Guidelines for Stretching

YUASA Small Desktop Test Machines

ST with the DMLHP

FS with the DMLHP or the DMLHB

1. Introduction

There are two Yuasa small desktop Jigs that can stretch samples. The ST is a stretching Jig that is designed only for stretching. The ST is driven only by the DMLHP stepping motor drive unit. The FS is a flexing Jig that can also be used for stretching (note that the FS-C Jig cannot be used for stretching, only for flexing). The FS can be driven by the DMLHP (HP) or the DMLHB (HB) or the older DLDM111LH (DLDM). Both the HB and the DLDM have DC motors. The DLDM is the same as the DMLHB in the linear drive mode -- both the ST and the FS are linear drive Jigs. For the remainder of this paper, the DLDM will not be referenced because it is always the same as the HB.

The Reciprocation Distance with the DC motors is set manually with a cam. As a result the linear drive shaft of the DC motors always moves back and forth the Reciprocation Distance from a central point. The maximum Reciprocation Distance of the DC motor drive units is ±60 mm. It always moves back and forth from a point 60 mm from its shortest possible distance from the motor drive. If the Reciprocation Distance is set to be less than ±60 mm, the linear drive shaft will not reach its shortest possible distance from the motor drive.

The Reciprocation Distance with a stepping motor is set by the Touch Panel and is not restricted to moving back and forth from some central point. With the stepping motor drive unit, we refer to the total Reciprocation Distance as the Stroke and only as a positive number. The maximum Stroke of the stepping motor drive unit is 120 mm. The HP can have a short Stroke with one end of the linear drive shaft travel at its shortest possible distance from the motor drive unit. This allows the HP drive to allow longer unstretched samples than can be handled with the HB.

In this paper, Figures are placed at the end. They show the possible combinations of Unstretched Sample Length, Stretching Percentage, and Stroke (for the stepping motor) or Reciprocation Distance (for the DC motors). Figure 1 demonstrates differences among the three possible test systems. The area under the red curves show the possible combinations of Stretching Percentage and Unstretched Sample Length. The area under the HP/ST red curve (solid line) is much greater than the area under the HP/FS red curve (dashed line), and the area under the HP/FS red curve (dashed line) is greater than the area under the HB/FS red curve (dotted line). The differences arise from the maximum Unstretched Sample Lengths possible. The maximum Unstretched Sample Length for the ST is 365 mm, it is 134 mm for the HP/FS, and it is 74 mm for the HB/FS.

A key feature of the Figures is that they can be used to determine the maximum possible Stretching Percentage for any specific Unstretched Sample Length. In all cases, the test parameters can be calculated by using equations. Any combination of test parameters below the Maximum Stretching Percentage curve is possible. Test parameters above the Maximum Stretching Percentage curve are not possible.

2. Specifications for Stretching

2.1. Terms

Lu => Unstretched Sample Length

Ls => Stretched Sample Length

Rd => +/- Reciprocating Distance (used with DC motor)

St => Stroke (used with stepping motor)

S% => Stretching Percentage

Stroke = Total Reciprocating Distance = 2 • Rd

2.2. DMLHP-ST

30 mm => Distance between Sample Clamps when Moving and Fixed Clamps are touching

30 mm => Shortest Unstretched Sample Length

365 mm => Longest Unstretched Sample Length

120 mm => Maximum Stretching

365 mm => Maximum Stretched Sample Length

Max Ls = 120 + Lu if Lu < 245

Max Ls = 365 if Lu > 245

S% = (Ls - Lu) / Lu = Ls / Lu - 1 = St / Lu

2.3. DMLHP-FS

2 mm => Distance between Sample Clamps when Moving and Fixed Clamps are touching

6 mm => Shortest Unstretched Sample Length

134 mm => Longest Unstretched Sample Length

120 mm => Maximum stretching

134 mm => Maximum Stretched Sample Length

Max Ls = 120 + Lu if Lu < 14

Max Ls = 134 if Lu > 14

S% = (Ls - Lu) / Lu = Ls / Lu - 1 = St / Lu

2.4. DMLHB-FS

2 mm => Distance between Sample Clamps when Moving and Fixed Clamps are touching

6 mm => Shortest Unstretched Sample Length

74 mm => Longest Unstretched Sample Length

120 mm => Maximum stretching

134 mm => Maximum Stretched Sample Length

Max Ls = 120 + Lu if Lu < 14

Max Ls = 148 - Lu if Lu > 14

S% = (Ls - Lu) / Lu = Ls / Lu - 1 = 2 • Rd / Lu

3. Stretching Setup

3.1. DMLHP-ST

The ST can be used only with the HP motor drive unit. If you are not familiar with the ST, you may want to watch the YUASA ST Setup Video and study the ST Instruction Manual and the DMLHP Instruction Manual. The ST has a "Minute Adjuster" and two "Squash Gauges" that can be used to more precisely mount the Unstretched Sample without sag before stretching.

3.1.1. Determining Sample Size

Two figures are provided for your convenience in determining Unstretched Sample Length and Stretching Percentage. Use Figure 2 when the stretching is going to be less than 100%. Use Figure 3 when the stretching is going to be greater than 100%. In the Figures, the Stretching Percentage is shown in red and its value is on the left vertical axis, also in red. The Stroke is shown in green and its value is on the right vertical axis, also in green.

In these Guidelines, the sample sizes, stretched and unstretched always will be stated as the portion of the sample that is getting stretched, the Clamping Distances will not be included in the values. Always remember to include the Clamping Distances when you are actually preparing a sample.

If you have a specific sample size, find that value on the horizontal axis, Unstretched Sample Length (not counting Clamping Distance). Go up the Unstretched Sample Length line until you reach the red curve to determine the maximum stretching you can achieve with that sample. That value will be on the left axis. Go up or down the Unstretched Sample Length line until you reach the green curve to determine the Stroke for maximum stretching. That value will be on the right axis. The example illustrated in Figure 2 is Lu = 270 mm. The Maximum S% = 35.6%. Therefore St = 96 mm for Maximum Stretching of the 270 mm sample.

If you have a specific Maximum Stretching Percentage, find that value on the red left vertical axis, go across that line until you reach the red curve to determine the Unstretched Sample Length (not counting Clamping Distance). That value will be on the horizontal axis. Go up or down the Unstretched Sample Length line until you hit the green curve to determine the Stroke for maximum stretching. The example illustrated in Figure 3 is Lu = 60 mm. The Maximum S% = 200%. Therefore St = 120 for Maximum Stretching of the 60 mm sample.

If you want to stretch the sample less than the maximum, use a shorter Stroke. You can use equations to calculate the values. There are four numbers, Lu (Unstretched Length) and Ls (Stretched Length) and St (Stroke) and S% (Stretching Percentage). You must specify two of them. Often that will be Lu and S%. The equations for determining the other two values are then:

St = Lu • S%

Ls = Lu + Lu • S% = Lu (1 + S%)

When using these equations, keep in mind the limits:

Maximum St is 120 mm

Minimum Lu is 30 mm

Maximum Lu is 365 mm

Maximum Ls is 365 mm

If you specify Lu and Ls, then:

$St = Ls - Lu$

$S\% = (Ls - Lu) / Lu$

If you specify Ls and S%, then:

$St = Ls \bullet S\% / (1 + S\%)$

$Lu = Ls / (1 + S\%)$

Remember also that:

$Max\ Ls = 120 + Lu \quad if \quad Lu < 245$

$Max\ Ls = 365 \quad if \quad Lu > 245$

The smallest unstretched sample the ST can accommodate is 30 mm plus the Clamping Distance. The longest unstretched sample the FS can accommodate is 365 mm plus the Clamping Distance; at 365 mm the sample cannot be stretched, a 364 mm sample can be stretched 1 mm.

When the unstretched sample is less than 245 mm, the full stretching capability of the ST is available. When the unstretched sample is greater than 245 mm, the maximum stretching capability decreases as the unstretched sample size gets longer.

3.2. DMLHP-FS

If you are not familiar with the FS, you may want to watch the YUASA FS Setup Video. While the FS does not have the FS-C Cartridge, the installation and setup will be similar. And you may want to refer to the FS Instruction Manual. You will be setting the Stroke with the DMLHP Touch Panel. That information can be found in the Yuasa DMLHP Setup Video and in the DMLHP Instruction Manual.

You must remove the Tilt Controllers when using the FS as a Stretching Machine. See Section 4.1.1 of the FS Instruction Manual. And, you must make the Tilt Clamps horizontal when using the FS as a Stretching Machine. See Section 3.5 of the FS Instruction Manual.

The FS can be used with the HB or the HP. The HP can provide a greater range of test parameters than with the HB, but at longer Strokes the testing speed is limited. The testing speed is not limited with the HB.

3.2.1. Determining Sample Size

Two figures are provided for your convenience in determining Unstretched Sample Length and Stretching Percentage. Both the HP/FS and the HB/FS are shown in these two figures. For the HP/FS, use the dashed lines in Figure 4 when the stretching is going to be less than 250%. For

the HP/FS, use the dashed lines in Figure 5 when the stretching is going to be greater than 250%. In the Figures, the Stretching Percentage for the HP/FS is shown with the dashed red curve and its value is on the left vertical axis, also in red. The Stroke for the HP/FS is shown with the dashed green curve and its value is on the right vertical axis, also in green.

In these Guidelines, the sample sizes, stretched and unstretched always will be stated as the portion of the sample that is getting stretched, the Clamping Distances will not be included in the values. Always remember to include the Clamping Distances when you are actually preparing a sample.

If you have a specific sample size, find that value on the horizontal axis, Unstretched Sample Length (not counting Clamping Distance). For the HP/FS, go up the Unstretched Sample Length line until you reach the dashed red curve to determine the maximum stretching you can achieve with that sample. That value will be on the left axis. For the HP/FS, go up or down the Unstretched Sample Length line until you reach the green dashed curve to determine the Stroke for maximum stretching. That value will be on the right axis. The example illustrated in Figure 4 using the HP/FS (dashed lines) is Lu = 67 mm. The Maximum S% = 100%. Therefore St = 67 mm for Maximum Stretching of the 67 mm sample.

If you have a specific Stretching Percentage, find that value on the red left vertical axis, go across that line until you reach the red dashed curve for the HP/FS to determine the Unstretched Sample Length (not counting Clamping Distance). That value will be on the horizontal axis. Go up or down Unstretched Sample Length line until you hit the green dashed curve for the HP/FS to determine the Stroke.

If you want to stretch the sample less than the maximum, use a shorter Stroke. You can use equations to calculate the values. There are four numbers, Lu (Unstretched Length) and Ls (Stretched Length) and St (Stroke) and S% (Stretching Percentage). You must specify two of them. Often that will be Lu and S%. The equations for determining the other two values are then:

$$St = Lu \bullet S\%$$

$$Ls = Lu + Lu \bullet S\% = Lu (1 + S\%)$$

When using these equations, keep in mind the limits:

Maximum St is 120 mm

Minimum Lu is 6 mm

Maximum Lu is 134 mm

Maximum Ls is 134 mm

If you specify Lu and Ls, then:

$$St = Ls - Lu$$

$$S\% = (Ls - Lu) / Lu$$

If you specify Ls and S%, then:

$$St = Ls \bullet S\% / (1 + S\%)$$

$$Lu = Ls / (1 + S\%)$$

Remember also that:

Max Ls = 120 + Lu if Lu < 14

Max Ls = 134 if Lu > 14

The smallest unstretched sample the HP/FS can accommodate is 6 mm plus the Clamping Distance. The longest unstretched sample the HP/FS can accommodate is 74 mm plus the Clamping Distance; at 74 mm the sample cannot be stretched, a 73 mm sample can be stretched 1 mm.

When the unstretched sample is less than 14 mm, the full stretching capability of the HP/FS is available. When the unstretched sample is greater than 14 mm, the maximum stretching capability of the HP/FS decreases as the unstretched sample size gets longer.

3.3. DMLHB-FS

If you are not familiar with the FS, you may want to watch the YUASA FS Setup Video. While the FS does not have the FS-C Cartridge, the installation and setup will be similar. And you may want to refer to the FS Instruction Manual. You will be setting the Reciprocating Distance with the DMLHB Cam Follower. That information can be found in the Yuasa DMLHB Setup Video and in the DMLHB Instruction Manual.

You must remove the Tilt Controllers when using the FS as a Stretching Machine. See Section 4.1.1 of the FS Instruction Manual. And, you must make the Tilt Clamps horizontal when using the FS as a Stretching Machine. See Section 3.5 of the FS Instruction Manual.

The FS can be used with the HB or the HP. The HP can provide a greater range of test parameters than with the HB, but at longer Strokes the testing speed is limited. The testing speed is not limited with the HB.

3.3.1. Determining Sample Size

Two figures are provided for your con+venience in determining Unstretched Sample Length and Stretching Percentage. Both the HP/FS and the HB/FS are shown in these two figures. For the HB/FS, use the dotted lines in Figure 4 when the stretching is going to be less than 250%. For the HB/FS, use the dotted lines in Figure 5 when the stretching is going to be greater than 250%. In the Figures, the Stretching Percentage for the HB/FS is shown with the dotted red curve and its value is on the left vertical axis, also in red. Double the Reciprocation Distance for the HB/FS is shown with the dashed green curve and its value is on the right vertical axis, also in green. The vertical blue dotted line at 74 mm marks the Maximum Unstretched Sample Length for the HB/FS.

In these Guidelines, the sample sizes, stretched and unstretched always will be stated as the portion of the sample that is getting stretched, the Clamping Distances will not be included in the values. Always remember to include the Clamping Distances when you are actually preparing a sample.

If you have a specific sample size, find that value on the horizontal axis, Unstretched Sample Length (not counting Clamping Distance). For the HB/FS, go up the Unstretched Sample Length line until you reach the dotted red curve to determine the maximum stretching you can achieve with that sample. That value will be on the left axis. For the HB/FS, go up or down the Unstretched Sample Length line until you reach the green dotted curve to determine Double the Reciprocation Distance for maximum stretching. That value will be on the right axis. The

example illustrated in Figure 5 using the HB/FS (dotted lines) is Lu = 28 mm. The Maximum S% = 329%. Therefore 2 • Rd = 92 mm for Maximum Stretching of the 28 mm sample.

If you have a specific Stretching Percentage, find that value on the red left vertical axis, go across that line until you reach the red dotted curve for the HB/FS to determine the Unstretched Sample Length (not counting Clamping Distance). That value will be on the horizontal axis. Go up or down the Unstretched Sample Length line until you hit the green dotted curve for the HB/FS to determine Double the Reciprocation Distance for Maximum Stretching.

If you want to stretch the sample less than the maximum, use a shorter Reciprocation Distance. You can use equations to calculate the values. There are four numbers, Lu (Unstretched Length) and Ls (Stretched Length) and Rd (Reciprocation Distance) and S% (Stretching Percentage). You must specify two of them. Often that will be Lu and S%. The equations for determining the other two values are then:

$$Rd = Lu \bullet S\% / 2$$

$$Ls = Lu + Lu \bullet S\% = Lu (1 + S\%)$$

When using these equations, keep in mind the limits for the HB/FS:

Maximum Rd is 60 mm

Minimum Lu is 6 mm

Maximum Lu is 74 mm

Maximum Ls is 134 mm

If you specify Lu and Ls, then:

$$Rd = (Ls - Lu) / 2$$

$$S\% = (Ls - Lu) / Lu$$

If you specify Ls and S%, then:

$$Rd = \tfrac{1}{2} (Ls \bullet S\% / (1 + S\%))$$

$$Lu = Ls / (1 + S\%)$$

Remember also for the HB/FS that:

$$\text{Max Ls} = 120 + Lu \text{ if } Lu < 14$$

$$\text{Max Ls} = 148 - Lu \text{ if } Lu > 14$$

The smallest unstretched sample the HB/FS can accommodate is 6 mm plus the Clamping Distance. The longest unstretched sample the HP/FS can accommodate is 74 mm plus the Clamping Distance; at 74 mm the sample cannot be stretched, a 73 mm sample can be stretched 1 mm.

When the unstretched sample is less than 14 mm, the full stretching capability of the HB/FS is available. When the unstretched sample is greater than 14 mm, the maximum stretching capability of the HB/FS decreases as the unstretched sample size gets longer.

4. Setup Procedure

4.1. DMLHP-ST Stretching Setup Procedure

Once you have determined the values, whether using the Figures or the Equations, you can prepare your sample and set up the ST Jig and HP Motor Drive Unit. Keep in mind that the graphs and equations do not include the sample clamping distance. When preparing the sample that must be taken into consideration. To mount the sample, follow the steps below:

1. Move the Jig's Fixed Clamp all the way to the end.

2. Set the Stroke using the DMLHP Touch Panel. You will set two values, "+SP" and "–SP". The +SP value will be the position where the Moving Clamp is pulled closest to the Motor Drive Unit. Normally this would be set to 120 mm. The -SP position will be 128 mm less the Stroke for the stretching test.

3. Use the Motor Drive's "-" Jog Button to move the Moving Clamp all the way to the end where it is closest to the Fixed Jig. This will be the -SP position.

4. Set the Fixed Clamp to the position where the distance between the Clamping Bars is the value Lu (not counting Clamping Distance).

5. Mount the sample. Use the Squashing Gauges to tighten the Clamping Bar evenly across the sample.

6. Follow the ST Setup Video instructions or the ST Instruction Manual to complete the mounting of the sample. Basically, you may find that the sample sags slightly when the Clamping Bars are tightened. Set the Minute Adjuster to 0. Then move the Fixed Slider to tighten the sample and record the new reading ("X") of the Minute Adjuster. Move the Fixed Slider back to the 0 position on the Minute Adjuster, and then move it further toward the Moving Clamp to "-X" the same amount that was required to tighten the sample. Remount the sample. Then move the Minute Adjuster to 0 and the sample should not be sagging.

7. Conduct the test.

If you decide you want to use a different Stretching Percentage or Reciprocating Distance, calculate your new values and make sure they are consistent with the limits above. Then repeat the Setup steps.

4.2. DMLHP-FS Stretching Setup Procedure

Once you have determined the values, whether using the Figures or the Equations, you can prepare your sample and set up the FS Jig and HP Motor Drive Unit. Keep in mind that the graphs and equations do not include the sample clamping distance. When preparing the sample that must be taken into consideration. To mount the sample, follow the steps below:

1. Move the FS Jig's Fixed Clamp all the way to the end.

2. Set the Stroke using the DMLHP Touch Panel. You will set two values, "+SP" and "–SP". The +SP value will be the position where the Moving Clamp is pulled closest to the Motor Drive Unit. Normally this would be set to 120 mm. The -SP position will be 128 mm less the Stroke for the stretching test.

3. Use the Motor Drive's "-" Jog Button to move the Moving Clamp all the way to the end where it is closest to the Fixed Jig. This will be the -SP position.

4. Set the Fixed Clamp to the position where the distance between the Clamping Plates is the value Lu (not counting Clamping Distance).

5. Mount the sample.

6. Conduct the test.

If you decide you want to use a different Stretching Percentage or Reciprocating Distance, calculate your new values and make sure they are consistent with the limits above. Then repeat the Setup steps.

4.3. DMLHB-FS Stretching Setup Procedure

Once you have determined the values, whether using the Figures or the Equations, you can prepare your sample and set up the FS Jig and HB Motor Drive Unit. Keep in mind that the graphs and equations do not include the sample clamping distance. When preparing the sample that must be taken into consideration. To mount the sample, follow the steps below:

1. Move the Jig's Fixed Clamp all the way to the end.

2. Set the Motor Drive Reciprocating Distance according to the determined value. Open the Adjusting Port and adjust the Cam Follower position to be the same as the Reciprocating Distance on the on the Cam Follower scale.

3. Use the Motor Drive's Jog to move the Moving Clamp all the way to the end where it is closest to the Fixed Jig.

4. Set the Fixed Clamp to the position where the distance between the Clamping Plates is the value Lu (not counting Clamping Distance).

5. Mount the sample.

6. Conduct the test.

If you decide you want to use a different Stretching Percentage or Reciprocating Distance, calculate your new values and make sure they are consistent with the limits above. Then repeat the Setup steps.

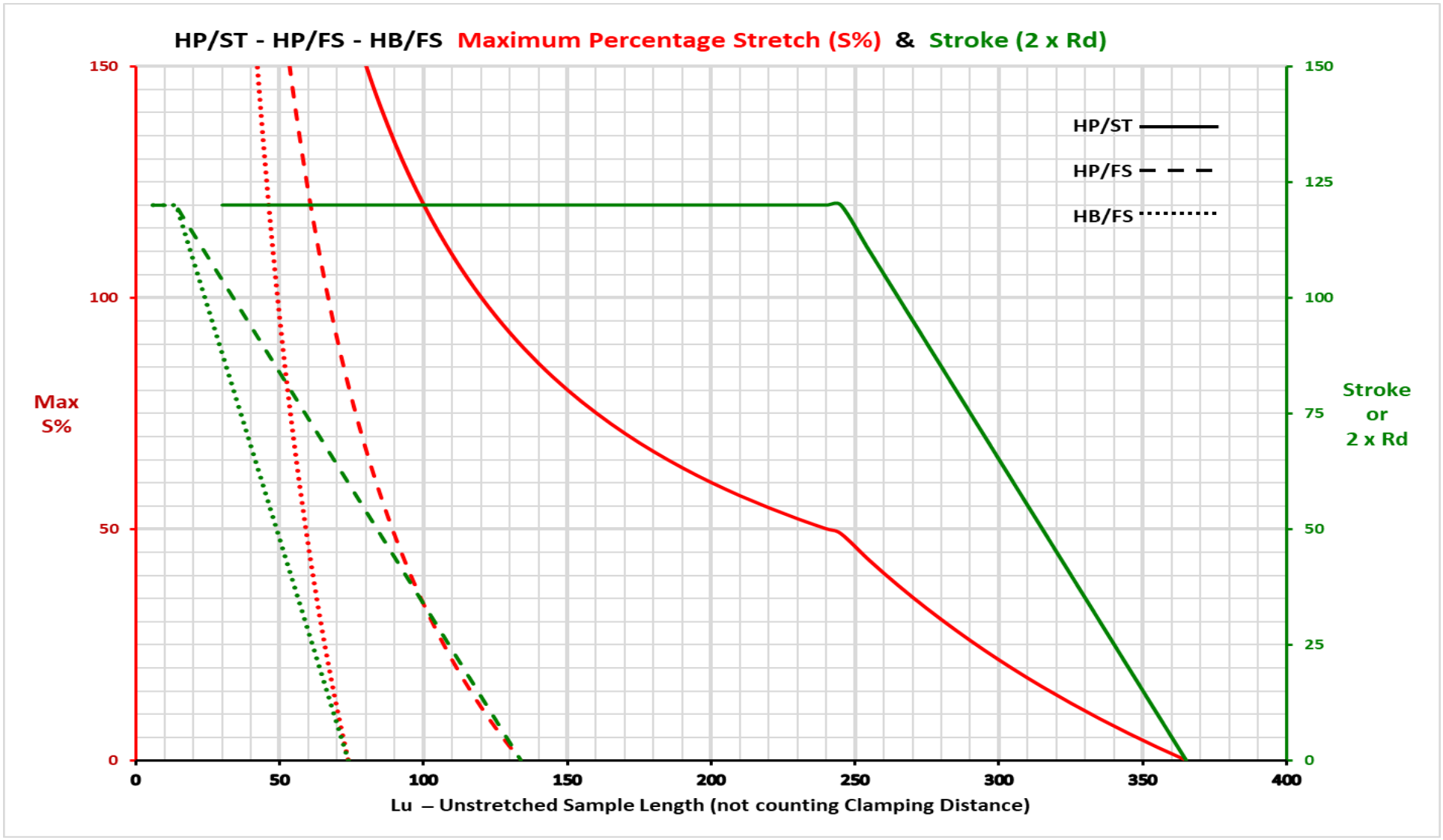

Figure 1. Comparison of Stretching Possibilities for HP/ST and HP/FS and HB/FS

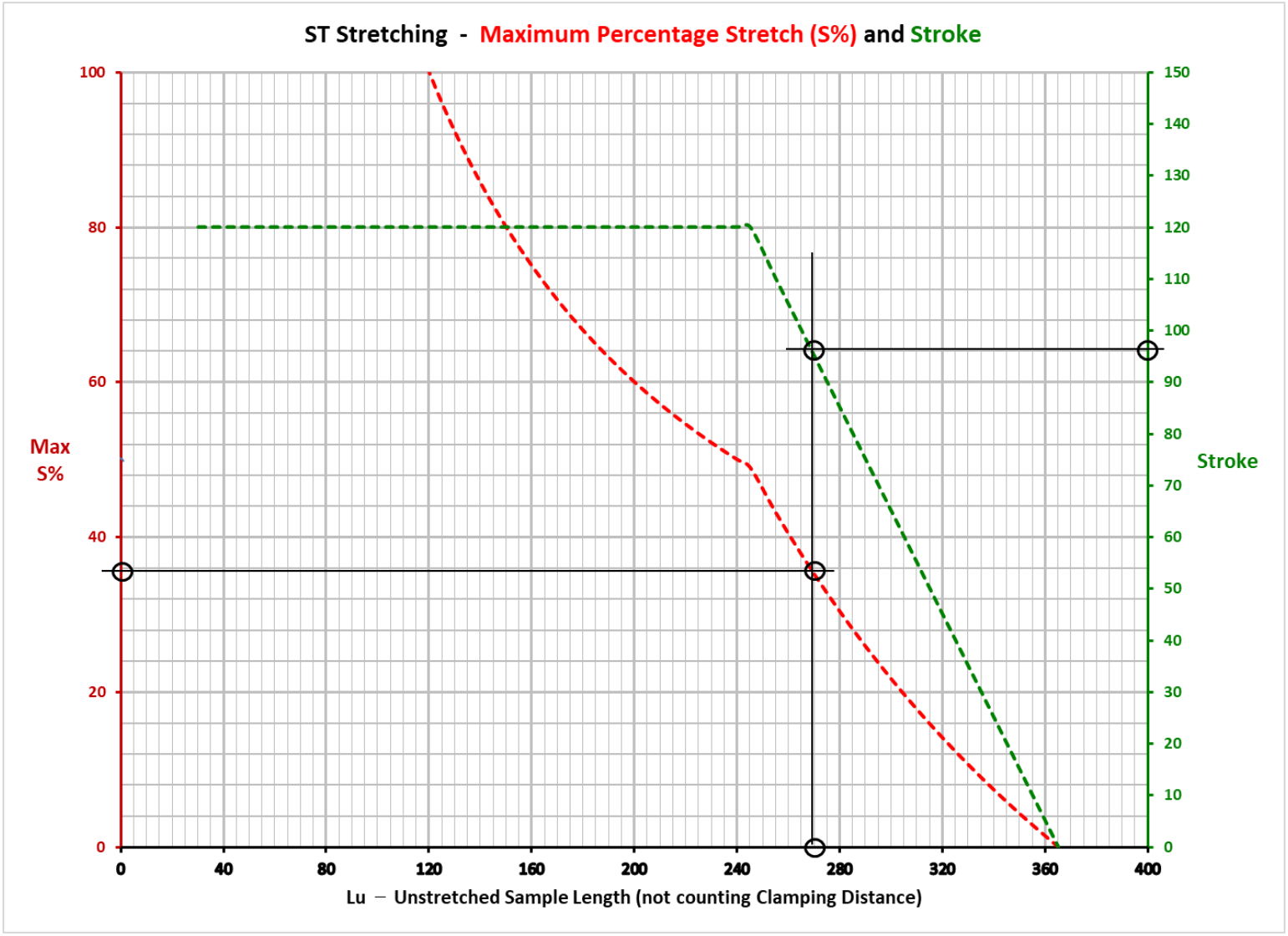

Figure 2. Stretching with the ST Jig
S% less than 100%

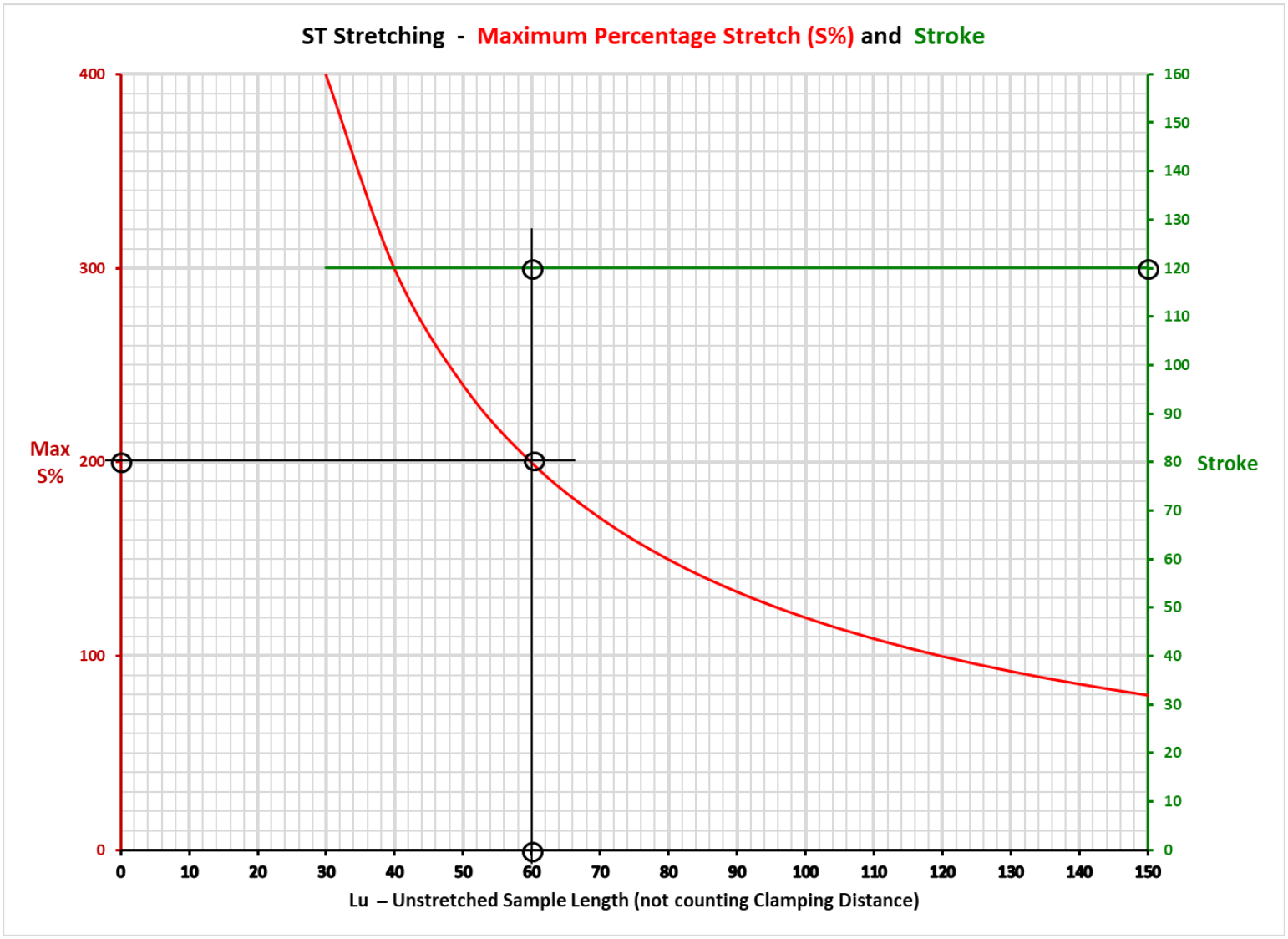

Figure 3. Stretching with the ST Jig
S% greater than 100%

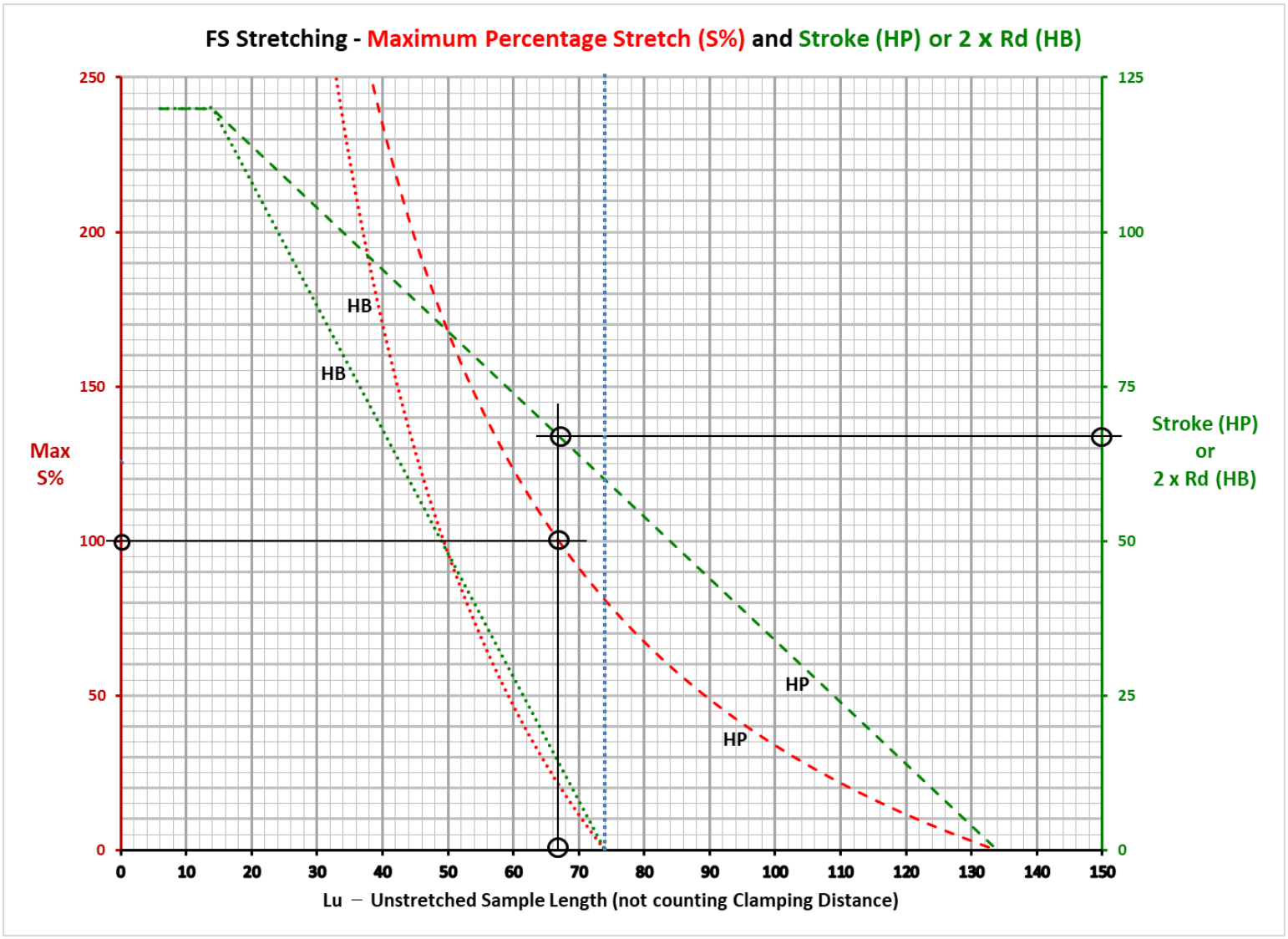

Figure 4. Stretching with the FS Jig using HP and HB Motor Drive Units S% less than 250%

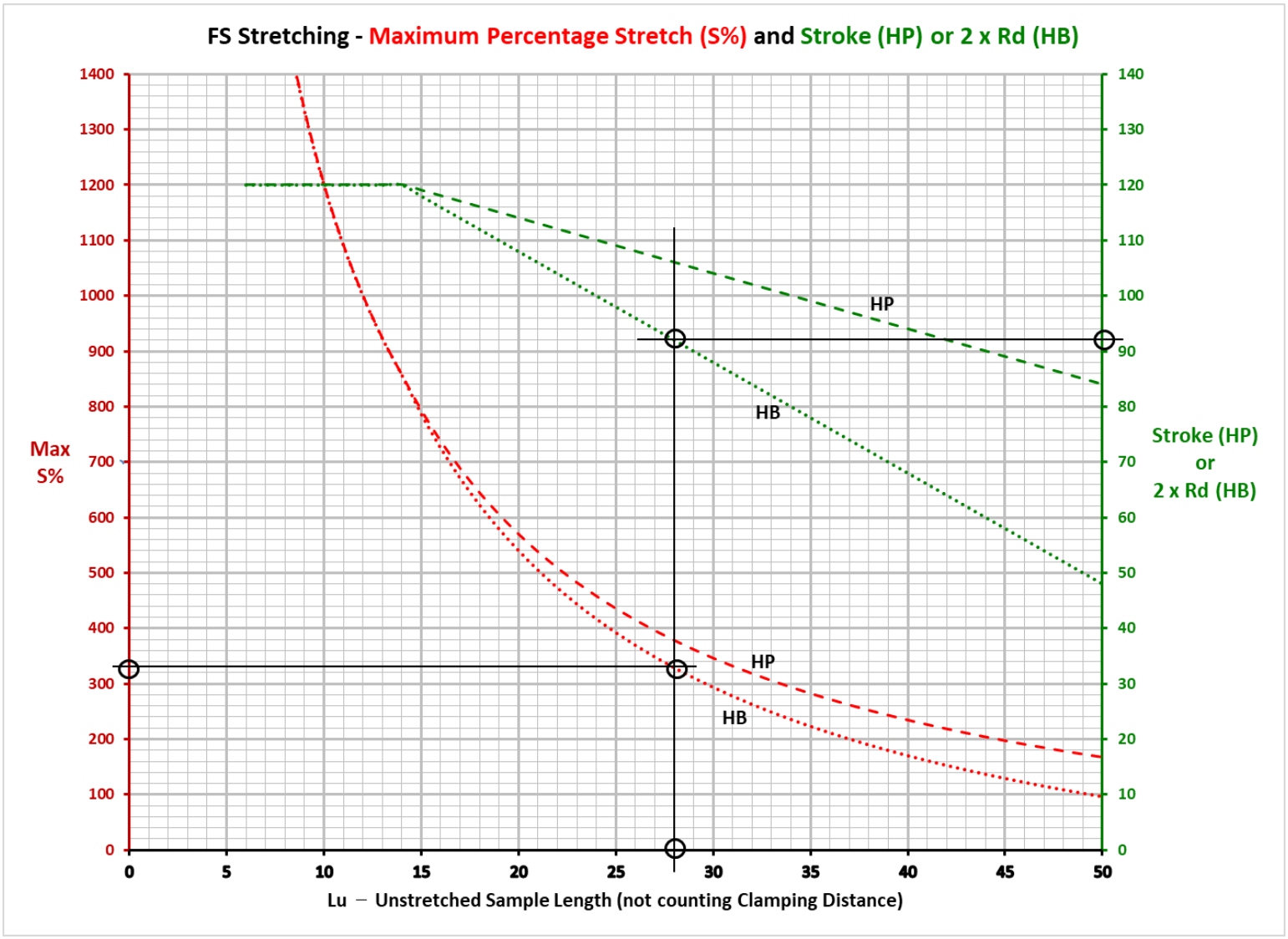

Figure 5. Stretching with the FS Jig using HP and HB Motor Drive Units S% greater than 250%