

How to extend rope service life.

How long will your rope last? There is not a simple answer but, rather, there are several factors involved, including:

- *The manner in which you install and “break in” your new rope.*
- *The operating technique and work habits of the machine operators.*
- *Physical maintenance of the rope throughout its service life.*
- *Physical maintenance of the system in which your rope operates.*

Recommended practices.

We’ve outlined several recommended practices you may use to extend your rope’s useful life. It’s also important to note that all sections of this handbook, in some respect, also review ways to help you get greater useful life from your rope, and that’s why you need to thoroughly understand all the material here.

Install your rope correctly.

The primary concern when installing a new rope is to not trap any twist in the rope system. Proper handling of the rope from the reel or coil to your equipment will help avoid this situation. Another important step on smooth faced drums is to spool with wraps tight and close together on the first layer. This layer forms the foundation for succeeding layers. Finally, spool the remaining rope on the drum with tension approximating 1% to 2% of the rope’s minimum breaking force.

Break in your new rope properly.

When you install a new operating rope, you should first run it for a brief period of time with no load. Then, for best results, run it under controlled loads and speeds to enable the wires and strands in the rope to adjust to themselves.

“Constructional” stretch.

When first put into service, new ropes normally elongate while strands go through a process of seating with one another and with the rope core. This is called “constructional” stretch because it is inherent in the

construction of the rope, and the amount of elongation may vary from one rope to another. For standard ropes, this stretch will be about 1/4% to 1% of the rope’s length.

When constructional stretch needs to be minimized, ropes may be factory prestretched. Please specify when placing your order.

Another type of stretch, “elastic” stretch, results from recoverable deformation of the metal itself. For more information, please refer to the *WRCA Wire Rope Technical Data Handbook*.

Cut off ends to move wear points.

If you observe wear developing in a localized area, it may be beneficial to cut off short lengths of rope. This may require an original length slightly longer than you normally use. When severe abrasion or numerous fatigue breaks occur near one end or at any one concentrated area – such as drag ropes on draglines or closing lines in clamshell buckets, for example – the movement of this worn section can prolong rope life.

Wire breaks from vibration fatigue occur at end terminations, so short lengths cut off there with reattachment of the socket may prolong the rope’s life. When broken wires are found, you should cut off sections of rope. In the case of a socket, you should cut off at least five or six feet. In the case of clips or clamps, you should cut off the entire length covered by them.

Where there is an equalizing sheave, such as that found in many overhead cranes, fatigue is localized at rope tangency points to the equalizing sheave. Rope life will be increased if you shift this point by cutting off a short length at the end of one of the drums. Be sure to make this cutoff before significant wear occurs at the equalizing sheave, and always do so at the same drum.

Reversing ends.

Frequently, the most severe deterioration occurs at a point too far from the end or is too long to allow the worn section to be cut off. In such cases, you may turn the rope end for end to bring a less worn section into the area where conditions are most damaging. This practice is beneficial for incline rope and draglines. The change must be made well before the wear reaches the removal criteria. When changing ends, be careful to avoid kinking or otherwise damaging the rope.

Clean and lubricate regularly to reduce wear.

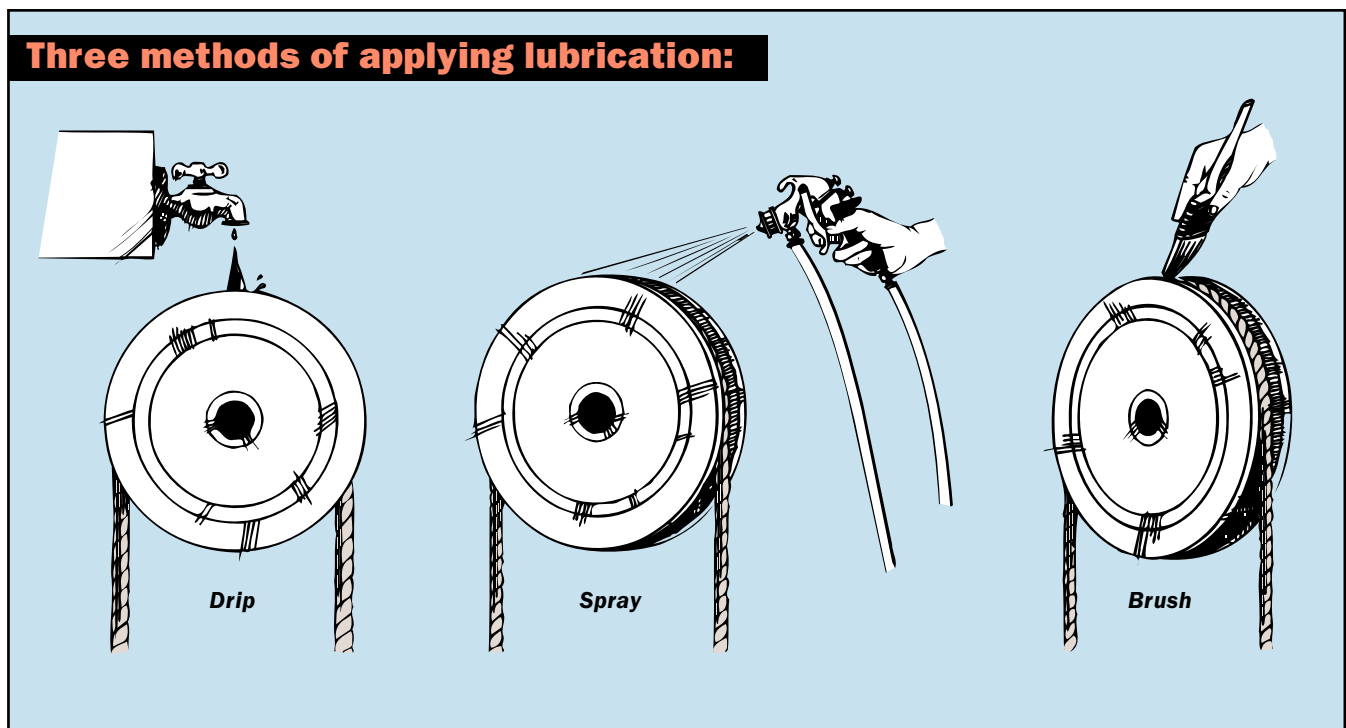
We lubricate our wire rope during manufacture so that the strands – as well as the individual wires in the strands – may move and adjust as the rope moves and bends. But no wire rope can be lubricated sufficiently during manufacture to last its entire life. That's why it's important to lubricate periodically throughout the life of the rope.

The surface of some ropes may become covered with dirt, rock dust or other material during their operation. This can prevent field-applied lubricants from properly penetrating into the rope, so it's a good practice to clean these ropes before you lubricate them.

The lubricant you apply should be light-bodied enough to penetrate to the rope's core. You can normally apply lubricant by using one of three methods: *drip it* on rope, *spray it* on or *brush it* on. In all cases, you should apply it at a place where the rope is bending such as around

a sheave. We recommend you apply it at the top of the bend because that's where the rope's strands are spread by bending and more easily penetrated. In addition, there are pressure lubricators available commercially. Your rope's service life will be directly proportional to the effectiveness of the method you use and the amount of lubricant that reaches the rope's working parts.

A proper lubricant must reduce friction, protect against corrosion and adhere to every wire. It should also be pliable and not crack or separate when cold – yet not drip when warm. Never apply heavy grease to the rope because it can trap excessive grit, which can damage the rope. Nor should you apply used “engine oil” because it contains materials that can damage the rope. For unusual conditions, you can specify special lubricants that we can apply at the factory.



Wire rope inspection.

All wire ropes will wear out eventually and gradually lose work capability throughout their service life. That's why periodic inspections are critical. Applicable industry standards such as ASME B30.2 for overhead and gantry cranes or federal regulations such as OSHA refer to specific inspection criteria for varied applications.

Three purposes for inspection.

Regular inspection of wire rope and equipment should be performed for three good reasons:

- It reveals the rope's condition and indicates the need for replacement.
- It can indicate if you're using the most suitable type of rope.
- It makes possible the discovery and correction of faults in equipment or operation that can cause costly accelerated rope wear.

How often.

All wire ropes should be thoroughly inspected at regular intervals. The longer it has been in service or the more severe the service, the more thoroughly and frequently it should be inspected. Be sure to maintain records of each inspection.

Appoint a qualified person to inspect.

Inspections should be carried out by a person who has learned through special training or practical experience what to look for and who knows how to judge the importance of any abnormal conditions they may discover. It is the inspector's responsibility to obtain and follow the proper inspection criteria for each application inspected.

For information on inspection methods and techniques, ask us for *Techreport 107: Wire Rope Inspection*. If you need further assistance, contact our Product Engineering Department.

What to look for.

Here's what happens when a wire breaks under tensile load exceeding its strength. It's typically recognized by the "cup and cone" appearance at the point of failure. The necking down of the wire at the point of failure to form the cup and cone indicates failure has occurred while the wire retained its ductility.



This is a wire with a distinct **fatigue break**. It's recognized by the **square end** perpendicular to the wire. This break was produced by a torsion machine that's used to measure the ductility. This break is similar to wire failures in the field caused by fatigue.



A wire rope that has been subjected to repeated bending over sheaves under normal loads. This results in **fatigue breaks**



in individual wires – these breaks are square and usually in the crown of the strands.

An example of **fatigue failure** of a wire rope subjected to heavy loads over small sheaves.



The breaks in the valleys of the strands are caused by "strand nicking." There may be crown breaks, too.

Here you see a single strand removed from a wire rope subjected to "**strand nicking**." This condition is a result of adjacent strands rubbing against one another. While this is normal in a



rope's operation, the nicking can be accentuated by high loads, small sheaves or loss of core support. The ultimate result will be individual wire breaks in the valleys of the strands.

Typical evidence of wear and abuse.

A **“birdcage”** is caused by sudden release of tension and the resulting rebound of rope. These strands and wires will not be returned to their original positions. The rope should be replaced immediately.



A typical failure of a rotary drill line with a poor cutoff practice. These wires have been subjected to continued **peening**, causing fatigue type failures. A predetermined, regularly scheduled cutoff practice can help eliminate this type of problem.



This is **localized wear** over an equalized sheave. The danger here is that it's invisible during the rope's operation, and that's why you need to inspect this portion of an operating rope regularly. The rope should be pulled off the sheave during inspection and bent to check for broken wires.



This is a wire rope with a **high strand** – a condition in which one or strands are worn before adjoining strands. This is caused by improper socketing or seizing, kinks or dog-legs.

At top, you see a closeup of the concentration of wear. At bottom, you see how it recurs every sixth strand in a 6 strand rope.



A **kinked wire rope** is shown here. It's caused by pulling down a loop in a slack line during handling, installation or operation. Note the distortion of the strands and individual wires. This rope must be replaced.



Here's a wire rope that has jumped a sheave. The rope **“curled”** as it went over the edge of the sheave. When you study the wires, you'll see two types of breaks here: tensile “cup and cone” breaks and shear breaks that appear to have been cut on an angle.



Drum crushing is caused by small drums, high loads and multiple winding conditions.



Removal criteria.

A major portion of any wire rope inspection is the detection of broken wires. The number and type of broken wires are an indication of the rope's general condition and a benchmark for its replacement.

Frequent inspections and written records help determine the rate at which wires are breaking. Replace the rope when the values given in the table below are reached.

Valley wire breaks – where the wire fractures between strands or a broken wire protrudes between strands – are treated

differently than those that occur on the outer surface of the rope. When there is more than one valley break, replace the rope.

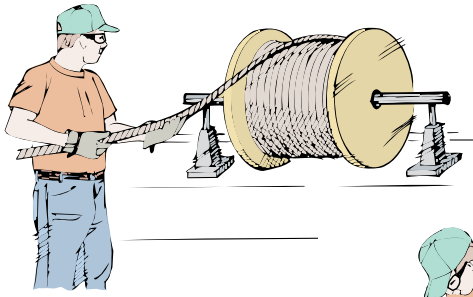
Broken wire removal criteria cited in many standards and specifications, like those listed below, apply to wire ropes operating on steel sheaves and drums. For wire ropes operating on sheaves and drums made with material other than steel, please contact the sheave, drum or equipment manufacturer or a qualified person for proper broken wire removal criteria.

When to replace wire rope – based on number of wires.

Standard	Equipment	# OF BROKEN WIRES IN RUNNING ROPES			# OF BROKEN WIRES IN STANDING ROPES		
		In one rope lay	In one strand	At end connection	In one rope lay	At end connection	
ASME/B30.2	Overhead and gantry cranes	12**	4	Not specified	Not specified		
ASME/B30.4	Portal, tower and pillar cranes	6**	3	2	3	2	
ASME/B30.5	Mobile and locomotive cranes	Running ropes	6**	3	2	3	2
		Rotation-resistant ropes	2 randomly distributed broken wires in 6 rope diameters or 4 randomly distributed broken wires in 30 rope diameters.**				
ASME/B30.6	Derricks	6**	3	2	3	2	
ASME/B30.7	Base-mounted drum hoists	6**	3	2	3	2	
ASME/B30.8	Floating cranes and derricks	6**	3	2	3	2	
ASME/B30.16	Overhead hoists	12**	4	Not specified	Not specified		
ANSI/A10.4	Personnel hoists	6**	3	2	2**	2	
ANSI/A10.5	Material hoists	6**	Not specified		Not specified		

**Also remove for 1 valley break.

How to unreel or uncoil wire rope.



Correct ways to unreel and uncoil wire rope.



The right way to unreel and uncoil a wire rope.

There is always a danger of kinking a wire rope if you improperly unreel or uncoil it. You should mount a reel on jacks or a turntable so that it will revolve as you pull the rope off. Apply sufficient tension by means of a board acting as a brake against the reel flange to keep slack from accumulating. With a coil, stand it on edge and roll it in a straight line away from the free end. You may also place a coil on a revolving stand and pull the rope as you would from a reel on a turntable.

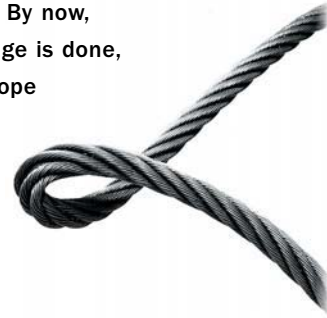
THE THREE STAGES OF KINKING:

1. The start:

A rope should never be allowed to accumulate twist as shown here because it will loop and eventually form a kink. If this loop is removed before being pulled down tight, you can normally avoid the kink.



2. The kink: By now, the damage is done, and the rope must not be used.



3. The result: Even if the wires do not appear badly damaged, the rope is still damaged and must be replaced.



If a twist develops, remove the twist from the rope before a kink can form.

How to store wire rope properly.

We recommend you store your wire rope under a roof or a weatherproof covering so that moisture cannot reach it. Similarly, you must avoid acid fumes or any other corrosive atmosphere – including ocean spray – in order to protect the rope from rust. If you're storing a reel for a lengthy period, you may want to order your rope with a protective wrap. If not, at least coat the outer layers of rope with a good rope lubricant.

If you ever take a rope out of service and want to store it for future use, you should place it on a reel after you've thoroughly cleaned and relubricated it. Give the same storage considerations to your used rope as you would your new rope.

Be sure to keep your wire rope in storage away from steam or hot water pipes, heated air ducts or any other source of heat that can thin out lubricant and cause it to drain out of your rope.

Standard wire rope abbreviations.

Strand construction.

PRF	Preformed
S	Seale
W	Warrington
WS	Warrington Seale
FW	Filler Wire
SWS	Seale Warrington Seale
SFW	Seale Filler Wire
FWS	Filler Wire Seale
STY G	Type of flattened strand construction with 6 wires forming a triangular-shaped strand center

Rope grades.

IPS	Improved plow steel
GIPS	Galvanized improved plow steel
DGIPS	Drawn galvanized improved plow steel
XIP®	Extra improved plow steel
GXIP®	Galvanized extra improved plow steel
DGXIP®	Drawn galvanized extra improved plow steel
XXIP®	Extra extra improved plow steel
GAC	Galvanized aircraft cable
GUC	Galvanized utility cable

Lays.

RR	Right regular lay
LR	Left regular lay
RL	Right lang lay
LL	Left lang lay

Type of core.

FC	Fiber core; natural or synthetic fiber
IWRC	Independent wire rope core
SC	Strand core

Special rope descriptions.

TBG	Tubing; special rope for tubing line applications in oilfields
TBDL	Special rope for rotary drilling line applications in oilfields
SS	Stainless steel
BRIGHT	Ropes in which the wires are not coated
SWAGED	Rope that is swaged to finished diameter
TUF-KOTE®/PFV®	Polymer-impregnated wire rope.
PowerFlex®	A swaged rope with compacted strands; used in logging applications.
POWER-SWAGE™	Extra-swaged rope with 30% higher strength; used in logging applications.
Flex-X®	A compacted strand wire rope.
TUF-MAX®	Special shovel hoist rope with features to increase service life.
7-Flex®	A seven strand wire rope.

- Abrasion** Surface wear on the wires of a wire rope.
- Aircraft cables** Strands and wire ropes made of special strength wire primarily for aircraft controls and miscellaneous uses.
- Alternate lay** Lay of a wire rope in which the strands are alternately regular and lang lay.
- Area, metallic** Sum of the cross-sectional areas of individual wires in a wire rope or strand.
- Becket loop** A loop of small rope or strand fastened to the end of a large wire rope to facilitate installation.
- Bending stress** Stress imposed on wires of a wire rope by bending.
- Cable-laid wire rope** A wire rope made of several wire ropes laid into a single wire rope.
- Centers** Wire, strand or fiber in the center of a strand about which the wires are laid.
- Closing line** Wire rope that closes a clamshell or orange peel bucket.
- Common strand** A grade of galvanized strand.
- Construction** Design of the wire rope including number of strands, the number of wires per strand and the arrangement of wires in each strand.
- Core** The axial member of a wire rope about which the strands are laid. It may be fiber, a wire strand or an independent wire rope.
- Corrosion** Chemical decomposition of the wires in a rope by exposure to moisture, acids, alkalines or other destructive agents.
- Corrugated** The term used to describe the grooves of a sheave or drum when worn so as to show the impression of a wire rope.
- Design factor** The ratio of the minimum breaking force to the design maximum working force. The minimum breaking force is the published catalog strength of the wire rope involved, and the design maximum working force is the maximum calculated static load to be applied.
- Diameter, rope** The distance measured across the center of a circle circumscribing the strands of a wire rope.
- Dog-leg** Permanent short bend in a wire rope caused by improper use.
- Drum** A cylindrical flanged barrel, either of uniform or tapering diameter, on which rope is wound either for operation or storage. Its surface may be smooth or grooved.
- Efficiency of wire rope** Percentage ratio of measured breaking strength of a wire rope to the aggregate strength of all individual wires tested separately.
- Elastic limit** Limit of stress above which a permanent deformation occurs.
- Equalizing Sheave** The sheave at the center of a rope system over which no rope movement occurs other than equalizing movement. It is frequently overlooked during crane inspections with disastrous consequences. It can be a source of severe degradation.
- Fatigue resistance** The characteristic of a wire rope which allows it to bend repeatedly under stress.
- Fiber core** Rope made of vegetable or synthetic fiber used in the core of a wire rope.
- Filler wire** A strand construction that has small auxiliary wires for spacing and positioning other wires.
- Fitting** Any accessory used as an attachment to a wire rope.
- Flattened strand rope** Wire rope with triangular shaped strands that presents a flattened rope surface.
- Grades, rope** Classification of wire rope by its minimum breaking force. Common grades in order of increasing minimum breaking force: Improved Plow Steel, Extra Improved Plow Steel, Extra Extra Improved Plow Steel.
- Grades, strand** Classification of zinc-coated strand by its minimum breaking force. In order of increasing minimum breaking force, they are: Common, Siemens-Martin, High Strength and Extra-High Strength. A Utilities grade strand is also made to meet special requirements.
- Grooved drum** Drum with a grooved surface to guide the rope for proper winding.
- Grooves** Depressions in the periphery of a sheave or drum that are shaped to position and support the rope.
- Idler** Sheave or roller used to guide or support a rope.
- Improved Plow Steel Rope** See “grades, rope.”
- Independent Wire Rope Core (IWRC)** A wire rope used as the core of a larger wire rope.
- Inner wires** All wires of a strand except the outer wires.
- IWRC** See “Independent Wire Rope Core.”
- Kink** A sharp bend in a wire rope that permanently distorts the wires and strands; the result of a loop being pulled through.
- Lang lay rope** Wire rope in which the wires in the strands are laid in the same direction that the strands in the rope are laid.
- Lay** (1) The manner in which the wires are helically laid into a strand or the strands in a rope, or (2) the length along the rope that one strand uses to make one complete revolution around the core.
- Left lay** (1) Strand – a rope strand in which the cover wires are laid in a helix having a left-hand pitch, or (2) Rope – a rope in which the strands are laid in a helix having a left-hand pitch.
- Marline clad rope** A rope with individual strands spirally wrapped with marline or synthetic fiber cord.
- Minimum breaking force** Published strength that has been calculated and accepted by the wire rope industry following a set standard procedure. The wire rope manufacturer uses this strength as a minimum strength when designing the wire rope, and the user should consider this to be the strength when making his design calculations.
- Peening** Permanent distortion of outside wire in a rope caused by pounding.
- Preformed wire rope** Wire rope in which the strands are permanently shaped before fabrication into the rope to the helical form they assume in the wire rope.
- Preformed strand** Strand in which the wires are permanently shaped before fabrication in the strands to the helical form they assume in the strand.
- Prestretching** Stressing a wire rope or strand before use under such a tension and for such a time that the constructional stretch is largely removed.
- Reel** The flanged spool on which wire rope or strand is wound for storage or shipment.
- Regular lay rope** Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.
- Reserve strength** The percentage of the minimum breaking force represented by the inner wires of the outer strands of a wire rope.

Right lay (1) Strand – a strand in which the cover wires are laid in a helix having a right-hand pitch or (2) Rope – a rope in which the strands are laid in a helix having a right-hand pitch.

Rotation resistant rope A wire rope consisting of an inner layer of strand laid in one direction covered by a layer of strand laid in the opposite direction. This has the effect of reducing torque.

Sand line The wire rope that operates the bailer for removing water and drill cuttings in drilling a well.

Seale A strand construction having one size of cover wires with the same number of one size of wires in the inner layer.

Seize To bind securely the end of a wire rope or strand with seizing wire or strand.

Seizing strand Small diameter strand usually of seven wires made of soft annealed iron wire.

Seizing wire A soft annealed iron wire.

Sheave A grooved pulley for wire rope.

Slings Wire ropes made into forms, with or without fittings, for handling loads and made to permit the attachment of an operating rope.

Smooth-faced drum A drum with a plain, ungrooved surface.

Splicing Interweaving of two ends of ropes so as to make a continuous or endless length without appreciably increasing the diameter. Also making a loop or eye in the end of a rope by tucking the ends of the strands.

Stainless steel rope Wire rope made of chrome-nickel steel wires having resistance to corrosion.

Strand An arrangement of wires helically laid about an axis, or another wire or fiber center to produce a symmetrical section.

Strength, breaking The load, applied through some type of tensile machine, that it takes to pull that piece of rope apart. This is the load at which a tensile failure occurs in the piece of wire rope being tested.

Strength, aggregate The sum of the breaking strength in tension of all the wires of a wire rope when the wires are tested individually.

Swaged rope A wire rope that is rotary-swaged after closing to produce a compact cross-section.

Warrington A strand construction in which the outer layer of wires is composed of alternating large and small wires.


Wire A single, continuous length of metal cold-drawn from a rod.

Wire rope A plurality of strands laid helically around an axis or core.

Warning.

In the real world, accidents do happen, and that's why you need to take special precautions. Before installing

wire rope in your applications, always read and follow the warning label attached to each product.



! WARNING

Wire rope WILL FAIL if worn-out, overloaded, misused, damaged, improperly maintained or abused.
Wire rope failure may cause serious injury or death!
Protect yourself and others:

- ALWAYS INSPECT wire rope for WEAR, DAMAGE or ABUSE BEFORE USE.
- NEVER USE wire rope that is WORN-OUT, DAMAGED or ABUSED.
- NEVER OVERLOAD a wire rope.
- INFORM YOURSELF: Read and understand manufacturer's literature or "Wire Rope and Wire Rope Sling Safety Bulletin".*
- REFER TO APPLICABLE CODES, STANDARDS and REGULATIONS for INSPECTION REQUIREMENTS and REMOVAL CRITERIA.*

* For additional information or the BULLETIN, ask your employer or wire rope supplier.

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Warranty.

Any warranty, expressed or implied as to quality, performance or fitness for use of wire rope products is always premised on the condition that the published strengths apply only to new, unused rope, that the mechanical equipment on which such products are used is properly designed and maintained, that such products are properly stored, handled, used and maintained, and properly inspected on a regular basis during the period of use.

Seller shall not be liable under any circumstances for consequential or incidental damages or secondary charges including but not limited to personal injury, labor costs, a loss of profits resulting from the use of said products or from said products being incorporated in or becoming a component of any other product.



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