FIRMWOOD DEDUCTIONS 2

2.0 Firmwood Deductions

The following sections discuss the concepts of firmwood deduction and outline methods for determining the net firmwood content of logs containing defects. The methods described in this manual are field calculations only.

2.1 Deduction Methods

The firmwood volume of timber excludes all rot, holes, missing wood, and charred wood. 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 catface, deadside, lightning scars, and charred sapwood. 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.

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 calculations. Tools, such as computers or calculators, are 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.

2.1.1 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. To perform a length deduction, the scaler must:

- Determine the volume of rot,
- Average unit volume of the log, and
- Divide the rot volume by the average unit volume of the log to find the required length deduction.

2.1.2 Diameter Deduction Method

Diameter deduction 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 use the radius class unit that most closely matches the result.

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.

2.2 Average Unit Volumes

References to Unit Volumes (UV) and the 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 volume of each end of the log averaged**. The UV of each end of the log added together and divided by two.

There are two simple ways to derive an average unit volume from the scale stick. Both methods are used by scalers according to their 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.

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.

1. 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 AUV.

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

The 10m half volume of 20 rads	=	628 dm^3
Plus the 10m 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. 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).

2.3 Determining Net Volume

Three methods are available for determining the net volume of a log; the gross/net method, the net method using a length deduction where necessary and the net method using a diameter deduction where necessary.

2.3.1 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.

2.3.2 Net Volume Using 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.

2.3.3 Net Volume Using Diameter 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.
- The above steps are to be followed on both ends 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.

2.4 Deduction Methods 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, standard methods are employed. To provide consistent scaling practices and maintain sound scaling principles throughout the Yukon, basic standards 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 methods, which have been developed over many years of practical application. Other methods may be developed from time to time to suit changing conditions. Scalers working in a new area should discuss local conditions with an experienced Forest Management Branch representative.

Firmwood deductions can be made only for rot, hole, missing wood, and charred wood. 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 and 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.

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. Firmwood scaling is concerned with determining the volume of sound or firm wood fibre in a log.