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Firmwood Scaling Procedures 5

Scaling plays a critical role in fulfilling the financial responsibility of the Crown in its forest resources in a systematic and equitable manner. Scaling must also serve the needs of the constituents, including timber manufacturing industry and the public in assessing the provincial harvest.

Many parties are dependent upon an accurate and meaningful scale. To give this assurance and ensure scale results mean the same thing to all users, all scaling must conform to standard measurement methods and conventions.

Scale results in British Columbia are reported in terms of the net firmwood volume in cubic metres. A cubic metre (m^3) of timber can be viewed as a cubic metre of solid wood, free of any rot, hole, char or missing wood; hence the expression "net firmwood volume."

Sections 5.1 to 5.4 of this chapter explain:

- the BC Metric Scale and its derivation,
- the various measurements which are taken to calculate scale volumes, and
- how the scale stick is used to take measurements and calculate volumes.

Sections 5.5 to 5.9 explain:

- how firmwood deductions are made to determine the net firmwood content of each log.

The other component of scaling which is assessing the quality of timber or grading is discussed under Chapter 6. The scaling of special forest products is discussed under Chapter 8.

5.1 Measurements

5.1.1 Units of Measure

The legal units of measurement for scaling in British Columbia have been based upon the *International System of Units (SI)* since the late 1970s. The *SI* system is commonly referred to as the Metric System.

The units of measure used fall into two general categories:

1. Base units (i.e., those measurements actually taken such as length, radius, diameter, width, thickness, and mass or weight):

    - the metre and the decimetre are used for lengths,
    - the centimetre is used for radii, widths and thicknesses,
    - the radius class unit or "rad" (equal to 2 cm) is used for diameters, widths and thicknesses,
    - the kilogram and tonne are used for mass (weight scaling - see Chapter 9), and
    - whole number units are used for piece counts (e.g., 527 Christmas trees - see Chapter 8).

2. Derived units (i.e., those units calculated from the base units such as cubic metres):

    - the cubic metre, cubic decimetre and the stacked cubic metre are used for volumes,
    - the square metre and square decimetre are used for areas, and
    - the weight scale ratio is expressed in cubic metres per tonne (see Chapter 9).

5.1.2 The British Columbia Metric Scale

In British Columbia the official scale rule for purposes of scaling under the *Forest Act* is the *British Columbia Metric Scale*. This scale rule uses Smalian's formula to calculate the volumes of individual logs. The net firmwood volumes, expressed in cubic metres, are recorded.

5.1.3 Errors in Measurement

No measurement is exact. Accuracy depends upon the calibration and reliability of the equipment used, and upon human limitations in interpolating graduation increments. The graduations used in scaling are a relatively broad division size, such as the "radius class unit" or rad, which allows any measurement falling within a range of 2 cm to qualify as a single unit. Similarly, length measurements allow any measurement falling within a range of plus or minus 0.1 m to be rounded to a single unit. These divisions are established to allow rapid measurement and to reduce errors.

Errors fall into four general classes:

Mistakes	Mistakes are caused by a misunderstanding of a problem, by carelessness, or by poor judgement. Large mistakes or blunders are detected by systematic checking of all work and may be corrected by redoing part or all of a job. Small mistakes can be very difficult to detect, because they merge with other types of errors.
Natural Errors	These errors are caused by variations in weather. For example, the length of a steel tape varies with changes in temperature, or severe weather conditions can impair visibility.
Instrumental Errors	These result from any imperfection in the construction or adjustment of the measuring instruments. For example, the painted graduations on a scale stick may not be perfectly spaced, or the tine may be bent.
Personal Errors	These arise from limitations of the human senses. For example, there may be an error in the measured value when projecting a "line of sight" while calipering the diameter of a log.

Each class of error falls into two types:

Systematic Errors	These errors are recurring errors and are relatively constant, depending on conditions. They will introduce biased results (i.e., consistently high or low of the true value). For example, if a steel tape is 0.02 m too long, it will introduce a 0.02 m error every time it is used, and
Compensating Errors	These are the errors which remain after mistakes and systematic errors have been eliminated, they are caused by factors beyond the control of the observer and fall into the law of probability. These errors tend to partially cancel themselves in a series of measurements. For example, a scaler interpolating to rads in a series of calipered butt log measurements will estimate too high on some logs and too low on others, thus cancelling the error. Individual personal characteristics may nullify such compensation, however, since some people are inclined to interpolate high while others interpolate low.

Standard measuring methods and conventions, good training, licencing, reliable tools, the check scaling function, and the second scale all serve to reduce mistakes and systematic errors to an acceptable level, which is established in the *Scaling Regulation*.

5.2 Smalian's Formula

Smalian's formula states that the volume of a log can be closely estimated by multiplying the average of the areas of the two log ends by the log's length. The units used for the areas and the length must be the same, (e.g., square metres and metres in British Columbia), in order to arrive at the volume in cubic metres.

Smalian's formula is commonly expressed as follows:

$$V = \left(\frac{A_1 + A_2}{2}\right) L$$

where:

V	=	The volume of the log in cubic metres (m^3),
A_1	=	The area of the small end in square metres (m^2),
A_2	=	The area of the large end in square metres (m^2), and
L	=	The length of the log in metres (m).

5.2.1 Log Forms and Smalian's Formula

A tree tapers from the base to the tip, but the rate of taper is not uniform throughout all parts of the stem. Logs approach the form of truncated cones , neiloids, paraboloids, and occasionally, cylinders. These truncated sections, illustrated in Figure 5.1, are referred to as frustums of the geometric figure they resemble. The scaler can identify the log shapes by noting the position of the average of the diameter at both ends. If the average diameter occurs exactly equidistant from both ends, the log form is conoid. If the average diameter is found in the butt half, the form is neiloid, and if in the upper half, the form is parabaloid.

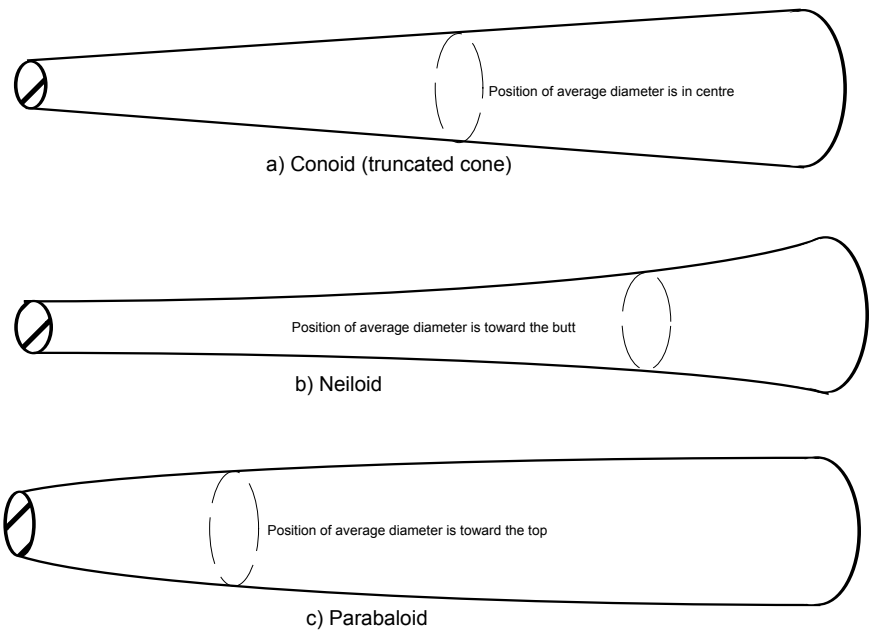


Figure 5.1 Depictions of three typical log forms.

A number of rules have been developed in North America to obtain log volumes, and they generally consider the log to be a cylinder having a scaling diameter equal to the diameter inside bark at the centre of the log. Log volume is equal to the area at the log's centre multiplied by the length of the log. The rules vary in the methods used in arriving at the average area, and Smalian's formula arrives at average area by averaging the areas of the top and butt ends of a log. The Smalian formula is the official log scaling rule for the Province of British Columbia (and the US Forest Service) because it is practical and works very well where logs are bucked prior to scaling.

The effect of bucking is to reduce taper, and experience has shown that where the difference between the top and butt diameters exceeds 30 percent (where the butt diameter exceeds 150 percent of the top diameter), the use of Smalian's formula is not an accurate reflection of log volume. This is demonstrated in Figure 5.2, where a one cubic metre cylinder is gradually reduced in diameter at one end, becoming a cone, which has a volume of 0.333 m³. Calculated with Smalian's formula, the volume is overstated as 0.500 m³, and if calculated by averaging the diameters, the volume is understated as 0.250 m³.

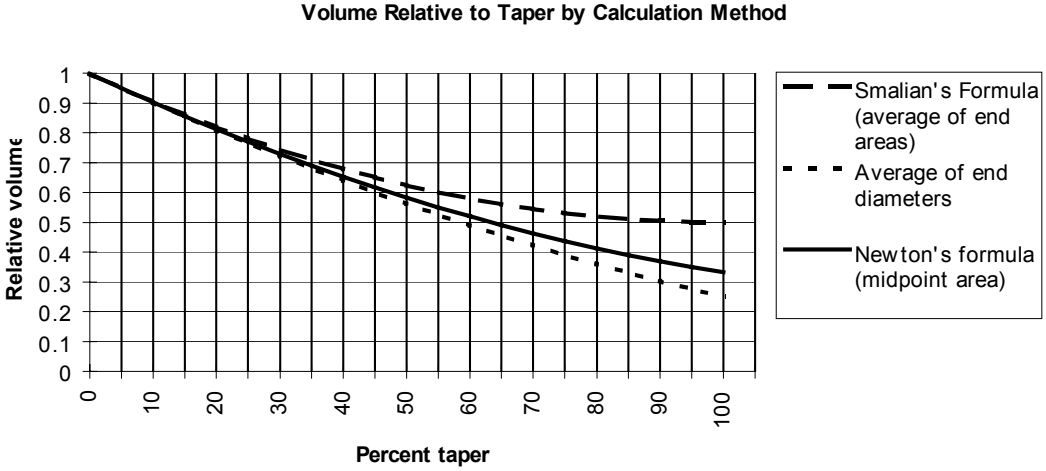


Figure 5.2 Graph of the effects of taper on log volume.

Normally, the difference between the top and butt diameters of typical logs is less than 30 percent, and Smalian's formula is an accurate reflection of the true log volume. However, the greater the difference in diameter between the log ends, the less reliable will be the volumes obtained using Smalian's formula. Where excessive taper exists, the Forest Service may order that logs be bucked prior to scaling to improve accuracy.

It is generally accepted that Newton's formula is the most accurate method of measuring the volume of the log shapes depicted in Figure 5.1. Newton's formula is not used commercially however, because of the additional (mid point) measurements required. The formula is used to determine the accuracy of commercial rules, and may be expressed as:

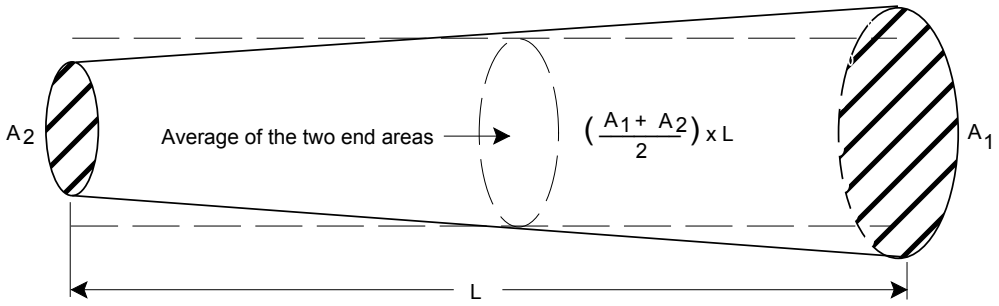
$$V = [(A_1 + 4A_2 + A_3)/6](L)$$

where: A_1 = The area of the small end of the log,

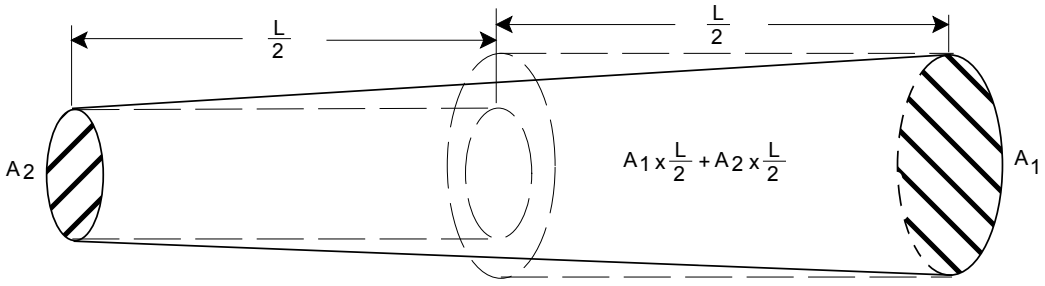
A_2 = The area at the centre of the log, and

A_3 = The area of the large end of the log.

Figure 5.3 illustrates how Smalian's formula may be visualized as either one cylinder projecting the average of the basal areas of the large and small ends for the full log length, or as two cylinders; one projecting the area of the small end for exactly one half the log length and the other projecting the area of the large end for exactly one half the log length. Either view will produce the same results; a volume equivalent of the log represented.



Here, the dashed outline represents a cylinder with a cross-sectional area equal to the average of the top and butt areas.



In this example, the solid represented by the dashed outline shows two cylinders - one with an end area equal to the top end area, the other equal to the butt end area; both running exactly half the log length. This is how the scale stick calculates Smalian volumes (using half-volume tables).

Figure 5.3 Two ways to visualize Smalian's formula.

5.2.2 Smalian's Formula in Detail

Smalian's formula uses the formula for the area of a circle to find A_1 (area of the top end in m^2) and A_2 (area of the butt end in m^2):

$$A_1 = \frac{\pi T^2}{10\,000}, \text{ and}$$

$$A_2 = \frac{\pi B^2}{10\,000}$$

Fully expressed, Smalian's formula becomes:

$$V = \left(\frac{\frac{\pi T^2}{10\,000} + \frac{\pi B^2}{10\,000}}{2} \right) L$$

where:

V = volume of the log in cubic metres,

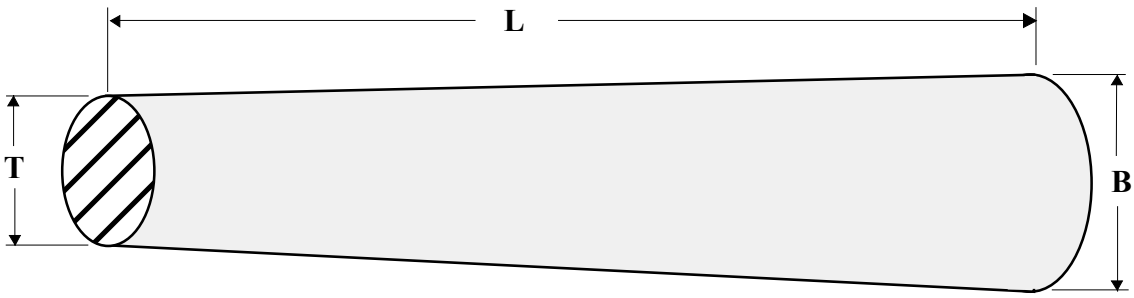
π = 3.141 592 (to 7 significant figures or 6 decimal places),

T = radius of the small end in centimetres (or the diameter in rads as illustrated in Figure 5.4),

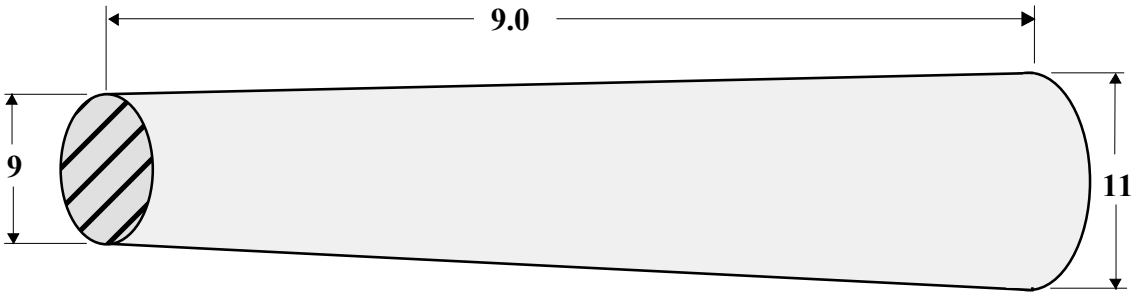
B = radius of the large end in centimetres (or the diameter in rads as illustrated in Figure 5.4), and

L = length of the log in metres as in Figure 5.4.

(Division of the top and butt areas by 10 000 converts square centimetres to square metres. Division of the sum of the top and butt areas by 2 determines the average end area.)



The location of the variables T, B, and L.



Substitution of the variables with measured values.

Figure 5.4 Measurements for finding the values "T", "B", and "L" in Smalian's formula.

If a log is measured across its diameter in rads, using a scale stick, the recorded measurement will also represent the radius of the log in centimetres.

5.2.3 Smalian's Formula - Example Calculation

If the log illustrated in Figure 5.4 is given a top radius "*T* " of 9 cm (9 rads in diameter), a butt radius *"B"* of 11 cm (11 rads in diameter), and a length *"L"* of 9 m.

Fully expressed, Smalian's formula states:

$$V = \left(\frac{\frac{\pi T^2}{10\,000} + \frac{\pi B^2}{10\,000}}{2} \right) L$$

Substitute the variables "T", "B" and "L" with the logs dimensions:

$$V = \left(\frac{\frac{\pi 9^2}{10\,000} + \frac{\pi 11^2}{10\,000}}{2} \right) 9.0$$

Calculate the area of the two ends in square centimetres:

$$V = \left(\frac{\frac{254.468\,952}{10\,000} + \frac{380.132\,632}{10\,000}}{2} \right) 9.0$$

Divide each area by 10 000 to change square centimetres to square metres:

$$V = \left(\frac{0.025\,446\,895\,2 + 0.038\,013\,263\,2}{2} \right) 9.0$$

Sum the areas of the two ends and divide by two to average the areas:

$$V = 0.031\,730\,079\,2 \times 9.0$$

Multiply the average end area by the length in metres to yield the volume:

$$V = 0.285\,570\,712\,8 \text{ m}^3,$$

Round the volume of the log to 3 decimal places:

$$\text{Volume} = 0.286 \text{ m}^3$$

5.2.4 Smalian's Formula - Simplified

The fully expressed Smalian's formula described in Section 5.2.3 contains three constants; "π", 10 000, and "2". The formula may be simplified by reducing these constants to one constant, expressed as "*C* ". Smalian's formula is:

$$V = \left(\frac{\frac{\pi T^2}{10\,000} + \frac{\pi B^2}{10\,000}}{2} \right) L$$

By rearranging the terms to consolidate the constants, the formula becomes:

$$V = \left(T^2 + B^2\right) L \left(\frac{\pi}{20\,000}\right)$$

The value of "*C*" is therefore:

$$C = \frac{\pi}{20\,000}$$

$$C = 0.000\ 157\ 079\ 6$$

Using the constant "*C*" provides for Smalian's simplified formula:

$$V = \left(T^2 + B^2\right) \text{ x } L \text{ x } C$$

where: V = the volume of the log in cubic metres,

T = the top radius in centimetres (or the diameter in rads),

B = the butt radius in centimetres (or the diameter in rads),

L = the length in metres, and

C = 0.000 157 079 6 (the constant).

5.2.5 Smalian's Simplified Formula - Example Calculation

Using the simplified Smalian's formula developed in Section 5.2.4 and substituting the log dimensions from Figure 5.4 into the formula, the volume of the log may be calculated in fewer steps than with the long formula demonstrated previously in Section 5.2.3.

$$V = \left(T^2 + B^2\right) \times L \times C$$

$$V = \left(09^2 + 11^2\right) \times 9.0 \times 0.000\,157\,079\,6$$

$$V = \left(81 + 121\right) \times 9.0 \times 0.000\,157\,079\,6$$

$$V = 202 \times 9.0 \times 0.000\,157\,079\,6$$

$$V = 1\,818 \times 0.000\,157\,079\,6$$

$$V = 0.285\,570\,71$$

Round the volume of the log to 3 decimal places:

Volume = *0.286 m³*

5.2.6 The Application of Smalian's Formula

Most scalers derive log volumes from the BC Metric Scale Stick, from the FS 546 *Table of the Half Volume of Cylinders in Cubic Decimetres* or from computer software. All of these methods, while still based upon Smalian's formula, save unnecessary arithmetic, but scalers must know and be able to use the formula in situations where these tools are not available.

Scalers must be able to demonstrate their knowledge and comprehension of the principles underlying scaling by stating the full version of Smalian's formula and by calculating volumes with either the full or simplified version on the written portion of the Licenced Scaler's Exam.

All persons designing software for scaling purposes must employ Smalian's formula and have the software approved by the Ministry of Forests. Additional information on volume calculation and compilation standards is found in Chapter 7, Appendix 7B. Information on approval procedures can be obtained from a regional office of the Ministry of Forests.

5.3 Scaling Tools

All scaling computation software and measuring devices must comply with Ministry of Forests and/or CSA standards for accuracy (CSA CAN3-0302.1-M86-12.x). It is the responsibility of scalers to ensure the accuracy of their equipment.

5.3.1 Tally sheets

Tally sheets are used to record scale data. The data is then key-punched into computers which use Smalian's formula to calculate volumes, or hand-compiled from the scale stick or *FS 546 Table of the Half Volume of Cylinders in Cubic Decimetres.* The summarized information is then submitted on Ministry approved forms. Chapter 7 details the selection and use of the approved forms to be used in different types of scales.

5.3.2 Hand-held Computers

Hand-held computers and data capture units, using ministry approved scaling software are now preferred over the tally sheet and summary sheet system. After entering the data, the machine generates a detailed log listing and a summary report including volumes by species and grades automatically. These computer generated forms may be submitted in lieu of the above tally sheet system, thereby substantially reducing the time required to manually determine volumes and complete the forms.

5.3.3 Volume Tables

The *FS 546 Table of the Half Volume of Cylinders in Cubic Decimetres* contains half volumes of cylinders with lengths from 2 m to 29.9 m and radii from 1 cm to 100 cm (diameters from 1 rad to 100 rad). It is often used to assist in hand compiling log volumes.

5.3.4 Measuring Tapes

The metric steel loggers' tape, calibrated to 0.05 m (0.5 dm) increments, is used to measure log lengths.

5.3.5 The BC Metric Scale Stick

The BC Metric Scale stick is the most important scaling tool. It is used to measure log diameters and lengths; and to calculate volumes and defect deductions. The stick is manufactured in three lengths; 1 m, 1.5 m, and 2 m. The handles of the 1 m and the 1.5 m sticks are in addition to the stick length, whereas the handle is included in the length of the 2 m stick. Scale sticks are also manufactured in left or right handed styles, in a version which is somewhat slimmer than standard sticks, and with a "spud" attached, similar to the American scribner stick. The spud is used to break out wedges of wood from log ends and knots so they may be examined for rot.

Equipped only with a metric scale stick, an approved tally sheet and a pencil, the licenced scaler can perform the official scale. The stick will allow the scaler to measure log diameters and lengths, slab widths and thicknesses, defect dimensions, knot sizes and twist and to calculate the gross log volume, the defect volume and the net volume and/or net dimensions and grade. It is the principle piece of scaling equipment.

5.3.5.1 Application of the Scale Stick to Measure Diameters

Smalian's Formula requires a log's top and butt radii and length to calculate a volume. The scale stick is graduated in 2 cm increments called "radius class units" or *rads*. This design allows the scaler to measure and express a log's diameters in rads and as well as expressing the radii in centimetres. Therefore, in measuring a round object:

> A diameter in rads is equal to the radius in centimetres.

5.3.5.2 Application of the Scale Stick to Measure Widths and Thicknesses

The scale stick is designed primarily for measuring diameters and calculating the volumes of round logs by giving the radius in centimetres. Widths and thickness of three and four sided slabs are also measured in rads but the mathematical correlation is different because radii are not involved. For example, a slab measuring 10 rads by 10 rads represents a width and thickness of 20 cm by 20 cm, not a radius of 10 cm. To avoid conversion of rads to centimetres for finding volumes, factors are applied, and the slab measurement section (Section 5.4.3) describes the application and use of these factors.

5.3.5.3 The Application of the Scale Stick to Measure Lengths

The scale stick may also be used for measuring length. Starting from the tine of the stick, lengths are graduated in 0.1 m (1 dm) increments. Odd decimetres are marked with a red line at the exact increment and even decimetres are indicated by red numbers which are offset from the exact increment.

5.3.5.4 The Application of the Scale Stick for Unit Volumes

Reference to unit volumes and average unit volumes are made throughout this manual. A unit volume is the volume of a 1 m length of one end of a log in cubic decimetres per metre, and an average unit volume is the average of the unit volumes of both ends of a log. They are directly proportional to end areas of a log; the end area in square decimetres is always 1/10 of the unit volume. Unit volumes are provided on the scale stick to calculate gross volumes, defect volumes, and net volumes.

5.3.5.5 The Application of the Scale Stick for Half Volumes

References to half volumes are made throughout this chapter. They are simply the expression of the volume, in cubic decimetres, of a log or slab of any given length for one-half of its length. Half volumes are provided on the scale stick to allow the calculation of a volume by simply adding the half volumes from each end of a log, rather than calculating a full volume for each end and dividing by two.

Figures 5.5 through 5.12 on the following pages illustrate the parts and use of the scale stick.

The approved BC Metric Scale stick specifications are documented in Appendix 5A.

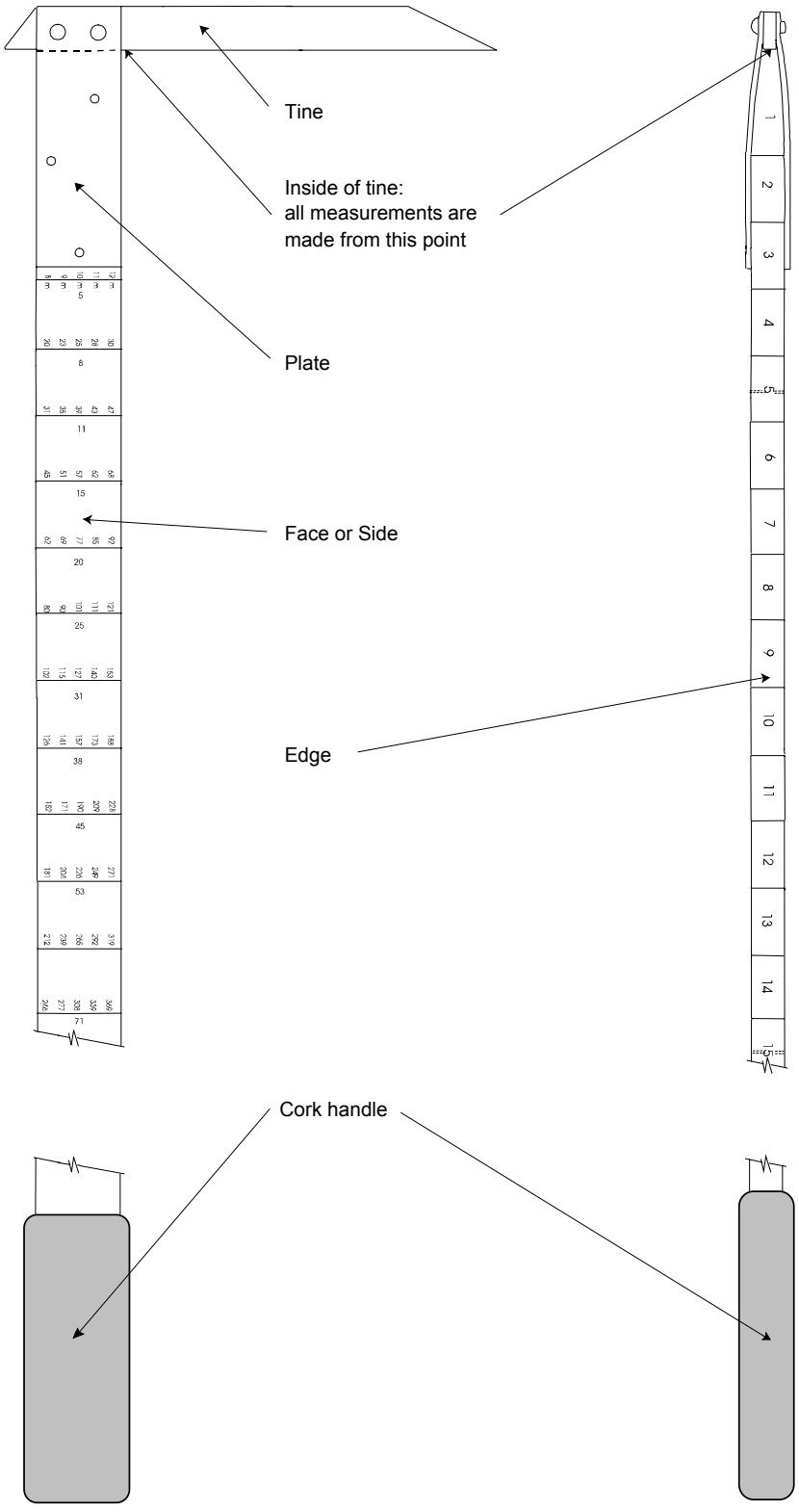


Figure 5.5 Basic parts of the official BC Metric Scale stick.

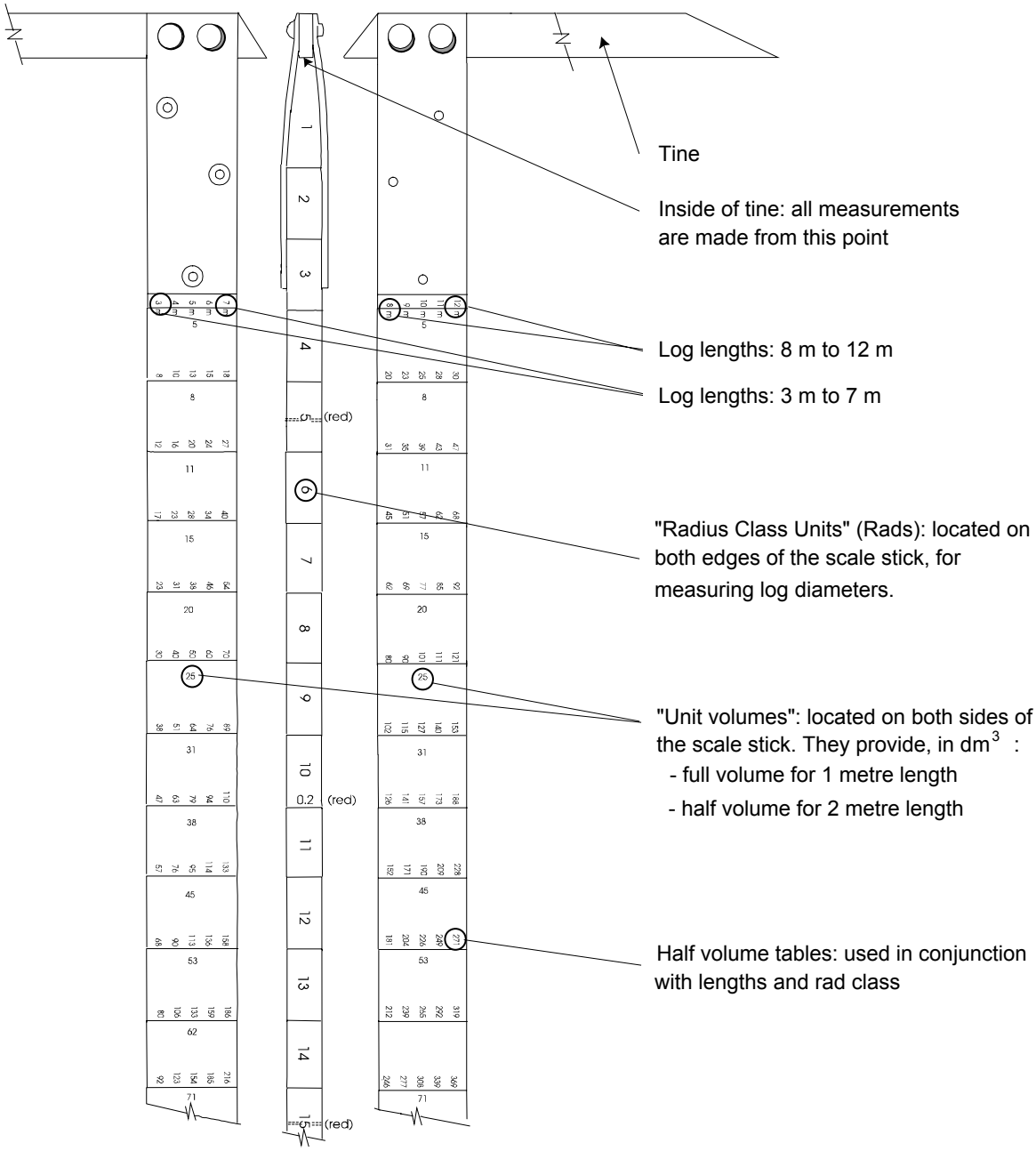


Figure 5.6 Sides and edge of a BC Metric Scale stick.

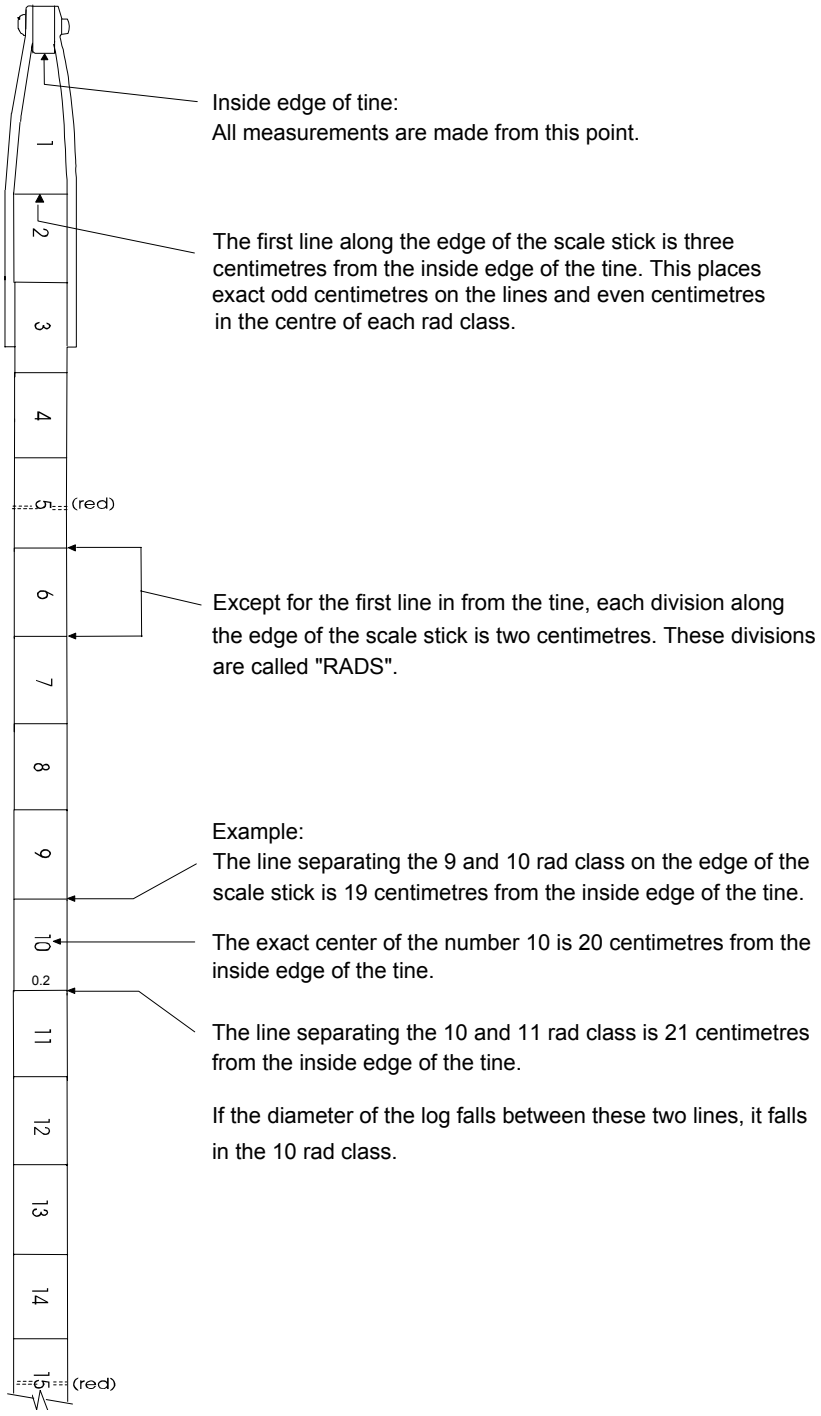


Figure 5.7 Locating centimetres from the edge of a BC Metric Scale stick.

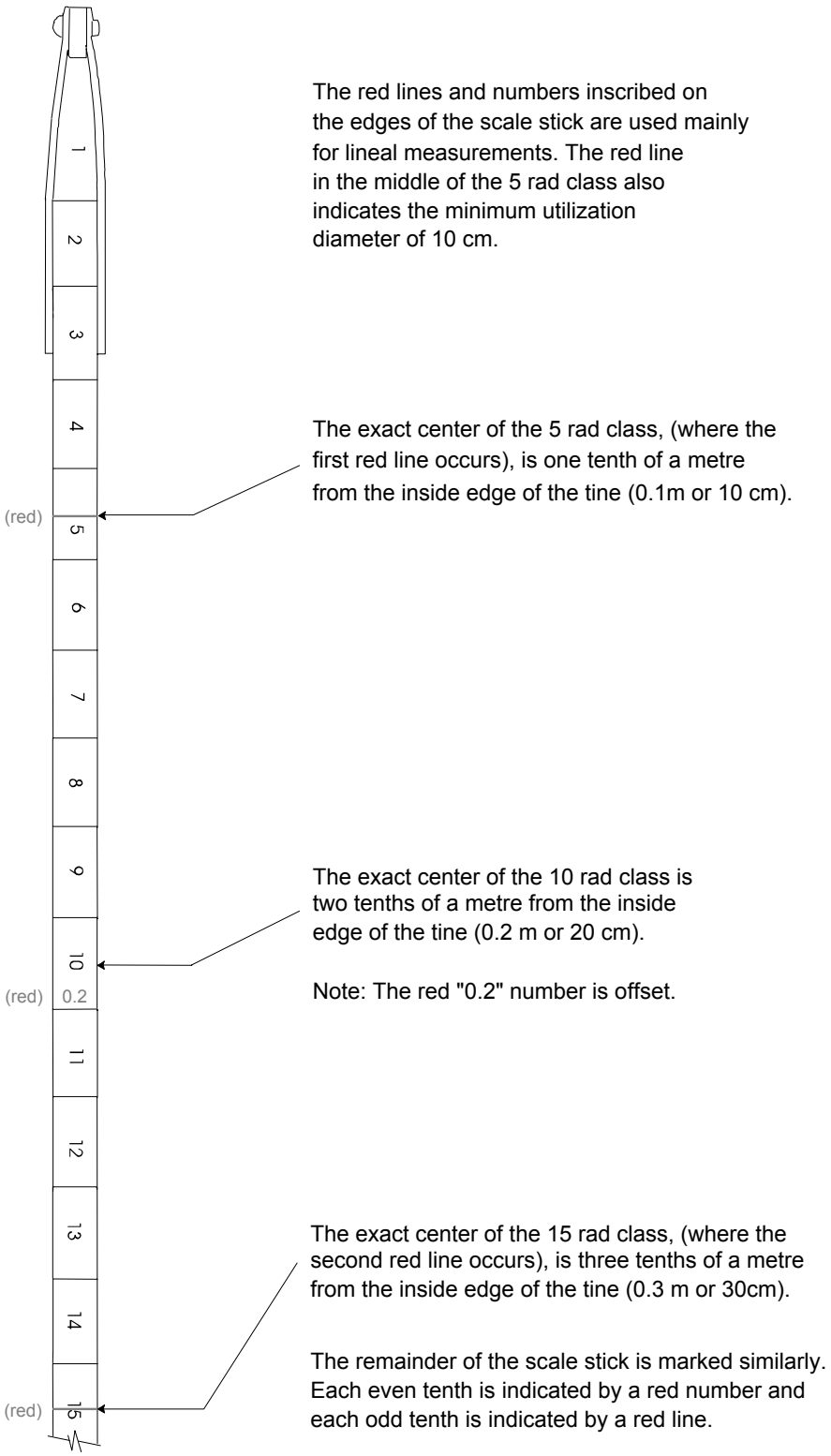
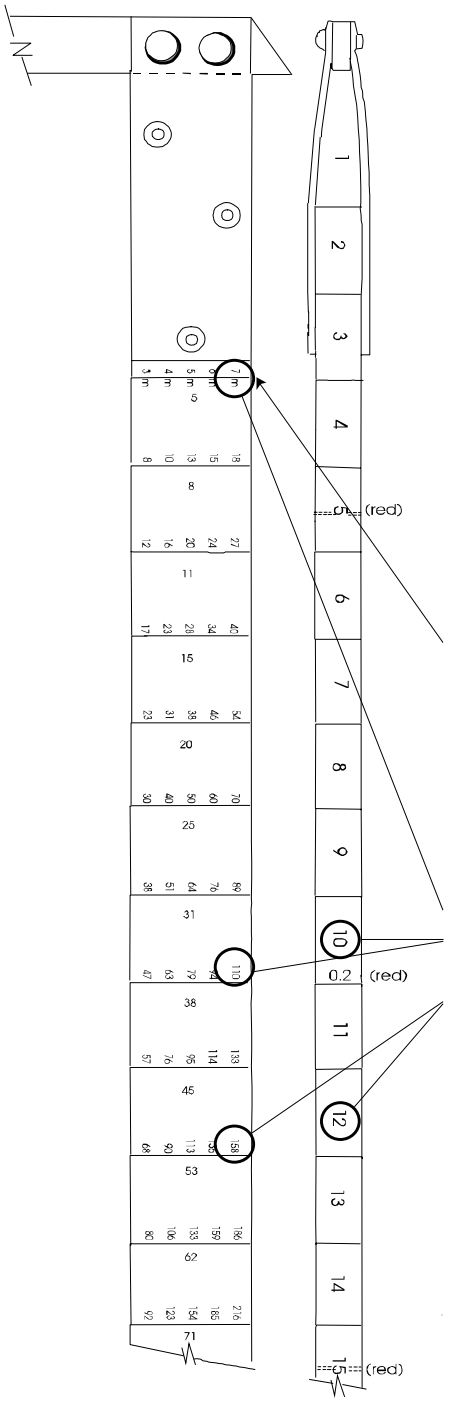


Figure 5.8 Scale stick edges showing the red markings for length measurements.



Log volumes on scale sticks and volume tables are printed in half volumes of cylinders in cubic decimetres.
- Half volumes are printed so that division by two is not necessary.
- Cubic decimetres are used to eliminate the printing of "decimal points". (1dm³ = 0.001 m³)

The numbers running parallel to the length of the scale stick represent the half volume table in cubic decimetres for a cylinder of a measured "rad class", and a log length.

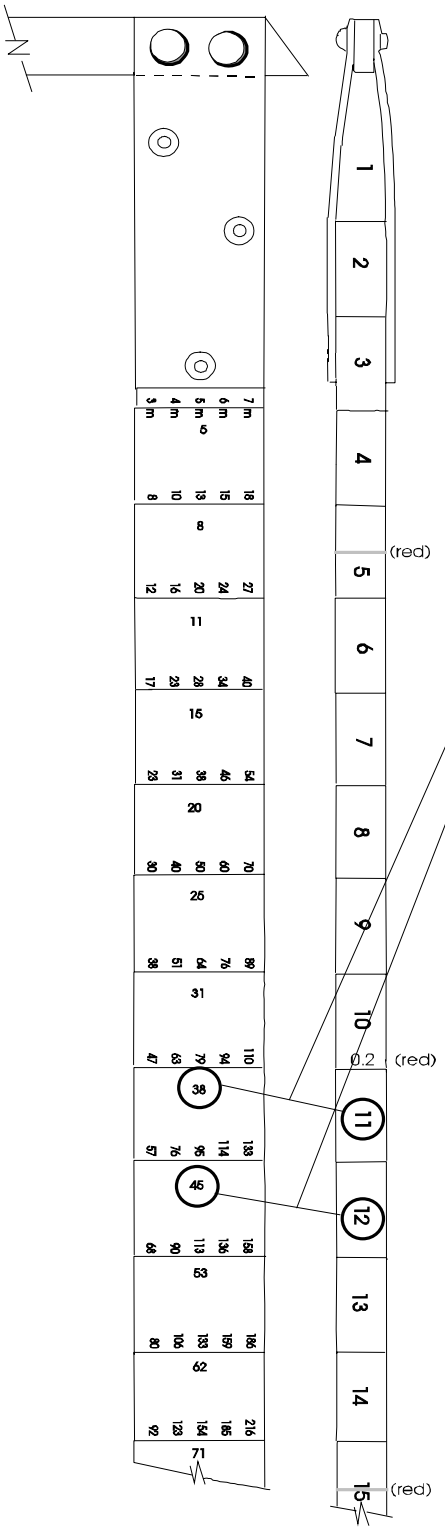
The log lengths for each row of half volumes are located in the "3 Rad" class, just above the tine.

Example:

A log -
7.0 metres in length with a small end diameter of
10 rads will have a half volume of 110 dm³
and a large end diameter of
12 rads will have a half volume of 158 dm³

The total log volume is 110 + 158 = 268 dm³
or 0.268 m³

Figure 5.9 Using the BC Metric Scale stick to calculate half volumes.



The numbers at right angles to the length of the scale stick represent half volumes in cubic decimetres for logs of a measured "rad class" and two metres in length.

Example:

A log 2.0 metres in length with a small end diameter of 11 rads will have a half volume of 38 dm³
and a large end diameter of
12 rads will have a half volume of 45 dm³

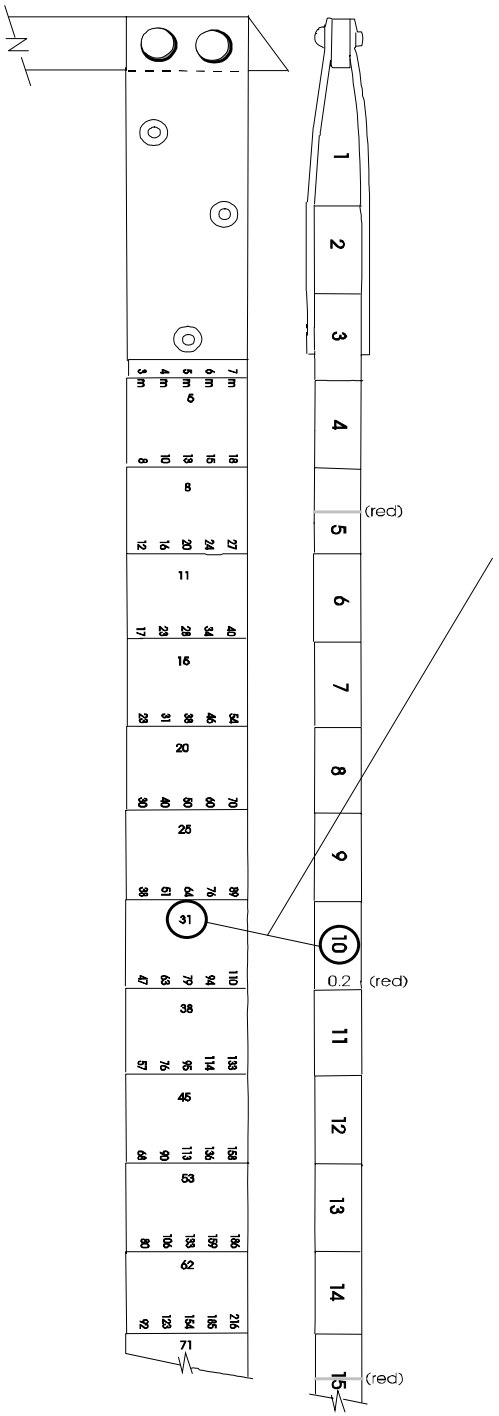
The total volume is:
38 + 45 = 83 dm³ (cubic decimetres) or 0.083 m³

To find half volumes for lengths not on the stick:

The half volume for logs one metre in length is:
one tenth of the 10 metre half volume
or one half of the 2 metre half volume.

The half volume for log segments one tenth (0.1) of a metre in length is:
one hundreth of the 10 metre half volume
or one tenth of the 1 metre half volume

Figure 5.10 Use of the side and edge of the stick in calculating 2 m half volumes.



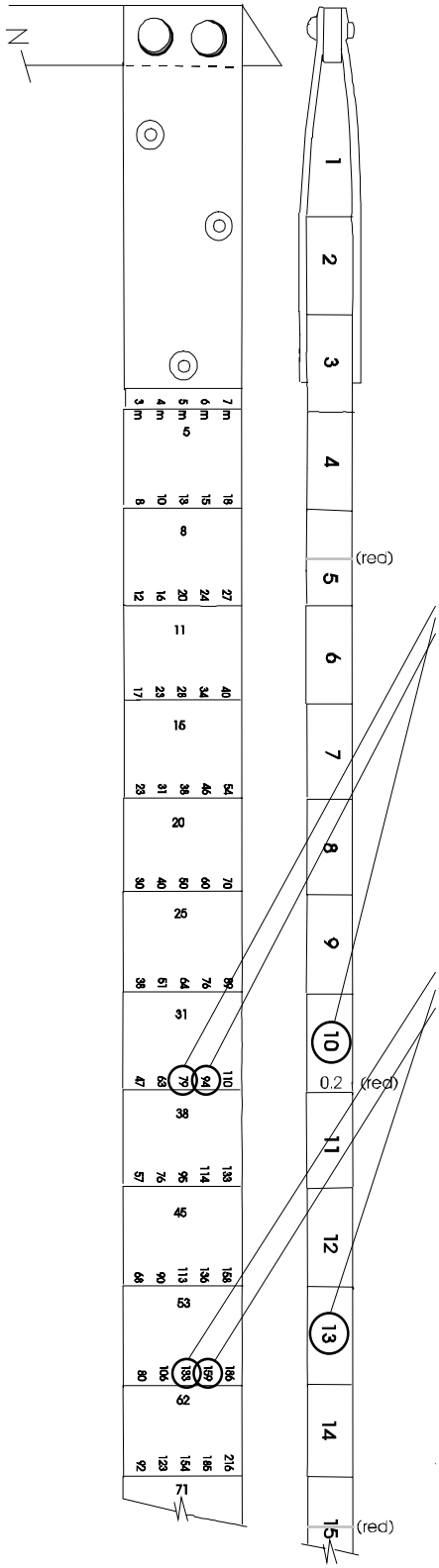
The numbers at right angles to the length of the scale stick also represent the full volume in cubic decimeters for a cylinder of a measured rad class 1 m long.

Example:

The unit volume for 10 rads equals 31dm³. This means a cylinder 10 rads in diameter and 1 metre in length contains a volume of 31 dm³ or 0.031 m³

Unit volumes may be used to calculate volumes for firmwood and/or lumber percentages, defect deductions, grade reductions, and determining the recorded dimensions for slabs.

Figure 5.11 Obtaining unit volumes (or "factors") from the Scale stick.



Half volumes are calculated for log lengths in metres and tenths of metres.

Example:

Small diameter:
The 10 rad half volume for 5.0 m is 79 dm³
The 10 rad half volume for 0.6 m is 9.4 dm³
(one tenth of the 10 rad half volume at 6.0 m is 9.4 dm³)

79 + 9.4 = 88.4 dm³ half volume for the small end of the log.

Large diameter:
The 13 rad half volume for 5.0 m is 133 dm³
The 13 rad half volume for 0.6 m is 15.9 dm³
(one tenth of the 13 rad half volume at 6.0 m is 15.9 dm

133 + 15.9 = 148.9 dm³ half volume for the large end of the log.

Total Volume:

88.4
+148.9
237.3 dm³ or 0.237 m³

Figure 5.12 Using the side and edge of the stick for lengths in tenths of metres.

5.4 Measuring Log Dimensions

Following consistent and recognized procedures for measuring log diameters and lengths is one of the most rigorous tasks of the scaler. It is important to develop identical ways of taking measurements throughout the province so that meaningful data is provided for users on an equitable basis. The scaling procedures are defined in the *Scaling Regulation* and this section explains those procedures.

Where Chapter 5 describes the measurements required for the determination of volume, Chapter 6 contains more information about measuring logs or slabs for the determination of grade, also defined in the *Scaling Regulation*.

5.4.1 Measuring Log Diameters

The objective of measuring log diameters is to record the single rad class that most closely represents the end area of a log, while avoiding excessive measurement. With the use of a BC Metric Scale Stick, radii for the purpose of volume calculations are found by:

- measuring, in rads, across the diameter, along a plane perpendicular to the longitudinal axis, inside the bark of each end,
- if a log has an elliptical or oval (egg shaped) cross section, measuring two diameters at right angles to one another, through both the short and long axis of each end, averaging the diameter measurements, and rounding the result to the nearest even number where the averaged measurement falls exactly half-way between two radius classes,
- if a log has an irregular cross section, determining the approximate area of the cross section by measuring two or more axes of the cross section and determining the radius of a circle with an equivalent area, and
- recording the rounded, average measurement (this measurement, if expressed as a diameter in rads is the same as the radius in centimetres).

Section 5.4.2 describes the methods for measuring the diameter of flared butt logs and Section 5.4.3 describes the measurement of slabs.

5.4.1.1 Measuring Round and Out of Round Log Ends

Figure 5.13 shows where measurements are taken on elliptical and oval logs and how they are averaged.

Diameter measurements are taken through the "centre of gravity" rather than the growth ring centre or geometric centre. This centre is found by first measuring at the widest point of the short axis and then measuring the long axis at right angles to the short axis. See Section 5.4.4 for a description of the geometric centre used for length measurements.

Voids or abnormal protuberances are not considered when measuring diameters. Voids are accounted for in firmwood deductions (Section 5.6) as holes or missing wood and protuberances are outside of the normal line of taper. Abnormal protuberances occur when logs are bucked through a knot, burl, or goitre.

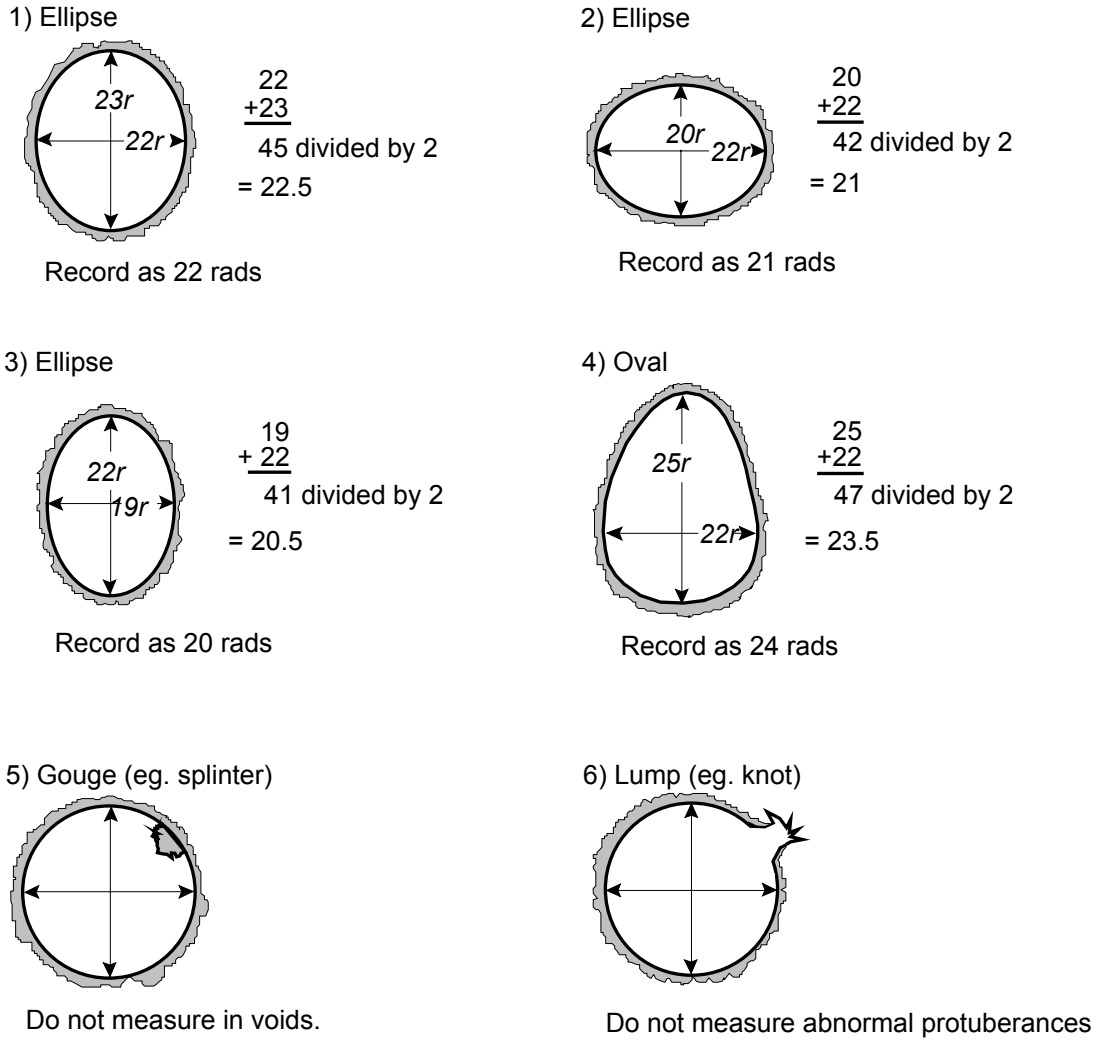


Figure 5.13 The method for measuring and averaging diameters.

5.4.1.2 Measuring Shattered and Split-back End Diameters

It is often difficult to measure across the end of a log with a shattered or split back end. They are measured by calipering the log at a point where the diameter of the log is obtainable, at a point as close as possible to the end (allowing for bark). If calipering at some distance from a top end, it may be necessary to reduce the calipered diameter to account for tapering down. If calipering some distance from a butt end, it may be necessary to increase the calipered diameter to account for tapering up. Calipering is described in detail in Section 5.4.2.

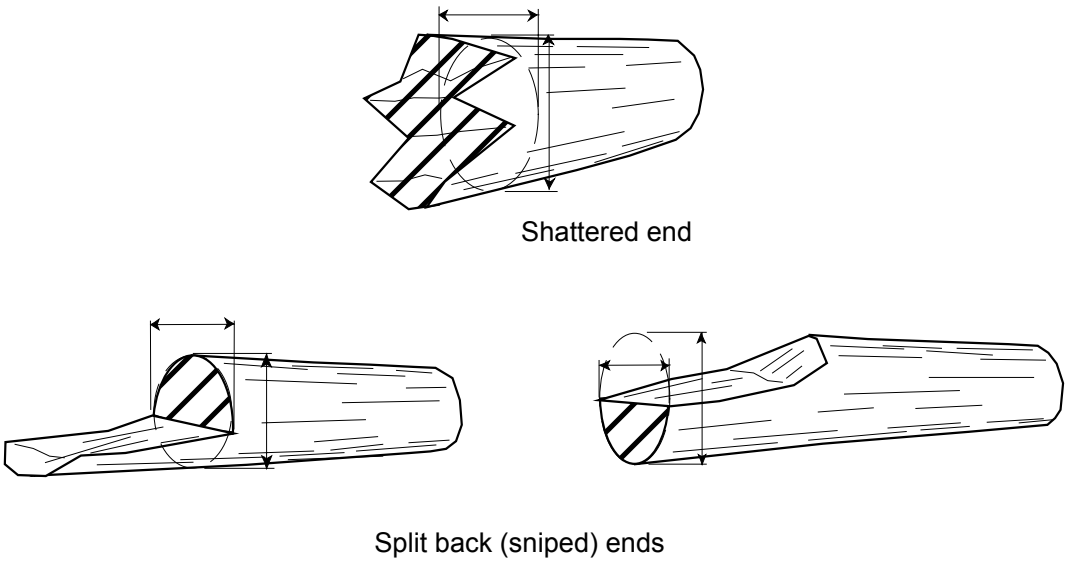
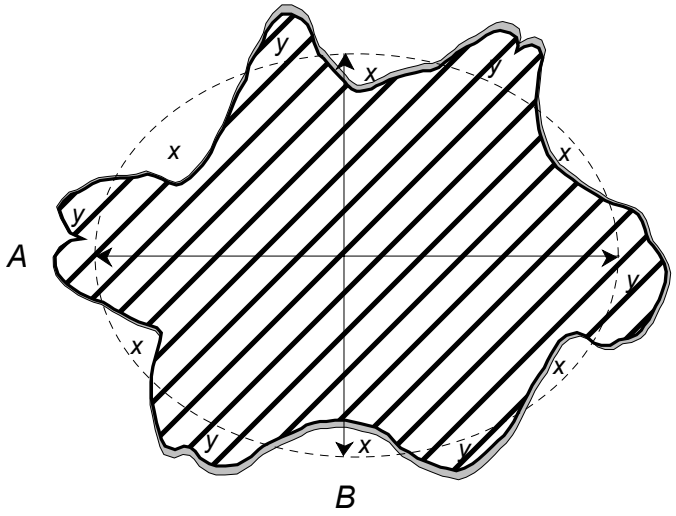


Figure 5.14 The method for measuring shattered and split back ends.

In all cases, the diameter is envisaged as if the wood was there, and if there is a significant amount of missing wood, a length deduction for missing wood should be taken as described in the Firmwood deductions section.

5.4.1.3 Measuring Irregular End Diameters

Irregular ends are difficult to measure in the normal manner because it is not often easy to choose the points to measure from. You must envisage a circle, ellipse, or other shape which best represents the firmwood volume of the irregular shape. Normally, irregular and fluted logs will fit in a circular or elliptical shape, where the widest part of the short axis can be found by taking sufficient measurements and the widest part of the long axis found by taking more measurements, then averaging the two. Flared *and* fluted logs must also have the flare accounted for. That is, any flutes or portions of flutes which are outside of the normal line of taper are not included in the assessment. Refer to Section 5.4.2 for flared log measurement and Section 5.4.3 for logs and slabs which are more rectangular or triangular in profile.



Voids = swellings, or

sum of areas x = sum of areas y

diameter = (A + B)/2

Figure 5.15 The method for measuring irregular diameters-except flared butts.

5.4.1.4 Measuring Forked End Diameters

Logs are often forked and normally come into a scaling yard already bucked off at or very near the juncture (crotch). The scaler is presented with a range of shapes depending on where the buck occurred, and not only is challenged to obtain a diameter, but also to find a length when forks are bucked at different lengths.

If the buck is located:

- just below the crotch of the fork, the shape is most likely oval or elliptical, and is measured as such. That is, across the widest part of the short axis and at the widest part of the long axis. The log may be calipered further down the log to confirm the measurement,

- at the crotch of the fork, the shape is evolving into distinctly separate stems, showing bark in between the two, but the adjoining faces are still in contact and quite flattened, and will not present enough of the individual cylinders to provide a diameter measurement from each segment. The face is measured as an oval or ellipse, but the measurement may have to be reduced to compensate for additional swell. Calipering further down the log is more reliable in these cases, and

- above the crotch of the fork, the individual stems become distinctly circular in form. In these cases, the log should be calipered further down the log where the main stem is cylindrical and an adjustment made to account for normal taper. If both forks are of similar size (where the large diameter is no more than 1.5 times the smaller diameter), find the average diameter in rads of each stem, add the unit volumes for the two diameters, and locate a radius class unit closest to the sum. If the forks are of unequal length, an adjustment must be made to the log length to place it half way between the long and short fork.

5.4.2 Measuring Flared Butt Diameters

The bottom of many trees is buttressed by way of a flared, swollen or fluted portion that develops in response to wind stress and degree of root spread. Logs bucked from this area (i.e., butt logs) are typically neiloidic in shape. Neiloids are discussed in Section 5.2.1.

> Smalian's formula tends to overestimate the volumes of neiloids. Therefore, it is important that scalers compensate by reducing the actual end measurement to compensate for any swell, flare, or fluting. Failure to do so is the single largest cause of overscaling.

There are two methods of finding flared butt diameters - calipering and projecting the normal line of taper. Although calipering is by far the commonest method, it is good practice for scalers to use both methods on the same log from time to time, comparing the results to develop confidence and confirm technique.

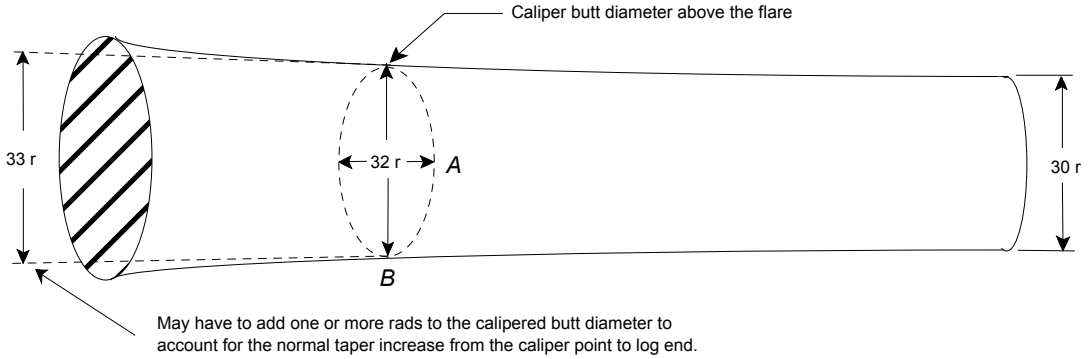
5.4.2.1 Calipering

"Calipering" a log means to measure the diameter at a point other than at the cut face by placing the scale stick across the log and projecting two perpendicular sight lines to the points where the measurement is read (Figure 5.16). The novice scaler may practice calipering by first selecting a log without flare and directly measuring across its end in the normal manner (Section 5.4.1). Calipering this log at a point close to the same end (allowing for bark) should give the same measurement. Practice will build confidence in calipering.

The larger the log, the more skill and care is required to get accurate dimensions and the greater the potential to overscale if the technique is not well developed.

Some points to remember when calipering are:

- select a spot just above the flare,
- keep sight lines perpendicular to the scale stick,
- take two measurements on out of round logs,
- caliper inside bark or subtract bark thickness,
- project the normal line of taper from the caliper point to the butt end face and add one or more rads (if required), and
- practice and compare results to the other method from time to time.



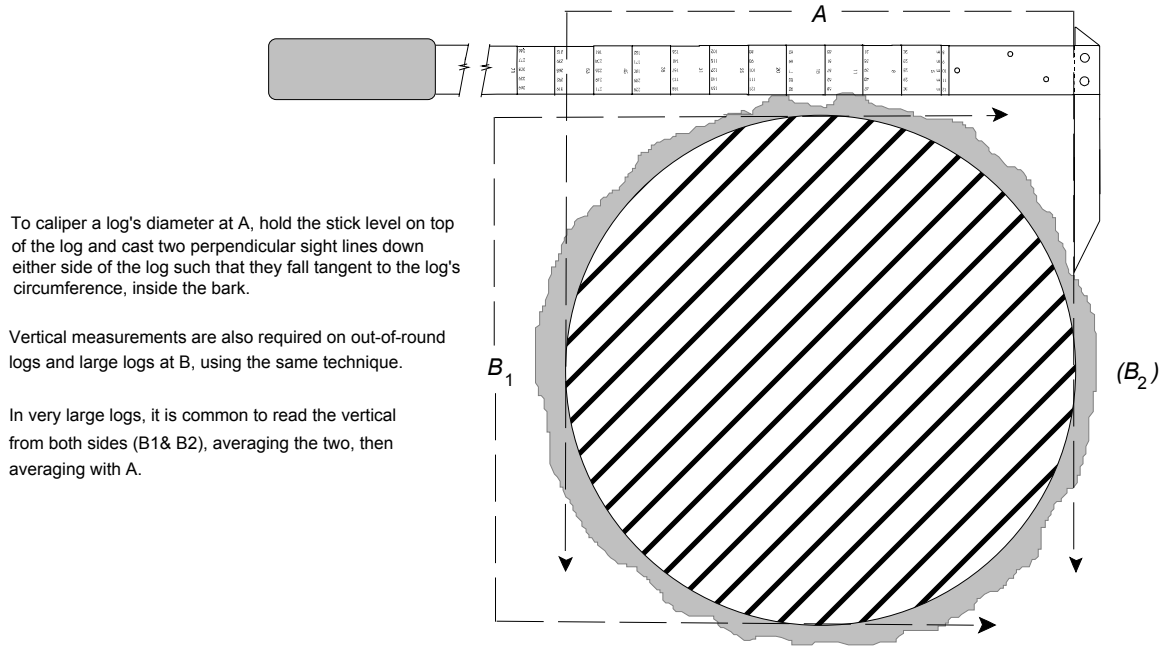


Figure 5.16 The method of measuring butt diameter by calipering.

5.4.2.2 Projecting the Normal Line of Taper

The other method for measuring flared butts is for the scaler to stand behind the flared end and project the normal line of log taper through the flare to the cut face as illustrated in Figure 5.17.

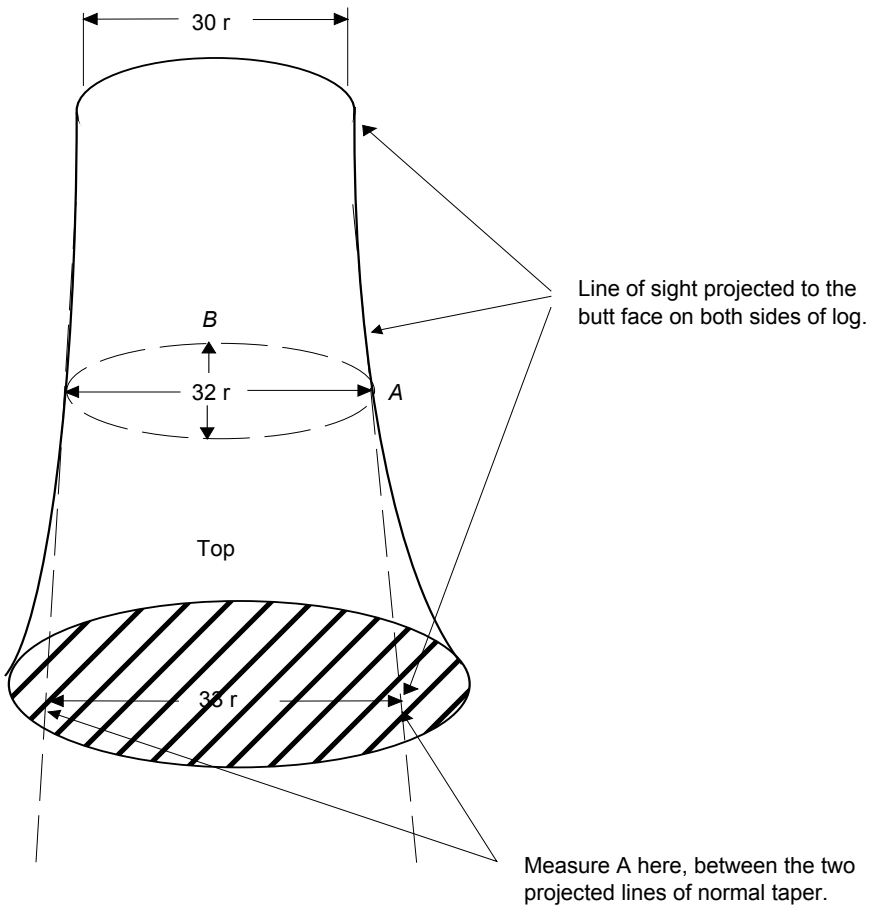
Novice scalers will find it helpful to use a logger's tape to project the line of taper: hook the tape at the top end of the log on one side, bring it back down the log and drape it over the flare. When pulled taut, the tape can be made to follow the taper and a mark can be placed upon the butt face. The process is repeated on the opposite side, and the projected diameter is measured between the two marks. This is not only a good way to learn the technique (which, when mastered, can be done by line of sight) but also can be useful, even to the expert, on the more challenging flared logs.

Where logs are out of round, they most frequently lie with their larger diameter, or long axis, in the horizontal plane. While it is easy enough to project the line of taper along both sides or top of a log, it is nearly impossible to project a line of taper along the bottom of a log because it is on the ground. Therefore, when scaling out of round logs, scalers should consider measuring the narrow diameter, or short axis, by calipering.

Projecting the normal line of taper is most commonly used on larger logs where calipering may be awkward or hazardous. On smaller flared logs it is generally expedient to caliper. Scalers should become adept at both methods.

Points to remember when projecting the line of taper:

- stand back from the butt end (approximately 1.5 to 3 m),
- project the normal line of log taper to the butt end face,
- measure, at the butt face, between points where the projected lines of taper intersect the butt face, and
- exercise caution on out of round logs.



Scaler stands 1.5 to 3 m back from the butt and projects the normal lines of taper through the flare.

The vertical measurement B for out-of-round logs is found by calipering.

Figure 5.17 Method of measuring butt diameter by projecting the normal log taper.

5.4.3 Measuring Slab Ends

In scaling jargon, a slab is a piece of timber that has fractured along a plane that is roughly parallel to the longitudinal axis of the original log. The shapes of slabs are quite variable, ranging from nearly "plank-like" to virtually perfect semicylinders; however, most fall between the ideals (see Figure 5.18). Even so, they can be seen as roughly triangular (three sided), quadrilateral (four sided), or semicircular in end view, and may be classified as *external*, or those having part of the outside circumference of the log in their shape, and *internal*, or those having no part of their outside circumference in their shape.

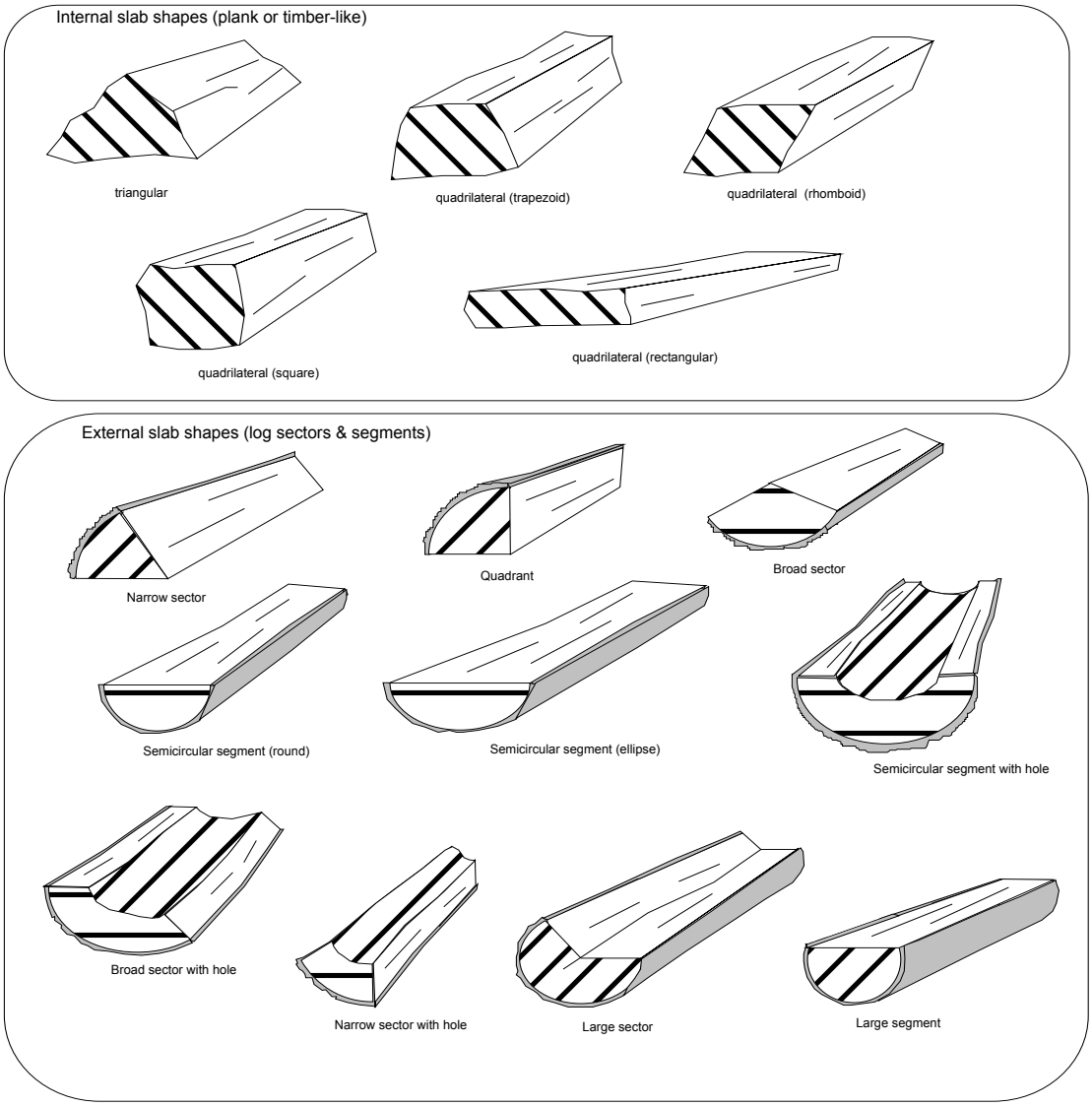


Figure 5.18 Typical slab shapes.

As stated Section 5.2, Smalian's formula uses an average of the two end areas projected over the length of the piece to determine the volume. It follows that the challenge to the scaler measuring a slab is to record the two radius class units which fairly represent the areas of both slab ends and which, when inserted into Smalian's formula, will yield the firmwood volume. This derived or "effective" radius can be determined either by enclosing the end area with one of a "semicircle", a "pie wedge", a quadrilateral (four sided) or a triangle (three sided) shape, depending upon which most nearly matches the slab end. Regardless of the shape, measurements are always taken at right angles (90 degrees) to one another. Internal slab shapes which are quite irregular may require more than one measurement on an axis to arrive at an average width or average thickness.

5.4.3.1. Measuring Semicircular Slab Ends

The most frequently encountered external slab shape has a "semicircular" end profile. A true semicircle is exactly one half the original circle. Normally logs are not perfect circles and rarely do they fracture exactly in the middle. Therefore, what we are calling a semicircle is more properly termed a segment, or the area transcribed by the intersection of a circle and a chord.

Although not usually perfect semicircles, these shapes may be viewed, for scaling purposes, as being half of a whole or "parent" log of round, oval or elliptical shape, as shown in Figure 5.19.

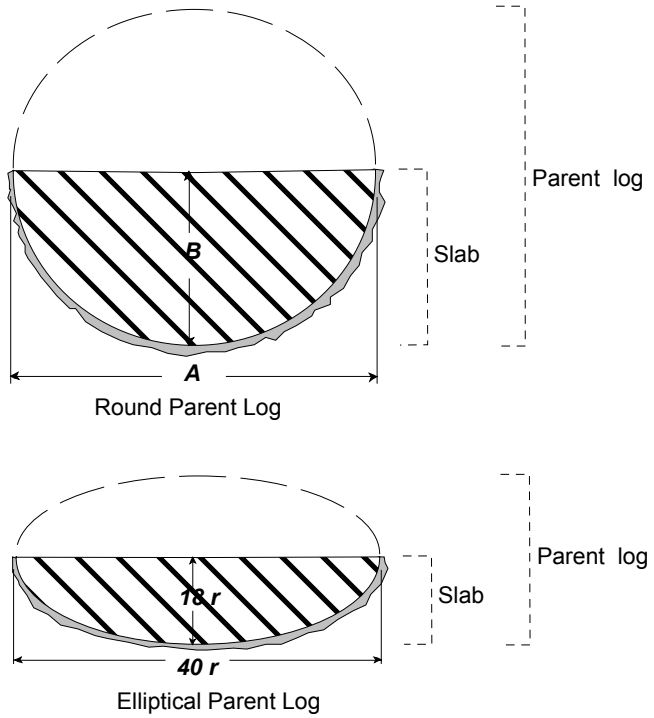


Figure 5.19 Measurement of a semicircular slab end.

To find the volume of a semicircular slab it is necessary to:

- first derive the average diameter of an end of the parent log, from two measurements of the end of its segment,
- find the unit volume of the end of the parent log,
- divide the unit volume in two to find the unit volume of the end of the segment,
- record the radius class unit which is closest to the segment's unit volume,
- repeat the above process for the other end of the slab, and
- record the length of the slab so that a volume may be calculated.

The scaling method to find a radius class representing the unit volume of the slab in Figure 5.19 is:

The measurements are taken across the width and thickness of the semicircular slab. The long-standing convention is to term the dimension "*A*" which falls across what is, more or less, the parent log's diameter as the width. The other dimension "*B*", perpendicular to "***A***", and which is, more or less, the parent log's radius is termed the thickness. The width is measured at the point of maximum width and the thickness is measured at the point of maximum depth at right angles to the width, ignoring any minor irregularities.

Then, the average diameter of one end of the parent log is derived from the measurements taken of its slab. The formula for determining the average diameter of one end of the parent log from the measurements of its semicircular slab is:

$$Parent \log diameter = \frac{A + 2B}{2}$$

For example, if A = 40 rads and B = 18 rads,

$$Parent \log diameter = \frac{40 + 2x18}{2}$$

$$Parent \log diameter = \frac{76}{2}$$

$$Parent \log diameter = 38 \; rads$$

Next, the unit volume for 38 is located on the scale stick (454) and divided by 2. Finally, the unit volume nearest to that resulting unit volume (227) is located on the scale stick, and the corresponding radius class unit is recorded. In this case, the closest unit volume is 229, which corresponds to 27 rads. The process is repeated at the other end of the slab.

5.4.3.2 Measuring Slab Ends and Sectors With a Hole

5.4.3.2.1 Measuring a Semicircular Slab End with hole

Logs with advanced heart rot or hole may split into slab sectors or segments. To scale a semicircular slab with a hole, the dimensions for the parent log and the hole are derived, and the unit volume of the hole is subtracted from the unit volume of the parent log before division by 2.

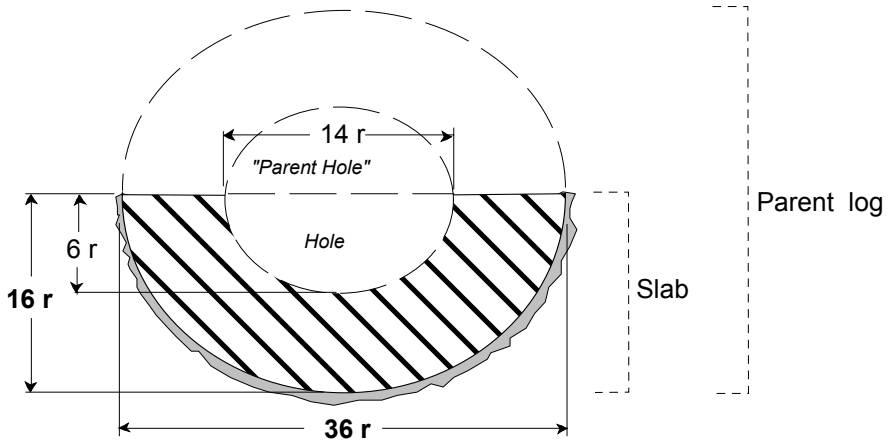


Figure 5.20 Measurement of a semicircular slab end with hole.

To find the volume of a semicircular slab with a hole, it is necessary to:

- first derive the average diameter of an end of the parent log, from two measurements of the end of its segment,
- find the unit volume of the end of the parent log,
- derive the average diameter of an end of the "parent hole", from two measurements of the end of its segment,
- find the unit volume of the end of the parent hole,
- subtract the unit volume of the parent hole from the unit volume of the parent log,
- divide the result in two to find the unit volume of the end of the slab,
- locate and record the radius class unit which is closest to the segment's unit volume,

- repeat the above process for the other end of the slab, and
- record the length of the slab so that a net volume may be calculated.

The scaling method to find a radius class representing the unit volume of the slab in Figure 5.20 is:The measurements are taken across the width and thickness of the semicircular slab as described in the example in Section 5.4.3.1. Then, the average diameter of one end of the parent log is derived from the formula:

$$Parent\ \log\ diameter = \frac{A + 2B}{2}$$

$$Parent\ \log\ diameter = \frac{36 + 2x16}{2}$$

$$Parent\ \log\ diameter = \frac{68}{2}$$

$$Parent\ \log\ diameter = 34\ rads$$

The unit volume for 34 rads is located on the scale stick (363).

Next, the average diameter of one end of the parent hole is derived in the same manner:

$$Parent\ hole\ diameter = \frac{14 + (2x06)}{2}$$

$$Parent\ hole\ diameter = \frac{26}{2}$$

$$Parent\ hole\ diameter = 13\ rads$$

The unit volume for 14 rads is located on the scale stick (53) and is subtracted from the unit volume of the parent log and divided by 2 to arrive at the unit volume of the slab.

$$Slab\ unit\ volume = \frac{parent\ \log\ unit\ volume - parent\ hole\ unit\ volume}{2}$$

$$Slab\ unit\ volume = \frac{363 - 53}{2}$$

$$Slab\ unit\ volume = \frac{310}{2}$$

$$Slab\ unit\ volume = 155$$

Finally, the unit volume nearest to the slab unit volume is located on the scale stick, and the corresponding radius class unit is recorded. In this case, the closest unit volume is 152, which corresponds to 22 rads. The process is repeated at the other end of the slab.

5.4.3.2.2 Measuring a Slab Sector with Hole

Slab sectors less than a semicircle with a hole are measured differently because it is virtually impossible to derive the dimensions of the parent log as shown in the previous example. There is not enough "meat" to reconstruct the parent log. The problem is similar with an attempt to apply the measurement technique of pie wedges as described in the next Section.

The alternative is to "flatten out" these types of slabs to form a rectangular shape and measure across their width and thickness. The net dimension may then be found as described in detail in Section 5.4.3.5,

where:

$$\text{Four-sided slab Unit volume} = A \times B \times 0.4$$

the unit volume nearest to the slab unit volume is located on the scale stick, and the corresponding radius class unit is recorded.

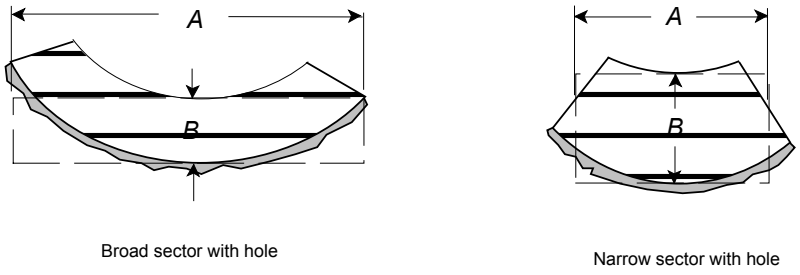


Figure 5.21 Measurement of a sector slab end with hole.

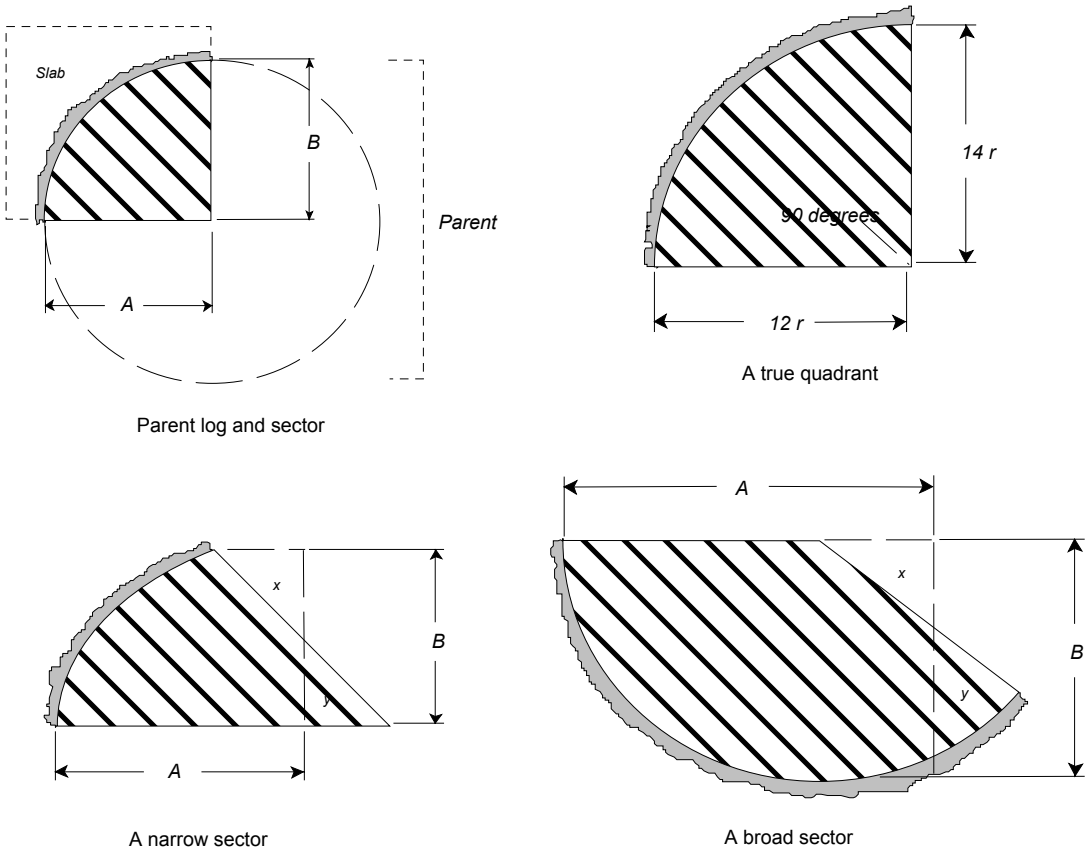
Figure 5.21 depicts broad and narrow slab ends with holes. The width "*A*" is the average of the inner and outer circumference of the slab sector, and the thickness "*B*" is the average thickness of the slab. The dashed lines represent the shape if they were envisioned to be rectangular to square in profile. The difficulty in measuring the width "*A*" is to arrive at the average of the inner and outer circumference by the use of a scale stick. As the arc of the slab exceeds 90 degrees (1/4 of a parent log) as shown in the example on the left, the width is best represented by a measurement across the full width of the slab. If less than that, the width is best represented by a measurement on the midpoint of each flat face as shown in the example on the right. More than one measurement "*B*" may be required if the thickness is uneven, to arrive at an average thickness.

Although not illustrated here, accomplished scalers will bypass this step by converting irregular shapes like these directly into a circle with a diameter closest to the area of the "square". This technique requires a great deal of practice to be able to understand the relationship of rectangular and square shapes to circular shapes well enough to produce good results. A circle with the same diameter as the side of a square will have about 78.5 percent of the area of the square; to produce a circle of the same area as a square of a given area, the circle's diameter must be increased by about 13 percent. In addition, the more out of square the slab, the more difficult it is to visualize a circle enclosing the area of the slab.

Notes:

5.4.3.3 Measuring Sectors (pie wedge slab ends) Smaller than a Semicircle

Sometimes logs will conveniently split into quarters or thirds of their original end profile. Other times a less convenient fraction will result. This slab type may be categorized as being a sector less than a semicircle, roughly a pie wedge in shape, and external, or having a portion of the original circumference of the log remaining, as illustrated in Figure 5.18. Examples for scaling with different methods follow.



$$\text{Average Diameter} = \frac{A + B}{2}$$

Figure 5.22 Measurement of sectors (pie wedge slab ends) .

5.4.3.3.1 Measuring Small Sectors by Averaging the Dimensions

Figure 5.22 illustrates various sectors smaller than a semicircle. These shapes may be scaled by direct measurement without using a factor relating to a proportion of a "parent" log as described next. This method, called the "*quarter-round*" method, is preferred for slabs which do not break into convenient fractions. Illustrated are quadrants, narrow sectors and broad sectors. As with the factored method, the measurements are taken at *A* and *B* and averaged to arrive at an effective radius class unit for recording.

The average diameter in rads of the end of a sector slab is derived from the measurement of its two faces. The measurement of a quadrant allows both measurements to be taken directly off each face because they are at 90 degrees to each other. Broad and narrow sectors must be measured with *A* being "drawn in" to the point where the void *x* is about equal to the projection *y* as shown on the examples so that *the two measurements are taken at 90 degrees to each other*. Overstatement of volume will result if this is not done.

To find the volume of a sector slab by averaging it is necessary to:

- first average the two measurements of an end of the slab,
- record the average,
- repeat the above process for the other end of the slab, and
- record the length of the slab so that a volume may be calculated.

The scaling method to find a radius class representing the unit volume of end of the sectors in Figure 5.22 is as follows.

The formula for determining the average diameter of a slab sector is:

$$\textit{Average diameter} = \frac{A + B}{2}$$

Replace the variables *A* and *B* with the measurements given. (*A* = 12 and *B* = 14).

$$\textit{Average diameter} = \frac{12 + 14}{2}$$

$$\textit{Average diameter} = 13\ \textit{rads}$$

The radius class unit is recorded, and the process is repeated for the other end of the slab.

5.4.3.3.2 Measuring a True Quadrant and Other Sectors by Applying a Factor

Figure 5.22 also includes a quadrant (i.e., 1/4 of a circle) of an external slab end. This example is 1/4 of an elliptic log with a measurement of A = 12 rads and B = 14 rads. The distances A and B (in cm) are actually two radii of the parent log's end. Therefore, if the parent log is a true circle, A and B will be identical. If the parent log end is elliptic, as in this example, the two radii will differ and the parent log's radius is their average.

When the two radii and the faces are at 90 degrees to each other as in this example, then the volume will be 1/4 of the volume of the parent log. Because the radius of the parent log is measurable, it's volume is obtainable, and so the volume of any sector may be derived using a factor or ratio of the sector to the circle. As long as a slab of this type is in convenient fractions of the parent log, a factor can be applied directly to the parent volume to obtain the volume of the slab. However, without another measurement, the factor remains as an estimate and is subject to systematic errors. One way is to find the arc of the sector and divide it by the circumference of the parent log. Good judgement gained through practice and experience will reduce these errors to within tolerance.

Finding the volume of a sector slab by applying a factor requires the following steps:

- first derive the average diameter of an end of the parent log, from two measurements of its sector,
- find the unit volume of the end of the parent log,
- apply a factor to find the unit volume of the end of the segment,
- record the radius class unit which is closest to the sector's unit volume,
- repeat the above process for the other end of the slab, and
- record the length of the slab so that a volume may be calculated.

The scaling method to find a radius class representing the unit volume of the quadrant in Figure 5.22 is as follows.

The average diameter of one end of the parent log is derived from the measurements taken of its sector. The formula for determining the average diameter of one end of the parent log from the measurements of its slab sector is:

$$Parent \log diameter = \frac{2A + 2B}{2}$$

Replace the variables A and B with the measurements given. (A = 12 and B = 14).

$$\textit{Parent}\ \log\ \textit{diameter} = \frac{(12\ x\ 2) + (14\ x\ 2)}{2}$$

$$\textit{Parent}\ \log\ \textit{diameter} = \frac{24 + 28}{2}$$

$$\textit{Parent}\ \log\ \textit{diameter} = \frac{52}{2}$$

$$\textit{Parent}\ \log\ \textit{diameter} = 26\ \textit{rads}$$

The unit volume for 26 rads is 212 dm³. Since this slab is a true quadrant (i.e., 1/4 of the original circular end or 90/360), 1/4 of the parent volume is 53 dm³.

Finally, the unit volume nearest to that resulting unit volume (53) is located on the scale stick, and the corresponding radius class unit is recorded. In this case, the closest unit volume is the same, which corresponds to 13 rads.

5.4.3.4 Measuring Slab Sectors and Segments Greater Than a Semicircle

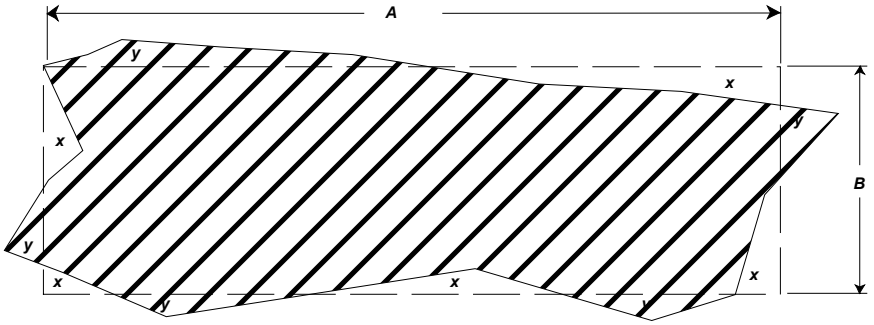
Sectors and segments greater than a semicircle (i.e., sectors or segments which contain more than half of the volume of its "parent" log and contain enough of their outer circumference to permit reliable measurement through the centre of the log), are classed as logs with missing portions, rather than as slabs.

Logs with missing portions are normally scaled by first measuring the diameter of the log and then making a firmwood deduction for the missing portion. The volume of the missing portion is determined in the same way that the volumes of sectors and segments are found. The volume of the missing sector or segment is found by an appropriate method described in this section and subtracted from the gross volume of the log to arrive at a net volume. Firmwood deductions are described in Sections 5.5 through Section 5.9.

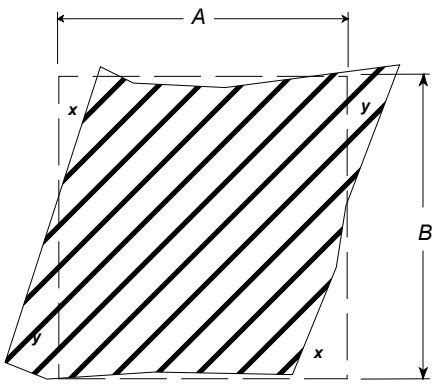
5.4.3.5 Measuring Four Sided (plank-like, timber-like) Slab Ends

Although logs rarely break up into truly rectangular or square cross-sections unless a sawmill is involved, slab ends can be more or less four sided and are all scaled in the same manner. Scalers often refer to them as "planks" or "timbers".

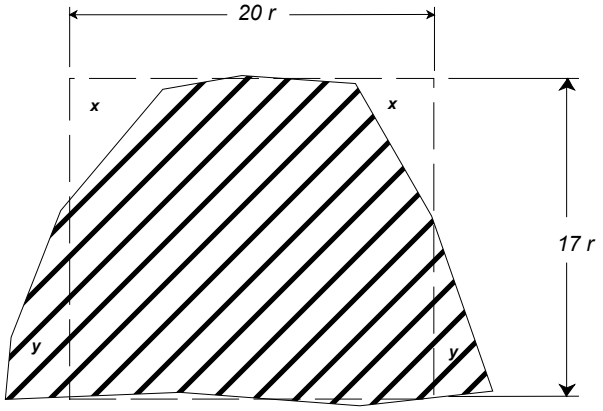
Figure 5.23 depicts such slab ends. As suggested in the diagram, the width and thickness measurements are taken so that the voids (areas *x*) balance the protuberances (areas *y*). Of the quadrilateral shapes, they can be more or less square, rectangular (plank-like), trapezoid, or rhomboid (timber-like). The measurements are taken in the same way for all of them, through the width and thickness, and at 90 degrees to each other. Shapes which are quite irregular may require more than one measurement on an axis to arrive at an average width or average thickness.



Rectangular (plank-like)



Rhomboid (timber-like)



Trapezoid (timber-like)

Slab Unit Volume = A x B x 0.4

Figure 5.23 Measurement of four-sided (quadrilateral) slab ends.

To find the volume of a four-sided slab it is necessary to:

- first derive a unit volume of an end of the slab, from the two measurements of its width and thickness,
- record an equivalent radius class unit which is close to the unit volume,
- repeat the above process for the other end of the slab, and
- record the length of the slab so that a volume may be calculated.

The scaling method to find a radius class unit representing the unit volume of the slab end in Figure 5.23 is as follows:

The area of a four-sided slab end is its average width times its average thickness. To arrive at an effective radius class, the calculation is different from circular shapes, because, unlike circular shapes, in which two measurements are averaged, the two are multiplied, which produces a different ratio, or factor, of dimension to unit volume. To obtain the unit volume of a rectangular slab end in order to locate an equivalent effective radius on the scale stick, a factor must be applied to the product of the slab's width and thickness in rads to convert to unit volumes (cubic decimetres per metre). This factor, which is constant, simply provides a shorter way of doing the calculation, similar to the way Smalian's formula is shortened. The full formula for finding the unit volume for one end of a rectangular slab is:

$$\text{Four-sided slab Unit volume} = \frac{(\text{Width in Rads x 2}) \text{ x } (\text{Thickness in Rads x 2}) \text{ x } 100}{1000}$$

Multiplication of the two measurements in rads by 2 converts rads to centimetres. Multiplication by 100 gives the volume in cubic centimetres for one metre of length. Division by 1 000 gives the volume in cubic decimetres for one metre, or the unit volume.

By naming the width and thickness of the slab as *A* and *B* the formula shortens to:

$$\text{Four-sided slab Unit volume} = \frac{(2A) \text{ x } (2B) \text{ x } 100}{1000}$$

By transposing *A* and *B* to combine the constants the formula becomes:

$$\text{Four-sided slab Unit volume} = A \text{ x } B \text{ x } \left(\frac{2 \text{ x } 2 \text{ x } 100}{1000}\right)$$

And by calculating the combined constants, the formula is simplified to:

$$\text{Four-sided slab Unit volume} = A \times B \times 0.4$$

Where:

A	=	Width in rads
B	=	Thickness in rads
0.4	=	the constant

By substituting the slab dimensions from the example in Figure 5.23 into the formula,

$$\text{Rectangular slab Unit volume} = 20 \times 17 \times 0.4$$

$$\text{Rectangular slab Unit volume} = 136\ dm^3$$

Finally, the unit volume nearest to 136 is located on the scale stick, and the corresponding radius class is recorded. In this case, the closest unit volume is 139, which corresponds to 21 rads. The process is repeated at the other end of the slab.

Accomplished scalers will bypass this step by converting irregular shapes like these directly into a circle with a diameter closest to the area of the "square". This technique requires a great deal of practice to be able to understand the relationship of rectangular and square shapes to circular shapes well enough to produce good results. A circle with the same diameter as the side of a square will have about 78.5 percent of the area of the square; to produce a circle of the same area as a square of a given area, the circle's diameter must be *increased* by about 13 percent. Of course, when the relationship is understood, a scaler will not have to do the following calculation each time:

- square up the slab by finding the square root of its area; it becomes a square measuring 18.4 by 18.4, and
- then the side dimension of the square is increased by 13 percent. 18.5 times 1.13 (113 percent) is equal to 20.8, or 21 rads.

Although the above exercises both produce the same results, the more plank-like a slab becomes, the more difficult it is to visualize a circle with the same area. It is not practical to average the width and thickness of a plank-like slab to square it up. A square having sides 20 units by 20 units has an area of 400 square units and the average of its two sides is 20 units. A rectangle 10 units by 40 units has the same area but the average of its two sides is *25 units.*

5.4.3.6 Measuring Triangular (three sided) Slab Ends

Logs can break into roughly triangular shapes, and although not perfectly shaped, may be enclosed in a triangle for purpose of measurement, similar to four-sided slab shapes.

Figure 5.20 depicts such slab ends. As suggested in the diagram, the width and thickness measurements are taken across the base and height of the triangle, accounting for minor imperfections in the shape. Of the triangular shapes, they can be more or less equilateral, right, or obtuse. The measurements are taken in the same way for all of them, through the base and height, and always at 90 degrees to each other.

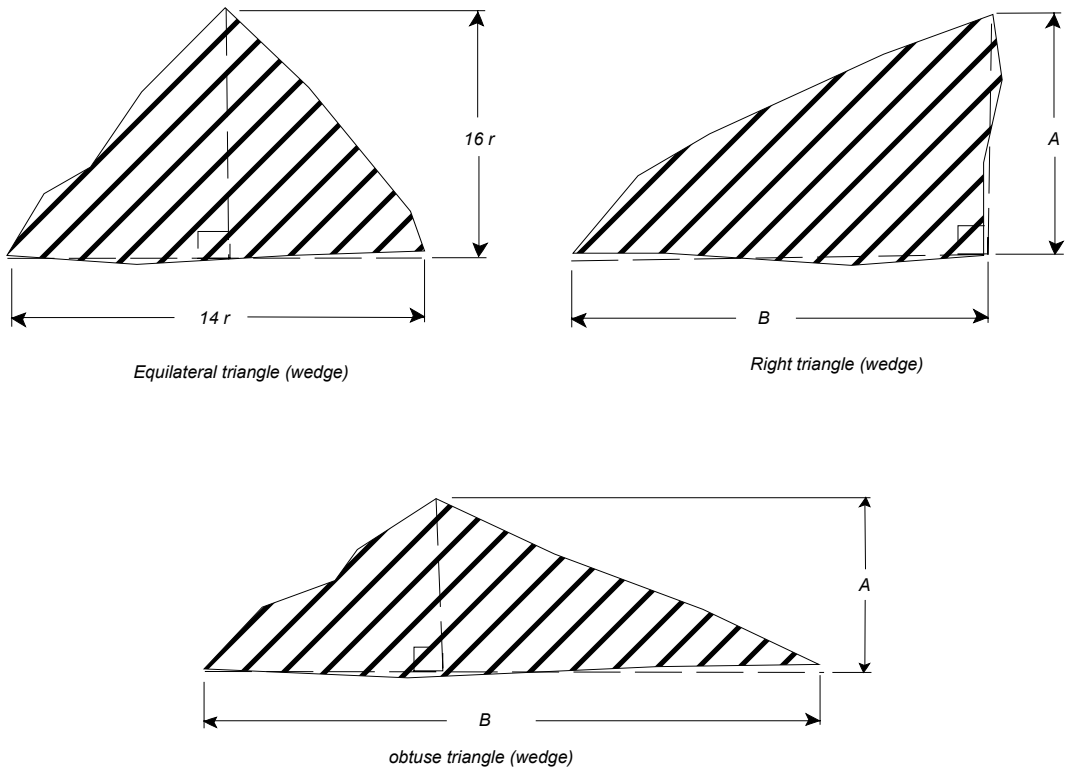


Figure 5.24 Measurement of triangular or wedge-shaped slab ends.

To find the volume of a triangular slab (wedge) it is necessary to:

- first derive a unit volume of an end of the slab, from the two measurements of its base and height,
- record a corresponding radius class unit which is close to the unit volume,
- repeat the above process for the other end of the slab, and
- record the length of the slab so that a volume may be calculated.

The scaling method to find a radius class representing the unit volume of the slab in Figure 5.24 is:

The area of a triangle is one half its base times its height. To arrive at an effective radius class, the calculation is different from circular shapes, because, unlike circular shapes, in which two measurements are averaged, the one measurement is first halved, then the two are multiplied, giving a different ratio, or factor, of dimension to unit volume. To obtain the unit volume of a triangular slab end in order to find an effective radius class on the scale stick, a factor must be applied to the product of 1/2 of the slab's base and its height in rads to convert to unit volumes (cubic decimetres per metre). This factor, which is constant, simply provides a shorter way of doing the calculation, similar to the way Smalian's formula is shortened. The full formula for finding the unit volume of an end of a triangular slab is:

$$\text{Triangular slab Unit volume} = \left(\frac{\left(\text{height in Rads x 2}\right) \text{ x } \frac{\left(\text{Base width in Rads x 2}\right)}{2} \text{ x 100}}{1000} \right)$$

Multiplication of the two measurements in rads by 2 converts rads to centimetres. Division of the base width by two is a requirement of the formula of the area of a triangle. Multiplication by 100 gives the volume in cubic centimetres for 1 m of length. Division by 1 000 gives the volume in cubic decimetres for 1 m, or the unit volume.

By naming the height and base of the slab as *A* and *B* the formula shortens to:

$$\text{Triangular slab Unit volume} = \frac{(2A) \times \left(\frac{(2B)}{2}\right) \times 100}{1000}$$

By transposing *A* and *B* to combine the constants the formula becomes:

$$\text{Triangular slab Unit volume} = A \times B \times \left(\frac{2 \times \left(\frac{2}{2}\right) \times 100}{1000}\right)$$

And by calculating the combined constants, the formula is simplified to:

$$\text{Triangular slab Unit volume} = A \times B \times 0.2$$

Where:

A	=	Height in rads
B	=	Base in rads
0.2	=	the constant

By substituting the slab dimensions from the example in Figure 5.24 into the formula,

$$\text{Triangular slab Unit volume} = 16 \times 14 \times 0.2$$

$$\text{Triangular slab Unit volume} = 44.8\ dm^3$$

Finally, the unit volume nearest to 44.8 is located on the scale stick, and the corresponding radius class is recorded. In this case, the closest unit volume is 45, which corresponds to 12 rads. The process is repeated at the other end of the slab.

5.4.4 Measuring Lengths

The length of a log or slab is the distance between two planes that are perpendicular to the longitudinal axis of the piece and situated at the geometric centre of each end face.

To locate an end face, all logs are deemed to be "bucked" for scaling purposes. There are three kinds of bucking; real, pencil, and conceptual. These terms apply to practices which are separate from each other, and will affect recorded log lengths in the scaling and grading process.

"Real bucking" is the point where the log is cut with a saw, and in the great majority of cases, it is the point where measurements are taken. Most logs are bucked perpendicular to the longitudinal axis, or "bucked off square", so it is only necessary to measure from the edge of one face to the edge of the other end face. Logs cut on the bias are measured from face to face through the geometric centre.

"Pencil bucking" refers to the act of recording one piece as two or more pieces (with a *pencil* and paper), as in the case of diameters less than 5 rads (10 cm). Scalers often mark the log at the point where the log becomes 5 rads in diameter, so that check scalers, and others, can confirm the recorded measurement.

"Conceptual bucking" is used where a scaler will think of a log as being segmented when assessing a log's volume and value, but does *not* record one piece as two or more pieces. In exercising the *grading concept* as it applies to crook and sweep for example, a scaler will view the log as being bucked into two or more pieces. Chapter 6 provides many examples of this type of "bucking". In determining volume, a scaler will often "visually fold in" a portion of a log to fill in a void, and measure a length from the point of the "buck". This Section provides examples for determining length. Different terms are used for this type of bucking, depending on locale. "visual bucking" and "mental bucking" are common expressions of the concept, and as computer usage increases in scaling, other terms such as "virtual bucking" are sure to appear, but they all mean the same thing.

The following figures and sub-sections demonstrate length measurement principles.

5.4.4.1 Length Rounding Conventions and Measuring Tools

Lengths are measured in metres to the nearest tenth of a metre (0.1 m or 1 dm) by using a scale stick or a steel tape calibrated to 0.05 m divisions. The steel tape is more accurate and preferred. Tapes *must* be used for measuring weight scale sample logs.

Where the measurement is 0.05 m or 0.5 dm from the nearest tenth of a metre, the length is rounded to the nearest even tenth of a metre.

Examples: 12.34 is recorded as 12.3

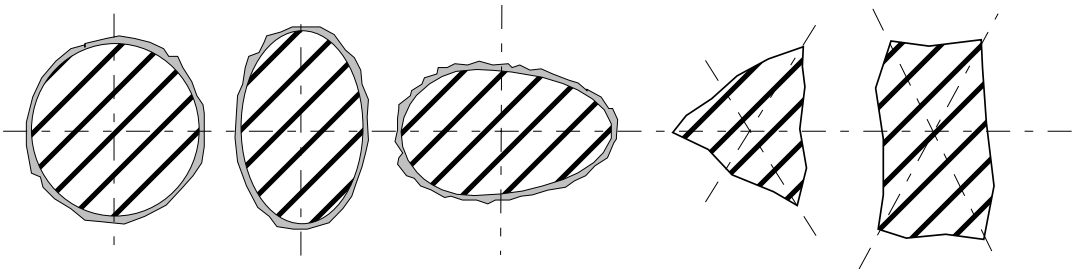
12.35 is recorded as 12.4

12.25 is recorded as 12.2.

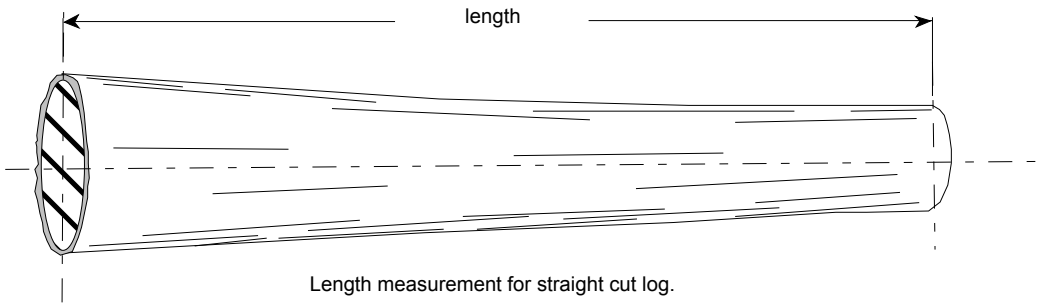
5.4.4.2 Finding the Geometric Centre of a Log for Length Measurement

Most logs are bucked perpendicular to their longitudinal axis and measuring from the edge of one end face to the matching edge of the other end face gives the same result. On bias cut ends, however, the scaler must estimate where the geometric centres are and then measure to these points as shown in Figure 5.25.

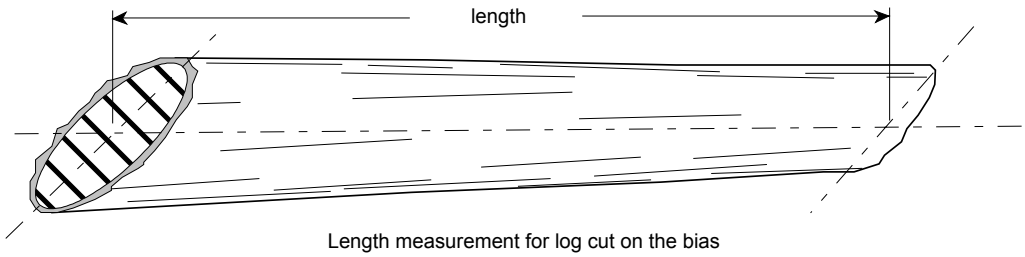
The geometric centre of a log is the point which is equidistant from the outer edges. It can be different from the "centre of gravity", which is found by the intersection of a line through the widest and narrowest points when measuring diameters. On round and elliptic logs, the centre of gravity is also at the geometric centre, but on oval and irregular shapes, it is not. See Section 5.4.1 for more information on diameter measurement.



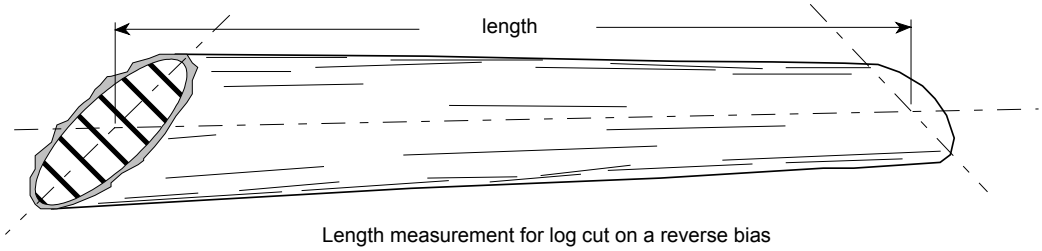
Geometric centres of log ends are equidistant from outside edge



Length measurement for straight cut log.



Length measurement for log cut on the bias



Length measurement for log cut on a reverse bias

Figure 5.25 Length measurement of logs through the geometric centre.

5.4.4.3 Measuring Lengths of Butt Logs With Undercut

Undercuts are not considered in length measurement, nor is the felling hinge. However, in the determination of net volume, a deduction for missing wood may be required, but normally, undercuts are not a significant volume loss because they tend to fall outside of the line of taper as shown by the dashed line in the figure below. It is also necessary to consider bias as shown in Figure 25, if present.

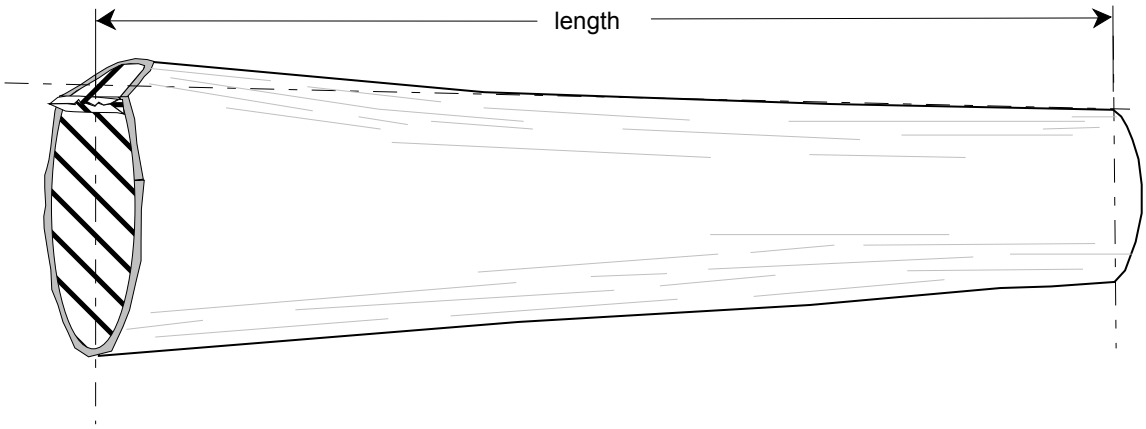


Figure 5.26 Length measurement of logs with undercut.

5.4.4.4 Measuring Lengths of Logs With Portions Under Ten Centimetres

The length of a log or slab is measured from where the log diameter or slab thickness first becomes 10 cm or greater when measuring from the smaller end, or top. Lengths for log diameters or slab thickness less than 5 rads must be recorded separately as firmwood rejects. These are instances where a single physical piece of timber is recorded as two separate scale data entries, or "pencil bucked". The log should be marked with crayon or paint at this point, to substantiate the point of measurement.

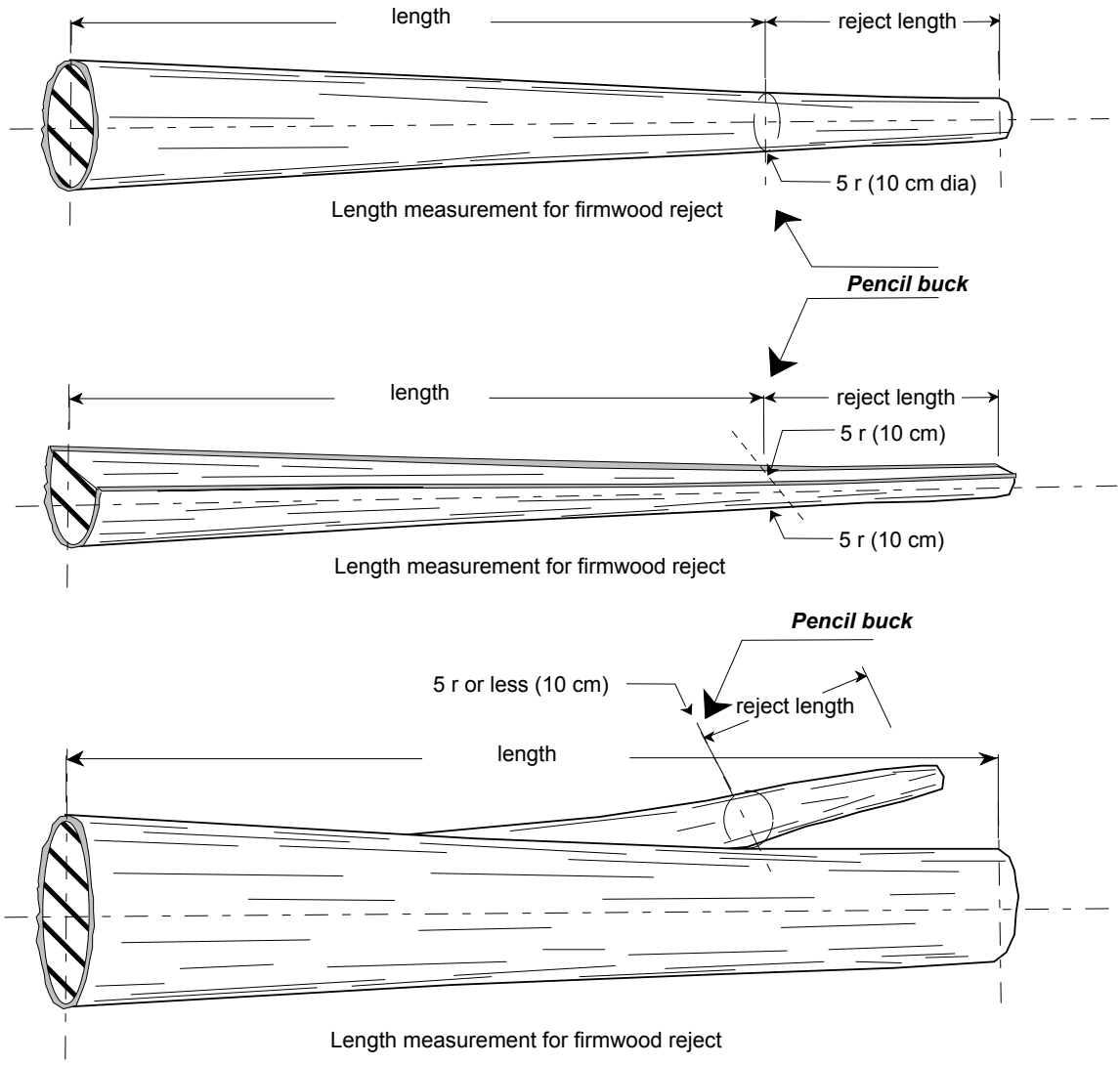


Figure 5.27 Length measurement of logs and slabs with segment under 10 cm.

5.4.4.5 Measuring Lengths of Logs With Shattered Ends

Logs with shattered ends offer another challenge. Shatter occurs when a log is stressed beyond its breaking point, and may or may not be "trimmed up" in the bucking process. The scaler must "visually fold in" the projections to compensate for the missing wood in the voids.

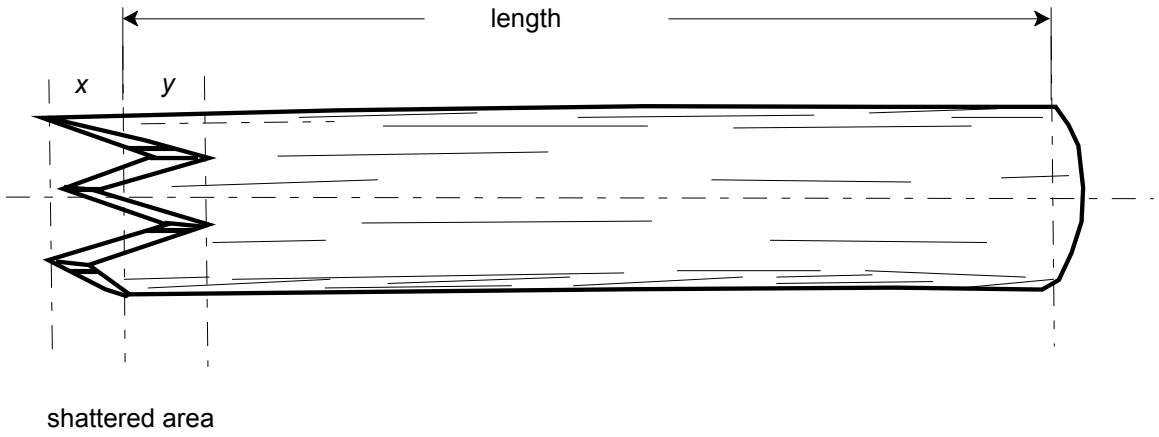


Figure 5.28 Length measurement of logs with shattered ends.

5.4.4.6 Measuring Lengths of Logs With Sniped Ends

Logs are often split off or "sniped" at one or both ends. Bending stresses cause the log to split before the buck is completed. Unlike shattered ends, where the scaler "folds back" protrusions to fill the voids and measures from that point, this type of log requires a firmwood deduction to account for the missing wood. Sections 5.5 through 5.9 discusses firmwood deductions.

Lengths are measured according to the following examples, starting at the point where the sniped end first becomes 10 cm thick. Measure the firmwood reject length from the "sniped" end to a point where the snipe first becomes 10 cm thick. A "pencil buck" occurs at this point, and the portion less than 10 cm must be recorded as a separate firmwood reject.

The following illustration shows two forms of sniping.

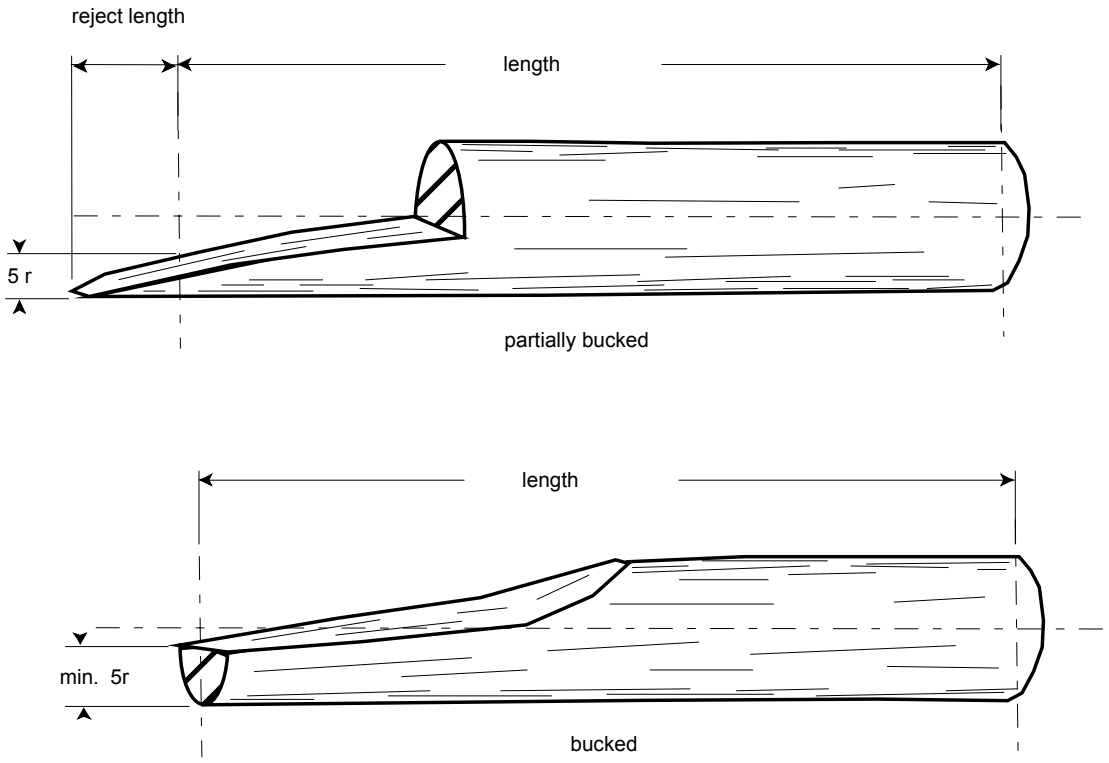


Figure 5.29 Length measurement of a partially bucked split-back (sniped) end.

5.4.4.7 Measuring Lengths of Logs With Missing Chunks

Sometimes a scaler will encounter logs with burned saddles or missing chunks in the central portion of the log. On such logs measure the gross length to the cut ends and make a firmwood deduction for the missing volume between the ends.

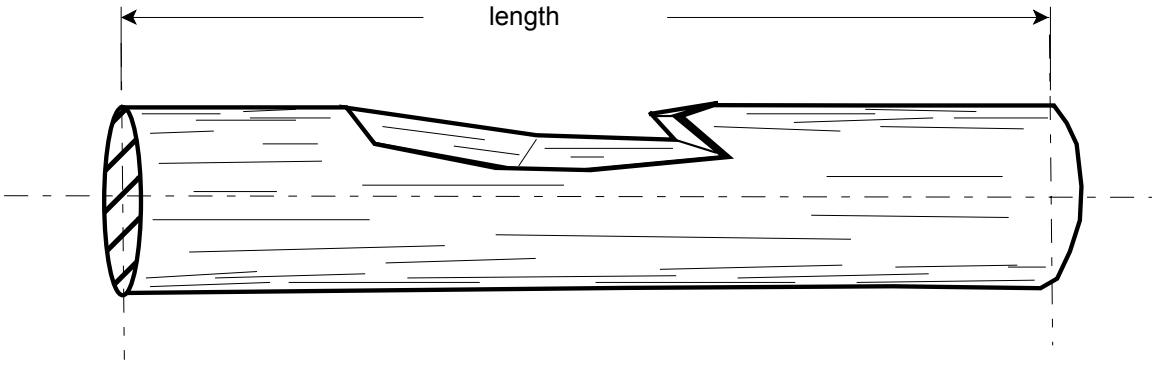


Figure 5.30 Length measurement of a log with missing chunk.

5.4.4.8 Measuring Lengths of Logs with Forks

Logs are often forked and normally come into a scaling yard already bucked off at or very near the juncture (crotch). The scaler is presented with a range of shapes depending on the relative fork sizes and where the bucks occurred, and not only is challenged to obtain a length, but also to find a diameter when forks are bucked at different lengths and different points.

In general:

Logs with forks bucked off at or near the crotch are scaled as one piece. The diameter or length may need adjustment in order to get a fair and accurate dimension for the log. See the section on diameter measurement for information on obtaining a diameter.

Logs with one fork remaining are scaled as one piece. If the attached fork approaches the size and taper of the main stem, the top diameter of the fork will serve as the top diameter of the log. If the fork is stunted in relation to the main stem, an increase in the top diameter may be required.

Logs with more than one fork remaining may be scaled as one piece if both forks are of similar size (30 percent) and the crotch occurs near the mid-point of the log length. Under these circumstances, it is possible to find the average diameter in rads of each stem, locate the unit volumes which correspond to the measurements, add the unit volumes, and locate a radius class unit closest to the sum. If the forks are of unequal length, an adjustment must be made to the log length to place it half way between the long and short fork.

If the forks are not similar in diameter and the crotch is not near the mid-point log length, they may be scaled as two or more pieces. Forks or portions less than 10 cm in diameter are also recorded as separate firmwood reject.

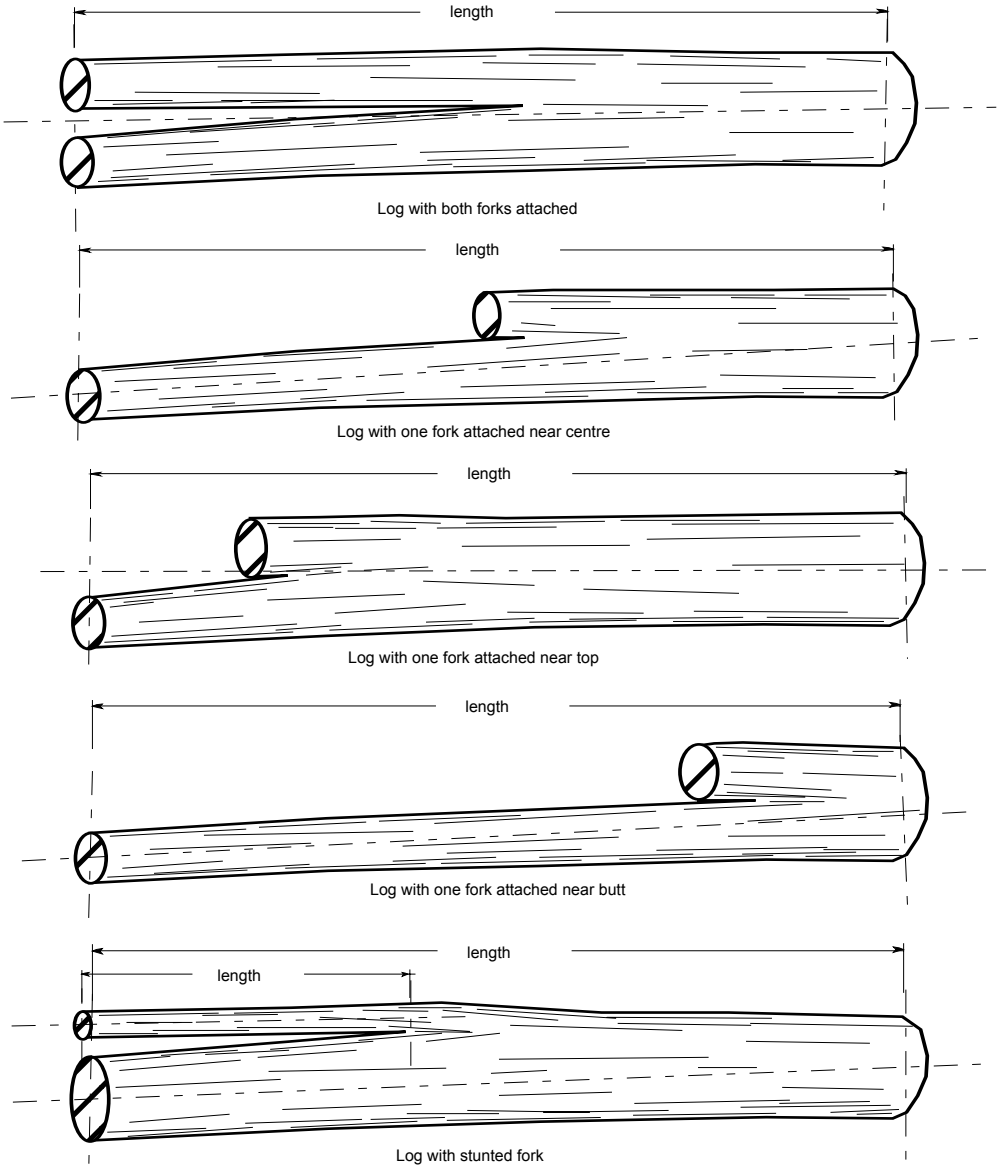


Figure 5.31 Length measurement of forked logs.

5.4.4.9 Measuring Lengths of Logs With Sweep

Length measurement for a log with sweep follows the contour through the geometric centre of the log.

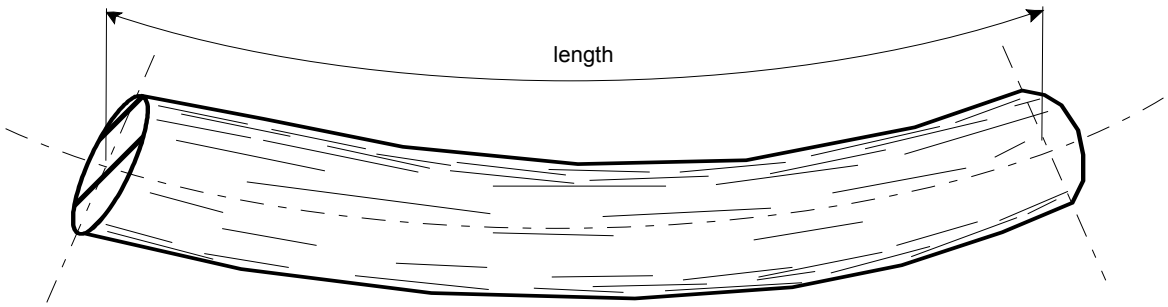


Figure 5.32 Length measurement of logs with sweep.

5.4.4.10 Measuring Lengths of Logs with Crook

Length measurement for a log with crook follows the contour through the geometric centre of the log.

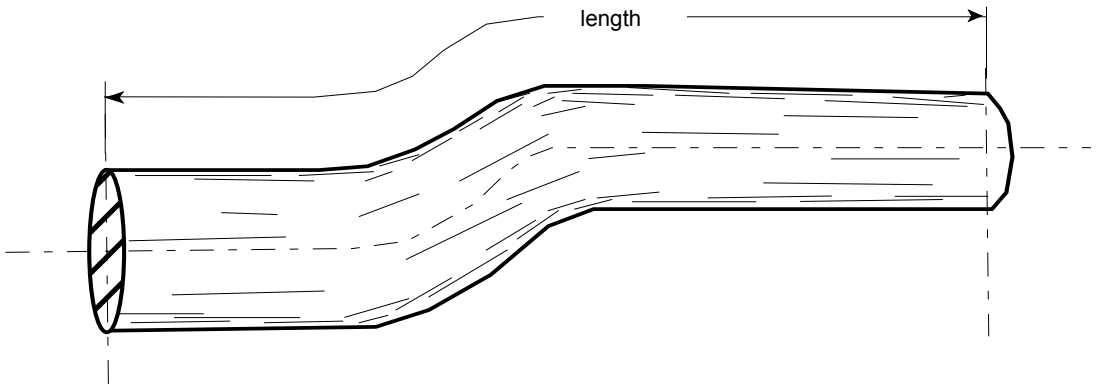


Figure 5.33 Length measurement of logs with crook.

Notes:

Notes:

5.5 Firmwood Deductions

5.5.1 Introduction to the Deductions Section

The following sections of Chapter 5 discuss the concepts of firmwood deduction and outline methods for determining the net firmwood content of logs containing defects. For each defect shape, there is a *formal calculation* and one or more examples of *field methods*.

The formal calculation can be thought of as the method a computer would use when presented with the required measurements and shapes. Apart from their inclusion in handheld scaling computer software, these formal calculations are most frequently used when analysing theoretical logs in a classroom setting, when dealing with particularly challenging or borderline logs or when arithmetic skills are strong and time is not a factor. Scalers with well developed arithmetic skills may wish to use some of them exclusively. They are expressed in full detail in Appendix 5B.

The field methods are based upon proven field experience and are provided for practicality and ease of use. Although the results often approximate those of the formal calculations, experience has shown that differences are rarely significant enough to be of concern because they tend to be "compensating errors". Compensating, or "self-cancelling" errors are discussed in Section 5.1.3. The field methods typically rely on reducing one or more of the gross dimensions of a log so that the recorded net dimensions closely reflect the net firmwood volume.

5.5.2 Firmwood Deduction Principles

Where the measurement sections of this chapter dealt with the more objective concepts of scaling, this section introduces many subjective concepts. Objective results are based on fact. That is, it is possible to perform most measurements and record the gross dimensions of a typical log by following standard procedures which do not vary, and are quite objective. Firmwood defects, on the other hand, can be subjective, or based on ideas and opinions gathered through experience. A reasonable estimation of the effects of internal rots where there are few indications of its presence, and no possibility of measurement is quite subjective. Through study, training, observation, and support from the scaling community in both industry and government, new scalers will gain enough experience to make judgements which are unbiased and within tolerances.

It is not the purpose of this manual to attempt to displace, and beyond the scope of this chapter to catalogue, the great amount of work which has been done in this area by generations of professional scalers.

5.5.3 Deduction Methods

The firmwood volume of timber excludes all rot, hole, missing wood, and charred wood. Although the current *Scaling Regulation* does not refer to missing wood as a separate entity from hole, missing wood has been added to scaling terminology to further define a hole. In scaling, a hole is a cavity or opening, such as a knot hole, an advanced heart rot, or an advanced butt rot. Missing wood refers to areas where wood is absent from a log that otherwise would be regarded as complete, such as sniped ends, equipment damage, and burn saddles. Deductions are made from the gross volume of a log for these defects as they occur. A deduction is made by subtracting the volume of the defect(s) from the gross volume of the log.

Two *field methods* of recording the outcome of a scale may used, depending on the tools available to the scaler:

- the *net dimensions method* is normally used when recording the scale on a paper form and consists of reducing the measured dimensions of the log so that the recorded net dimensions will calculate the correct firmwood volume, and

- the *gross/net method* requires the use of a hand held computer or an approved non-standard data capture form. Here the gross measurements of the log are recorded, as are the dimensions and form of the defect(s). The gross volume of the log and the volume of the defect are calculated and the latter is subtracted from the former to yield the net volume. Where this method is employed, the computer will produce a detailed log listing showing the gross volumes, defect types, defect volumes, and net firmwood volumes as well as facsimiles of the standard data submission forms such as the FS 531 and FS 72. For more detailed information on these forms see Chapter 7.

Where a formal calculation using formulas is rigid and structured, the field methods are more dynamic, allowing the scaler to use one or more proven methods to come up with an accurate result. Production scalers will soon adopt ways of bypassing excessive calculation if tools, such as computers or calculators, are not available to automate the process. Although the use of hand held computers is becoming common, all scalers must have the ability to scale without the use of them. It is a requirement of their certification to acquire and maintain competence in the traditional field methods.

5.5.4 Geometric Shapes

The approach taken for determining the net firmwood volume of a log are based on standard geometric shapes illustrated in Figure 5.34 that most closely approximate the form of a log and its defect. From careful study of the first part of this chapter on log measurement, it becomes clear that no new volumetric concepts are introduced; the shapes of logs, sectors, segments and slabs described earlier are able to be duplicated in virtually every defect shape by applying the standard shapes alone or in combination with others.

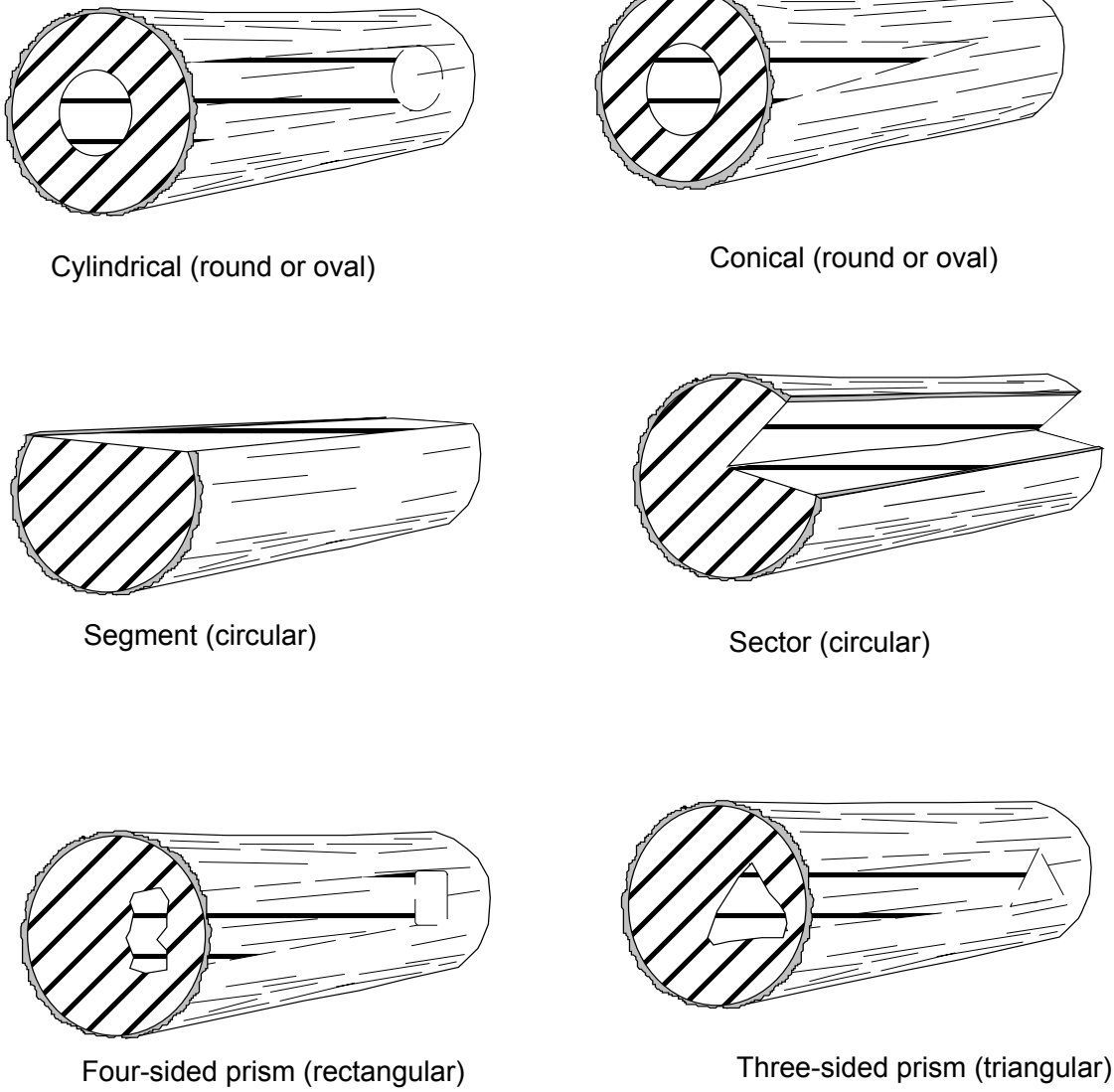


Figure 5.34 The geometric shapes used in scaling and firmwood deductions.

The shapes illustrated in Figure 5.34 are either round or oval in profile (cylindrical, conical, sectors, segments) or angular (three and four sided prism). The formulae are based on four geometric forms; the cylinder, the cone, the four sided (quadrilateral) prism and the three sided (triangular) prism.

Each procedure is described by example, using one or more proven field methods. The results of the formal calculations in *Appendix 5* are provided to substantiate the methods.

Net dimensions equivalent to net volumes are available to the scaler by calculating:

- a length deduction,
- a diameter deduction, or
- a combination of both, described below.

5.5.5 Length Deduction Method

Although this method requires more arithmetic, length deduction can be used for all defects and can accommodate a smaller defect than the diameter deduction method, in smaller diameter and longer logs. For this reason, the length deduction is very common in the interior of the province where logs tend to be somewhat smaller on average than in coastal regions. To perform a length deduction, the scaler must:

- first determine the volume of rot,
- then the average unit volume of the log, and
- finally divide the rot volume by the average unit volume of the log to find the required length deduction.

The length deduction is detailed in Section 5.8, and with practice, becomes easy to apply.

5.5.6 Diameter Deduction or Radius Reduction Method

Diameter deduction or radius reduction, as it is often called, is the easiest and quickest of the basic deduction procedures for a through running defect or a defect which is estimated to run half way through a log. The scaler has only to subtract the unit volume of the rot from the unit volume of the log and interpolate a radius class unit that most closely matches the result. However, when assessing an amount to deduct, it is easier to visualise the volume in a certain length of any size log than it is to visualise the volume contained in a certain diameter of any size log.

For example, in relation to length, a one metre segment of a 20 rad log contains 126 dm^3. A 1 rad diameter deduction (the minimum available) at both ends will reduce the volume by 13 dm^3. A length deduction of 0.1 m (the minimum available) will reduce the volume by roughly the same amount, so at this point the two methods increment equally. If the log were to be 10 m long, a 1 rad diameter deduction at both ends will reduce the volume by 130 dm^3, and a 1 rad deduction at one end will reduce the volume by 65 dm^3. The 0.1 m length deduction will reduce the volume by *the same 13 dm^3*.

In relation to diameter, a log with a 20 rad diameter at one end has a unit volume of 126 dm^3. A 1 rad deduction will reduce the volume to 113 dm^3, or by about 10 percent. A log with a 10 rad diameter at one end has a unit volume of 31 dm^3 and a 1 rad deduction will reduce the volume to 25 dm^3, or by about 19 percent. As the diameter of a log decreases, the proportion of volume in 1 rad of the outer circumference increases.

Although experienced scalers may apply either deduction where it is considered to be the closest reflection of the net volume, it is much easier for scalers to develop a sense of proportion by using length deductions.

If a scaler does not consider log length and diameter when making diameter deductions for defects which do not affect the full length or exactly half the length of a log, there is a risk of over-deducting. For this reason, diameter deductions are limited to defects which travel the length, or are estimated to travel exactly half the length of the log.

5.5.7 Rounding Net Volumes

Examples in this chapter will show slightly different volumes between the formal calculations and the field methods because the field methods rely on reducing gross dimensions to net dimensions which approximate the desired net volume.

Where either deduction method can be used, the one whose resultant net dimensions yield a volume closest to the calculated net volume is naturally the best. With experience, a scaler will begin to intuitively use an appropriate deduction for a given defect, keeping in mind that a length deduction will allow a finer increment of volume in smaller diameter and longer logs and a diameter deduction a finer increment of volume in large diameter and shorter logs.

The rounding convention described in Appendix 7B relates directly to computing devices and advises that a given number will round up on the exact 0.5. The use of a scale stick for average diameters or average unit volumes, or a tape for length, will round up or down to the nearest even number on the exact 0.5. Scalers must rely on one rounding convention which eliminates the possibility of bias (one up, one down). Although the two conventions appear to be in conflict, computers work in a different domain. For example, a hand held data capture unit is never required to average diameters or lengths; they are first averaged by the scaler, then entered into the unit.

5.5.8 Average Unit Volumes

References to *unit volumes* (UV) and *average unit volumes* (AUV) are made throughout this manual. A unit volume is simply the volume in dm^3, of a one metre length of a log. It is directly proportional to the end area, which in dm^2 is always 1/10 of the unit volume (or the area times 1 m). Unit volumes are read directly off the scale stick and because of their relation to end area, form the basis of comparison of defect proportion to firmwood proportion in the observation of a log. An *average unit volume* is the average of the unit volume of each end of a log.

Different terminology is used from region to region when discussing unit volumes, such as the *unit volume per metre (UVM), the factor*, the *one metre unit volume*, the *two metre half volume* or *one tenth of the ten metre volume*. These terms are derived from regional differences and the various approaches to finding a unit volume or an average unit volume on a scale stick, and should not be misinterpreted as something else; they are all in the same units, dm^3/m and are interchangeable.

> In this manual, unit volume, average unit volume and the abbreviations UV and AUV are used exclusively to reduce confusion of the novice scaler.

There are two simple ways to derive an average unit volume from the scale stick. Both are commonly used by scalers according to individual preference:

- in the first method, measure both ends of the log. Add the two corresponding unit volumes for the measured ends and divide by 2,
- in the second method, measure both ends of the log. Add the 10 m half volumes corresponding to the log ends and divide by 10, and
- rounding will often result in a difference of 1 dm^3 between the two methods . This difference is of no significance in unit volume calculations.

Section 5.3 of this chapter shows where unit volumes are located on the scale stick.

For example, to find the average unit volume of a log of a given length with a top diameter of 20 rads and a butt diameter of 32 rads.

To derive an average unit volume (AUV) from the scale stick by adding the unit volumes (UV) and dividing by two:

the UV of 20 rads	=	126 dm^3
plus the UV of 32 rads	=	322 dm^3
equals the sum of the UV's	=	448 dm^3
and divided by 2	=	224, the average unit volume.

To derive an AUV from the scale stick by adding the 10 m half volumes and dividing by ten:

the 10 m half volume of 20 rads	=	628 dm^3
plus the 10 m half volume of 32 rads	=	1608 dm^3
equals the sum of the half volumes	=	2236 dm^3
and divided by 10	=	224, again the same AUV.

Although simple enough to do, it is poor practice to take the short cut of averaging the top and butt diameters and finding the unit volume of the average, because it is not consistent with Smalian's formula, where the average of the end areas are required. As the spread between top and butt diameter increases, the degree of understatement will increase. Figure 5.2 includes a graph of the effect of averaging diameters. As shown in the following calculation:

the diameter of	=	20 rads
plus the diameter of	=	32 rads
equals	=	52 rads
and divided by 2 is	=	26 rads

The unit volume of 26 rads is 212 dm^3, or 12 dm^3 less the value found by averaging unit volumes in the two previous examples. While obtaining unit volumes from average diameters risks understatement of volume, scalers may do it where there is little spread between the two ends (no more than 4 rads different in diameter and both measurements are either even or odd). Beyond this range, adjustments must be made as demonstrated in Section 5.8.

5.6 Conventions for Estimating Rot

Where defects affect the heart of a log, scalers usually cannot see how far they penetrate its length. If indicators are present, rot penetration may be accurately estimated, but where there are none, conventions are employed. To provide consistent scaling practices and maintain sound scaling principles throughout British Columbia, basic conventions are outlined below to help the scaler in producing uniform and accurate results. In making volume deductions for defect, the scaler must pay close attention to the following conventions, which have been developed over many years of practical application. Other conventions may be developed from time to time to suit changing conditions. Scalers working in a new area should discuss local conditions with an experienced district scaling representative.

5.6.1 Standard Conventions

Firmwood deductions can be made only for rot, hole, missing wood, and charred wood. Although the current *Scaling Regulation* does not refer to missing wood as a separate entity from hole, missing wood has been added to scaling terminology to further define a hole. In scaling, a hole is a cavity or opening, such as a knot hole, an advanced heart rot, or an advanced butt rot. Missing wood refers to areas where wood is absent from a log that otherwise would be regarded as complete, such as sniped ends, equipment damage, and burn saddles. Deductions are made from the gross volume of a log for these defects as they occur. A deduction is made by subtracting the volume of the defect(s) from the gross volume of the log.

No firmwood deduction is made for discoloration or stain (incipient decay):

1. Until sufficient field experience is gained, the scaler may have difficulty determining the difference between stain or incipient decay (not a volume deduction) and bona fide rot. In scaling, rot is taken to be that level of decay where wood begins to lose its strength and fibre integrity. That is, when the attacking fungus has begun breaking down the cellulose and/or lignin (see Chapter 4 for more a more detailed discussion of fungal action).

2. The degree of deterioration is usually determined by using the tine of the scale stick, (or spud if so attached), to remove some wood from the suspect area and testing it for strength and fibre integrity by attempting to break and pull it apart with the fingers. Initially, or if uncertain, it may be beneficial to remove another sample of wood from a sound area of the log adjacent to the area suspected of being rotten. The two samples can be compared for relative strength and integrity.

No firmwood deduction is made for twist, sweep, crook, checks, stain, large knots or other quality considerations, even though these may indicate a grade *reduction*. A condition which may be considered a defect in a grade reduction is not necessarily considered to be a firmwood defect in a volume *deduction*. Firmwood scaling is concerned with determining the volume of sound or firm wood fibre in a log. Grading, on the other hand, is concerned with the potential quantity *and* quality of end product available from that log.

For the purposes of grading, the same formulae and methods described in this chapter may be used to calculate the portion of a log that can be manufactured into an end product. A "trim allowance" is added to certain defects before determining the grade reduction. Grading is detailed in Chapter 6.

5.6.2 Butt Rot Conventions

Butt logs are usually identified by observing the large end for flare, fluting, and/or faller's signs such as an undercut or hinge in hand fell trees, or the characteristic face left by a harvesting machine. It is important not to confuse heart rot and butt rot. Although heart rot may show in a butt cut log, and butt rot may show in a second cut log, the rot can usually be identified by its nature. For example, brown cubical butt rot is recognizable by the way the wood fibres are affected. As its name implies, the rot is brown, crumbly, and breaks easily into cubes. The "conk" rots, recognizable by the white, yellow, orange, or brown "fleck", are indicators of heart rots and are discussed in the following section on heart rot. Advanced scalers not only know the difference between, and the effects of, different species of rot, but also the variations in the effects by locale. The following basic conventions apply to butt rot:

1. Where rot appears only in the butt end of a butt log, treat it as butt rot unless other indicators are present, such as conk knots or conk rot.

2. Butt rot visible at the butt end only will be assumed to be conical in shape, with the same basal diameter as the average diameter of the visible end section of the rot.

3. Conical butt rot that extends the full length of a log may treated as though it is through running heart rot. However, if the rot diameter at the butt is greater than 1.5 times the rot diameter at the top, the cylinder (Smalian's) formula will tend to over deduct the volume of rot, and averaging the diameters will understate the volume of rot. If bucking is impossible, adjustments are required. There are two ways to do this; if using the cylinder formula, the rot diameter at the butt may be reduced to the difference between the calipered butt diameter and twice the average collar thickness. If averaging the diameters, the result will be closer to true defect volume of the neiloid or "golf tee" shape typical of logs with a high degree of flare. By adding 1 rad to the average, the result will be closer when the defect is a frustrum of a cone. The cylinder formula is suitable for rot shapes which are parabaloid (bullet shape). Section 5.8.2 provides example calculations to demonstrate the two concepts.

4. The diameter of butt rot used for deduction calculations must not exceed that of the recorded butt measurement where the actual measurement of butt rot exceeds the line of normal taper. This is a common occurrence in decadent logs with a great deal of butt flare.

There are many factors which affect the distance butt rot runs up from the stump; species, flare, taper, size, and age all contribute. Without indicators to establish rot penetration, it becomes necessary to estimate the length of the rot. Through decay studies, mill studies, and experience, the following conventions have been found to be reliable in most cases:

1. In the British Columbia interior, the average distance which butt rot travels in most logs is approximately 15 times the radius of the rot in centimetres, if there are no indicators to the contrary. For example, if the radius is 25 cm, (same as the diameter in rads), 25 x 15 = 375 centimetres, or 3.75 m. The penetration is therefore 3.8 m (rounded).

2. In coastal areas of British Columbia, butt rot, butt shake and related butt defects have the length of defect estimate based on the relation between the defect diameter and the recorded butt diameter of the log.

Where rot measures	It often penetrates
1/4 of the recorded butt dia.	1.8 - 2.4 m
1/2 of the recorded butt dia.	3.6 - 4.2 m
3/4 of the recorded butt dia.	5.4 - 6.0 m
4/4 of the recorded butt dia.	7.2 - 7.8 m

These figures may be adjusted slightly up or down depending on the species and visible butt flare. Douglas -fir and spruce, having pronounced butt flare may use the lower figure mentioned as butt rot in these species usually does not run far past the flare. In hemlock, balsam, and sometimes red cedar, where butt flare is minimal, rot may run further into the log and a larger estimate is required. These are general guidelines only.

The Forest Service may endorse other conventions, which are applicable to regional conditions.

5.6.3 Standard Heart Rot Conventions

Where Chapter 4 provides a general view of rot fungi, the following sections describe the treatment of rots in making firmwood deductions. Chapter 6 details the treatment of these rots for grading purposes.

1. Decayed heart wood may be visible at one or both ends of a log and will usually be circular or semicircular in shape. Its presence may only be indicated by rotten knots, or "conk".

2. If heart rot appearing at the end of a log is scattered or sporadic in nature, the cylinder of rot must be reduced in diameter to accommodate the firm wood scattered within the rot.

5.6.3.1 Heart Rot Visible at Both Ends

1. If rot is visible at both ends of the log, scale out the cylinder of rot as if it were a log inside the first log. The volume of the inner cylinder is the volume of the rot.

2. If rot is visible at both ends of the log, they are presumed to be connected unless there are indications to the contrary. For example, if different species of rot show at the ends, they may not be connected.

5.6.3.2 Heart Rot Visible at One End Only

1. Heart rot, pocket rot, ring rot, and similar defects when showing in only one end of the log are presumed to run half the length of the log to a maximum of 6 metres, unless there is evidence to the contrary. In all cases, good judgement must be used. Where local experience indicates otherwise, the Forest Service may order that this maximum be reduced, and in the interior regions of British Columbia where timber types are different, the *maximum is set to 4 metres*. Local experience is gained by observation of the bucking and manufacturing process.

2. In heart defects with only one end visible, the diameter of the defect at the unseen end is assumed to be the same as at the measured end where the defect penetrates 1/2 way or less. However, in logs where the rot penetrates more than 1/2 way, this assumption is less reasonable, and the Forest Service may order that logs be bucked prior to scaling to improve accuracy. If bucking is impossible, the ratio of the area of the rot to the area of the end which the rot occurs must be maintained at the unseen end, or an overdeduction will result. A shortcut method to calculate a length deduction where the defect is estimated to penetrate more than 1/2 way is:

$$\frac{\text{Unit Volume rot}}{\text{Unit Volume log end}} \text{ x length of rot} = \text{length deduction}.$$

5.6.3.3 Assessing Conk, Indian Paint Fungus and Pin Rot

While "Conk" is the name used for the mushroom-like fruiting body often seen on standing timber which indicates a fungal invasion of a tree, for scaling purposes conk refers to the types of rot which attack lignin (the glue) and leaves cellulose fibre more-or-less intact. It includes "white rot", "pin rot", and "paint brush". In the early stages the wood is only stained purple or light red and requires no firmwood deduction. In later stages, the wood breaks down to form a honeycomb appearance, identifiable at the end of a log by the white, yellow, orange or brown "fleck" (sometimes called "peck" and "white pocket") that distinguishes all conk rots.

During logging operations the external conk indicators are usually knocked off, leaving brown, yellowish brown, and/or orange powdery residues at the entry points. These residues are what a scaler looks for in assessing a log, because their presence indicates a very high probability of extensive conk rot. Conk knots should not be confused with rotten branch stubs, which may not indicate the presence of heart rot. Observation of the ends of logs, where they have been bucked through rotten knots, will indicate the differences in appearance.

Generally, the point of deepest penetration of conk rot is where a fruiting body enters the log. It commonly takes the shape of a crescent, and continues to spread through the cross-section of the tree. It can form into one or more full rings, which tend to follow the growth rings. Eventually it effects the entire heart. In the various configurations, firmwood deductions are taken according to the basic shape which is most suitable.

If rot does not show at either end of the log but its presence is indicated by conk knots, the challenge is to make a reasonable determination of its range, based only on its indicators. The indicators and the assessment of them are described in the following Section on conk rots.

5.6.3.3.1 Basic Conk Assessments

Because of the variability of the effects of conk, not only by species but by the tree species and location around the province, it is very difficult to establish with conviction any conventions which will have universal application. Mill visits and experience are essential for a scaler to learn to interpret the meaning of conk indicators. In general:

1. Conk can appear in several ways on logs and the estimates for making firmwood deductions and grading are affected by the indicators present. The location of conk knots and the diameter of rot on log ends may be used to estimate the distance that rot travels. That is, the observation of these relationships will help indicate whether the rot is getting worse down the log or "running out".

2. When conk stain or conk rot shows in log end(s) carefully look for conks on the log. Use the tine of the scale stick or a spud to dig into swollen spots, punk knots, and black knots. Size of conks is sometimes helpful in determining the extent of rot in some species.

3. Where there are two or more indications of conk, they are presumed to be connected.

4. If, among the enclosed rot, there is a substantial amount of firm wood that can be recovered in chips, then the defect diameter should be reduced proportionately for the firmwood volume determination.

5. In logs where conk shows in one or more knots and only a small amount of rot is present in the log end, and the scaler is positive that the rot showing in the end is not representative of the severity of the defect, then the firmwood deduction may be increased to one half the length that the conk is estimated to extend.

6. Where very large and/or numerous conks are present, an additional length deduction may be required to compensate for the "funnel" effect of the path of rot from the outside of the tree into the central cylinder of rot. In no case will this deduction exceed 0.1 m for every two knots.

5.6.3.3.2 Assessing Conk Rot; Visible Conk Knot(s), No Rot Visible

If the scaler observes conk knots but no rot shows at the ends of a log, the following conventions are commonly used:

1. Conk rot generally extends further down from a conk knot than up. Experience has shown that, in coastal regions of British Columbia, given no other indicators to the contrary, it may be presumed that the conk rot extends 2.4 m above the highest conk knot and 3.6 m below the lowest conk knot. In the interior regions of British Columbia, with different timber types, conk rot extends, on the average, 1 m above the highest conk knot and 2 m below the lowest conk knot. Where a conk knot is located closer to the top end or closer to the butt end than the above conventions, presume that the defect will travel one half the distance between the last knot and the log end.

2. When a conk knot is the only indication of conk and the severity of the rot is unknown, the firmwood deduction is calculated as one half the estimated length of the defect in coastal regions, and in interior regions, the diameter of the rot is assumed to be one-half the average diameter of the log for the full length of the defect.

3. Where there are conk knots and no sign of rot at the ends of a log, the scaler should, if possible, have the log bucked and/or observe the processing of the log to get a better idea of the internal effects of conks in their area.

5.6.3.3.3 Assessing Conk Rot; Visible Conk Knot(s), Rot Visible at One End

If a scaler observes one or more conk knots and conk rot showing in one end of a log, the following guides will serve in the assessment of the log:

1. Where conk shows in the top end of a log and there are conk knots, the rot should be run the greater distance of half the log length to a maximum of (6 m coast/ 4 m interior), or (3.6 m coast/ 2 m interior) below the last conk knot. If the last conk knot is closer to the butt end than (3.6 m coast/ 2 m interior), it may then be presumed to travel one-half the distance between the knot and the butt end.

2. Where conk shows in the butt end of a log and there are conk knots, the rot should be run the greater distance of half the log length to a maximum of (6 m coast/ 4 m interior), or (2.4 m coast/ 1 m interior) above the last conk knot. If the last conk knot is closer to the top end than (2.4 m coast/ 1 m interior), it may then be presumed to travel one-half the distance between the knot and the top end.

3. Where conk rot is visible in the butt end of a butt cut log, and there are conk knots present, the rot may be treated as conk rot, not butt rot. Therefore, it is scaled as a cylinder extending from the butt end, rather than as a cone.

5.6.3.3.4 Assessing Conk Rot; No Visible Conk Knot(s), Rot Visible at One End

1. Where conk rot is visible in one end of a log and there are no conk knots present, the rot is presumed to travel half the length of the log to a maximum of 6 m in coastal regions and 4 m in interior regions.

5.6.3.4 Assessing Goitre

Goitre is a swelling or abnormal growth on the bole of a tree and rot may be associated with this defect. Internal rot seldom travels more than 1 m above and below the goitre. The volume of the rot may be assumed to be one-half of the volume of the log in the same length. For example, if the rot is estimated to travel two metres, the volume deduction will be 1 m of length.

5.6.4 Ring Rot Conventions

1. Ring rot often does not form a complete circle. The volume should be calculated as if it were a full circle, then a factor of the circumference of the ring divided by the full circle is applied to obtain the true volume. That is, if the ring travels approximately two thirds of the way around its circumference, the "unit volume" or factor of the ring area is also two thirds of what a full circle of rot would be.

2. If there is more than one ring of rot, the firmwood deduction is taken progressively, from the outside rings to the inside rings.

3. When estimating the distance that ring rot travels down a log, use the same conventions as used in the heart rots, or conk rot, if there is evidence of conk.

5.6.5 Pocket Rot Conventions

1. Pocket rot, unlike heart rot, is not confined to growth rings and is therefore not often circular in profile. Each segment of decay may be enclosed in an area which most resembles the shape, four-sided, triangular or circular. Sections 5.1 through 5.4 define ways to enclose log segments and sectors for finding their volumes, and these same methods apply equally to irregular rot shapes. When calculating a deduction, the scaler then uses a method appropriate to the chosen shape.

2. Where multiple pockets of rot are present, and are less than 5 rads apart, experienced scalers group the individual rot volumes together visually rather than carrying out a number of discrete calculations. An example of enclosing pockets is provided in Section 5.8 (triangular defect).

3. When estimating the distance that pocket rot travels down a log, use the same conventions as used in the heart rots, including conk rot, if there is evidence of conk.

5.6.6 Sap Rot Conventions

In some scale settings, logs having sap rot for the full diameter and length of a log are scaled with the rot included in the gross scale, and the rot is deducted. This is the "gross-net" scale method. In others, the rotten sapwood, like the bark, is disregarded. This is the "net" scale method:

1. To obtain a net scale, simply measure the diameter of the sound core inside the rotten sapwood.

2. To obtain a gross-net scale, scale the outside diameter of the log, (the gross scale), scale the sound core of wood inside the rotten sapwood (the net scale). The difference between the gross scale of the outer scaling diameter and the net scale of the inner scaling diameter will be the deduction volume if no other defects are present.

3. If sap rot travels one half the length of a log, a diameter deduction (radius reduction) may be taken at one end. If it travels the full length, a diameter deduction (radius reduction) may be taken at both ends.

5.7 Measurements Required

Where Sections 5.1 through 5.6 concentrate on how to measure logs and slabs, firmwood deduction concepts, and common conventions used in estimating unseen defects, this section lists the essential measurements required to arrive at gross volumes, rot volumes, and net volumes.

To find gross volume, defect volume and net volume, the following measurements are required (defect measurements specific to type of defect are listed)and are found by using the methods described in Sections 5.1 through 5.5. Where an estimation is required, the means to arrive at a reasonable value is described in Section 5.6.

5.7.1 Measurements for Gross Volume

- the length of the log in metres to the nearest tenth of a metre, and
- the diameter of both ends of the log in rads (i.e., the radius in cm).

5.7.2 Measurements for Defect Volume

5.7.2.1 Butt Defect - Partial Length of Log

- the estimated defect length in metres to the nearest tenth of a metre, and
- the defect diameter visible at log end in rads.

5.7.2.2 Butt Defect - Through running

- the defect length in metres to the nearest tenth of a metre, (the same as the measured log length), and
- both defect end diameters in rads.

5.7.2.3 Heart Defect - Through Running

- the defect length in metres to the nearest tenth of a metre, (the same as the measured log length), and
- both defect end diameters in rads.

5.7.2.4 Heart Defect - Partial Length of Log

- the estimated defect length in metres to the nearest tenth of a metre, and
- the defect diameter visible at the log end in rads.

5.7.2.5 Ring Defect - Through Running

- the defect length in metres to the nearest tenth of a metre (the same as the measured log length),
- the outside diameter of the ring defect at the top end in rads,
- the inside diameter of the ring defect at the top end in rads,
- the outside diameter of the ring defect at the butt end in rads, and
- the inside diameter of the ring defect at the butt end in rads.

5.7.2.6 Ring Defect - Partial Length of Log

- the estimated defect length in metres to the nearest tenth of a metre,
- the outside diameter of the ring defect visible at the log end in rads, and
- the inside diameter of the ring defect visible at the log end in rads.

5.7.2.7 Sapwood Defect

- the defect length in metres to the nearest tenth of a metre,
- the net top end diameter (inside the defect) in rads,
- the net butt end diameter (inside the defect) in rads.

5.7.2.8 Pocket Defect - Through Running

- the defect length in metres to the nearest tenth of a metre (the same as the measured log length),
- if four-sided, the height and width of both defect ends in rads, and
- if round or out of round, the diameters at both ends in rads, and
- if triangular, the base and height at both ends in rads.

If multiple, the defects can be amalgamated or grouped together to form one defect.

5.7.2.9 Pocket Defect - Partial Length of Log

- the estimated defect length in metres to the nearest tenth of a metre,
- if four-sided, the height and width of the defect visible at the log end in rads,
- if round or out of round, the diameter visible at the log end in rads, and
- if triangular, the base width and height visible at the log end in rads.

If multiple, the defects are amalgamated or grouped together to form one defect.

In pocket defects with only one end visible, the diameter of the unseen end is assumed to be the same as at the measured end.

5.7.2.10 Catface Conical

- the defect length in metres to the nearest tenth of a metre, and
- the width and height (big end) of the defect in rads.

5.7.2.11 Catface Double Conical

- the defect length in metres to the nearest tenth of a metre, and
- the width and height at the largest point (usually near the middle) of the defect in rads.

5.7.2.12 Missing Wood and Other Surface Defects

- The length of the log in metres to the nearest tenth of a metre,
- the calipered diameters of both ends of the log at the points where the log is not affected by the defect,
- a factor for the missing portion of the log, or
- the measurements required for the shape of the defect in rads.

5.7.3 Determining Net Volume

5.7.3.1 Net Volume Using Gross/Net Method

To obtain the net volume of a log with defect(s), follow these steps:

- calculate the gross volume of the log,
- calculate the volume of the defect(s), and
- subtract the defect volume from the gross volume to get the net volume of the log.

If using a computer equipped with scaling software:

- enter the dimensions of the log,
- enter the type and required dimensions of the defect(s), and
- compute the net volume.

5.7.3.2 Net Volume Using Net Method - Length Deduction

To obtain a net length equivalent to the net volume for a log, follow these steps:

- calculate the average unit volume of the log,
- calculate the volume of the defect,
- divide the volume of the defect by the average unit volume of the log, (the result is the length in metres to be deducted), and
- subtract the deduction from the measured length of the log.

The result is the net length of the log to be recorded.

5.7.3.3 Net Volume Using Net Method - Diameter or Radius Deduction

Diameters measured in rads are equivalent to radii in cm, so this method may be called either the diameter or the radius deduction. It may be used only in defects which travel the full length or which are estimated to travel one half the length of a log.

To obtain a net diameter equivalent to the net volume for a log, follow these steps:

- measure the diameter of the log at the defect end and obtain the unit volume of that end of the log from the scale stick,
- measure the diameter of the defect and obtain the unit volume of the defect from the scale stick,
- subtract the defect unit volume from the unit volume of that end of the log to obtain the net unit volume, and
- locate a diameter on the scale stick with a unit volume closest to the net unit volume.
- repeat the above steps if the defect travels the full length of the log.

The result is the net diameter in rads or the radius in cm to be recorded.

5.8 Examples and Calculations

5.8.1 The Relationship of Field Methods to Formulas

In field methods, formulas are not normally used unless a hand-held computer is available and approved for use of the gross-net method of scaling (Section 5.5.3). Examples in this chapter may show slightly different volumes between the formal calculations and the field methods because the field methods rely on reducing gross dimensions to net dimensions which approximate the desired net volume. These differences, which show in the examples in this chapter, are not considered significant enough to be of concern.

5.8.2 Conical Defects

5.8.2.1 Butt Rot (Conical)

This method of calculation is usually used for defects found in and confined to the butt end of a first cut or butt (flared) log (i.e., butt rot), but this method may be used for all defects that have a geometrical shape of a cone or portion of a cone.

5.8.2.1.1 Example and Illustration - Butt Rot Visible at Butt End of Log

Figure 5.35 depicts a typical log harvested from an interior region of British Columbia with conical butt rot measuring 25 rads in diameter and estimated to penetrate 15 times the radius, or 3.8 m.

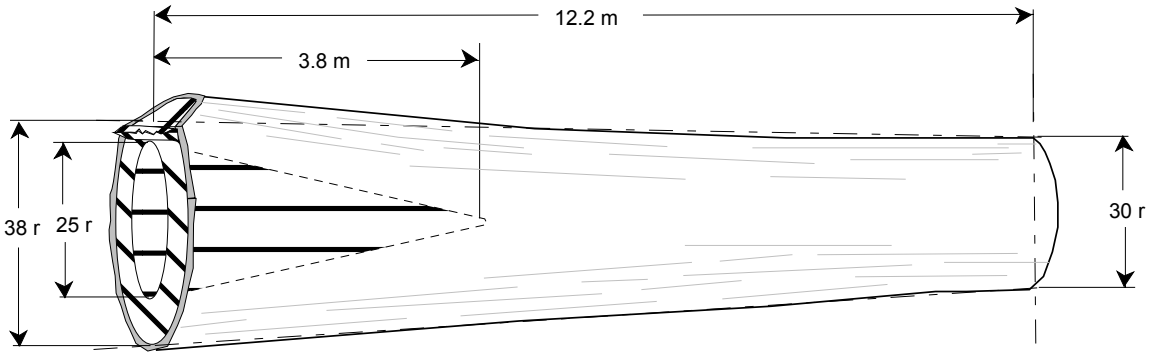


Figure 5.35 A log with butt rot - one end visible.

5.8.2.1.2 Formal Calculation - Butt Rot Visible at Butt End of Log

Using the cone deduction formula described in Appendix 5B, the net volume of the log is calculated to be 4.243 m³.

5.8.2.1.3 Field Calculation - Length Deduction - Butt Rot Visible at Butt End of Log

The gross length of a log is reduced by an amount equal to the defect volume. The result is a log with a net length equal to the net volume.

Defect volume:

Half volume of 3.0/25	=	295 dm³
Half volume of 0.8/25	=	+ 78 dm³
Half volume of 3.8/25	=	373 dm³
Full volume of 3.8/25	=	746 dm³ (2 x 373)

Divide cylinder volume by three to obtain the volume of the defect:

746 divided by 3	=	249 dm³

Calculate the average unit volume (AUV) of the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten.

Half volume of 10.0/30	=	1414 dm^3
Half volume of 10.0/38	=	+ 2268 dm^3
Full volume of 10.0/30/38	=	3682 dm^3
Full volume of 01.0/30/38	=	368 dm^3 (AUV)

Or, calculate the average unit volume of the log by adding the unit volumes of the end measurements and dividing by two:

unit volume of 30	=	283 dm³
unit volume of 38	=	+ 454 dm³
Total	=	737 dm³
Divided by 2	=	368.5 dm³ = 368 dm³ (AUV)

Calculate the length deduction by dividing the defect volume by the average unit volume of the log:

$$\frac{249}{368} = 0.677 \text{ m}$$

The length deduction rounded is 0.7 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

12.2 - 0.7	=	11.5 m
Volume	=	4.234 m^3 or 4234 dm^3

Record the net dimensions as 115 30 38

5.8.2.1.4 Example and Illustration - Butt Rot Visible at Both Ends of Log

Figure 5.36 depicts a typical log with conical butt rot measuring 30 rads and 6 rads in diameter and penetrating the full length of the log. Because the rot diameter at the butt is more than 1.5 times the rot diameter at the top, and the shape is the frustum of a cone, (30/6 = 5 times), an overstatement of the defect volume will result from summing the half volumes or from finding the average unit volume, and an understatement of the defect volume will result from averaging the diameters. Although it is possible to arrive at the volume of rot using a formula for the frustum of a cone in these cases, it is not yet practical to apply as a field method.

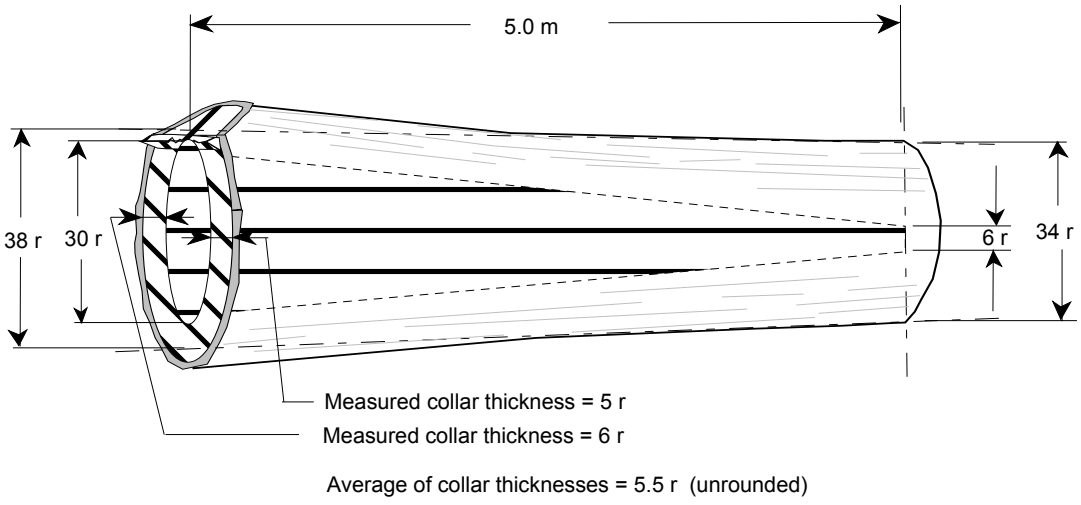


Figure 5.36 A log with butt rot - through running

5.8.2.1.5 Formal Calculation - Butt Rot Visible at Both Ends of Log

Using the cone deduction formula (frustum) described in Appendix 5B, the net volume of the log is calculated to be 1.457 m^3.

It is the general rule to treat butt defect as conical, and in many geographical areas, no other treatment is used. However, intimate experience with certain species and growth conditions may indicate that a neiloid (golf tee) shape or a parabaloid (bullet) shape is valid (see Figure 5.1). In these cases, different field approaches may be used for through running defects with extreme taper (the ability to use these parameters is governed by local conditions).

1. If the shape is assumed to be neiloid, average the diameters.

2. If the shape is assumed to be parabaloid, use the average of the end areas.

3. If the shape is assumed to be conoid, use one of the two following field methods.

5.8.2.1.6 Field Calculation - Length Deduction

The gross length of the log is reduced by an amount equal to the defect volume. The result is a log with a net length equal to the net volume. When conical butt rot projects through to the top end of a log it becomes a frustum of a cone. There are two field methods to arrive at the defect volume without resorting to excessive calculation:

Method 1. Determine the difference between the calipered butt diameter and twice the average collar thickness to obtain a reduced rot diameter at the butt (collar measurements are required at the butt to determine average collar thickness).

Calipered butt diameter	=	38 rads		
(Measured rot diameter	=	30 rads)		
Average collar thicknesses	=	$\frac{5 + 6}{2}$	=	5.5 rads
Twice av. collar thickness	=	5.5 x 2	=	11 rads
Reduced butt rot diameter	=	38 - 11	=	27 rads

Defect volume:

Half volume of 5.0/06	=	28 dm^3
Half volume of 5.0/27	=	+ 573 dm^3
Full volume of 5.0/06/27	=	601 dm^3

Method 2. Average the top and butt defect diameters. But because the rot is conoid and taper is extreme, add 2 rads to the average, (i.e., where the defect diameter at the butt exceeds the defect diameter at the top by:

< = 1.5 times, use the average
> 1.5 times and = < 2 times, use the average plus 1 rad
> 2 times, use the average plus 2 rads.

Average defect diameter	=	$\frac{6 + 30}{2}$	=	18 rads
Adjusted defect diameter	=	18 + 12	=	20 rads

Defect volume:

Half volume of 5.0/20	=	314 dm³
Half volume of 5.0/20	=	+ 314 dm³
Full volume of 5.0/06/20	=	628 dm³

Calculate the average unit volume (AUV) of the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten.

Half volume of 10.0/34	=	1816 dm^3
Half volume of 10.0/38	=	+ 2268 dm^3
Full volume of 10.0/34/38	=	4084 dm^3
Full volume of 1.0/30/38	=	408 dm^3 (AUV)

Calculate the length deduction by dividing the defect volume by the average unit volume of the log:

From method 1:	$\frac{601}{408}$	=	1.47 m
From method 2:	$\frac{628}{408}$	=	1.53 m

The length deduction is rounded to 1.5 m and negates the difference between the two concepts in this case. It is prudent to compare the two methods from time to time; the standard for comparison is the formula for the frustum of a cone in Appendix 5B.

Calculate the net length by subtracting the length deduction from the gross length of the log.

5.0 - 1.5	=	3.5 m
Volume	=	1.429 m³ or 1429 dm³

Record the net dimensions as 035 34 38

5.8.2.2 The Catface (Conical)

5.8.2.2.1 Example and Illustration - Single Catface

In the example illustrated on the next page (Figure 5.38), a portion of the tree's circumference has been scarred. As a result, it does not form a cylinder for part of its length. Where the catface tapers out as illustrated, the defect approximates the shape of a segment of a cone.

This log is 7 m long with a 20 rad top and a 24 rad butt. The conical catface is 4.8 m long and is 18 rads wide by 10 rads deep at the butt face.

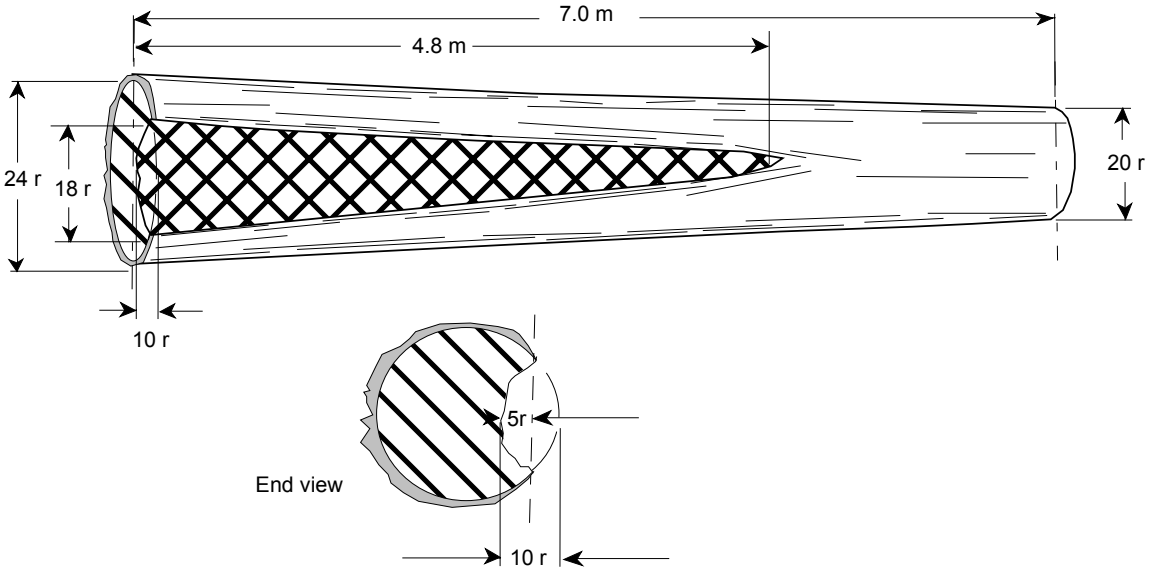


Figure 5.37 A log with conical catface.

5.8.2.2.2 Formal Calculation - Single Catface

Using the cone deduction formula described in Appendix 5, the net volume of the log is calculated to be 0.974 m³.

5.8.2.2.3 Field Calculation - Length Deduction

Calculate an end defect measurement in rads by dividing the sum of the width and height by 2.

$$\frac{10 + 18}{2} = 14 \text{ rads}$$

Calculate the defect volume by first looking up the half volume for 4.8 m 14 rads.

Half volume of 4.0/14	=	123 dm^3
Half volume of 0.8/14	=	+ 25 dm^3
Half volume of 4.8/14	=	148 dm^3

Next calculate the full volume by multiplying the half volume by two.

148 x 2	=	296 dm^3

Finally calculate the volume of the cone by dividing the cylinder volume by three.

$\frac{296}{3}$	=	99
Defect volume	=	99 dm^3

Calculate the average unit volume of the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10, or by adding the unit volumes of the measurements and dividing by 2.

Half Volume of 10.0/24	=	905 dm^3
Half Volume of 10.0/20	=	+ 628 dm^3
Full Volume of 100/20/24	=	1533 dm^3
Unit volume of 010/20/24	=	153 dm^3 (AUV)

Calculate the length deduction by dividing the defect volume by the unit volume of the log.

$\frac{99}{153}$	=	0.64 m

Length deduction is rounded to 0.6 m.

Calculate the net length of the log by subtracting the length deduction from the gross length of the log.

7 m - 0.6 m	=	6.4 m
Volume	=	0.981 m^3 or 981 dm^3

Record the net dimensions as 064/20/24.

5.8.2.3 The Catface (Double Conical)

5.8.2.3.1 Example and Illustration - Double Catface

In Figure 5.38 a full double conical catface affects a 7 m log. A portion of the tree's stem has been scarred and does not form a cylinder for part of its length. Where the catface tapers out on both ends as illustrated, the defect approximates the shape of two cones attached at the base.

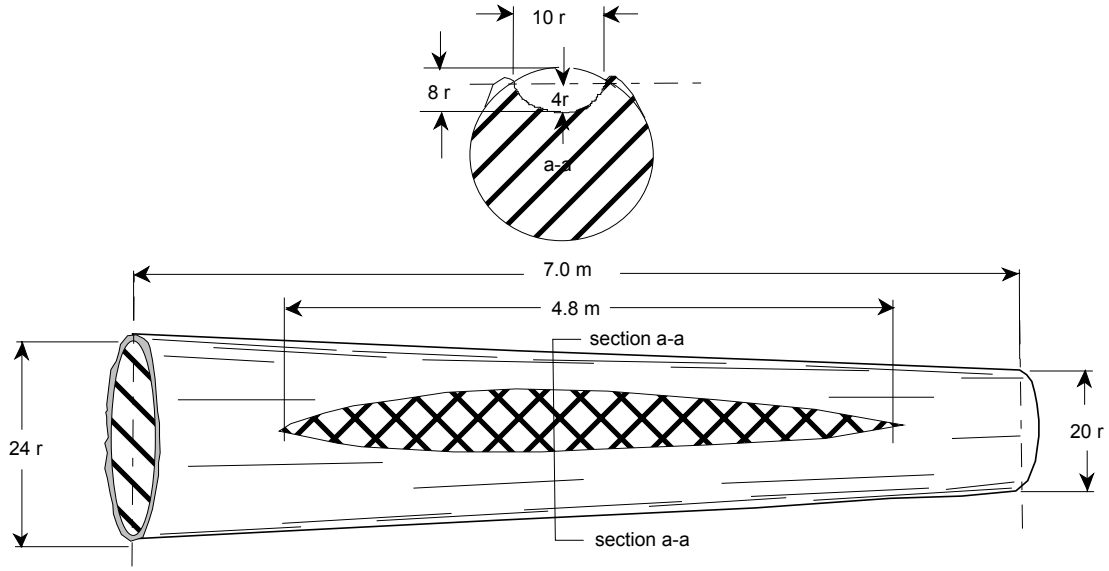


Figure 5.38 A log with a double conical catface .

5.8.2.3.2 Formal Calculation - Double Catface

Using the cone deduction formula described in Appendix 5B, the net volume of the log is calculated to be 1.032 m³.

5.8.2.3.3 Field Calculation - Length Deduction

Calculate a centre defect measurement in rads by dividing the sum of the width and height by two.

$$\frac{8 + 10}{2} = 9 \text{ rads}$$

Calculate the defect volume by looking up the half volume for the length of the defect, or 4.8 m and 9 rads.

Half volume of 4.0/09	=	51 dm^3
Half volume of 0.8/09	=	+ 10 dm^3
Half volume of 4.8/09	=	61 dm^3
Full volume of 4.8/09/09	=	122 dm^3 (2 x half volume)
Volume of cone 4.8/09	=	$\frac{122}{3}$ = 41 dm^3

Calculate the average unit volume of the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten.

Half volume of 10.0/24	=	905 dm^3
Half volume of 10.0/20	=	+ 628 dm^3
Full volume of 10.0/20/24	=	1533 dm^3
Unit volume of 1.0/20/24	=	153 dm^3

Calculate the length deduction by dividing the defect volume by the unit volume of the log.

$$\frac{41}{153} = 0.267 \text{ m}$$

Length deduction is rounded to 0.3 m.

Calculate the net length of the log by subtracting the length deduction from the gross length of the log.

7 m - 0.3 m	=	6.7 m
Volume	=	1.025 m^3 or 1 025 dm^3

Record the net dimensions as 069/20/24.

5.8.3 Cylindrical Defects

This method of calculation can be used for defects that have the geometrical shape of a cylinder.

This formula or combinations of this formula are used for calculating volumes of the following defects, through running heart defect, heart defect running partial length of a log, conk defect, sapwood defect, catface, dead side, missing wood, ring defect, ring shake, outside checks, and portions of collars.

5.8.3.1 Heart Defect - Through running

5.8.3.1.1 Example and Illustration - Heart Rot, Full Length

Heart rot extends completely through the log in Figure 5.39 and is measurable at both ends.

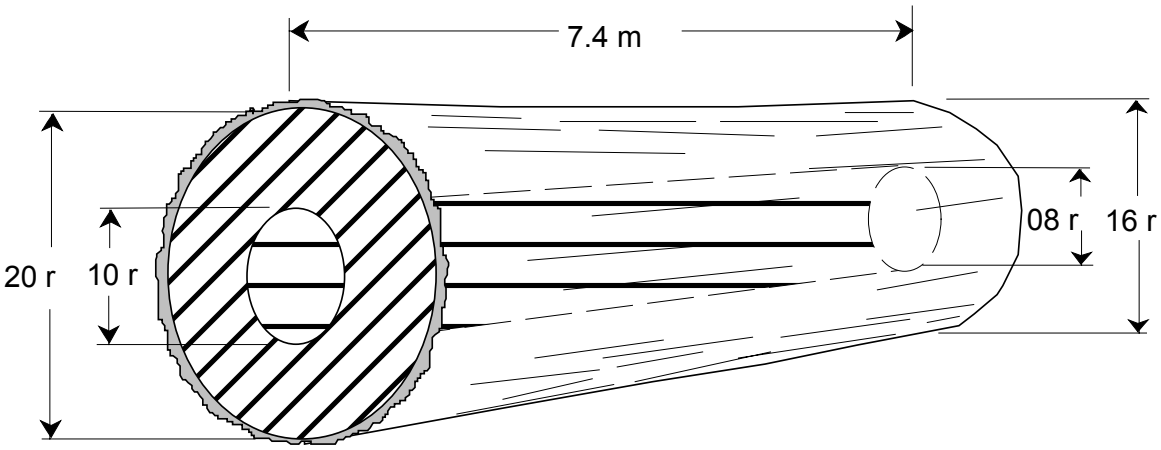


Figure 5.39 A log with through-running heart rot.

5.8.3.1.2 Formal Calculation - Heart Rot, Full Length

Using the cylinder deduction formula described in Appendix 5B, the net volume of the log is calculated to be 0.572 m^3.

5.8.3.1.3 Field Calculation - Length Deduction

To reduce the recorded length measurement of the log to create a log with net dimensions equal to the net volume in the example, follow these steps:

With the scale stick, look up the volume of a cylinder of the diameter and length of the defect by adding the:

Top defect half volume:

Half volume of 7.0/08	=	70 dm^3
Half volume of 0.4/08	=	+ 4 dm^3
Half volume of 7.4/08	=	74 dm^3

to the butt defect half volume:

Half volume of 7.0/10	=	110 dm^3
Half volume of 0.4/10	=	+ 6 dm^3
Half volume of 7.4/10	=	116 dm^3
Full defect volume of 7.4/08/10	=	(74 + 116) = 190 m^3

Calculate the average unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten.

Half volume of 10.0/16	=	402 dm^3
Half volume of 10.0/20	=	+ 628 dm^3
Full volume of 10.0/30/38	=	1030 dm^3
Full volume of 1.0/30/38	=	103 dm^3

Calculate the length deduction by dividing the defect volume by the average unit volume (the sum of the top one metre half volume and the butt one metre half volume) of the log:

$$\frac{190}{103} = 1.84 \text{ m}$$

The length deduction rounded is 1.8 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

7.4 - 1.8	=	5.6 m
Volume	=	0.564 m^3 or 564 dm^3

Record the net dimensions as 056/16/20.

5.8.3.1.4 Field Calculation - Diameter or Radius Deduction

Using unit volumes off the scale stick, find the unit volume for the top end measurement and subtract the unit volume of the defect.

Unit volume, top (16 r)	=	80 dm^3
Less the unit volume, top defect (8 r)	=	+ 20 dm^3
Net unit volume	=	60 dm^3

Find the rad class corresponding closest to the unit volume of 60 dm^3, which is 14 rads.

Calculate the unit volume for the butt end measurement and subtract the unit volume of the butt end defect.

Unit volume Butt (20 r)	=	126 dm^3
Less unit volume Butt defect (10 r)	=	+ 31 dm^3
Net unit volume	=	95 dm^3

Find the rad class corresponding closest to the unit volume of 95 dm^3, which is 17 rads.

The volume corresponding to the net dimensions of 7.4 m by 14 r by 17 r is 565 dm^3.

Record the net dimensions as 074/14/17.

> Use the diameter or radius deduction method only if heart defect or hole runs the full length or exactly half the length of the log.

5.8.3.2 Heart Defect - Partial Length of the Log

5.8.3.2.1 Example and Illustration - Heart Rot, Partial Length

The heart rot visible at the top end of the log shown in Figure 5.40 is estimated to travel 4.4 m and the diameter of the rot is assumed to be the same at both ends (10 rads). Although not demonstrated in this example, the diameter deduction method may be used if rot is assumed to travel exactly half-way or is through running.

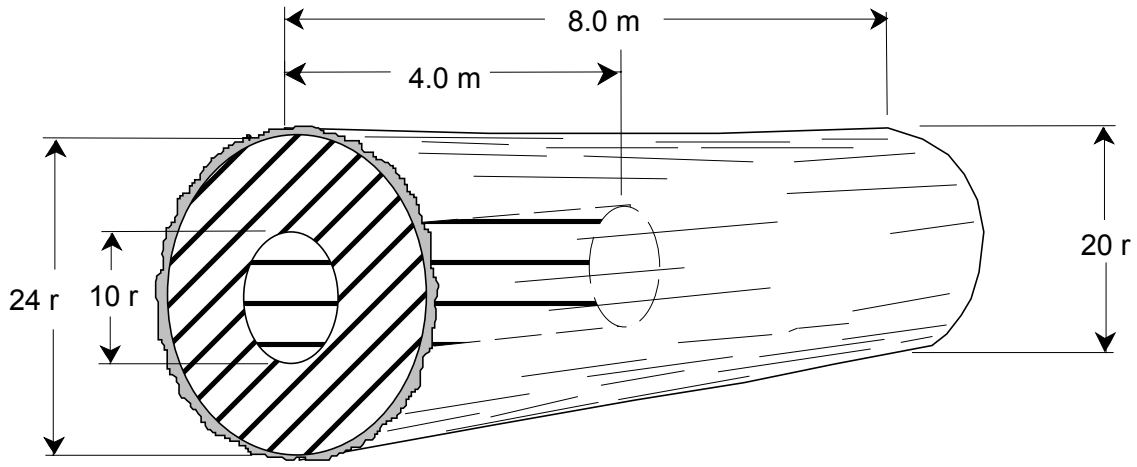


Figure 5.40 A log with partial length heart rot.

5.8.3.2.2 Formal Calculation - Heart Rot, Partial Length

Using the cylinder deduction formula described in Appendix 5B, the net volume of the log is calculated to be 1.100 m^3.

5.8.3.2.3 Field Calculation - Length Deduction

To reduce the recorded length measurement of the log to create a log with net dimensions equal to the net volume in the example, follow these steps:

Top defect volume

Half volume of 4.0/10	=	63 dm^3
Full volume of 4.0/10/10	=	126 dm^3 (2 x the half volume)

Calculate the average unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten.

Half volume of 10.0/20	=	628 dm^3
Half volume of 10.0/24	=	+ 905 dm^3
Full volume of 10.0/20/24	=	1533 dm^3
Full volume of 01.0/20/24	=	153 dm^3

Calculate the length deduction by dividing the defect volume by the average unit volume of the log:

$$\frac{126}{153} = 0.824 \text{ m}$$

The length deduction rounded is 0.8 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

8.0 m - 0.8 m	=	7.2 m
Volume	=	1.104 m^3 or 1104 dm^3

Record the net dimensions as 072/20/24.

5.8.3.3 Ring Defect - Through Running

Ring rot does not always form a full circle. The simplest method of determining the volume of a ring which does not form a full circle is to:

1. apply the methods described below as if it were a full circle.

2. estimate the arc of the rot as a percentage of the full circle.

3. apply this percentage factor to the full circle.

The result is the net volume of the partial ring.

5.8.3.3.1 Example and Illustration - Ring Rot, Full Length

In the example illustrated on Figure 5.41, a fungus has caused a ring shaped rot to destroy the wood fibres for the full length of the log. The rot volume may be visualised as a cylinder of rot containing another, smaller, cylinder of firm wood that is subtracted from the rot cylinder, leaving the volume of the ring.

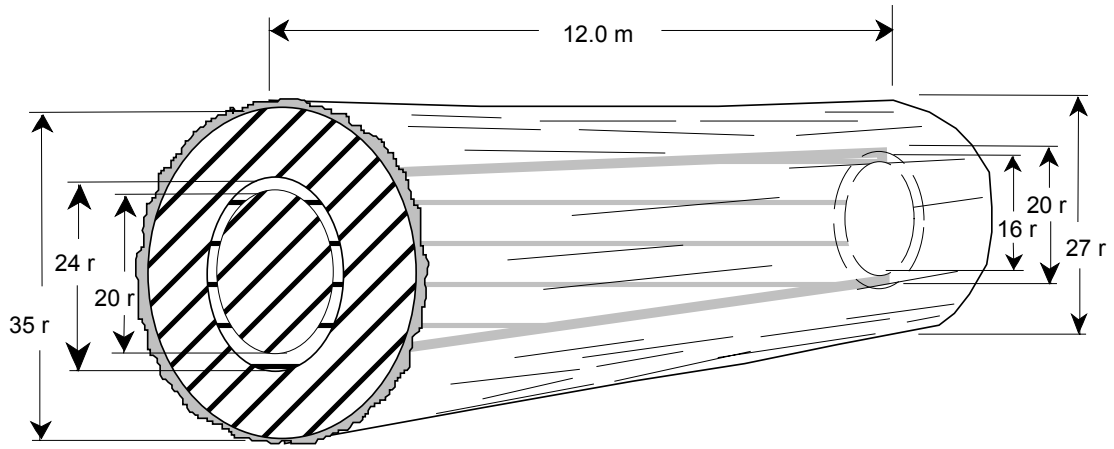


Figure 5.41 A log with through-running ring rot.

5.8.3.3.2 Formal Calculation - Ring Rot, Full Length

Using the cylinder deduction formulas described in Appendix 5B, the net volume of the log is calculated to be 3.080 m^3.

5.8.3.3.3 Field Calculation - Length Deduction

Three steps are required for a ring defect deduction. Using the same methods as for heart rot:

1. Find a volume using the outside diameters and length of the ring.

2. Find the volume of the sound core using the inside diameters of the ring.

3. Subtract the volume of the sound core to get the volume of the outside ring (Step 2 minus Step 1).

To reduce the gross length of the log to create a log with net dimensions equal to the net volume in the above example:

Calculate the volume of the defect using the outside and inside diameters of the defect.

Outside diameter cylinder volume:

Half volume of 12.0/24	=	1086 dm^3
Half volume of 12.0/20	=	+ 754 dm^3
Full volume of 12.0/20/24	=	1840 dm^3

Inside diameter cylinder volume:

Half volume of 12.0/20	=	754 dm^3
Half volume of 12.0/16	=	+ 483 dm^3
Full volume of 12.0/20/24	=	1237 dm^3

Volume of defect equals outside cylinder volume minus inside cylinder volume.

Defect volume	=	1840 - 1237 = 603 dm^3

A percentage factor may be applied at this point for a partial ring defect (i.e., if the ring arc forms only one third of the circumference, multiply the above volume by 0.33 or 33 percent).

Calculate the unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10.

Half volume of 10.0/27	=	1145 dm^3
Half volume of 10.0/35	=	+ 1924 dm^3
Full volume of 10.0/27/35	=	3069 dm^3
Full volume of 01.0/20/24	=	307 dm^3

Calculate the length deduction by dividing the defect volume by the unit volume of the log:

$$\frac{603}{307} = 1.964 \text{ m}$$

The length deduction rounded is 2 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

Net Length = 12 m - 2 m = 10 m

Volume = 3.069 m^3 or 3069 dm^3

Record the net dimensions as 100/27/35.

5.8.3.4 Ring Defect - Partial Length of Log

5.8.3.4.1 Example and Illustration - Ring Rot, Partial Length

Ring rot is visible at only one end of the log in Figure 5.42. Because there are no other indicators, the rot is estimated to travel one half the length of the log and the ring's inner and outer diameters are assumed to be the same at both ends.

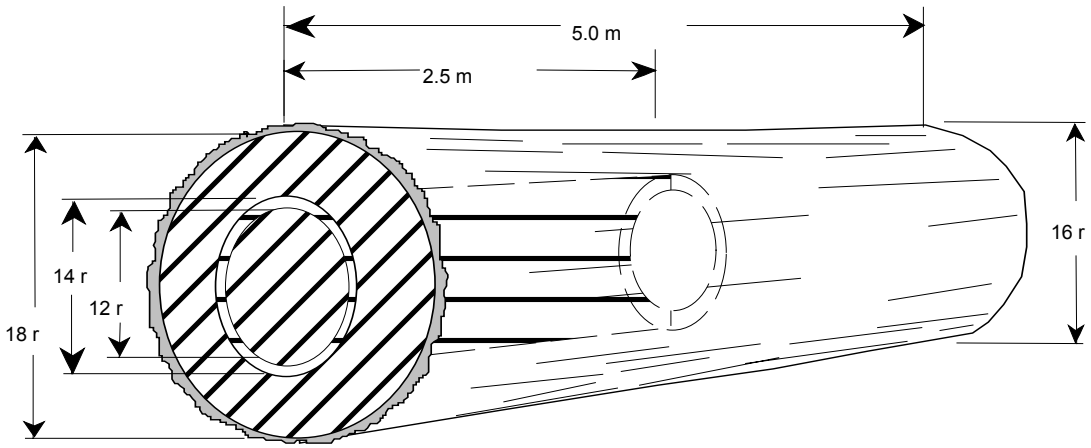


Figure 5.42 A log with partial length ring rot.

5.8.3.4.2 Formal Calculation - Ring Rot, Partial Length

Using the same cylinder deduction formulas described in Appendix 5B, the net volume of the log is calculated to be 0.415 m^3.

5.8.3.4.3 Field Calculation - Length Deduction

To reduce the gross length of the log to create a log with net dimensions equal to the net volume in the above example:

Calculate the volume of the defect using the outside and inside diameters of the defect.

Outside diameter cylinder volume:

Half volume of 020/14	=	62 dm^3
Half volume of 005/14	=	+ 15 dm^3
Half volume of 025/14	=	77 dm^3
Full volume of 025/14	=	154 dm^3 (2 x half volume)

Inside diameter cylinder volume:

Half volume of 020/12	=	45 dm^3
Half volume of 005/12	=	+ 11 dm^3
Half volume of 025/12	=	56 dm^3
Full volume of 025/12	=	112 dm^3 (2 x half volume)

Volume of defect equals outside diameter cylinder volume minus inside diameter cylinder volume.

Defect volume	=	154 - 112 = 42 dm^3

A factor may be applied at this point for a partial ring defect (i.e., if the ring arc forms only one half of the circumference, multiply the above volume by 0.5 or 50 percent).

Calculate the unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10.

Half volume of 10.0/16	=	402 dm^3
Half volume of 10.0/18	=	+ 509 dm^3
Full volume of 10.0/27/35	=	911 dm^3
Full volume of 01.0/20/24	=	91 dm^3

Calculate the length deduction by dividing the defect volume by the average unit volume of the log:

$$\frac{42}{91} = 0.46 \text{ m}$$

The length deduction is rounded to 0.5 m.

Find the net length by subtracting the length deduction from the gross length of the log.

5.0 m - 0.5 m = 4.5 m

Volume = 0.410 m^3 or 410 dm^3

Record the net dimensions as 045/16/18.

5.8.3.5 Sap Rot

The log in Figure 5.43 was bucked from a windfall tree and has been lying on the ground long enough for fungi to have eaten into the sap wood 2 rads deep at the butt end and between 1 and 2 rads deep at the top end.

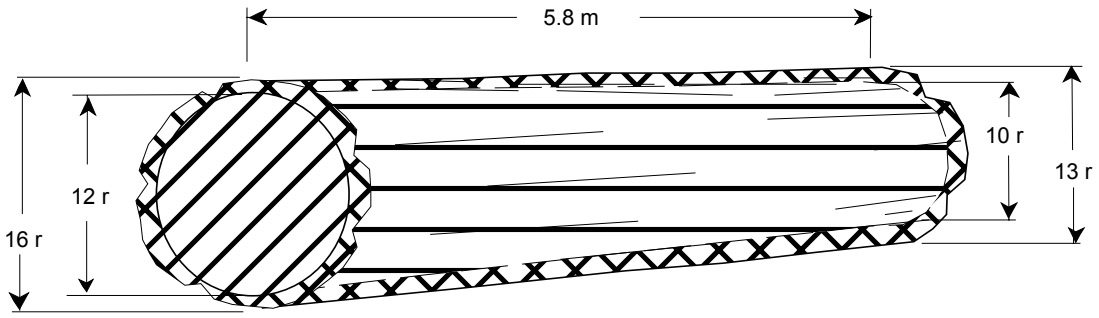


Figure 5.43 A log with sap rot.

5.8.3.5.1 Formal Calculation - Sap Rot

Using the cylinder deduction formulas described in Appendix 5B, the net volume of the log is calculated to be 0.222 m^3.

5.8.3.5.2 Field Calculation - Diameter Deduction

This method simply ignores the sap rot and uses the diameters of the sound core of wood to find the net volume and recorded net dimensions. Although very simple to apply, it is a "net" method, and does not provide users of scale data with any information about the rot. Scalers using "gross-net" scale may use the length deduction method demonstrated next, to provide additional information on the gross dimensions and volume of the log, the volume of the rot, and the net dimensions and volume.

Using the diameters of the firm core inside the rot:

Calculate the half volume of the top net inner cylinder:

Half volume of 050/10	=	79 dm^3
Half volume of 008/10	=	+ 13 dm^3
Half volume of 058/10	=	92 dm^3

Calculate the half volume of the butt net inner cylinder:

Half volume of 05.0/12	=	113 dm^3
Half volume of 00.8/12	=	+ 18 dm^3
Half volume of 05.8/12	=	131 dm^3

Add the half volume of the top cylinder to the half volume of the butt cylinder:

92 + 131	=	223
Full volume of 05.8/10/12	=	223 dm^3
Volume	=	0.223 m^3 or 223 dm^3

Record the net dimensions as 058/10/12.

5.8.3.5.3 Field Calculation - Length Deduction

Although more difficult to apply, method is a "gross-net" method , with the advantage of providing users of scale data with more information about the rot. Scalers using "gross-net" scale use this method, rather than the diameter deduction method described above, to provide additional information on the gross dimensions and volume of the log, the volume of the rot, and the net dimensions and volume.

Therefore, the volume of defect equals outer gross cylinder volume minus inner net cylinder volume, and to find it:

Calculate the gross top half volume of the outer cylinder:

Half volume of 05.0/13	=	133 dm^3
Half volume of 00.8/13	=	+ 21 dm^3
Half volume of 05.8/13	=	154 dm^3

Calculate the gross butt half volume of the outer cylinder:

Half volume of 05.0/16	=	201 dm^3
Half volume of 00.8/16	=	+ 32 dm^3
Half volume of 05.8/16	=	233 dm^3

Add the half volumes to find the full volume of the outer cylinder:

Full volume of 058/13/16	=	387 dm^3
Less the inner cylinder volume:	=	+ 223 dm^3
Equals the defect volume	=	164 dm^3

Find the average unit volume of the log using the gross diameters:

Unit volume 13	=	53 dm^3
Unit volume 16	=	+ 80 dm^3
Total	=	133 dm^3
Divide by 2	=	66 dm^3

Find the length deduction:

Divide the rot volume by unit volume = 164/66 = 2.484 rounded to 2.5

Subtract the length deduction from the gross length

5.8 - 2.5	=	3.3 m
Volume	=	221 dm^3

Record the net dimensions as: 033/13/16.

Notes:

5.8.4 Cubical Defects

5.8.4.1 Pocket Defect - Through-running

5.8.4.1.1 Example and Illustration - Pocket Defect, Through-running

The log in Figure 5.44 is infected with a type of rot which forms in pockets rather than following the growth rings. It's shape is closer to being rectangular than circular.

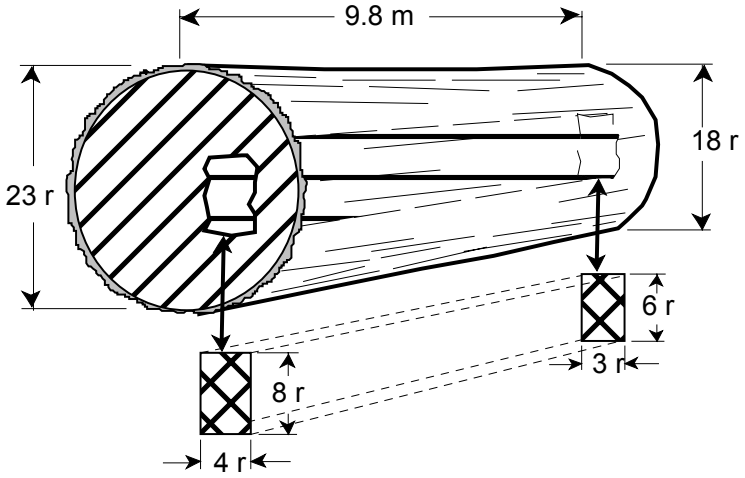


Figure 5.44 A log with through-running pocket rot.

5.8.4.1.2 Formal Calculation - Pocket Rot, Through Running

Using the four-sided prism or "rectangular box" deduction formulas described in Appendix 5B, the net volume of the log is calculated to be 1.215 m^3.

5.8.4.1.3 Field Calculation - Length Deduction

To reduce the gross length measurement of the log to create a log with net dimensions equal to the net volume in the example, the defect is enclosed in a box representing the area of the defect. The measurements section of this chapter provides detailed information on enclosing irregular defects and determining representative dimensions. An example of grouping multiple pockets into a unit is provided in Section 5.8.5.3, where three individual pockets of rot are enclosed in a triangular shape.

Calculate the unit volumes of the defect ends by multiplying the height by the width by the factor of 0.4 to convert the end area of the defect from "square rads" to unit volumes:

3 x 6 x 0.4	=	7 dm^3
4 x 8 x 0.4	=	+ 13 dm^3
Sum of unit volumes	=	20 dm^3
Divided by 2	=	10 dm^3, the AUV

Multiply the average unit volume of the defect by the length of the defect to obtain the defect volume:

Unit volume 10 dm^3 x 9.8 m	=	98 dm^3

> In the case of multiple scattered pockets (5 rads or more apart) or pipes, calculate the volume of each one and add them together. Where there are several small close pockets (less than 5 rads apart), visually group them together and use one measurement. An example is provided in Section 5.8.5.3.

Calculate the one metre volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by ten or adding the unit volumes and dividing by 2.

Half volume of 10.0/18	=	509 dm^3
Half volume of 10.0/23	=	+ 831 dm^3
Full volume of 10.0/18/23	=	1340 dm^3
Unit volume of 01.0/18/23	=	134 dm^3

Calculate the length deduction by dividing the defect volume by the unit volume of the log.

$$\frac{98}{134} = 0.731 \text{ m}$$

The rounded length deduction is 0.7 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

9.8 m - 0.7 m	=	9.1 m
Volume	=	1.219 m^3 or 1219 dm^3

Record the net dimension as 091/18/23

5.8.4.1.4 Field Calculation - Diameter Deduction

To reduce the gross diameter measurement of the log to create a log with net dimensions equal to the net volume in the example, the diameter deduction is possible, if the defect is through running, or runs exactly half way through the log.

Find the unit volume of the 18 rad top:	=	102 dm^3
Find the unit volume of the top defect	=	(03 x 06 x 0.4):
and subtract from top unit volume:	=	- 7 dm^3
to get the net unit volume	=	95 dm^3

Find the closest unit volume on the scale stick (91) and record the rad class of 17.

Find the unit volume of the 23 rad Butt:	=	166
Find the unit volume of the butt defect	=	(04 x 08 x 0.4):
and subtract from the butt unit vol:	=	- 13 dm^3
to get the Net unit volume	=	153 dm^3

Find the closest unit volume on the scale stick (152) and record the rad class of 22.

Volume	=	1.190 m^3

Record the net dimensions as 098 17 22.

It is the responsibility of the scaler to confirm the suitability of this method to a particular defect. In this case, the difference in net volume between this and the formal calculation is 2 percent, and the previous length deduction exercise is only 0.3 percent. As discussed at the beginning of the Deductions Section, it is good practice to compare the results of different methods on a regular basis to develop and maintain the "feel" of them.

5.8.4.2 Pocket Defect - Partial Length of the Log

The log in Figure 5.45 is infected with a heart rot in the shape of a pocket, and it is estimated to travel 2.4 m up from a conk knot.

5.8.4.2.1 Example and Illustration - Pocket Rot, Partial Length

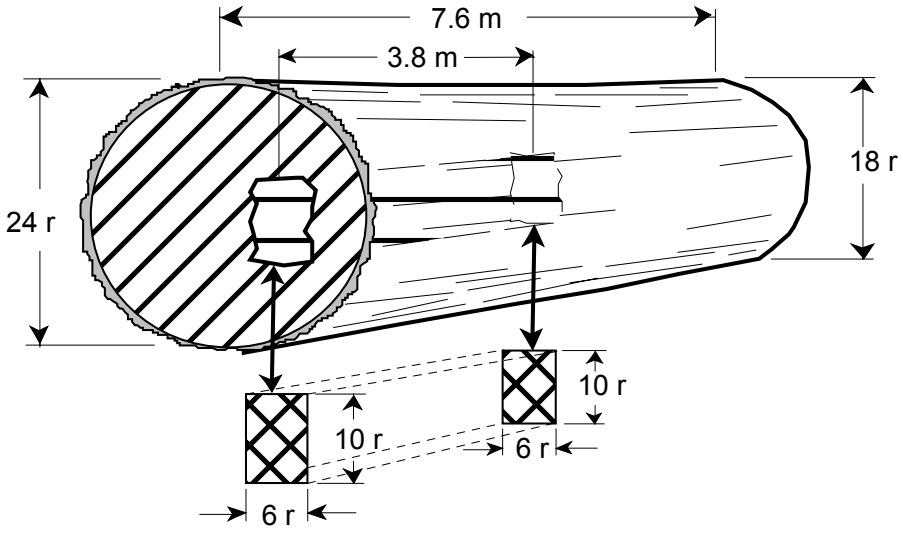


Figure 5.45 A log with partial-length pocket rot.

5.8.4.2.2 Formal Calculation

Using the cubical or "rectangular box" deduction formulas described in Appendix 5B, the net volume of the log is calculated to be 1.038 m^3.

5.8.4.2.3 Field Calculation - Length Deduction

To reduce the gross length measurement of the log to create a log with net dimensions equal to the net volume in the example, the defect is enclosed in a box representing the area of the defect. The measurements sections of this chapter provides detailed information on enclosing irregular defects and determining representative dimensions.

> In the case of multiple scattered pockets (5 rads or more apart) pockets or pipes, calculate the volume of each one and add them together. Where there are several small close pockets (less than 5 rads apart), visually group them together and use one measurement. An example is provided in Section 5.8.5.3.

Calculate the unit volumes of the defect ends by multiplying the height by the width by the factor of 0.4 to convert the end area of the defect from "square rads" to unit volumes, and multiply by the defect length to obtain the defect volume.

Unit volume	=	6 R x 10 R x 0.4 = 24 dm^3
Defect Volume	=	24 dm^3 x 3.8 m = 91 dm^3

Calculate the average unit volume for the log by adding the unit volumes and dividing by two:

unit volume of 18	=	102 dm^3		
unit volume of 24	=	+ 181 dm^3		
Sum of unit volumes	=	283 dm^3		
Average unit volume	=	141.5	=	142 dm^3

Calculate the length deduction by dividing the defect volume by the average unit volume of the log.

$$\frac{91}{142} = 0.641 \text{ m}$$

Length deduction is rounded to 0.6 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

7.6 - 0.6	=	7.0 m
Volume	=	0.989 m^3 or 989 dm^3

Record the net dimensions as 070/18/24.

5.8.5 Other Defects

5.8.5.1 Missing Segments

Missing wood can take many forms. This example demonstrates the use of a percentage factor to represent the missing part, but any of the other methods described previously will serve just as well if they are more representative of the shape of the defect.

5.8.5.1.1 Example and Illustration - Missing Wood

The defect shown in Figure 5.46 is typical of missing wood. Such defects as burn saddles or charred wood could also apply to this example, and in this case, the missing portion is equal to 50 percent or 1/2 the diameter of the log for 4.8 m.

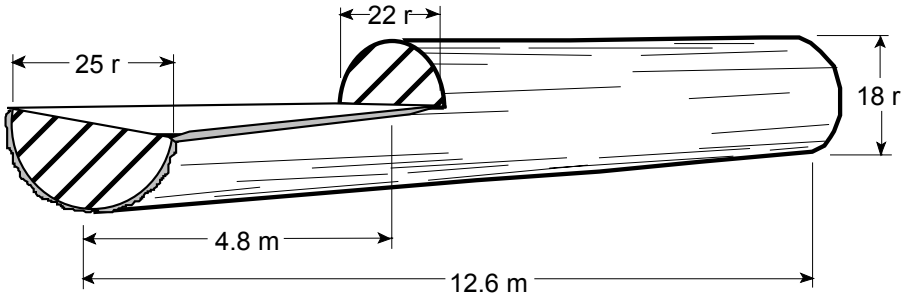


Figure 5.46 A log with missing segment.

5.8.5.1.2 Formal Calculation - Segment Defect

Using the cylindrical deduction formula with factor as described in Appendix 5B, the net volume of the log is calculated to be 1.460 m^3.

5.8.5.1.3 Field Calculation - Length Deduction

To reduce the recorded length measurement of the log to create a log with net dimensions equal to the net volume in the example, first look up the volume of a cylinder of the Diameter and length of the log affected by the defect.

The half volume at the upper limit of the defect:

Half volume of 04.0/22	=	304 dm^3
Half volume of 00.8/22	=	+ 61 dm^3
Half volume of 04.8/22	=	365 dm^3

Plus the half volume at the lower limit of the defect:

Half volume of 04.0/25	=	393 dm^3
Half volume of 00.8/25	=	+ 79 dm^3
Half volume of 04.8/25	=	472 dm^3

equals the full volume of the portion of the log affected by the defect:

Full volume of 4.8/22/25 = (365 + 472) = 837 dm^3

multiplied by the percentage missing, is the volume of the defect:

Volume of defect = 837 x 0.5 = 418.5 = 418 m^3

Calculate the average unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10 or by adding the Unit volumes and dividing by 2.

Half volume of 10.0/18	=	509 dm^3
Half volume of 10.0/25	=	+ 982 dm^3
Full volume of 10.0/18/25	=	1491 dm^3
Unit volume of 010/30/38	=	149 dm^3

Calculate the length deduction by dividing the defect volume by the unit volume:

$$\frac{418}{149} = 2.805 \text{ m}$$

The length deduction rounded is 2.8 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

12.6 - 2.8	=	9.8 m
Volume	=	1.461 m^3 or 1461 dm^3

Record the net dimensions as 098/18/25.

It is tempting to reduce the length of the log by 1/2 the length of the defect, but it is a dangerous concept to "fold in" 1/2 of the defect. In this example, the defect is 4.8 m long, so a deduction of 2.4 m will understate the volume of the defect. If this same defect occurred at the top end of the log, the 2.4 m deduction would overstate the volume of the defect. The relationship between the defect and the average unit volume of the log must be established, and *only experienced scalers can visualise the correct deduction in this way.*

5.8.5.2 Missing Sectors

5.8.5.2.1 Example and Illustration - Surface Defect

The log in Figure 5.47 has a pie-shaped sector split out of it. This sector is about 15 percent of the whole piece. Other surface defects such as lightning scars and frost checks *if they contain rot* are good candidates for this method of firmwood deduction. It may be used in grading too, for those types of defects which affect recovery.

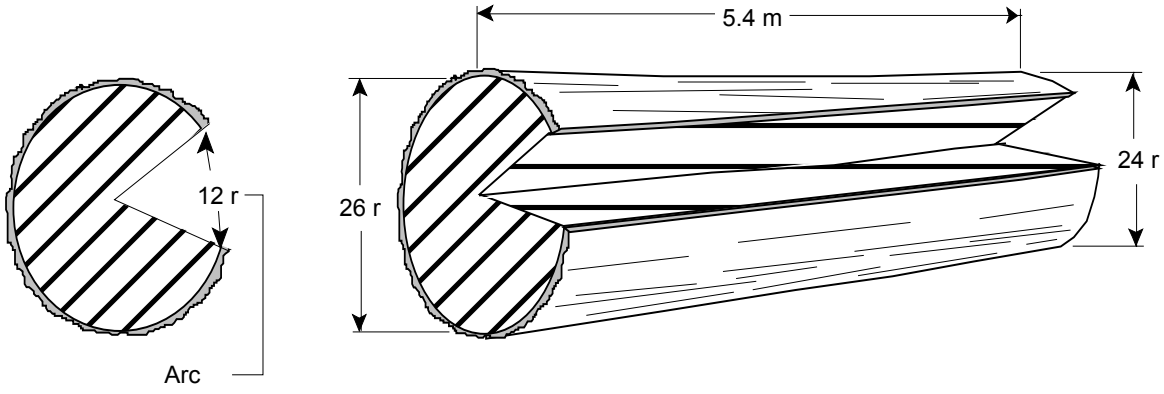


Figure 5.47 A log with sector defect extending to the heart.

5.8.5.2.2 Formal Calculation - Sector Defect

Using Smalian's formula with factor as described in Appendix 5B, the net volume of the log is calculated to be 0.903 m^3.

5.8.5.2.3 Field Calculation, Length Deduction Using a Factor

This example uses the application of a factor to determine net volume, in the same way as demonstrated in the previous example for missing wood. With pie-shaped defects which do not extend to the pith, however, it may be easier to find the volume of the defect by applying another shape as described in the measurements section of this chapter. This is because it is much more difficult to estimate the defect factor if it does not extend to the pith. That is, 75 percent of a log's volume is contained in the outer 50 percent of its diameter. If a defect penetrates half way to the heart, for example, the deduction is reduced by 25 percent.

To reduce the recorded length measurement of the log to create a log with net dimensions equal to the net volume in the example:

Using the scale stick, find the top end half volume:

Half volume of 05.0/24	=	452 dm³
Half volume of 00.4/24	=	+ 36 dm³
Half volume of 05.4/24	=	488 dm³

Find the butt end half volume:

Half volume of 05.0/26	=	531 dm³
Half volume of 00.4/26	=	+ 42 dm³
Half volume of 05.4/26	=	573 dm³

Add the half volumes:

Full volume of 5.4/24/26 = (488 + 573) = 1061 dm³

85 percent of this log is sound, and the remaining 15 percent is defect, so the factor becomes 15/100 or .15. This factor may be easily visualized, if it is in simple fractions such as 1/4, 1/3, and 1/2. It can be calculated as a ratio of the circumference by multiplying the diameter by π and dividing the result into the arc of the defective sector, but finding the arc is not practical with conventional scaling tools. Degrees of arc is one option, using a watch or compass dial to learn to visualize sectors which are not obvious divisions of 360 degrees.

Factor from formal calculation:

Radius times π	=	26 x 3.14159 = 82 r circumference
Defect arc factor	=	12r arc / 82 = .146 = 0.15 or 15 percent

Factor from a clock face, major divisions in 12ths (secondary divisions in 60ths (minutes) which are equal to 6 degrees):

Position of hands	=	12:00 to 9 minutes
Defect arc factor	=	9 / 60 = 0.15 or 15 percent

Factor from a compass, major divisions in 8ths or 16ths (secondary divisions in 36ths or 10 degrees):

Position from north	=	54 degrees
Defect arc factor	=	54 / 360 = 0.15 or 15 percent

There are several incremental options available to the scaler just from these two common objects, and of course, that which is most comfortable and familiar is preferred, even a piece of paper, which may be easily and accurately folded into 16ths.

Multiply the gross volume by the factor to obtain the volume of the defect.

Volume of defect	=	1061 x .15 = 159 dm³

Calculate the average unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10:

Half volume of 10.0/24	=	905 dm³
Half volume of 10.0/26	=	+ 1062 dm³
Full volume of 10.0/24/26	=	1967 dm³
unit volume (01.0/24/26)	=	197 dm³ (AUV)

or by adding the unit volumes and dividing by two.

unit volume of 24	=	181
unit volume of 26	=	+ 212
The sum of same	=	393
Divided by two	=	196.5 or 196 dm³ (AUV)

Calculate the length deduction by dividing the defect volume by the average unit volume of the log (two examples are shown here to demonstrate that although the result from using half volumes and from using unit volumes is different (197 vs. 196), the length deduction is the same):

$$\frac{159}{197} = 0.807 \text{ m}$$

or

$$\frac{159}{196} = 0.811 \text{ m}$$

The length deduction rounded is 0.8 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

5.4 - 0.8	=	4.6 m
Volume	=	0.905 m³ or 905 dm³

Record the net dimensions as 046/24/26.

5.8.5.2.4 Field Calculation, Length Deduction Using a Factor, Short cut

In a "net" volume scale, it is easiest to simply apply the defect factor to the gross length of the log.

Calculate the length deduction by multiplying the gross length of the log by the defect factor.

5.4 x 15 percent (.15) = 0.81 m

Calculate the net length by subtracting the length deduction from the gross length of the log.

5.4 - 0.8	=	4.6 m
Volume	=	0.905 m^3 or 905 dm^3

Record the net dimensions as 046/24/26.

5.8.5.3 Triangular defects

5.8.5.3.1 Example and Illustration - Triangular Defect

The log in Figure 5.48 has pockets of rot. The pockets fit best into a triangle shape, and because there are no other indicators, the rot is assumed to travel half way through the log. This method may be applied to any other defect which most closely fits a triangle shape.

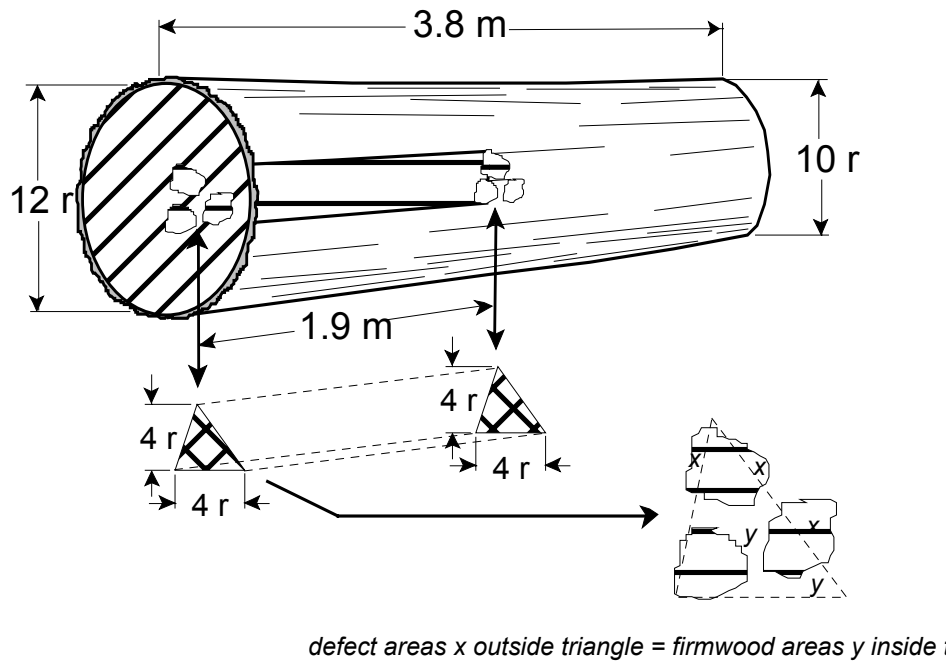


Figure 5.48 A log with partial length triangular defect.

5.8.5.3.2 Formal Calculation - Triangular prisms

Using Smalian's formula with factor as described in Appendix 5B, the net volume of the log is calculated to be 0.140 m^3.

5.8.5.3.3 Field Calculation, Length Deduction Using the Prism Formula

This method of making a deduction is appropriate in cases where the shape of the defect most closely approximates that of a triangle.

In the case of multiple scattered pockets (5 rads or more apart) pockets or pipes, calculate the volume of each one and add them together. Where there are several small close pockets (less than 5 rads apart), visually group them together and use one measurement. The volume of firmwood between the pockets must be accounted for as shown in Figure 5.48. In grading, it is excluded, as explained in Chapter 6.

Whatever form a triangle may take the formula for finding its area is always one half the base times the height.

The triangle formula for scaling purposes is:

$$Unit\ volume = BH\ x\ 0.2$$

For the pocket rot visible at the end of the log:

Base = 04 r

Height = 04 r

Unit volume = 04 x 04 x 0.2

Unit volume = 3.2 dm^3

Multiply the defect unit volume by the length of the defect:

Defect volume = 3.2 x 1.9 = 6 dm^3

Calculate the average unit volume for the log by adding the ten metre half volumes of the end measurements of the log and dividing by 10:

Half volume of 10.0/10	=	157 dm^3
Half volume of 10.0/12	=	+ 226 dm^3
Full volume of 10.0/10/12	=	383 dm^3
Unit volume (01.0/10/12)	=	38.3 or 38 dm^3

or by adding the unit volumes and dividing by two:

Unit volume of 10	=	31 dm^3
Unit volume of 12	=	+ 45 dm^3
The sum of same	=	76 dm^3
Divided by two	=	38 dm^3

Calculate the length deduction by dividing the defect volume by the average unit volume of the log:

$$\frac{6}{38} = 0.157\ m$$

The length deduction rounded is 0.2 m.

Calculate the net length by subtracting the length deduction from the gross length of the log.

3.8 m - 0.2 m	=	3.6 m
Volume	=	0.138 m^3 or 138 dm^3

Record the net dimensions as 036/10/12.

Appendix 5B Defect Calculations

5B.1 Formulas and Their Terms

Formulas are expressed in this section in standard algebraic form. A formula is a mathematical rule. It is an algebraic expression that can be solved to find a particular quantity. For example, the formula that is used to find the area of a rectangle is:

Area is equal to the length times the width,

or

$$A = lw$$

In a formula, the value that you are trying to find is usually written to the left of the equal (=) sign. The Algebraic expression you need to solve is usually written to the right. To find the value from a formula, substitute numbers for the words or letters (variables) in the algebraic expression and do the arithmetic. Variables are often enclosed in brackets or nested brackets; these variables are calculated before proceeding to the next steps, starting with the innermost nest.

To present a formula in a compact form, variables are reduced to terms or symbols that represent the variable. For example, in a mathematical calculation, it is much easier to use " x " or " y " to represent a phrase than it is to write out the phrase in every occurrence. *Table 1* describes the terms used in all formulas in this manual.

For the sake of simplicity, all measurements, excluding length measurements, used in the calculations are in rads.

It is important to remember that when measuring the diameter of a circle in rads, the resulting value is equal to the radius in centimetres. This is why the formulas may appear erroneous to those who are used to seeing the area of a circle being expressed as πr^2.

Table 5B.1 Chart of Terms Used in Scaling Formulas

Term	Definition
L	Length of log measured in metres.
T	Top or small end diameter of a log measured in rads.
B	Butt or large end diameter of the log measured in rads.
DL	Length of defect measured in metres.
DT	Top or small end diameter of a cylindrical defect measured in rads.
DB	Butt or large end diameter of a cylindrical defect measured in rads.
H	Height of a rectangular or triangular shape measured in rads.
W	Width of a rectangular or triangular shape measured in rads.
DHT	Top height of a rectangular or triangular defect measured in rads.
DWT	Top width of a rectangular or triangular defect measured in rads.
DHB	Butt height of a rectangular or triangular defect measured in rads.
DWB	Butt width of a rectangular or triangular defect measured in rads.
IDT	Inside diameter, top, or small end of a ring defect measured in rads.
IDB	Inside diameter, butt, or large end of a ring defect measured in rads.
ODT	Outside diameter, top, or small end of a ring defect measured in rads.
ODB	Outside diameter, butt, or large end of a ring defect measured in rads.
NDT	Net top or small end diameter of a log measured in rads.
NDB	Net butt or large end diameter of a log measured in rads.
F	Factor of 0.0001570796 (the constant used in shortened Smalian formula).
UV	One metre unit volume, expressed as dm^3/m. A ten metre volume may be divided by 10 to obtain the one (1) metre unit volume.
AUV	The average of the unit volumes of both ends of a log or defect.
V	Volume in cubic metres or cubic decimetres.

5B.1.1 The Cone Formula (Volume of a Cone)

The formula that is used to find the volume of a conical defect is expressed as follows, where the volume of a cone is one third of the volume of a cylinder with the same basal diameter:

$$V = \frac{\left(DB^2 + DB^2\right) \text{ x } DL \text{ x } F}{3}$$

The complete formula for finding the net volume of a log with a conical defect is expressed as follows, where the volume of the cone of defect is subtracted from the volume of the cylinder of firm wood:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\frac{\left(DB^2 + DB^2\right) x\, DL\, x\, F}{3}\right]$$

5B.1.2 The Cone Formula (Volume of a Frustum of a Cone)

The formula that is used to find the volume of a conical defect is expressed as follows, where the volume of the frustum of a cone is one third of the volume of the sum of the square of the top and butt diameters plus twice the product of the top and butt diameters, times the length:

$$V = \frac{\left[\left[DT^2 + DB^2 + DT\, x\, DB\right] x\, DL\, x\, F\right] x\, 2}{3}$$

The complete formula for finding the net volume of a log with a conical defect which is visible at both ends is expressed as follows, where the volume of the defect is subtracted from the volume of the cylinder of firm wood:

$$V = \left[\left[T^2 + B^2\right] x\, L\, x\, F\right] - \left[\frac{\left[\left[DT^2 + DB^2 + DT\, x\, DB\right] x\, DL\, x\, F\right] x\, 2}{3}\right]$$

5B.1.3 The Cylinder Formula (Volume of a cylinder)

The formula that is used to find the volume of a cylindrical defect is expressed as follows, using Smalian's shortened formula:

$$V = \left(DT^2 + DB^2\right) \text{x } DL \text{ x } F$$

The complete formula for finding the net volume of a log with a cylindrical defect is expressed as follows where the volume of the cylinder of defect is subtracted from the volume of the cylinder of firm wood:

$$V = \left[\left(T^2 + B^2\right) \text{x } L \text{ x } F\right] - \left[\left(DT^2 + DB^2\right) \text{x } DL \text{ x } F\right]$$

A variant of the formula used for finding the net volume of a log with a ring defect and is expressed as follows, where the volume of the inner core of sound wood is subtracted from the volume determined from the outside diameters of the ring before subtracting its volume from the gross volume of the log:

$$V = \left[\left(T^2 + B^2\right) \text{x } L \text{ x } F\right] - \left[\left[\left(ODT^2 + ODB^2\right) \text{x } DL \text{ x } F\right] - \left[\left(IDT^2 + IDB^2\right) \text{x } DL \text{ x } F\right]\right]$$

A variant of the formula used for finding the net volume of a log with a sapwood defect is structured the same as the one used above for a ring defect, except that the variables *ODT* and *ODB* are replaced with *T* and *B*, and the variables *IDT* and *IDB* are replaced with *NDT* and *NDB*.

5B.1.4 The Four-sided Prism Formula (Volume of a Rectangular Box)

The formula that is used to find the volume of a rectangular defect is expressed as follows:

$$V = \frac{\left[\left(DHT \text{ x } DWT\right) + \left(DHB \text{ x } DWB\right)\right] \text{x } DL \text{ x } 0.0004}{2}$$

The complete formula for finding the net volume of a log with a rectangular defect is expressed as follows where the volume of the defect is subtracted from the volume of the log cylinder:

$$V = \left[\left(T^2 + B^2\right) \text{x } L \text{ x } F\right] - \left[\frac{\left[\left(DHT \text{ x } DWT\right) + \left(DHB \text{ x } DWB\right)\right] \text{x } DL \text{ x } 0.0004}{2}\right]$$

5B.1.5 The Three-sided Prism Formula (Volume of a Triangular Shape)

The formula that is used to find the volume of a triangular defect is expressed as follows:

$$V = \left[\frac{\left(DHT \times \frac{DWT}{2} \right) + \left(DHB \times \frac{DWB}{2} \right)}{2} \right] \times DL \times 0.0004$$

The complete formula for finding the net volume of a log with a triangular defect is expressed as follows where the volume of the defect is subtracted from the volume of the log cylinder:

$$V = \left[\left(T^2 + B^2 \right) \times L \times F \right] - \left[\left[\frac{\left(DHT \times \frac{DWT}{2} \right) + \left(DHB \times \frac{DWB}{2} \right)}{2} \right] \times DL \times 0.0004 \right]$$

5B.2 The Butt Rot Calculation in Chapter 5, Figure 5.35

Using the formula for finding the net volume of a log with a conical defect:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\frac{\left(DB^2 + DB^2\right) x\, DL\, x\, F}{3}\right]$$

Where the following values are substituted for the variables:

T = 30 rads,

B = 38 rads,

L = 12.2 m,

F = 0.0001570796,

DB = 25 rads,

DL = 3.6 m,

$$V = \left[\left(30^2 + 38^2\right) x\, 12.2\, x\, 0.0001570796\right] - \left[\frac{\left(25^2\, x\, 25^2\right) x\, 3.6\, x\, 0.0001570796}{3}\right],$$

$$V = \left[2344\, x\, 12.2\, x\, 0.0001570796\right] - \left[\frac{1250\, x\, 3.6\, x\, 0.0001570796}{3}\right],$$

$$V = 4.492 - 0.236,$$

$$V = 4.256\ m^3.$$

5B.3 The Butt Rot Calculation in Chapter 5, Figure 5.36

Using the formula for finding the net volume of a log with a conical defect:

$$V = \left[\left[T^2 + B^2\right] x\, L\, x\, F\right] - \left[\frac{\left[\left[DT^2 + DB^2 + DT\, x\, DB\right] x\, DL\, x\, F\right] x\, 2}{3}\right]$$

Where the following values are substituted for the variables:

T = 34 rads,

B = 38 rads,

L = 5.0 m,

F = 0.0001570796,

DT = 06 rads,

DB = 30 rads,

DL = 5.0 m,

$$V = \left[\left(34^2 + 38^2\right) x\, 5.0\, x\, 0.0001570796\right] - \left[\frac{\left(06^2\, x\, 30^2\right) + \left(06\, x\, 30\right) x\, 5.0\, x\, 0.0001570796\, x\, 2}{3}\right]$$

$$V = \left[2600\, x\, 5.0\, x\, 0.0001570796\right] - \left[\frac{1116 x\, 5.0\, x\, 0.0001570796\, x\, 2}{3}\right],$$

$$V = 2.041 - 0.584,$$

$$V = 1.457\ m^3.$$

5B.4 The Catface Calculation in Chapter 5, Figure 5.337

Using the formula for finding the net volume of a log with a conical defect:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\frac{\left(DB^2 + DB^2\right) x\, DL\, x\, F}{3}\right]$$

Where the following values are substituted for the variables:

T = 20 rads,

B = 24 rads,

L = 7 m,

F = 0.0001570796,

DB = 14 rads,

DL = 4.8 m,

$$V = \left[\left(20^2 + 24^2\right) x\, 7.0\, x\, 0.0001570796\right] - \left[\frac{\left(14^2 + 14^2\right) x\, 4.8\, x\, 0.0001570796}{3}\right]$$

$$V = \left[976\ x\, 7.0\, x\, 0.0001570796\right] - \left[\frac{392\, x\ 4.8\, x\, 0.0001570796}{3}\right],$$

$$V = 1.07317 - \frac{0.295561}{3},$$

$$V = 1.07317 - 0.099,$$

$$V = 0.974\ m^3.$$

5B.5 The Catface Calculation in Chapter 5, Figure 5.38

Using the formula for finding the net volume of a log with a conical defect:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\frac{\left(DB^2 + DB^2\right) x\, DL\, x\, F}{3}\right]$$

Where the following values are substituted for the variables:

T = 20 rads,

B = 24 rads,

L = 7 m,

F = 0.0001570796,

DB = 9 rads,

DL = 4.8 m,

$$V = \left[\left(20^2 + 24^2\right) x\, 7.0\, x\, 0.0001570796\right] - \left[\frac{\left(9^2 + 9^2\right) x\, 4.8\, x\, 0.0001570796}{3}\right]$$

$$V = \left[976\ x\, 7.0\, x\, 0.0001570796\right] - \left[\frac{162\, x\ 4.8\, x\, 0.0001570796}{3}\right],$$

$$V = 1.07317 - \frac{0.122}{3},$$

$$V = 1.07317 - 0.041,$$

$$V = 1.032\, m^3.$$

5B.6 The Heart Defect Calculation in Chapter 5, Figure 5.39

Using the formula for finding the net volume of a log with a cylindrical defect which projects through a log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left(DT^2 + DB^2\right) x\, DL\, x\, F\right]$$

Where the following values are substituted for the variables:

T = 16 rads,

B = 20 rads,

L = 7.4 m,

F = 0.0001570796,

DT = 8 rads,

DB = 10 rads,

DL = 7.4 m,

$$V = \left[\left(16^2 + 20^2\right) x\, 7.4\, x\, 0.0001570796\right] - \left[\left(8^2 + 10^2\right) x\, 7.4\, x\, 0.0001570796\right]$$

$$V = \left[656\, x\, 7.4\, x\, 0.0001570796\right] - \left[164\, x\, 7.4\, x\, 0.0001570796\right],$$

$$V = 0.763 - 0.191,$$

$$V = 0.572\, m^3.$$

5B.7 The Heart Defect Calculation in Chapter 5, Figure 5.40

Using the formula for finding the net volume of a log with a cylindrical defect which does not project completely through the log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left(DT^2 + DT^2\right) x\, DL\, x\, F\right]$$

Where the following values are substituted for the variables:

T = 20 rads,

B = 24 rads,

L = 8.8 m,

F = 0.0001570796,

DT = 10 rads,

DL = 4.4 m,

$$V = \left[\left(20^2 + 24^2\right) x\, 8.8\, x\, 0.0001570796\right] - \left[\left(10^2 + 10^2\right) x\, 4.4\, x\, 0.0001570796\right]$$

$$V = \left[976\, x\, 8.8\, x\, 0.0001570796\right] - \left[200\, x\, 4.4\, x\, 0.0001570796\right],$$

$$V = 1.349 - 0.138,$$

$$V = 1.211\ m^3.$$

5B.8 The Ring Defect Calculation in Chapter 5, Figure 5.41

Using the formula used for finding the net volume of a log with a ring defect which projects through a log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left[\left(ODT^2 + ODB^2\right) x\, DL\, x\, F\right] - \left[\left(IDT^2 + IDB^2\right) x\, DL\, x\, F\right]\right]$$

Where the following values are substituted for the variables:

T = 27 rads,

B = 35 rads,

L = 12 m,

F = 0.0001570796,

ODT = 20 rads,

ODB = 24 rads,

IDT = 16 rads,

IDB = 20 rads,

DL = 12 m,

$$V = \left[\left(27^2 + 35^2\right) x\, 12.0\, x\, F\right] - \left[\left[\left(20^2 + 24^2\right) x\, 12.0\, x\, F\right] - \left[\left(16^2 + 20^2\right) x\, 12.0\, x\, F\right]\right]$$

$$V = \left[1954\, x\, 12.0\, x\, 0.0001570796\right] - -\left[\left[976\, x\, 12.0\, x\, 0.0001570796\right] - \left[656\, x\, 12.0\, x\, 0.0001570796\right]\right]$$

$$V = 3.683 - \left[1.840 - 1.237\right],$$

$$V = 3.683 - 0.603,$$

$$V = 3.080\, m^3.$$

5B.9 The Ring Defect Calculation in Chapter 5, Figure 5.42

Using the formula used for finding the net volume of a log with a ring defect which does not project through a log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left[\left(ODB^2 + ODB^2\right) x\, DL\, x\, F\right] - \left[\left(IDB^2 + IDB^2\right) x\, DL\, x\, F\right]\right]$$

Where the following values are substituted for the variables:

T = 16 rads,

B = 18 rads,

L = 5 m,

F = 0.0001570796,

ODB = 14 rads,

IDB = 12 rads,

DL = 2.5 m,

$$V = \left[\left(16^2 + 18^2\right) x\, 5.0\, x\, F\right] - \left[\left[\left(14^2 + 14^2\right) x\, 2.5\, x\, F\right] - \left[\left(12^2 + 12^2\right) x\, 2.5\, x\, F\right]\right]$$

$$V = \left[580\, x\, 5.0\, x\, 0.0001570796\right] - \left[\left[392\, x\, 2.5\, x\, 0.0001570796\right] - \left[288\, x\, 2.5\, x\, 0.0001570796\right]\right]$$

$$V = 0.456 - \left[0.154 - 0.113\right],$$

$$V = 0.456 - 0.041,$$

$$V = 0.415\, m^3.$$

5B.10 The Sap Rot Calculation in Chapter 5, Figure 5.43

Using the formula used for finding the net volume of a log with a sapwood defect which projects through a log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left[\left(T^2 + B^2\right) x\, DL\, x\, F\right] - \left[\left(NDT^2 + NDB^2\right) x\, DL\, x\, F\right]\right]$$

Where the following values are substituted for the variables:

T = 13 rads,

B = 16 rads,

L = 5.8 m,

F = 0.0001570796,

NDT = 10 rads,

NDB = 12 rads,

DL = 5.8 m,

$$V = \left[\left(13^2 + 16^2\right) x\, 5.8\, x\, F\right] - \left[\left[\left(13^2 + 16^2\right) x\, 5.8\, x\, F\right] - \left[\left(10^2 + 12^2\right) x\, 5.8\, x\, F\right]\right]$$

$$V = \left[425\, x\, 5.8\, x\, 0.0001570796\right] - \left[\left[425\, x\, 5.8\, x\, 0.0001570796\right] - \left[244\, x\, 5.8\, x\, 0.0001570796\right]\right],$$

$$V = 0.387 - \left[0.387 - 0.222\right],$$

$$V = 0.387 - 0.165,$$

$$V = 0.222\, m^3.$$

5B.11 The Cubical Rot Calculation in Chapter 5, Figure 5.44

Using the formula for finding the net volume of a log with a rectangular defect which projects the full length of a log:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\frac{\left[\left(DHT\, x\, DWT\right) + \left(DHB\, x\, DWB\right)\right] x\, DL\, x\, 0.0004}{2}\right]$$

Where the following values are substituted for the variables:

T = 18 rads,

B = 23 rads,

L = 9.8 m,

F = 0.0001570796,

DHT = 3 rads,

DWT = 6 rads,

DHB = 4 rads,

DWB = 8 rads,

DL = 9.8 m,

$$V = \left[\left(18^2 + 23^2\right) x\, 9.8\, x\, 0.0001570796\right] - \left[\frac{\left[\left(03\, x\, 06\right) + \left(04\, x\, 08\right)\right] x\, DL\, x\, 0.0004}{2}\right]$$

$$V = \left[853\, x\, 9.8\, x\, 0.0001570796\right] - \left[\frac{50\, x\, 9.8\, x\, 0.0004}{2}\right],$$

$$V = 1.313 - \left[\frac{0.196}{2}\right],$$

$$V = 1.313 - 0.098,$$

$$V = 1.215\, m^3.$$

5B.12 The Cubical Rot Calculation in Chapter 5, Figure 5.45

Using the formula for finding the net volume of a log with a rectangular defect which does not project the full length of a log:

$$V = \mathrm{V} = \left[\left(\mathrm{T}^2 + \mathrm{B}^2\right) \mathrm{x}\, \mathrm{L}\, \mathrm{x}\, \mathrm{F}\right] - \left[\left(\mathrm{DHT}\, \mathrm{x}\, \mathrm{DWT}\right) \mathrm{x}\, \mathrm{DL}\, \mathrm{x}\, 0.0004\right]$$

Where the following values are substituted for the variables:

T = 24 rads,

B = 26 rads,

L = 10.6 m,

F = 0.0001570796,

DHT = 06 rads,

DWT = 10 rads,

DL = 4.2 m,

$$\mathrm{V} = \left[\left(24^2 + 26^2\right) \mathrm{x}\, 10.6 \,\mathrm{x}\, 0.0001570796\right] - \left[\left(06 \,\mathrm{x}\, 10\right) \mathrm{x}\, 4.2 \,\mathrm{x}\, 0.0004\right],$$

$$\mathrm{V} = \left[1252 \,\mathrm{x}\, 10.6 \,\mathrm{x}\, 0.0001570796\right] - \left[60 \,\mathrm{x}\, 4.2 \,\mathrm{x}\, 0.0004\right],$$

$$\mathrm{V} = 2.085 - 0.101,$$

$$\mathrm{V} = 1.984\,\mathrm{m}^3.$$

5B.13 The Missing Wood Calculation in Chapter 5, Figure 5.46

Using the formula for finding the net volume of a log with a cylindrical defect and applying a percentage factor:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left[\left(DT^2 + DB^2\right) x\, DL\, x\, F\right] x \frac{\%f}{100}\right]$$

Where the following values are substituted for the variables:

T = 18 rads,

B = 25 rads,

L = 12.6 m,

F = 0.0001570796,

DT = 22 rads,

DB = 25 rads,

DL = 4.8 m,

$\%f$ = 50 percent,

$$V = \left[\left(18^2 + 25^2\right) x\, 12.6\, x\, 0.0001570796\right] - \left[\left[\left(22^2 + 25^2\right) x\, 4.8\, x\, 0.0001570796\right] x \frac{50}{100}\right],$$

$$V = \left[949\, x\, 12.6\, x\, 0.0001570796\right] - \left[\left[1109\, x\, 4.8\, x\, 0.0001570796\right] x\, 0.5\right],$$

$$V = 1.878 - 0.418,$$

$$V = 1.460\, m^3.$$

5B.14 The Pie-shaped Defect Calculation in Chapter 5, Figure 5.47

Using Smalian's formula for finding the gross volume of a log with a pie-shaped defect and applying a percentage factor:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] x \left[\frac{(100 - \%f)}{100}\right]$$

Where the following values are substituted for the variables:

T = 24 rads,

B = 26 rads,

L = 5.4 m,

F = 0.0001570796,

%f = 15 percent,

$$V = \left[\left(24^2 + 26^2\right) x\, 5.4\, x\, 0.0001570796\right] x \left[\frac{(100 - 15)}{100}\right],$$

$$V = \left[1252\, x\, 5.4\, x\, 0.0001570796\right] x \left[\frac{85}{100}\right],$$

$$V = 1.062\, x\, 0.85,$$

$$V = 0.903\, m^3.$$

5B.15 The Triangular Prism Shaped Defect Calculation in Chapter 5, Figure 5.48

Using the prism formula for finding the net volume of a log with a triangular defect:

$$V = \left[\left(T^2 + B^2\right) x\, L\, x\, F\right] - \left[\left[\frac{\left(DHT\, x \frac{DWT}{2}\right) + \left(DHB\, x \frac{DWB}{2}\right)}{2}\right] x\, DL\, x\, 0.0004\right]$$

Where the following values are substituted for the variables:

T = 10 rads,

B = 12 rads,

L = 3.8 m,

F = 0.0001570796,

DHT = 4 rads,

DWT = 4 rads,

DHB = 4 rads,

DWB = 4 rads,

DL = 1.9 m,

$$V = \left[\left(10^2 + 12^2\right) x\, 3.8\, x\, 0.0001570796\right] - \left[\left[\frac{\left(4 x \frac{4}{2}\right) + \left(4 x \frac{4}{2}\right)}{2}\right] x\, 1.9\, x\, 0.0004\right],$$

$$V = \left[244\, x\, 3.8\, x\, 0.0001570796\right] - \left[\left[\frac{8+8}{2}\right] x\, 1.9\, x\, 0.0004\right],$$

$$V = 0.146 - \left[8\, x\, 1.9\, x\, 0.0004\right],$$

$$V = 0.146 - 0.006,$$

$$V = 0.906.$$

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Timber Grading 6

Scaling under the *Forest Act* means to determine the volume and to classify the quality of timber. Classifying the quality of timber is known as timber grading. Timber is graded in accordance with the schedules of timber grades which are set by the *Scaling Regulation*.

Timber is graded to make the volume information of the scale more meaningful and useful to the sellers and purchasers of timber, and to managers of the forest resource. The quality and potential end use of logs has significant influence on their worth. A scale without grade does not provide enough information for transactions for industry or assessing Crown revenues for government.

In addition to monetary values, log grade can also determine whether or not logs are accounted for cut control purposes, and whether their utilization is mandatory or optional.

Grading is a key component in marketing finished products such as lumber, shingles and plywood. Instead of evaluating finished products, the challenge of the scaler is one of assessing the visible characteristics of each log, and with strict reference to schedules of log grades, visualize what can be recovered from the log given its size and other characteristics.

This chapter describes the principles of grading and details how timber is graded for purposes of the *Forest Act*.

6.1 History of Timber Grading in B.C.

Official scale rules (same as log rules) set the standard for estimating the net yield from logs. Since timber was first measured in B.C. in the mid-1800's five official scales have regulated timber measurement:

Official Scale		Yield Estimate: Units of
Prior to 1894	Foley and Doyle Log Rules	Board feet of lumber
1894	British Columbia Board Foot Scale (FBM)	Board feet of lumber
1944	British Columbia Cubic Scale (lumber cubic)	Cubic feet suitable to cut lumber
1965	British Columbia Firmwood Cubic Scale	Cubic feet of firmwood
1979	British Columbia Metric Scale	Cubic metres of firmwood

The significance of these official scales to grading lies in the fact that some of the practices and conventions followed in applying todays grading rules are very similar to the practices and conventions used in applying some of the official scales developed over 100 years ago.

As grading is in place to make scale data more meaningful it must serve many users including buyers, sellers and forest administrators. Similarly, grading must be responsive to changes in marketing, utilization, forestry practices and forest administration. While log grades have evolved and expanded in response to changing needs, the principles of grading have changed very little.

6.1.1 Coast Grading

Because of its valuable old growth forests, marine transport opportunities and historic settlement patterns, logging and lumbering first flourished on the coast.

Timber grading was first introduced to the coast with the 1902 *Timber Measurement Act*. Initial grading excluded hemlock and balsam as these species were not considered to be of commercial quality.

Coastal grades have changed over the years in response to varying needs. The most recent major revisions were made in 1981 with the implementation of a new schedule of grades. This schedule developed by a joint ministry/industry committee introduced the letter grades (recorded as alphabetical characters), and replaced their numeric predecessors. The 1981 schedule was subsequently revised in 1990.

6.1.2 Interior Grading

Significant growth in the interior forest sector did not commence until the mid 1960s. The first interior grading system under the *Scaling Regulation* was introduced in 1988 to enable reduced stumpage rates to be applied to lower quality logs. Prior to this, grading was restricted to firmwood reject logs and 'category 04' logs, recovered from decadent and damaged stands. The interior schedule was subsequently amended in 1990 to meet the needs of a new utilization policy.

6.2 Timber Grading Requirement

In British Columbia, all timber harvested from private or Crown lands or salvaged from the foreshore must be scaled. Grading is a legal requirement and an integral component of the scale.

The legal authority for grading falls under the *Scaling Regulation*. This regulation prescribes two grading schedules; one for the coast and one for the interior. The method of stumpage used in the area where the timber is cut determines which schedule must be used:

- timber cut in areas where a log based appraisal is used (predominantly coast) must be graded with the Schedule of Coast Timber Grades, and
- timber cut in areas where a lumber based appraisal is used (predominantly interior) must be graded using the Schedule of Interior Timber Grades.

This chapter details how timber is graded in accordance with the schedules of timber grades.

Other than poles, pilings and building logs, special forest products are not graded. Poles, pilings and building logs must be scaled in log form and graded in accordance with the appropriate schedule of timber grades.

6.3 Principles of Timber Grading

Grade rules typically include three components:

- minimum and/or maximum gross log dimensions,
- a requirement that a percentage of the logs gross volume must be available to manufacture a given product, and
- a requirement that a percentage of the product manufactured from the log must meet or exceed a given quality.

Application of the grade rules, as such, requires the scaler to:

- determine the log's gross dimensions,
- estimate what portion of the log is available to produce a given product, and
- consider the quality of the product which could be produced from the log.

To ensure grading is fair, consistent and reliable, it is premised on some basic principles:

- it is done in strict compliance with the grading rules contained in the schedule of grades,
- it assumes only common end products,
- it assumes only conventional manufacturing processes, and
- it is entirely independent of the marketing and/or processing practices of the purchaser.

The challenge for the scaler is to assess the visible characteristics of each log, and with strict reference to the schedule of grades, visualize what can be recovered from the log given the log's size and other characteristics.

The potential product recoveries in grading are:

- coastal grading: lumber, chips, veneer and shingles, and
- interior grading: lumber and chips.

The process of visualizing and quantifying the portions of the log not suitable for the production of lumber (or other product), is known as grade reduction. Unlike firmwood deductions (described in Chapter 5) which reduce the firmwood volume of the log, grade reductions are made solely for the purpose of determining the grade.

In addition to grade reduction, application of the grading rules requires the scaler to assess the quality of the products which could be produced from the log being graded. This requires an assessment of the size, frequency and distribution of knots, and an assessment of any visible spiral grain or twist of the log.

The following sections describe log characteristics which:

- impact potential product recovery, and
- impact product quality.

6.3.1 Log Characteristics Which Reduce Product Recovery (Quantity)

The log characteristics discussed in this section reduce the proportion of the gross log suitable for the production of lumber, veneer, or shingles. Rot, hole, and char will also reduce the quantity of chips that are recoverable. The scaler must determine what portion of the log is not suitable for manufacture because of these defects. This is known as grade reduction and the application is explained fully under Section 6.4.

Although the defects affecting timber quality are described separately, the scaler must evaluate the whole log in terms of the cumulative effect of the separate defects observed.

6.3.1.1 Fractures and Fibre Separation

Wood fibres may separate or split across the annual rings (e.g., surface checks, star shake) or between the annual rings (e.g., ring shake, water shake). Once this separation has occurred, any lumber manufactured across the separation will likely fall apart. Grading must account for the volumes of firmwood that cannot be cut into lumber, veneer, or shingles because of these fractures.

For the purpose of this manual, fibre separation from growth stresses are referred to as shake, and those from seasoning are referred to as check. Shakes are classified into two types according to the direction of the plane of fracture; the heart shakes (often termed heart check) and the ring shakes. Surface checking occurs on the outer surface (sapwood) and often penetrates to the inner part (heartwood) of logs. End checking occurs on the ends of logs and usually does not penetrate very far into a log. The loss in lumber recovery is considerably increased where shakes and surface checks are in conjunction with twist. In addition, where other factors are the same, surface checks have a proportionately greater lumber recovery loss on small logs than larger logs.

The amount of lumber lost due to deep checks is increased if they are combined with spiral grain. The most common situations where spiral checks occur are in logs with frost checks and in snags. The check wraps around the log, following the grain slope. Delays in presenting logs for scaling, such as leaving logs in the woods or in cold decks, often result in a type of surface check known as weather checks or sun checks, which are caused by rapid seasoning. These checks are usually about twice in depth at the ends of the log than elsewhere on the log, because the apex is where the fastest drying occurs, and observation of the log ends will tend to overestimate the overall penetration of the check.

Surface and end checks due to delays in processing are disregarded for the purposes of grading. The Forest Service may order that surface checks be ignored.

Breakage (splits and shatter), as a consequence of normal harvesting and log handling operations must be accounted for in the process of grading.

6.3.1.2 Bark Seams

Bark seams are formed as a result of bark enclosing a point on the outside of a tree which has no wood growth, so that over time a seam of bark is left extending inward from the edge of the tree. Lumber and veneer cannot be recovered from the area of the seam. The volume of firmwood that cannot be manufactured because of bark seams must be determined by blocking out the end area of the wood lost for product recovery and multiplying the cross sectional area by the length of the seam.

6.3.1.3 Sweep, Crook and Pistol Grip

Sweep is a bow like bend in the trunk of a tree, whereas crook is a definite kink at one point in the stem as a result of the tree losing its leader. Pistol grip is a pronounced bend at the butt end of a log resembling the handle of a pistol and is often seen on trees growing on steep sidehills. All three reduce the amount of product that can be recovered. Crook also frequently accompanies a firmwood loss since decay fungi may have entered the stem through the broken leader. The volume of wood that cannot be manufactured because of sweep, crook, or pistol grip must be estimated.

6.3.1.4 Rot, Hole, Char, and Missing Wood

Rot is caused by a variety of fungi which break down and feed off the lignin and/or cellulose in the wood. Hole is rot in its final stages. Char is wood that has been reduced or severely weakened by combustion or extreme heat exposure. Rot is the most common firmwood defect for which a grade reduction must be made.

The rot fungus typically enters the tree through a root, a broken branch, a damaged leader or a scar on the stem. The remains of an old scar, a damaged leader, a crook or fork in a log often means rot is present. Scalers must carefully inspect all visible log surfaces for indicators of firmwood defects. Logs cut from older trees are more likely to contain rot, especially logs cut from tree species such as cedar, hemlock and balsam which are more susceptible to attack by fungi.

No firmwood deductions are made for stain (incipient decay), as long as the wood is still firm, but it may be a consideration in assessing coast grades. If bits or fragments of wood can be picked more easily with the tine of the scale stick from the area in question than from the surrounding area, then the wood is rotten, not firm, and both a firmwood deduction and a grade reduction is made (see Chapters 4 and 5).

In grading, the scaler must estimate how much the rot will reduce the percentage of the log that can be manufactured. Some of the sound wood adjacent to the rot is also lost to lumber production since the sawyer must square out around the defect. To account for this additional loss a trim allowance around the defect is usually made.

The scaler must also consider collars and shells of firmwood which surround defects as well as logs and log segments, which are too short to manufacture the products assumed in the grade rules. Section 6.4.2 details the methods of grading for log characteristics which reduce product recovery.

6.3.2 Log Characteristics Which Reduce Product Quality

In addition to the defects that reduce the potential product recovery volume, some log characteristics reduce the quality of the products which may be recovered. These characteristics include twist (or spiral grain) and knots.

6.3.2.1 Twist (Spiral Grain)

As trees grow they often spiral about their central axis. When these twisted trees are manufactured, the resulting boards have a slope to the grain that reduces their strength and, therefore, the quality of the lumber. When twist is excessive no merchantable lumber can be milled from a log. Therefore, twist may not exceed 15 percent of the reference diameter.

Twist is measured over a representative 30 cm (15 rad) portion of the length of the log. Since the twist of a log is rarely uniform, scalers must carefully select the place to make the measurement. A spot that represents the degree of twist affecting the majority of the log's volume must be selected. Areas around large knots, clusters of knots or other irregularities such as crooks, forks, and burls should be avoided.

Twist is measured by carefully laying the scale stick on the surface of the log parallel to the central axis of the log, and measuring the side deflection of the grain over the indicated 30 cm (15 rads) of length.

On the coast, this deflection is then calculated as a percentage of the top radius class. In the interior, the measured deflection is calculated as a percentage of the top radius class for logs up to and including 8 m, and as a percentage of the measured mid-point radius class for logs over 8 m.

For example, a 5 m log with a 24 rad top showing 3 rads of grain deflection is calculated as having a 12.5 percent twist (i.e., $\frac{3}{24} x 100\% = 12.5\%$). Many scalers prefer to use centimetres, to avoid "half rads". For example, a 48 cm (24 rad) top showing 9 cm (4.5 rads) of grain deflection is calculated as having an 18.75 percent twist (i.e., $\frac{9}{48} x 100\% = 18.75\%$).

The twist allowances for specific log grades are detailed in Sections 6.5 and 6.6.

6.3.2.2 Knots

The size, type, and distribution of knots have a significant impact on lumber quality. As such, knots are a key consideration in applying the grade rules.

6.3.2.2.1 Size of Knots

The presence of any knots in lumber disqualifies it from being classified as clear. Knots larger than 1 rad will lower the strength of lumber and hence the amount of merchantable lumber cut. The larger the knot size, the greater the grain deflection, causing cross grain in the region of the knot. Extremely large knots will make the cutting of merchantable lumber impossible. Knot size is measured in centimetres or rads of diameter.

Individual grade definitions specify maximum knot sizes by top diameter class. In the interior, an exception is made for logs over 8 m in length where both the top diameter and midpoint diameters are referred to for knot assessment. For these longer, interior logs the top half is assessed using the top diameter while the bottom half is assessed against the measured mid point diameter.

6.3.2.2.2 Types of Knots

Knots in timber are sound or rotten, and tight or loose.

Sound knots may be tight or loose, and lumber sawn from logs with sound, tight knots is generally of a higher quality than lumber with loose knots or rotten knots.

Rotten knots in timber occur when there are broken and dead branches in trees as these represent an entry point for fungus spores, which lead to decay. Rotten knots can be indicators of internal decay; the appearance of log ends that have been bucked through, or adjacent to such knots serve as good evidence of the general pattern of decay characteristics for a particular timber stand and species.

Tight knots are found where the branches on the tree were still living or green when the tree was harvested. The tissue system of the branch is interconnected or intergrown with the tissue of the log, and the grain orientation in the trunk wood is laterally distorted around the knot and passes in a wide sweep on either side. In lumber grading, these are also known as intergrown or red knots.

When a branch dies, the cambium in the branch ceases to function, and there is a break in the continuity of the woody tissue between the branch and the stem. The portion of the branch base that is embedded in the tree trunk after the branch dies causes a loose, encased, or black knot in lumber. Since the wood of the tree trunk is not continuous with that of the encased knot, there is less distortion of the grain around it than with tight knots.

Considering knots in the application of the grading rules is covered under Section 6.4.3.1.

6.3.2.2.3 Distribution of Knots

The distribution of knots in logs is determined by the growth characteristics of the tree.

After getting established, coniferous trees typically grow 0.2 to 1 m per year depending on the species and suitability of the growing site. When the tree matures, apical or upward growth decreases significantly. As balsam, fir, pine, spruce and larch grow, they add a whorl of branches at the start of each year. Normal branch distribution in small diameter stems sees whorls spaced between 0.3 and 0.5 m apart. Red cedar, yellow cedar, and hemlock branches are not produced in regular whorls. Instead, their branches are spaced on the stems of young trees 0.3 to 0.5 m apart.

After a tree reaches mature height, additional branch whorls are still added each year but the branches are much closer together. Sometimes trees produce a number of branches in a bunch, resulting in a cluster of knots in the wood. A close grouping of knots (cluster knots or bunch knots) reduces the strength of the lumber cut from that portion of the log containing the cluster or bunch of knots.

In general, a cluster or bunch knot occurs where the knots are so close together that most of the grain of the wood is deflected around the knots rather than between them.

Bunches or clusters of knots are to be encircled with the smallest diameter circle or oval that will encompass the grouping. The average diameter of this circle or oval is then taken as the effective bunch knot diameter.

Knot specifications for specific coast and interior grades are found in Sections 6.5 and 6.6.

6.3.2.3 Grain Density (Ring Count) - Coastal Grading Only

The diameter growth rate of a tree is dependent upon the species, genotype (i.e., its genetic makeup), climate and other site specific conditions. Growth is more rapid early in the growing season, and the 'earlywood' produced at this time consists of large, light coloured cells. The 'latewood' cells produced later in the season are smaller with thicker walls, and so appear to be darker. Each pairing of light and dark bands comprise one 'annual ring', which marks one years growth.

Grain density or the closeness of the annual rings is a consideration in coastal grading. Finer grained logs (i.e., more closely spaced annual rings) yield higher quality lumber and veneer, and as such, usually command higher values than logs with more widely spaced annual rings.

Considering grain density in applying the grading rules is covered under Section 6.4.3.3.

6.4 Applying the Principles of Grading

6.4.1 Grade Reduction

Grade Reduction is the process of determining what portion of a log is not suitable for the manufacture of various products. Section 6.3 outlined the defects found in logs which reduce the amount of finished product which can be recovered from logs. These defects include:

- firmwood defects (including rot, hole, char, and missing wood), and
- non-firmwood defects (including shake, checks, frost cracks, shatter, splits, forks, catface, deadside, lightning scar, bark seams, goitre, pistol grip, sweep, and crook).

Because logs are round and usually tapering, it is not possible to produce lumber, shingles, or veneer from the entire defect free portion of the log. As detailed in later sections, grade reduction requires that a trim allowance be applied around most defects.

In addition, grade reduction must account for other volumes which are not available for manufacture. These include:

- collars of firmwood too thin to cut lumber,
- segments of slabs too thin to cut lumber,
- sound hearts that are too small in diameter, and
- the defect free portion of logs and slabs too short to cut lumber.

Grade reduction is only used in the assessment of log grade. The firmwood contents or the net dimensions that yield the firmwood contents must always be recorded as the official British Columbia Metric Scale volume.

The volume of the log not available for the manufacture of lumber or the other products is the grade reduction volume. In applying the grading rules, the scaler must deduct this volume from the gross log volume and express the remaining volume as a percentage of the gross volume. This percentage represents the percentage of the log which can be manufactured.

$$\%\ \text{Suitable for Manufacture} = \frac{\text{Gross Volume} - \text{Grade Reduction}}{\text{Gross Volume}} \text{ x } 100$$

(Where Gross Volume = Defect Free Vol. + Defect Volume)

Determining the grade reduction volume and calculating the percentage suitable for product recovery, while not difficult, can be time consuming. As scalers gain experience and complete numerous grade reduction calculations, they become proficient at estimating grade reductions.

> Experienced scalers usually find it necessary to perform only periodic full calculations for confirming their estimates and determining grades on borderline logs.

Experienced scalers follow a number of approaches to avoid needless calculations:

- look for obvious tree characteristics which may impact the grade (e.g., excessive knots or twist will considerably narrow a logs grade potential), and
- they understand the relationship between certain defects and log size (e.g., a 2 rad surface check on a small log may have a very significant impact compared to the same check on a large log.

These types of judgements become second nature to experienced scalers. Initially, scalers are strongly advised to calculate all grade reductions. It is only through such a background of disciplined practice that "log sense" and good judgement will develop.

While this log sense is never really lost, it can be weakened by periods of inactivity and even highly experienced scalers should periodically reconfirm their skills especially after periods of layoff.

6.4.1.1 Field Methods for Determining Grade Reduction

Instead of using a full metric volume approach using Smalians formula, shortened field methods may also be used to estimate grade reduction. Field methods such as that outlined in Appendix 6A reduce scaling time and the number of calculations, and at the same time can yield reliable results.

The reliability of field methods is dependent upon the specific characteristics of the logs being scaled. As discussed in Chapter 5, Smalians formula may yield unreliable results if there is excessive taper between the top and butt of the log. The same caveat applies to the use of field methods.

As such, it is most important for scalers to know the limitations and range of application of field methods if they are contemplating their use.

Appendix 6A is considered reliable for the purpose of applying the Coastal Schedule of Timber Grades.

6.4.2 Assessing Product Recovery

Grade rules require that a certain specified percentage of the gross log volume must be available for manufacture. This requires the grade reduction volume to be calculated. The net log volume, available for manufacture, must then be calculated and expressed as a percentage of the logs gross volume.

The official methods and field methods for calculating grade reduction are similar to those used for determining firmwood deduction. Scalers should carefully study Chapter 5 and practice these procedures on logs until they are thoroughly understood.

Except for logs with sap rot or char, which are otherwise sound, the grade reduction volume is always larger than the firmwood deduction volume. There are three reasons for this:

- there are a number of defects such as fractures, bark seams, goitre, sweep, and crook that reduce product recovery but do not cause firmwood loss,
- additional defect free volume around the allowable defects (i.e., the trim) is lost in the manufacturing process, and
- while the firmwood loss is related only to the size of the defect, the grade reduction loss is also dependent upon the orientation of the defects in the log. That is, a defect may be so positioned as to render additional log segments too short or may cause the residual collar (log shell) to be too thin for manufacture.

The following sub-sections detail grade reductions which affect lumber recovery.

6.4.2.1 Determining Grade Reduction for Collars (Shells)

Where logs have heart defects, the collar or shell of sound wood surrounding the defect must meet a minimum thickness requirement in order for lumber or shingles to be cut from it, according to the following specifications:

1. The minimum collar thickness specified is the actual unrounded measurement of the collar taken before trim allowance has been added to the defect.

2. For all species except interior red cedar and interior hemlock, the minimum collar or shell thickness needed in order to produce lumber is *5 rads (10 cm)*. This applies to all collars surrounding internal (heart) defects such as heart rot, pocket rot, holes, ring rot, ring shake, water shake, and star shake.

3. For interior red cedar and interior hemlock, the minimum collar thickness is *7.5 rads (15 cm)* for heart rot, holes, and star shakes only. For pocket rot, ring rots, ring shake and water shake in these species the minimum collar thickness is *5 rads (10 cm)*. The reasons for the exception are tied to the economic considerations in logging interior hemlock and cedar stands, lower predictability of rot patterns in these species, and a higher susceptability to shatter.

4. Where a collar or a portion of a collar does not meet the minimum thickness requirement, the volume of the collar or portion must be included in the grade reduction. An exception is where the diameter of the defect is 20 percent or less than the diameter of the log end in which it appears. In such cases, the collar is deemed to be thick enough to cut lumber, so trim allowance is added to the defect measurement and the grade reduction is then calculated This rule is used to prevent unreasonable down grading of smaller diameter logs with a very small core of heart rot. Only logs up to about 12 rads in diameter (with 5 rad collar requirement) or logs up to about 18 rads in diameter (with 7.5 rad collar requirement) are affected.

Scalers must exercise care when measuring or estimating collar thickness by taking actual, unrounded measurements of the collar. It is tempting to simply subtract the defect diameter from the recorded log diameter and divide the difference by two, but this method of averaging the collar thickness can lead to mistaken assumptions. For example:

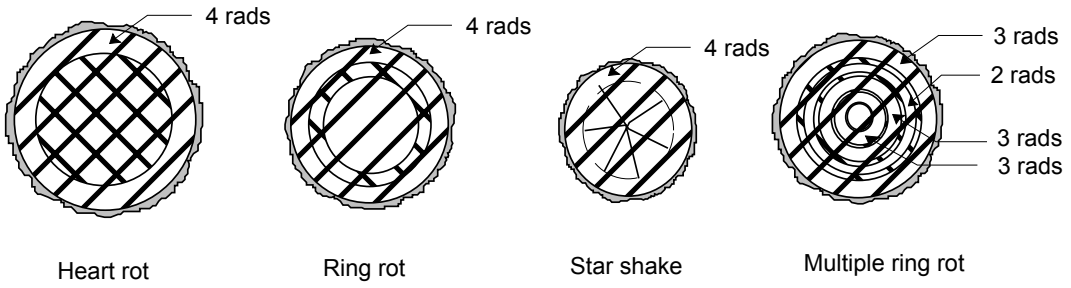
- on logs with excessive butt flare, this method will often considerably under-estimate the true collar thickness since the butt diameter has been reduced by calipering to compensate for the flare, but the defect is not. Experience has shown that defects usually follow the growth rings, so it is more reasonable to presume that if there is collar at the end of a log, there will still be collar at the point where the log was calipered, and

- on logs which have an off-centre defect, this method will not reflect the possibility that a portion of the log will or will not meet the grade requirement. For example, in Figure 6.10(1) the off-centre star check has a portion with sufficient collar and a portion without By averaging, a scaler may not take a grade reduction when one is available, and may take an excessive reduction when a portion of the collar actually does meet the grade requirement.

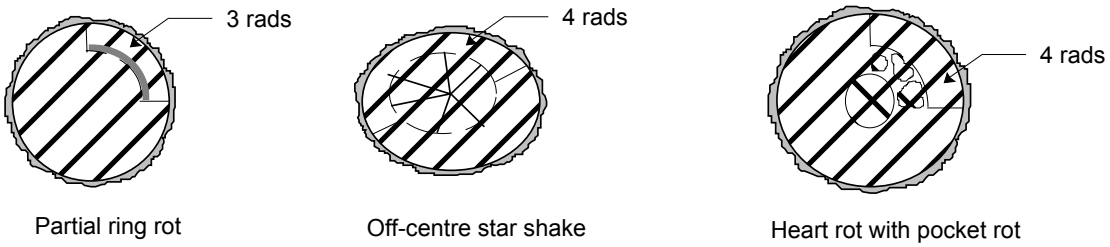
The following conventions are used to help ensure consistency in assessing collars:

- collar thickness is obtained by direct measurement of the collar with the scale stick at the log end in which the defect appears, including flared butt logs,
- if adequate collar is found on the cut face of a flared butt log, there will be adequate collar where the butt diameter was calipered,
- where a defect runs a partial length of a log, the measured collar thickness is presumed to hold true for the entire length affected by the defect, except for cone shaped defects (butt rot),
- where a defect runs the full length of a log, the collar determination made at each end is presumed to hold true for half the length of the log, and
- where a defect is located so that merely a portion of a collar is below the minimum requirement, only that portion is downgraded and added to any other grade reduction.

Collar thickness principles are provided in Figure 6.1, without showing trim allowance. Trim allowance is added *after* any collar assessments and is described fully in Section 6.4.2.5.



1. Examples of logs with entire collars too thin to produce lumber



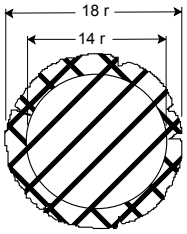
2. Examples of logs with a portion of the collar too thin to produce lumber.

3. Examples of logs with sufficient collar to produce lumber.
(trim allowance is added to the collar surrounding the defect when calculating grade reduction).

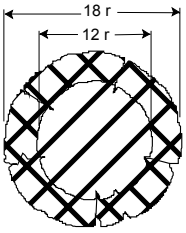
Figure 6.1 Examples of collars around internal defects.

6.4.2.2 Determining Grade Reduction for Sound Hearts (Residual Cores)

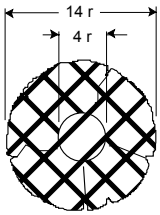
Sound hearts inside defects such as sap rot, charred wood, ring rot and ring shake are considered suitable for lumber production if they are 5 rads (10 cm) or more in diameter. Hearts less than 5 rads are included in the grade reduction. The treatment of sap rot is illustrated in Figure 6.2. Examples of grading residual cores inside ring shake and ring rot are provided in Section 6.4.2.5 (trim allowance section).



1. Sap rot



2. Advanced Sap rot



3. Residual core is grade reduction.

Trim allowance is not added to sap rot but may be added to surface checking of the residual core.

Figure 6.2 Residual Cores in Sap rot.

The first example in Figure 6.2 shows the end of a log with sap rot with an outer diameter of 18 rads and a residual core diameter of 14 rads. The grade reduction is the outer portion of the log for the distance the rot travels. From the scale stick:

Gross unit volume = UV 18 r = 102 dm^3

Grade reduction = UV 18 r - UV 14 r = (102 - 62) = 40 dm^3

% of log which can be manufactured = $\frac{102-40}{102} \times 100$ = 60.8 %

The second example in Figure 6.2 shows relatively advanced sap rot with an outer diameter of 18 rads and a residual core diameter of 12 rads. Advanced sap rot like this often requires an additional firmwood adjustment to account for irregular rot penetration, and a further grade adjustment for checks which penetrate into the sound core.

From the scale stick:

Gross unit volume = UV 18 r = 102 dm^3 per metre

Grade reduction = UV 18 r - UV 12 r = (102 - 45) = 57 dm^3 per metre

% of log which can be manufactured = $\frac{102-57}{102} \times 100$ = 44.1 percent

The third example in Figure 6.2 shows a log with sap rot which has advanced to the point where the residual core is less than 5 rads in diameter. This log is 100 percent grade reduction for the distance the rot travels, and automatically qualifies as firmwood reject.

Although the following calculations are unnecessary in field practice, they are shown to illustrate the principle of a cumulative grade reduction.

From the scale stick:

Gross unit volume = UV 14 r = 62 dm^3 per metre

The first grade reduction is the sap rot for the distance it travels the log:

Grade reduction = UV 14 r - UV 4 r = (62 - 5) = 57 dm^3 per metre

The second grade reduction is for the firmwood core which is under 5 rads in diameter:

Grade reduction = UV 4 r = 5 dm^3 per metre

Total grade reduction = (57 + 5) = 62 dm^3 per metre

% of log which can be manufactured = $\frac{62-62}{62} \text{x} 100$ = 00.0 %

6.4.2.3 Determining Grade Reduction for Multiple Defects

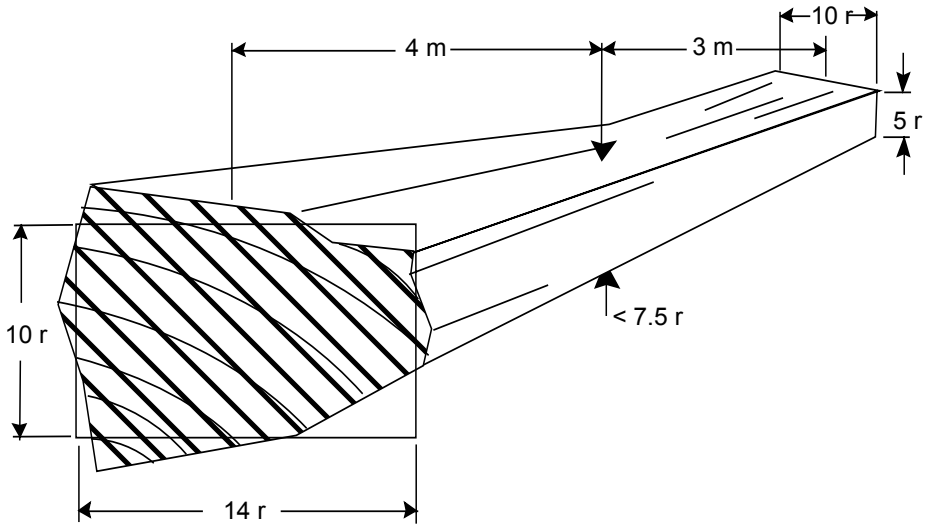
Occasionally, scalers will encounter log ends with two or more defects positioned such that there is less than 5 rads (10 cm) of usable fibre available between the defects. In these situations, simply adding the trim around each defect and calculating the grade reduction would understate the loss in recovery. In such cases the available material separating the defects is also unsuitable for manufacture and is added to the grade reduction. Examples of grading multiple defects with less than 5 rads of separation are provided in the trim allowance Section 6.4.2.5.

6.4.2.4 Determining Grade Reduction for Slabs

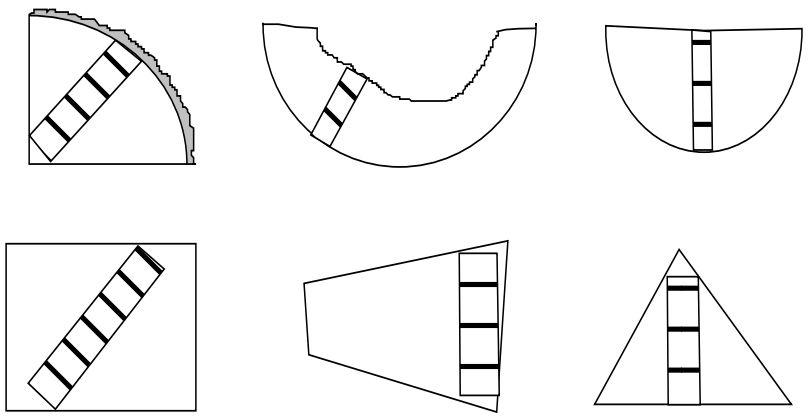
To be considered suitable for manufacture into lumber in the interior grades,, slabs must be at least 7.5 rads (15 cm) thick. For coastal grading, the maximum thickness at right angles to the grain where a 2 rad board can be sawn is used to determine whether a slab qualifies for a particular grade. Grades D, E, F, G, H, I, and K require 19 rads; L requires 13 rads; M and U require 8 rads; X requires 5 rads, and no slabs are allowed in B, C, and J grades.

The specified minimum thicknesses are the actual, unrounded measurements.

Portions of slabs which do not meet the minimum thickness must be assessed as grade reduction. This includes measured lineal portions since, unlike collars on round logs which can be measured only on the ends, slab thicknesses can be measured at any point along their length.



1. 4 m portion of log which is thick enough to cut lumber.



2. Maximum thickness is at right angles to the grain (coast).

Figure 6.3 Slabs with portions meeting the grade rule.

The slab in Figure 6.3 was measured for firmwood content according to the method described in Chapter 5, where the cut faces are enclosed in a rectangle which has an area equivalent to the slab end. The dimensions are 7 by 14 rads and 5 by 10 rads by 7 m, and an equivalent radius class unit is found for each end of the slab:

Slab Unit volume, big end	=	10 x 14 x 0.4	=	56 dm^3
Slab Unit volume, small end	=	05 x 10 x 0.4	=	20 dm^3
Average unit volume	=	(56 + 20 / 2)	=	38 dm^3
Gross volume	=	(38 by 7 m)	=	266 dm^3

The portion of the slab which is 7.5 rads or greater in thickness runs out 4 m up the slab, so 3 m of the slab is grade reduction.

Grade reduction	=	38 by 3 m	=	114 dm^3
% of slab which can be manufactured	=	$\frac{266-114}{266} x 100$	=	57.1 percent

6.4.2.5 Determining Trim Allowance

Trim allowance is included in the grade reduction and refers to the firmwood surrounding rot and other internal defects which is lost to lumber recovery when squaring up the areas adjacent to a defect. The standard trim allowance is 1 rad (2 cm) on all sides of the defect if the collar thickness requirements are met.

Once the trim allowance has been added, the total dimension is inserted into the appropriate formulae from Chapter 5 and the individual grade losses for the measured defects calculated. The individual losses are then summed to derive the total grade reduction.

The conventions associated with trim allowance are:

1. Trim allowance is added to internal defects such as heart rot, through running butt rot, pocket rot, ring rot, ring shake, water shake, heart shake, star shake, deep surface checks (checks which would remain after slabbing off), and fractures.

2. Trim allowance is not added to external defects such as sap rot, cat face, missing wood, shallow surface checks, sweep, crook, pistol grip, twist, char, and goitre.

3. Ring rot, ring shake, and water shake are characterized by having one or more *collars* of firmwood, interspersed by concentric rings or partial rings of defect surrounding one central *core* of firmwood. Trim allowance is applied to firmwood adjacent to the defect(s) as follows:

    - where the collar outside a ring defect and the core inside are both thick enough to produce lumber, a trim allowance is added to both the collar outside of the defect and the core inside of the defect in calculating the grade reduction,

    - where a sound collar does not meet the minimum thickness required to produce lumber, trim allowance is neither added to the collar nor to the core; the entire collar is included as grade reduction, and the entire core is considered to be available for manufacture (where the residual core is at least 5 rads or 10 cm in diameter),

    - where a sound core does not meet the minimum diameter of 5 rads (10 cm) trim allowance is not added to the core; the entire core is included as grade reduction, and trim allowance is added to the collar surrounding the core if it meets minimum thickness requirements.

    - where both the collar(s) and core do not meet the minimum thickness required to produce lumber, the length of the log affected is included as grade reduction, and

    - where there are multiple rings of defect, trim allowance is added to each collar which meets the minimum thickness required to produce lumber.

4. Trim allowance is added to the collar of firmwood surrounding the core of rot in heart rot and through running butt rot if the collar meets the minimum thickness required to produce lumber.

5. Trim allowance is added to all sides of pocket rot whether enclosed in a circle or a square or rectangle. Where numerous pockets are separated by less than 5 rads (10 cm) of firmwood, trim allowance is added around the group of pockets; the entire area of firmwood between the pockets is included as grade reduction.

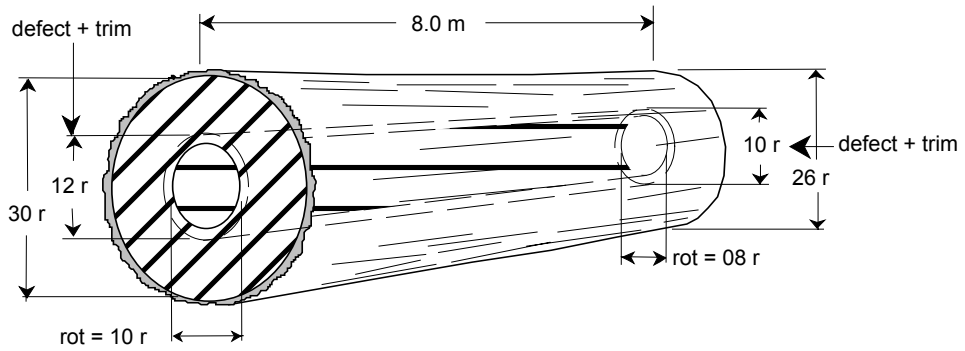
6. Trim allowance is added to both sides of single shakes, deep checks, and fractures. If they are irregular, the total width of the irregularity is determined, and the trim allowance added to it.

7. Star shakes and multiple deep surface checks (checks which would remain after slabbing off) are trimmed out in their entirety. The average diameter of a circle or ellipse to just enclose the star shake or to just exclude the deep surface checks is used to determine the grade reduction.

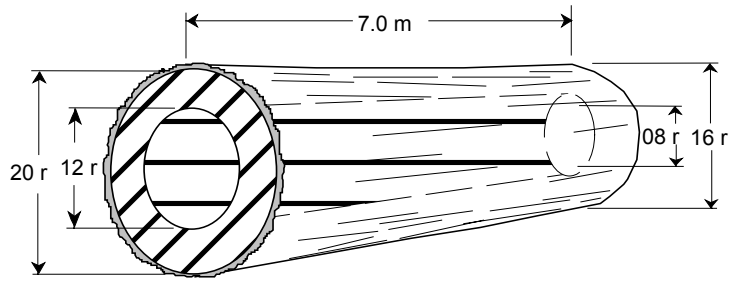
8. Spiral checks are trimmed out in their entirety; the amount of twist in the check is observed or calculated over a given length.

Note:

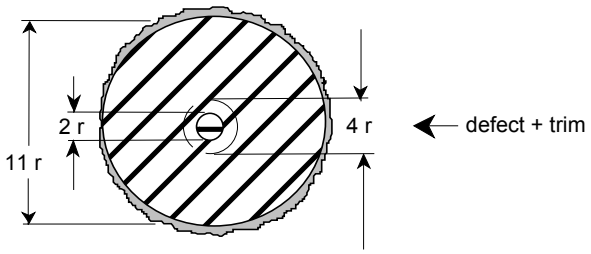
The following figures demonstrate examples of the principles of trim allowance in calculating grade reductions.



1. A log with heart rot and the collar is thick enough to produce lumber.



2. A log with heart rot and the collar is too thin to produce lumber.



3. Defect less than 20& of the end diameter

Collar thickness is always measured exclusive of trim

Figure 6.4 The application of trim allowance around heart rot and hole.

In Figure 6.4, the first log has a rot diameter of 8 rads at the top and 10 rads at the butt. The grade reduction will be for a 10 rad top defect and a 12 rad butt defect after the 1 rad trim allowance is added around the defect. From the scale stick:

Gross volume	=	8 m/26 r/30 r	=	(849 + 1131)	=	1980 dm^3
Grade reduction	=	8 m/10 r/12 r	=	(126 + 181)	=	307 dm^3
% of log which can be manufactured			=	$\frac{1980-307}{1980}$ x100	=	84.5 percent

The second log in Figure 6.4 has a collar thinner than the 5 rad minimum thickness requirement so the entire log is grade reduction. It is unnecessary to add trim allowance.

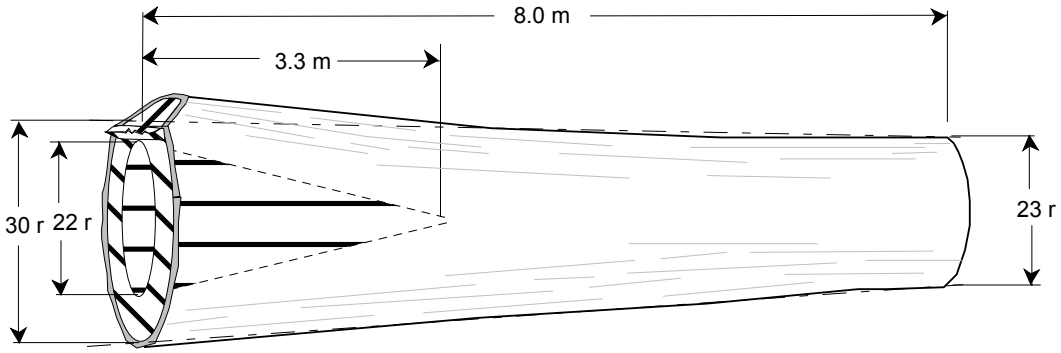
The following calculation is also unnecessary but is given to illustrate the principle of calculating a 100 percent grade reduction.

From the scale stick:

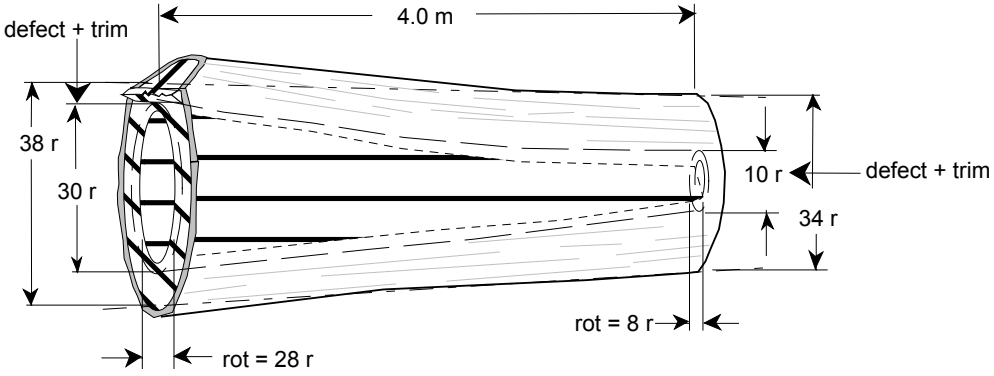
Gross volume	=	7 m/16 r/20 r =	(281 + 440)	=	721 dm^3
Grade reduction	=	7 m/16 r/20 r =	(281 + 440)	=	721 dm^3
% of log which can be manufactured	=		$\frac{721-721}{721}$ x100	=	00.0 %

An exception to the grade rule is the third log and in Figure 6.4. It has a heart defect diameter less than 20 percent of the log diameter (2 rads divided by 11 rads times 100 = 18 percent) *and* the residual collar is less than 5 rads thick. If the heart defect is less than 20 percent of the log diameter, collar thickness is not considered and trim allowance is added. Therefore, in this example, the grade reduction per metre of length from the scale stick is:

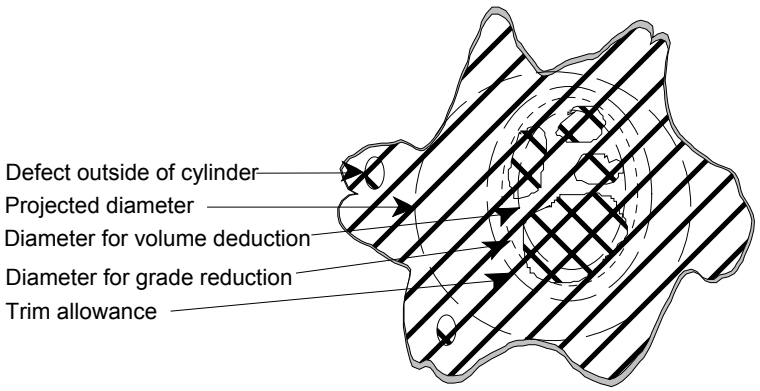
Gross volume per metre (11 r)	=	Unit volume: log	=	38 dm^3	
Grade reduction per metre (04 r)	=	Unit volume: defect	=	5 dm^3	
% of log which can be manufactured	=	$\frac{38-05}{38}$ x100	=	86.8 percent	



1. An interior log with simple butt rot estimated to penetrate 3.3 metres into the log (22 x 0.15 = 3.3m)



2. A log with through running butt rot



3. Irregular butt defects in fluted butt log.

Figure 6.5 The application of trim allowance around butt rot.

The first example in Figure 6.5 is the exception to the convention of adding trim allowance to a collar of firmwood. Because conical butt rot has a much more variable and complex effect on grade reduction, a number of approaches to a reasonable solution have been tested. Of those methods, doubling the firmwood deduction is a reliable and simple convention, which allows for both trim allowance and minimum collar requirements.

With the scale stick:

Gross volume	=	8 m/23 r/30 r	=	(665 + 1131)	=	1796 dm^3
Cone volume	=	3.3 m/22 r	=	$\frac{(251 + 251)}{3}$	=	167 dm^3
Grade reduction	=	167 x 2	=	334 dm^3		
% of log which can be manufactured			=	$\frac{1796-334}{1796} x 100$	=	81.4 percent

The second example of butt rot in Figure 6.5 follows the standard convention for adding trim allowance because the butt rot takes the form of heart rot. However, in the case of through running butt rot with the rot diameter at the but more than 1.5 times the rot diameter at the top, an overstatement of the grade reduction may result from summing the half volumes or from finding the average unit volume. And, because of the neiloid or "golf tee" shape of the rot in this example, the grade reduction may be based on the average of the two diameters, which is nearer to the true volume of the defect. If the shape of the rot is presumed to be a frustum of a cone, it is necessary to increase the average diameter. If the shape is presumed to be parabaloid or "bullet" shape, half volumes or average unit volumes may be used. See the example in Chapter 5 showing a volume deduction for conoid through running butt rot.

With the scale stick:

Gross volume	=	4 m/34 r/38 r	=	(726 + 907)	=	1633 dm^3
Average defect diameter			=	$\frac{10 + 30}{2}$	=	20 rads
Grade reduction	=	4 m/20 r/20 r	=	(251 + 251)	=	502 dm^3
% of log which can be manufactured			=	$\frac{1633-502}{1633} x 100$	=	69.3 percent

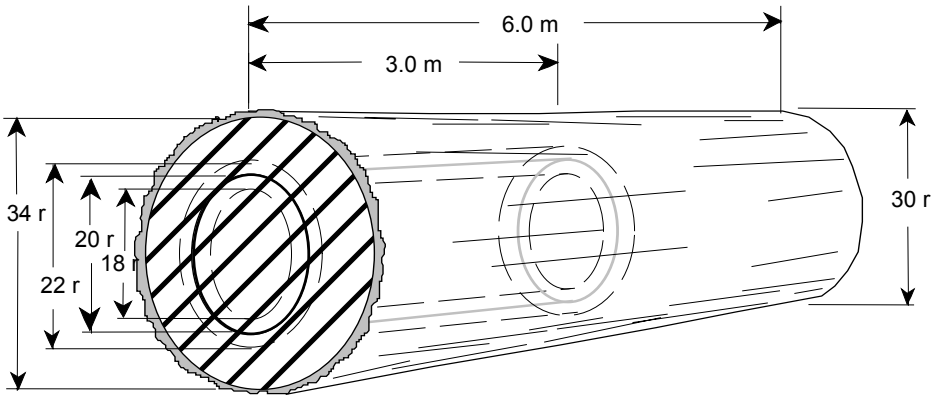
In this example, it is assumed that the collar is thick enough to cut lumber. Where the collar does not meet the minimum thickness, the lineal portion of the log without collar must be included as grade reduction. The collar thickness is determined by actual measurement, *not* as 1/2 the difference between the projected butt diameter and the defect diameter.

As with many procedures described in this manual, considerable field instruction is required to accurately apply these grade reduction procedures.

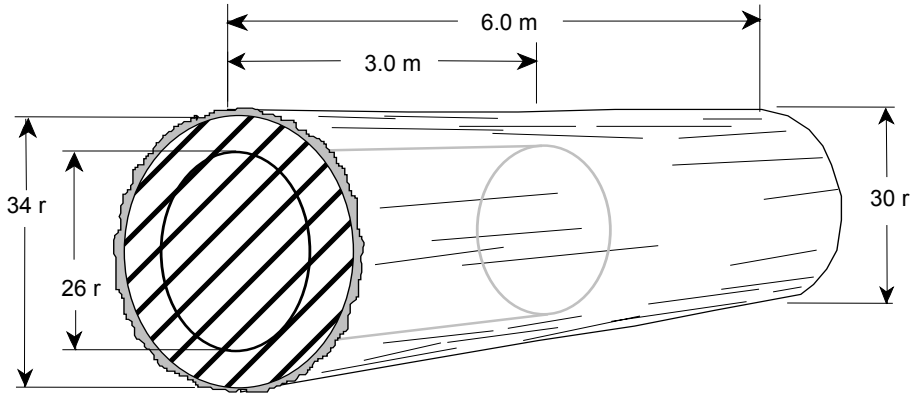
The third example in Figure 6.5 shows scattered butt rot. Irregular or sporadic rot and water shake and those with defect extending into the collar will require a significantly larger initial measurement (before adding trim) than what would be used for a firmwood deduction. The illustration includes the following relationships:

- any defects outside of the gross butt diameter (projected butt diameter) are not considered for either firmwood deduction or grade reduction, although these defects may serve to indicate the severity of a butt defect. i.e. the distance it penetrates up the log,
- the firmwood deduction diameter is *reduced* to account for firmwood in-between the scattered defects,
- the grade reduction diameter is *increased* to include all the rot and other defect within the cutting cylinder that affects lumber recovery,
- trim allowance is added to the diameter for grade reduction in through running butt rot, and
- when two or more defects are positioned such that there is less than 5 rads (10 cm) of usable fibre available between the defects, the available material separating the defects is also unsuitable for manufacture and is included in the grade reduction.

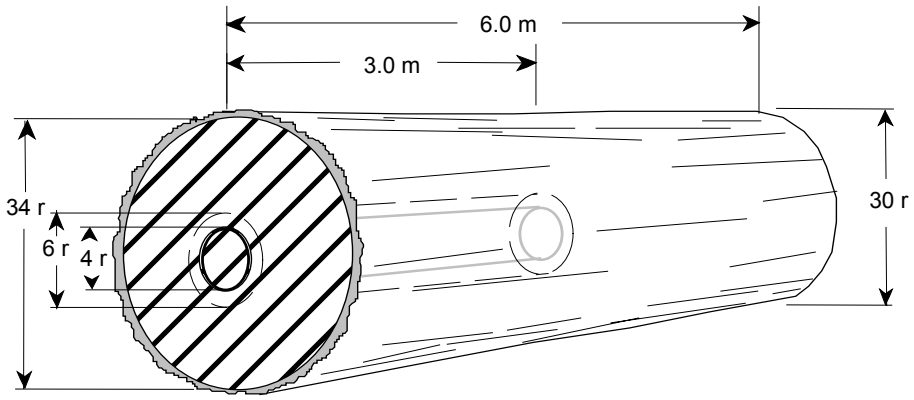
Notes:



1. A log with ring shake and the collar and core are thick enough to produce lumber.



2. A log with ring shake and the collar is not thick enough to produce lumber.



3. A log with ring shake and the core is not thick enough to produce lumber.

Figure 6.6 The application of trim allowance around ring shake.

Example 1 in Figure 6.6 shows a log with ring shake which is estimated to penetrate one-half of the log length. Because the collar meets the minimum collar requirements, add a 1 rad trim allowance on both sides of the shake and deduct the volume of a 2 rad ring.

From the scale stick:

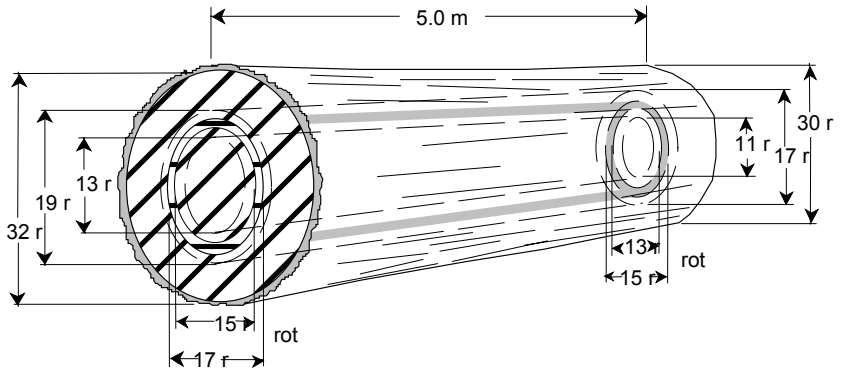
Gross volume	=	6 m/30 r/34 r	=	(848 + 1090)	=	1938 dm^3
Grade reduction	=	UV 22 r - UV 18 r for 3 m	=	(152 - 102) x 3	=	150 dm^3
% of log which can be manufactured			=	$\frac{1938-150}{1938}$ x100	=	92.3 percent

Example 2 in Figure 6.6 shows a log with the same gross dimensions as Example 1, but the ring shake is positioned so that the collar of firmwood is less than the minimum thickness requirement of 5 rads. Because the entire collar is a grade reduction, the entire core is considered suitable for recovery, and no trim allowance is added. From the scale stick:

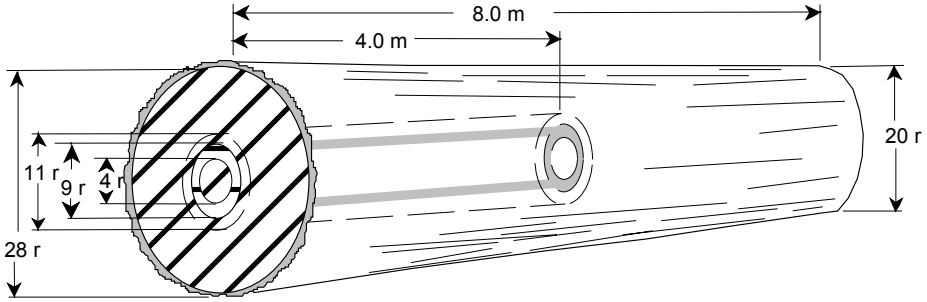
Gross volume	=	6 m/30 r/34 r	=	(848 + 1090)	=	1938 dm^3
Grade reduction	=	UV 34 r - UV 26 r for 3 m	=	(363 - 212) x 3	=	453 dm^3
% of log which can be manufactured			=	$\frac{1938-453}{1938}$ x100	=	76.6 percent

Example 3 in Figure 6.6 shows a log with the same gross dimensions as the first two examples but the core of firmwood is less than the minimum core thickness of 5 rads. Because the core is a grade reduction, trim allowance is added only to the collar. From the scale stick:

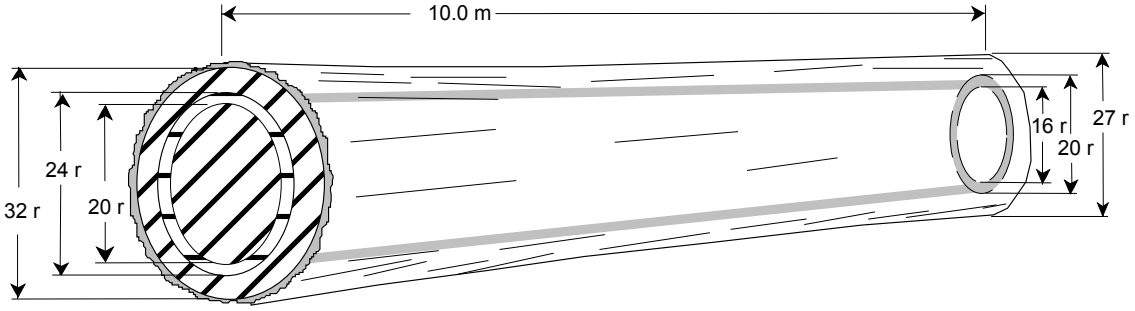
Gross volume	=	6 m/30 r/34 r	=	(848 + 1090)	=	1938 dm^3
Grade reduction	=	3 m/6 r/6 r	=	(17 + 17)	=	34 dm^3
% of log which can be manufactured			=	$\frac{1938-34}{1938}$ x100	=	98.2 percent



1. A log with ring rot where both core and collar meet the grade rules.



2. A log with ring rot where only the collar meets the grade rules.



3. A log with ring rot where only the core meets the grade rules.

Figure 6.7 Application of trim allowance around ring rot.

The first example in Figure 6.7 shows a log with 1 rad of ring rot penetrating the full length and circumference of the log. Because both the collar and the residual core meet minimum thickness requirements, trim allowance is added to both the collar and the core.

From the scale stick:

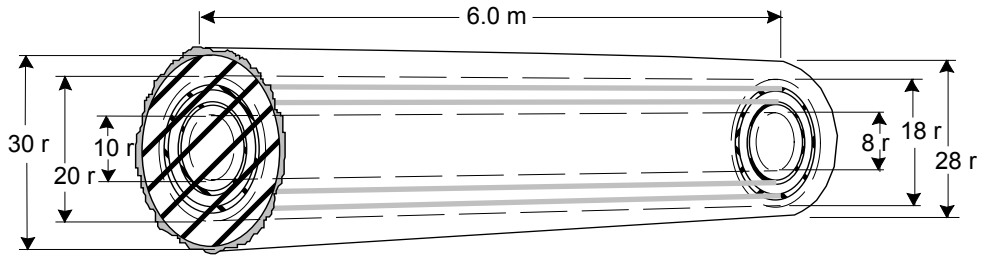
Gross volume	=	5 m3/0 r/32 r = (707 + 804)		=	1511 dm^3	
Grade reduction	=	Outside cylinder 5 m/17 r/19 r		=	(227 +284) = 511 dm^3	
less	=	Inside cylinder 5 m/11 r/13 r		=	(95 + 133) = 228 dm^3	
	=	(511 - 228)	=	283 dm^3		
% of log which can be manufactured	=	$\frac{1511-283}{1511} \times 100$	=	81.3 percent		

The second example in Figure 6.7 shows a log where the sound heart is only 4 rads, which is less than the 5 rads (10 cm) required to cut lumber. Because the entire core is a grade reduction, trim allowance is added only to the collar. With the scale stick:

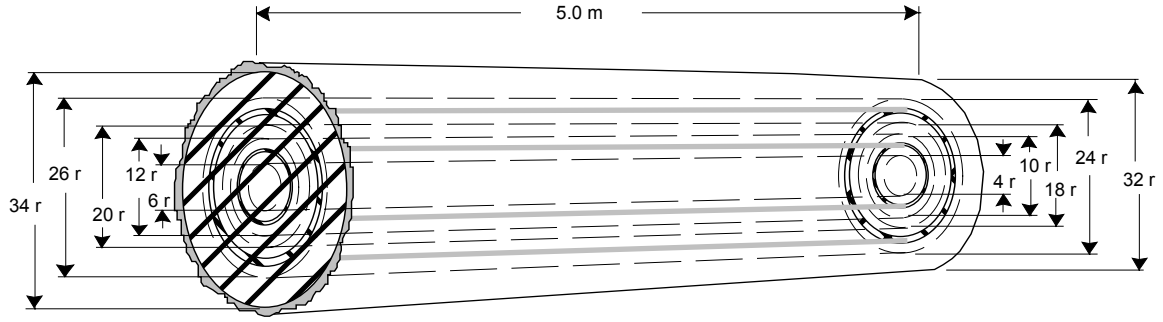
Gross volume	=	8 m/20 r/28 r	=	(503 + 985)	= 1488 dm^3
Grade reduction	=	4 m/11 r/11 r	=	(76 + 76)	= 152 dm^3
% of log which can be manufactured	=	$\frac{1488-152}{1488} \times 100$	=	89.8%	

The third example in Figure 6.7 shows a log where the sound collar is less than the minimum thickness required to cut lumber. Trim allowance is not added to either the collar or the core; the entire collar is grade reduction and the entire core is available for manufacture (when it is 5 rads or more in diameter).

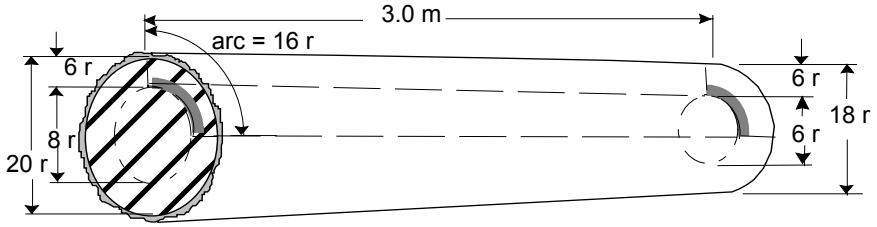
Gross volume	=	10 m/27 r/32 r	=	(1145 + 1608) =	2753 dm^3
Volume available	=	10 m/16 r/20 r	=	(402 + 628)	= 1030 dm^3
Grade reduction	=	2753 - 1030	=	1723 dm^3	
% of log which can be manufactured	=	$\frac{2753-1723}{2753} \times 100$	=	37.4 percent	



1. A log with multiple ring rot and the firmwood between rings is less than 5 rads.



2. A log with multiple ring rot and the firmwood between rings is 5 rads or greater.



3. A log with partial ring rot 2 rads thick.

Figure 6.8 The application of trim allowance around multiple and partial rings.

The first example in Figure 6.8 shows a log with two 1 rad rings of rot penetrating the full length and circumference of the log. Because both the collar and the residual core meet minimum thickness requirements, trim allowance is added to both the outer collar and the core, but the residual collar between the two rings does not meet the requirements, and it is grade reduction. If the outer collar and core also did not meet the minimum requirements, the whole log would be grade reduction.

From the scale stick:

Gross volume	=	6 m/28 r/30 r	=	(739 + 848)	=	1587 dm^3
Grade reduction	=	Outside cylinder 6 m/18 r/20 r = (305 + 377) = 682 dm^3				
less	=	Inside cylinder 6 m/08 r/10 r = (60 + 94) = 154 dm^3				
	=	(682 - 154)	=	528 dm^3		
% of log which can be manufactured			=	$\frac{1587-528}{1587}$ x100 = 66.7 percent		

The second example in Figure 6.8 shows a log with two 1 rad rings of rot penetrating the full length and circumference of the log. Because both collars and the residual core meet minimum thickness requirements, trim allowance is added to both collars and the core. Although the number of dimensions shown in this example appears to represent a complex situation, there is only one extra step involved, and as with calculating the firmwood deduction, the work is done progressively, from the outside ring to the inside ring.

From the scale stick:

Gross volume	=	5 m/32 r/34 r	=	(804 + 908)	=	1712 dm^3

Outside ring:

Grade reduction	=	Outer cylinder 5 m/24 r/26 r = (452 + 531) = 983 dm^3				
less	=	Inner cylinder 5 m/18 r/20 r = (254 + 314) = 568 dm^3				
	=	(983 - 568)	=	415 dm^3		

Inside ring:

Grade reduction	=	Outer cylinder 5 m/10 r/12 r = (79 + 113) = 192 dm^3				
less	=	Inner cylinder 5 m/04 r/06 r = (13 + 28) = 41 dm^3				
	=	(192 - 41)	=	151 dm^3		
Sum of grade reduction			=	(415 + 151)	=	566 dm^3
% of log which can be manufactured			=	$\frac{1712-566}{1712}$ x100	=	66.9 percent

The third example in Figure 6.8 shows a log with a partial ring of rot penetrating the full length and 1/4 of the circumference of the log. Because the collar does not meet the interior minimum thickness requirement, the entire portion of collar between the ring rot and the bark is grade reduction, and the entire core is available for manufacture. As with firmwood deductions, a factor is applied to obtain the net grade reduction. This factor may be easily visualized, if it is in simple fractions such as 1/4, 1/3, and 1/2. It can be calculated as a ratio of the circumference by multiplying the diameter by π and dividing the result into the arc of the defective sector, but finding the arc is not practical with conventional scaling tools, so an acceptable alternatives may be used. Degrees of arc is one option, using a watch or compass dial to learn to visualize sectors which are not obvious divisions of 360 degrees.

Factor from formal calculation:

Radius times π	=	20 *x* 3.14159	=	63 r circumference
Defect arc factor	=	16 r arc ÷ 63	=	1/4 or 0.25 or 25%)

Factor from a clock face, major divisions in 12ths (secondary divisions in minutes or 60ths, which are equal to 6 degrees/minute):

Position of hands	=	12:00 to 3:00	=	15 minutes
Defect arc factor	=	15 divided by 60	=	0.25 or 25%

Factor from a compass, major divisions in 8ths or 16ths (secondary divisions in 10 degrees or 36ths.):

Position from North	=	90 degrees		
Defect arc factor	=	90 divided by 360	=	0.25 or 25%

There are several incremental options available to the scaler just from these two common objects, and of course, that which is most comfortable and familiar is preferred, even a piece of paper, which may be easily and accurately folded into 16ths.

From the scale stick:

Gross volume	=	3 m/18 r/20 r	= (153 + 188)	= 341 dm^3
less	=	Inside cylinder 3 m/06 r/08 r/ = (17 + 30) = 47 dm^3		
Grade reduction	=	341 - 47 = 294 *x* factor of 0.25 = 73.5		= 74 dm^3
% of log which can be manufactured	=	$\frac{341-74}{341} \times 100$		= 78.3 percent

If a scaler encounters rot which does not penetrate the full length of the log, and indicators do not support the convention that it penetrates exactly 1/2 way, the use of unit volumes rather than half volumes is convenient. For example, with an assumption that the rot penetrates only 1.2 m in from the large end, from the scale stick:

Gross volume = 3 m/18 r/20 r/ = (153 + 188) = 341 dm^3

Grade reduction = UV log (20 r) - UV core (8 r) x factor (.25) x length (1.2)

= (126 - 20) x 0.25 x 1.2 = 106 x 0.25 x 1.2 = 32 dm^3

% of log which can be manufactured = $\frac{341-32}{341} x100$ = 90.6 percent

Example 1 in Figure 6.9 shows a log with an irregular heart shake estimated to penetrate one-half the length of the log. Because the check is not straight, the area affected is enclosed, and in this case a 1 rad "box" will just contain it. Trim allowance is then added to both sides of the area enclosing the check, so that the grade reduction is for a block 3 rads by 10 rads by 2.5 m. Two common ways of finding the result are described below, depending on scaler preference. The first uses a factor of 0.4 to convert "square rads" times metres to cubic decimetres as follows:

From the scale stick:

Gross volume = 5 m/23 r/26 r/ = (415 + 531) = 946 dm^3

Grade reduction = 3 r x 10 r x factor of 0.4 x 2.5 m

= 3 x 10 x 0.4 x 2.5 = 12 x 2.5 = 30 dm^3

Another popular method to find the grade reduction for rectangular defects is to use centimetres for the width and height of the defect (6 cm by 20 cm by 2.5 m), convert the measurements to decimetres, (cm/10 and m x 10) and calculate the example as follows:

Grade reduction = 6/10 dm by 20/10 dm by 25 dm

= 0.6 x 2 x 25 = 30 dm^3

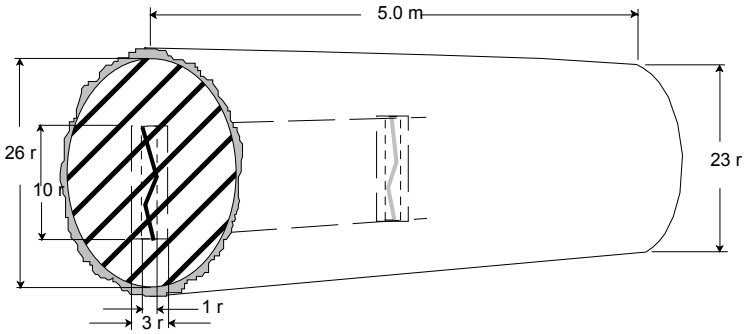
Either method will produce the same results:

% of log which can be manufactured = $\frac{946-30}{946} x100$ = 96.8 percent

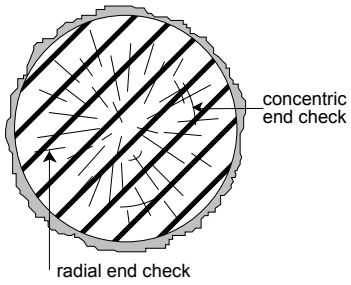
Example 2 in Figure 6.9 shows typical end checking. It is caused by rapid seasoning at the ends of logs after they are bucked green, and normally penetrates only a short distance into the log. It is typified by being numerous, usually following the wood rays (radiating out from the heart, and are not necessarily part of a surface check. They are occasionally concentric with the growth rings. Trim allowances and grade reduction may be applied only to those which have developed into extensive end split *and* are permissible under current grading rules (the Forest Service may order that end checking be ignored).

Example 3 in Figure 6.9 illustrates a log with multiple deep surface checks which cover the entire log, with the penetration clearly visible on the ends of the log. Here it is estimated that the recoverable core of the log is equal to a 5 rad by 13 rad log 12 m long, after excluding the area affected by the checks. From the scale stick:

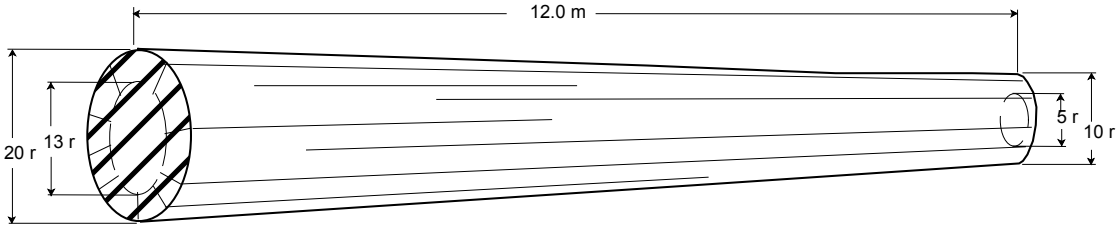
Gross volume	=	12 m/10 r /20 r	=	(188 + 754)	=	942 dm^3
Volume available	=	12 m/5 r/13 r	=	(47 + 319)	=	366 dm^3
Grade reduction	=	942 - 366	=	576 dm^3		
% of log which can be manufactured			=	$\frac{942-576}{942} \times 100$	=	38.8 percent



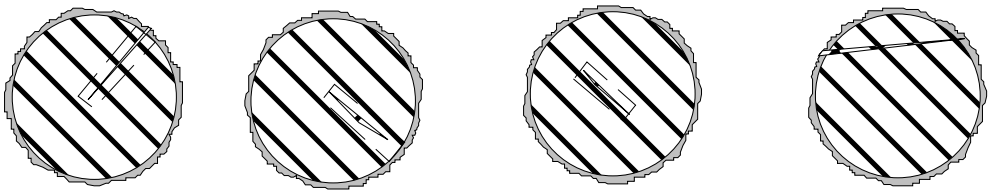
1. a log with an Irregular heart shake



2. End checking

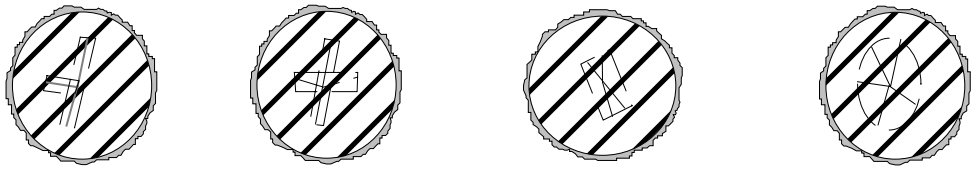


3. A log with extensive outside checking



a. Check runs into heart b. Shake runs into collar c. Shake does not run into collar d. Split bisects collar

4. Trim allowance for check, shake, and split in relation to collars.



a. Shakes meet b. Shakes cross c. Shakes at acute angle d. Star shakes

5. Trim allowance in logs with multiple heart shake

Figure 6.9 The application of trim allowance around checks and shake.

Example 4 in Figure 6.9 shows four log ends, each with one straight separation, located at different points on the log. Trim allowance is added according to the following conventions:

1. Log "a." has a straight surface check running to the heart. Trim allowance is added to both sides of the check.

2. In log "b.", a heart shake runs out at a point less than 5 rads from the bark. Trim allowance is added to both sides of the shake *and* extended to the bark to include the affected portion of collar in the grade reduction.

3. In log "c.", a heart shake runs out at a point 5 rads or more from the bark. Trim allowance is added only to the sides of it.

4. In log "d", a split bisects the collar less than 5 rads from the bark. Trim allowance is not added to the split, and the entire segment outside of it is grade reduction.

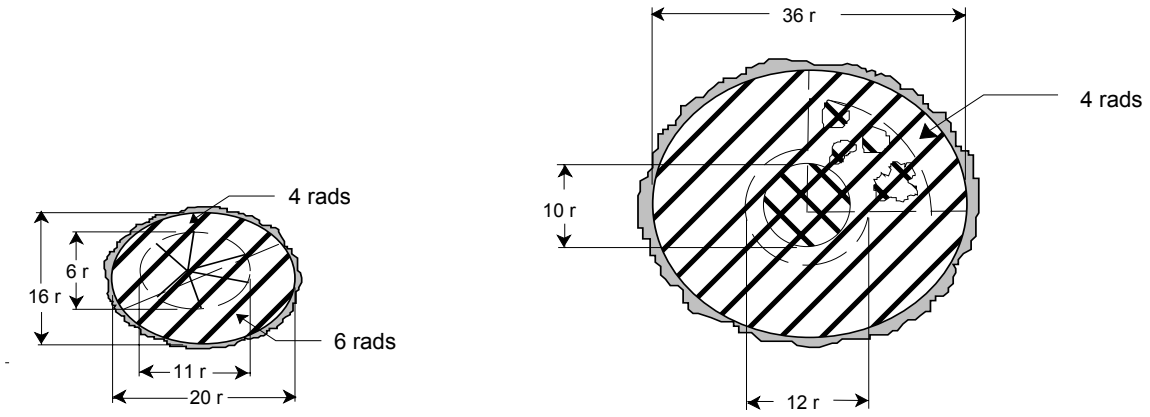
Example 5 in Figure 6.9 shows four log ends with multiple heart shake. It is necessary to apply trim allowance in a manner which best accommodates the forms which the shake takes. Two conventions allow for the full range of heart shakes.

1. Logs "a." and "b." both have two straight heart shakes which meet or cross each other, and they are at more or less right angles to each other. It is apparent from this form of separation that it is possible to "square up" around them by adding trim allowance individually to each one.

2. Log "c" also has two straight shakes, but they are at too extreme of an angle to each other to consider adding trim allowance to each one. Log "d" has a star shake, which is characterized by having more than four points which are asymmetric to each other. In this form of shake, trim allowance is added by encircling them, (in a circle or ellipse), because it is not practical to cut lumber from around each one. Depending on the size of the log and the arms of the star shake however, it may be possible to cut lumber from between them where any adjoining arms are 5 rads or greater apart. In these cases, the grade reduction should be decreased.

> End checking is not to be confused with splits, shakes and surface checking visible at the end of a log. End checking is caused by rapid drying at the end of a log after it is bucked green and normally penetrates only a short distance into the log. The Forest Service may order that end checking be ignored.

Although the two examples in Figure 6.10 are completely different types of defect, they are treated in a very similar manner to each other, where a heart defect extends into a portion of a collar. The only difference between the two is in the application of trim allowance, as described in the example calculations.



1. Off-centre star shake in fir

2. Heart rot with pocket rot in interior red cedar

Figure 6.10 The application of trim allowance to off-centre and overlapping defects.

The first example in Figure 6.10 shows the end of a fir log which has grown with an off-centre heart. Typical of this type of log, the defect- radiating from the pith, is also off-centre, and one-half of the collar is too thin to produce lumber. Since there are too many arms to add an allowance to each one, the affected area is completely enclosed in a circle or ellipse. The first grade reduction is for the star shake *for the distance it is estimated to travel*. From the scale stick:

Gross unit volume	=	UV 18 r	=	102 dm^3		
Grade reduction	=	(6 +11)/2	=	UV 08 r	=	20 dm^3
Net unit volume	=	102 - 20	=	82 dm^3		

The second grade reduction is for the collar which is less than 5 rads thick for 1/2 the circumference (based on the net unit volume from the first calculation to avoid duplication of the overlapping grade reductions):

Grade reduction	=	82 x 0.5	=	41 dm^3		
Total reduction	=	41 + 20	=	61 dm^3		
% of log which can be manufactured			=	$\frac{102-61}{102} x 100$	=	40.2 percent

This example also demonstrates the need to go through the calculations to achieve and maintain proficiency. At first glance, a scaler may decide that this log were 100 percent grade reduction, but because the defect is offset, it is not.

The second example in Figure 6.10 shows an interior red cedar log which has a rotten core and scattered pocket rot with less than 5 rads separation between the pockets. The entire area enclosing the pockets are grade reduction, and because the pockets are closer than 5 rads of the bark, the collar is 100 percent grade reduction. Trim allowance is added to the core of rot and to the area enclosed by the pockets. From the scale stick:

The first grade reduction is for the rotten core:

Gross unit volume	=	UV 36 r	=	407 dm^3
Grade reduction	=	UV 12 r	=	45 dm^3
Net unit volume	=	407 - 45	=	362 dm^3

The second grade reduction is for the collar which is less than 5 rads thick for 1/4 the circumference (based on the net unit volume from the first calculation to avoid duplication of the overlapping grade reductions):

Grade reduction	=	362 x 0.25	=	90 dm^3
Total reduction	=	45 + 90	=	135 dm^3

% of log which can be manufactured = $\frac{407-135}{407} x 100$ = 66.8 percent

Notes:

6.4.2.6 Determining Grade Reduction for Spiral Checks and Shakes

Where spiral checks occur, the scaler must "block out" the portion of the log affected by a check or shake to calculate the grade reduction. *No trim allowance is added to spiralled check or shake*.

In field application, this is normally a visual estimate. The scaler can easily assess the lumber loss due to a spiral crack by observing the deviation from a straight line over the length of the log. For example, if a surface check penetrating to the heart follows the spiral grain from "12 o'clock" at one end to "3 o'clock" at the other, the deviation is 3/12, or 25 percent of the log's circumference for the length of the check. The length of a log is important in calculating grade reduction: Logs less than 5 m long are assessed over their entire length. Logs 5 m and longer are assessed on 2.5 m segments.

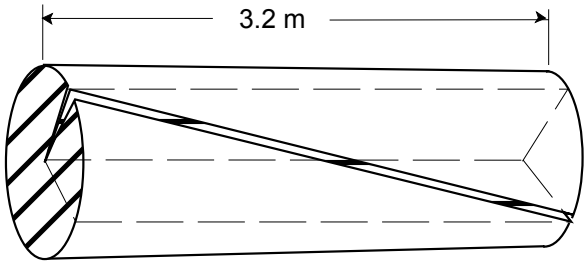
If a spiral surface check does not penetrate all the way into the heart, the grade reduction is of course less than for a full check, and it is important to understand the relationship between the depth of penetration and the effect on volume. For example, a check penetrating half-way to the heart would have 75 percent of the effect of a full check, because 75 percent of the volume of any round log is contained in the outer half of its radius.

The following examples show the effect of spiral check and heart shake on grade reduction for short and long logs, and ways of calculating grade reduction.

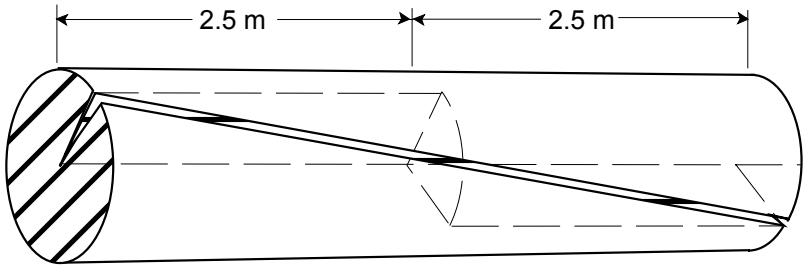
The first log in Figure 6.11 has a uniform spiral check running its full length. Because the log is less than 5 m long, assess the twist on the log length. In field practice, it is only necessary to observe the degree of spiral from one end to the other, and estimating the percentage of the log affected, in this case 25 percent of its circumference. Therefore the grade reduction on the log is also 25 percent.

The second log in Figure 6.11 also has a uniform spiral check running its full length and affecting 25 percent of its circumference. If a 25 percent grade reduction was taken, however, it is too severe for logs of this length or longer, because lumber recovery is gauged on 2.5 m minimum lengths. Therefore, the log is visually segregated into two segments, each with a 12.5 percent grade reduction.

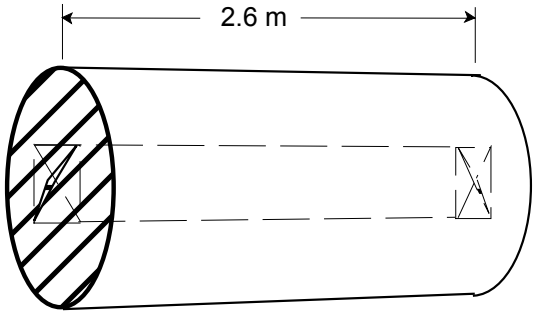
The third log in Figure 6.11 shows a a spiral heart shake. It may be treated similarly to acute or irregular heart shake, as shown in the examples in Figure 6.9, except that trim allowance is not added. That is, the grain deflection is projected to the opposite end of the log, the area affected is enclosed in a rectangle, and the grade reduction calculated from that.



1. Logs shorter than 5 m are assessed on their length.



2. Logs 5 m and longer are assessed in 2.5 m segments.



3. A log with spiral heart shake.

Figure 6.11 The effect of spiral check and shake on grade.

6.4.2.7 Determining Lengths for Purposes of Grade - Logs and Log Segments

Logs and slabs must be at least 2.5 m long to produce lumber. Logs, slabs, and chunks shorter than 2.5 m are considered to be 100 percent grade reduction. In most instances, the log's actual length which is 5 rads or more in diameter is the basis for its grade.

Some situations, however, require the scaler to deem the log to be another length for the purpose of establishing its grade. Where timber has been cut into lengths less than 2.5 m (interior), or 5.2 m (coast); for the purpose of grading they may be *deemed* to be 2.5 m (interior), or 5.2 m (coast) long if:

- the portion of a log cut from the top of a tree exceeds 5 rads (10 cm) in diameter and the log displays a cut face on the butt end, or
- the log is scaled after it has been bucked at the scale site, or
- if a scaler is instructed under the *Scaling Regulation* to use deemed lengths for the purpose of grading.

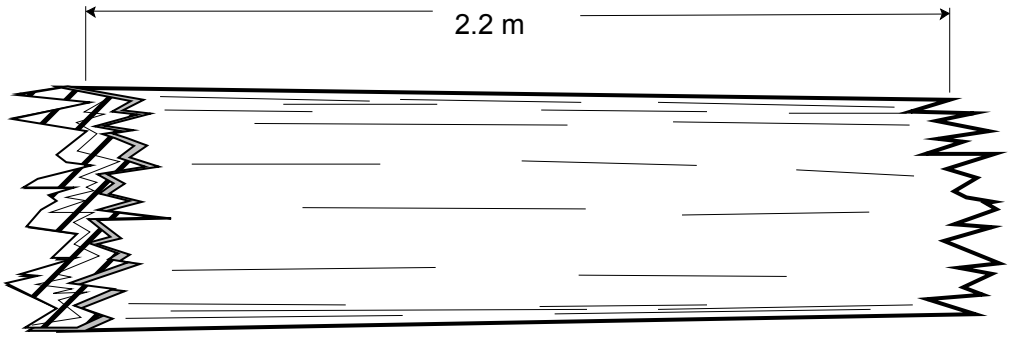
In all instances, breakage is always graded on the basis of its actual length (breakage is defined as any piece, meeting the minimum diameter of the cutting authority, which is shorter than 2.5 m in length and broken at the large end or at both ends).

> For reporting purposes, the actual net length of a log is always recorded on the tally sheet, not the deemed length.

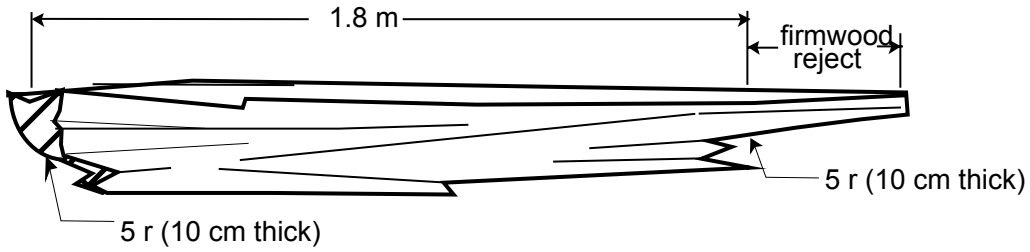
In general, deemed lengths are used in scaling short pieces for two purposes:

- they help to ensure that scaling is consistent with the utilization policy, and
- and they facilitate more consistent grading decisions.

The following figures demonstrate examples of the principles of length determination for calculating grade reduction in scaling, including situations where short logs are deemed to be another length for purposes of grading.



1. Log of any diameter over the utilization standard with broken ends.

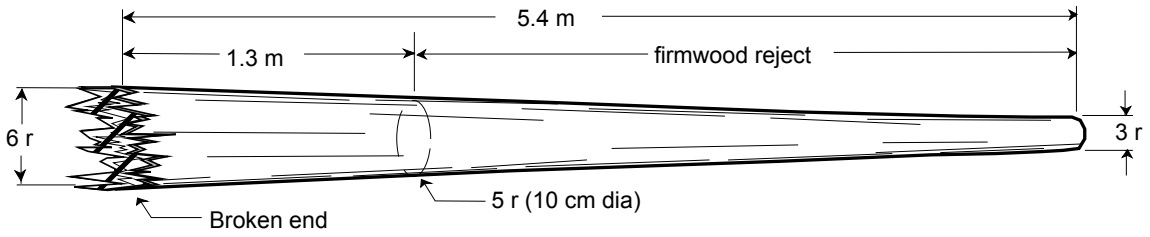


2. Slab with sharp ends cleaned up.

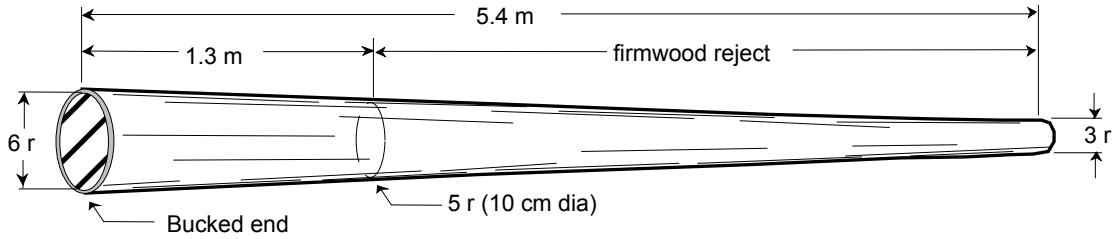
Figure 6.12 Short breakage pieces contained in a conventional load.

Figure 6.12 shows two examples of breakage which are graded on the basis that the log length available to cut lumber is less than 2.5 m. These pieces are considered to be normal breakage. If they were broken subsequent to delivery, however, they would be deemed to be 2.5 m (interior), and 5.2 m (coast) for the purpose of grading, excluding the firmwood reject portions.

In breakage, log ends may or may not be "cleaned up" when they arrive at a scale site. It is shown in the second example, sharp ends have been bucked off for obvious safety reasons, and is most often apparent to the scaler because some signs of breakage are usually showing, such as splits, pulled bark and remaining shatter. Therefore, when assessing these logs, if evidence of breakage is apparent, they are graded on the basis of actual length.



1. The 1.3 m portion of this log is graded on the basis of its actual length.

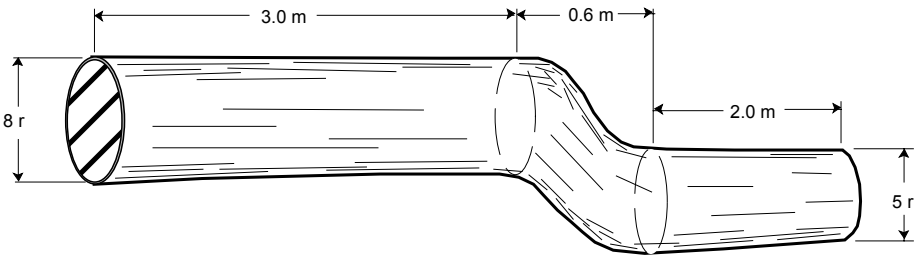


2. The 1.3 m portion of this log is deemed to be 2.5 m long.

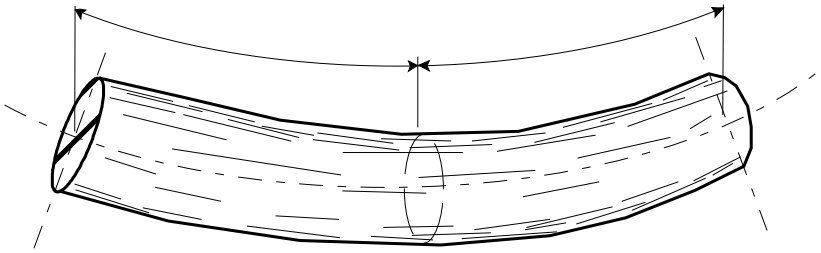
Figure 6.13 Rat tail tops delivered with a short segment over the 10 cm utilization policy.

Figure 6.13 shows two similar "rat tail" logs which were delivered to a scale site. For both logs, the portion of the log less than 5 rads (10 cm) in diameter is graded as firmwood reject. The portions of the logs 5 rads and larger , however, are treated differently for grading purposes because one log is normal breakage, and the other is "bucking waste"; it should have been bucked at the point where the log became 5 rads in diameter.

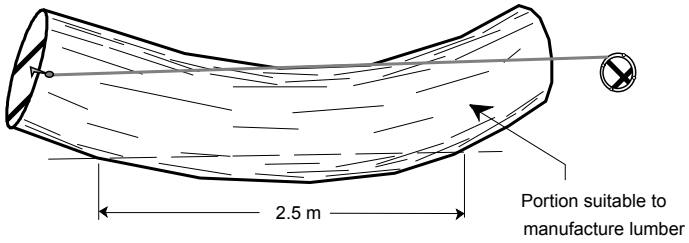
Notes:



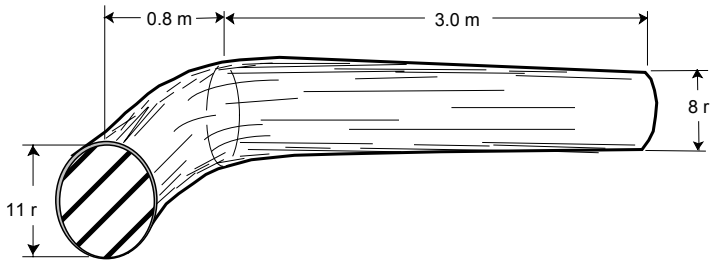
1. Visually bucking a log with crook to assess lumber recovery..



2. Visually bucking a log with sweep to assess lumber recovery.



3. Using a tape to evaluate sweep in logs < 5 m.



4. Visually bucking a log with pistol grip to assess lumber recovery.

Figure 6.14 Assessing grade in logs with sweep, crook and pistol grip.

The first log in Figure 6.14 is a log with severe crook near the top end of the log. The crook is grade reduction because that portion is not straight enough to recover lumber. The portion above the crook is also grade reduction because it is too short to cut lumber, so the log is 100 percent grade reduction for 2.6 m.

The second log in Figure 6.14 has severe sweep which is *uniform throughout* the length of the log. If a log can be bucked into two or more lengths before milling, the lumber loss caused by the sweep can be greatly reduced, and scalers should assess the grade reduction accordingly: the scaler visualizes the log being milled after bucking in order to assess the grade reduction for the sweep. Depending on the length of the log, two situations can occur:

1. If this log were 5 m long or more, visually bucking the log at its mid-point would produce two logs of adequate length and reduced sweep which would be suitable to produce lumber. Therefore milling losses are minimized.

2. If this log were less than 5 m long, visually bucking the log at its mid-point would produce two logs which are now too short to produce lumber even though each section has reduced sweep. Visually bucking at any other point would produce one log with too much sweep and one log which is too short. Therefore milling losses are not minimized and the log is assessed for loss over its full length.

The pistol grip in the third log in Figure 6.14 affects 0.8 m of the butt end of the log, and because this section is too short to manufacture lumber, it is a 100 percent grade reduction for 0.8 m.

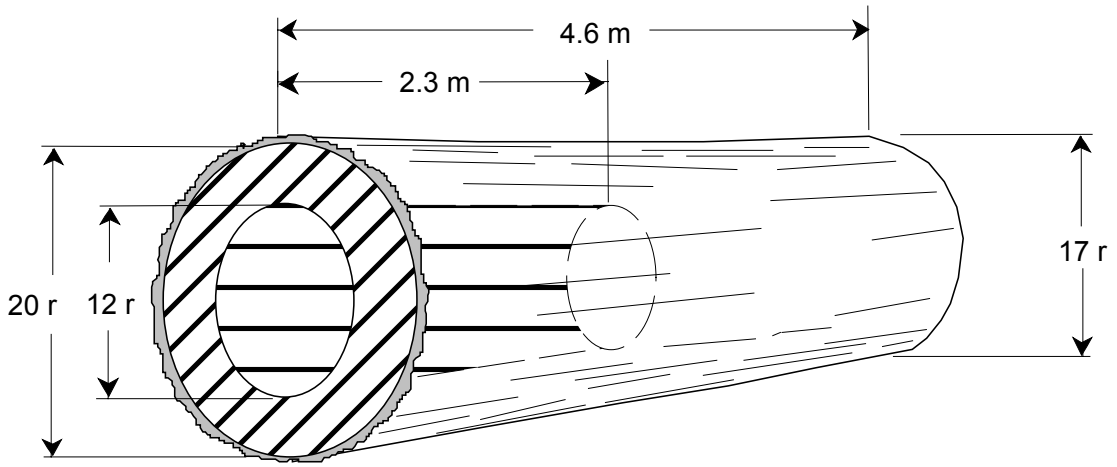


Figure 6.15 Assessing grade in log with severe heart rot and residual length is too short to cut lumber.

The log in Figure 6.15 has severe heart rot which is estimated to travel for half the length of the log. The 4 rad collar is too thin to cut lumber, and a normal grade reduction is made to include the rotten heartwood and the sound collar. That is, the gross volume attributable to the rotten end is a 100 percent grade reduction for 2.3 m. The other half of the log is sound but is shorter than the 2.5 m required for manufacture, so it must also be included as 100 percent grade reduction for 2.3 m. As a result, the entire log is 100 percent grade reduction.

> Although the following calculations are unnecessary in field practice, they are shown to illustrate the principle of a cumulative grade reduction.

From the scale stick:

The first grade reduction is the heart rot for one-half the length of the log:

Gross volume = 17 r/20 r/4.6 m = (209 + 289) = 498 dm^3

Grade reduction = 12 r/12 r/2.3 m = (52 + 52) = 104 dm^3

The second grade reduction is the collar which is too thin to produce lumber:

Grade reduction = UV 20 r - UV 12 r x 2.3 m = (126 - 45) x 2.3

= 81 x 2.3 = 186 dm^3

The third grade reduction is the sound half of the log which is too short to produce lumber:

Grade reduction = UV 17 r x 2.3 m = (91 x 2.3) = 209 dm^3

The three grade reductions are totaled and the percentage of the log available for manufacture is calculated:

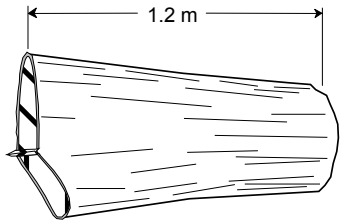
Total Grade reduction = 104 + 186 + 209 = 499 dm^3

(Rounding conventions and log taper result in a total grade reduction of 1 dm^3 more than the gross volume of the log, and because the grade reduction cannot exceed the gross volume, it is made equal to the gross volume).

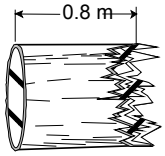
$$\% \text{ of log which can be manufactured} = \frac{498 - 498}{498} \times 100 = 0 \text{ percent}$$

In field practice, significantly different results can be expected from cumulative grade reductions among scalers, depending on method. Although in most cases, the actual grade of a log will not be affected, the assessment of borderline logs can become a concern, particularly in performance checks. The fault does not lie with the scaler, but in the suitability of the available methods to the size and shape of a particular log. Because grading is quite subjective, just as the determination of firmwood loss is, more emphasis should be placed on the actual grade classification by the scaler and the reasoning behind the grade call, rather than technicalities.

Figure 6.16 illustrates a number of examples of short logs left after handling and bucking at the scale site, prior to scaling. For grading purposes, these logs are all deemed to be 2.5 m long in the interior and 5.2 m long on the coast, even though the recorded measurements are as shown in the examples. That is, they may not be down-graded because they are shorter than the minimum requirements.

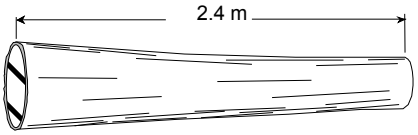


1. Flared butt trimmed off.

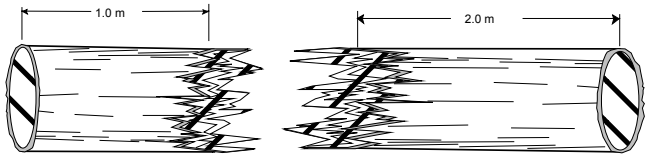


2. Broken end trimmed off.

3. Biscuits and trim ends.



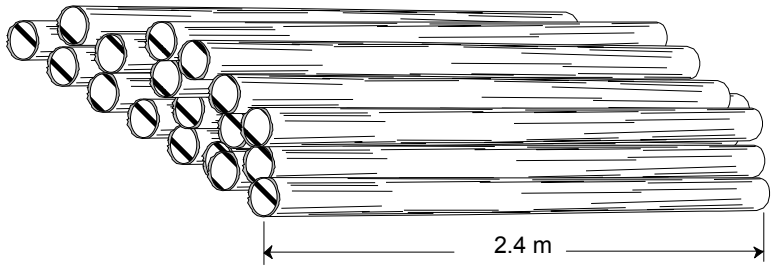
4. bucked to length shorter than 2.5 m.



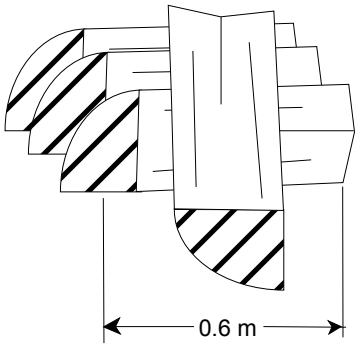
5. Broken in handling at the scale site.

Figure 6.16 Examples of short logs left after bucking at the scale site and deemed to be 2.5 m long (interior) and 5.2 m long (coast).

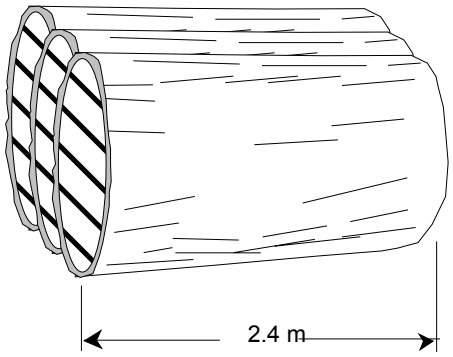
Where unscaled timber is bucked and delivered to a scale site or bucked at the scale site for the purpose of manufacturing special forest products prior to scaling, the timber is to be scaled and graded as logs unless it has been classified as a special forest product. The classification and scaling of special forest products are described in Chapter 8. Figure 6.17 provides examples of different logs which were bucked to specific lengths to suit the specifications of the product, but do not have special forest product status. Therefore, just as with other logs and chunks shorter than 2.5 m long *for grading purposes*, they are deemed to be 2.5 m long in the interior and 5.2 m long on the coast.



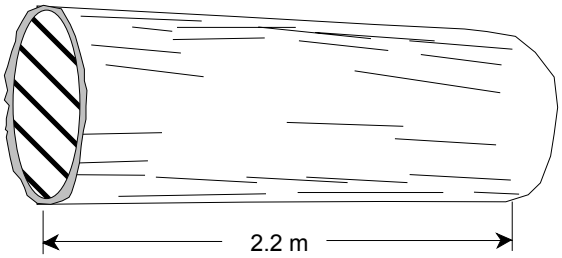
1. Fence posts



2. Shake blocks



3. Shingle bolts



4. Mining timber

Figure 6.17 Examples of logs cut to special forest product lengths but not classified as such, and deemed to be 2.5 m long (interior) and 5.2 m long (coast).

6.4.3 Assessing Product Quality

Section 6.4.2 looked at the grade reductions that tend to reduce the quantity of product that a given log is likely to yield. In log grading, we are also concerned with the quality of the products which can be produced from the log (i.e., its product out-turn).

In addition to the percentage of a log which can be manufactured into a given product, the grade rules also specify that a minimum percentage of the product manufactured from the log must be merchantable and/or clear.

Merchantability is determined by assessing the size and placement of knots, and the degree of any spiral or twist observed on the log. Merchantable lumber is considered to be lumber which grades out better than utility. There is no direct relationship between log grading and lumber grading, as lumber graders assess the finished product, whereas scalers must assess the round log from which the product is cut. For instance, the grain slope permitted in the NLGA Lumber Grade Rules differ from the twist allowance in the log grading schedules; a scaler cannot presuppose the affect of grain slope on lumber, because sawing methods have a major impact on grain slope. The log grading rules therefore only gauge the recovery potential of a log under average sawing conditions.

Where the grade rules require that a percentage of the out turn be clear, it means that the stated proportion of the product must be free of knots and stain.

In addition to the quantity and the quality of the product out turn, some grade rules require a log to be fine grained. The fineness of grain relates to the separation between seasonal growth rings. Fine grained logs have a higher fibre density (i.e., proportionately more cellulose and lignin per unit volume) and will, therefore, produce stronger lumber and higher quality veneer.

6.4.3.1 Assessing Knots

Knots larger than 2 rads (4 cm) reduce lumber quality because the grain deflection around the knots weaken the recovered lumber, even though the actual knot fibres may be denser and stronger than its supporting tissue.

Maximum allowable knot size increases with the diameter of the log and are expressed in radius class units (rads) or centimetres of diameter. When taking this measurement, only the actual knot should be measured and not the shoulder surrounding it. Figure 6.18 shows a log section with typical knot forms. Critical to the assessment of knot diameter is to exclude grain deflection around the knot in the measurement. Under close examination, the knot will have a circular grain pattern, like a log end, and this is the area measured. The tree stem wood grows around the knot (deflection), and forms the shoulder wood. It is easy to measure loose or encased knots, because there is a clear distinction between the knot wood and the tree wood; tight or inter grown knots are harder to learn to assess, because the two are interconnected.

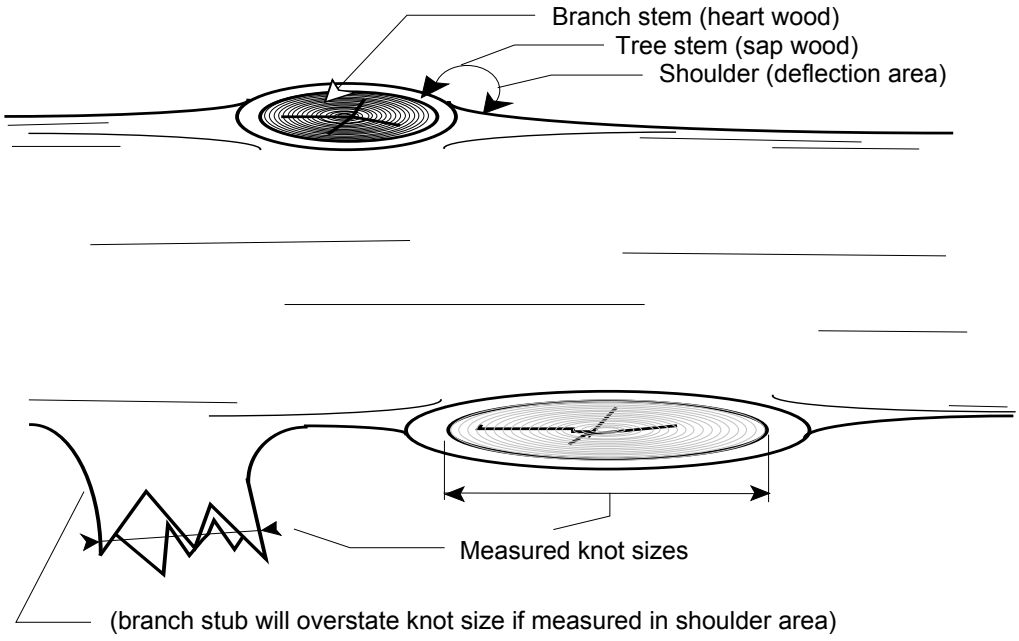


Figure 6.18 Measuring knot diameters.

Figure 6.19 shows the measurement of bunch knots. Bunch knots or cluster knots are defined as those circumstances where the majority of the log's grain deflects around, rather than through or between a close grouping of knots, reducing the strength of lumber produced. Where this occurs, the group of knots is assessed the same as an oversized knot; the smallest circle or ellipse that will surround the cluster is taken as the knot diameter.

Certain species such as Douglas-fir, larch, cedar, cypress and alder, when stressed, produce adventitious branches (sucker limbs) which, after a period of time, may come to take the appearance of knots or knot clusters. These sucker limbs do not, however penetrate very far into the log since they form much later in the tree's life cycle than regular branches. Therefore, they do not have nearly as much impact on the manufacturing potential of the log as their size might suggest. Scalers working with such logs should come to recognise this characteristic and observe some of these logs in the breakdown process.

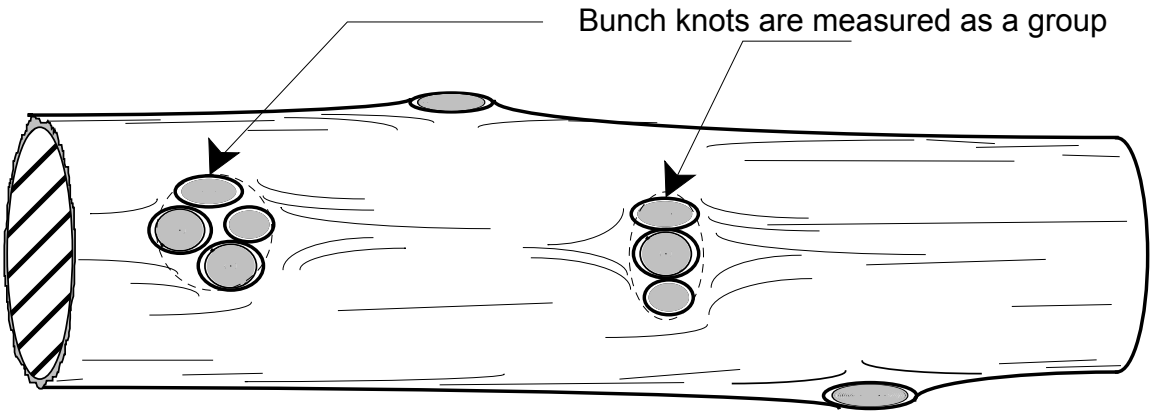
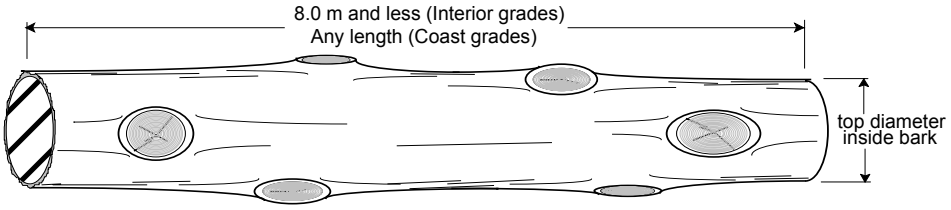


Figure 6.19 Measuring bunch (cluster) knots.

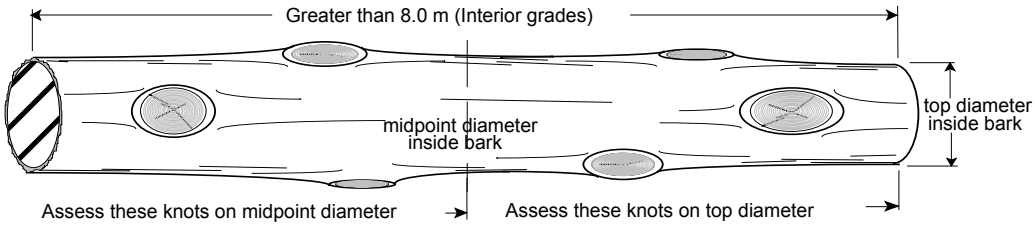
Knots which indicate the presence of conk or other stem rots should also be used in terms of their potential to indicate the extent of heart rot, rather than simply in terms of lowering lumber quality. For example, even though a knot may be under the maximum allowable size but is rotten, there is a good chance of a grade reduction for heart rot. However, the firmwood loss from rot confined to the knot is not significant enough to warrant a volume deduction or grade reduction in the large majority of cases.

The conventions used to assess knots are:

- the specified knot size and distribution in the grade schedules for any log grade is always based on the gross log diameter inside bark before any deduction is made for sap rot or other defects,
- the same averaging rules are used for measuring knots as for measuring log diameters as described in Chapter 5,
- for interior logs up to and including 8 m in length and for all coastal logs, knots are assessed against the top diameter of the log (Figure 6.20),
- for interior logs greater than 8 m in length, a midpoint diameter must be taken. Knots on the butt half are assessed against the maximums specified for the midpoint diameter, and knots on the top half of the log are assessed against the maximums specified for the top diameter (Figure 6.20), and
- slabs are measured across their width for determining knot allowances. Widths for slabs of all shapes are illustrated in Chapter 5. For purposes of knot assessment, if the thickness exceeds the width, the wider measurement is used.



1. Coast & interior: Knots are assessed against the gross top diameter of the log



2. Interior only: Knots are assessed against midpoint diameter and top diameter.

Figure 6.20 The relationship between log diameters and knot diameters.

In addition to their size and characteristics, the location and distribution of knots must be carefully considered. For example, if log segments must be 2.5 m long to produce merchantable lumber, occasional oversized knots are permitted if it possible to cut merchantable lumber from between them. In general, one oversized knot is permitted every 3 m, allowing ample room for recovery of merchantable lumber between the knots. Similarly, where the oversized knots are concentrated in one quadrant, along one side, or near one end of the log, the remaining portions will yield merchantable lumber.

Figure 6.21 illustrates three logs with identical gross dimensions with oversized knots distributed in three typical patterns;. In these figures, they are all closer together than the allowed 3 metre spacing.

> As knots are a key determinant in log grading, it is important that scalers become very familiar with their impact. This knowledge is best achieved through on-site training, observation of log breakdown, and practice.

Once the scaler has:

- identified the oversized knots from the top or top and mid-point diameters,
- determined that their spacing is less than 3 m along the length,

- decided that a grade reduction is warranted, then
- it becomes necessary to observe the orientation and distribution of the knots in order to evaluate the affect on grade.

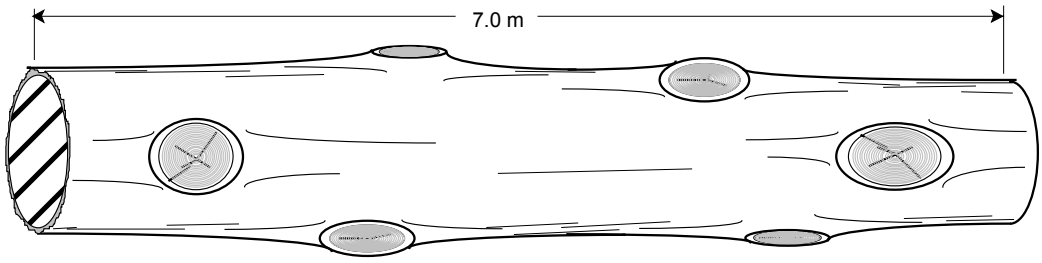
The first log in Figure 6.21 has its oversize knots distributed over the entire length of the log. Because there is no portion of the log which allows 2.5 m lumber, the log is a 100 percent grade reduction.

The second log has oversize knots concentrated near the top of the log. After the scaler notes that 3 m of the log is 100 percent grade reduction, the impact on the quality of the whole log is calculated to be about 43 percent of its total length, but somewhat less than 43 percent of it's volume.

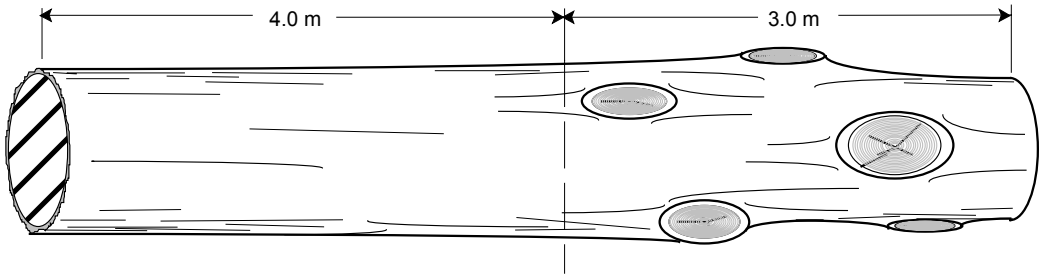
The third log has its oversize knots concentrated along one side. Almost half of the log is 100 percent grade reduction because of this, but more than half is not affected at all by knots. Therefore, the impact on the quality of the whole log is estimated to be about 45 percent of its volume. However, size is also a factor in the assessment; a 30 rad log may be broken down into quarters to maximize merchantability, where a 5 rad log cannot even be halved.

Of course, these examples are somewhat conceptual in that knots do not usually present themselves so obligingly. Although, in time, scalers will learn to quickly understand the impact of knot location and distribution, it is best for the beginner to pick out each of the elements in turn. For example, if the knots are distributed along one quadrant *and* around the top end, do one assessment, then the other. The total assessment is the cumulative effect on the log.

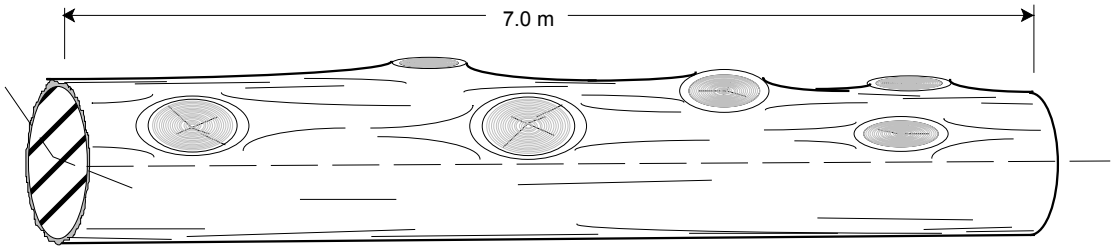
Finally, in any situation where knots and other defects are confined to 1/2 of the length of a log in such a way that a 100 percent grade reduction is identified in that half, it does not mean that 50 percent of the log is grade reduction, because the volume of down graded half must be determined and compared to the volume of the normal half. That is, if the top half of a log is 100 percent grade reduction, then it probably reduces the grade of the log by less than 50 percent. If the butt half of the log is grade reduction, then it probably reduces the grade of the log by more than 50 percent.



1. A log with oversized knots distributed over entire length.



2. A log with oversized knots concentrated near top end.



3. A log with oversized knots concentrated along one side.

Figure 6.21 Typical knot distributions and their effect on grade.

6.4.3.2 Twist (Spiral Grain)

Twist is measured over a 30 cm (15 rad) section of log length where it is representative of the average for the log. The amount of twist permitted for a particular grade is expressed as a percentage of the diameter of the log according to the rule for a particular grade (see Figure 6.22).

For coastal grading, the diameter of the log is always the top diameter. In addition to a maximum percentage, a maximum twist measurement is also prescribed for each grade which has twist specifications.

For interior grading, the log diameter used is the top diameter for logs up to and including 8 m, and the measured mid-point diameter for logs which are over 8 m in length.

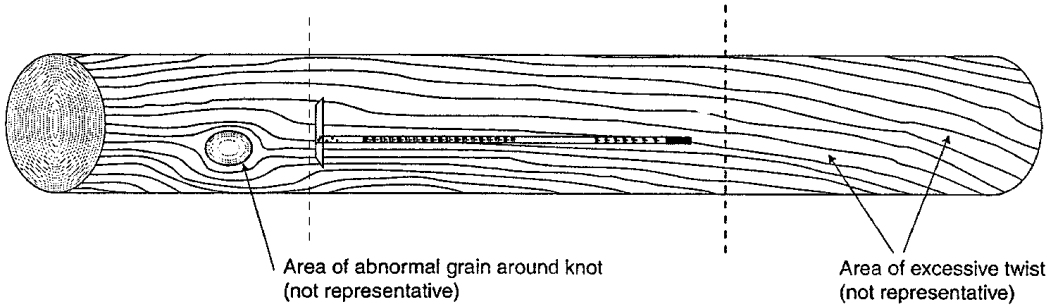
The interior grades also specify a maximum twist measurement within the prescribed percentage and, unlike the coast, a minimum measurement of 4 cm (2 rads). Twist which is over the prescribed percentage does not lower the grade unless it is over the prescribed minimum of 2 rads.

Twist must be measured where it is representative of the average for the log, given what the scaler can see. Assumptions may not be made about portions of the log which are not visible.

Where other, *quantity* reducing, defects which follow the grain such as spiral surface checks, occur in conjunction with twist, the loss in terms of product recovery caused by those defects is greatly increased.

The following two figures demonstrate the concept of measuring the average twist, and how the scale stick is used for measuring twist.

Specific twist requirements by grade can be found in Section 6.5 (coast) and Section 6.6 (interior).



Twist is measured where representative of the average

Figure 6.22 Measuring twist - placing the stick.

As shown in Figure 6.22, orient the scale stick parallel with log's central axis on an area where the grain deflection is representative of the log as a whole. In this example the scaler has taken care to place the stick parallel to the log's central axis. The tine, however, used in measuring the twist is too close to the abnormal grain deflection around the knot and is at one end of the log.

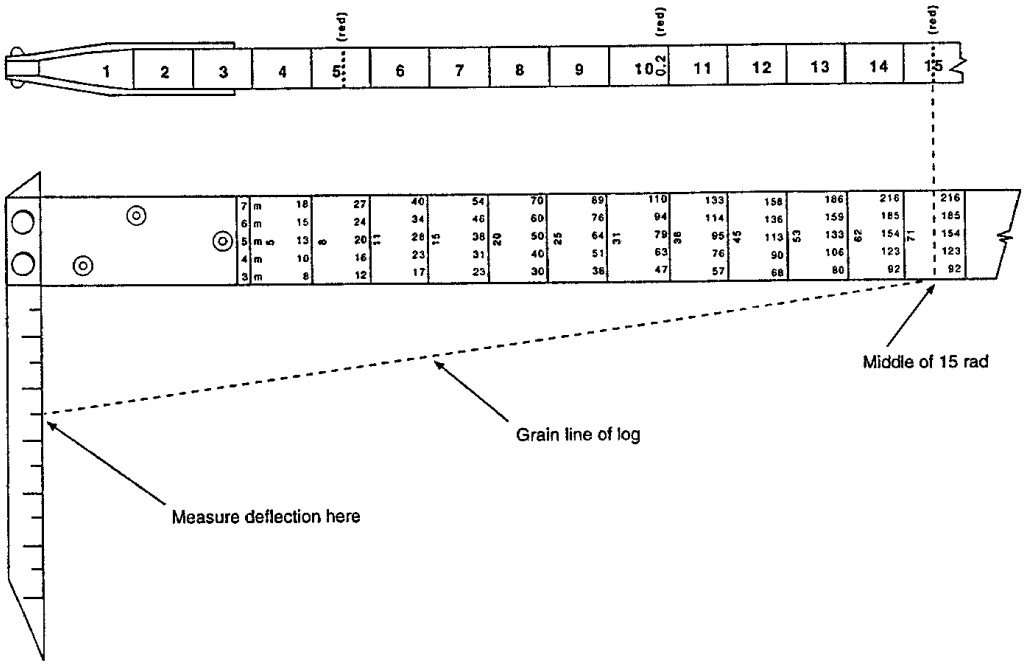


Figure 6.23 Measuring twist - reading the deflection.

With its shaft parallel to the log's central axis, the stick is positioned such that one of the log's grain lines passes right through the middle of the 15 rad class. The point where this grain line intersects the tine is the deflection. The deflection is then read where the grain line intersects the tine. Here, it reads as 5 cm or 2.5 rads. Note: the tine of this stick is graduated in centimetres. Although not a requirement, scalers often mark them out to simplify measurements.

6.4.3.3 Grain Density (Ring Count) - Coastal Grading Only

The ring count of a log can greatly affect its value. The reason for this is that the narrower the separation between the rings, the denser the woody tissue. Denser woody tissue has more cellulose and lignin and is, therefore, stronger. In addition to this strength factor, fine grained logs are easier to peel into veneer on a rotary lathe and yield higher quality and stronger veneer.

The annual rings may all be of equal thickness and centred perfectly around the central pith of the log, or they may be of varying thickness as a result of variations in growth rates (usually attributable to factors such as variations in nutrient availability, temperature, rainfall, and sunlight). They also may be offset from the geometric centre of the log.

When growth is not equally distributed and the heart is offset, the log will not peel well on a rotary lathe and can not yield high quality veneer no matter how fine grained.

Growth rings are counted at a point 1/3 of the radius in from the logs outer circumference at the small end. The rings are then to be counted in the one rad (2 cm) area from this point towards the outer circumference of the log. Where a log has an off centre heart, the rings are to be counted where their separation is widest.

6.4.3.4 Stain - Coastal Grading Only

As described in Chapter 4, the oxidation of phenolic compounds in tree tissues invaded and damaged or killed by micro-organisms (predominantly fungi) results in a pronounced discoloration of the woody tissue. This discoloration is commonly referred to as stain.

Some stains result soon after harvesting with the oxidation of newly exposed heartwood. Such stains are superficial and do not penetrate far into the log.

Also, the sawdust compacted between the cuts of logs bucked in the bush, but not separated, is often subject to staining fungus. These stains are also superficial and do not penetrate the log.

Stain does not cause any significant weakening of the wood fibre but it can detract from the appearance of the manufactured end products. Where these end products are for decorative or finishing purposes their value is lessened. For this reason the presence of stain is a grading consideration in some very valuable "clear lumber" coastal grades (refer to Section 6.5 for specific details).

Scalers must also be aware that some types of stain can be faded when logs are left exposed to the ultraviolet component of sunlight. Usually when this has happened the affected wood will still appear subtly different than the surrounding unaffected tissues.

6.4.4 Factors Unique to Interior Grading

Application of the Interior Schedule of Timber Grades requires the scaler to consider two additional factors:

- was the log cut from a tree which was dead when it was harvested, and
- was the log cut from a tree which was undersized for the purposes of utilization.

Interior grading rules must account for these factors for administration of cut control and the utilization policy.

6.4.4.1 Dead/Dry Log Status

Administration of the annual allowable cut (AAC) in the interior requires interior scalers to identify logs cut from trees which were dead and dry when harvested. Unlike the cruiser who identifies dead trees largely by looking at the tree's foliage, the scaler's job is more complex and requires experience and good judgement.

Identifying logs cut from trees which were dead and dry when harvested is not confined to simply looking at one characteristic. Rather, scalers must look for a number of characteristics known as indicators which indicate the tree may have been dead and dry when harvested. Scalers must also look for characteristics known as contraindicators which indicate the tree was green or living when harvested.

6.4.4.1.1 Indicators

To be classified as dead/dry a log must have at least one indicator to indicate it was cut from a tree which was dead when harvested. Indicators include:

- deteriorated cambium,
- loose or shedding bark,
- sap rot (encircling log end),
- wood borers, or
- deep checks (not weather checks).

6.4.4.1.2 Contraindicators

Contraindicators are log characteristics which indicate a log was cut from a living tree. Logs showing any contraindicators are deemed to be cut from a living tree.

Green logs which have not been scaled soon after harvesting, often display bark that has curled away from the wood as a result of rapid drying of the inner layer of bark.

Green logs, when stored in decks for extended periods, often display darkened and weathered ends. Such logs often show evidence of mould and/or mildew on exposed wood surfaces.

Some species, notably pines, are resinous and continue to exude pitch for some time after harvesting. As such, pitchy log ends are a contraindicator and indicate the log was cut from a live, green tree. However, fir and larch will exude pitch long after they are dead; therefore, pitchy log ends are not a reliable contraindicator in these species.

If branches with green foliage are attached to a log, the log must be assumed to have been cut from a tree which was living when harvested.

Logs cannot be classified as dead/dry if they display any of the following characteristics:

- curling bark,
- green needles,
- fresh cambium (sticky),
- mildew or mould on wood surface (except on windthrow),
- dark weathered ends (indicative of decked timber),
- pitching log ends, or
- logs carrying living bark beetles.

> Mortality in trees is often a gradual process and, as such, logs may display both indicators and contraindicators. In all cases, logs displaying both indicators and contraindicators are deemed to be cut from a living tree.

Two other principles apply:

- logs subjected to prolonged decking prior to scaling and logs cut from trap trees (an insect control measure) are graded as if they were cut from living trees, and
- logs displaying fire damage must be graded using indicators and contraindicators, and not automatically considered to be cut from trees which were dead when harvested.

Specific details of the interior dead/dry grades (grade codes 3 and 5) can be found in Sections 6.6.4 and 6.6.6.

6.4.4.2 Identifying Undersized Logs in the Interior

Cutting specifications in interior cutting authorities make reference to the diameter outside bark at stump height (DSH). This diameter is important as it determines whether or not the tree has to be utilized.

> When scaling interior timber, scalers must assign an undersized grade to logs which are cut from trees which are smaller than the diameter at stump height specified in the cutting authority.

The DSH is measured outside the bark at a point 30 cm (15 rads) above the highest ground at the base of the tree. Since scalers do not see the stump, but only the butt log cut from it, the DSH is measured outside the bark at a point 15 cm (7.5 rads) from the butt end on candidate logs.

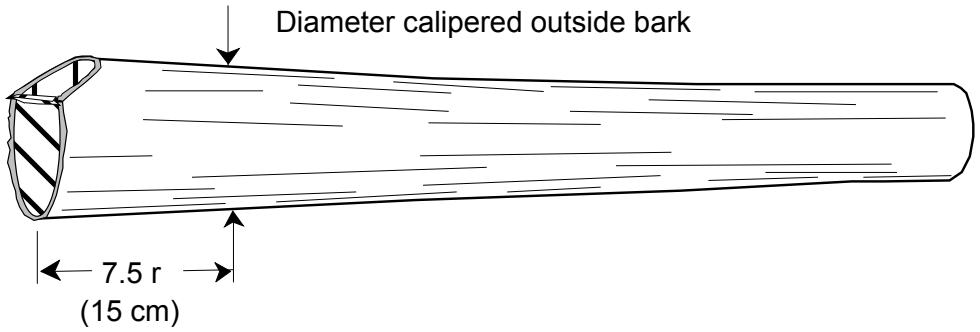
To be considered for the undersized grade:

- a log must show sufficient evidence such as an undercut, butt flare, or other bark characteristics to indicate it comprises a tree and not a top cut or long butt from a larger tree, and
- the outside bark measurement at a point 15 cm from the butt face, must be less than the minimum diameter at stump height specified in the cutting authority.

> If there is no evidence a log was cut from an undersized tree, it must not be graded as Grade 6.

The minimum DSH is set by the *Provincial Utilization Policy* at 15 cm (7.5 rads) for lodgepole pine, and 20 cm (10 rads) for all other species. More stringent utilization requirements may be set under the cutting authority. Utilization standards on the coast do not refer to the DSH. As such, the coast schedule of grades does not have an undersized log grade.

> Where timber is cut on an area where cutting specifications are not in place, scalers are to assume a DSH of 15 cm (7.5 rads) for lodgepole pine and 20 cm (10 rads) for all other species.



6.24 Measuring diameter for interior undersize grade.

6.5 Interpreting the Schedule of Coast Timber Grades

The Schedule of Coast Timber Grades is part of the *Scaling Regulation*. It is comprised of three parts. Part 1 applies to all species and describes the Firmwood Reject Grade (i.e., Grade Code Z). Part 2 describes the grades (other than Z) applicable to all commercial coniferous species except yew (i.e., *Taxus brevifolia*). Part 3 describes the grades (other than Z) applicable to all commercial broadleaf (i.e., deciduous or "hardwood") species, and yew.

6.5.1 Grade Applicability

The Schedule of Coast Timber Grades applies to all timber harvested in the Vancouver Forest Region and the North Coast Forest District, regardless of where it is actually scaled.

6.5.1.1 Grade Precedence

Timber that meets the requirements of more than one grade should ideally be placed in the grade of greater value. Since market demands affect values from day to day, a scaler may not know at any particular time which of two grades has the greater value. For this reason scalers are instructed to record a log against the first grade in order of presentation in the scaling regulation. The same order is followed in this chapter. Borderline logs should be taken one up and one down so as not to bias the scale. Some exceptions in the order of grade precedence are employed for shingle cedar, and are explained in this chapter.

6.5.2 Physical Characteristics Affecting Log Grades

Although characteristics are described individually, scalers must consider the whole log in determining its grade. Generally speaking, the scaler must determine and consider the following factors:

- log size,
- what proportion of the log will produce end products (lumber, veneer, shakes or shingles, and chips),
- the quality of end products,
- the presence of non-permissible defects, and
- whether a round log or a slab.

Some aspects of the above factors have been explained earlier in this chapter, while others require further explanation specific to coastal grading.

6.5.2.1 Log Size

6.5.2.1.1 Radius

The radius or diameter of a log affects its potential for the production of manufactured products in several ways. Other factors being equal, larger diameter logs will produce more lumber per cubic meter of log volume, produce a higher percentage of "clear" products and produce larger dimension lumber than smaller diameter logs. Diameter is also one of the factors that dictate the most advantageous end product use of logs, or whether material is classified as commercially useless (firmwood reject).

Consequently, all the coastal log grades have diameter specifications. In the official grade rules these are stated as centimetres of radius, which is the same as radius class or "rads" of diameter.

That dimension is the gross rounded top diameter, before any deductions are made. Therefore, a log with a top diameter which rounds up to the minimum for a grade qualifies for that grade. Diameter deductions may not be made to disqualify a log from meeting a minimum diameter for a grade, or to qualify a log for the maximum diameter for the J grade. This applies to all defects, including sap rot, for all species.

6.5.2.1.2 Length

Length measurements specified in the grade rules are the actual unrounded gross measurements.

Where a log meets the minimum gross length for a grade but requires a deduction which reduces the net recorded length below the minimum, it is graded based on its gross length.

Length is a factor in log value, both in terms of efficiency in handling and lumber value potential.

6.5.2.2 Potential for Manufacture of Product Quantity

The proportions of a log's gross scale which are suitable, and not suitable, for the manufacture of products are important factors in determining its commercial value.

All the grades higher than No. 7 Chipper (Y) specify percentages of the gross scale which must be suitable to cut out lumber, veneer for fir peelers or shingles and shakes for shingle cedar.

Log defects which reduce recovery of the above products are identified in Section 6.3, and procedures for calculating the amount of loss they cause (grade reduction) are outlined in Section 6.4, and in Appendix 6A.

In order to ensure standard application of grade reduction procedures, some additional information on assessment of defect in coastal timber is provided here.

6.5.2.2.1 Length of Defects

Where defects affect the heart of a log, scalers usually cannot see how far defects penetrate the length. In some cases experienced scalers can use various accepted indicators to accurately estimate this. In cases where there are no accepted indicators the following conventions are to be employed in order to maintain consistency among scalers in determining grade reduction.

1. Butt rot, butt shake and related butt defects have the length of defect estimate based on the relation between the defect diameter and the recorded butt diameter of the log.

Where rot measures	It often penetrates
1/4 of the recorded butt dia.	1.8 - 2.4 m
1/2 of the recorded butt dia.	3.6 - 4.2 m
3/4 of the recorded butt dia.	5.4 - 6.0 m
4/4 of the recorded butt dia.	7.2 - 7.8 m

   These figures may be adjusted slightly up or down depending on the species and visible butt flare. Douglas -fir and spruce, having pronounced butt flare may use the lower figure mentioned as butt rot in these species usually does not run far past the flare. In hemlock, balsam, and sometimes red cedar, where butt flare is minimal, rot may run further into the log and a larger estimate is required. These are general guidelines only.

2. Heart rot, pocket rot, ring rot, heart checks, ring shake and similar defects when showing in only one end of the log are presumed to run half the length of the log to a maximum of 6 m, unless there is evidence to the contrary.

3. Conk, pin rot and Indian paint rot are grouped together as heart rots which often show in the knots of a log. Such knots are collectively known as "conk knots", and must not be confused with rotten knots which do not indicate the presence of heart rot.

   Where one or more conk knots are present, but the rot does not show in the log end(s), the rot is presumed to travel 2.4 m above the uppermost conk knot and 3.6 m below the lowest conk knot.

   Where conk shows in one log end and there are conk knots, the rot should be run the greater distance of half the log length to a maximum of 6 m, or 2.4 m above the uppermost conk or 3.6 m below the lowest conk knot.

Where conk, pin rot or Indian paint rot shows in one end of a log but there are no visible conk knots, the rot is presumed to travel half the length of the log to a maximum of 6 m. For example, penetration would be 2.5 m on a 5 m log, 6 m on a 12 m log, and 6 m on a 15 m log.

6.5.2.2.2 Grade Reduction for Conk, Pin Rot and Indian Paint Rot

Where there are conk knots present, but the conk does not show in the log ends, the entire length affected is grade reduction. It is assumed that no lumber can be cut from 2.4 m above and 3.6 m below the conk knots. Of course, residual sound end segments less than 2.5 m long must also be included as grade reduction:

- where conk shows in one or both ends and there are conk knots, it is presumed that no lumber can be cut from the length of log affected by the defect, with the following exceptions,

- where the defect showing in the end(s) and the conk knots are confined to the same half of the log's diameter, it is possible to cut lumber from the unaffected side. In such cases scalers should calculate a partial grade reduction for the affected log length based on the visual information available, or

- where the defect is visible in the log end(s) but there are no conk knots, the grade reduction should be calculated in the same manner as for other rots.

6.5.2.3 Potential Quality of Manufactured Products

As well as prescribing a percentage of the gross scale which must be suitable to produce manufactured products, each grade rule above Y includes a specification regarding the quality of the potential product. Specifically, percentages of the lumber or shingles are required to be "clear" or "merchantable".

Each grade rule has guidelines appended which state requirements regarding quality factors.

The quality considerations of knots, twist, stain and annual ring count are described in Sections 6.3 and 6.4. Some additional considerations specific to coastal grades are described below.

6.5.2.3.1 Size of Knots

Clear knot free timber is highly valued. Knots less than 1 rad detract from the appearance and lessen the value of lumber. Knots larger than 1 rad will reduce the strength of the lumber. The larger the knot size the greater the loss in lumber strength, with extremely large knots making the cutting of merchantable lumber impossible.

In the sawlog grades, where knots are out of round, knot size is determined by averaging the maximum and minimum measurements. Peeler grades use the maximum measurement for out of round knots. The size of the knot does not include the shoulder.

Where the Grade Rule requirements stating maximum knot sizes and/or location are met, the merchantable or clear lumber percentage requirement for the grade will be satisfied.

6.5.2.3.2 Occasional Larger Knots

All sawlog grades can have occasional larger knots. Occasional larger knots are allowed to the extent of one per 3 m of log length and must be located where knot sizes for portions of logs are specified.

Interpretation:

If a grade requirement allows 4 cm knots over the entire log, occasional larger knots can be anywhere on the log. Where the requirement states 4 rads knots are allowed on the upper half of a log, the occasional larger knots must be confined to this area as well, with knots no larger than 1 rad permitted on the lower half of the log.

6.5.2.3.3 Pitch

Pitch may accumulate in pockets between the rings or within a ring shake. The presence of pitch will lower the value of clear lumber and veneer.

The requirements for the peeler grades and the premium and lumber grades for subject species include limits on the number and size of pitch pockets allowed. For butt cut logs, pitch pockets are assessed in the top end only.

6.5.2.3.4 Growth Rate (Ring Count)

As noted in Section 6.4, rings are counted at a point 1/3 of the radius (or 1/6 of the diameter) in from the outer circumference. The annual rings are then counted over 2 cm (1 rad) of distance from this point back toward the outer circumference.

Where logs have off centre hearts the rings are counted where they are widest. Where the heart is centred the rings are counted where they represent an average.

Ring counts are always taken at the top end of the log.

6.5.2.3.5 Insect or Worm Holes

A number of insects lay eggs under the bark of trees and the larvae will bore through the wood as they develop. When the presence of borings is observed, the quality of potential products may be reduced and the log grade affected.

Several grades of fir, pine and spruce do not allow borings other than those of the ambrosia beetle to penetrate beyond the sap wood.

The ambrosia beetle attacks felled timer, and the small holes made by this insect are common. This is not a serious defect for sawlog and utility grades which require merchantable quality lumber. Where the borings penetrate beyond the sap wood, the affected portion of the heart wood may not produce any clear lumber.

Cedar is affected by the borings of larvae of the western cedar borer. It is known as powder worm, and it is a serious defect, not allowed in six of the cedar grades.

Damage caused by marine creatures, including teredos, is not considered in the official scale for volume or grading purposes, but should be noted as a remark on the scale return.

6.5.2.4 Non-Permissible Defects

There are a number of defects which are not permitted to be present in certain grades of logs. Where such a defect is present, the log is disqualified from the grade, and from lower grades where the log is required to have been "otherwise" the higher grade for which it has a prohibited defect.

Examples of defects which are not permitted in certain grades are conk stain, powder worm and over-size knots.

Some grades permit certain defects only to a clearly defined limited extent. Examples are ring shake, pocket rot, pitch pockets and a number of peeler defects. When the defect is not confined to the stated limit, it is treated as a non-permissible defect for that grade.

All of the above defects are defined by log grade in Section 6.5.1.1 under the Log Requirements to Make the Grade.

6.5.2.5 Slabs

Slabs are not permitted in the sawlog J grade.

Slabs must be at least 38 cm (19 rads) to qualify for classification as D, E, F, G, H, I and K grades, and meet the minimum diameter for the grade.

The minimum slab thicknesses for the shingle grades are specified in the grade rule for each grade.

To qualify for the utility U grade slabs must be at least 16 cm (8 rads) thick with a mean diameter of 8 rads, and a shape suitable for lumber manufacture.

To qualify for the utility X grade slabs must be at least 10 cm (5 rads) thick, meet the grade rule minimum diameter of 5 rads and have a shape suitable for lumber manufacture.

Slab thicknesses specified are actual unrounded measurements.

Slab thickness for grading purposes is the maximum width at which a 4 cm (2 rads) thick board can be cut at right angles to the grain (annual rings).

6.5.3 Definition of Descriptive Terms Used in Section 6.5

6.5.3.1 Clear

Clear means free of knots and stain, and at least 2.5 m long in the case of lumber. Clear shingles must be free of knots, insect damage and meet the minimum shingle dimensions.

6.5.3.2 Gross Scale

Gross Scale means the volume of a log inside bark and includes unsound wood and holes in the log.

6.5.3.3 Merchantable

Merchantable with respect to lumber means good, strong, general purpose lumber graded as better than utility or number 3, and not less than 2.5 m long.

6.5.3.4 Shop grade

Shop grade refers to clear lumber at least 2.5 m long, which is cut out from between large knots.

6.5.3.5 Lumber

Lumber must be 2.5 m long and free of rot and fractures.

6.5.3.6 Side

Regardless of whether on land or in the water, the surface of a log has two visible sides, one on each side of a vertical plane that passes through the centre of each end of the log.

6.5.3.7 Shingles

Shingles must be at least 23 rads long, 4 rads wide, have no knots larger than 7 cm or 3.5 rads and have no knots on any of the four edges..

6.5.3.8 Upper

Upper means closest to the small end , or top end, of a log.

6.5.3.9 List of Permissible Defects

In the following sections, the end of each "Requirements to Make the Grade" are listed permissible defects. The defects indicated are those common to the species and a defect may not appear as it is not a common defect or does not affect that species.

6.5.3.10 Check (or Heart Check)

A separation of the wood, at a right angle to the annual rings, which runs through the heart of the log. Is also called heart shake.

6.5.3.11 Sun Check (or Outside Check)

A separation of wood which penetrates from the outside diameter in toward the heart of the log. Caused by drying of logs or standing dead trees. Is also called surface check.

6.5.3.12 Otherwise Grade

Means a log meets all the requirements of the "otherwise" grade, including being free of non-permissible defects, but has more grade reduction than the "otherwise" grade allows.

6.5.3.13 Ring Shake

Ring shake is a separation of the wood following the circumference, or part of the circumference, of an annular ring.

6.5.3.14 Pitch Ring (or Silt Shake)

Pitch ring is an accumulation of pitch or resin fully or partially around the circumference of an annual ring, where there is no visible wood separation.

1. Where a pitch ring appears at only one end of a log, no loss for lumber or plywood is considered.

2. Where a pitch ring appears at both ends of a log it is treated as a tight ring shake, and the log is graded accordingly.

Pitch rings are also called silt shakes, as the ring was made more visible when the grunge in the Fraser River clung to the pitch, and some individuals also call it "silk" shake.

6.5.3.15 Peeler Block

Peeler block is a segment of a log's length, usually 2.6 m, suitable for the manufacture of veneer on a rotary lathe.

6.5.3.16 Knot Indication

A knot indication is a characteristic feature showing in the bark of a log which indicates a branch once grew there, but has since been shed and the residual knot covered with new growth wood. Sometimes knot indications will also show on the sapwood surface when the bark has been removed.

These features indicate that the new growth wood covering the knot is shallow, and for log grades which must cut clear lumber they are treated the same as knots. The peeler B grade also treats indications the same as knots for smaller diameter logs. Where knot indications are to be treated as knots, this is specified in the requirements following the grade rules in Section 6.5.4.1. When not mentioned in the requirements knot indications are not a factor in grade determination.

As with most defects, considerable field training and experience is required for scalers to correctly identify knot indications, and distinguish them from other irregularities on the surfaces of logs.

6.5.3.17 Butt Log (or First Cut Log)

This refers to the first log cut from the bottom of the tree.

6.5.3.18 Second Cut Log

This refers to logs cut after the butt log.

6.5.4 Coast Grade Rules and Requirements

6.5.4.1 Firmwood Reject - all species - Grade Code Z (weight scale species code R)

The Y grade chipper or lumber reject grade is a log which is not considered viable for the production of any product other than chips. The Z grade firmwood reject is a log which is considered to have no commercial value, even for chips.

Firmwood rejects are the lowest grade on the scale, and are not considered for cut control purposes or charged stumpage. Despite their low value, some firmwood reject volumes are utilized in manufacturing processes.

The firmwood reject grade rule is identical for all species. When scaled in a weight scale sample Z logs are not identified by species, and the letter R is used in place of the species code.

6.5.4.2 Grade Rule

1. A log where:

    a. heart rot or hole runs the entire length of the log and the residual collar of the firmwood constitutes less than 50 percent of the gross scale of the log,

    b. rot is in the log and the scaler estimates the net length of the log to be less than 1.2 m, or

    c. sap rot or charred wood exists and the residual firmwood is less than 10 cm in diameter at the butt end of the log.

2. That portion of a log that is less than 10 cm in diameter or that portion of a slab that is less than 10 cm in thickness. Note that this is the only grade rule that specifies diameter in cm rather than radius in cm (which equals diameter in rads).

6.5.4.3 Coniferous Grades

The following sections present the grade rules for each species, as they appear in the Scaling Regulation. Following each grade rule is a section outlining the detailed requirements a log must meet to make the grade

Each grade rule except Y states dimensions, a minimum percentage of product recovery potential, and a product quality requirement. The following Log Requirements to Make the Grade deal primarily with the product quality requirement. Where a log meets the Log Requirements to Make the Grade it will meet the product quality requirement of the grade rule.

6.5.4.4 Balsam and Hemlock Grades

These two genera are graded the same and the grades apply to all four species of balsam and both species of hemlock found in the province.

6.5.4.5 No 1 Lumber Balsam and Hemlock, Grade Code D

6.5.4.5.1 Grade Rule

A log 5 m or more in length and 33 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.4.5.2 Log Requirements to Make the Grade

1. No conk, or conk stain is permitted.

2. There must be no fewer than six annual rings in each 2 cm of diameter.

3. Logs 33 to 37 cm in radius must have at least 90 percent of the visible surface clear with only a few well spaced knots or knot indications permitted on the upper 10 percent of two sides or the upper 20 percent of one side.

4. Logs 38 cm or over in radius must have at least 80 percent of the visible surface clear with only a few well spaced knots or knot indications permitted on the upper 20 percent of both sides or the upper 40 percent of one side.

5. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Pocket rot is allowed. In balsam the pocket rot must be confined to the centre of the log within a circle 1/3 of the log radius, measured from the pith.

7. Ambrosia, burls, butt rot, butt shake, checks, crook, goitre, heart rot, pocket rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.6 No. 2 Lumber Balsam and Hemlock, Grade Code F

6.5.4.6.1 Grade Rule

A log 5 m or more in length and 25 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear.

6.5.4.6.2 Log Requirements to Make the Grade

1. No conk, or conk stain is permitted.

2. There must be no fewer than 6 annual rings in each 2 cm of diameter.

3. Logs 25 to 32 cm in radius must have at least 75 percent of the visible surface clear, with knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

4. Logs 33 cm or over in radius must have at least 50 percent of the visible surface clear, with knots or knot indications permitted on the upper 50 percent of two sides or the upper 75 percent of one side.

5. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Pocket rot is allowed. In balsam the pocket rot must be confined to the centre of the log within a circle 1/3 of the log radius measured from the pith.

7. Ambrosia, burls, butt rot, butt shake, checks, crook, goitre, heart rot, pocket rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.7 No. 2 Sawlog Balsam and Hemlock, Grade Code H

6.5.4.7.1 Grade Rule

A log 5 m or more in length and:

1. 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

2. otherwise Grade Code D or F, 25 cm or more in radius, where at least 50 percent of the gross scale can be manufactured into merchantable lumber, and at least 25 percent of that lumber will be clear.

6.5.4.7.2 Log Requirements to Make the Grade

1. There must be no fewer than five annual rings in each 2 cm of diameter.

2. On logs 19 to 24 cm in radius there must be no more than well-spaced knots up to 5 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

3. On logs 25 cm or over in radius there must be no more than occasional knots up to 8 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 5 cm in diameter on the upper 66 2/3 percent of the visible surface or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

4. Maximum twist permitted over 30 cm in length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Ambrosia, burls, butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.8 No. 3 Sawlog Balsam and Hemlock, Grade Code I

6.5.4.8.1 Grade Rule

A log:

1. 3.8 m or more in length and 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber, and at least 50 percent of that lumber will be merchantable, or

2. otherwise Grade Code H, 5 m or more in length and 19 cm or more in radius, where less than 75 percent but at least 50 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

6.5.4.8.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
19 - 24 cm	8 cm
25 - 37 cm	9 cm
38 + cm	10 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Burls, butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversize knots, pocket rot, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.9 No. 4 Sawlog Balsam and Hemlock, Grade Code J

6.5.4.9.1 Grade Rule

A log 5 m or more in length and 8 to 18 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.4.9.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
8 - 13 cm	4 cm
14 - 18 cm	6 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter.

3. Burls, butt rot, butt shakes, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.10 No. 5 Utility Balsam and Hemlock, Grade Code U

6.5.4.10.1 Grade Rule

A log:

1. 5 m or more in length and,

    a. 5 to 7 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

    b. 8 to 18 cm in radius where at least 66 2/3 percent of the gross scale can be manufactured into lumber, or

2. 3.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber,

and at least 35 percent of that lumber will be merchantable.

6.5.4.10.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and the other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.11 No. 6 Utility Balsam and Hemlock, Grade Code X

6.5.4.11.1 Grade Rule

A log 3 m or more in length and 5 cm or more in radius where at least 33 1/3 percent of the gross scale can be manufactured into lumber and at least 35 percent of that lumber will be merchantable.

6.5.4.11.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

Logs 25 cm and over in radius will allow oversize knots up to a maximum of two per 3 m of log length.

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Ambrosia, butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.4.12 No. 7 Chipper Balsam and Hemlock, Grade Code Y

6.5.4.12.1 Grade Rule

A log lower in grade than utility and higher in grade than firmwood reject.

6.5.5 Cedar Grades

These grades apply only to red cedar.

6.5.6 Lumber Grades

The lumber grades identify logs with significant percentages of clear cutting as described in the grade rules.

Knot specifications for lumber quality slabs will be those appropriate to the original round log.

6.5.6.1 No. 1 Lumber Cedar, Grade Code D

6.5.6.1.1 Grade Rule

1. A log 5 m or more in length and 30 cm or more in radius, or a slab 5 m or more in length, 25 cm or more in radius and 38 cm or more in thickness, where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

2. a log 5 m or more in length and 60 cm or more in radius where at least 66 2/3 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.6.1.2 Log Requirements to Make the Grade

1. No powder worm damage is permitted.

2. Logs 30 to 37 cm in radius must have at least 75 percent of the visible surface clear with knots or knot indications permitted in the upper 25 percent of two sides or the upper 50 percent of one side.

3. Logs 38 cm or over in radius must have at least 66 2/3 percent of the visible surface clear with knots or knot indications permitted on the upper 33 1/3 percent of two sides or the upper 66 2/3 percent of one side.

4. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

5. Adventitious knots, bark seams, burls, butt rot, catface, checks, crook, heart rot, pocket rot, oversized knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.6.2 No. 2 Lumber Cedar, Grade Code F

6.5.6.2.1 Grade Rule

A log 5 m or more in length and 25 cm or more in radius, or a slab 5 m or more in length, 25 cm or more in radius and 38 cm or more in thickness, where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear.

6.5.6.2.2 Log Requirements to Make the Grade

1. No powder worm damage is permitted.

2. Logs 25 to 29 cm in radius must have the visible surface clear of knots and knot indications.

3. Logs 30 to 37 cm in radius must have at least 66 2/3 percent of the visible surface clear with knots or knot indications permitted on the upper 33 1/3 percent of two sides or the upper 66 2/3 percent of one side.

4. Logs 38 cm or over in radius must have at least 50 percent of the visible surface clear with knots or knot indications permitted on the upper 50 percent of two sides or the upper 75 percent of one side.

5. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Adventitious knots, bark seams, burls, butt rot, catface, checks, crook, heart rot, oversized knots, pocket rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7 Sawlog Grades

The sawlog grades describe logs suitable for the manufacture of lumber (i.e., basically round, sound logs that will permit efficient handling by a sawmill). These grades will permit frequent small to medium size knots. Slabs qualifying for these grades must be 38 cm thick and a shape regular enough to cut efficiently on a sawmill carriage.

6.5.7.1 No. 2 Sawlog Cedar, Grade Code H

6.5.7.1.1 Grade Rule

A log 5 m or more in length and 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

6.5.7.1.2 Log Requirements to Make the Grade

1. No powder worm damage is permitted.

2. On logs 19 to 24 cm in radius there must be no more than well-spaced knots up to 5 cm in diameter on the upper 50 percent of the visible surface or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

3. On logs 25 cm or over in radius there must be no more than occasional knots up to 8 cm in diameter on the upper 50 percent of the visible surface, or well-spaced knots up to 5 cm in diameter on the upper 66 2/3 percent of the visible surface or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

4. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Bark seams, burls, butt rot, catface, checks, heart rot, oversized knots, pocket rot, sap rot, shatter, splits, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.2 No. 3 Sawlog Cedar, Grade Code I

6.5.7.2.1 Grade Rule

A log:

1. 3.8 m or more in length and 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

2. 9.8 m or more in length and 25 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

3. otherwise grade code H, 9.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

6.5.7.2.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters which should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
19 - 24 cm	8 cm
25 - 37 cm	9 cm
38 + cm	10 cm

2. Maximum twist permitted over 30 cm in length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Ambrosia, burls, butt rot, catface, checks, crook, dryside, heart rot, insect holes, loose knots, oversized knots, pocket rot, powder worm, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.3 No. 4 Sawlog Cedar, Grade Code J

6.5.7.3.1 Grade Rule

A log 5 m or more in length and 8 to 18 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.7.3.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters which should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
8 - 13 cm	6 cm
14 - 18 cm	8 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter.

3. Burls, butt rot, catface, checks, crook, dry side, heart rot, insect holes, loose knots, oversized knots, pocket rot, powder worm, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.4 Shingle Grades

Shingle grade logs will have fewer but possible larger knots than sawlogs, so spaced to permit the production of shingle blocks. Shingle logs are generally not best initialized for the manufacture of lumber because of the nature of the knots or because they are irregular in shape, have excessive butt or heart rot, bark seams, open checks, rotten knots, shatter, or combinations of the above defects.

1. The shingle grade rules make no reference to the recovery of lumber. Scalers will judge the recovery percentage required to produce shingles or shakes.

2. Some very defective cedar logs should go into shingle grades.

3. 'D' quality logs with less than 75 percent suitable for lumber become 'K' grade, except D's 60 rads or larger which become K's if they have less than 66 2/3 percent suitable for lumber.

4. 'F' quality logs with less than 75 percent lumber become 'L' grade, except that those from 25 to rads which become K's if they have less than 75 percent suitable for lumber.

6.5.7.5 Other Considerations

Other defective cedar logs may fit either into a sawlog or shingle grade. The following types of logs and slabs should be given serious consideration for the shingle grade.

1. Logs less than 7.8 m in length, broken at one end.

2. Logs less than 9.8 m in length, broken at both ends.

3. Those 'H' or 'I' quality logs over 9.8 m in length containing 50 - 74 percent lumber, that are more suitable for quality shingle recovery and can meet grade 'L' requirements.

4. Logs less than 12.8 m in length and less than 75 percent lumber with a serious defect at both ends.

5. 'D' and 'F' quality logs cut too short for those grades.

6.5.7.6 No. 1 Shingle Cedar, Grade Code K

6.5.7.6.1 Grade Rule

A log 3.8 m or more in length and 25 cm or more in radius or a slab 3.8 m or more in length, 25 cm or more in radius and 38 cm or more in thickness, where at least 50 percent of the gross scale can be manufactured into shingles or shakes, and at least 75 percent of the shingles or shakes will be clear.

6.5.7.6.2 Log Requirements to Make the Grade

1. No powder worm damage is permitted.

2. Logs 25 to 29 cm in radius must have the visible surface clear of knots and knot indications.

3. Logs 30 to 37 cm in radius must have at least 75 percent of the visible surface clear with knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

4. Logs 38 cm or over in radius must have at least 66 2/3 percent of the visible surface clear with knots or knot indications permitted on the upper 33 1/3 percent of two sides or the upper 66 2/3 percent of one side.

5. Maximum twist permitted over 30 cm in length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Bark seams, burls, butt rot, catface, checks, crook, heart rot, oversized knots, pocket rot, sap rot, shatter, splits, sweep, or other defects are permitted providing that the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.7 No. 2 Shingle Cedar, Grade Code L

6.5.7.7.1 Grade Rule

A log 3.8 m or more in length and 19 cm or more in radius or a slab 3.8 m or more in length, 19 cm or more in radius and 26 cm or more in thickness where at least 50 percent of the gross scale can be manufactured into shingles or shakes and at least 50 percent of the shingles or shakes will be clear.

6.5.7.7.2 Log Requirements to Make the Grade

1. No powder worm damage is permitted.

2. Logs must have at least 50 percent of the visible surface clear, with knots and knot indications permitted on the upper 50 percent of two sides, or on all of one side.

3. Logs over 30 rads or slabs will permit large knots spaced so sufficient clear shingle blocks can be cut from the area between the knots to meet the grade rule. The large knots must have 30 rads (0.6 m) spacing to allow shingle blocks to be cut between them, and the blocks must be a quadrant.

4. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Bark seams, burls, butt rot, catface, checks, crook, heart rot, oversized knots, pocket rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.8 No. 3 Shingle Cedar, Grade Code M

6.5.7.8.1 Grade Rule

A log 3.8 m or more in length and 19 cm or more in radius or a slab 3.8 m or more in length, 13 cm or more in radius and 16 cm or more in thickness where at least 50 percent of the gross scale can be manufactured into shingles and at least 25 percent of the shingles will be clear.

6.5.7.8.2 Log Requirements to Make the Grade

The following are the log requirements to make this grade:

1. No powder worm is permitted.

2. Logs must have at least 25 percent of the visible surface clear, with knots and knot indications permitted on the upper 75 percent of two sides, or all of one side and the upper 50 percent of the other.

3. Logs over 25 rads or slabs will permit large knots spaced so sufficient clear shingle blocks can be cut from the area between the knots to meet the grade rule. The large knots must have 30 rads (0.6 m) spacing to allow shingle blocks to be cut between them, and the blocks must represent a quadrant.

4. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Bark seams, burls, butt rot, catface, checks, crook, heart rot, pocket rot, sap rot, shatter, splits, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.9 No. 5 Utility Cedar, Grade Code U

6.5.7.9.1 Grade Rule

A log:

1. 5 m or more in length and

    a. 5 to 7 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

    b. 8 to 18 cm in radius where at least 66 2/3 percent of the gross scale can be manufactured into lumber, or

2. 3.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber,

and at least 35 percent of that lumber will be merchantable.

6.5.7.9.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.10 No. 6 Utility Cedar, Grade Code X

6.5.7.10.1 Grade Rule

A log 3 m or more in length and 5 cm or more in radius where at least 33 1/3 percent of the gross scale can be manufactured into lumber and at least 35 percent of that lumber will be merchantable.

6.5.7.10.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

Logs 25 cm and over in radius will allow oversize knots up to a maximum of two per 3 m of log length.

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.7.11 No. 7 Chipper Cedar, Grade Code Y

6.5.7.11.1 Grade Rule

A log lower in grade than utility and higher in grade than firmwood reject.

6.5.8 Cypress Grades

These grades apply to cypress, also known as yellow-cedar.

6.5.8.1 No. 1 Lumber Cypress, Grade Code D

6.5.8.1.1 Grade Rule

A log 4 m or more in length and 30 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.8.1.2 Log Requirements to Make the Grade

1. Logs 30 to 37 cm in radius must have at least 75 percent of the visible surface clear with knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

2. Logs 38 cm or over in radius must have at least 66 2/3 percent of the visible surface clear with knots or knot indications permitted on the upper 33 1/3 percent of two sides or the upper 66 2/3 percent of one side.

3. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

4. Adventitious knots, burls, butt rot, catface, checks, crook, frost checks, heart rot, oversized knots, pocket rot, ring rot, sap rot, shatter, splits, stain, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.2 No. 2 Lumber Cypress, Grade Code F

6.5.8.2.1 Grade Rule

A log:

1. 4 m or more in length and 25 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear, or

2. otherwise grade code D, 6.2 m or more in length and 30 cm or more in radius where less than 75 percent but at least 50 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.8.2.2 Log Requirements to Make the Grade

1. Logs 25 to 29 cm in radius must have at least 75 percent of the visible surface clear with knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

2. Logs 30 cm or over in radius must have at least 50 percent of the visible surface clear with knots or knot indications permitted on the upper 50 percent of two sides or the upper 75 percent of one side.

3. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

4. Adventitious knots, burls, butt rot, catface, checks, crook, frost checks, heart rot, oversized knots, pocket rot, ring rot, sap rot, shatter, splits, stain, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.3 No. 2 Sawlog Cypress, Grade Code H

6.5.8.3.1 Grade Rule

A log 4 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

6.5.8.3.2 Log Requirements to Make the Grade

1. On logs 19 to 24 cm in radius there must be no more than well-spaced knots up to 5 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

2. On logs 25 cm or over in radius there must be no more than occasional knots up to 8 cm in diameter on the upper 50 percent of the visible surface, or well-spaced knots up to 5 cm in diameter on the upper 66 2/3 percent of the visible surface or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

3. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

4. Burls, butt rot, catface, checks, frost checks, heart rot, oversized knots, pocket rot, ring rot, sap rot, shatter, splits, stain, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.4 No. 3 Sawlog Cypress, Grade Code I

6.5.8.4.1 Grade Rule

A log 4 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.8.4.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
19 - 24 cm	8 cm
25 - 37 cm	9 cm
38 + cm	10 cm

2. Maximum twist permitted over 30 cm in length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Burls, butt rot, catface, checks, crook, dry side, frost checks, heart rot, insect holes, loose knots, oversized knots, pocket rot, ring rot, rotten knots, sap rot, shatter, splits, stain, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.5 No. 4 Sawlog Cypress, Grade Code J

6.5.8.5.1 Grade Rule

A log 4 m or more in length and 8 to 18 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.8.5.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
8 - 13 cm	4 cm
14 - 18 cm	6 cm

2. Maximum twist permitted over 30 cm in length is 10 percent of the diameter.

3. Burls, butt rot, catface, checks, crook, dry side, frost checks, heart rot, insect holes, loose knots, oversized knots, pocket rot, ring rot, rotten knots, sap rot, shatter, splits, stain, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.6 No. 5 Utility Cypress, Grade Code U

6.5.8.6.1 Grade Rule

A log:

1. 5 m or more in length and

   a. 5 to 7 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

   b. 8 to 18 cm in radius where at least 66 2/3 percent of the gross scale can be manufactured into lumber, or

2. 3.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber,

and at least 35 percent of that lumber will be merchantable.

6.5.8.6.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Burls, butt rot, catface, checks, crook, dry side, frost checks, heart rot, insect holes, loose knots, oversized knots, pocket rot, rotten knots, sap rot, shatter, splits, stain, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.7 No. 6 Utility Cypress, Grade Code X

6.5.8.7.1 Grade Rule

A log 3 m or more in length and 5 cm or more in radius where at least 33 1/3 percent of the gross scale can be manufactured into lumber and at least 35 percent of the lumber will be merchantable.

6.5.8.7.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

Logs 25 cm and over in radius will allow oversize knots up to a maximum of two per 3 m of log length.

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Ambrosia, butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.8.8 No. 7 Chipper Cypress, Grade Code Y

6.5.8.8.1 Grade Rule

A log lower in grade than utility and higher in grade than firmwood reject.

6.5.9 Fir and Pine Grades

With the exception that pine has no peeler grades, these two genera are graded the same. The grades apply to all species of pine found in the province.

6.5.9.1 No. 1 Lumber Fir and Pine, Grade Code D

6.5.9.1.1 Grade Rule

A log 5 m or more in length and 38 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.9.1.2 Log Requirements to Make the Grade

1. No conk or conk stain is permitted.

2. Pocket rot is allowable only if it is contained within a circle 1/3 the log radius, measured from the pith.

3. There must be no fewer than six annual rings in each 2 cm of diameter.

4. Logs must have at least 90 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 10 percent of two sides or the upper 20 percent of one side.

5. Maximum twist permitted over 30 cm in length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Only small pitch pockets ranging in numbers per end from three for logs 38 cm in radius to six for logs 76 cm or over in radius are permitted.

7. No ring shakes (full or partial) are permitted in that part of the log between 8 cm and 20 cm of the bark.

8. A ring shake within 8 cm of the bark is only permitted if the log inside the shake is at least 38 rads, and the log meets the rest of the grade rule.

9. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

10. Ambrosia, butt rot, burls, checks, crook, heart rot, ring shake, sap rot, shatter, splits, sweeps, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.2 No. 2 Lumber Fir and Pine, Grade Code F

6.5.9.2.1 Grade Rule

A log 5 m or more in length and 30 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear.

6.5.9.2.2 Log Requirements to Make the Grade

1. No conk or conk stain is permitted.

2. Picket rot is allowed only if it is contained within a circle 1/3 of the log radius, measured from the pith.

3. There must be no fewer than six annual rings in each 2 cm of diameter.

4. Logs 30 to 37 cm of radius must have at least 75 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

5. Logs 38 cm and over in a radius must have at least 50 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 50 percent of two sides or upper 75 percent of one side.

6. Maximum twist permitted over 30 cm in length is 4 percent of the diameter at the top of the log to a maximum deviation of 6 cm.

7. Only small pitch pockets ranging in number per end from two for logs 30 cm in radius up to six for logs 76 cm or over in radius are permitted.

8. A ring shake that encircles half or more of the circumference of the ring is not permitted in that portion of the log between 4 rads and 10 rads of the bark. A ring shake within 4 rads of the bark is only permitted if within that part of the log inside the shake is at least 30 rads and the log meets the rest of the grade rule.

9. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

10. Ambrosia, butt rot, burls, checks, crook, heart rot, ring shake, sap rot, shatter, splits, sweeps, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.3 No. 2 Peeler Fir, Grade Code B

6.5.9.3.1 Grade Rule

A log 5.2 m or more in length and 30 cm or more in radius where at least 80 percent of the gross scale can be manufactured on a rotary lathe into veneer.

6.5.9.3.2 Log Requirements to Make the Grade

1. No heart rot, conk, conk stain, or pocket rot is permitted.

2. There must be no fewer than six annual rings in each 2 cm of diameter.

3. Logs 30 to 37 cm in radius must have the 2.6 m butt block free of knots or knot indications.

4. Logs 38 cm or over in radius must have the 2.6 m butt block free of knots, - indications permitted.

5. No knots over 4 cm are permitted and knots or knot indications 4 cm or less in diameter must be well-spaced. Bunch knots that can be encircled in a 4 cm diameter are permitted.

6. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

7. Butt rot must not be present in logs less than 8 m in length.

8. The diameter of butt rot in logs 8 m to less than 10.4 m in length must not exceed 33 1/3 percent of the measured butt diameter after excluding flare.

9. The diameter of butt rot in logs 10.4 m or over in length must not exceed 50 percent of the measured butt diameter after excluding flare.

10. Butt star checks must not be longer than half the top diameter of the log.

11. No more than one heart check or split which must not affect the outer 25 percent of the radius is permitted at either end of log. A check appearing in both ends of the log must be considered to be the same check to be allowed.

12. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

13. An angular heart check will be allowed if it does not vary more than 45 degrees from a straight line and does not affect the outer 25 percent of the radius.

14. Only small pitch pockets ranging in numbers per end from three for logs 30 cm in radius to seven for logs 76 cm or over in radius are permitted.

15. One partial ring shake which does not extend around half the circumference of the ring and does not have checks at right angles to the shake, or a full ring shake with a diameter not exceeding 33 1/3 percent of the diameter of the log is permitted. An allowable shake in the outer 66 2/3 percent of the diameter is permitted in one end only. An allowable shake in the inner 33 1/3 percent of the diameter is permitted in both ends.

16. Ring shake with a check is permitted if both can be contained in the centre of a log by a circle not exceeding 1/3 the diameter of the log.

17. Logs can exhibit sap rot or sun checks to a depth of 4 percent of the top diameter of the log. The maximum depth of a sap rot or sun checks shall not exceed 5 cm.

18. At the top end of a log, off centre heart is permitted only where distance from true centre does not exceed 10 percent of the top diameter of the log.

19. Sweep is permitted to the following extent:

    a. logs 5.2 m to less than 8 m in length allow up to a 0.6 m consideration for sweep, with no mental bucking to reduce loss for sweep permitted in peelers less than 8 m long,

    b. logs 8 m to less than 10.4 m in length allow up to a 1.2 m consideration for sweep, with one mental buck allowed for logs 8 m to less than 12.8 m long,

    c. logs 10.4 m and over in length allow up to a 2 m consideration for sweep, with two mental bucks allowed for logs over 12.8 m long.

20. Crook (a definite kink) and pistol grip (a sharp bend near the large end of a butt log) is permitted to the following extent:

    a. logs 5.2 m to less than 8 m in length, no loss is allowed,

    b. logs 8 m to less than 10.4 m in length, up to a 1.2 m consideration is allowed,

    c. logs 10.4 m and over in length, up to a 2 m consideration is allowed.

21. On logs 10.4 m and over in length bucking breaks, splits and broken ends are allowed provided the defect can be eliminated in a length equal to the top diameter.

22. Burls are permitted to the extent of one medium or large size burl for every 2.6 m of log length.

6.5.9.4 No. 3 Peeler Fir, Grade Code C

6.5.9.4.1 Grade Rule

A log 5.2 m or more in length and 19 cm or more in radius where at least 80 percent of the gross scale can be manufactured on a rotary lathe into veneer.

6.5.9.4.2 Log Requirements to Make the Grade

1. No heart rot, conk, conk stain, or pocket rot is permitted.

2. There must be no fewer than six annual rings in each 2 cm of diameter.

3. No knots over 4 cm in diameter are permitted and knots 4 cm or less in diameter must be well spaced. Bunch knots that can be encircled in a 4 cm diameter are permitted.

4. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Butt rot must not be present in logs less than 8 m in length.

6. The diameter of butt rot in logs 8 m to less than 10.4 m in length must not exceed 33 1/3 percent of the measured butt diameter after excluding flare.

7. The diameter of butt rot in logs 10.4 m or over in length must not exceed 50 percent of the measured butt diameter after excluding flare.

8. Butt star checks must not be longer than half the top diameter of the log.

9. No more than one heart check or split that must not affect the outer 25 percent of the radius is permitted at either end of the log.

10. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

11. An angular heart check will be allowed if it does not vary more than 45 degrees from a straight line but must not affect the outer 25 percent of the radius.

12. Only small pitch pockets ranging in numbers per end from two for logs 19 cm in radius to seven for logs 76 cm or over in radius are permitted.

13. One partial ring shake that does not extend around half the circumference of the ring and does not have checks at right angles to the shake, or a full ring shake with a diameter not exceeding 33 1/3 percent of the diameter of the log is permitted. An allowable shake in the outer 66 2/3 percent of the diameter is permitted in one end only. An allowable shake in the inner 33 1/3 percent of the diameter is permitted in both ends.

14. Ring shake with a check is permitted if both can be contained in the centre of a log by a circle not exceeding one third the diameter of the log.

15. No sap rot or sun checks are allowed in logs less than 25 cm in radius. Logs 25 cm in radius and greater can exhibit sap rot or sun checks to a depth of 4 percent of the top diameter of the log. The maximum depth of sap rot or sun check shall not exceed 5 cm.

16. At the top end of a log, off centre heart is permitted only where distance from true centre does not exceed 10 percent of the top diameter of the log.

17. Sweep is permitted to the following extent:

    a. logs 5.2 m to less than 8 m in length allow up to a 0.6 m consideration for sweep, with no mental bucking to reduce the loss for sweep permitted in peelers less than 8 m long,

    b. logs 8 m to less than 10.4 m in length allow up to a 1.2 m consideration for sweep, with one mental buck allowed for logs 8 m to less than 12.8 m long, and

    c. logs 10.4 m and over in length allow up to a 2 m consideration for sweep, with two mental bucks allowed for logs over 12.8 m long.

18. Crook (a definite kink) and pistol grip (a sharp bend near the large end of a butt log) is permitted to the following extent:

    a. logs 5.2 m to less than 8 m in length, no loss is allowed,

    b. logs 8 m to less than 10.4 m in length, up to a 1.2 m consideration is allowed, and

    c. logs 10.4 m and over in length, up to a 2 m consideration is allowed.

19. On logs 10.4 m and over in length bucking breaks, splits, and broken ends are allowed provided the defect can be eliminated in a length equal to the top diameter.

20. Burls are permitted to the extent of one medium or large size burl for every 2.6 m of log length.

6.5.9.5 No. 2 Sawlog Fir and Pine, Grade Code H

6.5.9.5.1 Grade Rule

A log 5 m or more in length and

1. 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber.

2. 25 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber, and at least 65 percent of that lumber will be merchantable.

6.5.9.5.2 Log Requirements to Make the Grade

1. There must be no fewer than five annual rings in each 2 cm of diameter.

2. On logs 19 to 24 cm in radius there must be no more than well-spaced knots up to 5 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

3. On logs 25 cm or over in radius there must be no more than occasional knots up to 8 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 5 cm in diameter on the upper 66 2/3 percent of the visible surface or reasonably well spaced knots up to 4 cm in diameter over all the visible surface.

4. Maximum twist permitted over 30 cm in length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

6. Burls, butt rot, checks, conk, conk stain, crook, heart rot, oversized knots, pitch pockets, pocket rot, ring shake, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of log free from these defects is sufficient to meet the grade rule.

6.5.9.6 No. 3 Sawlog Fir and Pine, Grade Code I

6.5.9.6.1 Grade Rule

A log:

1. 3.8 m or more in length and

   a. 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

   b. 25 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber

   and at least 50 percent of that lumber will be merchantable, or

2. otherwise grade code H, 5 m or more in length and 19 to 24 cm in radius, where less than 75 percent but at least 50 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable.

6.5.9.6.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
19 - 24 cm	8 cm
25 - 37 cm	9 cm
38 + cm	10 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Bunch knots, burls, butt rot, checks, conk, conk stain, crook, heart rot, insect holes, loose knots, oversized knots, pitch pockets, pocket rot, ring shake, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.7 No. 4 Sawlog Fir and Pine, Grade Code J

6.5.9.7.1 Grade Rule

A log 5 m or more in length and 8 to 18 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.9.7.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
8 - 13 cm	4 cm
14 - 18 cm	6 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter.

3. Burls, butt rot, butt shakes, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.8 No. 5 Utility Fir and Pine, Grade Code U

6.5.9.8.1 Grade Rule

A log:

1. 5 m or more in length and

    a. 5 to 7 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

    b. 8 to 18 cm in radius where at least 66 2/3 percent of the gross scale can be manufactured into lumber, or

2. 3.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber

and at least 35 percent of that lumber will be merchantable.

6.5.9.8.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

2. Maximum twist permitted over 30 cm of length is 26 percent of the radius up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.9 No. 6 Utility Fir and Pine, Grade Code X

6.5.9.9.1 Grade Rule

A log 3 m or more in length and 5 cm or more in radius where at least 33 1/3 percent of the gross scale can be manufactured into lumber and at least 35 percent of that lumber will be merchantable.

6.5.9.9.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

Logs 25 cm and over in radius will allow oversize knots up to a maximum of two per 3 m of log length.

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.9.10 No. 7 Chipper Fir and Pine, Grade Code Y

6.5.9.10.1 Grade Rule

A log lower in grade than utility and higher in grade than firmwood reject.

6.5.10 Spruce Grades

Wavy grain or "Horse Mane" is a grain defect peculiar to spruce. If present to more than a slight amount or in conjunction with spiral grain, the log must be degraded. For spruce 'D, E and F wavy grain is permitted only to a slight degree. Spruce 'G' wavy grain is permitted to a slightly greater extent in larger logs.

6.5.10.1 No. 1 Premium Spruce, Grade Code D

6.5.10.1.1 Grade Rule

A fine grained log 4 m or more in length and 50 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.10.1.2 Log Requirements to Make the Grade

1. No conk or conk stain is permitted.

2. Pocket rot is permitted if it is contained in a circle 1/3 the log radius, measured from the pith.

3. There must be no fewer than 12 annual rings in each 2 cm of diameter.

4. Logs 50 - 59 cm in radius must have at least 90 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 10 percent of two sides or the upper 20 percent of one side.

5. Logs 60 cm or more in radius must have at least 80 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 20 percent of two sides or the upper 40 percent of one side.

6. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

7. Only small pitch pockets ranging from three for logs 50 cm in radius to six for logs 76 cm and over in radius are permitted.

8. Insect or worm holes other than ambrosia must not penetrate beyond the sapwood.

9. Ambrosia, burls, wavy grain (horse mane), butt rot, checks, crook, heart rot, sap rot, shatter, splits, sweep, bell butt, flared butt, or other defects are permitted providing the portion free from these defects is sufficient to meet the grade rule.

6.5.10.2 No. 2 Premium Spruce, Grade Code E

6.5.10.2.1 Grade Rule

A fine grained log

1. 4 m or more in length and 38 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear or,

2. otherwise grade code D, 6.2 m or more in length and 50 cm or more in radius, where less than 75 percent but at least 66 2/3 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.10.2.2 Log Requirements to Make the Grade

1. No conk or conk stain rot is permitted.

2. Pocket rot is permitted if it is contained within a circle 1/3 the log radius, measured from the pith.

3. There must be no fewer than 12 annual rings in each 2 cm of diameter.

4. Logs 38 - 49 cm in radius must have at least 75 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

5. Logs 50 cm in radius and over will allow a few well-spaced knots or knot indications on the upper 50 percent of two sides or the upper 75 percent of one side.

6. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

7. Only small pitch pockets ranging from two per end for logs 38 cm in radius to six for logs 76 cm and over are permitted.

8. Insect or worm holes other than ambrosia must not penetrate beyond the sapwood.

9. Ambrosia, burls, wavy grain (horse mane), butt rot, checks, crook, heart rot, sap rot, shatter, splits, sweep, butt, flared butt, or other defects are permitted providing the portion free from these defects is sufficient to meet the grade rule.

6.5.10.3 No. 1 Lumber Spruce, Grade Code F

6.5.10.3.1 Grade Rule

A log 4 m or more in length and 38 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 50 percent of that lumber will be clear.

6.5.10.3.2 Log Requirements to Make the Grade

1. No conk or conk stain is permitted.

2. Pocket rot is permitted if it is contained within a circle 1/3 the log radius, measured from the pith.

3. There must be no fewer than six annual rings in each 2 cm of diameter.

4. Logs must have at least 90 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 10 percent of two sides or the upper 20 percent of one side.

5. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

6. Only small pitch pockets ranging from three per end for logs 38 cm in radius to six for logs 76 cm or over in radius are permitted.

7. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

8. Ambrosia, burl, wavy grain (horse mane), butt rot, checks, crook, heart rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.4 No. 2 Lumber Spruce, Grade Code G

6.5.10.4.1 Grade Rule

A log 4 m or more in length and 30 cm or more in radius where at least 75 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of that lumber will be clear.

6.5.10.4.2 Log Requirements to Make the Grade

1. No conk or conk stain is permitted.

2. Pocket rot is permitted if it is contained within a circle 1/3 the log radius, measured from the pith.

3. There must be no fewer than six annual rings in each 2 cm of diameter.

4. Logs 30 to 37 cm in radius must have at least 75 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 25 percent of two sides or the upper 50 percent of one side.

5. Logs 38 cm or more in radius:

    a. must have at least 50 percent of the visible surface clear with only a few well-spaced knots or knot indications permitted on the upper 50 percent of two sides or the upper 75 percent of one side, or

    b. will permit large knots spaced so clear lumber, 2.5 m in length, shop type, can be cut from the area between the knots on at least 75 percent of the log's surface.

6. Logs 50 cm and over in radius will permit large knots spaced so clear lumber, 2.5 m in length, shop type, can be cut from the area between the knots on at least 50 percent of the log's surface.

7. Maximum twist permitted over 30 cm of length is 4 percent of the diameter up to a maximum deviation of 6 cm.

8. Only small pitch pockets ranging from two per end for logs 30 cm in radius to six for logs 76 cm or over in radius are permitted.

9. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

10. Ambrosia, burls, wavy grain (horse mane), butt rot, checks, crook, heart rot, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.5 No. 2 Sawlog Spruce, Grade Code H

6.5.10.5.1 Grade Rule

A log

1. 4 m or more in length and 19 cm or more in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable or,

2. otherwise grade code D, E, F or G, 4 m or more in length and 30 cm or more in radius, where less than 75 percent but at least 50 percent of the gross scale can be manufactured into merchantable lumber and at least 25 percent of the lumber will be clear.

6.5.10.5.2 Log Requirements to Make the Grade

1. There must be no fewer than five annual rings in each 2 cm of diameter.

2. On logs 19 to 24 cm in radius there must be no more than well-spaced knots up to 5 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

3. On logs 25 cm or over in radius there must be no more than occasional knots up to 8 cm in diameter on the upper 50 percent of the visible surface, or reasonably well-spaced knots up to 5 cm in diameter on the upper 66 2/3 percent of the visible surface, or reasonably well-spaced knots up to 4 cm in diameter over all the visible surface.

4. Maximum twist permitted over 30 cm of length is 7 percent of the diameter up to a maximum deviation of 8 cm.

5. Insect or worm holes other than ambrosia must not penetrate beyond the sap wood.

6. Ambrosia, burls, butt rot, checks, conk, conk stain, crook, heart rot, oversized knots, pitch pockets, pocket rot, ring shake, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.6 No. 3 Sawlog Spruce, Grade Code I

6.5.10.6.1 Grade Rule

A log 4 m or more in length and

1. 19 cm or more in radius where

   a. at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable, or

   b. otherwise grade code H, where less than 75 percent but at least 50 percent of the gross scale can be manufactured into lumber and at least 65 percent of that lumber will be merchantable, or

2. 25 cm more in radius where at least 50 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.10.6.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
19 - 24 cm	8 cm
25 - 37 cm	9 cm
38 - 49 cm	10 cm
50 + cm	13 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Bunch knots, burls, butt rot, checks, conk, conk stain, crook, heart rot, insect holes, loose knots, oversized knots, pitch pockets, pocket rot, ring shake, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.7 No. 4 Sawlog Spruce, Grade Code J

6.5.10.7.1 Grade Rule

A log 4 m or more in length and 8 to 18 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber and at least 50 percent of that lumber will be merchantable.

6.5.10.7.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
8 - 13 cm	4 cm
14 - 18 cm	6 cm

2. Maximum twist permitted over 30 cm of length is 10 percent of the diameter.

3. Burls, butt rot, butt shakes, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, shatter, splits, sweep, or other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.8 No. 5 Utility Spruce, Grade Code U

6.5.10.8.1 Grade Rule

A log:

1. 5 m or more in length, and

   a. 5 to 7 cm in radius where at least 75 percent of the gross scale can be manufactured into lumber, or

   b. 8 to 18 cm in radius where at least 66 2/3 percent of the gross scale can be manufactured into lumber, or

2. 3.8 m or more in length and 19 cm or more in radius where at least 50 percent of the gross scale can be manufactured into lumber

and at least 35 percent of that lumber will be merchantable.

6.5.10.8.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm

38 - 49 cm	14 cm
50 + cm	16 cm

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.9 No. 6 Utility Spruce, Grade Code X

6.5.10.9.1 Grade Rule

A log 3 m or more in length and 5 cm or more in radius where at least 33 1/3 percent of the gross scale can be manufactured into lumber and at least 35 percent of that lumber will be merchantable.

6.5.10.9.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size diameters that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 - 49 cm	14 cm
50 + cm	16 cm

   Logs 25 cm and over in radius will allow oversize knots up to a maximum of two per 3 m of log length.

2. Maximum twist permitted over 30 cm of length is 13 percent of the diameter up to a maximum deviation of 13 cm.

3. Butt rot, butt shake, checks, conk, conk stain, crook, goitre, heart rot, loose knots, oversized knots, pocket rot, rotten knots, sap rot, splits, shatter, sweep, and other defects are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.10.10 No. 7 Chipper Spruce, Grade Code Y

6.5.10.10.1 Grade Rule

A log lower in grade than utility and higher in grade than firmwood reject.

6.5.11 Broadleaf Species And Yew

6.5.11.1 Applicability

The grades apply to all hardwood (i.e., deciduous) species harvested on the coast and to yew (*Taxus brevifolia)*.

6.5.11.2 Sawlog, Grade Code Blank

6.5.11.2.1 Grade Rule

A log 2.6 m or more in length and 5 cm or more in radius, where at least 50 percent of the gross scale can be manufactured into merchantable lumber.

6.5.11.2.2 Log Requirements to Make the Grade

1. By log radii, maximum knot size that should not prevent the manufacture of the lumber requirements of the grade are:

Log radius	Knot size diameter
5 - 7 cm	4 cm
8 - 13 cm	6 cm
14 - 18 cm	8 cm
19 - 24 cm	10 cm
25 - 37 cm	12 cm
38 + cm	14 cm

2. Maximum twist permitted over 30 cm in length is 10 percent of the diameter up to a maximum deviation of 9 cm.

3. Adventitious knots, bunch knots, burls, butt rot, checks, conk, conk stain, crook, heart rot, insect holes, loose knots, oversize knots, pocket rot, ring shake, rotten knots, sap rot, shatter, splits, sweep, or other defects, are permitted providing the portion of the log free from these defects is sufficient to meet the grade rule.

6.5.11.3 Chipper, Grade Code Y

6.5.11.3.1 Grade Rule

A log lower in grade than sawlog but and higher in grade than firmwood reject.

6.6 Interpreting the Schedule of Interior Timber Grades

6.6.1 Area of Application

The Interior Schedule of Timber Grades applies to all timber harvested in all areas of the province except the Vancouver Forest Region and the North Coast Forest District.

> Remember, the area of harvest and not the place of scaling determines which schedule of timber grades must be used.

6.6.2 Rationale for Interior Grades

Interior grading is in place to meet two general objectives:

- differentiate log quality to enable lower stumpage rates to be applied against lower quality logs, and
- support cut control and utilization policies.

To meet these objectives, interior grading focuses on assessing the suitability of logs to manufacture merchantable lumber. In addition to this assessment, interior grading must determine:

- if logs were cut from trees which did not have to be utilized under contractual cutting specifications, and
- if logs were cut from trees which were dead when they were harvested.

6.6.3 Interior Schedule of Grades

SCHEDULE OF INTERIOR TIMBER GRADES

ALL SPECIES

1. Firmwood Reject, Grade Code Z
   - (a) A log where
     - (i) heart rot or hole runs the entire length of the log and the residual collar of the firmwood constitutes less than 50% of the gross scale of the log,
     - (ii) rot is in the log and the scaler estimates the net length of the log to be less than 1.2 m, or
     - (iii) sap rot or charred wood exists and the residual firmwood is less than 10 cm in diameter at the butt end of the log.
   - (b) That portion of a log that is less than 10 cm in diameter or that portion of a slab that is less than 10 cm in thickness.
2. Sawlog
   A log or slab 2.5 m or more in length and 5 cm or more in radius where
   - (a) for a hemlock log, at least 75% of the gross scale can be manufactured into lumber,
   - (b) for a cedar log
     - (i) up to and including 25 cm in radius at the midpoint, at least 75% of the gross scale can be manufactured into lumber, or
     - (ii) greater than 25 cm in radius at the midpoint, at least 50% of the gross scale can be manufactured into lumber,
   - (c) for a balsam log, at least 67% of the gross scale can be manufactured into lumber, and
   - (d) for a log of a species other than hemlock, cedar or balsam, at least 50% of the gross scale can be manufactured into lumber, and

   at least 50% of the lumber will be merchantable.
3. Dead and Dry Sawlog, Grade Code 3
   A log or slab graded as sawlog cut from trees which were dead and dry when harvested.
4. Lumber Reject, Grade Code 4
   A log or slab lower in grade than sawlog and higher in grade than firmwood reject.
5. Dead and Dry Lumber Reject, Grade Code 5
   A log or slab graded as lumber reject cut from trees which are dead and dry when harvested.
6. Undersized Log Grade, Grade Code 6
   A log or slab higher in grade than firmwood reject and cut from a tree which was below the minimum diameter, including the bark, at stump height.

Figure 6.25 Schedule of Interior Timber Grades, B.C. Reg 446-94.

Six grades are prescribed:

Firmwood Reject	Grade Code Z
Sawlog	Grade Code (Blank)
Dead and Dry Sawlog	Grade Code 3
Lumber Reject	Grade Code 4
Dead and Dry Lumber Reject	Grade Code 5
Undersized Log Grade	Grade Code 6

6.6.4 Principles for Applying the Interior Schedule

Applying the Interior Schedule requires the scaler to:

1. Determine the percentage of the log's gross volume which is suitable for cutting merchantable lumber.

2. Identify logs cut from trees which were dead and dry when harvested.

3. Identify logs cut from undersized trees.

6.6.4.1 Assessing Lumber Recovery

Scalers must apply the principles for calculating grade reduction and assessing product quality as detailed earlier in this chapter.

1. Minimum Dimensions

   To be suitable for the manufacture of lumber, logs, slabs and shells for interior grading must meet or exceed minimum dimensions. These are set as follows:

	Minimum Dimensions	
	Length	**Diameter/ Thickness**
a. logs and log segments *All species*	2.5 m	5 rads
b. slabs and slab segments *All species*	2.5 m	7.5 rads
c. collars of firmwood around: i. holes, heart rot and star check if defect is > 20 percent of end diameter ii. ring shake, water shake, ring to and pocket rot *All species except cedar and hemlock*	 2.5 m 2.5 m	 5 rads 5 rads
d. Collars of firmwood around: i. holes, heart rot and star check if defect is > 20 percent of end diameter ii. ring shake, water shake, ring rot and pocket rot *Interior cedar and hemlock*	 2.5 m 2.5 m	 7.5 rads 5 rads
e. sound hearts (cores) inside external defects, including sap rot, charred wood, ring rot and ring shake. *All species*	2.5 m	5 rads

All length, diameter, and thickness measurements in the schedule of grades are the actual gross measurement (e.g., a length of 2.46 m is not rounded to 2.5 m, etc.).

2. Diameter References

This table summarizes the type and use of diameter measurements in interior grading.

Diameter	**Referenced For**
top diameter (inside bark)	assessing twist, lengths ≤ 8 m. assessing knots, lengths ≤ 8 m and, knots on the upper 1/2, lengths > 8 m. minimum top diameter.
midpoint diameter (inside bark)	assessing twist on logs > 8 m. assessing knots on lower half of logs > 8 m. assessing lumber recovery in red cedar > 25 r at midpoint.
diameter (outside bark) 15 cm from the butt end	assessing if logs cut from undersized tree

6.6.4.2 Logs Cut from Dead Trees

Scalers must closely follow the criteria detailed under Section 6.4.4.1 of this manual.

> Logs showing both indicators and contraindicators must be assumed to be cut from living trees.

6.6.4.3 Logs Cut from Undersized Trees

Scalers must closely follow the criteria outlined under Section 6.4.4.2 of this manual.

To conclude that a log was cut from an undersized tree:

- the log must show sufficient evidence such as an undercut, butt flare, or other bark characteristics to indicate that it comprises a tree and not a top cut or second cut from a larger tree, and
- the outside bark measurement at a point 15 cm from the butt face, must be less than the minimum diameter at stump height specified in the cutting authority.

Logs must not be graded as Grade 6 if there is no evidence the log was cut from an undersized tree.

6.6.4.4 Knots

Merchantable lumber can be produced only from logs and log segments having knots not larger than specified maximums. For interior grading, both the midpoint and top diameters may be referenced in assessing knots. Knot specifications are as follows:

Log Diameter	**Maximum Knot Diameter**	
	RADS	**CM**
5 - 7	2	4
8 - 13	3	6
14 - 18	4	8
19 - 24	5	10
25 - 37	6	12
38+	7	14

To apply:

1. For logs $\leq$ 8 m in length assess knots against the top (inside) diameter.
2. For logs > 8 m in length, measure the midpoint diameter and:
   a. assess knots on the top log segment against the top diameter, and
   b. assess knots on the bottom log segment against the midpoint (inside) diameter.

Logs or log segments with excessive oversize knots are deemed to be unsuitable for the manufacture of merchantable lumber.

Knots which exceed the maximum are considered as oversize. Interior grading allows one oversize knot for every 3 m of log length. As the minimum log length for lumber recovery is 2.5, this assumes a 2.5 m sawlog segment could be cut between knots which are 3 m apart.

The location and frequency of oversize knots is a key determinant in assessing the merchantability of potential lumber recovery.

Refer to Section 6.4.3 for a more complete discussion.

6.6.4.5 Twist (Spiral Grain)

Measure twist over a representative 15 rad (30 cm) log section. To manufacture merchantable lumber, the grain deflection over the 15 rad (30 cm) section cannot exceed 15 percent of the reference diameter:

- for logs $\leq$ 8 m in length the reference diameter is the logs top diameter, and
- for logs > 8 m in length the reference diameter is the log's midpoint (inside bark) diameter.

Application of the interior twist criteria is subject to:

- twist must be at least 2 rads (4 cm) before it can be considered for grading purposes, and
- regardless of diameter, the maximum allowable twist for any log is 4.5 rads (9 cm).

> Logs or portions of logs displaying excessive twist are deemed to be unsuitable for the manufacture of merchantable lumber.

See Section 6.4.3 for details on twist measurement.

6.6.5 Definition of Terms in the Schedule of Interior Timber Grades

Gross Scale

Gross scale means the volume of a log inside the bark and includes unsound wood and holes in the log.

Lumber

Lumber must be 2.5 m long and free of rot and fractures.

Merchantable Lumber

Merchantable lumber means good, strong, general purpose lumber graded as better than utility or number 3 (this is assessed on the basis of knots and twist).

Radius and Diameter

Log radius in the grade rules is expressed as centimetres of radius, which is equal to and interchangeable with, rads of diameter.

An exception should be noted in the grade rule for firmwood reject where the measurement is expressed in centimetres of *diameter*.

6.6.6 Interior Grade Rules and Application

The following sections state each of the six interior grade rules as they appear in the *Scaling Regulation*.

The sections entitled "Application of the Grade Rule" which follows each grade rule includes information on how to apply the grade rule and enter the grade on the scale tally sheet or into a handheld data collector.

6.6.7 Firmwood Reject - Grade Code Z (weight scale species code R)

6.6.7.1 Grade Rule

1. A log where:
   a. heart rot or hole runs the entire length of the log and the residual collar of the firmwood constitutes less than 50 percent of the gross scale of the log,
   b. rot is in the log and the scaler estimates the net length of the log to be less than 1.2 m, or
   c. sap rot or charred wood exists and the residual firmwood is less than 10 cm in diameter at the butt end of the log.
2. That portion of a log that is less than 10 cm in diameter or that portion of a slab that is less than 10 cm in thickness.

6.6.7.2 Application of the Grade Rule

1. Firmwood reject takes precedence over all other grades.

2. Part 2 of the grade rule requires that any parts of logs less than 10 cm (5 rads) in diameter must be recorded as separate logs and graded as firmwood reject.

3. Similarly, portions of logs and slabs less than 10 cm (5 rads) must be recorded as separate logs and graded as firmwood reject.

4. When scaling weight scale sample loads for recording firmwood reject logs the species is not recorded. Instead, the letter R followed by a blank is recorded in the species field.

	SP	G
Example Weight Scale Entry:	R	Z

5. For piece scales and scaling examinations, the correct species is always entered against all grades.

	SP	G
Example Piece Scale and Scaling Exam Entry:	CE	Z

6.6.8 Sawlog Grade Code ( ) Blank

6.6.8.1 Grade Rule

A log or slab 2.5 m or more in length and 5 cm or more in radius where

1. for a hemlock log, at least 75 percent of the gross scale can be manufactured into lumber,
2. for a cedar log
   a. up to and including 25 cm in radius at the midpoint, at least 75 percent of the gross scale can be manufactured into lumber, or
   b. greater than 25 cm in radius at the midpoint, at least 50 percent of the gross scale can be manufactured into lumber,
3. for a balsam log, at least 67 percent of the gross scale can be manufactured into lumber, and
4. for a log of species other than hemlock, cedar or balsam, at least 50 percent of the gross scale can be manufactured into lumber, and
5. at least 50 percent of the lumber will be merchantable.

6.6.8.2 Application of the Grade Rule

1. Summary of Recovery Criteria

The sawlog grade lumber recovery rules by species are:

Species	**Lumber Quantity** **% of the Gross Scale which can be manufactured into lumber**	**Lumber Quality** **% of lumber manufactured that must be merchantable**
Hemlock	75	50
Red cedar Midpoint diameter inside bark: - 25R and less .- Greater than 25R	 75 50	 50 50
Balsam	67	50
All other species	50	50

2. For procedures to determine the percentage of the gross scale which can be manufactured into lumber see Section 6.4.2.

3. For procedures and criteria to assess lumber quality see Section 6.4.3.

4. Sawlogs are entered on the scale sheet as a blank (no other entries are permitted).

	SP	G
Tally Entry:	CE	

6.6.9 Dead and Dry Sawlog - Grade Code 3

6.6.9.1 Grade Rule

A log or slab graded as sawlog cut from a tree which was dead and dry when harvested.

6.6.9.2 Application of the Grade Rule

1. The requirements for this grade are identical to those of the sawlog grade except Grade 3 logs are logs which were cut from trees which were dead and dry when harvested.

2. The criteria outlined in Section 6.4.4.1 must be strictly followed in determining whether logs are cut from living or dead trees.

3. The grade is recorded on the tally sheet as follows:

SP	G
CE	3

6.6.10 Lumber Reject - Grade Code 4

6.6.10.1 Grade Rule

> A log or slab lower in grade then sawlog and higher in grade than firmwood reject.

6.6.10.2 Application of the Grade Rule

1. Logs and slabs which do not meet the requirements of the sawlog grade fall into this grade unless:

    - they meet the firmwood reject definition,
    - they are cut from trees which were dead/dry when harvested, or
    - they are cut from trees which did not have to be utilized under the cutting authority.

2. The grade is recorded on the tally sheet as follows:

SP	G
CE	4

6.6.11 Dead and Dry Lumber Reject - Grade Code 5

6.6.11.1 Grade Rule

> A log or slab graded as lumber reject cut from a tree which was dead and dry when harvested.

6.6.11.2 Application of the Grade Rule

1. Grade 5 logs are lumber rejects (Grade 4) cut from logs which were dead and dry when harvested.

2. The criteria outlined in Section 6.4.4.1 must be strictly followed in determining whether logs are cut from living or dead trees.

3. Logs cut from dead and dry trees measuring 15 cm (7.5 rads) or less at the midpoint may be considered for grade reduction if they contain two or more surface checks at least 4 cm (2 rads) in depth. The length affected by the checking is 100 percent grade reduction, and if sufficient volume of the log is so affected, it shall be coded as grade 5.

4. The grade is recorded or the tally sheet as follows:

SP	G
CE	5

6.6.12 Undersized Log Grade - Grade Code 6

6.6.12.1 Grade Rule

> A log or slab higher in grade than firmwood reject and cut from a tree which was below the minimum diameter, including the back, at stump height.

6.6.12.2 Application of the Grade Rule

1. Logs qualify for Grade 6 only where they can be clearly identified as being cut from a tree which was below the minimum diameter at stump height (DSH) specified in the cutting authority.

2. The criteria outlined in Section 6.4.4.2 must be closely followed in identifying undersized logs.

3. If timber is harvested on an area not having cutting specifications set by the Ministry, Scalers are to assume a DSH of 15 cm for pine and 20 cm for all other species.

4. If logs do not show evidence they are cut from undersized trees they must not be graded as Grade 6.

5. The grade is recorded on the tally sheet as follows:

SP	G
CE	6

6.6.13 Grade Precedence

Where a log meets the criteria of more than one grade, the following grade precedence applies:

1. A log or portion of a log that qualifies as firmwood reject (grade code Z) takes precedence over other grades.

2. A log that qualifies as undersize (grade code 6) takes precedence over all other grades except firmwood reject.

3. A log that qualifies as a Dead/Dry lumber reject (grade code 5) takes precedence over lumber reject (grade code 4).

4. A log which qualifies as a Dead/Dry sawlog (grade code 3) takes precedence over a green sawlog (grade code blank).

5. A log which qualifies as a Lumber Reject, (grade code 4) takes precedence over a green sawlog (grade code blank).

Appendix 6A Field Methods for Grade Reduction

The following methods for calculating grade reduction may be substituted for the methods described in Section 6.4, in most cases. These methods will closely approximate the prescribed formulas, and many scalers find them easier to apply. Their use can reduce both the time required to calculate grade reductions, and the chance of errors in calculation.

This appendix describes three field methods for three distinct types of defect situations. A description of where each may be used, and comment regarding the accuracy of the method are included.

The field methods express the grade reduction (GR) in terms of log length. The length of the grade reduction is then compared to the gross length of the log to determine the grade reduction percentage.

The three formulae are presented below, and explained in detail in the following sections.

- Formula #1 (non-conical defects):

  $$\frac{\text{UV of lumber loss}}{\text{average UV for the log}} \text{ x length of defect} = \text{GR length in metres}$$

  (follow Formula #1 with Formula #3 to convert GR in metres to a percent),

- Formula #2 (cone-shape defects):

  $$\frac{\text{UV of lumber loss}}{\text{average UV for the log}} \text{ x } \frac{\text{length of defect}}{3} \text{ x2} = \text{GR length in metres}$$

  (follow Formula #2 with Formula #3 to convert GR in metres to a percent), and

- Formula #3

  $$\frac{\text{length of GR}}{\text{log length}} \text{ x } 100 = \text{GR\%}.$$

6A.1 Formula #1

This formula is for use where the linear portion of the log affected by defect is partly suitable to cut lumber and part grade reduction.

The formula may not be used for conical defects such as butt rot and water shake (see Formula #2).

The "UV of lumber loss" is the unit volume for the log-end area unsuitable to cut lumber, including rim allowance where applicable.

Where the defect has two ends with different sizes, as with full length defects, the average of the two end unit volumes is used as the "UV lumber loss".

The "average UV of the log" is the average of the unit volumes for the top and butt diameters. For practical purposes, the UV for the average diameter may be used for most logs, but the accuracy of this short cut decreases as taper increases.

This formula expresses the grade reduction in log length. That length is then compared to the gross log length (as described by Formula #3) to obtain the percentage of the gross log that is grade reduction.

Use of this formula will yield identical results to the methods prescribed in Chapter 6. Because it employs unit volumes it is often easier to use, and is more adaptable to quick field calculations.

Examples of types of defects for which this formula may be used are heart rot, ring rot, pocket rot, ring shake, checks, and sap rot.

6A.2 Formula #2

This formula is for use with butt rot and butt shake, where the defect does not show in the top end of the log.

The "UV of lumber loss" is the unit volume for the base diameter of the defective area, when viewed in terms of suitability to cut lumber. For irregular and scattered defect that diameter will often be significantly larger than what would be used for a firmwood deduction.

The "UV of lumber loss" does not include trim allowance or collars too thin to cut lumber when using this formula.

Once the "UV of lumber loss" is established, the grade reduction is the same as a firmwood deduction would be, except that the result is doubled.

The "average UV of the log" is the average of the unit volumes for the top and butt diameters. The alternative of using the unit volume of the average diameter becomes less accurate as taper increases.

This formula expresses the grade reduction in log length, which is then compared to the gross length (as described by Formula #3) to obtain the percentage of the grade reduction.

Where the defect shows through to the top end, Formula #1 is used. The "UV of lumber loss" is the unit volume for average of the two defect diameters plus trim.

6A.3 Formula #3

6A.3.1 For Converting Grade Reduction in Metres to a Percentage

This formula simply converts the length of a log lost to grade reduction to a percent of the gross log length, which is then used as the percent of grade reduction.

When Formula #3 is used to convert length reductions derived from either Formula #1 or Formula #2, it is completely accurate.

6A.3.2 For Estimating Grade Reduction Percentage from Length Losses

A second application of Formula #3 is where an estimated length of log is completely lost for lumber recovery. In those cases, the length of the grade reduction portion of the log is compared to the gross log length (using this formula) to get an estimate of the grade reduction percentage.

Examples of where the formula may be used in this way are heart rot with a collar too thin to cut lumber, conk, shatter or breakage, pistol grip or crook, and bark seams.

This procedure of using a direct length comparison without applying a factor to account for the taper of the log (as Formulae #1 and #2 do) is sometimes called the lineal method of grade reduction.

Because log taper is not considered, this method is not precise, and the degree of error correlates with the amount of taper in the log. However, the errors tend to compensate over a number of logs, and the "lineal method" is readily adaptable to practical use in scaling.

Consequently, for the defect situations to which it applies, use of the lineal method is standard practise in coastal scaling for logs with up to 50 percent taper (or where the butt diameter is not more than 1.5 times the top diameter).

The method should be used with caution on logs with more than 50 percent taper, where it should not be relied upon for close grade calls. The method should not be used for logs with over 100 percent taper (butt diameter more than two times the top diameter).

The lineal method is less accepted in the interior, and whether it should be used at all is determined by whether it is used by local forest service check scalers. In areas where its use is sanctioned, it should not be used for logs with more than 50 percent taper.

The reasons for the geographic differences are found in the practical differences between weight scaling and piece scaling, and between scaling the different types of timber found in different areas.

The lineal method is more practical than volumetric calculations where large volumes of timber, or highly defective timber are scaled. It is also conducive to more consistent results, particularly on large diameter logs, because differences in diameter measurements will not influence the grade reduction calculation.

7.2.1 Penalties for Late Submission of Scale Returns

When a scale return is not received by the ministry within seven (7) days of the date specified in the scale site authorization penalties may be assessed.

When penalties are assessed, the amount of the penalty is the greater of:

- $100.00, or
- a percentage of the stumpage or royalty payable as a result of the scale return.

The penalty percentage, as set under the *Scaling Regulation,* increases with the period of delay in receiving the scale return.

If no stumpage or royalty is payable, the minimum penalty of $100.00 applies if a penalty is assessed.

> To assess a penalty for late submission of scale data, the *Scaling Regulation* requires the scale site authorization to define when scale returns are to be received by the ministry.

7.2.2 Electronic Submission of Scale Results

The regional manager may order the scale site owner or operator to enter into arrangements to submit scale returns to the ministry electronically, under the authority of Section 75(7) of the *Forest Act*, where:

- the regional manager estimates the annual volume of timber scaled at a scale site will exceed 50 000 cubic metres per year, and
- the ministry has the ability to receive scale data electronically.

The reasons for using electronic data submission include:

- greater accuracy in scale returns, as errors in scale data processing are reduced,
- streamlining administrative effort in processing scale data, and
- significantly improved audit control.

7.3 Scale Data Computation and Documentation Standards and Controls

1. The completeness, accuracy and security of scale data is the responsibility of all parties who collect, process, or submit scale data.
2. All parties collecting, processing or submitting scale data must have an adequate system of internal controls, including scale data controls, processing conventions and administrative processes to ensure all scale data is complete, accurate and secure.
3. The Ministry of Forests will conduct checks and audits to assess the accuracy and completeness of scale data and the adequacy of controls.

To ensure that scale data is consistent and reliable for all users, it must be captured, compiled, and reported in accordance with set standards. These standards are set by the Ministry of Forests.

Appendix B of this chapter documents standards for:

- compiling log and segregation volumes,
- compiling weight scale data, and
- reporting requirements for documenting the summary of scale and computed weight scale samples.

The ministry may set other standards regulating the submission, computation, control, and documentation of scale data. All persons processing scale data must ensure they are conversant with ministry requirements and ensure their standards are current.

Appendix C of this chapter identifies control requirements which must be part of any system designed to capture, compile or report scale data. The appendix further describes those scale data controls and processing conventions which should be in place to meet the control requirements.

Parties processing scale data are subject to periodic audit by the ministry. Licensees and any other parties processing scale data may be required to assess and report their compliance with control requirements. Section 6 of Appendix 7C outlines self assessment procedures.

Where the ministry considers controls to be deficient, it may deny parties from processing and submitting scale data.

All parties compiling and reporting scale data must be thoroughly familiar with Appendices B and C of this chapter.

7.4 Ensuring Compliance with Standards

In addition to setting scale computation and documentation standards and controls, the Ministry of Forests is responsible for ensuring they are complied with. This responsibility is met through two activities:

- approving all applications to process scale data, and
- assessing compliance with standards and controls.

7.4.1 Approving Applications to Process Scale Data

The following procedures are in place to approve scale data processing.

7.4.1.1 Piece Scale Computation

For approval to compile piece scale data, an application must be submitted to the regional manager. This application must include copies of supporting documentation (including both final reports and raw data) as well as a completed copy of the self-assessment questionnaire/report included under Appendix 7C of this manual. The application may also require submission of supporting software and source code.

Following the forest region's approval, proposals to compile piece scale data for any specific scale site must be approved by the forest district as part of the scale site authorization for that scale site.

7.4.1.2 Weight Scale Computation

All weight scale releases including the software to select samples and compile data must be submitted to Revenue Branch for approval. The application must include all supporting documentation, as well as a completed copy of the self-assessment questionnaire/report included under Appendix 7C of this manual.

Following approval by Revenue Branch, proposals to use the program for specific sites must be approved by the forest district as part of the scale site authorization for that site.

7.4.1.3 Handheld Data Processing

Proposals to capture, compile, or report scale data using handheld computers are subject to approval by Revenue Branch.

For this approval, applications must include copies of the software and user guide, raw scale data, detailed log listings, and computed reports (FS 531 - Computed weight scale sample and FS 72 - Summary of scale) which will be submitted to the ministry for processing (see Appendix 7B). The application must also include a completed copy of the self-assessment questionnaire/report included under Appendix 7C of this manual.

Following approval by Revenue Branch, proposals to use the handheld and software at specific sites must be approved by the forest district as part of the scale site authorization for that site.

7.4.1.4 Electronic Submission of Scale Data

The standards, conditions, and approval of the electronic submission of scale data will be set by Revenue Branch.

7.4.1.5 New Releases and Upgrades to Scaling Hardware/Software

All new releases and upgrades to hardware and/or software are subject to review by the ministry before they are to be used to process production data at any scale site.

Parties proposing new releases or upgrades should contact ministry staff as follows, to familiarize themselves with requirements:

For	Contact
piece scale computation	Regional Scaling Manager
weight scale computation	Scaling Policy Forester
handheld data processing	Scaling Policy Forester

7.4.2 Compliance Checking

District, regional, and headquarters staff are jointly responsible for assessing and ensuring compliance with ministry scale computation and documentation requirements.

Related activities include:

- on-site inspections,
- routine checking of raw tallies and computed reports,
- periodic rekeying of data,
- routine checking of summaries of scale reports used for billing input,
- periodic audits of computed submissions including:
    - verifying that the parties submitting the data have the necessary approvals in place,
    - verifying receipt of all tallies (log listings from handhelds) for the submission or package,
    - verifying receipt of all supporting documentation as specified in the approval to compile data,
    - verifying that documentation is complete, is in the correct format, signatures are in place, and there are no omissions,
    - rekeying of raw data to ensure key entry, calculations, and roll up of segregations are correct,
    - notifying parties submitting data of unacceptable submissions or errors, and
    - follow-up checking to ensure deficiencies have been remedied.

7.5 Correction of Errors

All scale returns submitted to the ministry may be subject to scrutiny for completeness and accuracy prior to further processing. Where errors or omissions are detected, they must be corrected.

The following conventions apply to all errors:

- to facilitate timely processing, obvious errors will be corrected by the ministry, and
- a copy of the corrected return will be returned to the originator.

7.5.1 Key Punch/coding Errors

The following conventions apply:

- to enable timely processing, obvious errors will be corrected by the ministry, and
- a copy of corrected returns will be returned to the originator.

7.5.2 Measurement/Grade Errors and Missing Dimensions

The scaler should be contacted directly if feasible. If in agreement, the scaler should consent to changes by initialing all changes.

If the scaler is not in agreement with the changes, changes will not be made unless the return cannot be processed in which case ministry staff will use their best judgement. A copy of the corrected returns will be returned to the originator.

Where the scaler cannot be contacted, either verbally or in writing, and no response is received in seven (7) days, the return will be processed by ministry staff using their best judgement.

In the case of weight scale samples, missing dimensions will result in cancellation of the sample unless the missing dimension can be completed and there is little doubt about its accuracy.

1. FS 244 Tally Sheet Scale Return - Small

Tally Sheet Scale Return - Small - FS 244

For a more detailed description of each field see page 7A-13.

A Page. Enter the page number of the return. Maximum number of pages is 10, using numbers 0 - 9.

B Scaler's licence number. Enter the four character licence number.

C Scaler's return number. Enter the three digit return or tally number.

D Scaled for. Enter the name of the person or company the timber is being scaled for.

E Camp boom number. Enter the load number, boom number, or other identification assigned to the parcel.

F Date. Enter the date the scaling is completed.

G Payable by. Enter the five digit name and address code for the party to receive the invoice. If unknown leave blank.

H FRS. Enter the number corresponding to the region of scale. See the detailed instructions for a list of the region code numbers.

I FRI. Forest region of invoice. Enter the number of the region to be invoiced.

J Scaler's log count. Enter the total number of logs in the return.

K Scaling station number. Enter the three character site code number.

L Place of scaling. Enter the name of the place where the scale is performed.

M Card Type 2. Enter the mark, species, grade, and up to five sets of log measurements. Once the scaling is complete, the total piece count for the segregation must be entered on this line ending in column 26.

N Card Type 3. This line is used only in conjunction with a card type 2. It is used to add additional log dimensions to the segregation.

Tally Sheet Scale Return - Large - FS 36

For a more detailed description of each field see page 7A-13.

A The tally sheet must be signed by the scaler upon completion.

B Scaled for. Enter the name of the person or company the timber is being scaled for.

C Page. Enter the page number of the return. Maximum number of pages is 10, using numbers 0 - 9.

D Scaler's licence number. Enter the four character licence number.

E Scaler's return number. Enter the three digit return or tally number.

F Camp boom number. Enter the load number, boom number, or other identification assigned to the parcel.

G Date. Enter the date the scaling is completed.

H Payable by. Enter the five digit name and address code for the party to receive the invoice. If unknown leave blank.

I FRS. Enter the number corresponding to the forest region of scale. See the detailed instructions for a list of the region code numbers.

J Scaler's log count. Enter the total number of logs in the return.

K Scaling station number. Enter the three character site code number.

L Place of scaling. Enter the name of the place where the scale is performed.

M Card type 2. Enter the mark, species, grade, and up to five sets of log measurements. Once the scaling is complete, the total piece count for the segregation must be entered on this line ending in column 26.

N Card type 3. This line is used only in conjunction with a card type 2. It is used to add additional log dimensions to the segregation.

O Remarks. Enter any pertinent information that pertains to the scale in this field.

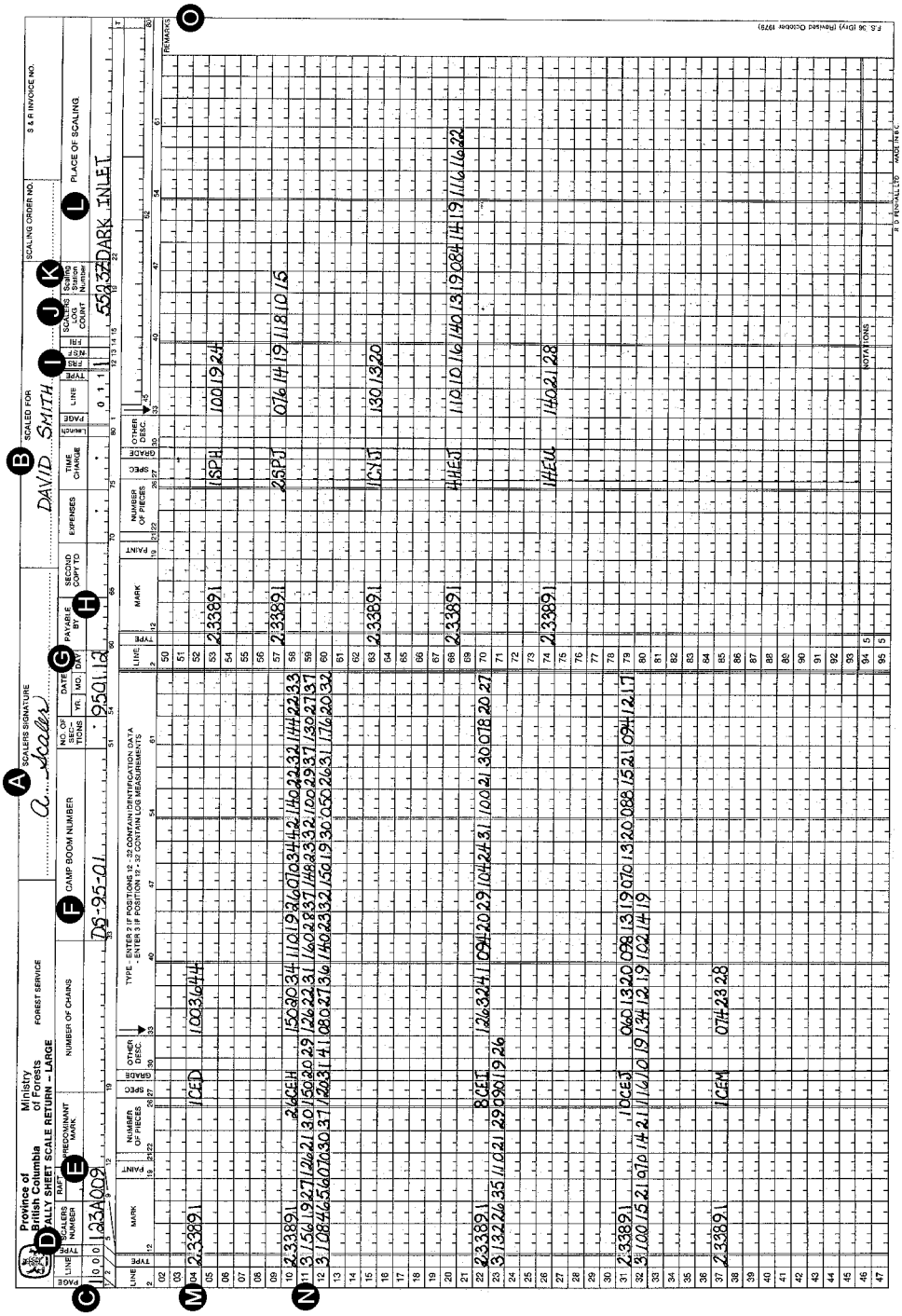


Figure 7A.2 FS 36 - Tally sheet scale return - large.

Record Type 2 (Segregation detail)

This record type is used to identify the segregation and to record the first five sets of log dimensions. Additional lines each containing eight sets of log dimensions can be added to the segregation, as required, using a record type 3.

Position	Field Name	Description
1	Page	Automatically duplicated from the header record.
2	Sequence or Line	This number is precoded on the line for all tally sheets.
4	Type	This field identifies the record type. The record type identifies the type of data that will be displayed on the remaining 76 positions of the line. Record type 2 identifies the segregation.
5-11	Scaler's number/raft	These fields are not displayed on the form as they are repeated from the header for all lines of the tally.
12	Mark	The timber mark that is stamped on the logs. This mark must be a valid timber mark in the HDBS mark file, NMV (no mark visible) or SB4 (scaled before) or else the tally will be rejected by the HDBS.
19	Paint	This field is not in use and should be left blank.
21	-	One position field, used to identify NMV or SB4 in conjunction with a valid timber mark in position 12. An N in this field indicates the logs are unmarked but would be rated and the volume attributed to the mark indicated in position 12 to 18 (e.g., a truck load that was not 100 percent marked but all logs originate from the same setting). An S in this column would indicate the logs were previously scaled as the mark indicated in columns 12-18. If SB4 is entered in this field no charges are applied and no volumes are added to the harvest history.

22	Number of Pieces	Once the scaling is completed the number of pieces for the mark/species/grade segregation should be added up and entered in this field. The piece count should be right oriented and the last digit should be entered in position 26.
27	Species	The species of the timber in the segregation.
29	Grade	The grade of the timber in the segregation.
30	Other Description	Left blank or if applicable to the logs in the segregation it must be a valid code from the following list: **B/S** Boomsticks **SLA** Slabs **CHU** Chunks **SLI** Slivers **DEA** Deadheads **SUB** Submerged **S/W** Swifters **SUN** Sunken **CA** Cants
33	Length	The length of the log expressed in decimetres. There are three positions allocated for each length measurement, and they are displayed on the form with a white background to provide a visual distinction dimension of each log's measurements (e.g., the length of each new log will begin in a white 'em' dash field, the next dimension for a log length would be recorded in 40-42). The field must be pre-filled with zeros if the length dimension does not require the entire field. See *Recording log dimensions,* below.
34	Top	The radius of the top of the log, measured in centimetres. The top measurement is always recorded in the first two positions shaded in green following the white length measurement field. Therefore the next log's top measurement would be recorded in positions 43-44. See *Recording log dimensions,* below.
38	Butt	The radius of the butt of the log measured in centimetres. The butt measurement is always recorded in the two positions directly following the top measurement, shaded in green. Therefore the next log's butt measurement would be recorded in positions 45-46. See *Recording log dimensions,* below.

3. FS 457 Interior Piece Scale Return

Recording the Interior Piece Scale Return - FS 457

For more detailed instructions on each data field refer to page 7A.24.

A Enter the number of pages making up the total return.

B Enter the Scaler's four character licence number.

C Enter the three-digit return number.

D Enter the three-character site code assigned to the scale site by the ministry.

E Enter the date the scaling was completed in the format YY/MM/DD.

F Enter the number of pages that make up the return.

G Enter the total volume for all pages of the return.

H Enter the code for the forest region to be invoiced.

I Enter the name and address code for the party responsible for payment of the invoice.

J Enter 0 (zero), unless otherwise specified.

K Enter the timber mark displayed on the logs.

L Enter the name of the party responsible for paying the invoice.

M Enter the name of the location where the timber is being scaled.

N Ensure the tally sheet scale return is signed upon completion.

O Enter the species code for the log.

P Enter the net length recorded to the nearest 0.2 m.

Q Enter the inside bark diameter to the nearest radius class.

R Enter the inside bark diameter to the nearest radius class.

S Enter the grade for the log.

T Enter the volume of the log in cubic decimetres (dm^3).

U Enter the total volume (dm^3) for the column.

V Enter the total volume for the page in cubic metres (m^3).

Unsegregated Timber - FS 416

The following is a list of the fields that must be completed on the return by the scaler. For a more detailed explanation of each field, turn to page 7A.33.

A Scaler licence number.

B Scaler return or raft number.

C Scale site number.

D Date of the scale.

E Number of pages for the return.

F Log count. This is the total log count from columns 16-17 of the upper and lower portions of the scale return. If more than one page is required for the parcel, their totals should be added to this figure.

G Forest region to be invoiced.

H Camp boom number. Load number, or other parcel identification.

I Scaled for. The company or person requesting the scale.

J Scaler signature. All scale returns must bear the scaler's signature once completed.

K The timber mark must be entered stating in column 6 of line 01.

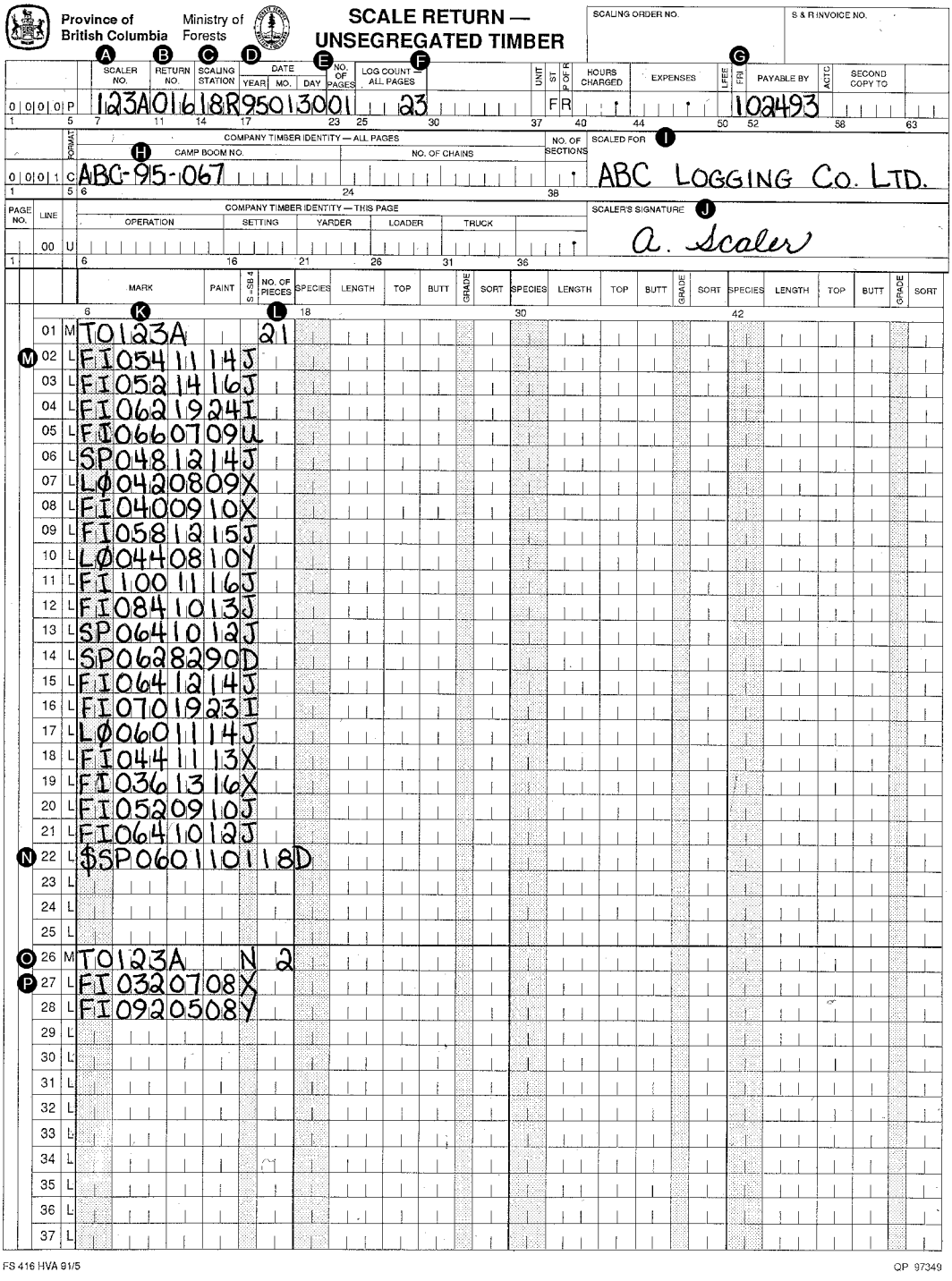
L The piece count for the logs recorded on the upper portion of the tally (lines 01 to 25) is entered ending in column 17 (maximum 99).

M The first log is recorded species, length, top, butt, and grade. The sort code is for company use only and is not mandatory for ministry purposes.

N This line shows the recording of an oversized log. The dollar sign in the first position indicates there will be three digits for each dimension (i.e., a fir D log with dimensions of 6.2 length, a 92 top, and a 102 butt measurement would be recorded $FI062092102D).

O The 2nd mark (M) line is used either for recording dimensions of additional logs, or to identify the logs within the load that did not have a visible timber mark. Unmarked logs are identified by entering the mark beginning in column 6, and an 'N' in column . The piece count for the lower section of the tally (rows 26-37) is entered ending in column 17.

P The species, length, top, and butt measurements and grade are entered for the lower section of the tally sheet.



Province of British Columbia — Ministry of Forests

SCALE RETURN — UNSEGREGATED TIMBER

SCALING ORDER NO. | S & R INVOICE NO.

A SCALER NO.	B RETURN NO.	C SCALING STATION	D DATE YEAR	MO.	DAY	E NO. OF PAGES	F LOG COUNT ALL PAGES	UNIT	ST	P OF R	HOURS CHARGED	EXPENSES	G LFEE	FR	PAYABLE BY	ACTC	SECOND COPY TO
0000P	123A	01618	R	95	01	30	01	23		FR					102493		

FORMAT	COMPANY TIMBER IDENTITY — ALL PAGES		NO. OF SECTIONS	SCALED FOR J
	H CAMP BOOM NO.	NO. OF CHAINS		
0001C	ABC-95-067			ABC LOGGING CO. LTD.

PAGE NO.	LINE	COMPANY TIMBER IDENTITY — THIS PAGE					SCALER'S SIGNATURE J
		OPERATION	SETTING	YARDER	LOADER	TRUCK	
	00 U						A. Scaler

		MARK K	PAINT	S-SB4	NO. OF PIECES L	SPECIES	LENGTH	TOP	BUTT	GRADE	SORT	SPECIES	LENGTH	TOP	BUTT	GRADE	SORT	SPECIES	LENGTH	TOP	BUTT	GRADE	SORT
01	M	T0123A			21																		
M 02	L	FI054 11 14			J																		
03	L	FI052 14 16			J																		
04	L	FI062 19 24			I																		
05	L	FI066 07 09			U																		
06	L	SP048 12 14			J																		
07	L	LØ042 08 09			X																		
08	L	FI040 09 10			X																		
09	L	FI058 12 15			J																		
10	L	LØ044 08 10			Y																		
11	L	FI100 11 16			J																		
12	L	FI084 10 13			J																		
13	L	SP064 10 12			J																		
14	L	SP062 82 90			D																		
15	L	FI064 12 14			J																		
16	L	FI070 19 23			I																		
17	L	LØ060 11 14			J																		
18	L	FI044 11 13			X																		
19	L	FI036 13 16			X																		
20	L	FI052 09 10			J																		
21	L	FI064 10 12			J																		
N 22	L	$SP060 11 01			18																		
23	L																						
24	L																						
25	L																						
O 26	M	T0123A		N	2																		
P 27	L	FI032 07 08			X																		
28	L	FI092 05 08			Y																		
29	L																						
30	L																						
31	L																						
32	L																						
33	L																						
34	L																						
35	L																						
36	L																						
37	L																						

FS 416 HVA 91/5 QP 97349

Figure 7A.5 FS 416 - Scale return unsegregated timber.

Record Type **P** (Header) continued.

52	Payable by	Enter the five digit HDBS name and address code of the party to be invoiced. If unknown, leave blank.
58	Second copy to	Enter the five digit HDBS name and address code if a second party is to receive a copy of the invoice. If unknown, leave blank.

Record Type **C** (Header)

Position	Field Name	Description
6	Camp boom number	Enter the boom, load, or parcel number.
24	Number of chains	Enter the number of boom chains, swifter wires, dog lines, etc., if applicable.
38	Number of sections	Enter the number of sections if applicable.
41	Scaled for	Enter the name of the party the timber is being scaled for.

Record Type **U** (Header)

Position	Field Name	Description
6	Operation	For industry use only. Any text entered in this field is not keyed by the ministry.
16	Setting	For industry use only. Any text entered in this field is not keyed by the ministry.
21	Yarder	For industry use only. Any text entered in this field is not keyed by the ministry.
26	Loader	For industry use only. Any text entered in this field is not keyed by the ministry.
31	Truck	For industry use only. Any text entered in this field is not keyed by the ministry.
36	Untitled	For industry use only. Any text entered in this field is not keyed by the ministry.
41	Scaler's signature	All scale returns must be signed by the scaler upon completion.

Record Type **M** (Detail)

Position	Field Name	Description
6	Mark	Enter the timber mark left oriented beginning in column 6. If the top portion of the tally sheet is completely filled with log records, the lower portion can be used to record additional log dimensions, starting in column 6 of line 26. The lower portion could also be used to identify any logs from the truck load that were not marked, by entering an N in column 15.
13	Paint	Leave blank.
15	S/SB4	An **S** entered in this field identifies the timber as scaled before. No volumes or charges will be generated for the mark. An **N** entered in this field identifies the timber as unmarked. The volumes and rates will be attributed to the mark entered in column 6.
16	Number of pieces	This is the total number of pieces contained on the upper portion of the tally, rows 01 to 25.

Record Type **L** (Log Detail)

Log details are recorded beginning in row 2 directly under the timber mark. The logs can be recorded on each consecutive row, row 3, row 4, etc. until row 25 has been completed. If there are more logs to be scaled, they can be recorded starting in column 18 of the first row, and then the second row etc. This can continue at lines 30, and 42, until the whole top portion of the return is completed (see example). The species and grade columns have been shaded in green to assist the scaler in identifying the correct starting point for recording the logs. The position numbers listed in bold print on the chart, do not have the field name printed on the tally sheet, as they are located in the same position as the mark line, but on the following row (see example).

Record Type **L** (Log Detail) continued.

Position	Field Name	Description
6, 18, 30, 42	Species	Enter the two character species code.
8, 20, 32, 44	Length	Enter the net length recorded to the nearest 0.2 m with exact odd 0.1 m being rounded to the nearest lower even number. Where a forest officer permits the timber to be cut into two or more pieces before scaling, the nearest 0.1 m is to be recorded.
11, 23, 35, 47	Top	Enter the inside bark diameter to the nearest radius class.
13, 25, 37, 49	Butt	Enter the inside bark diameter to the nearest radius class.
15, 27, 39, 51	Grade	Enter the grade code for the log.
16, 28, 40, 52	Sort	The sort code is not a mandatory field, and is for industry use only. As industry sort codes are not standardized, the ministry does not capture this information

The total number of pieces for the top portion of the tally (column 16-17 of record M on line 01) is added to the total number of pieces for the bottom portion of the tally (column 16-17 of Record M on line 26), and this is entered in the header of the tally in columns 25-29, right oriented*.

The maximum number of logs that can be recorded on the top portion of the tally sheet is 99. An additional 35 log measurements can be recorded on the lower portion of the tally. The timber mark is recorded in row 26, as identified in the chart above. The remainder of the logs can be recorded in rows 27 to 34 for the first column, then rows 26 to row 34 until the tally sheet is full. The FS 416 can accommodate up to a maximum of 134 logs per page.

* If additional pages are used for the return (i.e., there are more than 134 logs), the total piece count for all the pages that make up the return is entered in columns 25-29 of the header of the first page of the return.

Once the scale is complete, it should be batched with any other returns performed by the scaler, bearing the same scale site, payable by, and month and year of scale. These returns must be listed on an FS 416 Ledger sheet and summarized prior to submission to the ministry. An example of an unsegregated tally ledger batch sheet is shown in Figure 7A.7.

Province of British Columbia — Ministry of Forests

UNSEGREGATED TALLY LEDGER SHEET

Vancouver Forest Region

S & R Invoice #: _____

Record #: _____

Company/Payable By: ABC LOGGING CO. Second Copy To: _____

Scale Site Name: RIVER BANK MILL Scale Station #: 18R

Scaler License #: 123A Number of Tallies: 5

Last Tally/Rtn #: 018 Date of Scale: 95/01/30-95/01/31

	Tally/Rtn#	Camp Boom Number	Timber Mark	# of Pages	# of Pieces
1.	014	ABC-95-065	EACDX	1	54
2.	015	ABC-95-066	NDQRJ	2	143
3.	016	ABC-95-067	T0123A	1	23
4.	017	ABC-95-068	EACDX	1	65
5.	018	ABC-95-069	T0123A	1	21
6.					206
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
				Total	

Figure 7A.7 Summary ledger sheet to accompany non-computed FS 416 tally sheets.

6. FS 287 Monthly Scale Return

Monthly Scale Return - FS 287

A Scaler's licence number. Enter the four character licence number.

B Day of year. Enter the three digit tally number, using the Julian Calendar date. However, if the scaler performs more than one scale on the same day, the same number should not be used, as the return must maintain a unique identity (see also 'raft number' under recording a tally sheet scale return, page 7A.13).

C Position 33 - 50 untitled. This field can be used to record any identification such as the FS 222, or FS 200 number. The information entered in this field is displayed on the invoice.

D Date of return. Enter the date the scaling was completed.

E Payable by. Enter the five digit name and address code for the party to receive the invoice. If the name and address code is unknown, leave this field blank.

F FRS. Forest region scaled. Enter the number of the region in which the timber is scaled.

G Total pieces. Enter the total number of pieces included in the return. If there is no piece count enter 0 (zero), as this field must be populated.

H Scaling station number. Enter the three character scale site number issued by the ministry.

I Place of scaling. Enter the name of the location where the timber is scaled.

J Timber mark. Enter the timber mark left oriented.

K Number of pieces. Enter the number of pieces for the species/grade or product segregation. If there is no piece count, enter 0 (zero), as this field must be populated.

L Species. Enter the two character species code.

M Grade. Enter the grade (if any) that applies to the timber.

N Product code. Enter the special forest product code that applies to the timber. Leave blank for logs.

O Quantity. Enter the volume right oriented and to one decimal place. If there is no volume (e.g., Christmas trees), enter 0 (zero).

7A.2 Weight Scale Forms

For weight scaling, the forms required for submission are the Weight scale load slip (FS 488), Weight scale station daily load inventory (FS 482), the Weight scale sample tally (FS 239), the Weight scale monthly return (FS 493), and the Weight scale monthly return summary sheet (also reported on an FS 493). Most companies today are using hand held computers, random number generators, and systems that produce computer generated versions of these forms. All computer generated forms must be approved by the ministry, prior to their use.

A Weight scale load slip (see Figure 7A.14) is generated for every truck load of logs arriving at the scale site. It records the gross weight upon arrival, and the tare weight prior to departure. The net weight is then calculated, and the sum of the net weight of all the loads for the day is entered on the weight scale monthly return.

The weight scale station daily load inventory is a list of all loads arriving at the scale station on a daily basis. It lists the load arrival number, stratum, timber mark, weight slip number, truck number, in and out times, as well as the gross, tare and net weight (see Figure 7A.16).

The Weight Scale Sample Tally

When a truck load is identified as a sample, it must be 100 percent piece scaled on a weight scale sample tally, or its electronically produced equivalent. The sample tallies (see
Figure 7A.20) are submitted to the ministry and input into the Harvest Billing System (HBS), which establishes a volume to weight ratio for each species grade.

A weight scale monthly return (see Figure 7A.22) must be completed at the end of each month for each population, stratum, and timber mark. It displays the total loads and weight for each day, as well as the monthly totals. This is the input document used to generate a scale and royalty invoice.

A weight scale summary sheet monthly scale return summarizes all the monthly returns for a population and must be submitted with them.

1. FS 488 Weight Scale Load Slip

Weigh Scale Load Slip - FS 488

The following fields are mandatory and must be filled in by the scaler. To view a computer generated version of this form see Figure 7A.14.

A Place of scale.

B Scale station number.

C Enter the time the truck was weighed in at the station.

D Enter the time the truck was weighed out.

E Enter the date the truck was weighed.

F Enter the gross weight (the total weight of the load and the truck).

G Enter the tare weight (the weight of the unloaded truck).

H Enter the net weight of the load (subtract the tare weight from the gross weight).

I Enter the species in the load from the load description slip.

J Enter the load arrival number. This is a consecutive number assigned to each load as it arrives at the scale station.

K Enter the population, the stratum, and the year. The 'year' is the cyclic billing year end.

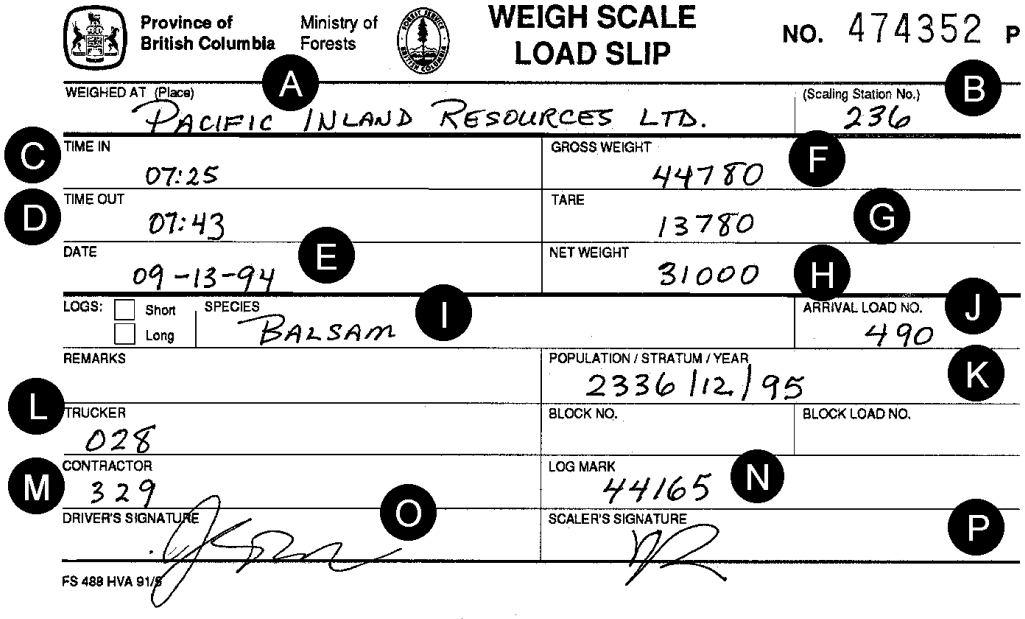
L Enter the truck number.

M Enter the contractor number.

N Enter the timber mark on the load. There can be only one timber mark per load.

O Ensure the truck driver has signed the load slip.

P The load slip must be signed by the scaler.



Province of British Columbia Ministry of Forests

WEIGH SCALE LOAD SLIP NO. 474352 P

A WEIGHED AT (Place): PACIFIC INLAND RESOURCES LTD.

B (Scaling Station No.): 236

C TIME IN: 07:25

D TIME OUT: 07:43

E DATE: 09-13-94

F GROSS WEIGHT: 44780

G TARE: 13780

H NET WEIGHT: 31000

I LOGS: ☐ Short ☐ Long SPECIES: BALSAM

J ARRIVAL LOAD NO.: 490

REMARKS

K POPULATION / STRATUM / YEAR: 2336 / 12 / 95

L TRUCKER: 028

BLOCK NO.

BLOCK LOAD NO.

M CONTRACTOR: 329

N LOG MARK: 44165

O DRIVER'S SIGNATURE

P SCALER'S SIGNATURE

FS 488 HVA 91/5

Figure 7A.13 FS 488 - Weight scale load slip.

Recording the Weight Scale Daily Load Inventory - FS 482

For an example of a computer-generated daily load inventory see Figure 7A.16.

A Enter the three digit site number assigned by the ministry.

B Enter the name of location of the scale station.

C Enter name of the company or operation.

D Enter the page sequence you are working on. If there is more than one page for the day, enter the total pages in second line upon completion.

E Enter the day the loads where weighed.

F Enter the name/licence number of the weight-scaler.

G Enter the monthly load arrival number, assigned sequentially throughout the month at the site.

H Enter the load slip number or ticket retrieval number from the load slip (also called a load description slip or bush slip).

I Enter the number of the stratum into which the load is designated.

J Enter the block and load number where applicable.

K Enter an S to indicate a sample load to be set aside for scaling.

L Enter the timber mark on the load.

M Enter the truck number.

N Enter the times the truck was weighed upon arrival to, and departure from, at the scale site.

O Enter the gross (truck and load), tare (truck only), and net (gross minus tare) weight in kilograms.

P Enter the total number of loads and weights at the bottom of the page.

Province of British Columbia — Ministry of Forests

Page 1 of 2 (D)

Weight Scale No. 236 (A)

Location SMITHERS (B)

Operation PACIFIC INLAND RESOURCES (C) **WEIGHT-SCALE STATION** DAILY LOAD INVENTORY

Date of weighing 09-13-94 (E)

Weight-scaler (F)

Monthly Load No.	Slip No.	Stratum	Block and Load No.	S	Mark	Truck	Time In	Time Out	O/H	Weight Gross	Weight Tare	Weight Net kg
484	671489	11			NAGPA	090	06:07	06:19		45540	18540	27000
485	671646	04			EM7626	018	06:26	06:42		59580	19240	40340
486	671803	08			WG8357	542	06:29	06:56		40520	13320	27200
487	671960	08			WG8357	168	06:38	07:03		45440	13660	31780
488	672117	04			EM7626	017	06:49	07:05		50880	17140	33740
489	672274	04			EM7602	108	07:20	07:36		41480	14620	26860
490	672431	12		S	44165	028	07:25	07:43		44780	13780	31000
491	672588	03			YR1142	050	07:38	08:03		42600	13420	29180
492	672745	03			L40205	004	07:45	08:05		51140	16380	34760
493	672902	03			L40205	800	07:46	08:08		49380	15940	33440
494	673059	04			EM7626	036	07:50	08:15		51320	16100	35220
495	673216	11			NAGPA	090	07:57	08:11		46560	18560	28000
496	673373	04			EM7626	021	08:13	08:26		51160	15760	35400
497	673530	04			EM7626	035	08:24	08:42		52100	15400	36700
498	673687	08			44165	038	08:30	08:47		45000	14260	30740
499	673844	06			EM7626	010	08:44	08:58		42620	14000	28620
500	674001	08			WG8357	542	08:48	09:09		44360	13280	31080
501	674158	07			WG8374	015	08:50	09:07		44100	14400	29700
502	674315	01			FD2600	972	09:02	09:21		49040	15900	33140
503	674472	08			WG8357	168	09:19	09:47		44020	13660	30360
504	674786	03			YR1142	050	09:27	09:45		42420	13420	29000
505	674943	11			NAGPA	090	09:41	09:53		44760	18720	26040
506	675257	07			WG8374	098	10:01	10:20		47400	16140	31260
507	675414	04			EM7602	053	10:07	10:27		44160	15900	28260
508	675571	01			FD2201	650	10:12	10:29		52720	15120	37600
509	675728	04			EM7602	014	10:31	10:51		42100	12300	29800
510	675885	08			WG8357	542	10:44	11:03		43680	13280	30400
511	676042	04			EM7602	335	10:58	11:13		41480	14220	27260
512	676199	12			44165	028	10:59	11:19		44800	13880	30920
513	676356	11			NAGPA	090	11:17	11:31		45260	18700	26560
514	676513	04			EM7602	023	11:43	12:00		42160	12300	29860
515	676670	03			L40205	004	11:45	12:04		50280	16520	33760
516	676827	03			L40205	800	11:48	12:09		50020	15980	34040
517	676984	11			NADHU	033	11:49	12:10		50840	15740	35100
518	677141	07			WG8357	168	12:01	12:18		43520	13660	29860
519	677298	07			WG8374	015	12:17	12:39		42540	14440	28100
520	677455	06			YR1142	050	12:35	12:52		38300	13420	24880
521	677612	04			EM7602	121	12:37	12:58		53820	16180	37640
522	677926	08			WG8357	542	13:06	13:22		44560	13240	31320
523	678083	11			NAGPA	090	13:11	13:24		46500	18660	27840
524	678240	08			WG8374	098	13:25	13:40		43900	16140	27800
525	678397	04			EM7527	185	13:27	13:48		42020	16500	25520
526	678554	02			36517S	042	13:36	13:56		56520	17500	39020
527	678711	04			EM7626	018	13:53	14:09		58380	19620	38760
528	678868	04			EM7626	017	14:04	14:29		51860	17120	34740
(G)	(H)	(I)	(J)	(K)	(L)	(M)		(N)			(O)	
45 LDS.										2105660	696060	1409600

(P)

FS 482 VAL 82/9 M28-2452

Figure 7A.15 FS 482 - Weight scale daily load inventory.

Weight Scale Sample Tally - FS 239

The computerized version of an FS 239 is called an FS 531. An example of an FS 531 can be viewed in Figure 7A.20.

A Enter the Scaler's four character licence number.

B Enter the scaler's tally number (for a more detailed explanation of this field see page 78).

C Enter the three digit site number assigned by the ministry.

D Enter the date the sample scale is performed.

E Enter the load arrival number, right oriented, zero filled.

F Enter the load description (bush) slip or ticket retrieval number, right oriented, zero filled.

G Enter the population/stratum/cyclic billing year (billing year end).

H Enter the block or sample number, right oriented (zero filled to the left).

I Enter the net weight (from the load slip), right oriented, zero filled.

J Enter the timber mark on the load.

K Enter an F if the load is an original scale. Enter a C if the load is a check scale.

L Enter the total number of logs in the load, right oriented.

M Enter M for metric if not hardwired (pre-printed) in system.

N Enter the name of the scale site.

O The scaler must sign the tally upon completion of the scale.

P Enter a 2, in card type 3 column, followed by the species and grade for the following segregation of logs.

Q Enter a 3, in card type 3 column to continue to add log dimensions to the segregation. Each card type 3 must be preceded by a card type 2 identifying the species and grade.

R Enter the total number of pieces for the segregation once the scale is completed. For a more detailed explanation of the card types, refer to page 7A-76.

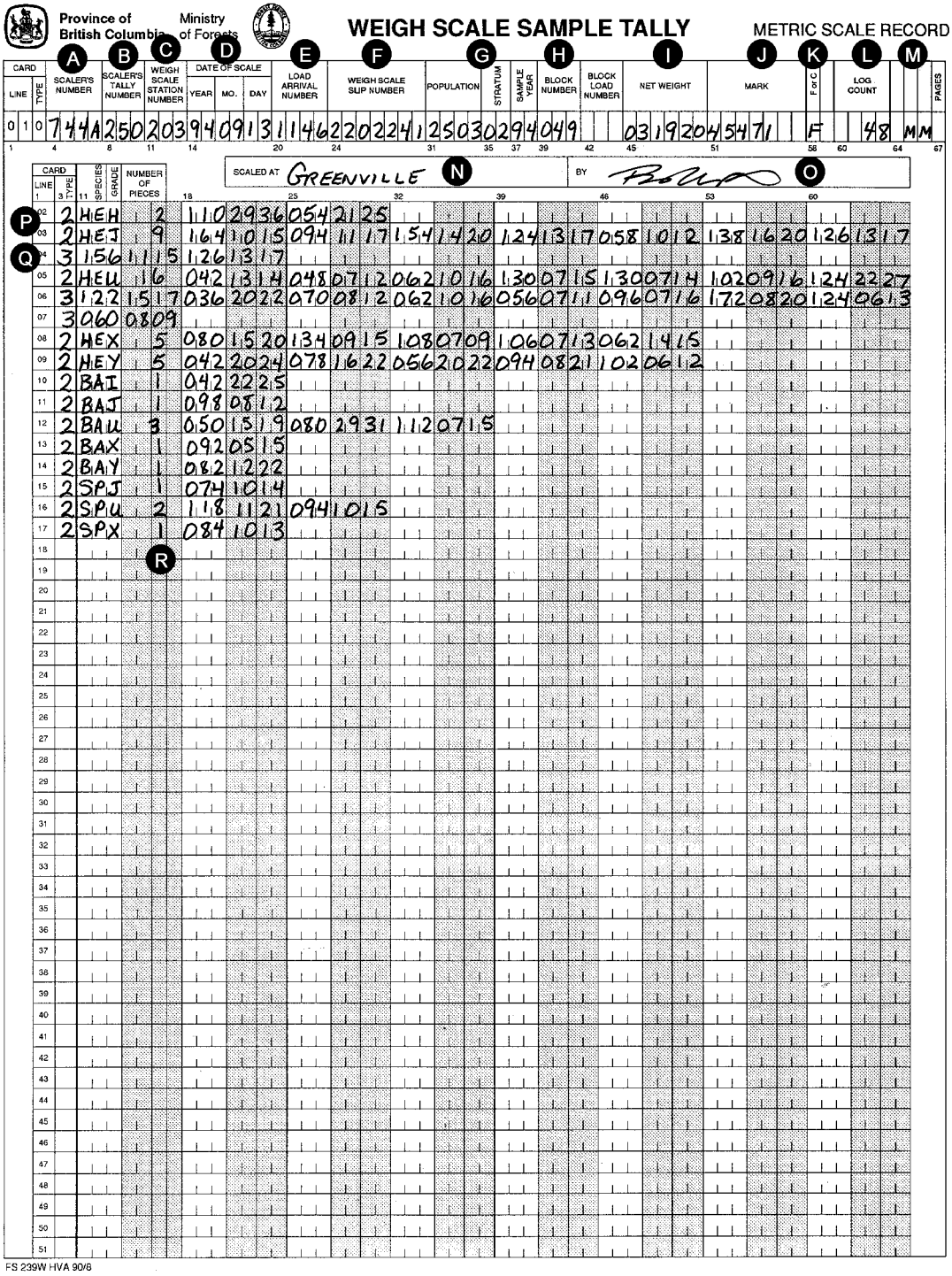


Figure 7A.19 FS 239 - Weight scale sample tally.

7. FS 493 Weight Scale Monthly Return

Recording the Weight Scale Monthly Return - FS 493

A Enter the name of the forest region of scale.

B Enter the name of the forest district of scale.

C Ensure the scaler's signature is recorded as verifying the document.

D Enter the scaler's licence number.

E Enter the number of loads for each day of the month.

F Enter the net weight for the total loads weighed each day.

G Enter the population/stratum/cyclic billing year (billing year end).

H Enter the timber mark on the loads (only one mark can be summarized per FS 493).

I Enter the last date of the month of scale in the format year/month/day.

J Enter the total number of loads weighed during the month.

K Enter the total net weight for all the loads weighed during the month.

L Enter the three digit scale site number.

Recording the Weight Scale Monthly Summary Sheet - FS 493

Although identical in format to the monthly return, the FS 493 Summary sheet is a summary of all the FS 493s (i.e., all the timber marks) for a population for each month.

The fields are filled out exactly the same as the monthly return with the following exceptions. An example of a computer generated weight scale monthly return is shown in Figure 7A.22.

E Enter the total number of loads for each day from all the FS 493s for the month.

F Enter the total net volume for those corresponding loads.

H Enter *summary* in the timber mark field.

J Enter the total number of loads for the month, for all timber marks.

K Enter the total net weight for the month, for all timber marks.

7A.3 Scale and Royalty Invoices

A scale return, for a truck load, a boom, a monthly production, or any other identifiable parcel of timber must be input into the ministry billing system to produce a scale and royalty invoice (S&R). The invoices are the means by which the ministry bills the clients for stumpage and or royalty charges due on the timber. In addition, the volumes from the invoices make up the harvest history, which is used for cut control purposes. For this reason all timber must be scaled and reported to the ministry regardless of whether there are any charges owing.

A scale and royalty invoice displays the calculated volume for each mark by species and grade. The volume is then multiplied by the applicable stumpage or royalty rate to determine the charges due the ministry. The invoices are payable upon receipt. In addition, each client will receive a statement of account at regular intervals identifying the invoices issued and any payments received. If unpaid by the due date, interest is applied at a prescribed rate.

The ministry issues two types of S&R invoices to provide for the different scaling methods used in the province. An example of a weight scale invoice (FS 433) is shown in
Figure 7A.23, and an example of a piece scale invoice (FS 37) is shown in Figure 7A.24.

Scale and royalty invoices are sometimes issued for alternate types of billing. For further information see the HBS Administration Manuals, piece scale billing: regions and districts and weight scale billing: regions and districts.

1. FS 433 Scale and Royalty Invoice - Weight

7A.4 Administrative Documents

Other documentation is required to ensure controlled timber transport and a complete and accurate scale. As scaling and timber transport occur under a diversity of operating conditions, documentation requirements may vary to reflect these varying conditions.

Load Description Slips

Load description slips are documents that accompany timber in transport from the cut block or initial load out area to the place of scale, and provides a description of timber being transported, its origin, and its destination. It can also be used for scaled timber in which case it must identify the place where the timber was scaled. A forest officer can use this to monitor the movement of timber while in transport. The ministry load slip is called an FS 649, and is illustrated in Figure 7A.25.

Load Destination Notice

Load destination notices (FS 1146s) are similar to the Load description slip, but are large pieces of sturdy paper that are physically attached to the load. They provide a forest officer with clearly visual description of the timber being transported and location where it is being transported. This may enable the forest officer to monitor timber movement without having to stop the vehicle in transport. It is often used for timber crossing district or regional boundaries. An example of the load destination notice is shown in Figure 7A.26.

> These documents are included in this manual to reflect the type of administrative documentation which may be required through the scaler and/or scale site authorization - or other directive. Please ensure you are familiar with the specific requirements as set by the ministry.

Water Transport Record

The water transport record is similar to the load description slip used when transporting by truck. The record identifies the place of loading, the destination, the estimated arrival and scale dates, the tug boat operator, and the barge name. It must be accompanied by a bundle addendum, and must be signed by a responsible company official. An example of a water transport record is provide in Figure 7A.27.

Bundle Addendum

Bundle addenda list each bundle included on a barge and provides details such as bundle numbers, piece counts, timber marks. An example of a bundle addendum is provided in Figure 7A.28.

Raft Tags

Raft tags are tags attached to the parcel by the scaler, to show the parcel has been scaled. The tag provides the parcel number, scaler number, timber mark, piece count, and scaler return number. The ministry form is called an FS 308 and is displayed in Figure 7A.29.

Scaler Diaries or Scaler Site Diaries

Scaler diaries are documents that list all the timber that a scaler has scaled for a specified time period. It includes details such as timber marks, piece counts, load numbers, and is signed by the scaler upon completion. The diaries are used to ensure the ministry receives all the scale returns completed by the scaler. An example of a scaler diary is shown in Figure 7A.30.

Incoming Site Ledgers and Outgoing Site Ledgers

Site ledgers are documents that record every parcel or load of timber that is received at, or transported from a scale site. It can also be used as a 'nil' report. It lists the load number, the timber mark, the number of pieces, and must be signed by the scale site operator. An example of a incoming scale site ledger is provided in Figure 7A.31, and an example of an outgoing scale site ledger is provided in Figure 7A.32.

Site Activity Report

Site activity reports list all the scaler's working at a specific scale site for a specified time period, which assists the ministry in determining which scaler's should be submitting scale returns. This is especially important in areas where scaler's work at various scale sites. It is also submitted when no scaling activity is occurring, therefore, the ministry would not anticipate the receipt of any scale returns from the site for that time period. It must be signed by a responsible company representative. An example of a site activity report is shown in Figure 7A.33.

Load Listing

The load listing is a computer generated list of all loads that make up an FS 72, Summary of scale. It is supplied by the computing service and will assist the ministry in identifying any missing documentation. An example of a load listing is shown in Figure 7A.34.

Load Summary Report

A load summary report is a summary of each individual load within a summary package (i.e., all the loads that make up the summary). It is supplied by the computing service and enables the ministry to audit individual loads for accuracy and completeness. An example of a load summary is shown in Figure 7A.35.

1. FS 649 Load Description Slip

Load Description Slips - FS 649

The ministry may require the use of load description slips, to accompany timber in transport, as part of the scale site authorization. The FS 649 is the ministry form used for this purpose, and may be used for both scaled and non-scaled timber. Alternate industry load slips may be approved by the ministry providing they meet ministry requirements. As the FS 649 is designed for truck transportation, an alternate form may be required when transporting timber by water. An example of a suitable description slip for water transportation is provided under Figure 7A.27.

A Date. Enter the date the timber is being transported from the cutblock.

B Timber mark. Enter the timber mark that is applied to the timber.

C Destination. Enter the scale site where the timber is being transported for scaling.

D Contractor. Enter the contractor's name.

E Name of carrier. Enter the truck driver's name.

F Landing supervisor's signature must be obtained prior to departure.

G Driver's signature must be obtained before delivery of the timber.

H Receiver's signature must be obtained at the time of delivery to the scale site or mill.

I Geographic location of timber's origin. Enter the location name.

J Tenure number or legal description. Enter where applicable.

K Cutting permit number. Enter where applicable.

L Cut block/landing/setting number. Enter where applicable.

M Description of timber and load. Check the appropriate species box, and special forest products if applicable. If the special forest products box is marked, enter the product code(s) on the 'type' lines listed below the box.

N Certification of previously scaled timber. Check this box if the timber has been scaled. Proof of scale may be required by a forest officer.

O Signature of scaler.

P Licence number.

Appendix 7C Scale Data Controls and Processing Conventions

1. Introduction.
2. How to Use this Appendix.
3. General and User Control Requirements.
4. Weight scale Controls.
5. Piece scale Controls.
6. Audit and Self-assessment Procedures.
7. Standards.

7C.1 Introduction

All parties collecting, processing, or submitting scale data must ensure there is an adequate level of internal control in place to ensure all scale data are complete, accurate and secure. Internal control includes scale data controls, processing conventions and administrative processes. This appendix outlines the scale data control requirements and practises which should be in place whenever information is processed using a handheld computer, a personal computer, a mainframe or hand compilation.

All systems used to process scale data are subject to periodic audit by the ministry. Licensees and other parties processing scale data may be required to assess and report their own compliance with control requirements. Section 6 of this appendix outlines self assessment procedures. Where the ministry considers internal controls to be deficient, it may disallow parties from processing scale data.

7C.2 How to Use this Appendix

This appendix identifies control requirements and their intent in meeting the overall objective of complete, accurate, and secure scale data. Control practices are described as essential or desirable.

> Control practices which are described as essential are viewed as fundamental to maintaining a complete and accurate reporting of revenue. These or alternative processes which meet the same objectives are mandatory.

Desirable practices are viewed as less fundamental, however, they constitute sound business practice and contribute to improved data control. These or similar approaches should be included in any mix of data controls and processing conventions to satisfy internal control needs.

Section 6 of this appendix outlines procedures for any party to assess their compliance with those guidelines.

This appendix is technical in content and is directed at persons who develop data processing systems and conduct system audits.

For clarification on any aspect of this appendix, please contact Revenue Branch.

7C.3 General and User Control Requirements

Control Requirements	Control Practices	Rating
1. Audit Trail *Objective:* *Required to provide data continuity from source documents to final summary and ability to verify the completeness and accuracy of transactions.*	i. The unique scale site number assigned by the ministry must be captured and appear on all reports and data submissions generated from that site.	E
	ii. All changes made to scaling information after a scale return has been prepared and signed must be logged. This Audit Change File must be maintained and available for review by the ministry.	E
	iii. Where initial data has been changed by a manual entry, the system must capture the userid of the person performing the change in the Audit Change File.	E
	iv. Users will have the capability to view and print the audit change file, but will be prevented from changing or deleting any data.	E
	v. Instances of data input being overridden by a manual entry must be clearly indicated on all the data output forms.	E
2. Logical Security *Objective:* *Access to confidential files restricted to authorized persons.*	i. Access to the following files must be restricted through user identification and password to Ministry of Forests personnel: ☐ Sampling Plans, ☐ List Data File, ☐ Purge Data File, and ☐ Ministry Passwords.	E

E = Essential

D = Desirable

Control Requirements	Control Practices	Rating
	ii. After software installation, master passwords must be removed and functional passwords enabled.	E
	iii. Master files and data critical to scale data compilation must be protected through a checksum authentication method. The checksum detects files that have been altered by any means.	E
	iv. Installed program code must be limited to object code only. Source and object code must be version controlled and placed in trust for safekeeping by the software vendor and not accessible to users.	E

3. Data Transmission *Objective:* *Controls to ensure transmissions are complete.*	i. Data transmission must be completed through standard software protocols which support cyclical redundancy checking and other forms of data integrity control.	E
	ii. The application system must provide control total verification on the number of records sent and received.	E
	iii. During or after transmission of scale data the number of pieces and total volume must be confirmed by the sending and receiving software system.	E

Control Requirements	Control Practices	Rating
	iv. As part of the transmission process for scale data, the following information must be retained in a data transmission audit file: ☐ original data source, ☐ scaler number, ☐ scale site number, ☐ date(s) of scale, ☐ number of returns, ☐ timber mark(s), ☐ first return number, and ☐ last return number.	E

4. Backup and Recovery *Objective:* *Routine procedures designed to accurately and quickly recover lost or destroyed data.*	i. Backup procedures must be documented and then tested every six (6) months to ensure they provide the intended recovery. Evidence of testing must be retained. ii. Where data are known to be lost, the procedures outlined in Section 7.6.2 of the *Scaling Manual* must be followed.	E E

5. User Training and Documentation *Objective:* *Skilled and well trained operators supported with user and system documentation to reduce risk of operator error and ensure data accuracy.*	i. Staff must be adequately trained and must be conversant with procedures to follow in the event of software or hardware failure included in Chapter 7 and 10A of this manual. ii. Each software application must be supported by a user manual. iii. Application programs should make provision for help facilities.	E E D

Control Requirements	Control Practices	Rating
	iv. Documentation must highlight user security procedures, such as: ☐ Equipping their PC with virus scanning systems, and ☐ Scanning diskettes prior to use.	E

6. Support Facilities *Objective:* *Timely technical support to users for problem resolution.*	i. Users must be able to contact a named resource during normal business hours to obtain support for both hardware and software.	E
	ii. Suitable user and system documentation must be retained and be available to Ministry of Forests.	E

7. Data Integrity *Objective:* *Ensure the data is complete, safe and secure during data entry and processing.*	i. A user must be prevented from exiting the program in a manner which leads to incomplete information being recorded to files which create scale returns.	E
	ii. Users are responsible to ensure that proper procedures are in place for the timely and secure submission of source documents to the ministry.	E
	iii. Safe and secure storage procedures must be in place.	E
	iv. The program should perform an internal data integrity review to ensure that the databases are complete and accurate. The data integrity review includes re-programming edits, checking control totals against detail values and reviewing data indices.	D

Control Requirements	Control Practices	Rating
	v. After a scaler has completed a scale return the electronic version of the scale return must be marked to indicate the return is final. Any changes to the return after this point must be recorded into the Audit Change File.	E

8. Physical security over computer assets *Objective:* *To protect hardware and software against theft, tampering and physical destruction.*	i. All non-portable computing devices must be configured in a manner that will provide protection in the event of a loss of power. For portable computing devices, redundancy in the form of stand-by battery packs and internal "dual" power strategies must be in place.	E
	ii. Security procedures should be designed to limit the probability of theft. These may include limited access to non-portable equipment, locking cabinets or similar safeguards for unattended portable equipment.	D
	iii. Computing devices must be designed to operate in the conditions they will be subjected to. Provisions must be made for: ☐ operation in ambient temperatures between -40c and 35c, ☐ dust and other contaminants, ☐ rain and snow, ☐ the risk of being dropped, ☐ vibration, static electricity, shock or other adverse operating condition, and ☐ floating or retrieval if used on a water sort.	E

7C.4 Weight Scale

Control Requirements	Control Practices	Rating
1. Audit Trail *Objective:* *Required to provide data continuity from source documents to final summary and ability to verify completeness and accuracy of transactions.*	i. The load arrival number must be in sequence and cannot be changed or modified by the user. ii. Instances of the weight scale input being overridden by a manual entry must be recorded in the Audit Change File. The weight scale load slip must indicate that the input has been manually entered. iii. The weight scale load slip must include the identity of the scale site generating the information.	E E E
2. Data Retention *Objective:* *Ability to recreate previous data in the event of loss and for audit confirmation.*	i. The current and previous twenty four (24) months of weight scale load slips and any changes must be accessible in computer readable magnetic form. ii. Backup and recovery procedures must be in place to secure data and minimize downtime. Procedures must be documented and available for review by the ministry.	E E
3. Stratum Control *Objective:* *Requirement to maintain the unique identity of all weight scale data and ensure the integrity of sampling plans.*	i. All data collected under weight scaling must carry the unique eight (8) digit identity assigned by the ministry (i.e., population/ stratum/year). ii. Changes to the strata file must be recorded in an Audit Change File. This file must identify: ☐ the user making the change, ☐ date and time, and ☐ a record of the data before and after the change.	E E

Control Requirements	Control Practices	Rating
4. Weigh-in/Weigh-out *Objective:* *To enable a complete and accurate record of all weighings.*	i. All weighings (gross, net and tare weights) must be recorded. Weighings not contributing to the weight scale population are to be noted. "For record purposes only."	E
	ii. If a weight scale load slip must be edited, voided or changed, the original must contain an explanation and the initials of the scaler/weigh master making the change. This must be attached to the reprinted load slip.	E
	iii. The accuracy and completeness of the FS 493 is the exclusive responsibility of scaling personnel and must be clearly indicated by either a manual or electronic signature.	E
	iv. Manual entry or override of the weight must be recorded to an audit change file. This file must contain the before and after weight and user identification.	E

5. Data Input *Objective:* *To ensure the completeness of data.*	i. Where "batches" of information are processed, the following batch controls are in place: ☐ The total volume, number of loads and number of documents in the batch are matched to totals processed, and ☐ An audit trail links the source data or the batch to the processed result.	E

7C.5 Piece Scale

Control Requirements	Control Practices	Rating
1. Data Retention *Objective:* *Ability to recreate previous data in the event of loss and for audit confirmation.*	i. The scaler must obtain a printout and perform a backup of all scale returns after each load has been scaled and before it has been moved.	E

2. Data Editing *Objective:* *Designed to confirm data validity at various processing stages.*	i. Piece scale details are to be edited against valid species and grade combinations.	E
	ii. Error messages are displayed at the time of entry and cannot be by-passed without correction. If editing can be disabled to streamline the data entry function, the editing process must be completed before any reporting or transmission takes place.	E
	iii. Any changes made to scaling information after a scale return has been prepared and signed must be logged by the software. This Audit Change file is to contain the following: ☐ User making the change, ☐ Date and time, and ☐ Before and after image of the modified data.	E
	iv. The Audit Change file must be maintained and available for review by the ministry.	E
	v. Species and grades should be edited against valid dimensions for each species and grade combination.	D

Control Requirements	Control Practices	Rating
	vi. The computing program should provide a facility for data elements to be displayed and reviewed. Data elements include: ☐ log dimensions, ☐ log species and grade, ☐ number of pieces, ☐ total volume, ☐ date of scale, ☐ scale site, ☐ timber mark, and ☐ weight, if applicable.	D

7C.6 Audit and Self Assessment Procedures

All parties processing scale data are subject to periodic audits by the ministry. Licensees and other parties developing software or processing scale data may also be required to assess and report their own compliance with this appendix.

Periodic audit and self assessment fulfil several objectives:

- to provide a standard means to assess the risk that scale data may not be accurate, complete or secure,
- to help isolate any internal control deficiencies which should receive attention, and
- to help satisfy all users that the data is reliable.

Figure 7C.1 shows the self assessment questionnaire/report format. This document is available in both hard copy and disk. This questionnaire is to be completed:

- at the request of the ministry, and
- upon the introduction of a new version of scaling software and/or hardware.

Where either ministry audits or the self assessment procedures identify internal control deficiencies, it is the responsibility of the licensee and the person processing or submitting scale data to ensure they are remedied. In all instances, the ministry must be advised in writing of the changes made to remedy the deficiencies.

If ministry audits or self assessment reveal major deficiencies which may impact the integrity of scale data, the ministry may:

- rescind or suspend its approval to process scale data, and/or
- cancel the scale site authorization.

7C.7 Standards

Ministry of Forests standards are in place for:

1. Data Input:

    - species codes (see Table 7C.1),
    - valid species and grade combinations (see Table 7C.2),
    - edit conventions to assess gross top diameter against each species/grade combination (see Table 7C.3), and
    - mandatory data formats (see Appendices 7A and 7B).

2. Data Processing:

    - computation of Scaling Volumes inclusive of rounding conventions. (see Appendix 7B Sections 7B.1 and 7B.2).

3. Reporting

    - deadlines - as specified in the scale site authorization, and
    - format (see Appendix 7B Section 7B.3).

4. Emergency Procedures

    - emergency procedures in the event of a weight scale breakdown (see Appendix 10A), and
    - procedures to reconstruct scale data which is lost (see Section 7.6.2).

Table 7C.1 Species Codes

Alder	AL
Arbutus	AR
Aspen	AS
Balsam fir	BA
Birch	BI
Cedar	CE
Cypress	CY
Cottonwood	CO
Douglas-fir	FI
Hemlock	HE
Larch	LA
Lodgepole Pine	LO
Maple	MA
Spruce	SP
White Pine	WH
Whitebark Pine	WB
Willow	WI
Yellow Pine	YE
Yew	UU

Table 7C.2 Valid Species/Grade Combinations

Coast	
Species	**Valid Grades**
All	Z (species code R for Weight Scale data)
BA and HE	D, F, H, I, J, U, X, Y, Z
CE	D, F, H, I, J, K, L, M, U, X, Y, Z
CY	D, F, H, I, J, U, X, Y, Z
FI	B, C, D, F, H, I, J, U, X, Y, Z
LO, WH, YE, WB	D, F, H, I, J, U, X, Y, Z
SP	D, E, F, G, H, I, J, U, X, Y, Z
Broadleaf and UU	(Blank), Y, Z

Interior	
All Species	**Valid Grades**
	(Blank)
	3
	4
	5
	6
	Z (species code R for Weight Scale data)

Table 7C.3 Species/Grade Edit by Minimum Gross Top Radii

Validation checks:

- check that numeric data fields only contain digits, and
- check that the top radius for the species and grade combination is not less than the minimum value specified in parentheses.

Species	Grade and Minimum Top Radius
CY	D(30), F(25), H(19), I(19), J(8), U(5), X(5), Y(5), Z(0)
BA	D(33), F(25), H(19), I(19), J (8), U(5), X(5), Y(5), Z(0)
CE	D(25), F(25), H(19), I(19), J(8), K(25), L(19), M(13), U(5), X(5), Y(5), Z(0)
SP	D(50), E(38), F(38), G(30), H(19), I(19), J(8), U(5), X(5), Y(5), Z(0)
WH, LO, YE, WB	D(38), F(30), H(19), I(19), J(8), U(5), X(5), Y(5), Z(0)
FI	B(30), C(19), D(38), F(30), H(19), I(19), J(8), U(5), X(5), Y(5), Z(0)
HE	D(33), F(25), H(19), I(19), J(8), U(5), X(5), Y(5), Z(0)
AL, UU, AS, BI, CO, MA, OT	Blank(5), Y(5), Z(0)

Questionnaire for Scale Data Controls and Processing Conventions

Instructions:

1. This questionnaire is to be completed at the request of the Ministry of Forests or upon the introduction of new versions of scaling hardware and/or software.
2. In completing this questionnaire, please ensure:
   - you identify the specific hardware/software application you are describing in the questionnaire,
   - you respond to all sections applicable to your hardware/software application,
   - you provide complete answers and use extra pages if required,
   - you complete the declaration on the final page, and
   - return the completed document to the ministry.

Background Information:

For the hardware/software application(s) described by this questionnaire, please provide the following:

1. Application description **Attach Description** (include name and version number if applicable)
2. Company name of user _____.
3. Used at locations (i.e., scale site number) _____.
4. Name of software/developer _____.
5. Name and telephone number of contact for clarification of responses if required:

   _____.

Figure 7C.1 Self Assessment Questionnaire/Report (cover sheet).

General and User Control Requirements

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
1. Audit Trail	i. The unique scale site number assigned by the ministry must be captured and appear on all reports and data submissions generated from that site.		
	ii. All changes made to scaling information after a scale return has been prepared and signed must be logged. This Audit Change File must be maintained and available for review by the ministry.		
	iii. Where initial data has been changed by a manual entry.		
	iv. Users will have the capability to view and print the audit change file, but will be prevented from changing or deleting any data.		
	v. Instances of data input being overridden by a manual entry must be clearly indicated on all the data output forms.		

Page 1

Figure 7C.1 Self Assessment Questionnaire/Report (page 1).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
2. Logical Security	i. Access to the following files must be restricted through user identification and password to Ministry of Forests personnel: ☐ Sampling Plans, ☐ List Data File, ☐ Purge Data File, and ☐ Ministry Passwords.		
	ii. After software installation, master passwords must be removed and functional passwords enabled.		
	iii. Master files and data critical to scale data compilation must be protected through a checksum authentication method. The checksum detects files that have been altered by any means.		
	iv. Installed program code must be limited to object code only. Source and object code must be version controlled and placed in trust for safekeeping by the software vendor and not accessible to users.		

Page 2

Figure 7C.1 Self Assessment Questionnaire/Report (page 2).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
3. Data Trans-mission	i. Data transmission must be completed through standard software protocols which support cyclical redundancy checking and other forms of data integrity control.		
	ii. The application system must provide control total verification on the number of records sent and received.		
	iii. During or after transmission of scale data the number of pieces and total volume must be confirmed by the sending and receiving software system.		
	iv. As part of the transmission process for scale data, the following information must be retained in a data transmission audit file: ☐ original data source, ☐ scaler number, ☐ scale site number, ☐ date(s) of scale, ☐ number of returns, ☐ timber mark(s), ☐ first return number, and ☐ last return number.		

Page 3

Figure 7C.1 Self Assessment Questionnaire/Report (page 3).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
4. Backup and Recovery	i. Backup procedures must be documented and then tested every six (6) months to ensure they provide the intended recovery every six months. Evidence of testing must be retained.		
	ii. Where data are known to be lost, the procedures outlined in Section 7.6.2 of the *Scaling Manual* must be followed.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 4).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
5. User Training and Documentation	i. Staff must be adequately trained and must be conversant with procedures to follow in the event of software or hardware failure included in Chapter 7 and 10A of this manual.		
	ii. Each software application must be supported by a user manual.		
	iii. Application programs should make provision for help facilities.		
	iv. Documentation must highlight user security procedures, such as: ☐ Equipping their PC with virus scanning systems, and ☐ Scanning diskettes prior to use.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 5).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
6. Support Facilities	i. Users must be able to contact a named resource during normal business hours to obtain support for both hardware and software.		
	ii. Suitable user and system documentation must be retained and be available to Ministry of Forests.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 6).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
7. Data Integrity	i. A user must be prevented from exiting the program in a manner which leads to incomplete information being recorded to files which create scale returns.		
	ii. Users are responsible to ensure that proper procedures are in place for the timely and secure submission of source documents to the ministry.		
	iii. Safe and secure storage procedures must be in place.		
	iv. The program should perform an internal data integrity review to ensure that the databases are complete and accurate. The data integrity review includes re-programming edits, checking control totals against detail values and reviewing data indices.		
	v. After a scaler has completed a scale return the electronic version of the scale return must be marked to indicate the return is final. Any changes to the return after this point must be entered into the Audit Change File.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 7).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
8. Physical security over computer assets	i. All non-portable computing devices must be configured in a manner that will provide protection in the event of a loss of power. For portable computing devices, redundancy in the form of stand-by battery packs and internal "dual" power strategies must be in place.		
	ii. Security procedures should be designed to limit the probability of theft. These may include limited access to non-portable equipment, locking cabinets or similar safeguards for unattended portable equipment.		
	iii. Computing devices must be designed to operate in the conditions they will be subjected to. Provisions must be made for: ☐ operation in ambient temperatures between -40c and 35c, ☐ dust and other contaminants, ☐ rain and snow, ☐ the risk of being dropped, ☐ vibration, static electricity, shock or other adverse operating condition, and ☐ floating or retrieval if used on a water sort.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 8).

Weight Scale

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
1. Audit Trail	i. The load arrival number must be in sequence and cannot be changed or modified by the user.		
	ii. Instances of the weight scale input being overridden by a manual entry must be recorded in the Audit Change File. The weight scale load slip must indicate that the input has been manually entered.		
	iii. The weight scale load slip must include the identity of the scale site generating the information.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 9).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
2. Data Retention	i. The current and previous twenty four (24) months of weight scale load slips and any changes must be accessible in computer readable magnetic form.		
	ii. Backup and recovery procedures must be in place to secure data and minimize downtime. Procedures must be documented and available for review by the ministry.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 10).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
3. Stratum Control	i. All data collected under weight scaling must carry the unique eight (8) digit identity assigned by the ministry (i.e., population/ stratum/year).		
	ii. Changes to the strata file must be recorded in an Audit Change File. This file must identify: ☐ the user making the change, ☐ date and time, and ☐ a record of the data before and after the change.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 11).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
4. Weigh-in/Weigh-out	i. All weighings (gross, net and tare weights) must be recorded. Weighings not contributing to the weight scale population are to be noted. "For record purposes only."		
	ii. If a weight scale load slip must be edited, voided or changed, the original must contain an explanation and the initials of the scaler/weigh master making the change. This must be attached to the reprinted load slip.		
	iii. The accuracy and completeness of the FS 493 is the exclusive responsibility of scaling personnel and must be clearly indicated by either a manual or electronic signature.		
	iv. Manual entry or override of the weight must be recorded to an audit change file. This file must contain the before and after weight and user identification.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 12).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
5. Data Input	i. Where "batches" of information are processed, the following batch controls are in place: ☐ The total volume, number of loads and number of documents in the batch are matched to totals processed, and ☐ An audit trail links the source data or the batch to the processed result.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 13).

Piece Scale

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
1. Data Retention	i. The scaler must obtain a printout and perform a backup of all scale returns after each load has been scaled and before it has been moved.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 14).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
2. Data Editing	i. Piece scale details are to be edited against valid species and grade combinations.		
	ii. Error messages are displayed at the time of entry and cannot be by-passed without correction. If editing can be disabled to streamline the data entry function, the editing process must be completed before any reporting or transmission takes place.		
	iii. Any changes made to scaling information after a scale return has been prepared and signed must be logged by the software. This Audit Change file is to contain the following: ☐ User making the change, ☐ Date and time, and ☐ Before and after image of the modified data.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 15).

Control Requirements	Control Practices	Compliance Y/N	Describe Practices in Place to Meet Control Requirement
	iv. The Audit Change file must be maintained and available for review by the ministry.		
	v. Species and grades should be edited against valid dimensions for each species and grade combination		
	vi. The computing program should provide a facility for data elements to be displayed and reviewed. Data elements include: ☐ log dimensions, ☐ log species and grade, ☐ number of pieces, ☐ total volume, ☐ date of scale, ☐ scale site, ☐ timber mark, and ☐ weight, if applicable.		

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Figure 7C.1 Self Assessment Questionnaire/Report (page 16).

Declaration:

This questionnaire is a true and complete statement of the practices in place.

Signature _____ Date _____

Print Name _____

Title _____ Telephone _____ Fax _____

Company _____

Address _____

_____

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Figure 7C.1 Self Assessment Questionnaire/Report (page 17).

Glossary of Terms

The following definitions apply in this manual:

Accuracy	how close measurements or estimates are to their actual value or quantity.
Advanced decay	the late stage of decay in which the decomposition is readily recognized as the wood becomes punky, soft, stringy, pitted, or crumbly.
Adventitious	used to describe a plant part, means that it develops outside the usual order of time or position, or both (e.g., adventitious branching on trees).
Airdry	the condition at which the moisture content of wood is closely in equilibrium with conditions outdoors, but undercover (usually at about 12% moisture content).
Annual ring	the annual increment of wood (including early-wood and late-wood) which appears on a transverse section (or cross section) of a piece of wood and denoting one year's growth.
Bark	the tissues of a tree outside cambium and is composed of inner living bark and outer dead bark.
Bark Seams	seams of bark extending into or embedded in the log.
Bias	a consistent or systematic distortion of sampling results or measurements arising from an incorrect method of sampling or measurement.
Bird holes	holes and damage caused by woodpeckers and other species of birds.
Bole	the trunk of a tree (seeding and saplings have stems, not boles).

Bolt	any short log specially cut to length, usually for the manufacture of a specific product (e.g., shake bolt).
Borer holes	voids made by wood-boring insects or worms.
Branch whorl	a more or less circular arrangement of branches around a point on the stem of a tree.
Burl	a hard woody bump on a tree, more or less rounded in form, usually resulting from the entwined growth of a cluster of adventitious buds.
Butt end	the fat end of a log.
Butt log	a log which was originally connected to the stump.
Butt rot	any decay or rot developing in, and sometimes characteristically confined to, the butt log.
Butt swell	that part of a log outside its normal taper and extending from where the normal taper ends and the flare begins to the large end of the log. It is usually manifest only in butt logs due to the self buttressing growth of the tree near its base.
By the piece	by a count or tally of pieces.
Calipering	to take a diameter measurement at a point on a log other than at an end.
Catface	a defect on the surface of a tree or log resulting from a wound where healing has not re-established the normal cross section.
Check	wood separation starting on a log's outer surface and travelling inward toward the pith; caused by differential shrinkage from drying. Also see "Sun Check", "Spiral Check", "End Check", and "Weather Check".
Chipper	a machine for cutting wood into wood chips, and includes chipper canters, chipper edgers, chipping headrigs, and portable debarker chippers.
Church door fire scar	a defect on the surface of a butt log caused by a ground fire, resulting in a tapered piece of sound wood missing from the butt end of the log.

Coast	for the purpose of scaling, coast is defined as that area of the province where a log based stumpage appraisal is used (generally west of the Cascades).
Coefficient of variation	a measure of variability among units expressed as the ratio of the standard deviation (s) to the mean (x) and is usually expressed by the formula CV = s/x.
Collars	the portion of the log between the inside of the bark and a hole or rot in the heart of the log (the same as shells).
Confidence interval	the interval within which the true value of an estimate is said to be with a given probability of the statement being correct (e.g., at 2 confidence intervals there is a 95% [or 19 lines out of 20] probability the estimate will be within $\pm$ 2 sampling errors of the true value).
Continuous variable	a variable that is characterized by being related to some numerical scale of measurement, any interval of which may, if desired, be subdivided into an infinite number of values, such as length, height, volume, and mass.
Contraindicators	log characteristics where presence deem the log to be cut from a living tree.
Crook	an abrupt bend or curvature in the length of a log.
Dead side	a misshapen side of a log caused by the lack of growth of wood because of the death or removal of the inner bark, or phloem, along the side of the living tree.
Decay	the decomposition of wood substance cause by the action of wood-destroying fungi, resulting in softening, loss of strength and mass, and often change of texture and colour.
Defect	any abnormality or irregularity which lowers the commercial value of wood. Typically defects may reduce a logs firmwood volume and/or log grade.
Diameter, small end	the average diameter, inside bark, at the upper end of the log.

Diameter breast height (DBH)	the stem diameter of a tree measured outside bark at breast height (1.30 m above ground level). DBH is used for standing trees, usually in the context of cruise data. The minimum butt diameter is usually used in the context of utilization standards.
Diameter deduction	a method of compensating for through-running firmwood defects by reducing the recorded radius or radii of a log or slab.
Diameter tape	a tape measure specially graduated so that the diameter may be read directly when the tape is placed round a tree stem, bole, or piece of roundwood.
Discrete variable	a qualitative variable represented by an integral value or ratio of integral values, such as number of logs in a stacked cubic metre, that cannot be expressed as a proportion. By increasing the number of values that a discrete variable can assume, it is often possible to handle such data by continuous variable methods.
Dryland sorts	flat areas, usually paved where loads of logs are lifted out of the water or off loaded from logging trucks and spread onto the ground for scaling, grading and subsequent sorting.
Earlywood	that part of the growth ring which is produced at the beginning of the growing season (usually it is less dense and lighter in colour than late wood). It is also called springwood.
End Check	a type of weather check caused by rapid drying at the cut faces of a green cut log. They are usually multiple and normally penetrate only a short distance into a log.
Estimate (of a sample)	a value for a characteristic or parameter derived through using a sampling method.
Face (of a pile)	one of the surfaces of a pile of logs showing only the cut ends of the logs.
Figure	any design or distinctive markings on the long surfaces of wood.

Fire scar	a healing or healed-over injury, caused or aggravated by fire, on a woody plant.
Firm redheart	a form of incipient decay characterized by a reddish colour produced in the heartwood that does not render the wood unfit for the majority of uses. Firm redheart contains none of the white pockets that characterize the more advanced stage of decay (not to be confused with natural red heartwood).
Firmwood deductions	deductions made from the gross volume of a log to account for rot, hole, char and missing wood.
Flare	a rapid increase in the taper of a log at the butt end of the log due to swell.
Foreign material	any material extraneous to roundwood such as earth, ice, snow, and branches, any of which add mass to the load.
Forest	a plant community consisting predominantly of trees and other wood vegetation, growing together.
Fork	a division of a log or a stem of a tree into two or more branches.
Fuelwood	roundwood, whole or split, produced for burning.
Grade deduction	in log grading, the process of determining the portion of the log not suitable for the manufacture of various products.
Grain	the general direction of the longitudinal wood elements in the tree.
Grain density	used in some log grading, refers to the spacing between the annual rings and measured as a ring count over a set distance.
Gross oven dry weight	the gross weight (or mass) of wood, bark, and defect less their moisture content.
Gross volume	total inside bark volume and includes any defects.
Gross weight	the weight of a load before any deduction for moisture content and, when present, bark, defect, and foreign material.

Hardwoods	trees of the botanical group Angiospermae that generally have broad leaves in contrast to the conifers. The term has no reference to the actual hardness of the wood.
Heart	see Heartwood.
Heart rot	any rot characteristically confined to the heartwood. It generally originates in the living tree.
Heart shake	a shake that originates at the pith of a log and extends across the annual rings (also called heart check and reft crack).
Heartwood	the inner core of a woody stem wholly composed of non-living cells and usually differentiated from the outer enveloping layer (sapwood) by its darker colour. It is usually more decay resistant than sapwood.
Hole	any opening in a log, other than check, shake, or split. It may extend partially or entirely through a log and be from any cause.
Honeycomb decay	see Pocket rot.
Incipient decay	the early stage of decay in which the decomposition has not proceeded far enough to soften or otherwise change the hardness of the wood noticeably. It is usually accompanied by a slight discolouration of the wood (see also Firm redheart).
Insect holes	voids made by insects or insect larvae.
Interior	for the purpose of scaling, interior is defined as the area where a lumber based stumpage appraisal is used (generally east of the Cascades).
Intermediate decay	a more advanced stage of decay than incipient decay characterized by a change in the colour of the wood and some slight decomposition and loss of strength that do not, however, render the wood unfit for general purposes (see also White specks).
Knot	a branch base that is embedded in the wood of a log.
Latewood	the denser, smaller-celled, usually darker, later formed part of an annual ring, also called summerwood.

Length deduction	a method of compensation for firmwood defects by reducing the recorded length of a log or slab.
Linear measure	a measure of length.
Local volume table	a table showing, for one or more species, the average cubic contents for tree lengths by diameter classes, within a smaller geographic region.
Log	any section of the bole, or of the thicker branches, of a felled tree, after trimming and cross cutting.
Log rule	a table showing the estimated or calculated volume of wood that is contained in logs of given length, form, and end diameter inside bark.
Mass	the same as the weight.
Mean	the average of a set of measurements derived by summing all values and dividing by the total number of measurements.
Minimum butt diameter	the smallest diameter, inside bark, that can be measured through the geometric centre of the large end of a log with visible butt swell.
Minimum collar thickness	same as minimum shell thickness. The collar of firmwood surrounding heart defects considered in grading to be the minimum thickness for the manufacture of lumber.
Missing wood	wood that is absent from a log or part of a log that otherwise would usually be regarded as naturally complete. It may be caused by advanced decay, fire, or the operation of a machine to tool.
Moisture content	the mass of water in wood expressed as a percentage of its total weight.
Mould or mildew	a superficial fungal growth usually appearing in the form of a woolly or furry coating of varying colour.
Net firmwood volume	the volume remaining after all allowable firmwood deductions for defects from gross volume have been made; in stacked measure, deductions include voids.

Normal taper	the regular decrease in diameter of a log from its large to small end, exclusive of butt swell.
Out of round	used to describe a shape and means that it departs from what is usually regarded as approximately circular.
Outside checks	checks or fractures on the outside part of the log which extend through the bark into the adjacent sapwood. Severe checking will extend into the heartwood.
Oven dry weight	the weight of wood obtained by drying it in an oven at 105° C until there is no further weight loss.
Parameters	certain constants, characterizing a population or a whole, to be studied in a survey.
Parcel	any quantity of grouped logs.
Peeled	all or most of the bark has been removed.
Piece	a part of a whole (as of a tree); it also means an object regarded as a unit of a kind (as one of a number of products of the group).
Piece product	a product scaled by the number of separate pieces of one kind.
Piece scale	the scaling method whereby each piece is scale by recording the timber mark, species and by taking its length, top and butt diameter, deducting for firmwood defects, and assigning a grade.
Pile	for scaling purposes, an orderly arrangement of logs that are longer than the 2.6 m class.
Pile divider	in tree-length scaling, the surface formed by butt ends that have been piled with the butts all aligned in a nearly vertical plane.
Pipe	a hole, the product of decay, running through the centre of a log.
Pistol grip	a pronounced bend at the butt end of a log and resembling the handle of a pistol.
Pith	the small cylinder of primary tissue of a tree stem around which the annual rings form.

Pocket rot	in wood, any rot localized in small areas, generally forming rounded or lens shaped cavities.
Pocket rot	see Decay.
Population	the aggregate of all units from which samples are selected to make estimates about the aggregate.
Precision	the closeness, to each other of repeated measures of the same quantity. When precision is achieved, values will be clustered around their mean.
Probability statement	a statement that gives a range of a characteristic within which the true value lies, with a stated probability that the statement is correct (e.g., there is a 95% probability that value X will be within 2 sampling errors of the actual value).
Pulpwood	wood cut and prepared primarily for manufacture into wood pulp.
Punky	a soft, weak, often spongy wood condition caused by decay.
Punky	see Decay.
Quality considerations	in log grading, the factors which reduce the log's quality in terms of its potential product recovery and is usually confined to the size and placement of knots and the degree of any twist observed on the log.
Ring rot	any rot localized mainly in the earlywood of the annual rings, giving a concentric pattern of decayed wood in cross section.
Ring shake	a shake that separates along the growth rings and partially or completely encircles a pith.
Rot	see Decay.
Round (adjective)	approximately correct; of an approximate circular cross section.
Round (transitive verb)	to express as a round number.

Rounding	the process of approximating to a number by omitting certain of the end digits, replacing by zeros if necessary, and adjusting the last digit retained so that the resulting approximation is as near as possible to the original number. It the last digit is increased by unity, the number is said to be rounded up; if decreased by unity, it is rounded down. When both are under consideration, the process is said to be one of rounding off.
Roundwood	any section of the stem, or of the thicker branches, of a tree of commercial value that has been felled or cut but has not been processed beyond removing the limbs or bark, or both, or splitting the section (for fuelwood).
Sample	a unit or part selected from a population that is representative of that population.
Sample scaling	the method of scaling where only a portion of the total production is piece scaled. Weight scaling is the most prominent example of sample scaling. Sample scaling is also used to scale some special forest products.
Sample size	the number of samples to be taken to sample the population to meet the sampling objectives.
Sampling error	a statistic which defines how reliable (or precise) sampling results are (the same as the standard error of the estimate, or the standard error of the mean and the standard error).
Sap rot	any rot characteristically confined to the sapwood.
Sapwood	the living wood of pale colour near the outside of the log. Under most condition the sapwood is more susceptible to decay than heartwood.
Scale (noun)	the measured or estimated quantity, expressed as the volume, or area, or length, or mass, or number of products obtained from trees and measured or estimated after they are felled.
Scale (verb)	to measure or estimate the quantity, expressed as the volume, or area, or length, or mass, or number of products obtained from trees after they are felled.

Scale stick	a graduated stick for measuring the end diameters of logs or felled trees inside bark. Of many types, it usually has a shaped handle on one of its ends, a tine at the other, and a log rule reproduced on its length; it also means a graduated stick for measuring the external dimensions of stacked wood.
Scaler	a person who is licenced or appointed to scale timber under the *Forest Act*.
Scales	an instrument or machine for determining weight.
Schedule of Coast Timber Grades	the set of coast grade rules appended to the *Scaling Regulation*.
Schedule of Interior Timber Grades	the set of interior grade rules appended to the *Scaling Regulation*.
Segregated tally	a tally sheet that is segregated into sections for timber with the same species and grade. It can be used as an input document into the Harvest Data Base system (HDBS) to generate an invoice.
Shake	one or more separations along the grain of a log or tree, normally radiating outward from the pith (i.e., heart shake, [also called heart check]); caused by stresses during growth. Where several such separations radiate outward, they are referred to as "star shake" (see "Ring Shake").
Shells	see Collars.
SI units	only the base, supplementary, and derived units of measure included within the International System of Units (SI) (see CSA Standard CAN3-Z234.2).
Significant digit	any digit that is necessary to define the specific quantity or value.
Slab	a piece of timber that has fractured along a plane roughly parallel to the longitudinal axis of the original log.
Softwood	generally, one of the botanical groups of trees that in most cases have needle- or scale-like leaves; the conifers; also the wood produced by such trees. The term has no reference to the actual hardness of the wood.

Solidwood Equivalent	the firmwood volume of logs required to produce a given quantity of a specified product.
Sound wood	wood free from defect.
Special Forest Products and Special Forest Products Regulation	as defined under the Forest Act to include: poles, post, pilings, shakes, shingle, bolts, Christmas trees, building logs, mining timbers, props and caps, cribbing, firewood and fuel logs, hop poles, orchard props, car stakes, round stakes, sticks and pickets, split stakes, pickets, palings and logging, shake bolts, blocks, and blanks and shingle blocks.
Spiral check	wood separations starting on a log's surface and travelling toward the pith. If the natural grain of the log twists, the checks will follow and spiral around the log's axis.
Spiral grain	see Twist.
Split	cleft completely and lengthwise along the grain of a log; usually results from falling, bucking or handling damage.
Springwood	see Earlywood.
Stack	for scaling purposes, an orderly arrangement of bolts less than or equal to the 2.6 m class in length.
Stacked cubic metre (symbol m^3 [stacked])	the total amount of wood, bark, and airspace contained in a stack of roundwood, as determined by its external dimensions, equal to 1 m^3.
Stacked cubic metre peeled (symbol m^3 [stacked] peeled)	the total amount of wood and airspace contained in a stack of peeled roundwood, as determined by its external dimensions, equal to 1 m^3.
Stacked scaling	the act or process of measuring or estimating the total amount of wood, bark, and airspace contained in a stack of roundwood, where the bolt length is less than or equal to the 2.6 m class as determined by its external dimensions.
Standard deviation	the square root of the variance. It is symbolized by *s*.
Stem	the principle axis of a plant, from which buds and shoots develop.

Stratum	a subdivision of the entire population.
Sun check	also referred to as weather check. Wood separations on the outer surface or on the cut face of a log, resulting from exposure to sun and drying. May follow and/or transect annual rings, but are normally minor and do not penetrate more than a few centimetres. Not to be confused with "shake".
Sweep	a gradual curve in the length of a log, as distinct from an abrupt bend or curvature.
Tally	a form completed by a scaler used to capture timber details such as timber marks, species, grade, volume, products, and dimensions. It also identifies the time and place of scale, as well as who the ownership timber is scaled for. It is used as a basis for stumpage collection.
Tally number	also called a raft or return number. It is a unique number (in conjunction with the scaler's licence number and date), and is assigned to a parcel of timber by a scaler. The scaler assigns #001 to the first parcel scaled each year and continues consecutively through to 999. If the scaler scales more than 999 parcels of timber in a year they then restart with 001. The dates will then determine the uniqueness of the number.
Taper	the progressive decrease or increase in the diameter of a log from one end or point on its length to another.
Tare	the weight of the unloaded vehicle or container.
Tier	one of a set of layers or rows arranged one above another.
Tolerance	the total range of variation permitted for a required size.
Tracheid	an imperforate wood cell with bordered pits to congeneric elements.
Tree	a woody perennial plant, typically large and with a single well-defined stem carrying a more or less definite crown.
Tree length	the trimmed bole of a tree that has been felled and had the top removed.

Trim allowance	the sound wood surrounding rot and other defects made in grade deductions to account for loss in lumber recovery because defects must be squared out by a sawyer.
Trunk	see Bole.
Twist	a quality consideration in log grading where the logs grain is aligned in a helical orientation around the axis of the log. It is the same as spiral grain and its measurement is often referred to as the slope of grain.
Unsegregated tally	a tally that is used to scale timber in the order it is spread out for scaling. There are no species and grade segregations, therefore, it cannot be used as an input document for the HBS. It must be summarized and segregated through a pre-processing system prior to input into the HBS to generate an invoice.
Variable	a characteristic of a population that may vary from one unit to another.
Variance (of a population)	a measure of the dispersion of individual unit values about their mean.
Vessel	an axial series of cells that have coalesced to form an articulated tube-like structure of indeterminate length; the pits of congeneric elements are bordered.
Void	an unnecessary airspace in a stack of roundwood, large enough to accommodate the average size of log or bolt in the stack.
Weather check	a type of check caused by rapid drying of the outer surface of a green cutlog. They are usually multiple where exposed to the drying effect of the wind and sun, and may eventually develop into one or more deep checks (see "End check").
Weigh	to measure the weight of an object.
Weighing machine	any device for measuring weight (or mass).
Weight	a measure of the force of gravity (or heaviness).

White specks	the intermediate stage of Fomes pini decay, characterized by small white pits or streaks in the wood.
Wood	the hard fibrous substance, basically xylem, that makes up the greater part of the stems and branches of trees or shrubs, beneath the bark.
Wood Chips	as a collective term, the total material that is produced from passing wood fibre through a chipper. Unless specified otherwise, the wood fibres being subjected to the chipping process must have passed through a debarking procedure.
Wood chip	a small, thin, flat piece of wood cut from a larger piece of wood by knife action, mechanically operated. A wood chip must show two knife cuts and its width must be greater than its thickness.
Wood fibres	any long, narrow cells of xylem, other than vessel elements or parenchyma; it also means (as a loose term) wood elements in general.
Wood pulp	wood fibres separated by mechanical means for use in manufacturing paper, textiles, and many other products derived from cellulose.
Worm holes	see Borer holes.
Worm holes	voids (or holes) made by insects or insect larvae.
Xylem	the woody part of the tree which functions chiefly in conduction but also in support and storage.

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