Rigging for tree removal is more complicated than climbing and demands experience and an understanding of the effects on the rope with the various knots and hitches used. It is widely known that knots can significantly reduce rope strength and corresponds to a reduction in the work load limit recommended by a manufacturer. The rigging techniques and knots presented here are meant to give a general overview of the basic principles of rigging. Prior to beginning any tree work, it is important to thoroughly examine the tree for structural imperfection, faults or weaknesses that could compromise safety. This text is not a substitute for proper training.

One of the most potentially dangerous aspects of rigging is “chunking out” large trunk sections of wood that are rigged vertically upon themselves.

Safety, as always, is the primary concern. It is important when rigging to minimize shock-loads and manage friction efficiently. This is easiest to achieve when using arborist grade rigging blocks in conjunction with appropriate friction/lowering devices both of which have been tested and rated.

Excessive shock loading must always be considered when rigging. The rigging system should be constructed to withstand the maximum shock-load potential. Generally, maximum shock loads are experienced in a rigging system when the rigged piece is “snubbed off” and not gradually decelerated.

Avoid “snubbing off” whenever possible. Testing and research show the block and sling can experience more than double the shock-load force in this situation.

**RUNNING BOWLLINE WITH HALF HITCH**

These knots are used in conjunction with one another to attach rigging lines to tree sections that are being rigged for removal. The running bowline is easily untied. It securely chokes the piece when steady pressure is applied. The half hitch increases safety and provides stability and holding power.

**ADJUSTABLE SLINGS**

Loopies or Whoopie Slings are an excellent alternative to the traditional timber hitch as they cannot come untied. The timber hitch can be used to attach a rigging block or a friction device to a tree to use as a lowering device to lower or hoist limbs. Tendency for the hitch to come untied can be minimized by tucking for a minimum of five wraps, spreading out the tucks over as much of the circumference of the trunk as possible, and ensuring that the hitch is loaded “against the bight” whenever possible.
Energy Absorption in Arborist Rigging

When rigging trees for limb or top removal, care must be taken to avoid failure in any part of the system, including the limbs and hardware that support you in the tree. Perhaps the most important tools are the ropes that provide your way in and out of the tree, keep you safe while in the tree, and assist with the work you do to the tree.

The strength of rope is based on the maximum load or force it can withstand without failure. However, when selecting rope for a given job you must take into consideration that the actual load placed on the rope can be more than the weight of the object being suspended.

For example, when a tree-rigging operation is setup for the purpose of limb removal and the rigging point is below the load, the portion of the tree being cut will fall a significant distance. The rope will reach its peak load and be shock loaded when it catches the limb and brings it to a stop. The type of rope, or fiber content of the rope involved, will determine whether or not the rope fails under the forces at work in this situation. A rope made of 100% polyester, such as Stable Braid, has lower elongation than a rope made with a blend of polyester and nylon, such as Nystron. A rope made of 100% nylon has extremely high elongation and is not recommended for this application.

To absorb the amount of energy it takes to stop a falling limb using a rope with higher elongation will result in lower peak forces than using a rope with lower elongation. Ropes with high elongation, such as Nystron, have a number of advantages when compared to a less elastic rope, such as Stable Braid:

- Reduced peak loading
- Reduced risk of system failure due to:
  - Less stress on the rope
  - Less stress on rigging hardware
  - Less stress on the tree
  - More energy absorption by the rope

As a result of the reduced risk of failure in the rigging system the margin of safety increases.

- The disadvantages of using a rope with higher elongation include:
  - Reduced control of the position of the object

We recommend that the arborist use the right tool for the job:

- For top roping and dropping loads in tight spaces: Stable Braid provides the greatest control for rigging of objects.

- Rigging objects above the anchor point and dropping in open spaces: Nystron provides improved shock absorption capabilities and reduces the chance of failure with a dropped load.

The load vs. elongation curves of two ropes with similar breaking strengths. The shaded area beneath each of the curves represents the energy absorbed as the rope stretches. The two areas shown are equal representations of the same energy absorption or the catching of the same falling load. As shown, Nystron absorbs the energy while reaching the lowest load, but stretching the farthest.
Comparison of Fiber Characteristics

<table>
<thead>
<tr>
<th>GENERIC FIBER TYPE</th>
<th>NYLON</th>
<th>POLYESTER</th>
<th>POLYPROPYLENE</th>
<th>HMPE</th>
<th>LCP</th>
<th>ARAMID</th>
<th>PBO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenacity (g/den)¹</td>
<td>7.5 – 10.5</td>
<td>7 – 10</td>
<td>6.5</td>
<td>32 (SK-60)</td>
<td>23 – 26</td>
<td>28</td>
<td>42</td>
</tr>
<tr>
<td>Elongation²</td>
<td>15 – 28%</td>
<td>12 – 18%</td>
<td>18 – 22%</td>
<td>3.6%</td>
<td>3.3%</td>
<td>4.6%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Coefficient of Friction³</td>
<td>.12 – .15</td>
<td>.12 – .15</td>
<td>.15 – .22</td>
<td>.05 – .07</td>
<td>.12 – .15</td>
<td>.12 – .15</td>
<td>.18</td>
</tr>
<tr>
<td>Melting Point</td>
<td>425° – 490° F</td>
<td>480° – 500° F</td>
<td>330° F</td>
<td>300° F</td>
<td>625° F</td>
<td>930° F*</td>
<td>1200° F*</td>
</tr>
<tr>
<td>Critical Temperature⁴</td>
<td>325° F</td>
<td>350° F</td>
<td>250° F</td>
<td>150° F</td>
<td>300° F</td>
<td>520° F</td>
<td>750° F</td>
</tr>
<tr>
<td>Specific Gravity⁵</td>
<td>1.14</td>
<td>1.38</td>
<td>.91</td>
<td>.98</td>
<td>1.40</td>
<td>1.39</td>
<td>1.56</td>
</tr>
<tr>
<td>Creep⁶</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Application Dependent</td>
<td>Application Dependent</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

¹ Char temperature — does not melt
² TENACITY is the measurement of the resistance of fiber to breaking.
³ ELONGATION refers to percent of fiber elongation at break.
⁴ COEFFICIENT OF FRICTION is based on the rope's resistance to slipping.
⁵ SPECIFIC GRAVITY is the ratio between the mass of a material and the mass of an equal volume of water. Specific gravities below 1 indicate the material will float in water; greater than 1 and the material will sink.
⁶ CRITICAL TEMPERATURE is defined as the point at which degradation is caused by temperature alone.
⁷ SPECIFIC GRAVITY is the ratio between the mass of a material and the mass of an equal volume of water. Specific gravities below 1 indicate the material will float in water; greater than 1 and the material will sink.
⁸ CRITICAL TEMPERATURE is defined as the point at which degradation is caused by temperature alone.
⁹ SPECIFIC GRAVITY is the ratio between the mass of a material and the mass of an equal volume of water. Specific gravities below 1 indicate the material will float in water; greater than 1 and the material will sink.

Rope Construction

All sizes stated are nominal diameters and do not reflect exact dimensions. Weights depicted are average net rope weights relaxed and standard tolerances are ± 5% unless agreed to in writing.

All Samson ropes are categorized for testing purposes as Class I or Class II ropes. Class I ropes are manufactured from polyolefin, nylon and/or polyester fiber. Class II ropes are manufactured from high-modulus fiber (i.e., Dyneema®, Zylon® Technora®, Vectran®).
Elongation (Stretch)

Defining Elastic Elongation
In order to establish definitions involving stretch in ropes, it is necessary to review the terms used to define its basic components.

ELASTIC ELONGATION (EE)
Elastic elongation refers to the portion of stretch or extension of a rope that is immediately recoverable after the load on the rope is released. The rope’s tendency to recover is a result of the fiber(s) rather than the rope construction. Each type of synthetic fiber inherently displays a unique degree of elasticity. Relatively speaking, high-performance fiber has extremely low elasticity as compared to nylon fiber.

ELASTIC HYSTERESIS
Elastic hysteresis refers to a recoverable portion of stretch or extension over a period of time after a load is released. In measuring elastic recovery, it is the portion that occurs immediately when a load is removed. However, a remaining small percentage of elastic recovery occurs gradually over a period of hours or days. Elastic hysteresis is measured in a length/time scale.

PERMANENT EXTENSION (PE) AFTER RELAXATION
Permanent extension after relaxation refers to the portion of extension that prevents the rope from returning to its original length due to construction deformation, such as compacting of braid and helical changes, and some plastic deformation of the yarn fibers.

PE WHILE WORKING
Permanent extension while working is the amount of extension that exists when stress is removed but no time is given for hysteretic recovery. It includes the nonrecoverable and hysteretic extension as one value and represents any increase in the length of a rope in a constant working situation, such as during repeated surges in towing or other similar cyclical operations. The percentage of PE over the working load range is generally in order of 4–6% for braided ropes and two to three times as much for plaited. However, it varies slightly with different fibers and rope constructions. In some applications, such as subsurface mooring or devices that demand precise depth location and measurement, allowances must be made for this factor.

CREEP
A material’s slow deformation that occurs while under load over a long period of time. Creep is mostly nonreversible. For some synthetic ropes, permanent elongation and creep are mistaken for the same property and used interchangeably when in fact creep is only one of the mechanisms that can cause permanent elongation.

CONSTRUCTIONAL ELONGATION
The elongation of a loaded rope that results from compaction as the fibers and strands align and adjust.

SPLICE SETTING
The elongation of a spliced rope caused by the adjustment and settling of the strands in the splice.

### TABLE 2. ELASTIC ELONGATION FOR ALL PRODUCTS.

<table>
<thead>
<tr>
<th>Product</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AmSteel®Blue</td>
<td>0.46%</td>
<td>0.70%</td>
<td>0.96%</td>
</tr>
<tr>
<td>ArborMaster®</td>
<td>3.00%</td>
<td>5.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>Arbor-Plex</td>
<td>3.00%</td>
<td>3.30%</td>
<td>4.20%</td>
</tr>
<tr>
<td>Bail Out</td>
<td>1.00%</td>
<td>1.20%</td>
<td>1.60%</td>
</tr>
<tr>
<td>Ice Tail</td>
<td>1.08%</td>
<td>1.61%</td>
<td>1.64%</td>
</tr>
<tr>
<td>Nystron</td>
<td>2.40%</td>
<td>4.50%</td>
<td>5.90%</td>
</tr>
<tr>
<td>Pro-Master</td>
<td>2.00%</td>
<td>3.20%</td>
<td>3.90%</td>
</tr>
<tr>
<td>Prusik Cord</td>
<td>1.10%</td>
<td>2.20%</td>
<td>3.50%</td>
</tr>
<tr>
<td>Stable Braid</td>
<td>1.10%</td>
<td>1.70%</td>
<td>2.70%</td>
</tr>
<tr>
<td>Tenex</td>
<td>1.40%</td>
<td>2.30%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Tenex-TEC</td>
<td>1.40%</td>
<td>2.30%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Tree-Master</td>
<td>2.90%</td>
<td>5.60%</td>
<td>8.20%</td>
</tr>
<tr>
<td>True-Blue</td>
<td>2.60%</td>
<td>3.00%</td>
<td>4.00%</td>
</tr>
<tr>
<td>True-White</td>
<td>2.60%</td>
<td>3.00%</td>
<td>4.00%</td>
</tr>
<tr>
<td>Ultra-Tech</td>
<td>0.63%</td>
<td>0.97%</td>
<td>1.24%</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.00%</td>
<td>5.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>Vortex</td>
<td>3.00%</td>
<td>5.00%</td>
<td>6.00%</td>
</tr>
</tbody>
</table>
TECHNICAL DATA

Rope Selection

SELECT THE RIGHT ROPE FOR THE JOB
Selecting a rope involves evaluating a combination of factors. Some of these factors are straightforward like comparing rope specifications. Others are not easily quantified, like color preference or how a rope feels in your hand. Cutting corners, reducing sizes, or strengths on an initial purchase creates unnecessary replacements, potentially dangerous conditions, and increases long-term costs. Fiber and construction being equal, a larger rope outlasts a smaller rope because of the greater surface wear distribution. Similarly, a stronger rope outlasts a weaker one because it will be used at a lower percentage of its break strength with less chance of being overstressed. The following areas should be considered in your rope selection:

STRENGTH
When given a choice between ropes, select the strongest of any given size. A load of 200 pounds represents 2% of the strength of a rope with a breaking strength of 10,000 pounds. The same load represents 4% of the strength of a rope that has a breaking strength of 5,000 pounds. The weaker rope is having to work harder and as a result will have to be retired sooner. Braided ropes are stronger than twisted ropes of the same size and fiber type.

Note carefully the quoted breaking strengths of the various Samson products. These are average breaking strengths. Published breaking strengths are determined by standard cordage testing and do not cover conditions such as sustained loads or shock loading. These strengths are attained under laboratory conditions. Remember also, that this is a breaking strength—not a recommended working load.

ELONGATION
It is well accepted that ropes with lower elongation under load will give you better load control—a big help on complicated job sites. However, ropes with lower elongation that are shock loaded, such as a lowering line, can fail without warning even though it appears to be in good shape. Low elongating ropes should be selected with the highest possible strength. Both twisted ropes and braided ropes are suitable for rigging. Twisted rope has lower strength and more stretch. Braided rope has higher strength and lower stretch.

SHOCK LOADING
Working loads as described herein are not applicable when rope has been subjected to shock loading. Whenever a load is picked up, stopped, moved, or swung there is an increased force caused by the dynamic nature of the movement. The force increases as these actions occur more rapidly or suddenly, which is known as "shock loading." Examples of applications where shock loading occurs include ropes used as a tow line, picking up a load on a slack line, or using rope to stop a falling object. In extreme cases, the force put on the rope may be two, three, or more times the normal load involved. Shock-loading effects are greater on a low elongation rope such as polyester than on a high-elongation rope such as nylon, and greater on a short rope than on a long one.

For example, the shock load on a winch line that occurs when a 5,000-lb object is lifted vertically with a sudden jerk may “weigh” 30,000 lb under the dynamic force. If the winch line is rated in the 30,000-lb break-strength range, it is very likely to break.

Where shock loads, sustained loads, or where life, limb, or valuable property is involved, it is recommended that an increased working load factor be used.

It is recommended that a lower working load factor be selected with only expert knowledge of conditions and professional estimates of risk; if the rope has been inspected and found to be in good condition; and if the rope has not been subject to shock loads, excessive use, elevated temperatures, or extended periods under load.

For dynamic loading applications that involve severe exposure conditions, or for recommendations on special applications, consult the manufacturer.

FIRMNESS
Select ropes that are firm and round and hold their shape during use. Soft or mushy ropes will snap easily and abrade quickly causing accelerated strength loss. Because the fibers are in a straighter line, which improves strength but compromises durability, loose or mushy rope will almost always have higher break strengths than a similar rope that is firm and holds its shape.

CONSTRUCTION AND ABRASION
It is important to choose the right rope construction for your application, because it affects resistance to normal wear and abrasion. Braided ropes have a round, smooth construction that tends to flatten out somewhat on a bearing surface. This distributes the wear over a much greater area; as opposed to the crowns of a 3-strand or, to a lesser degree, an 8-strand rope.

ASSIGNED WORKING LOAD FACTORS
Assigned working load factors vary in accordance with the different safety practices and policies of utilities and industrial users. However, our recommendation, and one that is fairly well accepted in the industry, is a minimum 10:1 working load factor for climbing lines and 5:1 working load factor for rigging lines. As an example, your maximum rigging line work load should be approximately 1/5th, or 20%, of the quoted breaking strength. This factor provides greater safety and extends the service life of the line.

Assume that you have seven identical ropes, each with a 30,000-lb breaking strength and you work these ropes daily with each rope lifting a different load, as shown in Table 3.

Table 3 shows that the higher the working load factor, the greater the service life and the lower the replacement factor. Therefore, the working load factor directly reflects the economy of the purchase.

TABLE 3. WORKING LOADS FOR SEVEN ROPES WITH BREAKING STRENGTHS OF 30,000 LB.

<table>
<thead>
<tr>
<th></th>
<th>Working Load*</th>
<th>Working Load Factor</th>
<th>Number of Lifts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30,000 lb</td>
<td>5,000 lb</td>
<td>6:1</td>
</tr>
<tr>
<td>2</td>
<td>30,000 lb</td>
<td>6,000 lb</td>
<td>5:1</td>
</tr>
<tr>
<td>3</td>
<td>30,000 lb</td>
<td>7,500 lb</td>
<td>4:1</td>
</tr>
<tr>
<td>4</td>
<td>30,000 lb</td>
<td>10,000 lb</td>
<td>3:1</td>
</tr>
<tr>
<td>5</td>
<td>30,000 lb</td>
<td>15,000 lb</td>
<td>2:1</td>
</tr>
<tr>
<td>6</td>
<td>30,000 lb</td>
<td>20,000 lb</td>
<td>1.5:1</td>
</tr>
<tr>
<td>7</td>
<td>30,000 lb</td>
<td>28,000 lb</td>
<td>1:1:1</td>
</tr>
</tbody>
</table>

*Relative values only. The higher the working load factor the greater the service life, and, of course, the lower the replacement factor. Thus, a working load factor also directly reflects an economy factor. If you are always lifting the same weight, then the stronger the rope, the higher the working load factor, and the longer the rope will last.

IMPORTANT NOTE: It is important to note that many industries are subject to state and federal regulation on working load limits that supersede the manufacturer's recommendation. It is the responsibility of the rope user to be aware of and adhere to those laws and regulations.
Rope Handling and Usage

**DIELECTRIC PROPERTIES**
Based on rope industry practices, dielectric property testing is conducted on clean, new rope samples and holds true only under such ideal conditions. Dirt, grease, foreign matter, and moisture (including humidity) will alter the nonconductive/conductivity of any synthetic rope or material. No rope manufacturer can attest to a rope's dielectric properties under actual operating conditions.

**REMOVING ROPE FROM A REEL OR COIL**
Synthetic-fiber ropes are normally shipped on reels for maximum protection while in transit. The rope should be removed from the reel by pulling it off the top while the reel is free to rotate. This can be accomplished by passing a pipe through the center of the reel and jacking it up until the reel is free from the deck. Rope should never be taken from a reel lying on its side. If the rope is supplied on a coil, it should always be uncoiled from the inside so that the first turn comes off the bottom in a counter-clockwise direction.

**ROPE STORAGE: COILING, FLAKING, AND BAGGING**
Great care must be taken in the stowage and proper coiling of 3-strand ropes to prevent the natural built-in twist of the line from developing kinks and hockles. Braided ropes on the other hand have no built-in twist and are far more resistant to kinking. Even if kinks do develop, they cannot develop further into hockles.

Three-strand and braided ropes should be coiled in a clockwise direction (or in the direction of the lay of the rope) and uncoiled in a counter-clockwise direction to avoid kinks. An alternate and perhaps better method is to flake out the line in a figure eight. This avoids putting twist in the line in either direction and lessens the risk of kinking.

Bagging is the most common method of storing braided or twisted climbing lines. The rope is allowed to fall into its natural position without deliberate direction.

**BENDING RADIUS**
Any sharp bend in a rope under load decreases its strength substantially and may cause premature damage or failure. In sizing the radius of bitts, fairleads and chocks for best performance, the following guidelines are offered:

Where a rope bends more than 10 degrees around bitts or chocks, or is bending across any surface, the diameter of that surface should not be less than 3 times the diameter of the rope. Stated another way, the diameter of the surface should be at least 3 times the rope diameter. A 4-to-1 ratio (or larger) would be better yet because the durability of the rope increases substantially as the diameter of the surface over which it is worked increases.

On a cleat when the rope does not bend radially around, the barrel of the cleat can be one half the rope circumference (minimum).

The ratio of the length of an eye splice to the diameter of the object over which the eye is to be placed (for example, bollard, bitt, cleat, etc.) should be a minimum 3-to-1 relationship and preferably 5-to-1. In other words, if you have a bollard 2 feet in diameter the eye splice should be 6 or 10 feet in length. By using this ratio the angle of the 2 legs of the eye splice at its throat will not be so severe as to cause a parting or tearing action at this point (thimbles are normally designed with a 3-to-1 ratio).

**DANGER TO PERSONNEL**
Persons should be warned against the serious danger of standing in line with a rope under tension. Should the rope separate, it may recoil with considerable force. In all cases where any such risks are present, or where there is any question about the load involved or the condition of use, the working load should be substantially reduced and the rope properly inspected before every use.
TECHNICAL DATA

Rope Handling and Usage (cont.)

EYE SPICES
The standard eye splice cannot be pulled out under tension, however, it can be pulled out by hand when the winch line is in a relaxed state. To prevent such tampering, it is recommended that lock stitching or tight seizing be applied to the base or throat of the splice.

Lock stitching may also prove advantageous on some splices to prevent no-load opening due to mishandling. The material required is one fid length of nylon whipping twine approximately the same size diameter as the strands in the rope you are lock stitching. The strands cut from the rope you are lock stitching may also be used, but whipping twine is preferable. You may download lock-stitch instructions from our website SamsonRope.com or call customer service to receive them by mail.

Eye splices at the end of winch lines (if not put in at the factory) should be done in strict accordance with the steps and procedures outlined in Samson splicing instructions. These splicing methods can be easily learned and executed by line crews and shop personnel. Splicing instruction assistance is available through the Samson Technical Representative in your area.

Splicing Training Kits, manuals, and tools can be ordered through your local Samson Distributor or direct from the factory. Instructions are also available online at SamsonRope.com.

KNOTS AND WINCH LINES
While it is true that a knot reduces rope strength, it is also true that a knot is a convenient way to accomplish rope attachment. The strength loss is a result of the tight bends that occur in the knot. With some knots, ropes can lose significant strength, however, this number can change based on rope construction and fibers used. It is vital that the reduction in strength by the use of knots be taken into account when determining the size and strength of a rope to be used in an application. To avoid knot strength reduction, it is recommended that a rope be spliced according to the manufacturer's instructions. Splice terminations are used in all our ropes to determine new and unused tensile strengths. Therefore, whenever possible, spliced terminations should be used to maximize the rope strength for new and used ropes.

USE OF SLINGS WITH WINCH LINES
The winch line itself should not be used as a choker to pick up a pole or other objects. The hook attached on the end of the winch line can cut deeply into the rope itself. We recommend a separate line, sling or strap be used as the choker and not the winch line itself.

TEMPERATURE
Friction can be your best friend or worst enemy if it is not managed properly. Friction takes place anytime two surfaces come in contact. Mild friction, sometimes referred to as grip is a good characteristic, especially in winching applications. However friction creates heat, the greater the friction, the greater the heat buildup. Heat is an enemy to synthetic fiber and elevated temperatures can drastically reduce the strength and/or cause rope melt-through.

High temperatures can be achieved when checking ropes on a cable or running over stuck or non-rolling sheaves or rollers. Each rope's construction and fiber type will yield a different coefficient of friction (resistance to slipping) in a new or used state. It is important to understand the operational demands, and take into account the size of the rope, construction, and fiber type to minimize heat buildup.

Never let ropes under tension rub together or move relative to one another. Enough heat to melt the fibers can buildup and cause the rope to fail quickly; as if it had been cut with a knife.

Be aware of areas of heat buildup and take steps to minimize them. Under no circumstances let any rope come in contact with an exhaust muffler or any other hot object. The strength of a used rope can be determined by testing, but often the rope is destroyed in the process so the ability to determine the retirement point before it fails in service is essential.

That ability is based on a combination of education in rope use and construction along with good judgment and experience. Remember, you almost always get what you pay for in the form of performance and reliability.

TABLE 4. THE CRITICAL AND MELTING TEMPERATURES FOR SYNTHETIC FIBERS.

<table>
<thead>
<tr>
<th>FIBER TYPE</th>
<th>CRITICAL TEMP</th>
<th>MELTING TEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMPE</td>
<td>150° F</td>
<td>300° F</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>250° F</td>
<td>330° F</td>
</tr>
<tr>
<td>Nylon</td>
<td>325° F</td>
<td>425 - 490° F</td>
</tr>
<tr>
<td>Polyester</td>
<td>350° F</td>
<td>480° F</td>
</tr>
<tr>
<td>Aramid</td>
<td>450° F</td>
<td>900° F</td>
</tr>
</tbody>
</table>

*While the term “melting” does not apply to this fiber, it does undergo extreme degradation in these temperatures, and they char.

STRENGTH DEGRADATION FROM ULTRAVIOLET LIGHT
Prolonged exposure of synthetic ropes to ultraviolet (UV) radiation from sunlight causes varying degrees of strength degradation.

Polyester fibers are the least affected by UV exposure, and the resulting strength degradation of exposed fibers is negligible. Nylon is more susceptible to strength loss due to ultraviolet rays, but with both polyester and nylon, the degree of susceptibility to UV damage is dependent on the type of fiber and the various UV inhibitors with which the fiber manufacturer treats them (i.e., Samthane coating).

Polyolefin and PBO fibers are severely affected by ultraviolet exposure, especially in their natural, undyed, and/or unused states.

HARMFUL CHEMICALS
Certain chemicals can break down synthetic fibers. Sulfuric acids, alkalis, and chlorinate hydrocarbons over 150° F should be avoided, while strong cleaning agents or bleaches may be harmful. If you are unsure about the effect of a specific chemical, contact our customer service department for more information.

AVOID SHOCK LOADING
Shock loading of any line—synthetic, manila, or wire—produces a drastically different set of physical properties and results as compared with normal loading. Shock loading is a jerking or snatching of a line, or a very sudden change in tension such as from a relaxed state or low load to one of high load. A sudden drop off of a platform from as short a distance as four inches actually doubles the rope’s load. Similarly, an overwrap “falling off” the winch drum can result in a shock load. This results in accelerated wear of the rope. For more information about working load factors and shock loading, see page 22.

FATIGUE
Synthetic fibers have memory; they remember and retain the effects of being overloaded and shock loaded. This why winch line procedures are so important to reducing the danger of shock loading, which prolongs the life of the rope and reduces premature down grading. If there is reason to believe that a line has been shock loaded above its recommended working load, it should be logged. If a number of these instances occur, the line should be inspected and rotated.

END-FOR-ENDING
It is recommended that every winch line be rotated end-for-end on a periodic basis. This will vary high stress and wear points and extend useful life. The recommended end-for-ending period is six months, at which time visual inspection and washing can also be done.
Retire the Rope When It’s Time

One question frequently asked is “When should I retire my rope?” The most obvious answer is before it breaks. But, without a thorough understanding of how to inspect it and knowing the load history, you are left making an educated guess. Unfortunately, there are no definitive rules nor are there industry guidelines to establish when a rope should be retired because there are so many variables that affect rope strength. Factors like load history, bending radius, abrasion, chemical exposure or some combination of those factors, make retirement decisions difficult. Inspecting your rope should be a continuous process of observation before, during, and after each use. In synthetic fiber ropes, the amount of strength loss due to abrasion and/or flexing is directly related to the amount of broken fiber in the rope’s cross section. After each use, look and feel along every inch of the rope length inspecting for abrasion, glossy or glazed areas, inconsistent diameter, discoloration, and inconsistencies in texture and stiffness.

VISUAL INSPECTION

The load-bearing capacity of double braid ropes, such as Stable Braid, is divided equally between the inner core and the outer cover. If upon inspection, there are cut strands or significant abrasion damage the rope must be retired because the strength of the entire rope is decreased.

Core-dependent double braids such as Ultra-Tech have 100% of their load-bearing capacity handled by the core alone. For these ropes, the jacket can sustain damage without compromising the strength of the load-bearing core. Inspection of core-dependent double braids can be misleading because it is difficult to see the core. In the case of 12-strand single braids such as AmSteel® and AmSteel® Blue, each of the 12-strands carries approximately 8.33%, or 1/12th, of the load. If upon inspection, there are cut strands or significant abrasion damage to the rope, the rope must be retired or the areas of damage removed and the rope repaired with the appropriate splice.

ABRASION

When a 12-strand single-braid rope, such as AmSteel® Blue, is first put into service, the outer filaments of the rope will quickly fuzz up. This is the result of these filaments breaking, which actually forms a protective cushion and shield for the fibers underneath. This condition should stabilize, not progress. If the surface roughness increases, excessive abrasion is taking place and strength is being lost. When inspecting the rope, look closely at both the inner and outer fibers. When either is worn, the rope is obviously weakened.

Open the strands and look for powdered fiber, which is one sign of internal wear. Estimate the internal wear to estimate total fiber abrasion. If total fiber loss is 20%, then it is safe to assume that the rope has lost 20% of its strength as a result of abrasion. As a general rule for braided ropes, when there is 25% or more wear from abrasion, or the fiber is broken or worn away, the rope should be retired from service. For double braid ropes, 50% wear on the cover is the retirement point, and with 3-strand ropes, 10% or more wear is accepted as the retirement point.

GLOSSY OR GLAZED AREAS

Glossy or glazed areas are signs of heat damage with more strength loss than the amount of melted fiber indicates. Fibers adjacent to the melted areas are probably damaged from excessive heat even though they appear normal. It is reasonable to assume that the melted fiber has damaged an equal amount of adjacent unmelted fiber.

DISCOLORATION

With use, all ropes get dirty. Be on the lookout for areas of discoloration that could be caused by chemical contamination. Determine the cause of the discoloration and replace the rope if it is brittle or stiff.

INCONSISTENT DIAMETER

Inspect for flat areas, bumps, or lumps. This can indicate core or internal damage from overloading or shock loads and is usually sufficient reason to replace the rope.

INCONSISTENT TEXTURE

Inconsistent texture or stiff areas can indicate excessive dirt or grit embedded in the rope or shock load damage and is usually reason to replace the rope.

RESIDUAL STRENGTH

Samson offers customers residual strength testing of our ropes. Periodic testing of samples taken from ropes currently in service ensures that retirement criteria are updated to reflect the actual conditions of service.
Single Braids

**Inspection and Retirement Checklist**

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

- the length of the rope,
- the time it has been in service,
- the type of work it does,
- where the damage is, and
- the extent of the damage.

In general, it is recommended that you:

- Repair the rope if the observed damage is in localized areas.
- Retire the rope if the damage is over extended areas.


### REDUCED VOLUME

**WHAT**
- 25% reduction

**CAUSE**
- Abrasion
  - Sharp edges and surfaces
  - Cyclic tension wear

### MELTED OR GLAZED FIBER

**WHAT**
- Fused fibers
  - Visibly charred or melted fibers, yarns, and/or strands
  - Extreme stiffness
  - Unchanged by flexing

**CAUSE**
- Exposure to excessive heat, shock load, or a sustained high load

### DISCOLORATION/DEGRADATION

**WHAT**
- Fused fibers
- Brittle fibers
- Stiffness

**CAUSE**
- Chemical contamination

### INCONSISTENT DIAMETER

**WHAT**
- Flat areas
- Lumps and bumps

**CAUSE**
- Shock loading
- Broken internal strands

**INSPECTING FOR ABRASION DAMAGE**

Internal abrasion can be determined by pulling one strand away from the others and looking for powdered or broken fiber filaments. (ABOVE)

To determine the extent of outer fiber damage from abrasion, a single yarn in all abraded areas should be examined. The diameter of the abraded yarn should then be compared to a portion of the same yarn or an adjacent yarn of the same type that has been protected by the strand crossover area and is free from abrasion damage. (LEFT)
Inspection and Retirement Checklist*

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

> the length of the rope,
> the time it has been in service,
> the type of work it does,
> where the damage is, and
> the extent of the damage.

In general, it is recommended to:

> Repair the rope if the observed damage is in localized areas.
> Retire the rope if the damage is over extended areas.


DOUBLE BRAID vs. CORE-DEPENDENT

Double braid ropes consist of a cover or jacket braided over a separately braided core. Samson produces two types of double braided ropes: standard double braids and core-dependent double braids.

The strength of standard double braid ropes is shared between the cover and the core. Damage to the cover also usually affects the core and ultimately the strength of the rope.

In core-dependent double braids, the core is the strength member and carries the entire load. Damage to the cover of a core-dependent double braid may not compromise strength of the rope.

Inspection of both standard double braids and core-dependent double braids is essential to determining whether the rope can be repaired or if it needs to be retired.

DOUBLE BRAID CHECKLIST

INCONSISTENT DIAMETER  Repair or retire

WHAT  > Flat areas
> Lumps and bumps

CAUSE  > Shock loading
> Broken internal strands

REDUCED VOLUME  Repair or retire

WHAT  > 50% volume reduction

CAUSE  > Abrasion
> Sharp edges and surfaces
> Cyclic tension wear

MELTED OR GLAZED FIBER  Repair or retire

WHAT  > Fused fibers
> Visibly charred and melted fibers, yarns, and/or strands
> Extreme stiffness
> Unchanged by flexing

CAUSE  > Exposure to excessive heat, shock load, or a sustained high load

DISCOLORATION/DEGRADATION  Repair or retire

WHAT  > Fused fibers
> Brittle fibers
> Stiffness

CAUSE  > Chemical contamination

CUT STRANDS  Repair or retire

WHAT  > Three or more adjacent cut strands

CAUSE  > Abrasion
> Sharp edges and surfaces
> Cyclic tension wear

DOUBLE BRAID: Repair or retire

CORE-DEPENDENT: May not affect strength

WHAT  > Fused fibers
> Visibly charred and melted fibers, yarns, and/or strands
> Extreme stiffness
> Unchanged by flexing

CAUSE  > Exposure to excessive heat, shock load, or a sustained high load

CORE-DEPENDENT: May not affect strength

WHAT  > 50% volume reduction

CAUSE  > Abrasion
> Sharp edges and surfaces
> Cyclic tension wear