie remarked that the original "Hannah" values were very erratic, which would seem to support the contention that the Hanna is a diagram rule.

The rule was used locally in Pennsylvania, Tennessee, Virginia, New York, and Massachusetts.

References--44, 47, 86, 95, 134.

Herring Rule

This mill scale rule, devised by T. F. Herring of Beaumont, Texas, in 1871, is based on 1-inch lumber. In scaling, the small-end diameter outside bark is used for logs up to 20 feet in length. Each length over 20 feet is given an additional inch in diameter and scaled as a separate log. In application this rule is sometimes changed so that for logs over 20 feet and up to 40 feet the scaling diameter is increased by 1 inch, and for logs over 40 feet and up to 60 feet the diameter is increased by 2 inches.

Originally the rule was made for logs 12 to 42 inches in diameter and 10 to 60 feet in length. To permit scaling of smaller logs, R. Chester Davant, a scaler for the Texas Tram and Lumber Company of Beaumont, devised an extension based on the Orange River Rule and agreeing closely with the Scribner extension. This Davant Extension covers logs down to 5 inches in diameter.

Another extension covered logs over 60 and up to 70 feet in length. This appeared in a table of the Herring Rule published by the Kirby Lumber Company and is credited to W. A. Cushman of Beaumont.

McKenzie (134) expressed the Herring Rule by two formulae:

1) $BF = \left[(1 - .392)\ \frac{\pi D^2}{48} - 1\right] L$, for logs up to 30 inches in diameter:

2) $BF = \left[(1 - .313)\ \frac{\pi D^2}{48} - 5.5\right] L$, for logs 30 to 42 inches in diameter.

The Herring Rule is used mostly on Texas pine and is said to give a large over-run. It is similar to or the same as the Beaumont Rule.

References--4, 25, 47, 86, 104, 134, 164.

Holden Rule --See the Derby Rule.

Holden and Robinson Rule --See the Derby Rule.

Holland Rule --See the Maine Rule,

Hoyt Rule

No information. Possibly a "standard" rule expressed in board feet (like the New Hampshire Rule).

Reference--l 92.

Humboldt Rule --See the Spaulding Rule.

Humphrey Rule

This is a caliper rule (diameter measured at the middle of the log) used in central New England for estimating the portion of a cord in bolts or logs. According to David M. Smith of Yale University the primary application of the rule was in the measurement of old-field white pine logs purchased for the box industry. Because round-edged boards were acceptable, utilization was very close and it was assumed that the maximum yield of a standard cord (4 by 4 by 8 feet) was about 100 cubic feet of solid wood. Therefore, the Humphrey Rule measures logs in cubic feet and divides by 100 to give the volume in "Humphrey Decimal Cords." Smith notes that there was a variant of the rule in which division was by 128 rather than 100.

The Vermont Rule (a board foot rule) is also called the Humphrey Rule.

Reference--50.

Hyslop Rule

This is said to be practically the same as the Scribner Decimal Rule.

Reference--88.

Inscribed Square Rule

The width of a square inscribed in a 24-inch circle is about 17 inches. If we assume that the width of the square inscribed in any circle is 17/24 of the diameter, then the cubic volume of the square timber that can be cut from a log D inches in diameter is,

$$CF = \left(\frac{17D}{24}\right)^2 \left(\frac{L}{144}\right) = \frac{D^2 L}{287}$$

This formula, which is similar in concept to the Seventeen Inch Rule (discussed later), gives 63.4 percent of the cubic content of a cylinder 1 foot long and proportionately less of an entire log depending on taper, length, and diameter.

References--47, 86, 88.

International 1/8-Inch Kerf Rule

This rule was developed by Judson F. Clark in 1900 while working for the Province of Ontario and was published (53) in 1906. It is based on a very carefully reasoned analysis of the losses occurring during the conversion of sawlogs to lumber and is one of the few rules incorporating a basis for dealing with log taper. The basic formula was developed for 4-foot logs.

$$BF \text{ (for a 4-foot log)} = (0.22D^2 - 0.71D)$$

Based on studies of a number of northeastern tree species, Clark made a conservative taper assumption of 1/2 inch in 4 feet. The volumes for longer lengths are then obtained by calculating and accumulating the volumes of successive 4-foot sections. Alternatively, the basic formula could be expanded to cover the desired lengths. Thus,

$$BF \text{ (for 8-foot lengths)} = 0.44D^2 - 1.2D - 0.3$$

$$BF \text{ (for 12-foot lengths)} = .66D^2 - 1.47D - 0.79$$

$$BF \text{ (for 16-foot lengths)} = .88D^2 - 1.52D - 1.36$$

$$BF \text{ (for 20-foot lengths)} = 1.10D^2 - 1.35D - 1.90$$

Clark specified that lengths over 20 feet were to be scaled as 2 or more logs.

The formula given by McKenzie (134) for 4-foot sections is,

$$BF \text{ (for a 4-foot log)} = (1 - 0.16)\frac{\pi(D - 1.62)^2}{48} L$$

Grosenbaugh (90) has given the following integrated formula for the International 1/8-Inch Rule applicable to logs of any length up to 20 feet.

$$BF = 0.055\ 000\ LD^2 + 0.006\ 875\ L^2D$$
$$-0.205\ 000\ LD + 0.000\ 286\ 458\ 33L^3$$
$$-0.012\ 812\ 50L^2 + 0.046\ 666\ 67L$$

A rule of thumb sometimes used for logs of any length is,

$$BF = (0.66D^2 - 2.12D)\ \frac{L}{12}$$

In his original publication, Clark (53) presented a table of the rule in which all formula values had been rounded to the nearest multiple of 5 board feet (a suggestion made by Overton W. Price of the U.S. Forest Service). Chapman (48) has pointed out that it is not the formula but this table which is the real International 1/8-Inch Kerf Rule.

The principles enunciated by Clark in the development of this rule are of interest.

1. The loss due to saw kerf and shrinkage in thickness varies directly with the cross-sectional area of the cylinder (or cubic volume of the log) and hence, as the square of the diameter. After deducting for a saw kerf of 1/8 inch and shrinkage (plus variations in thickness due to sawing) of 1/16 inch, the board foot content of a 12-foot log is $\left(\frac{16}{19}\right)\left(\frac{\pi D^2}{4}\right) = 0.66D^2$. For a 4-foot log this would be $0.22D^2$.
2. To allow for shrinkage in the width, all fractions of an inch encountered in measuring board widths are dropped. This is equivalent to an allowance of nearly 1/2 inch per board.
3. The waste due to slabbing and edging is proportional to the area of the bark surface, and hence, to the diameter of the log. Unlike the loss in saw kerf which can be derived mathematically, the loss in slabs and edgings must be obtained from diagrams and subjected to mill tests.
4. The waste in slabs and edgings depends on the minimum width of board allowed. In developing his rule, Clark specified that the minimum board be 3 inches in width, containing not less than 2 board feet. A 3-inch board then must be at least 8 feet long; a 5-inch board, 5 feet long and a 6-inch board, 4 feet long.
5. Normal crook does not exceed 4 inches in 12 feet and averages 1-1/2 inches but is found in 99 percent of all logs and should be accounted for by increasing the allowance for slabbing and edging. Any crook over 4 inches must be taken into account by the scaler.
6. Clark found that the necessary allowance for slabs, edgings, crook, etc., amounts to 2.12D for 12-foot logs or 0.71D for 4-foot logs.
7. The result then, to this point, is

$$BF\ (\text{for 4-foot lengths}) = 0.22D^2 - 0.71D$$

8. Taper can be standardized for purposes of a log rule by assuming an average of 1/2 inch every 4 feet and scaling each 4-foot section as a cylinder. This method of dealing with taper was the principal improvement by Clark over Daniels Universal Rule.

To handle saw kerfs other than 1/8 inch, Clark (53) gives the following factors:

Kerf	Factor
7/64 inch	plus 1.3 percent
3/16 inch	less 5.0 percent
1/4 inch	less 9.5 percent
5/16 inch	less 13.6 percent
3/8 inch	less 17.4 percent
7/16 inch	less 20.8 percent

This is also known as Clark's International Rule .

References--l3, 17, 34, 39, 44, 47, 48, 50, 52, 53, 81, 86, 90, 91, 124, 131, 134, 180, 205.

International 1/4-Inch Kerf Rule

Though a properly operating bandsaw mill cutting the type of timber on which Clark based his estimates of waste allowance should be able to equal the recoveries indicated by the International 1/8-Inch Kerf Rule, many mills obviously did not meet these requirements and the rule received little support from buyers. For this reason, Clark in 1917 modified the rule to allow for a saw kerf of 1/4 inch (Chapman and Meyer (50) say that this was done in 1920 at the suggestion of

H. H. Chapman). The change was made as follows:

$$BF \text{ (for 4-foot lengths)} = (0.22D^2 - 0.71D)\left(\frac{19}{21}\right)$$

As in the rule for 1/8-inch saw kerf, a taper of 1/2 inch in 4 feet is assumed in calculating the volume of longer logs and all values are rounded to the nearest multiple of 5 board feet.

$$BF \text{ (for 4-foot lengths)} = (0.199D^2 - 0.642D)$$

$$BF \text{ (for 8-foot lengths)} = (0.398D^2 - 1.086D - 0.27)$$

$$BF \text{ (for 12-foot lengths)} = (0.597D^2 - 1.330D - 0.72)$$

$$BF \text{ (for 16-foot lengths)} = (0.796D^2 - 1.375D - 1.23)$$

$$BF \text{ (for 20-foot lengths)} = (0.995D^2 - 1.221D - 1.72)$$

Lengths over 20 feet are to be scaled as two or more logs.

Grosenbaugh's (90) integrated formula for the rule is,

$$BF = 0.049\ 761\ 91\ LD^2 + 0.006\ 220\ 239\ L^2D - 0.185\ 476\ 2\ LD + 0.000\ 259\ 176\ 7L^3 - 0.011\ 592\ 26L^2 + 0.042\ 222\ 22L$$

As an approximation for the volume of 16-foot logs, Gervorkiantz (81) gave the formula:

$$BF = 2D\left(\frac{2D}{5} - 3/4\right)$$

There have been a number of modifications proposed for the International 1/4-Inch Rule. In 1944, Simmons (180) published a table of "International 1/4-inch" values for logs 20 feet in length and over with diameter measured inside bark at the middle of the log.

Grosenbaugh and Arend (91) modified the rule for use on small eastern red cedar logs. For this species, boards as small as 1 inch by 2 inches by 2 feet are considered merchantable and this close utilization results in sizable over-runs. The formulae for the modified rule are:

$$BF \text{ (for 4-foot logs)} = 0.20D^2 - 0.36D + 0.33$$

$$BF \text{ (for 8-foot logs)} = 0.40D^2 - 0.52D + 0.53$$

$$BF \text{ (for 12-foot logs)} = 0.60D^2 - 0.48D + 0.70$$

$$BF \text{ (for 16-foot logs)} = 0.80D^2 - 0.24D + 0.94$$

Grosenbaugh (90) also developed an integrated formula to be used for the "International 1/4-Inch Rule" when the taper is assumed to be T inches per foot of length rather than the standard taper of 1/2 inch in 4 feet.

$$BF = 0.0498\ LD^2 - 0.1607\ LD + 0.0498\ L^2DT + 0.0166\ L^3T^2 - 0.0804\ L^2T - 0.1992\ LDT - 0.0996\ L^2T^2 + 0.3214\ LT + 0.1328\ LT^2$$

In 1953, an "International Decimal 1/4-Inch Kerf Rule" was authorized (131) for use on National Forest timber sales. The basic International formula was used to calculate values which were then rounded to the nearest 10 board feet and a table was published showing values for logs 6 to 30 inches in diameter by 1-inch classes and 8 to 16 feet long by 2-foot classes.

There are three other modifications of the rule which found little favor in the eyes of H. H. Chapman (48). One of these involved an "improvement" in the rule made by the Federal Land Bank of Springfield, Mass., on the scale sticks they distributed to small woodland owners. The "improvement" involved using interpolated values rather than the original tabular values for six small sizes.

Diameter (inches)	6	6	7	8	8	9
Length (feet)	8	13	8	8	10	8
Correct value	10	15	10	15	20	20
Altered value	9	13	13	18	22	22

The second unauthorized change was made by the U.S. Forest Service Division of Mensuration with the publication of a table showing 'International 1/4-inch' values calculated to the nearest board foot rather than the nearest multiple of 5 board feet. This appeared in the 1927 and 1930 editions of Farmers Bulletin 1210 but was corrected in 1939 in Vocational Division Bulletin 196 and in the 1940 edition of Farmers Bulletin 1210.

Finally, the American Forestry Association, after distributing 1,000 scale sticks bearing the unauthorized Forest Service values, decided in 1939 to make some further changes. They recalculated 16 of the Forest Service values, again to the nearest board foot, and issued 500 more sticks with these amended values.

The International 1/4-Inch Kerf Rule is the statute rule in Connecticut, Delaware, Maine, Massachusetts, Michigan, New York (1930), and Vermont.

References--See International 1/8-Inch Kerf Rule.

International 5/16-Inch Kerf Rule --
See the Alberta Rule.

Jackson's Rule --See Baughman's Rule.

Knouf's Rule

This rule was devised in 1895 by Clyde E. Knouf and Elmer Lancaster as a rule-of-thumb approximation to the Scribner Rule (132).

$$BF = \frac{(D^2 - 3D)L}{20}$$

In the State of Idaho, the statute rule is the Scribner Decimal C. For logs with diameters larger than those given on the scale stick or in cases where a scale stick is not available, the Idaho scaling manual (106) recommends the above formula be used as a rule of thumb. To conform with decimal C practice, the calculated values are divided by 10 and rounded off to the nearest unit.

References--106, 132.

Leaver Scale --No information.

Lehigh Rule --See the Square of Two-Thirds Rule.

Licking River Rule--Referred to by Chapman (47); no further information available.

Los Angeles Rule --See French's Rule.

Lumberman's Rule --See Lumberman's Favorite Rule.

Lumberman's Favorite Rule

This diagram rule was devised by W. B. Judson in 1877. It has been used in Virginia, West Virginia, Michigan, New York, Texas, Tennessee, Indiana, North Carolina, Pennsylvania, and Missouri. It was published in the Lumberman's Handbook in 1880.

The original values, which were quite erratic, were approximated by McKenzie (134) with the formula,

$$BF = \left[(1 - 0.285) \frac{\pi D^2}{48} - 3 \right] L$$

On small logs, this rule runs about 15 percent under the Scribner Rule.

The rule is also known as the Favorite Rule and the Lumberman's Rule .

References--47, 86, 134

Lumberman's Scale -- See Square of Three-Fourths Rule.

Maine Rule

This rule was devised by Charles T. Holland, a surveyor, in either 1856 or 1867. It is a diagram rule based on 1-inch boards with a minimum width of 6 inches and an allowance of 1/4 inch for kerf. Graves and Ziegler (88) say that the values were obtained by diagraming the inscribed square of a log with 1-inch boards and a 1/4-inch kerf allowance. Boards outside the square were included only if 6 inches wide or over. As Young (202) points out, this is, in effect, similar to sawing "around the log" rather than "through and through" as was assumed in the Scribner Rule. The original Maine Rule was for logs 6 to 48 inches in small-end diameter (162). Chapman (47) claims that fractional parts of a board foot amounting to over 0.5 were reckoned as a whole foot, and those less than 0.5 were rejected, and that this resulted in a rule that is the most consistent and accurate of any diagram rule in common use.

Taper is ignored, except that 32-foot lengths are scaled as two or more logs with the scaler measuring the diameter of the first log and estimating the diameter of the remaining logs. The rule was actually devised for short logs and performs poorly when applied to long ones. Young (202) recom-

mended that logs over 16 feet long be scaled as two or more logs with an increase in scaling diameter of 1 inch for every 16 feet of length.

There are several different tables for the Maine Rule in circulation. Cary (44) and Watson (196) published tables of the original diagram values. Because these values are somewhat erratic as are all diagram and mill-tally rules, several authors have attempted to smooth them out. The values published by Graves (86) were "made regular by interpolation by H. D. Tiemann." The formula given by Tiemann (192) for approximating the "corrected" Maine Rule is,

$$BF = \frac{L}{16}\left(\frac{17D^2}{21} - \frac{59D}{42} - \frac{5}{7}\right)$$

Young (202) presents a table with values calculated from a regression equation fitted to the Maine Rule. The equation for 16-foot logs is,

$$BF\ (16\text{-foot logs}) = 0.848\ 797\ D^2 - 2.366\ 196D + 6.2815$$

Daniels (65) proposed the following equation for 12-foot logs:

$$BF\ (12\text{-foot logs}) = 0.635\ D^2 - 1.45D + 2$$

McKenzie (134) used two equations to approximate the Maine Rule.

1) $BF = \left[(1 - 0.222)\ \frac{\pi D^2}{48} - 0.67\right] L$, for logs 6 to 15 inches in diameter

2) $BF = \left[(1 - 0.222)\ \frac{\pi D^2}{48} - 2\right] L$, for logs 16 to 48 inches in diameter

The Maine Rule is also known as Hollands Rule or Fabian's Rule . It is also called the Bangor Rule in some areas, but Young (202) points out that there is a distinct but seldom used Bangor Rule.

References--13, 44, 47, 60, 77, 86, 88, 105, 134, 162, 188, 192, 195, 196, 202.

Margolin Rule

Cook (58) states that this is a mill scale rule constructed from data collected by Margolin and Lyford in southern New Hampshire and published in the 1905-06 report of the New Hampshire Forestry Commission. It is said to be similar to the Massachusetts Rule. For 12-foot logs with diameter measured at the middle of the log outside bark, Cook gives the following values:

Middle diameter	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
BF	13	19	27	34	43	53	64	76	88	104	119	136	155	173	193	211

Reference--58.

Massachusetts Rule

This rule is based on yield studies made in 1905 at 12 New England mills by R. C. Hawley. Tallies were made of 1,200 white pine logs, down to 4 inches small-end diameter, cut with a 1/4-inch saw kerf. The rule is constructed for round- and square-edged boards as sawed from small logs for close utilization of second growth. Some 1-1/4-inch and 2-1/8-inch lumber was included, so the values are slightly high for 1-inch boards. Belyea (13) states that the boards were measured on their average face, thus most fully utilizing the factor of taper and at the same time reducing the factor of slab to a minimum. For 4- to 10-inch logs the rule runs 20 to 50 percent higher than those given by the International 1/8-Inch Kerf Rule.

This rule is presented in two forms: (1) Small-end diameter inside bark, and (2) middle diameter outside bark. In the second form, Cook (58) gives the following values for 12-foot logs.

Middle diameter	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
BF	16	20	26	33	41	51	62	73	85	99	116	132	148	166	185	204

References--13, 16, 47, 50, 58, 87.

McKenzie Rule

There is no specific rule of this name. McKenzie, like Daniels (in 1903), Clark (in 1906), and Tiemann (in 1910), made a detailed analysis of the board foot yield of logs and concluded that the factors to consider in calculating the volume in boards that may be sawed from a log are the slabs and edgings, normal crook, saw kerf, shrinkage, the dimensions of the sawed lumber, log taper, and excessive taper in small logs. Specifically

1. The allowance for slabs and edgings is a function of the barked area and varies directly with it.
2. Normal crook is also a function of the barked

area and varies directly with it.

3. The allowance for sawdust is a function of the saw kerf and the average dimension of the lumber being sawed. Similarly, shrinkage is a function of the average lumber dimension. For any given saw kerf and shrinkage, and any specified average lumber dimension the loss allowance should vary directly as the volume after deduction for slabs.
4. Taper is allowed for by figuring an average taper of "e" inches in "f" feet of length and accumulating the cylinder volumes of sections.
5. The excessive taper in small logs is offset by adding a constant not to exceed 10 board feet.

In 1915, McKenzie published a general log rule formula which could be used in any specified set of operating conditions.

$$BF = \left(1 - \frac{(w + c + k)(t + b + k) - wt}{(w + c + k)(t + b + k)}\right) \frac{\pi(D - a)^2}{48} L + C$$

where: D = diameter (inches) inside bark at the small end of the log.
L = log length (feet)
a = a constant allowing for loss in slabs, edgings, and normal crook
b = loss in thickness due to shrinkage and dressing (inches)
c = loss in width due to shrinkage and dressing (inches)
C = a constant of less than 10 board feet to allow for excessive taper in small top logs
k = width of saw kerf (inches)
t = thickness of lumber sawed (inches)
w = width of lumber sawed (inches)

Although the idea of a universal formula which could be adapted to any situation has an intuitive appeal, McKenzie's formula has had very little use in practice. Tiemann (193), while recognizing the great merit of McKenzie's work, felt that a general formula was undesirable since the resulting proliferation of local log rules would cause even greater confusion in the already abominable log rule situation

To illustrate the use of his formula, McKenzie made a study of the Red River Lumber Company mill in Lassen County, Calif. The formula was first applied to 16-foot logs, thereby getting the effects of taper over the 16-foot length included with the slabs. The results were:

k = 1/8 inch, w = 12 inches, t = 5/4 inch, a = 1 inch, and C = 2.

Ignoring the losses in shrinkage and dressing, the formula for 16-foot logs would be,

$$BF \text{ (for 16-foot logs)} = 0.942\ (D - 1)^2 + 2$$

It was pointed out that in this case the constant a had an unusually small value (1 inch) because of the fact that slabs were cut very thin and edgings were graded as moulding stock. Also, short lengths were cut from logs where taper was great enough to permit it. The volume of logs of other lengths was calculated with a taper allowance of 1 inch in 8 feet and tables were prepared for logs 8 to 32 feet in length, and 4 to 120 inches in diameter. This is what is sometimes referred to as the McKenzie Rule.

In addition to the development of a general formula, McKenzie analyzed many of the existing log rules and found that almost all of them could be expressed by an equation of the form,

$$BF = \left[(1 - c)\ \frac{\pi(D - a)^2}{48} - b\right] L$$

where: a = a reduction in diameter to allow for the loss in slabs and edgings
b = a constant
c = a value between 0 and 1 representing the proportional loss in saw kerf after allowing for the loss due to slabs, edgings, and normal crook.

None of the log rules analyzed had values for both a and b such that one of them could not easily be eliminated. This led to the classification of rules into three general types.

$$\text{Type A.}\quad BF = (1 - c)\ \frac{\pi(D - a)^2}{48} L$$

$$\text{Type B.}\quad BF = (1 - c)\ \frac{\pi D^2}{48} L$$

$$\text{Type C.}\quad BF = \left[(1 - c)\ \frac{\pi D^2}{48} - b\right] L$$

References--134, 193.

Michigan Decimal C Rule --No information.

Mid-Doyle Rule --See Doyle Rule.

Miller Rule --See Bangor Rule.

Miner Rule --See Square of Two-Thirds Rule.

Minnesota Rule --See Scribner Rule.

Minnesota Standard --See Scribner Role.

Mississippi Pine Pole Scale

There may be several local rules known by this name or something similar. One of these was developed by R. S. Spencer, mill manager for the Daley Lumber Company at Oxford, Miss. The rule is based on mill tallies of 250,000 feet of southern pine logs sawed at the Daley Mill. Several checks have been made and local loggers claim that it "gives a good scale." For 16-foot logs over 8 inches in diameter the values are very close to those of the formula Scribner Rule. Logs other than 16 feet long are given a volume proportional to their length.

A fairly good approximation to the rule is given by,

$$BF = (0.891D^2 - 5.503D + 22.198)\frac{L}{16}$$

or, when expressed as a general formula of the type used by McKenzie,

$$BF = \left[(1 - 0.149)\frac{\pi(D - 3.1)^2}{48} + 0.856\right] L$$

Moore Rule --See Doyle Rule.

Moore and Beeman Rule --See Doyle Rule.

Murdoch Rule --See Partridge Rule.

Murdoch and Fairbanks Rule --See the Partridge Rule.

New Rule --See the Doyle Rule.

New Brunswick Rule

This is one of the oldest board foot rules on record, having been made the statute rule for the Province of New Brunswick on April 14, 1845. Ker (113) states that it is an uncurved diagram rule based on 1-inch boards and a 5/16-inch kerf. The original table, reprinted by Robinson (162), shows values for logs 11 to 24 inches in diameter and 12 to 50 feet in length. This table indicates that volume was made proportional to length for logs up to 24 feet. Greater lengths were apparently treated as two nearly equal-length short logs with the scaling diameter of the second log being 1 inch greater than that of the first log. Thus, the value given for a 14-inch log 36 feet long is equal to the sum of values for a 14- and a 15-inch log, each 18 feet long. The value shown for an 18-inch 30-foot log is equal to the sum of values for an 18-inch log 16 feet long and a 19-inch log 14 feet long.

The official table now issued by the New Brunswick Department of Lands and Mines (DLM) has values for logs 3 to 30 inches in diameter and 8 to 23 feet long. Ker (113) says that in application, diameter is always rounded down to the nearest whole inch and logs longer than those covered by the table are to be scaled in two or more lengths.

It will be noted that this table includes log diameters not covered by the original rule. Robinson (162) reports that the "New Brunswick Statute Log Scale" as published in 1919 contained values for logs 8 to 10 inches in diameter and up to 34 feet in length plus values for logs 25 to 30 inches in diameter up to 28 feet long. Still later, in 1927, values were provided for logs 3 to 7 inches in diameter and 10 to 18 feet in length and some of these were said to have been "adjusted" in 1933. The sources of the various extensions are not known. In the DLM tables the values shown for logs 25 to 30 inches in diameter are identical to those of the Maine Rule. Similarly, the values given for 6- and 7-inch logs are the same as those of the Maine Rule. Cary (44) states that logs, 7, 8, 9, and 10 inches in diameter were given values equal to 2, 2-1/2, 3, and 4 times their length respectively and this is verified by the current tables except for the 7-inch logs. No explanation has been found for the values of 3-, 4-, and 5-inch logs.

Although both Robinson (162) and Ker (113) have identified this as a diagram rule, others have classified it as a mill scale rule and Ross (164) claims that it is a combination rule, the values up through 18 inches being from the Vermont Rule while the values for larger logs are from the Maine Rule.

This seems rather doubtful in view of the very early publication date for the New Brunswick Rule. However, it is worth noting that the values for logs 11 to 16 inches in diameter can be calculated by

$$BF = \frac{D^2L}{24}$$

which is the current form of the Vermont Rule.

References--12, 13, 16, 44, 47, 113, 162, 164.

New Hampshire Rule

This rule was, at one time, extensively used in Maine, New Hampshire, and Vermont. It is based on a "standard" 1 foot long and 16 inches in diameter which is taken to equal 1 cubic foot. This is referred to as a "Blodgett foot" and all logs are scaled in terms of Blodgett feet. Since the actual volume of the standard is 1.396 cubic feet, the rule is a rough attempt to allow for the waste in squaring round logs. However, an inscribed square uses 63.6 percent of a circle while the "Blodgett Foot" uses 71.6 percent and would be a waney square.

The diameter is measured at the middle of the log and the formula for the volume in Blodgett Feet is:

$$\text{Blodgett Feet} = \frac{D_m^2L}{256}$$

The legal factor for conversion to board feet was set at 100 Blodgett feet = 1,000 board feet, but in practice this was thought to give a too high a board foot scale so an arbitrary factor of 115 was adapted. When diameter is measured at the small end of the log a factor of 106 is used, though it would be more accurate to use a factor that varied with the diameter and length of the log.

As an approximation for the board foot volume of logs by the New Hampshire Rule, A. L. Daniels (65) gave the following formula:

$$BF = 0.41D_m^2 - 0.1D_m + 1$$

This became known as the New Hampshire Rule when it was adapted as the Statute rule of that State. Previously it was more commonly known as the Blodgett Rule .

References--13, 16, 44, 47, 50, 65, 86, 88, 187, 191.

Newfoundland Rule

Robinson (162) reports that this became the statute rule of Newfoundland in 1916. The act reads in part, "The board measure shall be determined by multiplying the diameter of the log at the top by one-half of said diameter in inches, and multiplying the product by length of the log in feet and dividing the resulting product by 12. The result shall be the board foot measure of the log in feet." This is the same as the formula often given for the Vermont Rule.

$$BF = \frac{D^2L}{24}$$

Except for the point of measurement, it is also identical to the Delaware Middle Diameter Rule. Robinson (162) says that, "Compared with the International 1/4-Inch Rule which is used in Manitoba and Saskatchewan, and with the Roy and New Brunswick log rules, it is high for logs with small-end diameters under 10 inches, and low for logs of 14 inches in diameter and up."

References--113, 162.

New Scribner Rule --See the Doyle Rule.

New York Twenty - Two - Inch Standard -- See Adirondack Standard.

New York Twenty - Four - Inch Standard -- See Adirondack Standard.

Nineteen-Inch Standard --See Adirondack Standard.

Noble Rule --See Square of Three-Fourths Rule.

Noble and Cooley Rule --See Square of Three-Fourths Rule.

Northeastern Rule --No information.

Northwestern Rule

This is an extremely erratic diagram or mill scale rule based on 3/8-inch saw kerf. It was used to some extent in Michigan and Illinois. For 16-foot logs, Graves and Ziegler (88) give the following values:

Diameter	8	10	12	14	16	18	20	22	24	26	28	30
Board feet	33	61	77	117	170	206	248	324	392	450	536	632

Diameter	32	34	36	38	40	44	48
Board feet	725	845	920	1,037	1,160	1,402	1,696

References--4, 47, 86, 88, 164.

Ochiltree Rule --See the Orange River Rule.

Ohio River Rule --See Big Sandy Cube Rule.

Ohio River Cube Rule

A standard rule--may be the same as the Big Sandy Cube Rule.

Reference--4.

Ontario Cubic Foot Formula

Robinson (162) indicates that cubic foot volumes in Ontario shall be based on Smalian's formula.

$$CF = \frac{\pi(D_1^2 + D_2^2)L}{1{,}152}$$

where D_1 and D_2 are the diameters at the ends of the logs in inches. No other references to this rule were found.

Reference--162.

Ontario Rule

As Ker (113) notes, the Scribner Rule was authorized for use in the Province of Ontario in 1869. It was superseded in 1879 by the Doyle Rule which for this reason is sometimes called the Ontario Rule. The rule which is now known as the Ontario Rule was adopted as the official rule in 1952. It applies to logs 4 to 40 inches top diameter and 8 to 18 feet long. The accepted formula is:

$$BF = (0.55D^2 - 1.2D)\frac{L}{12}$$

The rule is based on a general lumber recovery formula outlined by Chapman (47) in 1921.

$$BF = \left[(1 - b)\frac{\pi D^2}{4} - AD\right]\frac{L}{12}$$

where: b = percentage of volume deducted for saw kerf, shrinkage, and sawing inaccuracy.

A = an allowance for loss in slabs and edgings. For convenience, this loss is expressed in terms of a plank with a width of D inches, a thickness of A inches, and a length of L feet.

Using lumber recovery data published by Bell (12), the appropriate values were found to be b = 0.30 and A = 1.1. The value of A was adjusted to 1.2 to move the curve between the values given by Bell and those presented by industry.

Morison and Pennock (141) have given details on the application of the Ontario Rule. For logs of 4 to 20 inches in diameter, 1/2-inch diameter classes are used and measurements are always rounded down to the next lower 1/2-inch class. For logs over 20 inches, 1-inch classes are used and measurements are rounded down to the next lower 1-inch class. The rule applies to logs 8 to 18 feet long; other lengths must be scaled by other methods.

References--7, 12, 17, 47, 113, 141, 162.

Orange River Rule

The formula for this rule is:

$$BF = \frac{D^2L}{30}$$

McKenzie's (134) formula for the rule is,

$$BF = (1 - 0.491)\frac{\pi D^2}{48}L$$

The rule was used in Texas and is similar to or the same as the Ochiltree Rule and the Sabine River Rule .

References--47, 86, 134.

Parsons Rule

This is a diagram rule once used in Maine and similar in construction to the Bangor Rule and the Maine Rule. The values, which run about 2 percent lower than those of the Maine Rule, can be approximated by McKenzie's (134) formula.

$$BF = \left[(1 - 0.246)\ \frac{\pi D^2}{48} - 1\right] L$$

References--4, 47, 86, 134.

Partridge Rule

The origin of this rule is not clear. Chapman (47) described it as an obsolete rule based on a cubic foot formula while Belyea (16) lists it as a diagram rule and claims that it was based on 7/8-inch boards. Graves (86) also notes that it was based on 7/8-inch boards but says nothing about the derivation. The suggestion that it is not a formula rule seems to be supported by McKenzie's (134) comment that the original values were somewhat erratic. His formula for approximating the values is,

$$BF = (1 - 0.312)\ \frac{\pi D^2 L}{48}$$

The Partridge Rule was once used in Massachusetts and is said to be similar to or the same as the Murdoch Rule , Fairbanks Rule , or Murdoch and Fairbanks Rule .

References--16, 47, 86, 134.

Penobscot Rule --See the Bangor Rule.

Pine Pole Scale --See the Mississippi Pine Pole Scale.

Portland Rule --See the Square of Three-Fourths Rule.

Preston Rule

This rule was used in Florida and Georgia and is regarded as a seller's rule. McKenzie (134) used two formulae for approximating the values of the Preston Rule.

$$\text{For small logs, } BF = (1 - 0.20)\ \frac{\pi(D - 1.75)^2 L}{48}$$

$$\text{For large logs, } BF = (1 - 0.20)\ \frac{\pi(D - 1.5)^2 L}{48}$$

The dividing line between small and large logs is not given.

Although McKenzie's formulae appear to be consistent with the allowances for saw kerf and slabs given for the Preston Rule, the values calculated from these formulae do not agree too well with the tabular values. Better approximations are given by the equations:

$$BF = (1.456D^2 - 18.39D + 89.00)\ \frac{L}{16}$$

$$\text{for } 8 \leq D \leq 17$$

$$BF = (.783D^2 + 1.44D - 67.26)\ \frac{L}{16}$$

$$\text{for } 18 \leq D \leq 44$$

References--47, 86, 134.

Puget Sound Rule --See the Drew Rule.

Quebec Rule

This is a diagram rule devised around 1889. It was at one time the statute rule of the Province but was replaced by a cubic foot rule in 1936 and by the Roy Rule in 1945.

The original rule was for logs 6 to 44 inches in diameter but at a later date, arbitrary values were assigned to logs down to 3 inches in diameter. The rule assumes a 1/4-inch saw kerf and a minimum board width of 5 inches. Values were obtained for 1- and 3-inch-thick boards and the averages of these were adjusted and curved after comparison with mill tallies made on a few hundred logs. The original table was based on 12-foot logs and other lengths are given values proportional to their length. Taper is ignored except that on logs over 18 feet long, the average of the two end diameters is used as the scaling diameter. one peculiarity is that the 3/4-inch mark is used as the lower

limit of the diameter class.

References--13, 44, 47, 50, 78, 162, 169.

Quebec Standard --See Adirondack Standard.

Rapraeger Rule

A West Coast cubic foot rule with diameter measured at the small end of the log and an assumed taper of 1 inch in 8 feet. No further information.

Reference--35.

Robinson Rule --See the Derby Rule.

Robinson's Cubic Foot Rule

In 1908, Halbert G. Robinson (161) of Patten, Maine, published a table showing the average cubic foot volume for logs of a given mid-point diameter and length. The table covered logs up to 40 feet long and was based on taper and volume measurements of 4,398 spruce logs. He found that for logs up to 40 feet long, taper averaged 1 inch in 7.5 feet; longer logs had a more rapid taper and hence were omitted from the table. He also found that the calculated cubic volumes over-ran those given by the Huber Formula by an average of 4.9 percent. To express the values in the table and to aid in interpolating where the original data were insufficient, Robinson developed a formula which is a simple modification of Huber's Formula.

$$CF = 0.005721 D_m^2 L$$

(Huber's Formula is $CF = 0.005454 D_m^2 L$.)

References--47, 87, 161.

Ropp Rule

This rule was used in Illinois by C. Ropp and Sons of Chicago. It was originally a diagram rule for 1-inch lumber and a 1/4-inch kerf. Later the rule was reduced to a rule-of-thumb formula which severely underscales logs under 13 inches in diameter.

$$BF = (D^2 - 60)\frac{L}{20}$$

McKenzie's (134) formula is,

$$BF = \left[(1 - 0.236)\frac{\pi D^2}{48} - 3\right] L$$

References--47, 86, 134, 163.

Rotary Log Scale --See Baughman's Rule.

Roy Rule

This rule was devised by Henri Roy (169). The formula is,

$$BF = (D - 1)^2 \frac{L}{20}$$

In 1945 it was made the official rule of the Province of Quebec. Robinson (162) reports that it is applied to logs 3 to 44 inches in small-end diameter and 4 to 20 feet in length. Logs over 20 feet are to be measured by the Quebec cubic foot scale. Ker (113) says that in Quebec the Roy Rule is not applied to logs over 18 feet long.

The formula is identical to that of the Sammi Log Rule.

References--113, 162, 169.

Sabine River Rule --See the Orange River Rule.

Saco River Rule

Chapman (47) claimed that this was a cubic volume rule with multiplication by a constant for conversion to boardfeet. However, both Ross (164) and Belyea (16) list it as a mill scale rule and the values given by Graves (88) for 16-foot logs are not consistent enough for a formula rule.

Diameter	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Board feet	26	49	75	108	147	192	246	302	366	436	513	590	674	771

McKenzie (134) noted that the original values were slightly erratic and approximated them by the formula.

$$BF = (1 - 0.276)\frac{\pi D^2 L}{48}$$

This rule was used in Maine and was sometimes called the Saco Rule .

References--4, 16, 47, 86, 88,134, 164.

St. Croix Rule --See the Doyle Rule.

St. Louis Hardwood Rule --See the Square of Two-Thirds Rule.

Sammi Log Rule

This was devised by John C. Sammi of the New York State College of Forestry as a rule of thumb for approximating the values of the International 1/4-Inch Rule. Noting that the Clement Rule was fairly close, he simplified the Clement formula for 16-foot logs to,

$$BF = 0.8D\ (D - 2)$$

A year later in 1937, he published a second approximation called the Sammi Log Rule.

$$BF = (D - 1)^2\ \frac{L}{20}$$

This gives values that are quite close to those of the International 1/4-Inch Rule for 16-foot logs, but somewhat high for shorter logs and low for longer logs. The formula is identical to that of the Roy Rule.

References--170,171

Santa Clara Rule --See the Scribner Rule.

Saranac Standard --See Adirondack Standard.

Schenck Rule --Believed to be a mill scale rule, but no further information available.
References--4,164.

Scribner Rule

This rule was published in 1846 by J.M. Scribner, a country clergyman. It is a diagram rule for 1-inch lumber with a 1/4-inch allowance for saw kerf. The minimum board width is unknown. The original table gave values for logs 12 to 44 inches in diameter inside bark at the small end and for lengths of 10 to 24 feet. Fractional inches of diameter were dropped and log taper was ignored. At a later date the author modified the original rule by increasing the slab allowance on larger logs.

Scribner's account of the construction of the rule is of interest.

> "This table has been computed from accurately drawn diagrams for each and every diameter of logs from 12 inches to 44, and the exact width of each board taken after being squared by taking off the wane edge and the contents reckoned up for every log, so that it is mathematically certain that the true contents are here given, and both buyer and seller of logs will unhesitatingly adopt these tables as the standard for all future contracts in the purchase of sawlogs where strict honesty between party and party is taken into account. In these revised computations I have allowed a thicker slab to be taken from the larger class of logs than in the former edition, which accounts for the discrepancy between the results given in these tables and those in former editions.
>
> "The diameter is supposed to be taken at the small end, inside the bark, and in sections of 15 feet, and the fractions of an inch not taken into the measurement. This mode of measurement, which is customary, gives the buyer the advantage of the swell of the log, the gain by sawing it into scantling, or large timber, and the fractional part of an inch in the diameter. Still it must be remembered that logs are never straight and that oftentimes there are concealed defects which must be taken as an offset for the gain above mentioned. It has been my desire to furnish those who deal in lumber of any kind with a set of tables that can implicitly be relied upon for correctness by both buyer and seller, and to do so I have spared no pains nor expense to render them perfect. And it is to be hoped that hereafter these will be preferred to the palpably erroneous tables which have hitherto been in use. If there is any truth in mathematics or dependence to be placed in the estimates given by a diagram, there cannot remain a particle of doubt of the accuracy of the results here given."

An interesting discussion of J. M. Scribner and his log rule has been published by H. C. Belyea (15, 16).

Commenting on the performance of the Scribner Rule, Belyea (13) notes that it is fairly consistent

on logs 16 feet or less in length and under 28 inches in diameter, but that for larger logs the rule gives increasingly large over-runs.

There have been a number of modifications and extensions to Scribner's original tables. The simplest of these was the early Lake States practice of rounding all values to the nearest 10 board feet and omitting the cipher, creating the so-called decimal form of the rule. When it comes to extensions of the rule, things get to be very confusing. In 1900 the Lufkin Rule Company tabulated the decimal values then in use for small logs under three schedules, termed A, B, and C, as shown below:

Length	Decimal A						Decimal B						Decimal C					
	Diameter in inches						Diameter in inches						Diameter in inches					
	6	7	8	9	10	11	6	7	8	9	10	11	6	7	8	9	10	11
12	1	1	2	3	4	5	1	2	2	3	4	4	1	2	2	3	3	4
14	1	1	2	3	4	6	1	2	3	3	4	6	1	2	2	3	4	5
16	1	2	3	4	5	6	2	3	3	4	5	7	2	3	3	4	6	7
18	1	2	3	4	5	7	2	3	4	5	6	8	2	3	3	4	6	8
20	1	2	3	4	6	8	2	3	4	6	7	8	2	3	3	4	7	8
22	1	2	3	5	7	9	3	4	5	7	8	9	3	4	4	5	8	9
24	1	3	4	5	7	10	4	5	6	7	9	10	3	4	4	6	9	10

The decimal form of the original rule along with the Decimal C extension is the form of the rule most commonly used today.

Another set of values for logs under 12 inches was that used by the Santa Clara Lumber Company of New York State. Values for 16-foot logs were published in Graves and Ziegler's Woodsman's Handbook in 1910 and were adopted by the Canadian Forestry Branch in 1914 (47). The State of Minnesota adopted a set of slightly different values which were published by Cary (44) and Belyea (13). The American Lumberman Vest Pocket Ready Reckoner gives values calculated from the formula,

$$BF = (D - 3)^2 \frac{L}{16}$$

Some tables contain values based on the equation developed by Bruce and Schumacher (39).

$$BF = (0.79D^2 - 2D - 4), \text{ for 16-foot logs}$$

In 1905, E. A. Ziegler of the U.S. Forest Service developed an extension for logs over 44 inches in diameter. This was published in the 1910 edition of the Woodsman's Handbook (88). The extension was based on a comparison of the curve formed by the plotted values of the rule with similar curves for the International and Spaulding Rules. It was built up on a 12-foot log and applied to lengths from 8 to 16 feet. As a concession to logging methods in the Northwest, logs up to 32 feet were scaled without taper by this rule. Rapraeger (152) says that for logs over 40 feet the rule was extended by allowing a fixed taper of 1 inch in 10 feet and was then called the Revised Scribner Scale for Long Logs . These revised tables were used in the Douglas-fir region by some commercial scaling bureaus, but the U.S. Forest Service uses the actual taper in scaling long logs.

There have been a number of formulae proposed for approximating the Scribner Rule. The one by Bruce and Schumacher mentioned above is the most familiar and most commonly used. One of the earliest is a formula often called Knouf's Rule (132):

$$BF = (D^2 - 3D) \frac{L}{20}$$

which was developed in 1895. In 1903, A.L. Daniels offered two equations:

$$BF \text{ (for 12-foot logs)} = (0.555D^2 - 0.55D - 23)$$

$$BF \text{ (for 16-foot logs)} = (0.74D^2 - 0.73D - 31)$$

Evidently there was some mistake in Daniels' calculations as all of the values given by his formulae are below the actual Scribner values. In 1939, Lemieux (123) developed a smoothed approximation which gave results similar to those of the Bruce and Schumacher formula, and in the same year, Gevorkiantz and Becton each published equations for approximating the values of Scribner Decimal C. For 16-foot logs, Gevorkiantz (81) suggested

$$BF = \frac{2D}{10}\left(\frac{2D}{5} - 1\right)$$

Becton gave

$$BF \text{ (for logs 8 to 17 inches in diameter)} = \frac{(D - 3)^2 L}{4}$$

$$BF \text{ (for logs 18 to 27 inches in diameter)} = \frac{(D - 3)^2 L}{4} - 25$$

These apparently were misprints as neither one comes close to the intended values. Since Becton

drew an analogy between his formulae and the Doyle Rule, it is possible that the divisor in each formulae should have been 16.

McKenzie (134) used the following formula as an approximation:

$$BF = \left[(1 - 0.266) \frac{\pi D^2}{48} - 3 \right] L$$

The Scribner, in one form or another, is one of the most widely used rules in the country. For many years it was the rule prescribed by the U.S. Forest Service and the Dominion Forestry Branch of Canada. It is or has been the Statute rule in Idaho, Iowa, Minnesota, Nevada, Oregon (Coos County), Pennsylvania, West Virginia, and Wisconsin. In Canada, Ker (113) says that it was adapted by Ontario in 1869 (replaced by Doyle in 1879), Manitoba (replaced by International 1/4-Inch Rule in 1933), and Alberta (replaced by International 5/16-Inch in 1957). In Saskatchewan the Scribner Rule was used until replaced by the International 1/4-Inch Rule in 1931 (162).

Rules that are similar to, or the same as, the Scribner are the Old Scribner Rule (after publication of the Doyle Rule in Scribner's Ready Reckoner), the Hyslop Rule , Minnesota Rule , Minnesota Standard Rule , and the Santa Clara Rule .

References--11, 13, 15, 16, 17, 37, 39, 44, 46, 47, 50, 55, 77, 81, 86, 88, 112, 113, 123, 124, 132, 134, 136, 151, 152, 175, 176.

Scribner Rule (erroneous)

When Scribner's rights to the Ready Reckoner expired the book was reissued by Fisher who substituted the Doyle Rule for the Scribner. Because of this, the Doyle has been referred to as the Scribner, the New Scribner, or the New Rule. This publication also led some people to confuse the Doyle Rule with the Doyle-Scribner or Scribner-Doyle combination rules.

References--15, 16.

Scribner-Doyle Rule

This is a combination rule using Scribner values for logs up to 28 inches small-end diameter and Doyle values for larger logs. This has been the statute rule of Louisiana since 1914.

Reference--13.

Seven-Tenths Log Rule

Information on this rule was supplied by Richard C. Smith of the University of Missouri. This rule, which he reported using in southwest Georgia in the early 1940's, is similar in construction to the Square of Three-Fourths and Square of Two-Thirds Rules and several others. Seven-tenths of the small-end diameter represents the largest square timber that can be sawed from a log. The volume of this squared timber times 12 is the board foot scale of the log. Apparently in practice, the fraction obtained after multiplying the diameter by 0.7 was rounded down to the nearest whole inch before squaring.

The rule overscales logs up to about 13 inches in diameter and underscales logs larger than this.

Seventeen-Inch Rule

This cubic foot rule is a variation of the Inscribed Square Rule. Since a square inscribed in a circle 17 inches in diameter would have 12 inches on a side, a log 17 inches in diameter and 1 foot long would yield 1 cubic foot of square timber. All other logs are expressed in terms of this standard,

$$CF = \frac{D^2 L}{17^2} = \frac{D^2 L}{289}$$

References--47, 88.

Seventeen-Inch Standard --See Adirondack Standard.

Sorenson Log Rule

This is a West Coast cubic volume rule devised in 1945 by Chester J. Sorenson. Diameter is measured (in inches) inside bark at the small end of the log and cubic volume is given as:

$$CF = 0.005454154 \left(D + \frac{L}{20} \right) L$$

The $\frac{L}{20}$ term is, in effect, a conversion from small-end to mid-point diameter based on an assumed taper of 1 inch in 10 feet.

References--182, 183.

Spaulding Rule

This rule was devised by N. W. Spaulding of San Francisco in 1868. It is based on diagrams of logs 10 to 96 inches in small-end diameter and 12 to 24 feet long. Karr (132) states that it was for logs 10 to 44 inches in diameter in sections 12 feet long but, considering the size of timber for which the rule was developed, this seems doubtful. A saw kerf of 11/32 inch and the production of 1-inch lumber is assumed. The allowance for slabs increases with the size of the log, thus increasing the over-run on larger logs. In practice, taper is ignored on logs up to 40 feet long and their volume is made proportional to their length. For logs over 40 feet long, Rapraeger (152) says that an allowance for taper of 1 inch in 10 feet is made and that the rule is then called the Columbia River Rule (see also the Columbia River Taper Rule).

McKenzie (134) approximated the values of the Spaulding Rule by the formula,

$$BF = \left[(1 - 0.266) \frac{\pi D^2}{48} - 2 \right] L$$

Buell (40) reports that a special technique is used when the Spaulding Rule is applied to the scaling of redwoods. The diameter is measured at two points. The first point is inside bark, 20 feet above the butt end. The second is either at the beginning of the sound wood just below the first break or at the upper limit of merchantability, whichever is lower. The two diameters are averaged and the scale is taken for a length equal to the total length from the butt up to the point where the top diameter was measured.

The Spaulding Rule is said to give fair results on sound logs. However, mill men claim that because of felling cracks, weather checking, fire scars, etc., the mill tally underruns the scale by about 30 percent. To compensate for this, Spaulding values have been reduced by 30 percent creating what is called the Humboldt Scale . A table of the Humboldt Scale is credited to an A. W. Elam.

The Spaulding Rule was adapted as the statute rule of California in 1878 and it is sometimes known as the California Rule . It is also used in Nevada, Oregon, Utah, Washington, and Wairaropa, New Zealand.

References--13, 27, 40, 44, 47, 77, 86, 88, 132, 134, 152, 185.

Square of Mean Diameter Rule

Brereton (27) mentions a rule by this name and points out that squaring the mean-end diameter (in feet) and multiplying the length gives 27.32 percent more volume than any log contains. He claims that its use became general in the export trade in 1918 as a result of losses suffered by Pacific Coast shippers who unwisely contracted to carry logs on the Scribner, Spaulding, or British Columbia log scales "whose erroneous construction gave only 40 to 60 percent of the actual log contents in board feet."

Reference--27.

Square of Three-Fourths Rule

This rule was once used in New England and both Knouf (132) and Graves (86) report that the rule is mentioned in a "Table for Measuring Logs" published in 1825 in Plymouth, Maine. To get the volume of a log by this rule, "deduct one-fourth from the diameter at the small end and express the squared timber volume in board feet." In formula form,

$$BF = \left(\frac{3}{4} D \right)^2 \frac{L}{12}$$

McKenzie's (134) formula for the rule is,

$$BF = (1 - 0.283) \frac{\pi D^2}{48} L$$

Duff (76) reports that in New Zealand, Canterbury sawmilllers use the Goss or Canterbury Table which shows the volume of logs by the Square of Three-Fourths Rule. Rules that are similar to or the same as the Square of Three-Fourths Rule are the Portland Scale , Noble Rule , Cooley Rule , Noble and Cooley Rule , Cook Rule , Crooked River Rule , Lumberman's Scale , and Three-Fourths Rule .

References--47, 76, 86, 132, 134.

Square of Two-Thirds Rule

In this rule, diameter is measured inside bark at the middle of the log and the cubic foot volume given by the Two-Thirds Cubic Foot Rule is converted to board feet using a 12 to 1 conversion

ratio. In effect, this comes down to:

$$BF = \frac{D_m^2 L}{27}$$

McKenzie's (134) formula for the rule is,

$$BF = (1 - 0.435)\ \frac{\pi D_m^2 L}{48}$$

The rule is frequently and erroneously applied using the small-end diameter of the log. This rule has been used in the Ozarks for redcedar logs, in the Middle Atlantic States for hardwood logs, and to some extent on pine logs in the South Atlantic States.

Rules that are similar to, or the same as, the Square of Two-Thirds Rule are the Two-Thirds Rule , St. Louis Hardwood Rule , Tennessee River Rule , Lehigh Rule , Miner Rule , and Cedar Log Scale .

References--47, 86, 132, 134.

Stillwell Rule --Seethe Stillwell Vade Mecum Rule.

Stillwell's Vade Mecum Rule

This rule, used in Georgia, is of obscure origin. Chapman (47) states that it is an obsolete rule based on a cubic foot formula, while Belyea (16) lists it as a diagram rule. McKenzie's (134) comment that the original values were erratic would seem to support Belyea.

For approximating the values of this rule, McKenzie (134) gave the formula,

$$BF = (1 - 0.368)\ \frac{\pi D^2 L}{48}$$

Other names that have been used for the rule are Stillwell's Rule and Vade Mecum Rule .

References--16, 47, 86, 134.

Tatarian Rule

Chapman (47) says this rule was used in Wisconsin and describes it as a board foot rule based on a cubic foot formula. The values may be approximated by,

$$BF = (0.84)\ \frac{\pi D^2 L}{48}$$

Reference--47.

Tennessee River Rule --See the Square of Two-Thirds Rule.

Third and Fifth Rule --See the Cumberland River Rule.

Thomas's Accurate Rule

Chapman (47) gives the formula for this rule (for a 1/4-inch saw kerf) as,

$$BF = (0.78)\ \frac{\pi(D - 1)^2 L}{48} = 0.051\ (D - 1)^2 L$$

A formula has also been developed for 1/8-inch kerf.

Reference--47.

Three-Fourths Rule --See the Square of Three-Fourths Rule.

Thurber Rule --See the Doyle Rule.

Tiemann Rule

In publishing his rule in 1910, H. D. Tiemann (192) wrote, "The log scale has been for so long a time a hackneyed subject of discussion, and has been attacked from so many points of view, that to bring it up once more would seem almost inexcusable without particularly good reason. Yet the very fact that the means of reducing round logs to some tangible unit of measure is still a mooted question shows that the problem has not yet reached an altogether satisfactory solution.

"To find the cubical contents of a log is a simple matter, and to determine how much a given log with a known 'rise' in taper would saw out as boards under given conditions is also comparatively easy. If this were all there were to deter-

mine, there would be no problem Nor would there be a problem if all logs were cylindrical. It is the taper, then, which really constitutes the main difficulty and makes a theoretically simple matter exceedingly complex in its practical application."

Tiemann followed the principles enunciated by Daniels (65) and Clark (53) except for the manner in which he handled the taper problem. Daniels pretty much ignored taper while Clark assumed an average taper and built up volumes from a series of 4-foot-long cylinders with increasing diameters. Tiemann's solution was to measure diameter inside bark at the middle of the log rather than at the small end.

From the results of a mill scale study in Maine, primarily on white pine, Tiemann curved the yield of 1-inch lumber from 224 "perfect" logs slash-sawed with 3/16-inch kerf. The log rule he devised to conform to this curve is

$$BF = \frac{L}{16}\left(\frac{3}{4}D_m^2 - 2D_m\right)$$

This is applied on logs up to 24 feet long. As Tiemann pointed out, the use of mid-point diameter does not completely solve the taper problem. The rule is accurate for 16-foot logs, but gives a very small over-run on shorter logs and a slight under-run on longer ones. Logs between 24 and 48 feet long are divided and scaled as two equal length logs, using two mid-log diameter measurements. Logs over 48 feet long require three diameter measurements.

Because of the difficulty in measuring mid-point diameters, the end diameters ($\overline{D}_1$ and $\overline{D}_2$) sometimes are measured. In this case, the values of D_2 in the formula is obtained from,

Although the Tiemann Rule has considerable merit, it has seen very little practical application because of the added difficulty and cost of mid-point measurement of diameter.

References--14, 47, 48, 192, 194.

Twenty-Four-Inch Standard --See the Adirondack Standard.

Twenty-One-Inch Standard --See the Adirondack Standard.

Twenty-Two-Inch Standard --See the Adirondack Standard.

Two-Thirds Rule --See the Square of Two-Thirds Rule.

Two-Thirds Cubic Foot Rule

The cubic volume by this rule is obtained by reducing the middle diameter (D_m) by one-third, squaring, and multiplying by log length.

$$CF = \left(\frac{2D_m}{3}\right)^2 \frac{L}{144}$$

In some cases, the average of the two end diameters is used. In the redcedar industry, the small-end diameter is used and the cubic volume multiplied by 12 for conversion to board feet.

This rule is sometimes called the Big Sandy Cube Rule though the rule commonly known by that name specifies diameter measurement at the small end of the log.

References--47, 86, 88, 177, 205.

Universal Rule

The Champlain Rule introduced by A. L. Daniels in 1902 was not well received. The complaints made against it were that it assumes all logs to be straight, round, and free from defects. In addition, it assumes that the loss in manufacture of the board is due only to sawdust, slabbing, and edging, and not to crooks, knots, or other blemishes. To overcome these shortcomings, Daniels, in October 1903, modified the Champlain Rule to produce the Universal Rule. The only change is to increase surface waste allowance to the equivalent of a 2-inch plank whose width equals the diameter of the log (the Champlain Rule has a surface waste allowance equivalent to a 1-inch plank). With this change the formula becomes:

$$BF = (0.62832D^2 - 2D)\frac{L}{12}$$

Graves (86) gave the formula as

$$BF = \frac{0.62832D^2L}{12} - 2D$$

which is apparently a misprint.

McKenzie's (134) formula for the Universal Rule is,

$$BF = (1 - 0.20)\ \frac{\pi(D - 1.6)^2}{48}\ L$$

This is also called Daniels Rule and Daniels Universal Rule .

References--18, 47, 65, 66, 80, 134, 192.

Universal Standard Log Scale --See the Doyle-Scribner Rule.

Vade Mecum Rule --See Stillwell's Vade Mecum Rule.

Vannoy Rule --See the Doyle Rule.

Vermont Rule

The Vermont Rule values are simply 12 times the cubic foot volumes given by the Inscribed Square Rule.

$$BF = 12\left(\frac{D^2L}{287}\right) = 0.0418D^2L$$

Graves (86) reports that the Vermont Rule, which was the legal standard in Vermont, though seldom used there, was revised in 1894 to:

$$BF = \frac{D^2L}{24}$$

which is not greatly different from the first formula. However, it was specified that the revised formula was for 12-foot logs and that longer logs would be scaled in 12-foot lengths starting at the small end. This leads to the simplified form,

$$BF = \frac{D^2}{2}$$

McKenzie's (134) formula for the Vermont Rule is,

$$BF = (1 - 0.363)\ \frac{\pi D^2L}{48}$$

The Winder Rule may be similar to, or the same as, the Vermont Rule. The Vermont Rule has also been called the Humphrey Rule , but there is also a cubic volume rule with this same name.

References--47, 50, 86, 134.

Warner Rule

This is a diagram rule once used locally in New York. Chapman (47) described it as a worthless rule with an excessive allowance of 3/4 inch for saw kerf.

McKenzie's (134) formula for approximating the values of the Warner Rule is,

$$BF = \left[(1 - 0.466)\ \frac{\pi D^2}{48} - 1\right] L$$

References--47, 86, 134.

Western Pine Association Rule

This is a rule of thumb used in Idaho for logs over 30 inches in diameter and 16 feet or less in length.

$$BF\ (decimal) = \left(\frac{3D^2}{40}\right)\frac{L}{16}$$

Reference--106.

Wheeler Rule

For 16-foot logs, Graves (86) gives the following values:

Diameter	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Board feet	22	40	65	95	132	174	223	277	337	404	475	553	636	725

No other information is available,

References--47, 86, 88.

White Rule

This diagram rule, a modified version of the Scribner, was devised by J. A. White of Augusta,

Mont., in 1898. For 16-foot logs, Graves (86) gives the following values:

Diameter	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Board feet	30	51	79	114	161	214	290	338	402	492	575	649	728	797

References--47, 86.

Wilcox Rule

This Pennsylvania rule is obscure in origin. It is labeled as a diagram rule by some, but Ross (164) says it is a mill scale rule for softwood timber. It has a saw kerf allowance of 3/8 inch and gives low and irregular values.

McKenzie's formula is,

$$BF = \left[(1 - 0.340) \frac{\pi D^2}{48} - 2 \right] L$$

References--47, 86, 134, 164.

Wilson Rule

This rule was devised in 1825 by Clark Wilson, a mathematician of Swanzey, N.H. The rule ignores taper and assumes the production of 7/8-inch boards. Chapman (47) mentions that the rule was used by E. A. Parks for 1-inch boards, which resulted in a lawsuit. Chapman claims that it is probably the first authentic formula log rule for board feet, but Ross (164) and others list it as a diagram rule and McKenzie's (134) comment about the original values being erratic would seem to support this view. At any rate, the values are said to be higher than those of the International 1/4-Inch Kerf Rule for logs up through 16 feet in length, but lower than International for longer logs.

McKenzie (134) gave the following formula for the Wilson Rule:

$$BF = \left[(1 - 0.193) \frac{\pi (D - 1)^2}{48} \right] L$$

References--4, 47, 48, 86, 134, 164.

Winder Rule --See the Vermont Rule.

Windsor Rule --No information. Possibly a corruption of Winder.

Wisconsin State Rule

Corwin (62) mentions this rule but gives no information except for the board foot scale of a few selected log sizes. Graves (86) mentions the Wisconsin State Rule and presents a table which, according to the revised Wisconsin statute of 1901 is to be used in scaling logs. The values in the table are identical to those of the Scribner Decimal C Rule.

References--62, 86.

Younglove Rule

This rule was devised in 1840 by Tyler Younglove, a carpenter, of Fitchburg, Mass. It is supposed to have been derived from diagrams and mill tallies and is said to give results similar to those of the Baxter, Massachusetts, or Margolin Rules. Cook (58) states that diameter measurements are to be made outside bark at a point one-third of the length of the log from the small end or inside bark at the middle. Colton (56) claimed that the "best" results were obtained by measuring diameter outside bark at the small end of the log.

For 12-foot logs with diameter measured inside bark at the middle of the log, Cook (58) gives the following values:

Middle diameter	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
BF	18	21	30	37	46	56	68	79	91	103	119	137	154	172	189	208

For 16-foot logs, the values of the rule can be approximated by the formula,

$$BF \text{ (for 16-foot logs)} = \left(\frac{5}{8} D_m^2 + \frac{9}{20} D_m - 7 \right)$$

References--56, 58, 86, 88.

SECTION II

SOME VOLUME FORMULAE, LUMBER MEASURES, AND FOREIGN LOG RULES

Adams Table

This is a volume table used on the North Island of New Zealand. It gives volumes based on the Brereton Rule but the diameter is measured inside bark at the middle of the log rather than being the average of the two end diameters.

Reference--76.

Albany Board

When Albany, N. Y., was an important lumber marketing center, a standard unit of measure was the Albany Board. This was a piece 1 inch thick, 10 inches wide, and 13 feet long. Much of the timber for the Albany market came from the Adirondack region and it is interesting to note that the length of the Albany Board is the same as that of the Adirondack Standard log.

Reference--16.

Bangor Board

Most of the timber cut in Maine was marketed in Bangor where the unit of measure for lumber was the Bangor Board. This was a board 1 inch thick, 12 inches wide, and 12 feet long.

Reference--16.

Breyman's Formula

This is a mensurational formula for the cubic volume of a log which requires measurement of diameter at four points; the small end of the log (D_o), one-third of the length ($D_{1/3}$), two-thirds of the length ($D_{2/3}$), and the large end (D_1). Then, if diameters are measured in inches,

$$CF = 0.000\ 681\ 769 \left(D_0^2 + 3D_{1/3}^2 + 3D_{2/3}^2 + D_1^2 \right) L$$

If cross sectional areas (B) in square feet are used in place of diameters, the formula is:

$$CF = (B_0 + 3B_{1/3} + 3B_{2/3} + B_1) \frac{L}{8}$$

References--47, 86.

British Customs String Measure --See Hoppus Measurement.

British Measure --See Hoppus Measurement.

Burtons Scale --See Hoppus Measurement.

Burts Quarter Girth --See Hoppus Measurement.

Calliper Measurement --See Hoppus Measurement.

Canterbury Tables

Most Canterbury sawmillers in New Zealand use the Goss or Canterbury Tables for calculating log volume. The values are based on the Square of Three-Fourths Rule.

Reference--76.

Christiana Standard

An obsolete lumber measure; 120 pieces of 1-1/4 inch by 9 inch by 11 feet. Equal to 103-1/8 cubic feet.

Reference--107.

Cord

A measure commonly used in North America, primarily for pulpwood and fuelwood. It is a pile 4 by 4 by 8 feet equal to 128 cubic feet of wood and space. There have been some variations in the size of the pile. In the New Brunswick Fuelwood Act of 1848 a pile 8 feet by 4 feet by 4 feet 4 inches was specified (162). The "French Cord" mentioned by Kellog (111) is another local form.

References--111, 162.

Cubage au réel

Bruce (36) reports that in France the "true" volume of a log in cubic meters is obtained by measuring either diameter (D_m) or circumference (C_m) at the mid-point of the log (usually outside bark unless the log has been peeled) and applying Huber's Formula.

$$\text{Cubic Meters Réel} = 0.7854D_m^2L = 0.0796C_m^2L$$

Three log rules may be used to estimate the volume of products that can be sawn from a log. All of them are metric variations on the quarter-girth formula. Cubage au quart sans déduction gives the volume of a squared timber cut from a log. The timber will have waney edges above the middle of the log where diameter is measured.

$$\text{Cubic meters au quart} = 0.6168D_m^2L = \left(\frac{C_m}{4}\right)^2 L$$

Cubage aux sixiéme déduit gives the volume of the squared timber with no wane but with "sappy" edges.

$$\text{Cubage au sixiéme} = 0.4284D_m^2L = \left(\frac{5C_m/6}{4}\right)^2 L$$

Finally, Cubage au cinquiéme déduit gives the volume of the squared timber which for most species will have neither wane nor sap.

$$\text{Cubage au cinquiéme} = 0.3984D_m^2L = \left(\frac{4C_m/5}{4}\right)^2 L$$

In all of the above rules, diameter and length are both measured in meters.

References--36, 107.

Cubage au cinquiéme --See Cubage au réel.

Cubage au quart --See Cubage au réel.

Cubage au sixiéme --See Cubage au réel.

Cubic Metre Francon --See Hoppus Measurement.

Cunit

In 1923 the Pulp and Paper Magazine of Canada ran a contest for the most suitable name for a unit of 100 cubic feet of solid wood. The winner was C. W. Halligan of the News Print Service Bureau who suggested the word "Cunit." The name Cunit has also been used on the West Coast for either 100 cubic feet of sawdust or 100 cubic feet of pulp chips.

References--l62, 184.

Customs Measurement --See Hoppus Measurement.

Daboll's Rule --See Hoppus Measurement.

Die-Square Measurement

This is a variation of the Hoppus formula, using a divisor of 181 in place of 144. Thus,

$$CF = \left(\frac{G}{4}\right)^2 \cdot \frac{L}{181}$$

where G is the girth in inches inside bark at the mid-point of the log. Die-square measurement is supposed to show the maximum cubic contents the log can yield when squared.

Reference--143.

Drammen Standard

An obsolete lumber measure; 120 pieces 1-1/4 inches by 9 inches by 13 feet. Equal to 121-7/8 cubic feet.

Reference--107.

Dublin Standard

A softwood lumber measure used in Eire; 120 pieces 3 inches by 9 inches by 12 feet. Equal to 270 cubic feet. One time referred to as the Irish Standard or the London Standard .

Reference--107.

English Deal --See the Quebec Board.

Ferguson Rule --See Hoppus Measurement.

Festmeter

A term used in Germany for a cubic meter of solid wood. A cubic meter of stacked wood is called a Raummeter or Ster .

Francon System --See Hoppus Measurement.

French Cord

The dimensions of the French Cord as used in the Province of Quebec are 8-1/2 feet by 4 feet by 4-1/4 feet. This is equal to 144.5 cubic feet.

Reference--l Il.

Gefle Standard

Jennings (107) reports that this is used as a measure of the cubic contents of imported telegraph poles in Finland, Norway, and Sweden. By an agreement made in 1924, a Gefle Standard was reckoned to consist of 100 cubic feet because such a quantity, as regards loading space, was considered to be equivalent to one Petrograd, or St. Petersburg standard of 165 cubic feet of sawn timber.

Reference--107.

Goss Table --See the Canterbury Table.

Gothenburg Standard

The most common use of this term is as a measure of pitwood. In this case it is a pile of roundwood 6 feet by 6 feet by 5 feet = 180 cubic feet. At one time it also meant 120 pieces of sawn wood with each piece 2 inches by 9 inches by 12 feet = 180 cubic feet. The term has also been used by the National Coal Board in the United Kingdom where it is equal to 120 solid cubic feet.

References--27, 107.

Haakon Dahl Measure

Duff (76) says that the Haakon Dahl Table, probably the best known volume table in New Zealand, shows the volume of logs in Haakon Dahl Superficial feet which are the same as Hoppus Superficial feet--i.e., Hoppus feet times 12. Jennings (107) implies that Haakon Dahl Measure is the same as the Francon System which is simply Hoppus measure expressed in metric units.

References--76, 107.

Holzmarkt Measure

Gives cubic volume by Huber's Formula expressed in metric units.

Reference--107.

Hoppus Measurement

This is a cubic volume formula used primarily in the United Kingdom, India, Australia, and New Zealand. The formula is:

$$\text{Hoppus feet} = \left(\frac{G}{4}\right)^2 \cdot \frac{L}{144}$$

The Girth (G) is ordinarily measured at the center of the log in 1/4-inch gradations. If the measurement is made outside bark, the deduction for bark may be according to the following schedule:

Girth	Reduction in girth to allow for bark
11-3/4 inches or less	1/2 inch
12 to 17-3/4 inches	1 inch

An additional 1/2 inch is deducted for each increase in girth of 6 inches or fraction thereof.

Jennings (107) reports that "tape over bark" measurement is handled by making a percentage reduction in the quarter-girth according to the "Liverpool Conventional Allowance, " or the percentage deduction may be applied to the calculated volume. The size of the allowance varies between England and Scotland and between species.

	England and Wales Pct.	Scotland Pct.
Conifers	7-1/2	10
Ash, sycamore, beech, birch	7-1/2	7-1/2
Poplar, elm, alder, lime	15	15
Oak, chestnut, others	10	10

Brereton (30) claims that in practice a string is passed around the middle of the log then doubled twice and measured, giving the quarter-girth. Because of the method of measurement, the procedure is sometimes called Hoppus String Measure or Liverpool String Measure . Other names are British Measure , Quarter Girth Formula , Square of Quarter Girth Formula , Burton's Scale , Daboll's Rule , and Ferguson Rule . The Francon System or Cubic Metre Francon is simply Hoppus Measurement expressed in metric units.

For conversion purposes a Hoppus foot is considered equivalent to 10 board feet. The Hoppus formula gives 78.5 percent of the actual cubic volume of a log. To get the "true" cubic volume a divisor of 113 is used in place of 144 in the quarter-girth formula,

$$CF = \left(\frac{G}{4}\right)^2 \frac{L}{113}$$

This is known as Burt's Quarter Girth Formula after E.A.P. Burt of London. It is also called Customs Measurement or British Customs String Measure .

If average diameter (D_a) is used instead of quarter-girth, the formula for "true" volume given by Burt is:

$$CF = \frac{D_a^2 L}{183}$$

This is sometimes called Calliper Measurement . It is said to have been used to some extent on the British Government dockyards but was little used in trade.

References--30, 47, 64, 67, 76, 86, 108, 132, 143, 162.

Hoppus Superficial Feet

Hoppus feet times 12. Also called Quarter Girth Superficial Feet and in New Zealand, Haakon Dahl Superficial Feet .

References--76, 107.

Hossfeldt's Formula

This cubic volume formula requires the measurement of two diameters; one at the small end of the log (D_o) and one at a point two-thirds of the distance to the large end ($D_{2/3}$). Then,

$$CF = 0.001363537 \left[D_0^2 + 3D_{2/3}^2 \right] L$$

If cross sectional areas (B) in square feet are used instead of diameters, the formula is,

$$CF = (B_0 + 3B_{2/3}) \frac{L}{4}$$

On butt logs, Hossfeldt's Formula is said to give more accurate results than either the Smalian or the Huber Formula but the measurement of diameter at the two-thirds point is somewhat of a disadvantage.

Belyea (13) claimed that this was a tree volume formula and that D_o is the diameter at stump height while the second measurement is made at 1/3 of the distance from the stump to the top of the tree. This seems questionable.

References--13, 47, 86.

Huber's Formula

Huber's is one of the three cubic volume formulae most commonly used in forest mensuration research. The other two are Smalian's and Newton's, Huber's formula requires measurement of diameter at the mid-point of the log ($D_{1/2}$),

$$CF = 0.00545415D_{1/2}^{2}L$$

Huber's formula looks much simpler if the mid-point cross sectional area ($B_{1/2}$) in square feet is used in place of diameter.

$$CF = B_{1/2}L$$

This formula, like Smalian's, is completely accurate if the log is in the form of a truncated paraboloid. But, as Chapman (47) points out, if the log is more convex and lies between a paraboloid and a cylinder, the volume given by Huber's formula will be too large. If the log falls between the frustrum of a paraboloid and a cone, as many logs do, the Huber volume will be too small. The error by Huber's formula is one-half that of Smalian's and opposite in sign.

In one test of this formula on spruce and fir logs up to 40 feet long it was found that the true volume averaged 1.049 times as large as that given by the formula

References--13, 36, 39, 47, 50, 86, 89.

Irish Standard --See Dublin Standard.

Kohlmann's Rule

This is merely a metric form of the cubic volume determined by Huber's formula It is also referred to as Kohlmann Measure.

Reference--107.

Liverpool Brokers Mahogany Sale Measure

Brereton (27) reports that this was a system used in Great Britain for the measurement of hewn mahogany and satinwood logs. Length is measured to the nearest 1/2 foot. Square or rectangle timbers 12 inches and over in width and thickness are measured to the inch, fractions being discarded. For smaller sizes, half inches are reckoned in thickness only. In irregularly shaped timbers the minimum side is taken as the measurement. After the dimensions are taken according to the foregoing System a reduction of 3 inches is made in both thickness and width. Tapering timbers are measured at one-third of the length from the small end.

Jennings (107) gives a different version of what he refers to as Liverpool Sales Measure. He reports that, as an allowance for saw kerf, measurements were made in "mahogany inches" which are 1/8 inch longer than the standard English inch To facilitate the measuring, special rules were manufactured showing "mahogany inches" on one side and English inches on the other.

References--27, 107.

Liverpool String Measure --See Hoppus Measurement.

Load

A term used in shipping during the 19th century. A load was the space required for 50 cubic feet of timber.

Reference--162.

London Standard --See Dublin Standard.

Matheson's Tables

The tables in "Matheson's Australian Sawmiller's Log and Timber Ready-Reckoner" show log volumes in quarter-girth cubic and quarter-girth superficial feet.

Reference--76.

Mercer Tables

These tables are used in India and Pakistan. They show the contents in cubic feet of logs and sawn timbers of given dimensions and also timber price calculations in rupees. The volume of round timber is calculated by the Quarter-girth method (divisor of 144). The tables were compiled by L. Mercer and published in 1951 by the Manager of Publications, Delhi, India.

Reference--107.

Moore Table

Duff (76) reports that this table, which shows

board foot volumes by the Doyle Rule, was used some years ago in the Ohakune district of New Zealand. It was also known as the Ohakune Table.

Reference--76.

Moulmein Timber Calculator

Jennings (107) describes this as a set of tables showing the cubical contents of logs and timbers, running feet per ton, number of pieces per ton, and also timber price calculations in rupees and sterling currency. The tables, which are used for measuring teak in Burma, were compiled by Tsong Ah Phott of Moulmein, Burma.

Reference--107.

Newton's Formula

This is the most accurate of the three common cubic volume formulae, but it requires measurement of diameter at the small end (D_0), midpoint ($D_{1/2}$), and large end (D_1) of the log.

$$CF = 0.000\ 909\ 025\ (D_0^2 + 4D_{1/2}^2 + D_1^2)\ L$$

When expressed in terms of cross sectional areas (B) in square feet rather than diameters, the formula is:

$$CF = (B_0 + 4B_{1/2} + B_1)\ \frac{L}{6}$$

Newton's formula may be used to get the volume of a log which has the form of a frustrum of a cone, paraboloid, or a neiloid.

References--13, 47, 50, 86, 89.

Ohakune Table --See the Moore Table.

Petrograd Standard

A lumber measure; 120 pieces of 1-1/2 inch by 11 inches by 12 feet or its equivalent. Equal to 165 cubic feet or 1980 board feet. This measure is used mainly in the United Kingdom Russia, and Scandinavia. It is also known as the St. Petersburg Standard .

References--27, 107.

Philippine Measurement

In the Philippine Islands logs are measured in cubic meters. For logs less than 8 meters long, the diameter is measured at the small end of the log. On longer logs diameter is measured at the center, or if this is impractical, the average of the two end diameters is used. Then,

$$\text{Cubic meters} = 0.000\ 078\ 54\ D^2 L$$

where: D = log diameter in centimeters
L = log length in meters.

References--47, 107.

Pressler's Formula

This is a cubic foot formula for tree volume, not a log rule. It is suitable for trees whose form approximates that of a cone or a paraboloid. Two measurements are required; the diameter (D) in inches at a point well above the influence of the butt swell, and the height (H) in feet at a point where the diameter is one-half of D. Then,

$$CF = 0.003\ 636\ 1\ D^2 H$$

When the cross sectional area in square feet (B) is used instead of the diameter, the formula is,

Reference--13.

Quarter-Girth Formula --See Hoppus Measurement.

Quarter-Girth Superficial Feet --See Hoppus Superficial Feet.

Quebec Board

This was a lumber unit 2-1/2 inches by 11 inches by 12 feet. In Defebaugh (69) it is called the Quebec or English Deal . It has also been called the Quebec Standard (162) though this term is more properly applied to 100 pieces of this size.

References--69, 162.

Quebec Deal --See Quebec Board.

Quebec Standard

This is a lumber measure defined to be 100 pieces, 2-1/2 inches by 11 inches by 12 feet = 229-1/6 cubic feet. The full name is Quebec Standard Hundred of Deals . There is also a log rule known as the Quebec Standard.

References--27, 107, 162.

Raummeter

A German term for one cubic meter of stacked wood. The term Ster may also be used. A cubic meter of solid wood is called a Festmeter .

Rudorf's Formula

This cubic volume formula requires the measurement of diameter in inches at the small end (D_0) and the large end (D_1) of the log. Then,

$$CF = \frac{\pi}{4}\left(\frac{L}{144}\right)\left[\left(\frac{D_0 + D_1}{2}\right)^2 + \frac{2}{3}\left(\frac{D_1 - D_0}{2}\right)^2\right]$$

$$= 0.000\ 454\ 512\ (5D_0^2 + 2D_0D_1 + 5D_1^2)\ L$$

Reference--86.

St. Petersburg Standard --See Petrograd Standard.

Schiffel's Formula

This is an adaptation of Newton's Formula for total tree volume. Diameter is measured in inches at stump height (D_s) and at midheight (D_m) of the tree. Tree height (H) is measured in feet.

$$CF = 0.005\ 454\ 149\ (0.16D_s^2 + 0.66D_m^2)\ L$$

References--13, 47, 50, 86, 89.

Shichi-ku Gake Sunken Ho Log Rule (0.79 Scale)

In Japan, the basic units of measure for logs are as follows:

Shaku = 0.303 meters = 0.994 feet =11.93 inches
Sun = a tenth part of a shaku = 1.193 inches
Koku = a unit of volume equal to 10 cubic shaku. In commerce, the koku is regarded as equivalent to 120 board feet.

Brereton (31) describes the Shichi-ku Gake Sunken Ho Log Rule as follows: "To determine log content in koku, multiply the square of the shortest diameter inside bark at the small end of the log by the length in shaku, the result by 0.79 and divide by 10. In scaling, the fractions of a sun in diameter and the fractions of a shaku in length are disregarded and when computing contents, the one-thousandth of a koku is ignored."

Jennings (107) says that the Shichi-ku Gake Sunken Ho Log Rule is based on Hoppus measure except for the use of small-end measurements in place of measurement at the mid-point of the log. However, this does not agree with the procedure given above by Brereton. Brereton's procedure in formula form is,

$$\text{Koku} = 0.79\ \frac{D^2L}{10}$$

If the procedure is as Jennings describes it, the formula would be

$$\text{Koku} = (0.785D)^2\ \frac{L}{10} = 0.62\ \frac{D^2L}{10}$$

References--31, 107, 206.

Simoney's Formula

This is a little-used cubic volume formula which requires the measurement of diameter at one-fourth ($D_{1/4}$), one-half ($D_{1/2}$), and three-fourths ($D_{3/4}$) of the length of the log.

$$CF = 0.001\ 818\ (2D_{1/4}^2 - D_{1/2}^2 + 2D_{3/4}^2)\ L$$

If instead of diameter in inches, we use the cross sectional area in square feet (B), the formula is:

$$CF = (2B_{1/4} - B_{1/2} + 2B_{3/4}) \frac{L}{3}$$

References--47, 86.

Smalian's Formula

Smalian's is a cubic volume formula requiring the measurement of diameter at the small (D_0) and large (D_1) ends of the log.

$$CF = 0.002\ 727\ 075\ (D_0^2 + D_1^2)\ L$$

Alternatively, cubic volume is calculated as the average cross sectional area in square feet at the ends of the log times log length.

This gives the correct volume if the log is in the form of a truncated paraboloid. If the log is more convex and lies between a paraboloid and a cylinder, Smalian gives too small a volume. For logs having slightly convex sides but not the full form of a paraboloid, as is true of most logs, Smalian gives too large a volume. In either case, the error in Smalian's Formula is twice as large as that in Huber's and opposite in sign. By using short lengths, 4 feet or less, the error for a 16-foot log can be kept down to 1 percent or less of the true volume.

A common mistake in the application of Smalian's Formula is to square the average-end diameter rather than use the squares of the two end diameters. Then,

$$CF = 0.005\ 454\ 149 \left(\frac{D_0 + D_1}{2}\right)^2 L$$

This gives slightly less volume than the correct method, but for 16-foot logs with less than 2 inches of taper, the error is under 1 percent. Actually, this tends to offset the positive error usually associated with the use of Smalian's Formula.

References--13, 39, 47, 50, 86, 89.

Square of Quarter-Girth Formula --See Hoppus Measurement.

Standard Mine

This term appears in Robinson's (162) quotation of an act passed in the Province of Quebec in 1843. It was applied to staves and for "Standard" or "Measurement" staves was defined to be one thousand pieces, five and a half feet long, five inches broad, and two inches thick For "West India" or "Puncheon" staves the Standard Mille was defined as one thousand two hundred pieces, three and a half feet long, four inches broad, and three-fourths of an inch thick. For "Barrel" staves the standard was one thousand two hundred pieces, two feet eight inches long, three and a half inches broad, and three-fourths of an inch thick.

Stere

In France and other European countries a cubic meter of stacked wood is called a stere. The German word for a stacked cubic meter is Raum - meter though they also use the term Ster .

String Measure --See Hoppus Measurement.

Toya Menka Kaisha, Ltd. Table

This table shows the Haakon Dahl or Hoppus Superficial Feet for logs of a given small-end diameter inside bark. The tabular values were calculated by adding different amounts to the small-end diameter in order to approximate midpoint diameters. The additions were as follows: 0.5 inch for logs up to 13 feet long, 1 inch for loge 16 to 22 feet, 1.5 inches for logs 25 to 30 feet long, and 2 inches for logs 39 feet and longer.

The tables are used in the Bay of Plenty area of New Zealand.

Reference--76.

Tun

Robinson (162) reports that the British, apparently more interested in the space occupied by timber than in its actual weight, used the unit of a "tun," which had originally been the space occupied by a large cask or "tun" of wine. Later legislation specified that the "ton," as it became known,

was equal to 40 cubic feet. The Oxford dictionary refers to the use of the word “tun” in 1677, stating that 1-3/4 “tun” equaled one “coard” The “ton” is still used in England and India where it refers to 50, not 40 cubic feet of wood

Jennings (107) equates a ton to 0.4 Standards (presumably Telegraph Pole or Gefle-Standard), or to 1.32 “loads,” or to 0.55 piled cubic fathoms of wood or timber,

References--107. 162.

A pulpwood measure equal to 168 cubic feet of wood and space.

York Lumber and Log Scale --No information.

Board Foot Volume of 16-Foot Logs According to Various Log Rules

Log rule	Small-end diameter of log (inches)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Ake	24	42	65	94	128	167	212	261	316	376	442	512	588	669	755	847
Ashe	16	35	56	82	116	158	202	256	316	380	445	516	585	--	--	--
Ballon	22	40	61	79	117	170	206	280	--	--	--	--	--	--	--	--
Bangor	23	41	69	100	137	182	238	300	369	444	526	609	697	792	892	--
Baughmans 1/8 inch	20	41	73	112	156	209	270	340	417	500	590	686	790	900	1,022	1,182
Baughmans 1/4 inch	17	41	70	105	145	193	244	310	382	457	540	633	722	822	934	1,054
Baxter	--	34	56	84	117	156	200	250	305	366	432	504	582	665	754	848
Boynton	--	32	60	90	124	170	216	266	322	384	450	522	--	--	--	--
Brereton[1]	38	67	105	151	205	268	339	419	507	603	708	821	942	1,072	1,210	1,357
British Columbia	15	32	55	84	119	160	207	261	320	386	457	535	619	708	804	906
Brubaker	NO INFORMATION															
Calcasieu	18	32	50	73	99	129	164	202	244	291	341	396	454	517	584	654
Carey[2]	24	44	--	104	--	191	--	303	--	--	--	--	715	--	--	--
Cedar Log Scale	21	38	59	85	116	152	192	--	--	--	--	--	--	--	--	--
Champlain	22	43	70	105	146	193	247	308	376	451	532	619	714	815	923	1,038
Chapin	--	--	64	84	112	144	186	233	294	374	465	563	666	777	896	1,027
Clements	19	38	63	94	132	176	226	283	346	415	490	572	660	754	855	961
Click	16	35	60	91	128	172	223	280	343	412	488	571	660	755	856	964
Columbia River Taper	--	32	56	86	123	166	216	272	334	403	--	560	--	742	--	980
Constantine	38	67	105	151	205	268	339	419	507	603	708	821	942	1,072	1,210	1,357
Cuban One-fifth[3]	19	34	53	76	103	135	171	211	255	303	356	413	474	539	608	682
Cumberland River	17	30	47	68	93	121	154	190	229	273	320	372	427	485	548	614
Delaware Middle Diameter[3]	24	43	67	96	131	171	216	267	323	384	451	523	600	683	771	864
Derby	28	49	75	110	148	195	248	307	368	438	512	593	680	773	872	977
Doyle	4	16	36	64	100	144	196	256	324	400	484	576	676	784	900	1,024
Drew	NO INFORMATION															
Dusenberry	--	--	42	68	100	136	170	229	285	346	414	487	567	652	744	841
Favorite	--	--	--	64	98	142	197	248	324	392	476	562	632	725	845	920

Finch and Apgar	--	--	--	74	112	157	203	258	318	400	474	552	624	733	840	928
Forty-five	21	38	61	90	125	168	218	275	341	415	498	590	691	803	925	1,058
French's	----------NO INFORMATION----------															
Hanna	--	32	51	80	117	160	213	272	336	416	501	576	656	741	832	933
Herring[4]	19	34	53	77	107	142	183	230	284	344	411	485	567	655	752	857
Hoyt	----------NO INFORMATION----------															
Hyslop	----------NO INFORMATION----------															
International 1/8 inch	20	45	70	105	150	200	255	320	390	470	555	645	745	850	965	1,085
International 1/4 inch	20	40	65	95	135	180	230	290	355	425	500	585	675	770	875	980
International 5/16 inch	20	35	60	95	130	170	220	275	340	405	480	560	645	735	835	935
Knouf's	14	32	56	86	123	166	216	272	334	403	478	560	648	742	843	950
Licking River	----------NO INFORMATION----------															
Maine	20	44	68	105	142	179	232	302	363	439	507	614	706	795	900	1,026
Margolin[2,5]	17	36	57	85	117	159	207	257	--	--	--	--	--	--	--	--
Massachusetts[2,5]	13	35	55	83	113	155	197	247	--	--	--	--	--	--	--	--
McKenzie[6]	25	48	78	116	161	214	273	342	417	499	590	688	793	907	1,025	1,155
Mississippi Pine	21	34	56	86	124	166	210	266	330	400	484	--	--	--	--	--
New Brunswick	20	40	64	96	130	170	229	300	362	432	507	614	706	--	--	--
Newfoundland	24	43	67	96	131	171	216	267	323	384	451	523	600	683	771	864
Northeastern	----------NO INFORMATION----------															
Northwestern	--	33	61	77	117	170	206	248	324	392	450	536	632	725	845	920
Ontario	17	34	57	86	121	162	209	261	320	384	454	530	612	700	793	893
Orange River	19	34	53	77	105	137	173	213	258	307	361	418	480	546	617	691
Parson's	21	41	64	100	140	179	231	300	366	433	506	600	705	--	--	--
Partridge	26	46	68	102	140	180	236	288	350	416	486	564	650	738	834	998
Preston	--	33	52	77	113	168	219	284	337	413	497	583	677	783	888	1,008
Quebec	16	32	59	80	120	160	213	280	347	420	507	580	673	760	867	947
Ropp	--	--	--	69	109	157	211	272	339	413	493	579	672	771	877	989
Roy	20	39	65	97	135	180	231	289	353	423	500	583	673	769	871	980
Saco River	26	49	75	108	147	192	246	302	366	436	513	590	674	771	--	--
Sammi	20	39	65	97	135	180	231	289	353	423	500	583	673	769	871	980
Scribner[7]	18	32	54	79	114	159	213	280	334	404	500	582	657	736	800	923

Board Foot Volume of 16-Foot Logs According to Various Log Rules—continued

Log rule	Small-end diameter of log (inches)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Seven-tenths	24	42	65	94	128	167	212	261	316	376	442	512	588	669	755	847
Spaulding	--	--	50	77	114	161	216	276	341	412	488	569	656	748	845	950
Square of three-fourths	27	48	75	108	147	192	243	300	363	432	507	588	675	768	867	972
Square of two-thirds[3]	21	38	59	85	116	152	192	237	287	341	401	465	533	607	685	768
Stillwell's	--	--	65	96	133	176	225	261	320	385	456	533	588	675	768	--
Tatarian	NO INFORMATION															
Thomas's Accurate	20	40	66	99	138	184	236	295	360	432	510	595	686	784	889	1,000
Tiemann[3]	15	32	55	84	119	160	207	260	319	384	455	532	615	704	799	900
Universal	14	32	57	89	127	172	223	282	347	419	497	582	674	773	878	990
Vermont	24	43	67	96	131	171	217	268	324	385	452	524	602	685	773	867
Warner	--	30	40	62	98	128	162	203	258	316	372	431	490	560	630	--
Wheeler[8]	22	40	65	95	132	174	223	277	337	404	--	553	--	725	--	--
White	--	30	51	79	114	161	214	290	338	402	492	575	649	728	797	--
Wilcox	--	--	--	66	101	144	180	240	313	373	446	513	592	673	754	853
Wilson	23	46	67	101	144	184	244	306	374	448	529	616	713	814	922	--
Youngglove[2,3]	24	40	61	91	121	159	205	252	--	--	--	--	--	--	--	--

Board Foot Volume of 16-Foot Logs According to Various Log Rules--continued

Log rule	Small-end diameter of log (inches)											
	38	40	42	44	46	48	50	52	54	56	58	60

Bangor	--	--	--	--	--	--	--	--	--	--	--	--
Baughmans 1/8 inch	1,286	1,425	1,582	1,745	1,900	2,089	2,270	2,449	2,636	2,841	3,073	3,265
Baughmans 1/4 inch	1,142	1,294	1,430	1,577	1,732	1,884	2,041	2,206	2,396	2,590	2,764	2,898
Baxter	--	--	--	--	--	--	--	--	--	--	--	--
Boynton	--	--	--	--	--	--	--	--	--	--	--	--
Brereton[1]	1,512	1,676	1,847	2,027	2,216	2,413	2,618	2,832	3,054	3,284	3,523	3,770
British Columbia	1,015	1,129	1,249	1,376	1,508	1,647	1,791	1,942	2,099	2,262	2,431	2,606
Brubaker	NO INFORMATION											
Calcasieu	729	808	891	978	1,069	1,164	--	--	--	--	--	--
Carey[2]	--	--	--	--	--	--	--	--	--	--	--	--
Cedar Log Scale	--	--	--	--	--	--	--	--	--	--	--	--
Champlain	1,159	1,287	1,422	1,563	1,711	1,866	--	--	--	--	--	--
Chapin	1,161	1,296	1,437	1,577	1,721	1,865	2,016	2,160	2,313	2,467	2,627	2,791
Clements	1,074	1,194	1,319	1,451	1,590	1,734	--	--	--	--	--	--
Click	1,079	1,200	1,327	1,460	1,600	1,747	--	--	--	--	--	--
Columbia River Taper	--	1,184	--	1,443	--	1,728	--	2,038	--	2,374	--	2,736
Constantine	1,512	1,676	1,847	2,027	2,216	2,413	2,618	2,832	3,054	3,284	3,523	3,770
Cuban One-fifth[3]	760	842	929	1,019	1,114	1,213	--	--	--	--	--	--
Cumberland River	685	759	836	918	1,003	1,092	--	--	--	--	--	--
Delaware Middle Diameter[3]	963	1,067	1,176	1,291	1,411	1,536	--	--	--	--	--	--
Derby	--	--	--	--	--	--	--	--	--	--	--	--
Doyle	1,156	1,296	1,444	1,600	1,764	1,936	--	--	--	--	--	--
Drew	NO INFORMATION											
Dusenberry	945	1,054	1,170	--	--	--	--	--	--	--	--	--
Favorite	1,037	1,160	1,266	1,402	1,546	1,696	--	--	--	--	--	--
Finch and Apgar	1,054	1,181	1,280	1,410	1,584	--	--	--	--	--	--	--
Forty-five	1,201	1,356	1,524	1,704	1,896	2,101	--	--	--	--	--	--
French's	NO INFORMATION											
Hanna	1,066	1,200	1,333	1,477	1,616	1,765	1,930	--	--	--	--	--
Herring[4]	963	1,067	1,176	--	--	--	--	--	--	--	--	--
Hoyt	NO INFORMATION											
Hyslop	NO INFORMATION											
International 1/8 inch	1,210	1,345	1,490	1,635	1,790	1,955	2,125	2,300	2,485	2,675	2,870	3,075

Board Foot Volume of 16-Foot Logs According to Various Log Rules--continued

Log rule	Small-end diameter of log (inches)											
	38	40	42	44	46	48	50	52	54	56	58	60
International 1/4 inch	1,095	1,220	1,345	1,480	1,620	1,770	1,920	2,080	2,245	2,420	2,600	2,785
International 5/16 inch	1,045	1,160	1,285	1,415	1,545	1,685	1,835	1,985	2,145	2,310	2,480	2,655
Knouf's	1,064	1,184	1,310	1,443	1,582	1,728	--	--	--	--	--	--
Licking River	NO INFORMATION											
Maine	1,135	1,261	1,401	1,523	1,701	1,848	--	--	--	--	--	--
Margolin[2,5]	--	--	--	--	--	--	--	--	--	--	--	--
Massachusetts[2,5]	--	--	--	--	--	--	--	--	--	--	--	--
McKenzie[6]	1,290	1,430	1,585	1,740	1,905	2,080	--	--	--	--	--	--
Mississippi Pine	--	--	--	--	--	--	--	--	--	--	--	--
New Brunswick	--	--	--	--	--	--	--	--	--	--	--	--
Newfoundland	963	1,067	1,176	1,291	1,411	1,536	--	--	--	--	--	--
Northeastern	NO INFORMATION											
Northwestern	1,037	1,160	1,266	1,402	1,546	1,696	--	--	--	--	--	--
Ontario	998	1,109	--	--	--	--	--	--	--	--	--	--
Orange River	770	853	941	1,033	1,129	1,229	--	--	--	--	--	--
Parson's	--	--	--	--	--	--	--	--	--	--	--	--
Partridge	--	--	--	--	--	--	--	--	--	--	--	--
Preston	1,113	1,236	1,385	1,527	--	--	--	--	--	--	--	--
Quebec	1,040	1,173	1,267	--	--	--	--	--	--	--	--	--
Ropp	1,107	1,232	1,363	1,501	1,645	1,795	1,952	2,115	2,285	2,461	2,643	2,832
Roy	1,095	1,217	1,345	1,479	--	--	--	--	--	--	--	--
Saco River	--	--	--	--	--	--	--	--	--	--	--	--
Sammi	1,095	1,217	1,345	1,479	1,620	1,767	--	--	--	--	--	--
Scribner[7]	1,068	1,204	1,343	1,480	1,587	1,728	--	--	--	--	--	--
Seven-tenths	943	1,045	1,152	1,265	1,382	1,505	--	--	--	--	--	--
Spaulding	1,064	1,185	1,312	1,448	1,581	1,724	1,872	2,025	2,184	2,350	2,524	2,704
Square of three-fourths	1,083	1,200	1,323	1,452	1,587	1,728	--	--	--	--	--	--
Square of two-thirds[3]	856	948	1,045	1,147	1,254	1,365	--	--	--	--	--	--
Stillwell's	--	--	--	--	--	--	--	--	--	--	--	--
Tatarian	NO INFORMATION											

Thomas's Accurate	1,117	1,241	1,372	1,509	1,652	1,803	--	--	--	--	--	--
Tiemann[3]	1,007	1,120	1,239	1,364	1,495	1,632	--	--	--	--	--	--
Universal	1,108	1,234	1,366	1,505	1,650	1,802	--	--	--	--	--	--
Vermont	966	1,070	1,180	1,295	1,416	1,541	--	--	--	--	--	--
Warner	--	--	--	--	--	--	--	--	--	--	--	--
Wheeler[8]	--	--	--	--	--	--	--	--	--	--	--	--
White	--	--	--	--	--	--	--	--	--	--	--	--
Wilcox	973	1,120	--	--	--	--	--	--	--	--	--	--
Wilson	--	--	--	--	--	--	--	--	--	--	--	--
Younglove[2,3]	--	--	--	--	--	--	--	--	--	--	--	--

[1] In the Brereton Rule the average of the end diameters is used.

[2] The values shown here were obtained by proportional expansion from a table for 12-ft. logs.

[3] Diameters are measured inside bark at the midpoint of the log.

[4] Herring Rule values for logs less than 12 in. in diameter are those of the Davent extension. They do not agree with the values given by Graves and Ziegler (88).

[5] Diameter is measured outside bark at the midpoint of the log.

[6] These values are from McKenzie's (134) table; they may differ slightly from values given by the formula and values over 1,000 are rounded down to the next lower multiple of 5.

[7] Scribner values for logs less than 12 in. in diameter are those of the Santa Clara extension. Values for logs over 44 in. in diameter are from the Ziegler extension.

[8] Wheeler Rule values are from a table by H. E. Young, University of Maine.

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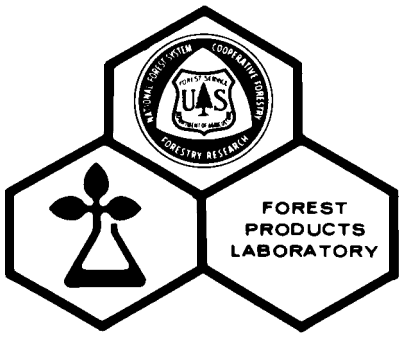
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