BIOMETRIA

*Swedish Instructions for Timber Measurement*

# APPLICATION GUIDE

## Measurement of Roundwood Stacks

1 January 2019

# Contents

# 1 Introduction

## 1.1 VMK Application guides for timber measurement

Application guides for timber measurement serve as support for interpretation of the corresponding measurement instructions (*Instruction*) adopted by the SDC Board. The application guides are adopted by the Control Commission, with representatives from VMK (*Timber Measurement Control*), VMF Nord, VMF Qbera and VMF Syd. Current instructions and application guides are available on www.sdc.se under the tab 'Virkesmätning'.

## 1.2 Scope and application of this application guide

*Instruction: Stack measurement is used for roundwood, and gives a volume in cubic metres solid under bark ($m^3$sub). The measurement is of form-adjusted solid volume, i.e. deduction is made for any bulging. This volume should correspond to the volume obtained in top-butt measurement of logs (see Swedish instruction, 'Measurement of log volume under bark').*

*These instructions apply to measurement of roundwood as the basis of remuneration, regardless of species, assortment or intended use. The timber may be in fixed lengths or in varying lengths between 2.5 and 6.5 m. The instructions apply to measurement of timber loaded on vehicles and to measurement of stacks at a storage site. Quality provisions are described in assortment-specific instructions.*

## 1.3. Basic requirements for stack measurement

*Instruction: The timber must be measured carefully and according to the provisions applicable to the measurement. If local conditions do not allow the measurement to be carried out in this way, the timber must not be measured. The timber must be measured as seen.*

Before measurement, the consignment/stack is examined by the scaler (measurement official) to check that the timber properties, and conditions for measurement, e.g. confirmed identity, comply with applicable instructions and agreements. If this is not the case, measurement is refused.

*When the timber is to be measured on a vehicle, measurement may be refused on the grounds of work environment, such as the way the timber is loaded or the presence of contaminants, such as stones.*

*If measurement is refused, both seller and buyer of the timber concerned are to be informed immediately and notified of the reason for refusal.*

If the stack properties are such that the scaler assesses that the work cannot be performed accurately, measurement is refused.

A basic requirement when measuring stacks is that the distance between stacks or to the front wall of the vehicle must be at least 30 cm. If this is not possible, there must nevertheless be a clear gap. If individual logs must protrude, these should not be placed at the edges of the stack (i.e. against the stakes or in the top layer). If the stack cannot be measured with sufficient accuracy, the logs may have to be reloaded.

# 2 Stack dimensions and wood volume percentage

*Instruction: The wood volume of the stack under bark is calculated through its dimensions and wood volume percentage. The stack dimensions, i.e. stack length, log length and height, are measured as if the timber were placed in an imaginary tightly fitting rectangular box. On the log-end side of the stack, the imaginary box side is placed so that the volume of the cavity caused by the logs not reaching the end is compensated by protruding logs. The distance between opposite sides in the imaginary box is measured at right-angles to the sides. The dimensions are given in cm with rounding off according to Swedish Standard. The wood volume percentage is the proportion of wood in the volume of the imaginary box. The timber volume is the product of the stack dimensions and the wood volume percentage. The timber volume is given in cubic metres (m³sub) to at least two decimal places.*

The wood volume percentage is the wood volume expressed as a percentage of the stack volume. The wood volume of a timber batch is calculated as the product of its stack volume and the wood volume percentage divided by 100.

For training purposes and as an instrument in measurement, tables have been produced that use the relevant log and stack properties to enable calculation of the wood volume percentage.

The principle of the tables is that a base figure is adjusted with the value of individual assessment factors. The final figure is the wood volume percentage of the stack. As experience grows, in practical terms the wood volume percentage of a stack is assessed by the scaler who, based on an overall impression of timber density in a stack, directly estimates the wood volume percentage.

*Instruction: Height*: *The height of the stack is the distance between a horizontal bottom surface and an average of the highest points of the top layer of logs.*

The stack's top surface and bottom surface, also called the bottom line, should be 'levelled' in the same way as other sides so that the imaginary box is well-filled. The distance between the top surface and the bottom line is the stack height.

The top surface of the stack is to be 'levelled' while retaining the density in the stack or the section as a whole. The top surface is to be fixed at a level that makes the logs in the levelled sections neither denser nor less dense than the logs in the rest of the stack.

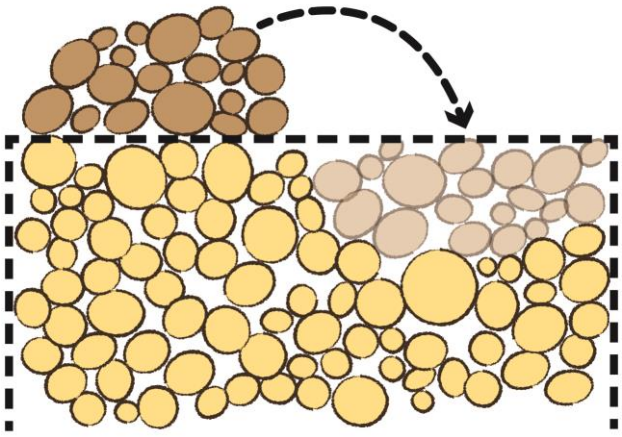

*Figure 1. Levelling the top surface of the stack.*

When measuring a high stack, for example on a landing or on a roadside, if the observer is standing close to the stack, it may be difficult to see the extent of the top surface of the stack or the section. In such cases, the levelled top surface can be assessed at a distance from the stack, where the level of the top surface is fixed to a set point on a suitable log end. The height is then determined as the total of two measurements – the measurement from the fixed point on the top surface down to a mark at a suitable working height, and the other measurement from the bottom line up to the mark. The bottom line is generally determined by the underside of the logs if the stack is placed on a flat surface. If the bottom line of the stack is not straight, it must be levelled in the same way as for the top surface.

Pulpwood timber is included in the volume of the stack. The volume of the pulpwood may be estimated.

*Instruction: Log length (formerly stack width)**:** For timber in varying lengths, the log length of the stack is the basal area-weighted average length that would be obtained through log measurement. For timber of fixed lengths, the basic rule is that the agreed log length applies as the measurement. When necessary, this is checked by measuring the length of individual logs in accessible parts of the stack. If this measurement gives an average log length that deviates more than 3 cm from the agreed length, the measured length applies.*

The basal area-weighted average length is calculated by adding, for each log, the product of its length and area (basal area) in a plane through the centre of the stack. The product total obtained is then divided by the total basal areas of all the logs. The length of the log is thereby 'weighted', with the areas of the logs as weights. This means that thicker logs affect the calculated average length more than thinner logs.

# 3 Stack measurement on a vehicle

## 3.1 Measurement of stack dimensions

*Instruction: When measuring a stack on a vehicle, measurements are taken as shown in Figure 1. Stack height and timber length are usually measured from one of the sides of the stack, which is called one-side measurement. In cases where the stack is measured from ground level, measurements must be taken from both sides of the stack, called two-side measurement.*

The main rule is that the height is to be measured at each of the stakes round the stack, and then an average figure calculated. The top length dimension of the stack, the upper bank width measurement, should be determined as an average of the measurements between the stakes. The reason for this method are that the stakes can become deformed over time and with wear, and that the loading can cause the stakes to bulge out at varying amounts. Generally, it can be said that stakes bulge differently as a result of different manufacturers, the weight of the timber, and with different loading styles.

*Instruction: The lower bank width shown in Figure 1 is difficult to measure when the vehicle is loaded. This dimension must therefore be previously measured and displayed on the vehicle or must be made available in some other way to the measuring official. The measured/labelled lower bank width is adjusted on measurement/registration according to measured/estimated upper bank width, taking into account the bulging of the stakes.*

The lower bank width measurement is to be registered for each truck and trailer. This information is to facilitate measurement of the length of the stack and the bank width. The registered bank width is to be stored in the measurement site documentation. An upper bank width may also be registered when the upper and lower measurements are thought to differ. The system then automatically calculates an average of the two figures.

## 3.2 Measurement of bank width

After ordinary measurement, in cases where the truck and/or trailer are not registered in the bank width registry, the vehicle must return to the measurement platform after unloading for measurement and recording. Where a measurement site is unmanned, the vehicle must have a recorded lower bank width before any measurements can be performed. If the lower bank width is unknown, measurement must be performed by an official at a manned measurement site or the vehicle must be taken to the haulier for measurement and labelling.

When measuring bank width, a calibrated measuring instrument must be used, such as a measuring pole. The measurement point is the lowest point on the widest stake pair, and it is the internal distance between the stake pair that is to be measured. The measurement recorded is the average of the widths of all stakes on the truck and trailer (Figure 2).

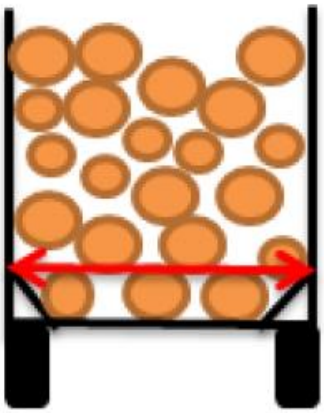

*Figure 2. Measurement point for measuring lower bank width.*

The recorded measurements of a vehicle's bank width must be checked by VMF officials at least every third year and must also be checked after new manufacture or repairs to the stakes. The three-year regulation will start to apply no later than the date when this is supported by the SDC measurement site system.

## 3.3 Labelling of vehicle

After measurement and recording in the measurement site documentation, the bank width of the truck and trailer must be marked on special adhesive labels that are to be kept available at every measurement site. (In the example below, Figure 3, 34 means that the bank width has been measured to be 234 cm. For space reasons, only the final two figures are shown). If there is not enough room for the figures to be displayed horizontally, they may be placed vertically, with the tens figure on top. The labels are to be placed visibly on the lower part of the stakes at the rear of the stack and behind the rear stack on the trailer (see Figure 3).

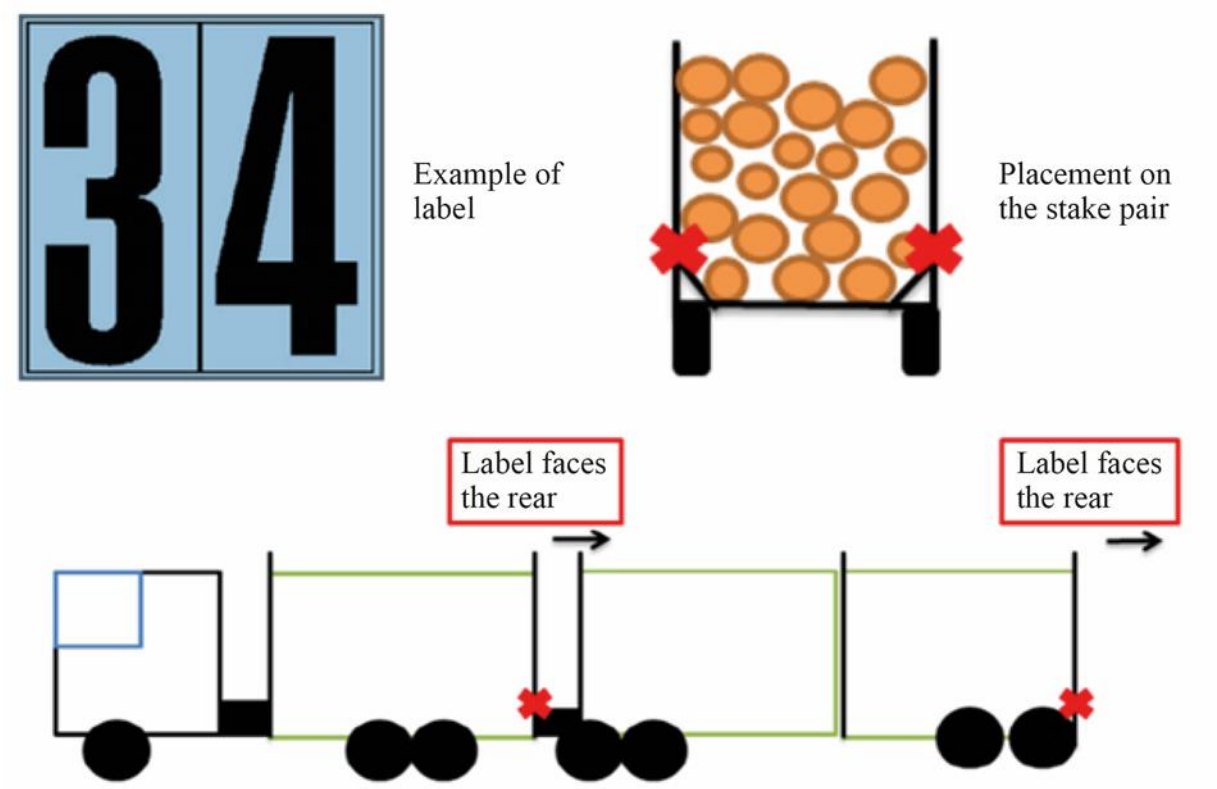


*Figure 3. Examples of labels showing lower bank width, and how they should be placed on the vehicle and trailer. Before the labels are applied, the surface should be cleaned thoroughly to ensure that that the labels adhere properly and remain in place.*

# 4 Stack measurement at a storage site

*Instruction: A storage site may be a road, harbour, terminal, etc.*

*Section measurement of stack. If the stack exceeds 3 m in length, section measurement must be used for log length and height. The stack is then divided into a number of equal-length sections of no longer than 3 m. When measuring log length, one measurement is taken for each section. When measuring stack height, one measurement is taken at each log-end side of each section, and the average is given as the height of the stack.*

The length of a crooked stack is measured with the instrument close to the stack. The length of the stack comprises the average length of each side.

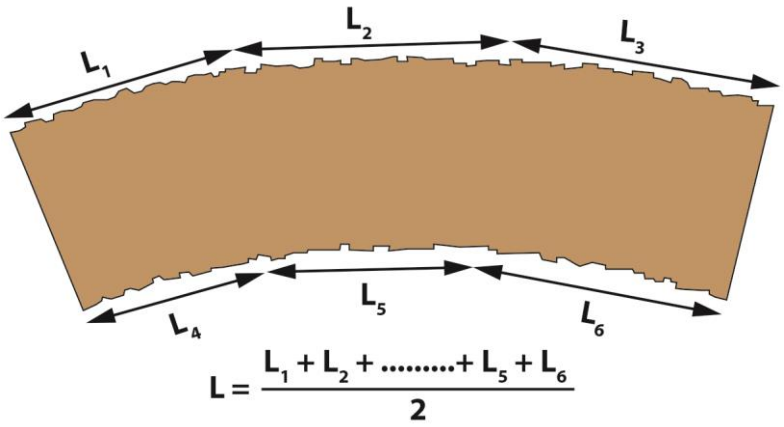


*Figure 4. Measuring the length of a crooked stack.*

For a stack, two different volumes are calculated in principle: (i) the stack volume, which is the product of the stack length, width and height, and (ii) the wood volume, which is the product of the stack volume and wood volume percentage divided by 100.

Volume calculations in a stack are described in the following example. Assume that we have a stack with the measurements shown in Figure 5.

| **Section** | **Length cm** | **Width cm** | **Front** | **Height cm** | **Back** |
|---|---|---|---|---|---|
| **1** | 100 | 303 | 54 | | 37 |
| **2** | 100 | 301 | 139 | | 119 |
| **3** | 100 | 299 | 134 | | 135 |
| **4** | 100 | 302 | 137 | | 148 |
| **5** | 100 | 300 | 101 | | 111 |
| **6** | 100 | 303 | 83 | | 93 |
| **Average (rounded)** | 600 | 301.3<br>301 | | 107.6<br>108 | |

Stack volume can be calculated by:

$$6.00 \times 3.01 \times 1.08 = 19.505 \text{ m}^3\text{t}$$

With an assumed wood volume percentage of 55%, the wood volume is:

$$19.50480 \times 0.55 = 10.72764 = 10.73 \text{ m}^3\text{sub}$$

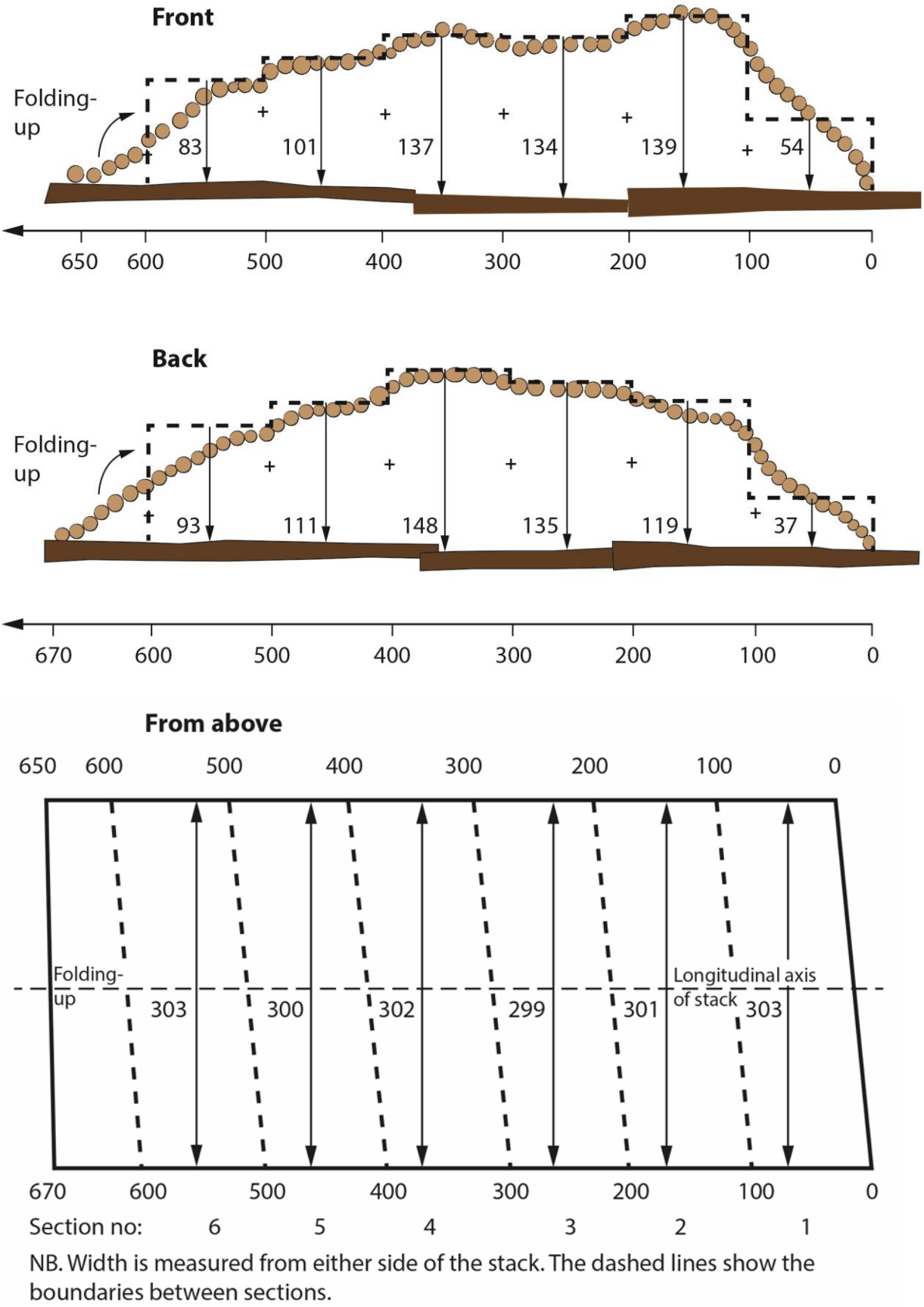


*Figure 5. Measuring the volume of a stack.*

# 5 Equipment for stack measurement

## 5.1 Instruments for manual measurement of stack dimensions

*Instruction: Instruments for measuring stack length, log length and height must be approved according to the measuring company's regulatory framework.*

The stack height must be measured with equipment at least as long as the greatest height of the stack. This is because of the risks of incorrect measurement if the height must be measured in two stages because the equipment is too short. Because of this provision, the measuring poles used are normally 3 m long.

## 5.2 Stack measurement using photos

*Instruction: Stacks on a vehicle may be measured using photos. The photos must enable equivalent measurement and allow equivalent checking procedures to those of manual measurement on the vehicle. For the vehicle in question, the bank width must be registered and be available for the scaler.*

*The following apply when photos are used to measure a stack:*

- *A photo must be taken perpendicular to the stack for measurement of height and log length.*
- *Function for calibration, e.g. clearly visible calibration object in the photo where the measurement is taken.*
- *At least one photo per stack at such an angle that as much as possible of the stack's end area can be assessed.*
- *It must be possible to zoom in so that the supplier's labelling can be read and the quality assessed.*

For further specifications regarding the set-up of a measuring site for stack measurement using photos, see the measuring stick information (currently being revised).

For checking procedures regarding, e.g. supervision, refer to the respective checking instructions for image measurement on photo rigs with fixed distance and for enhanced images.

# 6 Tables for assessment of wood volume percentage in a stack

*Instruction: Correction for the mean diameter of the timber (arithmetic mean diameter on bark).*

Important for calculating the wood volume percentage in a stack is the relationship between the diameter of an individual log and mantle area and between diameter and volume. Consequently, there is also a relationship between log diameter and mantle area per volume unit. The principle of this relationship is shown in Figure 6.

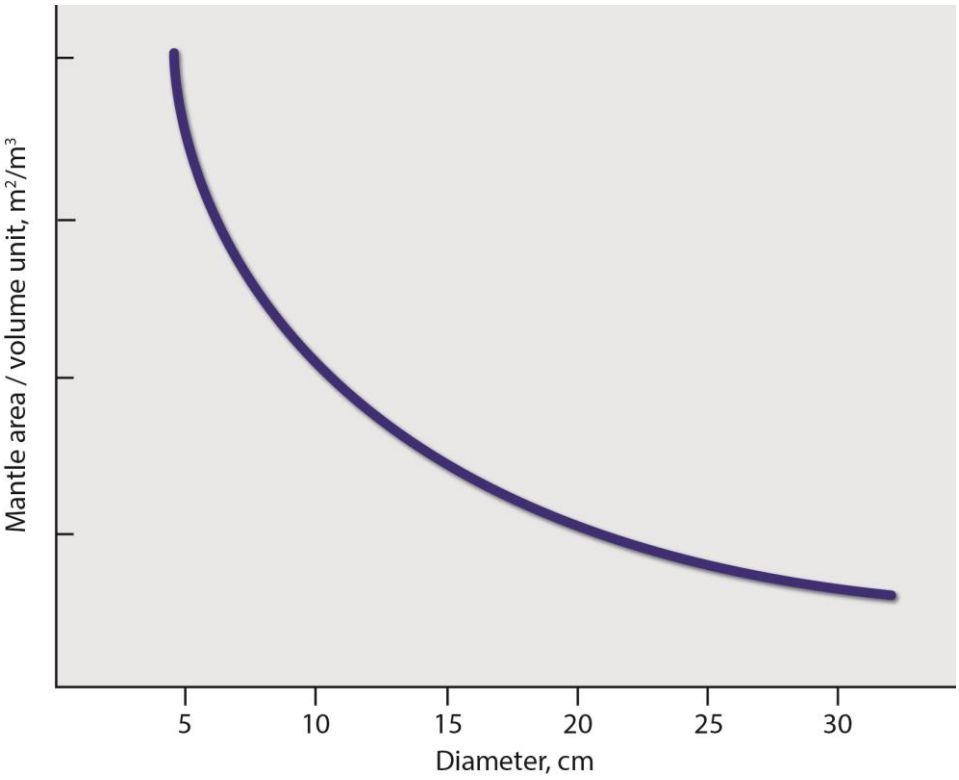


*Figure 6. Relationship between log diameter and mantle area per volume unit.*

One consequence of this relationship, as shown by the diagram, is that the total mantle area of the logs in a stack of thin logs is greater than the mantle area of thicker logs in a stack of similar volume. The greater mantle area means that the number of points of contact between the logs also increases. If these points are made up of branch stumps or branch knots, the wood volume percentage in a stack of thin logs will naturally be smaller than in a stack of thicker logs, even if the degree of delimbing in both cases is the same. At a certain thickness of, for example, ice-covered bark, for the same reason the wood volume percentage in a stack of thin logs is affected more negatively than in a stack of thicker logs.

Because the stack density is affected by many properties, directly or indirectly related to the total mantle area of the logs in a stack, the diameter is in practice a very important factor for determining the wood volume percentage. It is also the relationship between the diameter and other properties that the correction figure for the factor ‘mean diameter’ takes into account.

The diagram showing area per volume unit shows that the area falls strongly as diameter increases up to 20-25 cm but that the curve then flattens out. This relationship is also considered in the table. The correction figure in the table increases up to a diameter of 26-27 cm but remains unchanged after that point. Special attention is therefore required in assessing wood volume percentage when the stack contains logs with very small or large mean diameters.

*Instruction: Deduction for bark and stacking.*

The ‘stacking’ factor refers to the density in the stack, which depends on the relative positions of the logs in the stack. The appearance and form of the individual logs has nothing to do with stacking. Signs of poor stacking are that the logs are not placed straight and that they are not placed sufficiently closely to the stakes on the vehicle.

In theory, even if round, evenly-thick (cylindrical) logs of a certain diameter are stacked perfectly, the stack will include 10-20 % air. Depending on how the logs are stacked, the wood volume percentages can be obtained as shown in Figure 7.

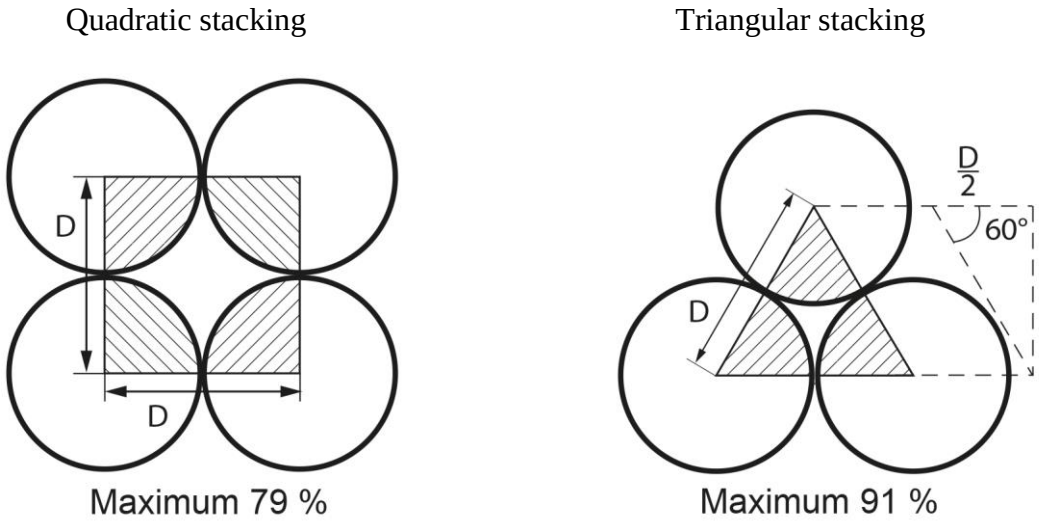


*Figure 7. Wood volume percentages in quadratic and triangular stacking.*

In practice, perfectly quadratic or triangular stacking never occurs, and it is very rare to find logs with the same diameter in stacks. The log diameter and form usually vary, and this together with other properties means that the wood volume percentage is never higher than 79 %.

*Instruction: Deduction for crookedness and delimbing.*
The 'crookedness' factor refers to the crookedness in the timber that reduces the density in the stack, because crooked logs cannot normally be placed very close to each other. In the assessment, consideration must be taken only to the effect of the crookedness on the density in the stack.

*Instruction: Correction for stem form/tapering.*

This factor concerns the influence of the stem form on the wood volume percentage. In particular, butt logs are characterised by a distinctly tapered form, to which the bulge of the butt naturally contributes. The stem form of a butt log corresponds to the shape of a neiloid. As shown in Figure 8, this tapering is not constant throughout the length of the log, but increases at the butt end. The contours of the mantle area are therefore curved. A high proportion of butt logs therefore reduces the relative wood volume of the stack. This tendency is particularly pronounced for timber of standard length where the log ends have been drawn in such a way that an even end surface is created. Protruding butt ends may distort assessment of the stack.

*Figure 8. Log with neiloid shape.*

The described log with the neiloid shape is bucked from the butt end of a tree with the stem shape as shown in Figure 9.

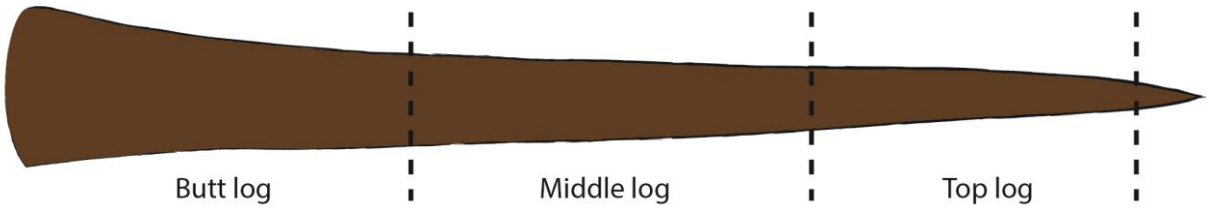


*Figure 9. Sketch of the stem form.*

The tree stem can be roughly divided into a butt part, a middle part, and a top part. The stem part nearest the butt cut is normally swollen, so the butt log has quite severe tapering (= poor stem form). The size of the swelling, and the stem form generally, varies between different tree species and between individuals of the same species.

The middle part, the middle log, generally has very little tapering. Consequently, a large proportion of middle logs can significantly increase the wood volume percentage, which must be taken into account when assessing wood volume in the factor ‘stem form’.

The top part of a tree stem generally has quite severe tapering. Unlike the neiloid-shaped butt log, the top log has an increasing taper towards the top end, which gives the log a paraboloid shape (Figure 10).

*Figure 10. Log with paraboloid form.*

The factor ‘log position in the stack’ is not included in the assessment tables. However, in practical measurement, it is important to consider the effect on wood volume percentage of both the individual logs’ position in the stack and their diameter distribution. The density of the stack increases considerably with greater variation in the logs’ diameter. This effect is because the space between thick logs can be filled with thinner logs.

Previous studies show that mixing logs of different diameters can increase stack density by 4 percentage points. The wood volume table does not show a variation as large as 4 percentage points but, because the table is used as a guide for assessing the wood volume percentage, a

greater correction may be made than that shown in the table, for example when assessing the wood volume percentage in a timber stack with a particularly wide range of diameters.

*Instruction: Deduction for snow and ice, and logging waste.*

The use of the factor 'snow and ice' depends ultimately on the climatic conditions in the geographical area where the measurement is taking place. Consequently, this factor should be significant for more months of the year in northern Sweden than in the southern parts of the country.

However, in certain cases, the problems caused by snow and ice may be perceived to be greater in the southern parts of the country than in the north. The explanation could be that the experiences in general of snow and ice are limited, that the temperature in the south often varies around zero degrees with crisp snow or ice formation as a result. In these conditions, the effect on wood volume percentage will be greater than if the snow is constantly cold and loose.

# 7 Revision history

| | |
|---|---|
| 22 April 2015 | The Application Guide replaces the stack measurement parts in the Compendium of Timber Measurement, Part III (Chapters 1.3.4-1.3.6) General Information about Timber Measurement.<br>Guide adopted by Control Commission |
| 1 January 2018 | Swedish instructions and new front page.<br>Production measurements are called 'original scales' and checks are called 'check scales'.<br>Section 1.1. Under the tab, *Virkesmätning*.<br>Sections 3.1-3.3. Text revised and supplemented to include remote measurement and bank widths. Two new diagrams. Instruction also changed.<br>Section 5.2. For checking procedures regarding, e.g. supervision, refer to checking instructions for photo rigs. |
| 1 August 2018 | Section 1.3 Basic requirement for measurement. New wording: *If the stack properties are such that the scaler assesses that the work cannot be performed accurately, measurement is refused*. |
| 1 January 2019 | Front page changed after formation of Biometria.<br>Section 1.3. Basic requirements for stack measurement. Final paragraph on 'distance between stacks' added.<br>Section 6. First paragraph removed. Minor text revision in the new first paragraph. 'Buttress logs' changed to 'butt logs'. |