



## Rappelling Safety: Rope Contamination and Sky Genie Wear

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With the widespread application of wildland fire foam by helicopters, possible adverse effects resulting from contact of foam concentrate transported in helicopters with rappelling ropes is a point of issue. There are also concerns regarding possible adverse effects due to washing ropes in detergent.

In response to these issues, the San Dimas Technology and Development Center conducted destructive pull tests of Sky Genie rappel ropes soaked in solutions and concentrates of three types of wildland fire foams approved for use in helicopters. In addition, a pull test was conducted on a sample of rappel rope which had been heat damaged (glazed) during a fast rappel.

A separate testing program was conducted to determine if any strength degradation occurs to the Sky Genie descent control devices as they are worn from use.

Detailed engineering test reports for both of these tests are available by request from the San Dimas Technology and Development Center. This *Tech Tips* summarizes the rappel rope tests and the

Sky Genie Engineering test reports and provides recommendations regarding the use and care of this equipment.

### Rappel Rope Test

Twenty 3-foot sections of used 1/2-inch diameter L4 Sky Genie Type 4 Nylon Line rope were tested. The rope's minimum rated tensile strength is 5,000 lbs. From the rappelling history of the used rope, it was known that each section had been used for at least seven, but for no more than 17 rappels.

The wildland foams used to conduct the test were Ansul (Silv-Ex), Fire-Trol FireFoam 103, and Phos-Chek WD-861. Samples underwent a four week soak-dry cycle and then were allowed to dry for six days before being pull tested. The ropes were never rinsed with water during this time. Sky Genie rope samples were divided into groups of three and soaked in either diluted Silv-Ex (0.6%), Silv-Ex concentrate, Fire-Trol concentrate, WD-861 concentrate or a solution of Tide laundry detergent. Control groups of unsoaked ropes were also pull tested.

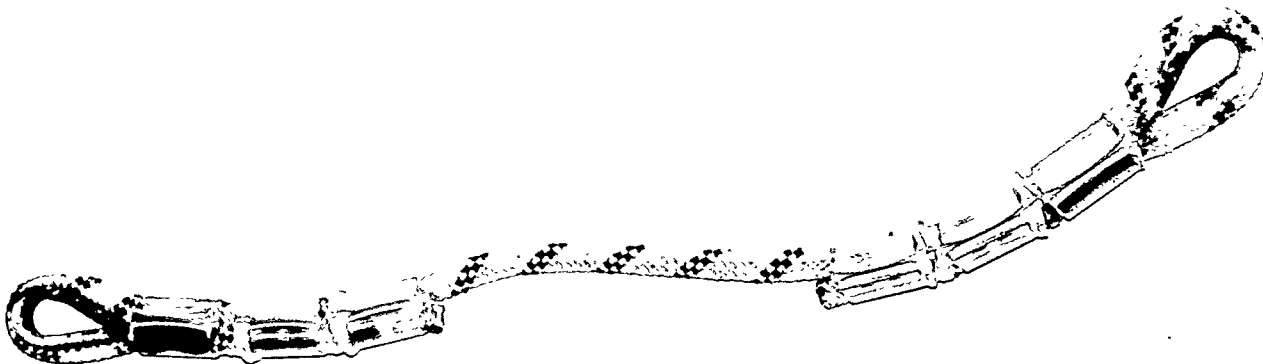


Figure 1.—A test specimen.

## Results And Conclusions of Rappel Rope Test

The approximate average failure force for the Sky Genie rope test groups soaked in the various substances were as follows:

<u>Substance</u>	<u>Failure Force</u>	<u>(lbs) Strength Reduction (%)</u>
Control Group-----	5,460 lbs	—
Diluted Silv-Ex-----	5,250 lbs	3.8
WD-861 concentrate-----	5,220 lbs	4.4
Fire-Trol concentrate-----	5,020 lbs	8.1
Washed in Tide-----	4,660 lbs	14.7
Silv-Ex concentrate-----	4,650 lbs	14.8
Heat glazed rope-----	4,400 lbs	19.4

Because all of the test sections came from the same piece of rope, the control group average strength of 5,460 lbs was used as a basis of comparison. Therefore, the heat-glazed rope had the greatest strength reduction. Of the ropes exposed to foams or detergents, the most damage was caused by Silv-Ex concentrate followed by the Tide detergent. Fire-Trol concentrate, WD-861 concentrate, and then diluted Silv-Ex were the next most damaging to the rope strength.

### Recommendations Regarding Rappel Rope Care

Descent Control Inc., manufacturer of the Sky Genie rope, discourages washing ropes in any type of detergent. Instead, they recommend washing ropes in a mild soap, or rinsing with water alone.

As a result of our testing, we recommend:

1. Do not wash ropes in any form of detergent. It is recognized that dirt, grit and sand accumulated on the ropes can be very abrasive and damaging to the ropes and descent devices. Therefore, it is recommended to only clean the ropes with water. When necessary to clean them more thoroughly, use a very mild soap solution (not detergent).

2. Do not use a rope which has been contaminated with foam concentrate.

3. Do not use a rope if it shows evidence of any overheating or burning, such as glazing.

4. Do not use a rope that has been soaked with any foam solution more than four times. It is recom-

mended that, after each known or suspected contact with a foam solution, the rope be rinsed with water as soon as possible after use and so noted in the rope log.

These recommendations are further supported by Item 5 of "Helicopter Rappelling Ropes, Time In Service and Condition Guidelines" issued May 1990 by the USDA Forest Service Washington office. This document states that "No rope shall be used if it shows evidence of any overheating or burning, visible damage which would compromise its strength or safety, contamination with foam concentrate, retardant, or any petroleum product, or any damage which affects more than 25% of any woven strand of the rope."

### Sky Genie Test

Three Sky Genies, manufactured by Descent Control Inc., were tested. Two of the specimens were new and the third was used with visible wear grooves (average depth of the wear groove was .014 inches). A 1/4-inch deep notch was machined into the shank of one of the new specimens to simulate an extreme wear groove. Shank diameter and hardness measurements were taken for each specimen prior to testing. All specimens were pulled in tension to failure in a Tinius Olsen testing machine. Figure 2 shows a Sky Genie in the testing machine.

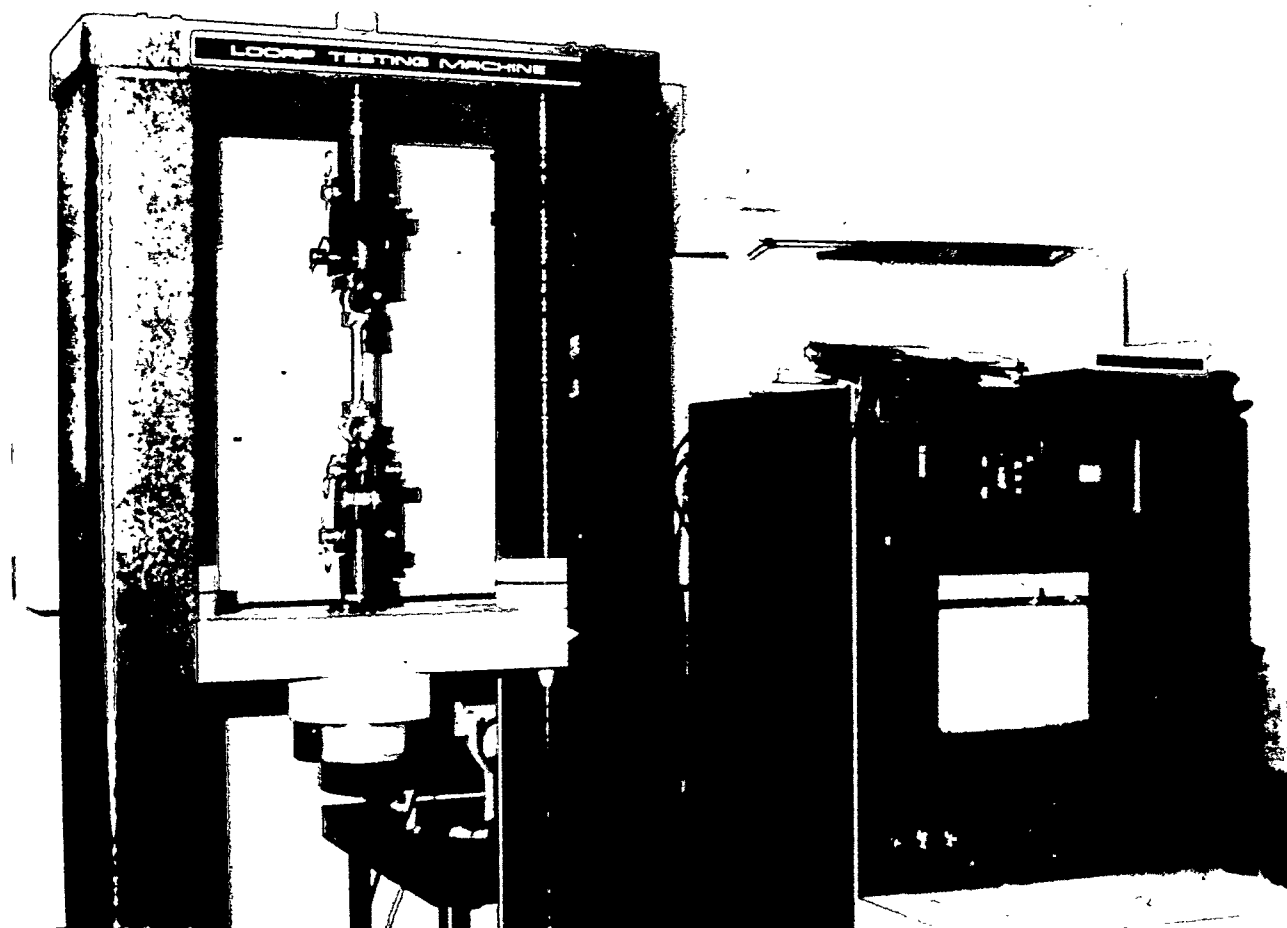


Figure 2.—Testing machine, with Sky Genie, ready to pull.

## Results and Conclusions of Sky Genie Test

According to Descent Control, the design proof load for the Sky Genie devices is 3,600 lbs, and the minimum design failure load is 10,000 lbs. Descent Control tests the Sky Genies with a pure axial loading. This same loading procedure was followed during this test.

The new, unworn device broke at 14,580 lbs at the upper eyelet. The used device with a wear groove broke at 14,200 lbs also at the upper eyelet. The new device, with the machined groove, broke at 8,860 lbs at the machined notch in the shaft. Obviously, the severe groove of 1/4-inch depth caused the part to be weakened below the 10,000-lb design failure load. Data from the worn part was of little help in determining effects of groove depth, since the strength degradation of the worn part was not significant. Therefore, data from breaking the machined part with the 1/4-inch deep groove was used to relate the results to other groove depths.

It was determined that a shaft with a 1/16-inch deep wear groove would be able to withstand a 10,000-lb pure tensile load with a safety margin of a 1/16-inch of material. However, in actual use, a Sky Genie is not loaded in straight tension. It is loaded in bending since it is not completely vertical when used. Therefore, it was concluded that a new, unworn Sky Genie in actual use would theoretically break when loaded to only 4,670 lbs (not 10,000 lbs), and would yield (deform) at approximately 4,150 lbs.

## Recommendations Regarding Use of Sky Genies

Based upon the higher stresses incurred during the actual use of a Sky Genie descent device, it is not recommended that any Sky Genie device, new or used, be loaded in actual use conditions to greater than 3,900 lbs. This includes the total of static and dynamic load factors.

Provided that the 3,900-lb load limit in use is adhered to (which should be no problem, considering that it would be nearly impossible to load a Sky Genie per recommended use to that high a loading), it is recommended that all Sky Genie devices be retired after a 1/16-inch deep wear groove is observed. This wear is approximately equivalent to 570 rappels.

## Additional Information

Detailed engineering reports for both tests can be obtained by request from the Technology and Development Center. To obtain copies of the reports or additional information regarding the equipment discussed in this *Tech Tips*, contact:

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