The use of rope and cordage products has inherent safety risks which are subject to highly variable conditions and which may change over time. Compliance with standards and guidelines of the Cordage Institute does not guarantee safe use under all circumstances, and the Institute disclaims any responsibility for accidents which may occur. If the user has any questions or uncertainties about the proper use of rope or cordage or about safe practices, consult a professional engineer or other qualified individual.

1. Industrial Grade (High Tenacity) Fibers
   Fibers are the foundation for all twine, cables, cordage, rope, and netting products. In the past ten years, there have been many new developments in fibers. It is important; therefore, that engineers and users understand and appreciate the "building blocks" of any strength member product.

   Historically, cordage, ropes and twines were made from natural (vegetable) fibers. While these are still important for some applications, virtually all modern cordage products are based on synthetic fibers.

   For the purpose of this document industrial grade fibers used in quality cordage and rope are synthetic fibers with a tenacity up to 15 grams per denier (gpd). High tenacity fibers used in quality cordage and rope are synthetic fibers with a tenacity above 15 grams per denier (gpd).

   Many synthetic fibers can have a pigment added during the manufacturing process resulting in permanent color. A variety of colors are available.

1.1 Polyamide (Nylon)
   The first man-made fiber used in cordage was nylon. It is a manufactured fiber composed of linear macromolecules having in the chain recurring amide linkages, at least 85% of which are joined to aliphatic or cycloaliphatic units. Two types of nylon are commonly used in rope making. Nylon 6 is made from amino caprolactam. Nylon 6,6 is made from hexamethylene diamine and adipic acid. The principal property difference is melt point.

   The proper chemical name for nylon is polyamide. Chemical abbreviation PA; Chemical formula:
   
   \[-\text{NH-(CH2)5-CO-}\]n (nylon 6), and
   
   \[-\text{NH-(CH2)6-NH-CO(CH2)4-CO-}\]n (nylon 6,6).

   Fiber tenacity ranges are from 7.5 to over 10.5 gpd.
1.2 **Polyester**
A manufactured fiber produced from the linear polymer 'polyethylene terephthalate'.
Chem. abbr. PET (PES is also sometimes used);
Chem. form.: -[OC- C6H4 -COO-CH2-CH2-0]-

More generally, polyester includes polymers composed of linear macromolecules having in the chain at least 85% by mass of an ester of a diol and terephthalic acid. Such linear polyesters are fiber forming.

Tenacity ratings of industrial polyester fibers range from 7.0 gpd to over 10.0 gpd.

Higher modulus polyesters, such as PEN (Polyethylene naphthalate) are also available.

1.3 **Polyolefins**
A class of polymers in which the fiber-forming substance is any long-chain synthetic polymer composed of at least 85% by weight of ethene (ethylene), propane (propylene), or other olefin units. This class includes Polypropylene and Polyethylene.

1.3.1 **Polypropylene**
A manufactured fiber formed by melt spinning and drawing polymers or copolymers of propylene, an aliphatic saturated hydrocarbon linear macromolecule where one carbon atom in two carries a methyl side chain in an isostatic disposition and without further substitution.
Chem. abbr. PP; chem. form. -(CH2-CH)-
I
CH3

1.3.2 **Polyethylene**
A manufactured fiber formed of polymers of ethylene, synthetic linear macromolecules of unsubstituted aliphatic saturated hydrocarbon.
Chem. abbr. PE; chem. form. -(CH2-CH2)-

1.3.3 **Copolymer Fibers**
Copolymer is the industry term for the melt combination of olefin polymer(s) (polypropylene/polyethylene) together or with other polymer(s) such as polyester. In most cases, copolymer combinations are based on proprietary formulas.

1.4 **Fluoropolymers**
A class of fluorocarbon based polymers with very strong carbon-fluorine bonds which are inherently chemically stable.

1.4.1 **Expanded Polytetrafluoroethylene (ePTFE)**
A manufactured fiber formed of long polymer chains of PTFE stretched into nodes and fibrils.
Chem. form.: -(CnF2n)-

2. **Combination, Duplex, or Blended Fibers**
Cordage and rope can be made with the properties of more than one fiber by combining them in a single construction. In stranded and single-braided ropes, this is usually done by the combining of yarns or filaments of different fibers in the making of strands. In double-braided ropes this can also be done by using one type of fiber in the core and another in the cover, by utilizing differences in the fiber characteristics through the braid design.
3. Natural Fibers

NOTE: Ropes made from natural fibers can lose significant strength under normal storage conditions. For this reason, natural fiber ropes should NOT be used in applications where life and limb is at risk.

Natural fibers are classified as hard fibers and soft fibers. Generally speaking, hard fibers form the structural system of the leaf or plant, and soft fibers are found in the bast layer of the plant stem.

3.1 Abaca (manila): Abaca is obtained from the tropical plant Musa Testilis, a member of the banana plant family. It is commonly known as Manila hemp, which is a misnomer since the hemp plant belongs to the soft fiber group. Abaca is the strongest of the natural fibers. The majority of manila is grown in the Philippines.

3.2 Sisal and henequen: Sisal (Agave sisalana) and henequen (A. fourcroydes) are hard fibers. Henequen is sometimes called Mexican or Cuban sisal. Various sisals are identified by country of origin: Brazil, Haiti, Kenya, Tanzania, and Indonesia being the major producers.

3.3 Others: Jute is a soft fiber and comes from two closely related plants: Corchorous capsularia and C. olitorius. Hemp is a soft fiber and comes from the Cannabis sativa plant. Cotton is a natural fiber widely used in the textile industry, including some cordage and smaller diameter ropes. Cotton is often blended with synthetic staple fibers for additional strength and improved abrasion resistance.

4. High-Performance High-Modulus Fibers

These fibers have a tenacity greater than 15.0 grams/denier (gpd). The first of these was para-aramid (1970’s) followed by High Modulus PolyEthylene (HMPE, 1980’s) and liquid crystal polyester (LCP, 1990’s).

4.1 Para-aramid fibers. A manufactured high-modulus fiber in which the fiber-forming substance is a long chain synthetic aromatic polyamide in which at least 85% of the amide linkages are attached directly to two aromatic rings.

4.2 High Modulus PolyEthylene (HMPE). A polyolefin fiber produced by gel spinning or solid-state extrusion of an Ultra High Molecular Weight PolyEthylene (UHMWPE) feedstock to produce extremely high tenacity. Also called Extended-Chain PolyEthylene (ECPE) or High-Performance PolyEthylene (HPPE).

4.3 Liquid Crystal Polyester, (LCP). A thermotropic liquid crystal aromatic polyester fiber produced by melt spinning. It is a high-performance multifilament yarn with high tenacity and modulus. Also known as polyester-arylate.

4.4 PBO. PBO is a poly-para-phenylene bisoxazole fiber. PBO is polymerized from diaminoresocinol dichloride and terephthalic acid in polyphosphoric acid.
### Table 1  Cordage Institute Industrial Fibers Chart
(Industrial fibers are defined as having an average breaking tenacity between 5 and 15.0 grams/denier)

<table>
<thead>
<tr>
<th>Generic Fiber Description</th>
<th>Density, g/cm³</th>
<th>Breaking Tenacity (gpd)</th>
<th>Elongation at Break %</th>
<th>Melting Temperature °C</th>
<th>Moisture Regain %</th>
<th>Resistance to Abrasion, Creep, and Sunlight Exposure</th>
<th>Chemical Exposure Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyamide (nylon) PA 6 or PA6,6</td>
<td>1.14</td>
<td>7.5 – 10.5</td>
<td>15 – 40</td>
<td>218 (PA6), 258 (PA6,6)</td>
<td>4.0 – 6.0</td>
<td>Very good abrasion resistance when dry, poor abrasion resistance when wet unless special finishes are applied. Creep resistance is fair, and sunlight resistance is good with appropriate UV inhibitors.</td>
<td>Resistant to weak acids, decomposed by strong mineral acids. Resistant to alkalis. Resistant to organic solvents, soluble in phenols and formic acid</td>
</tr>
<tr>
<td>Polyethylene terephthalate (polyester) PET or PES</td>
<td>1.38</td>
<td>7.0 – 10.0</td>
<td>12 – 18</td>
<td>254 – 260</td>
<td>&lt;0.5</td>
<td>Very good abrasion and sunlight resistance. Good resistance to creep.</td>
<td>Resistant to mineral acids, decomposed by strong sulfuric acids. Decomposed by strong alkalis at high temperature. Resistant to organic solvents, soluble in phenols.</td>
</tr>
<tr>
<td>Polyethylene naphthalate PEN</td>
<td>1.40</td>
<td>10</td>
<td>6</td>
<td>275 – 280</td>
<td>&lt;0.5</td>
<td>Very good abrasion and sunlight resistance. Good resistance to creep.</td>
<td>Resistant to mineral acids, decomposed by strong sulfuric acids. Decomposed by strong alkalis at high temperature. Resistant to organic solvents, soluble in phenols.</td>
</tr>
<tr>
<td>Polypropylene PP</td>
<td>0.91</td>
<td>6.5</td>
<td>18 – 22</td>
<td>165</td>
<td>0</td>
<td>Abrasion and sunlight resistance is fair. Poor resistance to creep.</td>
<td>Resistant to acids. Resistant to alkalis. Resistant to organic solvents, soluble in chlorinated hydrocarbons.</td>
</tr>
<tr>
<td>High Modulus Polypropylene HMPP</td>
<td>0.84</td>
<td>8</td>
<td>7-8</td>
<td>165</td>
<td>0</td>
<td>Poor abrasion resistance, fair sunlight resistance, and very good resistance to creep.</td>
<td>Resistant to acid, alkali, organic solvents, salt water. Soluble in chlorinated hydrocarbons at elevated temperature.</td>
</tr>
<tr>
<td>Polyethylene PE or LDPE</td>
<td>0.95</td>
<td>6</td>
<td>20 – 24</td>
<td>140</td>
<td>0</td>
<td>Abrasion and sunlight resistance is fair. Poor resistance to creep.</td>
<td>Resistant to acids. Resistant to alkalis. Resistant to organic solvents, soluble in chlorinated hydrocarbons.</td>
</tr>
<tr>
<td>Expanded Polytetrafluoroethylene ePTFE</td>
<td>1.82-1</td>
<td>5.0 – 6.0</td>
<td>3-5</td>
<td>327</td>
<td>0</td>
<td>Excellent abrasion and sunlight resistance. Resistance to creep is fair.</td>
<td>Chemically inert. Extremely resistant to chemical attack and does not dissolve in most solvents. Attacked by molten or dissolved alkali metals.</td>
</tr>
<tr>
<td>Copolymer PP/PE</td>
<td>0.93</td>
<td>7.5</td>
<td>14 – 18</td>
<td>140</td>
<td>0</td>
<td>Abrasion and sunlight resistance is fair. Poor resistance to creep.</td>
<td>Resistant to acids. Resistant to alkalis. Resistant to organic solvents, soluble in chlorinated hydrocarbons.</td>
</tr>
<tr>
<td>Copolymer PP/PES</td>
<td>0.99</td>
<td>7.0</td>
<td>12 – 16</td>
<td>196</td>
<td>0</td>
<td>Very good abrasion (with 50/50 blend) and sunlight resistance. Good resistance to creep.</td>
<td>Resistant to most acids. Degraded by strong sulphuric acids. Resistant to alkalis. Resistant to organic solvents, soluble in chlorinated hydrocarbons.</td>
</tr>
<tr>
<td>Cotton (see Note 3) Natural cellulose fiber</td>
<td>1.54</td>
<td>2.0 – 3.0</td>
<td>2 – 3</td>
<td>Chars @ 148</td>
<td>100</td>
<td>Very good resistance to creep and sunlight. Abrasion resistance is fair.</td>
<td>Degraded by acids in high concentration or high temperature. Resistant to alkalis. Degraded by organic solvents and sea water. Subject to bacterial attack (rot). <strong>Should not be used where life and limb are at risk.</strong></td>
</tr>
<tr>
<td>Natural fiber (see Note 3) Abaca, agave, sisal</td>
<td>1.32</td>
<td>4.0 – 6.0</td>
<td>10 – 12</td>
<td>Chars @ 148</td>
<td>100</td>
<td>Very good resistance to creep and sunlight. Abrasion resistance is fair.</td>
<td>Degraded by acids in high concentration or high temperature. Degraded by alkalis. Resistant to organic solvents. Subject to bacterial attack (rot). <strong>Should not be used where life and limb are at risk.</strong></td>
</tr>
</tbody>
</table>

**Physical Property Definitions:**
Breaking Tenacity: break load in grams force per denier weight.
Elongation at Break: change in yarn length at break, expressed as percent of initial gage length.

Moisture regain tested at standard conditions of 72 deg F at 65% relative humidity

**Notes:**
Note 1: Resistance to abrasion is relative to other industrial fibers in this chart
Note 2: LDPE is Low Density Polyethylene
Note 3: Natural fibers are subject to degradation by fungal/bacterial attack during storage. Ropes made from natural fibers should not be used in applications where life and limb are at risk.

This information is provided by the fiber manufacturers and is not intended as a Cordage Institute endorsement.
Fiber selection should involve discussions with both fiber and cordage manufacturers. Special overlay finishes are available to enhance the strength and abrasion resistance. See page 7 for fiber producers contact information.

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Web: www.cordageinstitute.com
Table 2  Cordage Institute High Tenacity Fiber Chart

<table>
<thead>
<tr>
<th>Fiber Description</th>
<th>Physical Properties (see footnotes)</th>
<th>Long-Term / Environmental Properties (see footnotes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Density [g/cm³]</td>
<td>Creep Resistance, Abrasion Resistance, Sunlight (UV) Resistance, and Effects of Chemical Exposure</td>
</tr>
<tr>
<td></td>
<td>Breaking Tenacity [ppi]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaking Strength [GPa]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initial Modulus [GPa]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elongation at Break [%]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50%-Strength Temperature [°C]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Melting Point or Decomp Temperature [°C]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moisture Regain [%]</td>
<td></td>
</tr>
<tr>
<td>LCP Polyester- Polylarylate</td>
<td>Vectran®</td>
<td>Light Gold Other colors also available</td>
</tr>
<tr>
<td>Para-Aramid</td>
<td>Kevlar®, Twaron®</td>
<td>Yellow Other colors also available</td>
</tr>
<tr>
<td>Aramid Copolymer</td>
<td>Technora®</td>
<td>Gold Black also available</td>
</tr>
<tr>
<td>HMPE (1) (gel spun)</td>
<td>Dynema®, Spectra®, Doyentron-Tex®</td>
<td>White</td>
</tr>
<tr>
<td>HMPE (solid state)</td>
<td>Tensylon®, Endumax®</td>
<td>White</td>
</tr>
<tr>
<td>PBO (2)</td>
<td>Gold</td>
<td>1.54-1.56</td>
</tr>
</tbody>
</table>

**Physical Property Definitions:**
- Breaking Tenacity: break load in grams force per denier weight.
- Breaking Strength: break load divided by fiber cross sectional area.
- Elongation at Break: change in yarn length at break, expressed as percent of initial gauge length.
- Melting Point: temperature at which the fiber melts.
- Decomposition Temperature: temperature at which the fiber decomposes.
- Moisture Regain: tested at standard conditions of 72 deg F at 65% relative humidity.

**Long-Term / Environmental Property Definitions:**
- Creep Resistance: Creep is the gradual change in length under the effects of an applied static tensile load. Influenced by testing temperature and applied load.
- Abrasion: Abrasion is the reduction in strength caused by interaction with surrounding fibers or surfaces. Overlap finishes and lubricants can enhance abrasion resistance under both wet and dry conditions.
- Sunlight/UV: Synthetic fibers are susceptible to degradation on direct exposure to sunlight. Degradation of fibers within a rope can vary depending on rope construction, coatings and other factors.
- Chemical Exposure: Fibers may be chemically degraded by exposure to specific agents. Data on chemical resistance should be obtained from the fiber companies, as listed on page 7, and the rope manufacturers.

**Notes:**
- Note 1: HMPE is High Modulus Polyethylene.
- Note 2: PBO is Poly Paraphenylene-2,6 Benzobisoxazole.
- This information is provided by the fiber manufacturers and is not intended as a Cordage Institute endorsement.
- Fiber selection should involve discussions with both fiber and cordage manufacturers.
- Special overlay finishes are available to enhance the strength and abrasion resistance.
- See page 7 for fiber producers contact information.

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Tel: +86 (10) 56710302
Fax: +86 (10) 56710309
E-mail: nina@bjtyz.com, bjtyz@bjtyz.com
Website: http://en.bjtyz.com

Products:
Ultra High Molecular Weight Polyethylene fiber (UHMWPE)
Available in wide range of customized deniers
Colored UHMWPE fiber, like Neon Green, Lemon Yellow, Flame Red, Black, Blue, etc.

Brand Name:
Doyentrontex®

DSM Dyneema
Bill Fronzaglia
1101 Highway 27 South
Stanley, NC 28164
Tel: 704-862-5000
Fax: 704-862-5001
E-mail: bill.fronzaglia@dsm.com
Website: www.dyneema.com

Products:
HMPE Polyethylene. Ten grades (Dyneema® SK38, SK60, SK62, SK65, SK75, SK78, SK99, DM20, SK78XBO & DM20XBO).

Brand Name:
Dyneema®

DuPont Safety and Construction Kevlar® and Nomex® Products
Jack Yant
Spruance Plant
P.O. Box 27001
Richmond, VA 23261
Tel: 302-383-7330, 1-800-4-KEVLAR
Fax: 302-999-4094, 1-800-787-7086
E-mail: Jack.W.Yant@usa.dupont.com
Website: www.dupont.com/afs/

Products:
High Modulus Kevlar® aramid fibers – Deniers: 55-15,000
HMPE Polyethylene Material

Brand Name: Kevlar®, Nomex®, Tensylon™
Hailide America, Inc.
Stuart Smith  
1776 Peachtree St. NW  
710S  
Atlanta, GA 30309  
Tel: (404) 974-3232  
Fax: (404) 974-3233  
E-mail: stuart.smith@hailideamerica.com  
Website: www.hailideamerica.com  

**Products:**  

**Brand Name:**  
Halead®

---

**Honeywell Advanced Fibers & Composites**  
Brent Gerdes  
15801 Woods Edge Road  
Colonial Heights, VA 23824-0031  
Tel: 302-501-2136  
Alternate Tel: 804-930-7567  
E-mail: brent.gerdes@honeywell.com  
Website: www.spectrafiber.com

**Products:**  

**Brand Name:**  
Spectra®

---

**Invista Sarl**  
Steve Clark  
175 Townpark Drive, Suite 300  
Kennesaw, Georgia 30144  
Office: 678-581-6037  
Cell: 316-200-8572  
Email: steve.clark@invista.com  
Website: www.invista.com
**Invista - Canada**
P.O. Box 2100  
455 Front Road  
Kingston, Ontario, K7L 4Z6  
Canada  
Office: 678-581-6037  
Cell: 316-200-8572  
Email: steve.clark@invista.com

**Products:**
Nylon 6,6 deniers 210-1050  
Packaging: tubes

**Brand Names:**
Multiplex™ fibers  
Cordura™

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**Kuraray America, Inc.**
Forrest Sloan  
460-E Greenway Industrial Drive  
Fort Mill, SC 29708  
Tel: 803-396-7350  
Fax: 803-547-5888  
E-mail: forrest.sloan@kuraray.com  
Website: www.kuraray.us.com

**Products:**
High tenacity liquid crystal polyester (LCP) fiber

**Brand Name:**
Vectran® HT, UM

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**Nexis Fibers**
Barbara Danak  
Market Manager, North and South America  
Nexis Fibers  
Tel: 1-770-331-5380  
Cell: 1-423-802-6161  
Email: Barbara.danak@nexis-fibers.com  
Website: www.nexisfibers.com  
Twitter: @nexisfibers

**Products:**
High and Super High Multifilament Fiber in Polyamide 6 & 6,6  
Spun Dyed High Tenacity Multifilament Fiber in Polyamide 6
Teijin Aramid USA
Amy Solomon
801 F Blacklawn Rd
Conyers GA 30012
Tel: 800-451-6586
Fax: 770-929-8138
Email: amy.jenkins@teijinaramid.com
Website: www.teijinaramid.com

Products:
Low, intermediate, and high modulus aramid fibers
HMPE material

Brand Names:
Twaron® and Technora®
Endumax®

TP Industrial Yarns
Contact Friso Heeren
8530 Steele Creek Place Drive, Suite A
Charlotte, NC 28273
United States of America
Phone +1-734-548-8046
Email Friso.Heeren@tp-industrial.com
Website https://www.tp-industrial.com/

Products:
TITAN HMPE Polyethylene: Three grades (Type 850, 860 & 850 Spun Dyed Colors)
Aramid: Para Aramid yarns four grades (type 951 (also in black), 961,971,971), Meta Aramid yarns
deniers available 200D, 1200D, 1600D
High Tenacity (HT), Polyester: Available in natural & various colors, deniers, and packaging. High
Tenacity (HT), Super High Tenacity (SHT), Marine Finish.
Polyamide 6: Available in natural & various colors, deniers, and packaging. High Tenacity (HT), Super
High Tenacity (SHT), Low Shrinkage (LS) Marine Finish.
Polyamide 6.6: Available in natural & black, deniers, and packaging. High Tenacity (HT), Super High
Tenacity (SHT), Marine Finish.

Brand Names:
TITAN
Purpose
This Guideline is provided to help in the selection and safer use of cordage products. Compliance with Cordage Institute Standards and Guidelines does not guarantee safe use under all circumstances, and the Institute disclaims any responsibility for any accidents that may occur.

1. Overview
There are inherent risks in the use of rope and cordage because such products are subject to highly variable conditions that change over time. Therefore, Design Factor selections and Working Load Limits must be calculated with consideration of exposure to risk and actual conditions of use for each application. If in doubt, consult an experienced engineer or other qualified individual regarding the design, application and selection of a rope product.

2. Minimum Breaking Strength
The Minimum Breaking Strength (MBS) is the force that a given rope is required to meet or exceed in a laboratory test when it is new and unused. MBS values are given in Cordage Institute Standards and individual manufacturers’ specifications.

3. Working Load / Working Load Limit
The Working Load (WL) is the weight or force applied to rope or cordage in a given application. The Working Load Limit (WLL) is a guideline for the maximum allowable capacity of a rope product in a particular application and should not be exceeded. Applied loads higher than a specified WLL can overstress and damage fibers, resulting in premature rope failure. For optimal product performance and the safety of personnel and property, the Working Load of an application should not exceed the WLL.

4. Design Factors
The Design Factor (DF) is the ratio between the minimum breaking strength and working load, (MBS/WL). This value is the margin of safety for an application. For a particular application, the factors affecting rope behavior and the degrees of risk to life, personnel and property must be considered when setting a DF.

Commercial, industrial and “general use” consumers should determine a DF based on actual service conditions and establish operating procedures for a specific application. The consumer must also assess his application and determine any hazards that may exist.

As a rule, the more severe the application, the higher the DF needs to be. Selection of a DF in the general range between 5:1 and 12:1 is recommended. This specific range of values does not apply to Life Safety ropes and/or rope products designed and manufactured for specific engineered services. A design factor at the low end of this range should only be selected with expert knowledge of conditions and professional estimate of risk. DF at or above the high end of the range should be used for more severe conditions. When in doubt, always select the highest practical DF, or contact the manufacturer for additional guidance. Engineering assistance may be necessary to determine the service loads and risks and to set the appropriate DF. Expert guidance is strongly suggested when shock loads are possible and/or when the rope is used for lifting purposes.

Considerations in the Selection of a Design Factor
• Select a DF value supported by industry standards, best practices, and/or regulations.
• All components of the system should be considered when determining the DF.
• Consider increasing the Design Factor if:
  - Problems have previously been observed in similar applications
  - Injury, death or loss of property may result if rope fails
  - Loads are not accurately known
  - High or continuous dynamic loads are anticipated (See Section 6)
  - Shock loads are anticipated
  - Extensive cyclic loads are likely to occur
  - Tension is on the rope for long periods
  - Knots are used, as knots reduce strength
  - Operators are in training or are not well experienced
  - Operation/use procedures are not well defined and/or controlled.

5. Calculation of Values
After the WL has been estimated and the DF has been determined, a rope can be selected by calculating the required new rope Minimum Breaking Strength. The required MBS is determined by multiplying the Working Load by Design Factor. WL * DF = MBS. For example, an application with a Working Load of 3 tons and a Design Factor of 10 would require rope with MBS = 3 * 10 = 30 tons.

Similarly, the Working Load Limit of a new rope is determined by dividing the Minimum Breaking Strength by the Design Factor for a given application. MBS/DF = WLL. Examples of WLL based on a DF are given in some individual Cordage Institute Standards. The WLL in CI standards are for new ropes with standard terminations.

6. Dynamic Loading
A dynamic load is any load that is not static, such as a live load or a wind load. If not properly taken into account, dynamic loading could shorten the service life of a rope and may even cause failure. Dynamic load effects are influenced by the stiffness or modulus of the rope and are more severe when using low-stretch rope. Dynamic load effects are more severe on short sections of rope. In extreme dynamic loading cases, the forces sustained by the rope may be two, three or more times the static load.

When an object is moved the force on the rope increases due to acceleration or deceleration. The more rapidly or suddenly such actions occur, the greater the forces. Objects should be moved slowly and smoothly to minimize dynamic effects whenever possible. When dynamic loading is anticipated, the Design Factor should be calculated based on the dynamic instead of the static load. The advice of a qualified individual should be used in calculating the Design Factor.

7. Recoil/Snapback Safety Warning
When a tensioned rope breaks, an attachment fails, or tension is suddenly released, the energy stored in the rope may cause it to recoil back in unpredictable directions with great force. The recoil may result in injury or death to persons in its path. Persons should never stand under, in line with or in the general path of rope under tension to avoid snapshot injuries.

8. Special Applications
The DF ranges can be raised or lowered for applications where field experience has proven successful, where a recognized standard or specification exists, where qualified professionals have made a thorough engineering analysis of all conditions of use and/or a regulatory agency has granted specific permission. In such controlled cases, breaking strength, elongation, energy absorption, and other factors, including operating procedures, must be evaluated during the selection of the Design Factor.

When warning tags are provided by the product manufacturer, they should be attached to each rope per industry or application specific guidelines.