Wet n Wild
Hydra Fighter
Non Kiddie

HYDRA FIGHTER

RIDE SYSTEM

MAINTENANCE

AMUSEMENT WATER SPORT ACTION & THRILL RIDE

1. Ride system inspection is to be performed by maintenance personnel before each initial start up and include the following procedure:

   A. Visually inspect each supporting arm at the top center union flanges for loose bolts at the bolt to nut torque stripe indicator and visually inspect for weld or metal cracks or separations, and corrosion on all components.

   B. Visually inspect all arms at the ends for each support cable eyebolt tightness and wear, any loose connectors, any corrosion.

   C. Visually inspect the support cables per the "Guideline for wire rope inspection" at the end of this section. The support cables, thimbles, shackles, and eyebolts are category "critical component".

   D. Visually inspect the gondolas for support cable eyebolt tightness, loose connectors, cracks, metal fragments, leaking lubricant at bearings and swivels, test restraining harness latches, and any corrosion.

   E. Visually inspect the ride main support pipe column at the base plate including the welds for cracks, separations, and any corrosion.

   F. Visually inspect the ride platform deck including the load and unload ramps for obstacles or failure.

   G. The above noted items must pass inspection or be repaired before start up except that any gondola may be disabled for use at the control podium

2. The water pumps and sump pits are to be inspected weekly for obstructions or lubrication leaks and main plumbing cracks.

3. Swivel bearings are to be removed at four-month intervals and have grease repacked. Gondola swivel bearings are not critical components and in the event of seizure or failure would not cause injury, i.e. would only affect ride performance.

4. The control podium is to be inspected weekly for loose plumbing or electrical connections and corrosion.

GUIDELINE TO INSPECTIONS AND REPORTS FOR EQUIPMENT, WIRE ROPE AND WIRE ROPE SLINGS

1) Maintain all inspection records and reports for the length of time deemed appropriate.
2) Prior to each daily use, the following procedure should be followed.
   a. Check all equipment functions.
   b. Lower load blocks and check hooks for deformation or cracks.
   c. During lowering procedure and the following raising cycle, observe the rope and the reeving. Particular notice should be paid to kinking, twisting or other deformities. Drumwinding conditions should also be noted.
   d. Check wire rope and slings for visual signs of anything that can cause them to be unsafe to use, i.e., broken wires, excessive wear, kinking or twisting, and marked corrosion. Particular attention should be given to any new damage during operation.
3) Monthly inspections are recommended with a signed report by an authorized competent inspector. The *Monthly Reports* should include inspection of the following:
   a. All functional operating mechanisms for excessive wear of components, brake system parts and lubrication.
   b. Limit switches.
   c. Crane hooks for excess throat opening or twisting along with a visual for cracks.
   d. Wire rope and reeving for conditions causing possible removal.
   e. Wire rope slings for excessive wear, broken wires, kinking, twisting and mechanical abuse.
   f. All end connections such as hooks, shackles, turnbuckles, plate clamps, sockets, etc. for excessive wear, and distortion.
4) An *Annual Inspection* with signed report must be made for the following:
   a. Crane hook for cracks.
   b. Hoist drum for wear or cracks.
   c. Structural members for cracks, corrosion and distortion.
   d. For loose structural connections such as bolts, rivets, and weldments.

WIRE ROPE INSPECTION

The following is a fairly comprehensive listing of critical inspection factors. It is not, however, presented as a substitute for an experienced inspector. It is rather a user's guide to the accepted standards by which ropes must be judged.

1) *Abrasion*
   Rope abrades when it moves through an abrading medium or over drums and sheaves. Most standards require that rope is to be removed if the outer wire wear exceeds ⅓ of the original outer wire diameter. This is not easy to determine and discovery relies upon the experience gained by the inspector in measuring wire diameters of discarded ropes.

2) *Rope stretch*

All ropes will stretch when loads are initially applied. For an extended discussion of stretch, see pp. 73 and following.

As rope deteriorates from wear, fatigue, etc. (excluding accidental damage), continued application of a load of constant magnitude will produce varying amounts of rope stretch. A "stretch" curve plotted for stretch vs. time (Fig. 35) displays three discrete phases:

Phase 1. Initial stretch, during the early (beginning) period of rope service, caused by the rope adjustments to operating conditions (constructional stretch).

Phase 2. Following break-in, there is a long period—the greatest part of the rope's service life—during which a slight increase in stretch takes place over an extended time. This results from normal wear, fatigue, etc. On the plotted curve—stretch vs. time—this portion would almost be a horizontal straight line inclined slightly upward from its initial level.

Phase 3. Thereafter, the stretch begins to increase at a quicker rate. This means that the rope is reaching the point of rapid deterioration; a result of prolonged subjection to abrasive wear, fatigue, etc. This second upturn of the curve is a warning indicating that the rope should soon be removed.

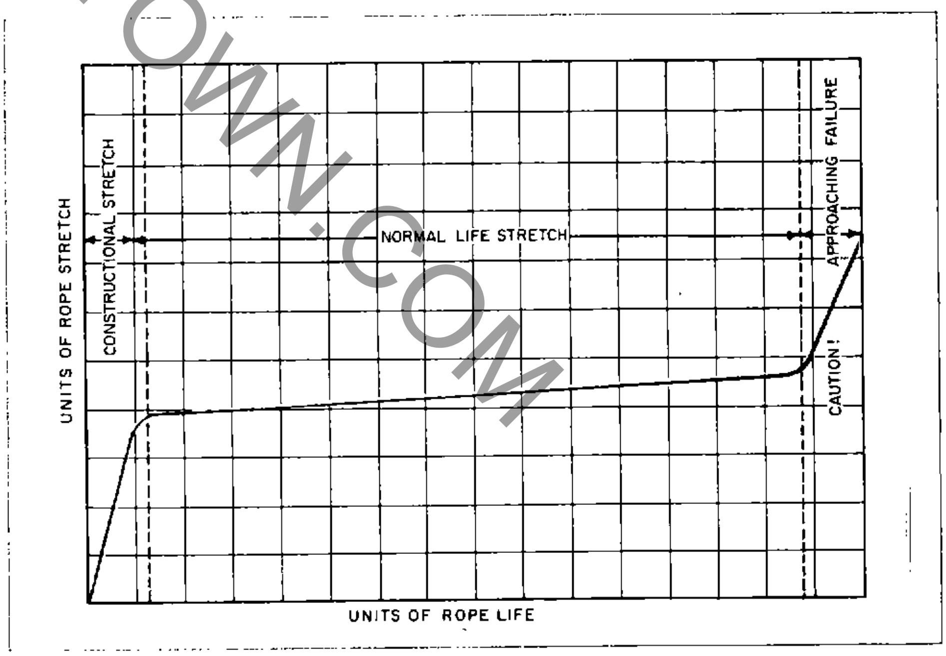


Figure 35. This curve is plotted to show the relationship of wire rope stretch to the various stages of a rope's life.

3) *Reduction in rope diameter*

Any marked reduction in rope diameter indicates degradation. Such reduction may be attributed to:

excessive external abrasion
internal or external corrosion
loosening or tightening of rope lay
inner wire breakage
rope stretch
ironing or milking of strands

In the past, whether or not a rope was allowed to remain in service depended to a great extent on the rope's diameter at the time of inspection. Currently this practice has undergone significant modification.

Previously, a decrease in the rope's diameter was compared with published standards of minimum diameters. The amount of change in diameter is, of course, useful in assessing a rope's condition. But, comparing this figure with a fixed set of values is, for the most part, useless. These long-accepted minima are not, in themselves, of any serious significance since they do not take into account such factors as: 1) variations in compressibility between IWRC and Fiber Core; 2) differences in the amount of reduction in diameter from abrasive wear, or from core compression, or a combination of both; and 3) the actual original diameter of the rope rather than its nominal value.

As a matter of fact, all ropes will show a significant reduction in diameter when a load is applied. Therefore, a rope manufactured close to its nominal size may, when it is subjected to loading, undergo a greater reduction in diameter than that stipulated in the minimum diameter table. Yet, under these circumstances, the rope would be declared unsafe although it may, in actuality, be safe.

As an example of the possible error at the other extreme, we can take the case of a rope manufactured near the upper limits of allowable size. If the diameter has reached a reduction to nominal or slightly below that, the tables would show this rope to be safe. But it should, perhaps, be removed.

Today, evaluations of the rope diameter are first predicated on a comparison of the original diameter—when new and subjected to a known load—with the current reading under like circumstances. Periodically, throughout the life of the rope, the actual diameter should be recorded when the rope is under equivalent loading and in the same operating section. This procedure, if followed carefully, reveals a common rope characteristic: after an initial reduction, the diameter soon stabilizes. Later, there will be a continuous, albeit small, decrease in diameter throughout its life.

Core deterioration, when it occurs, is revealed by a more rapid reduction in diameter and when observed it is time for removal.

Deciding whether or not a rope is safe is not always a simple matter. A number of different but interrelated conditions must be evaluated. It would be dangerously unwise for an inspector to declare a rope safe for continued service simply because its diameter had not reached the minimum arbitrarily established in a table if, at the same time, other observations lead to an opposite conclusion.

Because criteria for removal are varied, and because diameter, in itself, is a vague criterion, the table of minimum diameters has been deliberately omitted from this manual.

4) *Corrosion*
Corrosion, while difficult to evaluate, is a more serious cause of degradation than abrasion. Usually, it signifies a lack of lubrication. Corrosion will often occur internally before there is any visible external evidence on the rope surface. Pitting of wires is a cause for immediate rope removal. Not only does it attack the metal wires, but it also prevents the rope's component parts from moving smoothly as it is flexed. Usually, a slight discoloration because of rusting merely indicates a need for lubrication.

Severe rusting, on the other hand, leads to premature fatigue failures in the wires necessitating the rope's immediate removal from service. When a rope shows more than one wire failure adjacent to a terminal fitting, it should be removed immediately. To retard corrosive deterioration, the rope should be kept well lubricated. In situations where extreme corrosive action can occur, it may be necessary to use galvanized wire rope.

5) *Kinks*
Kinks are permanent distortions caused by loops drawn too tightly. Ropes with kinks must be removed from service.

6) *"Bird Caging"*
Bird caging results from torsional imbalance that comes about because of mistreatments such as sudden stops, the rope being pulled through tight sheaves, or wound on too small a drum. This is cause for rope replacement unless the affected portion can be removed.

7) *Localized Conditions*
Particular attention must be paid to wear at the equalizing sheaves. During normal operations this wear is not visible. Excessive vibration, or whip can cause abrasion and/or fatigue. Drum cross-over and flange point areas must be carefully evaluated. All end fittings, including splices, should be examined for worn or broken wires, loose or damaged strands, cracked fittings, worn or distorted thimbles and tucks of strands.

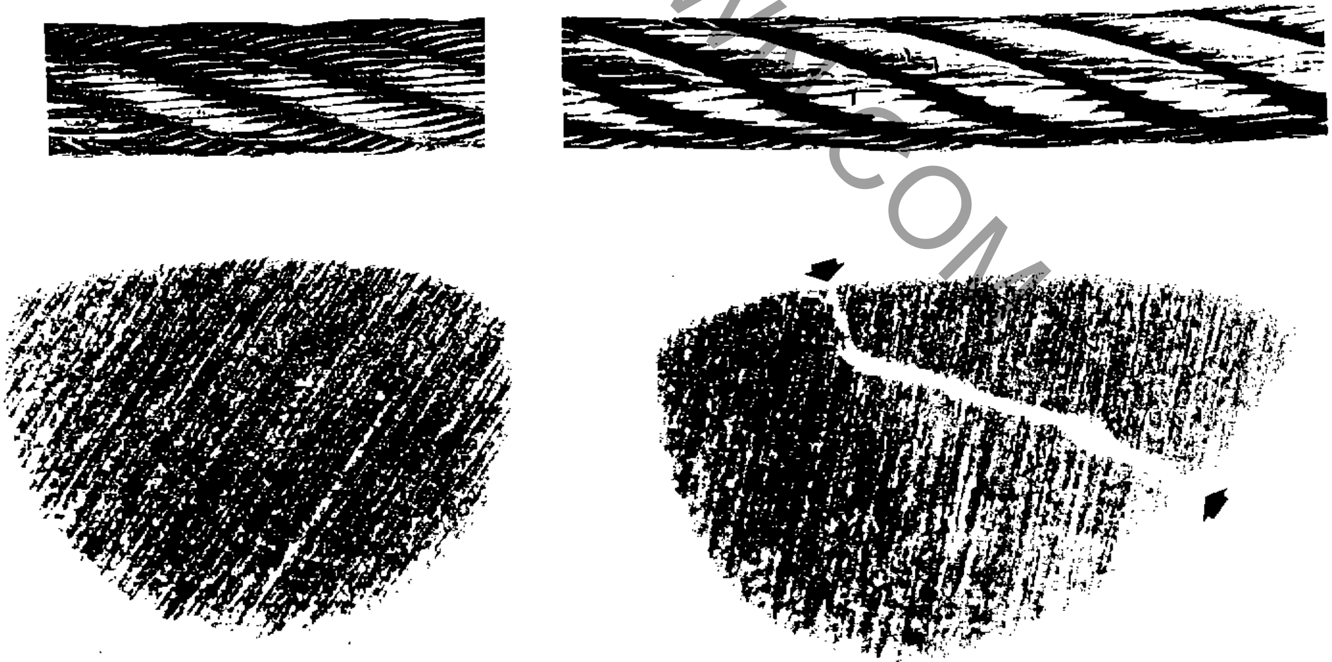
8) *Heat Damage*
After a fire, or the presence of elevated temperatures, there may be metal discoloration, or an apparent loss of internal lubrication; fiber core ropes are particularly vulnerable. Under these circumstances the rope should be replaced.

9) *Protruding Core*
If, for any cause, the rope core protrudes from an opening between the strands the rope is unfit for service.

10) *Damaged End Attachments*
Cracked, bent, or broken end fittings must be eliminated. The cause should be sought out and corrected. In the case of bent hooks, the throat openings —measured at the narrowest point—should not exceed 15% over normal nor should twisting be greater than 10°.

11) *Peening*
Continuous pounding is one of the causes of peening. The rope strikes against an object such as some structural part of the machine, or it beats against a roller, or it hits itself. Often, this can be avoided by placing protectors between the rope and the object it is striking. Another common cause of peening is continuous passage—under high tension—over a sheave or drum. Where peening action cannot be controlled, it is necessary to have more frequent inspections and to be ready for earlier rope replacement.

Figure 36 shows the external appearance of two ropes, one of which has been abraded and the other peened. Also shown are the cross-section of both wires in these conditions.



abrasion

peening

Figure 36. These plan views and cross sections show the effects of abrasion and peening on wire rope. Note that a crack has formed as a result of heavy peening.

12) *Scrubbing*

Scrubbing refers to the displacement of wires and strands as a result of rubbing around or against an object. This, in turn, causes wear and displacement of wires and strands along one side of the rope. Corrective measures should be taken as soon as this condition is observed.

13) *Fatigue Failure*

Wires that break with square ends and show little surface wear, have usually failed as a result of fatigue. Such failures can occur on the crown of the strands, or in the valleys between the strands where adjacent strand contact exists. In almost all cases, these failures are related to bending stresses or vibration.

If diameter of the sheaves, rollers or drum cannot be increased, a more flexible rope should be used. But, if the rope in use is already of maximum flexibility, the only remaining course that will help prolong its service life is to move the rope through the system by cutting off the dead end. By moving the rope through the system, the fatigued sections are moved to less fatiguing areas of the reeving. This technique is most frequently used in rotary drilling.

14) *Broken Wires*

The number of broken wires on the outside of a wire rope are 1) an index of its general condition, and 2) whether or not it must be considered for replacement. Frequent inspection will help determine the elapsed time between breaks. Ropes should be replaced as soon as the wire breakage reaches the numbers given in Table 13. Such action must be taken without regard to the type of fracture.

On occasion, a single wire will break shortly after installation. However, if no other wires break at that time, there is no need for concern. On the other hand, should more wires break, the cause should be carefully investigated.

On any installation, valley breaks—i.e., where the wire ruptures between strands—should be given serious attention. When two or more such conditions are found, the rope should be replaced immediately.

It is well to remember that once broken wires appear—in a normal rope operating under normal conditions—a good many more will show up within a relatively short period. Attempting to squeeze the last measure of service from a rope beyond the allowable number of broken wires (Table 13), will create an intolerably hazardous situation.

A diagnostic guide to some of the most prevalent rope abuses is given in Table 14. On the following pages these abuses are illustrated and described.

TABLE 13 WHEN TO REPLACE WIRE ROPE—BASED ON NUMBER OF BROKEN WIRES

ANSI No.	Equipment	Number Broken Wires In Running Ropes		Number Broken Wires In Standing Ropes	
		In One Rope Lay	In One Strand	In One Rope Lay	At End Connection
B30.2	Overhead & Gantry Cranes	12	4	Not Specified	
B30.4	Portal, Tower & Pillar Cranes	6	3	3	2
B30.5	Crawler, Locomotive & Truck Cranes	6	3	3	2
B30.6	Derricks	6	3	3	2
B30.7	Base Mounted Drum Hoists	6	3	3	2
B30.8	Floating Cranes and Derricks	6	3	3	2
A10.4	Personnel Hoists	6*	3	2*	2
A10.5	Material Hoists	6*	Not Specified	Not Specified	

*Also remove for 1 valley break.

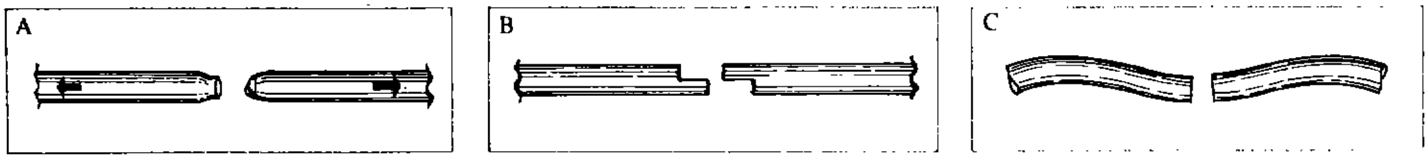


Figure 37. A wire that has broken under a tensile load in excess of its strength, is recognized by the "cup and cone" configuration at the fracture point (A). The *necking down* of the wire at point of failure shows that failure occurred while the wire retained its ductility. A fatigue break is usually characterized by squared-off ends perpendicular to the wire either straight across or Z-shaped (B & C).

TABLE 14 DIAGNOSTIC GUIDE TO COMMON WIRE ROPE ABUSES

Abuse	Symptoms	Possible Causes
Fatigue	Wire break is transverse—either straight across or Z shape. Broken ends will appear grainy.	Check for rope bent around too small a radius; vibration or whipping; wobbly sheaves; rollers too small; reverse bends; bent shafts; tight grooves; corrosion; small drums & sheaves; incorrect rope construction; improper installation; poor end attachments. All running rope if left in service long enough will eventually fail by fatigue.
Tension	Wire break reveals predominantly cup and cone fracture with some 45° shear breaks.	Check for overloads; sticky, grabby clutches; jerky conditions; loose bearing on drum; fast starts, fast stops, broken sheave flange; wrong rope size & grade; poor end attachments. Check for too great a strain on rope after factors of deterioration have weakened it.
Abrasion	Wire break mainly displays outer wires worn smooth to knife edge thinness. Wire broken by abrasion in combination with another factor will show a combination break.	Check for change in rope or sheave size; change in load; overburden change; frozen or stuck sheaves; soft rollers, sheaves or drums; excessive fleet angle; misalignment of sheaves; kinks; improperly attached fittings; grit & sand; objects imbedded in rope; improper grooving.
Cut or Gouged or Rough Wire	Wire ends are pinched down, mashed and/or cut in a rough diagonal shear-like manner.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Torsion or Twisting	Wire ends show evidence of twist and/or cork-screw effect.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Mashing	Wires are flattened and spread at broken ends.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Corrosion	Wire surfaces are pitted with break showing evidence either of fatigue tension or abrasion.	Indicates improper lubrication or storage.
Abrasion plus Fatigue	Reduced cross-section is broken off square thereby producing a chisel shape.	A long term condition normal to the operating process.
Abrasion plus Tension	Reduced cross-section is necked down as in a cup and cone configuration. Tensile break produces a chisel shape.	A long term condition normal to the operating process.

ROPE INSPECTION SUMMARY

Any wire rope that has broken wires, deformed strands, variations in diameter, or any change from its normal appearance, must be considered for replacement. It is always better to replace a rope when there is any doubt concerning its condition or its ability to perform the required task. The cost of wire rope replacement is quite insignificant when considered in terms of human injuries, the cost of down time, or the cost of replacing broken structures.

Wire rope inspection includes examination of basic items such as:

1) *Rope diameter reduction*
2) *Rope lay*
3) *External wear*
4) *Internal wear*
5) *Peening*
6) *Scrubbing*
7) *Corrosion*
8) *Broken wires*

Some sections of rope can break up without any prior warning. Already discussed in some detail as to cause and effect, sections where this occurs are ordinarily found at the end fittings, and at the point where the rope enters or leaves the sheave groove of boom hoists, suspension systems, or other semi-operational systems. Because of the "working" that takes place at these sections, no appreciable wear or crown breaks will appear. Under such an operation, the core fails thereby allowing the strands to notch adjacent strands. However, when this happens, valley breaks will appear. As soon as the first valley break is detected, the rope should be removed immediately.

If preventive maintenance, previously described, is diligently performed, the rope life will be prolonged and the operation will be safer. Cutting off a given length of rope at the end attachment *before* the core deteriorates and valley breaks appear, effectively eliminates these sections as a source of danger.

EQUIPMENT INSPECTION

Any undetected fault on a sheave, roller, or drum—be it of relatively major or minor significance—can cause a rope to wear out many times faster than the wear resulting from normal operations. As a positive means of minimizing abuses and other-than-normal wear, the procedures here set forth should be adhered to. Every observation and measurement should be carefully recorded and kept in some suitable and accessible file.

1) Give close examination to the method by which the rope is attached both to the drum and to the load. Make certain that the proper means of attachment is applied correctly, and that any safety devices in use are in satisfactory working order.

2) Carefully check the groove and working surface of every sheave, roller, and drum, to determine whether each (groove and surface) is as near to the correct diameter and contour as circumstances will permit, and whether all surfaces that are in contact with the rope are smooth and free of corrugations or other abrasive defects.
3) Check sheaves and rollers to determine whether each turns freely, and whether they are properly aligned with the travel of the rope. All bearings must be in good operating condition and furnish adequate support to the sheaves and rollers. Sheaves that are permitted to wobble will create additional forces that accelerate the deterioration rate of the rope.
4) If starter, filler, and riser strips on drums are used, check their condition and location. Should these be worn, improperly located or badly designed, they will cause poor winding, dog legs, and other line damage.
5) Wherever possible, follow the path that the rope will follow through a complete operating cycle. Be on the lookout for spots on the equipment that have been worn bright or cut into by the rope as it moves through the system. Ordinarily, excessive abrasive wear on the rope can be eliminated at these points by means of some type of protector or roller.

FIELD LUBRICATION

During fabrication, ropes receive lubrication; the kind and amount depending on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

Following, are the important characteristics of a good wire rope lubricant:

1) It should be free from acids and alkalis,
2) It should have sufficient adhesive strength to remain on the ropes,
3) It should be of a viscosity capable of penetrating the interstices between wires and strands,
4) It should not be soluble in the medium surrounding it under the actual operating conditions,
5) It should have a high film strength, and
6) It should resist oxidation.