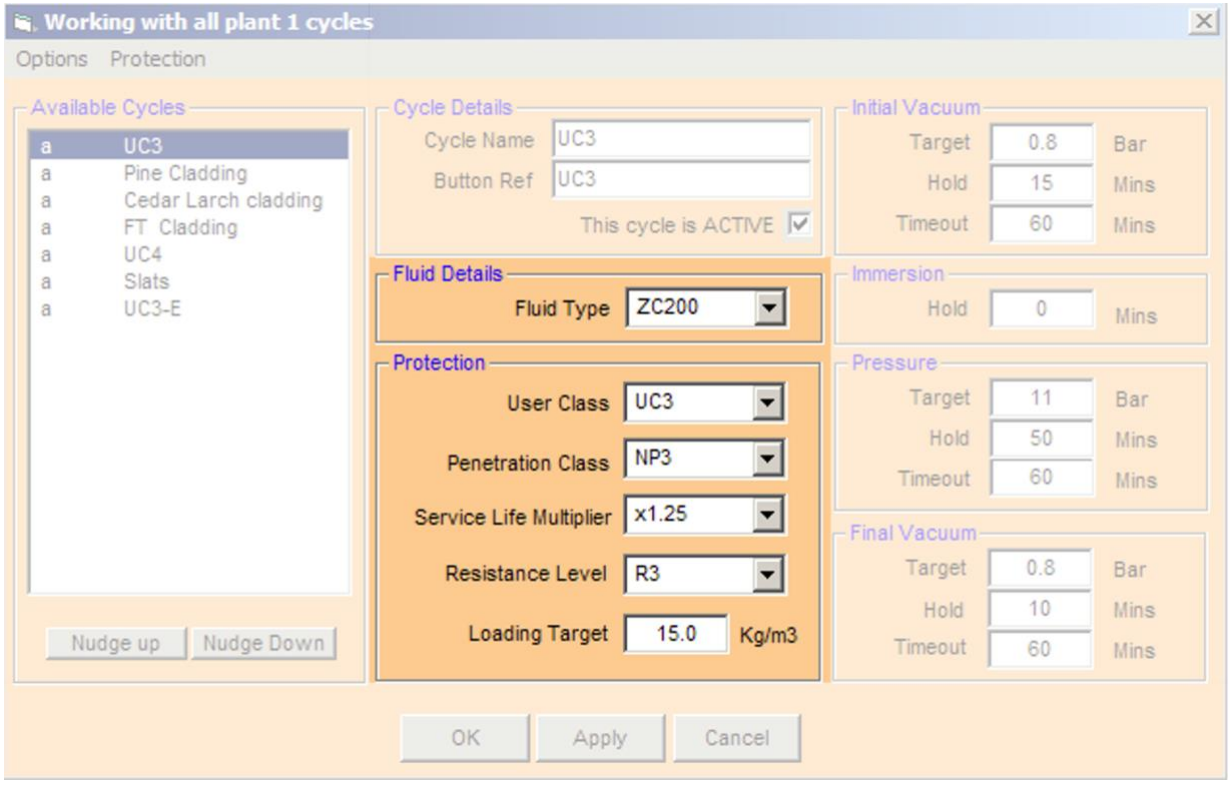
Treating Timber in the Analytical Zone



Prepared by:

David Poundall
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Revision 1

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1. What is all the fuss about?

1.1. Glossary

Analytical Zone (AZ) – The volume of wood in a pack of timber that requires to contain additive.
Additive – The active element added to water to create working fluid that is used to treat timber with.
Loading – The amount of active element, in Kg/m^3, achieved throughout the **analytical zone**.
Working Fluid – The mixed water and additive combination with which timber is treated.
Concentration – The ratio of additive to water within the working fluid, by weight, as a percentage.

1.2. Introduction

Fluid providers will specify that in order for wood to be considered treated to a particular use class there needs to be a minimum number of kilograms of active compound in the **analytical zone** of a timber pack.

The question is though, what is the **analytical zone** ? Are we talking about all of the wood or just part of it ? Clearly it is extremely difficult if not impossible to achieve fluid penetration into heartwood so as a first guess we must be talking about the sapwood of the timber.

If the timber being treated is redwood (permeable) then yes, full penetration of sapwood is required and the sapwood percentage of the timber is used to calculate the **analytical zone** directly. We cover this calculation in section 2.1. Similarly in section 2.2 we also cover how to calculate the **analytical zone** for the less permeable / more resistant, species like whitewood.

The **analytical zone** of a pack of timber can never be larger than the actual volume of the pack. It helps if we do a worked example here. But first let's have a look at the calculation.

$$\text{Timber Loading (Kg/m}^3\text{)} = \frac{\text{Working Fluid retained (Kg) x (Concentration / 100)}}{\text{AZ (m}^3\text{)}}$$

Calc 1 – The Achieved Loading Calculation

Doing a worked example.

Let's assume we have just treated a charge of 10m^3. Let's also assume that the **analytical zone** for the timber packs has been calculated to be 2.5m^3. With the working fluid concentration of 3% and the amount retained as 850Litres.

Note - 1Kg of working solution has a volume of 0.994 Litres as the density of the working fluid is slightly different to that of water. This is the effect of the additives when the working fluid is mixed. For ease of calculation it is taken that 1litre of working solution weighs 1Kg. That being the case …

Achieved Loading = 850 x (3/100) / 2.5
= 850 x 0.03 / 2.5
= 10.2 Kg/m^3

If the target loading for the wood was 9.6Kg/m^3 then congratulations, you have a charge that has been treated to its target use class.

This is a really useful equation because if you were out on your achieved loading (let's say it came in at 7.5Kg/m^3) you can work out what steps to take to increase the loading on the next charge? The formula tells us that there are two things you can do.

1. Treat the wood for longer so that more working fluid is retained by the timber.
2. Increase the concentration of the active element in the working fluid.

To summarise then, correct timber treatment comes down to getting the right amount of active compound into the correctly defined **analytical zone** of the timber packs being treated.

1.3. Fluid comparisons

Take a look at two hypothetical fluids to see which would be the most cost effective to use.

Fluid A
Requires a loading of 9.2Kg/m3 to achieve use class 3 (HC3) in a pack of timber. The cost of the active element is £5000 per 1200Kg IBC.

Fluid B
Requires a loading of 11Kg/m3 to achieve HC3, and the cost of the active element is £3,000 but that is for only 1000Kg of additive.

Let's assume that we are treating 4m^3 of timber and the **analytical zone** for the timber works out to be 1.25m^3. We will look at how we come by the figures for the **analytical zone** in the next section. The cost to treat these packs of timber works out …

Using fluid A = (9.2 x 5000 / 1200) x (1.25 / 4) = £11.97 /m^3
Using fluid B = (11 x 3000 / 1000) x (1.25 / 4) = £10.31 /m^3

Fluid A looked to be cheaper as it needed less additive per m^3, but in fact Fluid B is cheaper, by 8.6% due to its much reduced cost per Kg of the additive. Also, and most importantly, the same timber volume with a different **analytical zone** will not cost the same to treat. If the **analytical zone** is higher it will cost more, if less it will cost less.

In section 2 you will see that the **analytical zone** is directly related to the cross sectional area and the species of the timber being treated.

1.4. Concentrations

Remember from our first calculation, the achieved **loading** in the **analytical zone** depends on the **concentration** of the fluid being used using and how much of the mixed solution can be retained by the treated timber.

But what value do you use for **concentration**?

Based on years of research and experience, the fluid provider will advise on the best **concentration** to use for the timber type being treated. Concentration ranges vary between 1.5% and 7% depending on the process and required timber standard.

In summer it is relatively easy to get fluid into timber compared to winter as the relative humidity in the air will cause the standing **moisture content** in the wood to increase in the winter months, leaving less volume for working fluid penetration.

If timber has a high **moisture content** the ability to achieve the required penetration of working fluid into the timber is diminished. You could of course increase the percentage of the fluid concentration to achieve the required **loading** but you may not get the correct distribution of additives within the wood.

If additive does not adequately penetrate the wood the timber is not as well protected.

There is one way to treat timber across all seasons and that is to kiln dry the wood to a required moisture level prior to processing the wood in the treatment plant. You will often find kilns on timber treatment sites. They enable consistent timber treatment at fixed fluid percentages all year round.

2. Calculating the Analytical Zone for timber packs?

To recap from the glossary, the **analytical zone** is the volume of wood in a timber pack that is targeted to contain a set amount of chemicals. The amount of chemicals impregnated into the wood may be (and normally is) different for different use classes and different protection lifetimes.

The **analytical zone** calculations are different depending on the species of timber being used. The differentiation depends on if the timber species being treated is classed as Permeable or Resistant'

2.1. Permeable Species Calculations (Typically Redwood)

This calculation is based simply on the percentage of sapwood in the timber. It is expected that in treating a permeable wood full sapwood penetration will be achieved. This leaves us with the following equation.

$$AZ\ (m^3) = \text{Timber volume } (T_{vol}) \times \text{The average sapwood ratio } (T_{asr}).$$

Calc 2 – Calculating AZ for Permeable Timber

Worked example.

$T_{vol} = 2.5m^3$
$T_{asr} = 35\%$

$AZ = 2.5 \times 0.35 = \underline{0.875m^3}$

An average figure of 35% for sapwood ratio seems to be the baseline figure for working with permeable timber. However, if the timber being treated is large diameter poles the sapwood ratio could be as high as 60%. Whereas, if the timber being treated is mainly heartwood it could be as low as 20%.

It is left to the timber treater to ascertain the best value for sapwood ratio that they can.

2.2. Resistant Species Calculations (Typically Whitewood)

Resistant timber is treated differently when it comes to calculating the **analytical zone** volume. The rules are simple though, and split between use classes. They are based on radial and lateral penetration.

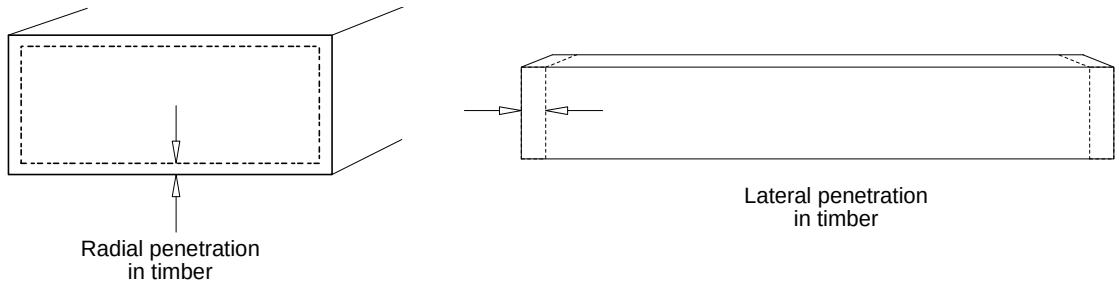


Figure 1 – Radial and Lateral Penetration of timber

Use class 1,2 and 3
Radial penetration of the wood must be 3mm.
Lateral penetration of wood is 40mm at each end.

Use class 4
As Use Class 3 but radial penetration must be 6mm.

2.3. Putting it all together

If you are able to calculate the **analytical zone** for every pack of timber treated in a charge then you are able to determine how much fluid the charge will need to retain. If you look back at calc1 earlier and shuffle the formulae around you can get at the target uptake for a charge. Like so …

Target Retained Fluid (Kg) = AZ (m^3) x Target Loading (Kg/m^3) / (Concentration / 100)

Calc 3 – Target Uptake Calculation

So if you calculate the **analytical zone** of the timber in a charge to be 3.45m^3 (even though the actual cube may be higher at say 6.8m^3) and you are treating with a fluid concentration of 3%, and your target loading for the timber is 9.6Kg/m^3 (required by your chosen use class), then the number of kilograms or litres that the charge will need to retain will be …

Target Litres = 3.45 x 9.6 / 0.03
= 1,104 Litres

If your charges consistently take 2,000 litres then you would be overtreating. If much less, say 500 litres, then you would be undertreating. Cycle pressure and vacuum time adjustments would need to be made to correct for these issues. These can be worked on empirically by a good plant operator who knows their timber. Alternatively, fluid suppliers should be able to advise.

2.4. Things to consider

Properly treated wood needs to not only have the right amount of Kg/m^3 impregnated into the timber, but it also needs to have the required radial and lateral penetration as well.

Fluid providers will be bearing this in mind when they recommend a working concentration. They will also take into account that the moisture content of the timber being treated is below a certain level to ensure correct fluid penetration.

If the timber being treated has moisture content of > 28% there may be too much water in the wood to be able to treat it effectively.

You may think at this point that that's not a problem as you can increase the concentration of the working fluid to make sure that the right amount of additives get into the wood. This works in theory but not in practice as typically radial penetration is compromised.

The only way to fully determine if timber has been treated correctly is to take regular samples of the treated wood and cut them cross sectionally to see that the required penetrations are being achieved for the use class required. If you are getting the right penetrations, and you are achieving the target loadings then you are successfully treating timber as per the requirements of your fluid provider.

If you are able to do this reliably, repeatedly and demonstrably then any fluid provider warranties should be able to be passed on to a treaters customers.

It is up to the treater to treat the wood in a controlled and informed manner. To help them do that a computerised system becomes essential. As a minimum, such a system should be able to …

1. Calculate the **analytical zone** of any timber pack and species that you use.
2. Accurately maintain the concentration percentages of your working fluids.
3. Track fluid used in all timber charges.
4. Ensure graphically that the correct process has been performed on the charge.
5. Automatically configure fluid loadings from the required use class parameters, enabling correct fluid targets to be calculated in advance.

3. Spinnaker PC - an informed way of treating timber.

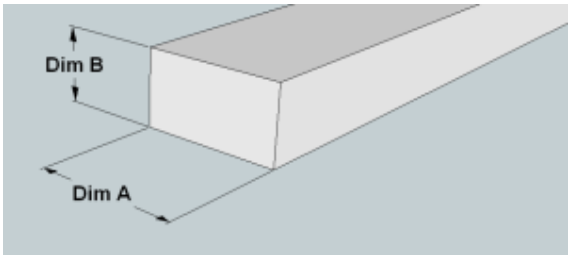
The Spinnaker control system can demonstrably assist plant operators in an informed way when it comes to treating timber. To address the points identified at the end of the last section.

3.1. Calculating Analytical Zones using Spinnaker

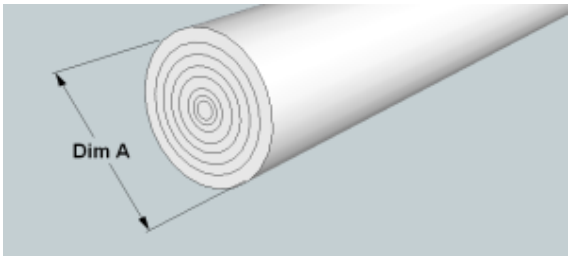
Spinnaker automatically handles the **analytical zone** calculations for the operator in the background as pack information is entered on to the system.

If you fully define a pack of timber you have to know the length and cross sectional area of wood that is to be treated. You also need to define which species of wood you have and finally you need to tell the system how many pieces are in a pack and what their lengths are.

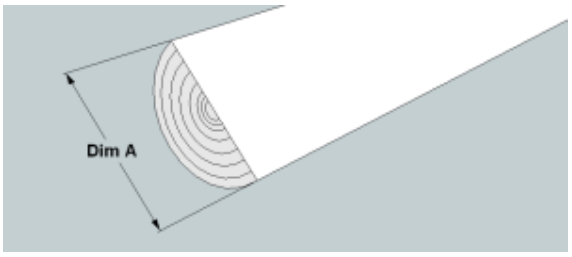
With all of this information to hand, all of the radial, lateral and sapwood calculations are done for you with the Spinnaker system. The following wood profiles are supported at the point of timber entry.



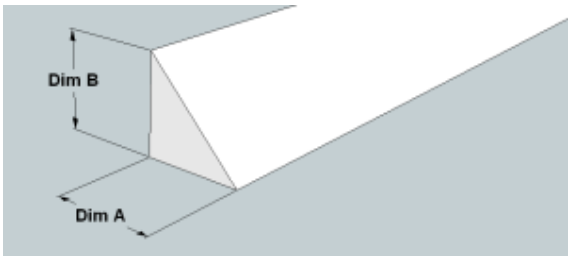
Rectangular



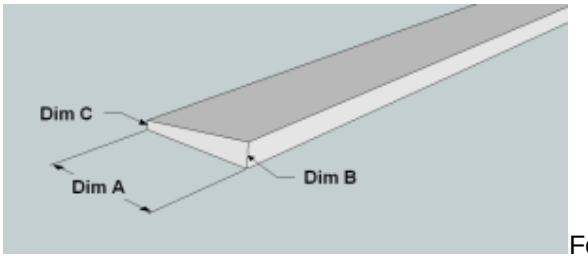
Round



Half Round



Arris



Feather Edge

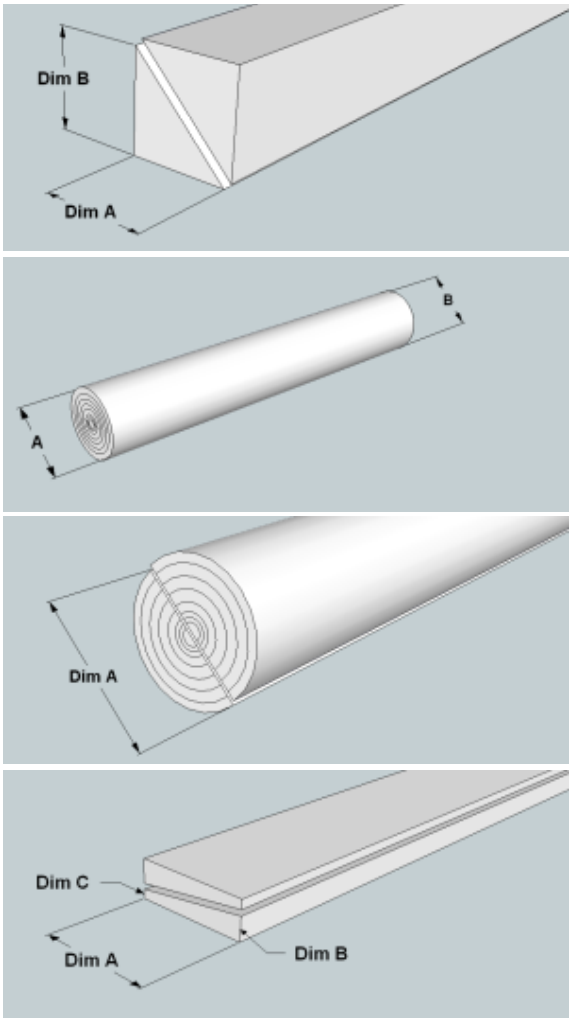


Figure 2 - Wood types covered by Spinnakers Analytical Zone auto calculations

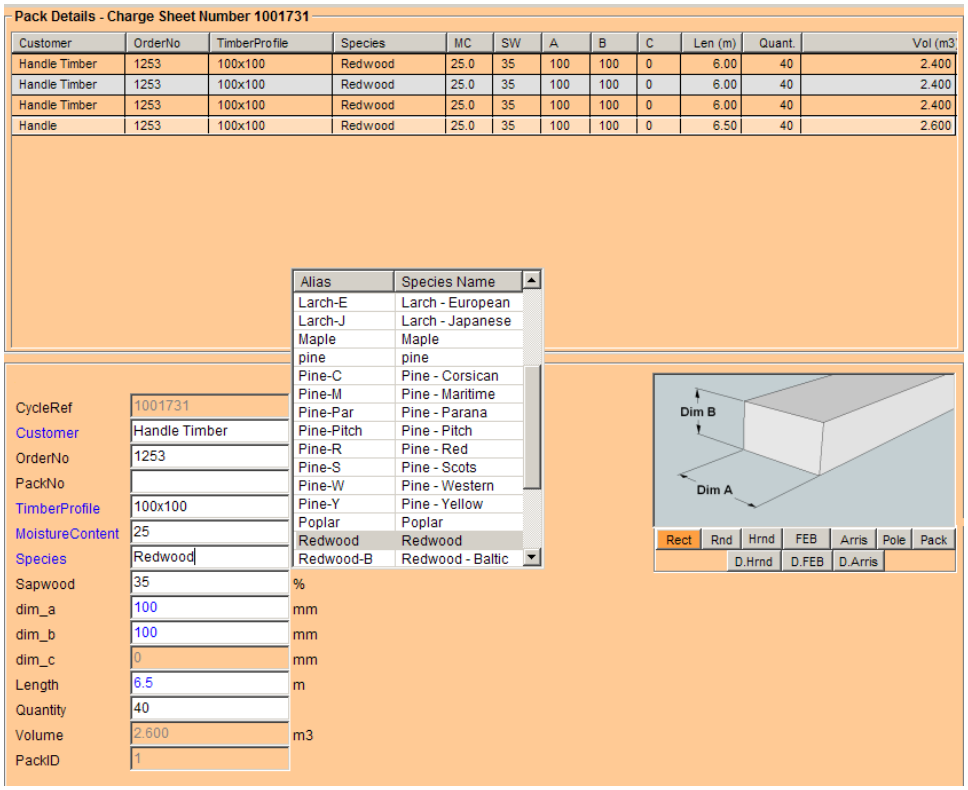


Figure 3 – Pack data entry and building a charge.

Analytical zone figures are calculated on the fly and applied to a charge either before or after the charge has been run. If a mistake has been made it may be rectified easily. The pack entry page in Figure 3 shows how easy it is to select and enter a timber type.

3.2. Accurately maintain the concentrations of working fluids

With low pressure systems the treatment fluid was traditionally sent to site ready to use (RTU) as the working fluid used to be spirit based, but with today's water based working solution RTU is diminishing. Instead mixing, also known as fluid dosing, is done on site from an IBC.

There are many ways to dose a storage vessel. All require the supply of at least one compound mixed with the correct volume of water and transferred directly to a target storage tank.

In some instances it may take additives from 4 separate IBC's to be added in the correct ratio to ensure the correct preparation of the working fluid. To do this manually would be highly impractical.

Spinnaker takes the guesswork out of dosing. Every plant is able to operate with up to 5 additive sources and dose up to 5 working tanks.

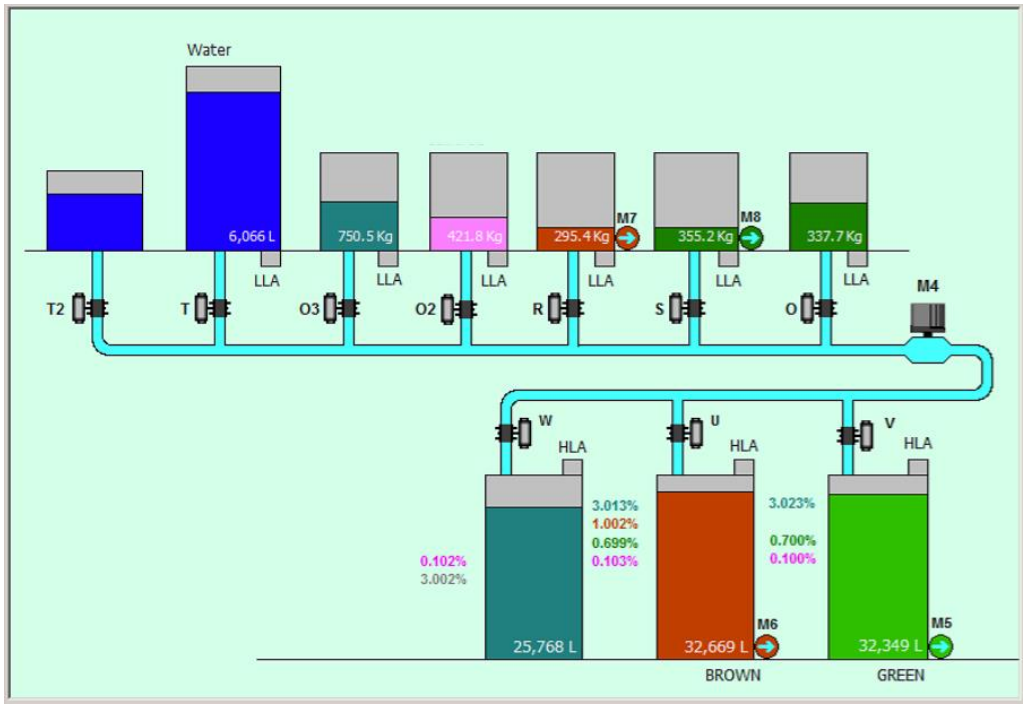


Figure 4 - Spinnaker PC dosing multiple storage tanks

3.3. Tracking fluid usage

All Spinnaker systems track fluid usage in three areas. Firstly, in the charge sheet summary area. Here the target and actual retained fluid are displayed along with the achieved loading in the **analytical zone.** The printed charge sheet differs slightly in that it shows achieved and retained fluid information but not target data.

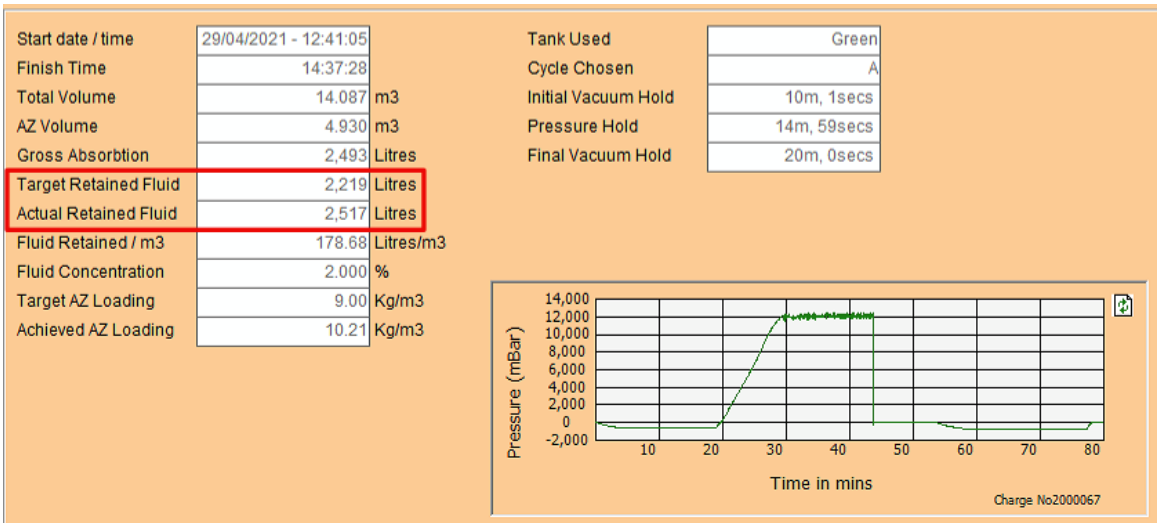


Figure 5 - Charge Level Fluid Tracking

Secondly, at a cycle information level. Finer details of a cycle are available tracking pump and valve movement on a by the second basis. In this information area the user is also able to investigate what cycle parameters were configured for the charge. As a point of reference graphical details for the charge are also made available. In the event of unexpected fluid usage the pressure profile that the wood has been treated to can be most informative.

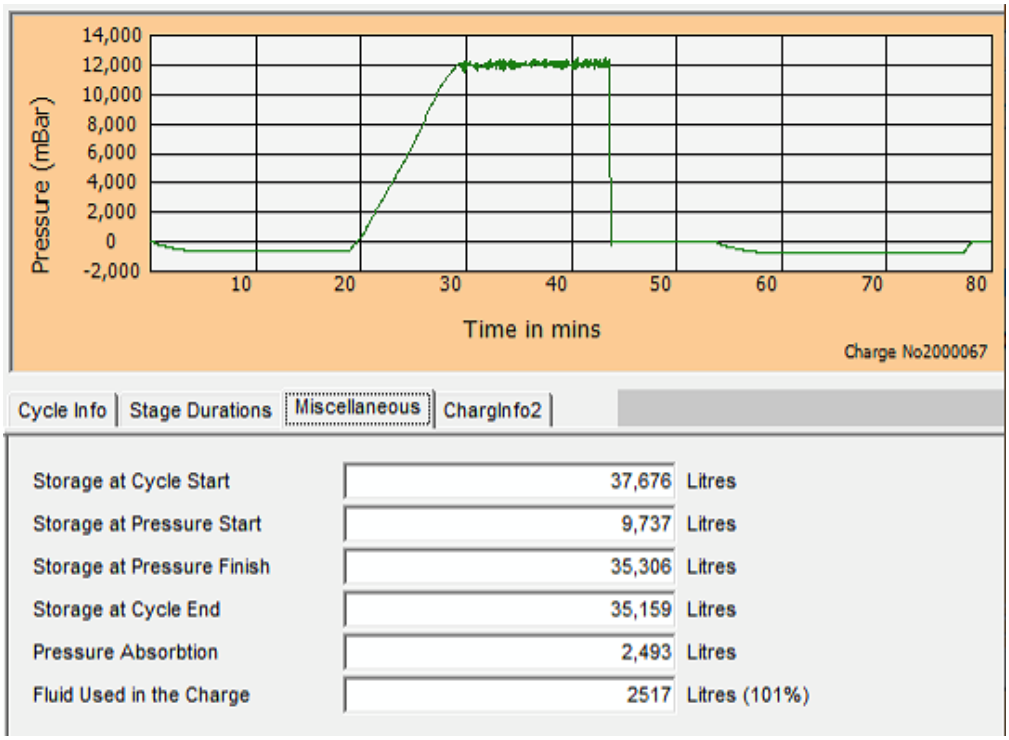


Figure 6 – Cycle Level Fluid Tracking

Thirdly, log files record the analogue values on the system every 30 seconds that the Spinnaker system is running. This can be extremely useful for looking at fluid transfer between tanks even when a charge is not being run as manual fluid movement is trackable in real time.

Date	Time	Plant 1 - TV Pressure	Plant 1 - Brown	Plant 1 - Green 1	Plant 1 - Green 2	Plant 1 - Green (P2)	Plant 1 - Brown (P2)	Plant 2 - TV Pressure	Plant 2 - Green	Plant 2 - Brown	Plant 2 - SLT	
29/04/2021	12:41:16	9139	23786	2794	18202	37670	8138	-22	37676	8177	1247.4	[2] - 2000067 - Vacuum Build Up
29/04/2021	12:45:46	9219.5	23786	2758	18194	37670	8138	-496	37670	8180	1253.1	[2] - 2000067 - Initial Vac Hold
29/04/2021	12:46:16	-20.5	23772	3346	18194	37634	8138	-493	37667	8180	1252.2	[1] - 1000242 - Second Transfer
29/04/2021	12:55:47	0.5	23772	15478	18202	35606	8126	-480	35576	8171	1195.2	[2] - 2000067 - First Transfer
29/04/2021	13:01:47	0.5	23758	22750	18202	9674	8090	159	9701	8156	1185.6	[2] - 2000067 - Press Build Up
29/04/2021	13:06:47	-27.5	23758	25210	18202	8918	8102	4661	8951	8150	1186.2	[1] - 1000242 - Final Vac Build up
29/04/2021	13:11:47	-367	23744	25198	18218	8054	8114	9141	8108	8159	1186.5	[2] - 2000067 - Pressure Hold
29/04/2021	13:16:47	-549	23772	25210	18226	7370	8186	9157	7484	8204	1186.2	[1] - 1000242 - Final vac Hold
29/04/2021	13:26:47	-545.5	23758	25198	18202	8006	8150	-23	8624	8204	1186.2	[2] - 2000067 - Second Transfer
29/04/2021	13:36:47	-423	23786	25210	18210	34694	8162	0	34706	8222	1185.6	[1] - 1000242 - Release
29/04/2021	13:37:17	-293.5	23786	25198	18202	34670	8162	-92	34733	8222	1257.9	[2] - 2000067 - Final Vac Build up
29/04/2021	13:38:17	-59	23758	25258	18202	34718	8162	-262	34736	8222	1242	[1] - 1000242 - Scavenge
29/04/2021	13:41:18	0.5	23758	25330	18202	34694	8162	-538	34721	8219	1216.8	[1] - 1000242 - Scavenge
29/04/2021	13:41:48	0.5	23758	25390	18194	34706	8162	-549	34715	8222	1213.2	[2] - 2000067 - Final vac Hold
29/04/2021	13:54:48	-24	23758	27010	18194	34706	8150	-545	34706	8222	1214.4	[1] - 1000243 - Vacuum Build Up
29/04/2021	14:01:48	-444	23772	27010	18194	34694	8162	-333	34706	8219	1212.9	[2] - 2000067 - Release
29/04/2021	14:02:18	-465	23772	27010	18202	34490	8150	-45	34529	8216	1214.1	[2] - 2000067 - Scavenge
29/04/2021	14:03:18	-503.5	23758	27010	18194	34946	8150	-1	34970	8210	1213.8	[1] - 1000243 - Initial Vac Hold
29/04/2021	14:04:18	-493	23758	27010	18202	34994	8150	-1	35165	8213	1177.8	[2] - 2000067 - Scavenge

Figure 7 – Log Level Fluid Tracking

3.4. Configuring correct target loadings

Spinnaker is able to work with all fluid types using one of two methods for calculating additive loading figures. The first is the Service Life method, the second is the Protection Class method.

Before a cycle is chosen to be run, one of the above two methods must be used to correctly calculate the Kg/m^3 figure required by the use class. Below are screen shots of the configuration area's within the cycle configuration page for the two methods.

A hands on understanding of the subject is introduced in this video. https://youtu.be/sr2YAfaOyVE

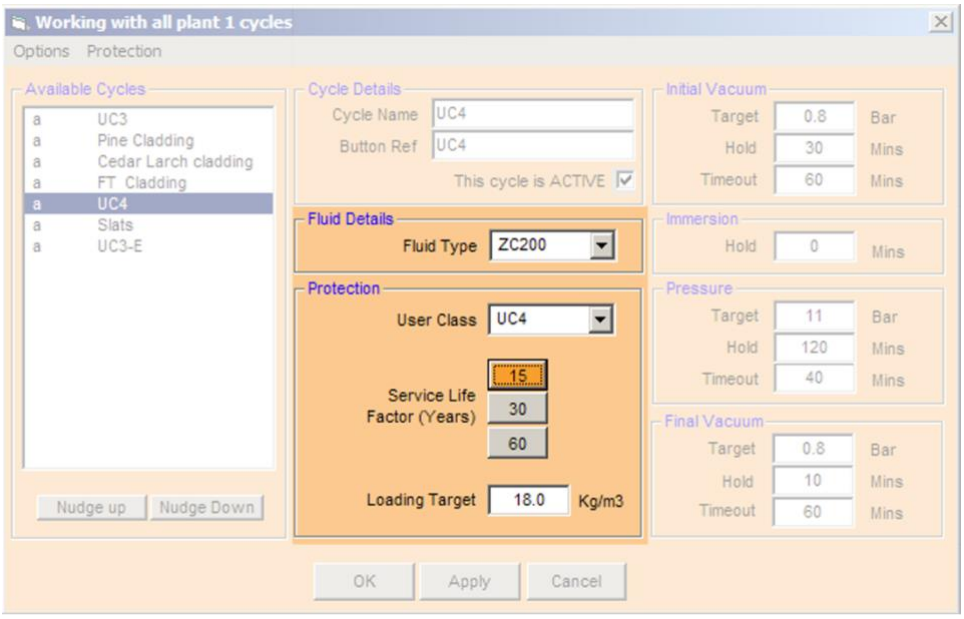


Figure 8 – Calculating timber Loading using the Service Life model

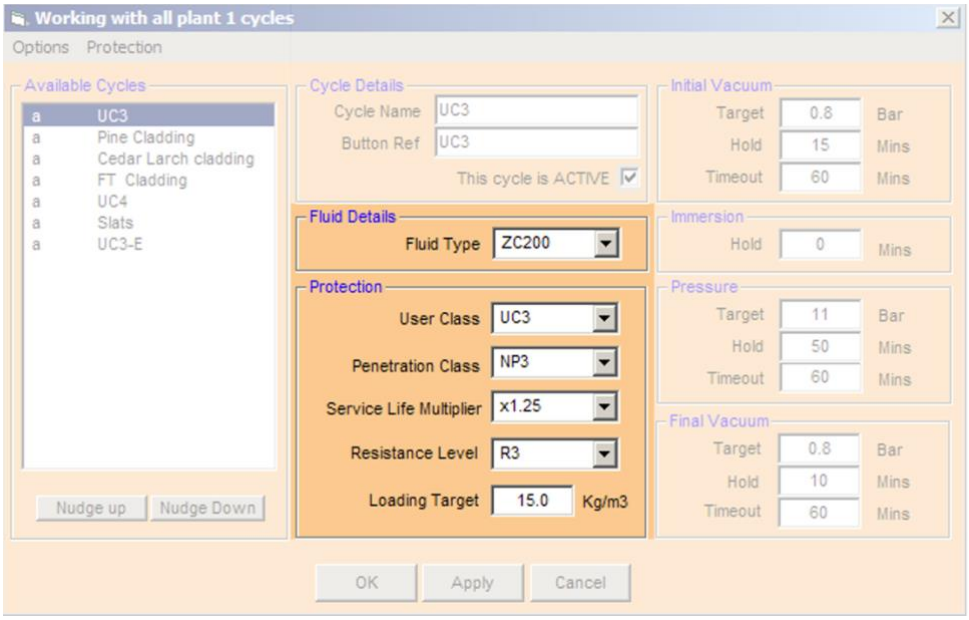


Figure 9 – Calculating timber Loading using the Protection Model

4. In conclusion

Fluid providers should provide **analytical zone** loading data (in Kg/m3) for each use class that a treater is looking to support. It is also important that all compounds used to create the working fluid for the treatment plant be identified as well.

From this it is then up to the treater to apply this information to the specific timber profiles and species types that they are looking to treat. Only then will the treater get a full understanding of the true cost of treating their timber.

Hopefully, this document enables treaters to do just that.

On a final note. Computer systems are crucial in tracking fluid and additive usage, performing **analytical zone** calculations and providing fluid retention target information. TSL's Spinnaker PC system supports treaters in all of these areas.

5. More Information

Find us on our web page at … https://treatmentservices.co.uk/

Find working video's of the Spinnaker system at … https://treatmentservices.co.uk/thenittygritty/video/

Peruse more of our screen shots … https://treatmentservices.co.uk/screenshots/

We have downloads here … https://treatmentservices.co.uk/downloads/

If you need more details of the Spinnaker system or require clarification of anything mentioned in earlier sections please contact TSL on either of these two numbers. We run extended office hours.

+(44) 7966 261 720
+(44) 7984 158 882

Or email us on ..
janet.poundall@treatmentservices.co.uk
david.poundall@treatmentservices.co.uk