

SAMSON TECHNICAL BULLETIN

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VULCAN: A Synthetic Emergency Tow-Off Pendant



Emergency tow-off pendants (ETOPs), commonly referred to as “fire wires,” provide a means of towing the ship away from the dock in the event of a fire. Wire rope is currently used in this application; however, the handling of these heavy wire ropes has resulted in many injuries to deckhands. Samson has developed a synthetic alternative named Vulcan, which is significantly lighter and eliminates “fish-hooks,” broken wires that protrude from the wire rope that result in hand injuries. Maintenance costs are also reduced when using synthetic ropes in comparison with wire ropes.

Samson has developed a synthetic alternative named Vulcan, which is significantly lighter, reducing weight-related injuries, and eliminates “fish-hooks,” broken wires that protrude from the wire rope that result in hand injuries. Maintenance costs are also reduced when using synthetic ropes in comparison with wire ropes.

Since no testing standards or high heat performance requirements exist, Samson has developed a set of testing parameters by which to compare Vulcan to wire. Table 1 provides a comparison between wire and Vulcan with regard to the OCIMF minimum breaking strength requirements.

The patented synthetic ETOP Vulcan is made of Technora® fiber in conjunction with a proprietary fire-resistant coating that meets the OCIMF required breaking strength after exposure to flames and a high-temperature environment (Chou, et al., 2007, 2008, 2010).

TABLE 1. Vulcan vs. wire: meeting OCIMF minimum breaking strength requirements prior to heat exposure.

| VESSEL SIZE (DWT) | MIN. BREAK STRENGTH REQUIREMENT METRIC TONS | WIRE DIAMETER INCHES | VULCAN DIAMETER INCHES | WIRE WEIGHT PER 100 FT. | VULCAN WEIGHT PER 100 FT. | WEIGHT SAVINGS OVER WIRE |
|-------------------|---|----------------------|------------------------|-------------------------|---------------------------|--------------------------|
| < 20,000 | 30 t | 7/8" | 1" | 142 lb | 30 lb | 80% |
| 20,000–100,000 | 55 t | 1-1/8" | 1-5/16" | 234 lb | 69 lb | 70% |
| 100,000–300,000 | 100 t | 1-1/2" | 1-7/8" | 416 lb | 125 lb | 70% |
| 300,000+ | 120 t | 1-5/8" | 2-1/8" | 488 lb | 149 lb | 70% |

Because some strength is lost when Vulcan is exposed to high temperatures, the user may choose to use a larger diameter so that its retained strength still meets the required break strengths even when operating under severe heat or flame conditions. Table 2 represents the rope sizes that meet the OCIMF strength requirements (Table 1). Ropes at these sizes were tested at 575°F (300°C) after being held at 20% of their break strengths for 30 minutes at the same temperature. Note that the wire sizes are larger here than in Table 1. This is due to the strength loss that is also observed in wire when exposed to the same high-temperature testing parameters as the synthetic rope.

TABLE 2. Vulcan: Rope sizes to meet OCIMF strength requirements after heat exposure.

| VESSEL SIZE (DWT) | MIN. BREAK STRENGTH REQUIREMENT METRIC TONS | WIRE DIAMETER INCHES | VULCAN DIAMETER INCHES | WIRE WEIGHT PER 100 FT. | VULCAN WEIGHT PER 100 FT. | WEIGHT SAVINGS OVER WIRE |
|-------------------|---|----------------------|------------------------|-------------------------|---------------------------|--------------------------|
| < 20,000 | 30 t | 7/8" | 1-1/4" | 142 lb | 61.6 lb | 57% |
| 20,000–100,000 | 55 t | 1-1/4" | 1-11/16" | 289 lb | 107 lb | 63% |
| 100,000–300,000 | 100 t | 1-5/8" | 2-1/4" | 488 lb | 168 lb | 65% |
| 300,000+ | 120 t | 1-3/4" | 2-1/2" | 567 lb | 192 lb | 65% |

FIBER SELECTION

Technora® fiber was chosen for this product due to its ability to retain certain properties at elevated temperatures, including strength retention when exposed to higher temperatures for extended periods of time.

ENHANCING FLAME RESISTANCE

Although a rope made solely of Technora® fiber can withstand high temperatures, it has a diminished ability to withstand direct contact with a flame.

TABLE 3 Time until failure, during 750° open flame testing on coated and uncoated ropes.

| FIBER TYPE | UNCOATED | COATED |
|------------|----------|----------|
| Technora® | 12 min | 65 min |
| Polyester | < 1 min | 1.75 min |
| Nylon | < 1 min | 1.5 min |
| Dyneema® | < 1 min | < 1 min |

By utilizing a nonload-bearing jacket made of 100% Technora® fiber and applying a proprietary fire-resistant coating to the core, resistance to the damage of direct flames is increased, the coating's special intumescent property provides maximum protection to the rope by expanding to form a high-density char that acts as insulation when it is exposed to fire or high heat. This allows the rope to retain more of its strength for a longer period of time.

HEAT AND FLAME TESTING PROCEDURES

To determine the effect that heat or flame exposure has on rope and wire in a potential real-world scenario, Samson developed specific heat and flame testing procedures.

Heat Testing

Special equipment was fabricated to perform these tests, as shown in Fig. 1. A heated cylinder was installed in a test bed and the rope pulled through without direct contact of the rope and the heat source.

The heat test consisted of the following conditions:

1. A 575°F (300°C) temperature oven;
2. 30 minutes exposure of the rope to the heat source while loaded to 20% of break strength; and
3. the rope was broken while still at temperature (575°F, or 300°C).



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FIGURE 1 Special equipment for heat and flame testing. In small scale testing, the results were as listed:

- > The jacketed construction outperformed single braid ropes, which is a result of the increased insulation that protected the core (the strength member).
- > The same jacketed rope construction with standard polyurethane (PUR) coatings actually lost more strength than an uncoated Technora® single braid, indicating that PUR coatings may actually act as an accelerant, increasing the heat transfer through the rope.
- > Wire rope also shows about a 12% reduction in strength due to heat exposure.

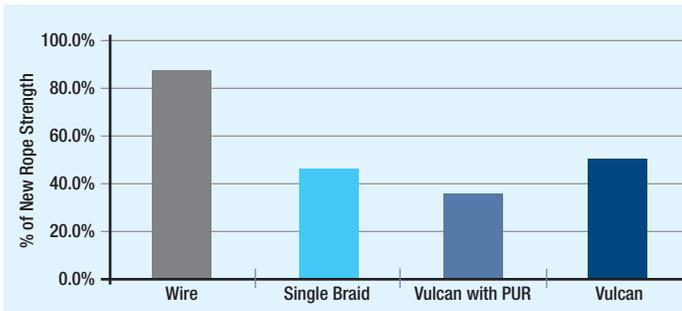


FIGURE 2 The retained strength of 1-inch diameter ropes of varying fibers and constructions after 30 minutes exposure to 575°F (300°C) at 20% load.

The results shown in Fig. 2 are a “worst case scenario” since heat transfers more quickly through a smaller diameter rope than a larger diameter rope. As the diameter increases, the strength loss will be minimized. Based on actual test data and known fiber properties, we are able to model the strength loss under these specific heating conditions and provide ropes that will meet OCIMF strength requirements even after heat exposure.

Flame Testing

Specialized testing equipment was prepared for this test application as illustrated in Fig. 3. This equipment provided to the rope direct exposure to an open flame in a controlled setting. The flame test consists of the following conditions:

1. Direct exposure to a 1100°F (600°C) open flame for 10 seconds, then
2. tested for tensile strength at room temperature (see Fig. 4).

The result demonstrated that there was no significant strength loss for wire or Vulcan.



FIGURE 3 Open flame-test equipment.

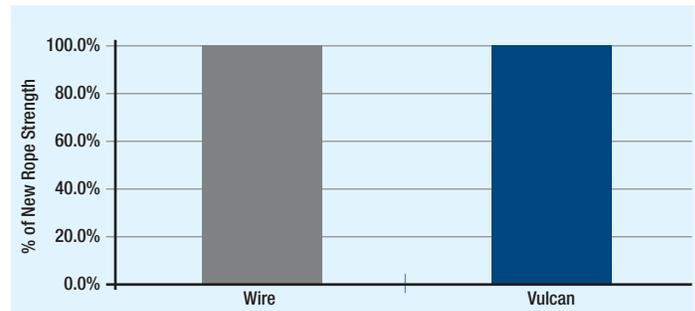


FIGURE 4 Retained strength of 1-inch diameter wire and Vulcan after 10-second direct exposure to a 1100°F (660°C) flame.

BIBLIOGRAPHY

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Technora® is a registered trademark of Teijin, Ltd.

Dyneema® is a registered trademark of Royal DSM N.V.

Dyneema® is DSM's high-performance polyethylene product.