

Fire Management Tech Tips

United States Department of Agriculture
Forest Service



Technology & Development Program

September 2002

5100

0251 1307—SDTDC

Hardline Hose Comparison Study

Lois P. Sicking, Mechanical Engineer

Introduction

A booster hose is lined and covered with rubber, and designed to withstand high pressure. Used as a hardline hose on engine live reels during the initial attack in wildland firefighting, it is normally exposed to high temperatures and subjected to rough wear over rocky, abrasive, and mountainous terrain. It is constructed to the Forest Service specification and procured through General Services Administration (GSA) as a rubber-braided hose, consisting of a compounded rubber tube, multiple plies of high-strength textile yarn reinforcement, and a tough rubber compound cover. Working pressure for the hose is up to 600 psi with a burst pressure of 2,400 psi.

Recent changes in hardline hose technology resulted in a lighter construction with comparable performance capable of holding a burst pressure to 2,400 psi. This lightweight construction includes a woven fabric jacket, a plastic helical reinforcement component, and a coating to improve abrasion resistance. The construction of REELTEX® and HOTSTOP™, manufactured by Niedner Fire Hose Company, are evaluated below. REELTEX® is manufactured in a 3/4- and 1-in construction for use as a hardline hose. HOTSTOP™ is constructed with a Kevlar-type woven fabric, and single jacket with a helical interior reinforcement. In addition, some fire engines use 1-in lightweight, single jacket cotton-synthetic fire hose, with a burst pressure of 900 psi as a live reel hardline hose.

An initial evaluation of this new lightweight hose by field personnel generated concern regarding its durability and abrasion resistance, compared to the Forest Service rubber-braided hardline hose (figure 1).

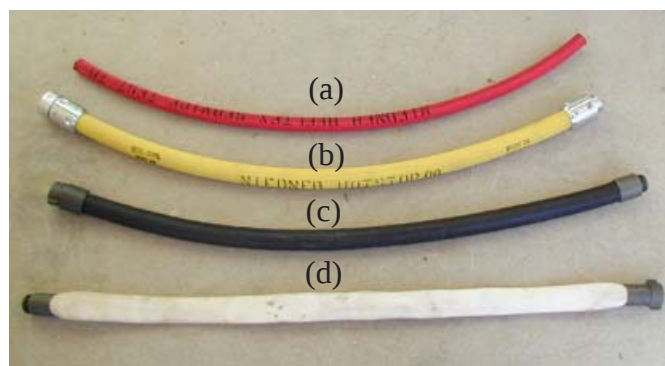


Figure 1—(a) REELTEX®, (b) HOTSTOP™, (c) rubber-braided, and (d) cotton-synthetic hardline hose.

Rubber-Braided Hardline Hose

A rubber-braided, wire-constructed, hardline hose is semirigid and is used during the initial attack in wildland firefighting. It is developed in accordance with Specification 5100-185, Specification for Hose, Rubber, High Pressure, 3/4-in Waterway, and constructed with an inner rubber tube, one or more plies of high strength textile yarn reinforcement, and an abrasion-resistant rubber cover. The reinforcement yarn may be braided or knitted into one or more plies over the tube, or helically wound in multiples of two layers with alternate layers wound in opposite directions. A rubber compound is used between plies for complete adhesion of the reinforcement, tube, and cover. It is designed with a high abrasion resistance and an exterior covering not readily damaged by the usual solvents for use on hot fires. The thread coupling series designation is 1 in, 1 1/2-in National Pipe Straight Hose (NPSH), with a nominal inside diameter of 3/4 in, and an overall length of 50 ft. The maximum weight for a 50-ft ± 6-in (hose length with couplings is 27.9 lb. The rated working pressure is up to 600 psi with a burst pressure of 2,400 psi.



Cotton-Synthetic Single Jacket as a Hardline Hose

A cotton-synthetic hose is a single jacket hose with an elastomer lining developed in accordance with Forest Service Specification 5100-186, Specification for Fire Hose, Single Jacket, Woven, Cotton-Synthetic. The coupling thread series designation is 1 in, 1 1/2-in NPSH. Cotton-synthetic fire hose is supplied by GSA in lengths of 100 ft. The weight of a coupled length of 100-ft cotton-synthetic hose is 20.4 lb. The rated working pressure is up to 450 psi with a burst pressure of 900 psi.

REELTEX® Woven Fabric Hardline Hose

REELTEX® consists of a lightweight woven fabric of spun polyester warp yarns. A plastic helical reinforcement component forms the rigid, durable covering, with an elastomer extruded tubing contributing to the semirigid hardline hose. It is capable of withstanding a proof pressure of 600 psi and a burst pressure of 2,400 psi. REELTEX® has an ENCAP® encapsulation for abrasion resistance and the manufacturer claims increased resistance to oil and chemicals, with improved water repellency. The extruded tubing is an ozone-resistant, age-resistant EPDM extruded elastomer. REELTEX® is available in lengths of 50, 100, and 150 ft (table 1).

Table 1—REELTEX® hardline performance.

Hose size in	Bowl size in	Weight for 100 ft of hose, uncoupled lb	Service test pressure psi	Proof pressure psi	Burst pressure psi
3/4	1-1/16	6.0	300	600	2,400
1	1-5/16	21.0	300	600	2,400

Note: Hose and bowl size are to manufacturer’s specifications.

REELTEX® couplings may be ordered with National Hose (NH) or NPSH aluminum expansion ring-type couplings or with new field repairable couplings. REELTEX® field repairable coupling are designed to give long service life, providing it is properly installed and maintained. These couplings may be detached and reattached many times and used as either an end coupling or as a means of splicing two or more damaged sections of hose together (figure 2 and appendix A).

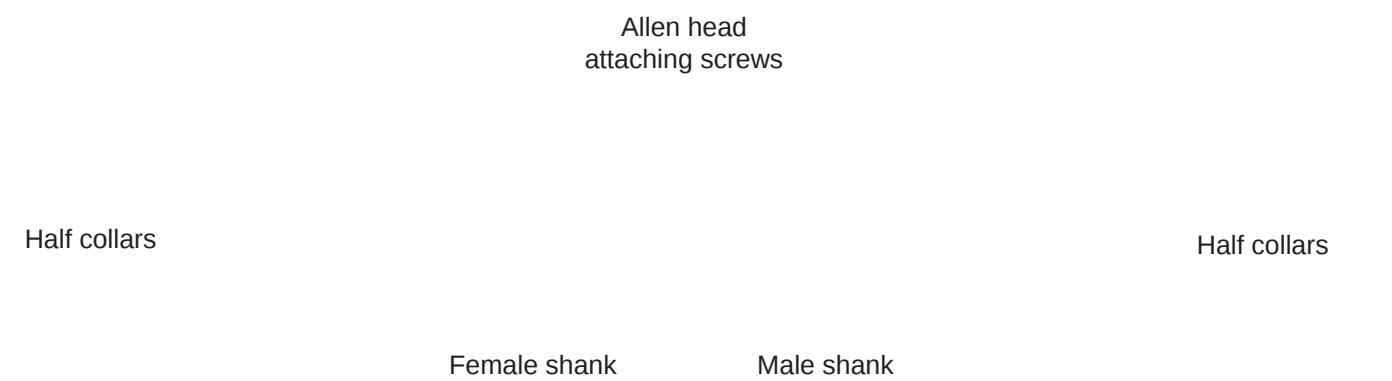


Figure 2—REELTEX® field repairable couplings.

HOTSTOP™ Woven Fabric Kevlar-Type Hardline Hose

HOTSTOP™ is constructed with ARAMID, a Kevlar-type woven single jacket for improved abrasion resistance. According to the manufacturer, its yellow ENCAP® encapsulation treatment provides improved repellency and resistance to abrasion, oil, and chemicals. HOTSTOP™ hose has a helical interior reinforcement and a lightweight extruded T.P.U. elastomer liner. The ARAMID construction has improved heat resistant properties. HOTSTOP™ is available in lengths of 50 to 100 ft (table 2).

Table 2— HOTSTOP™ performance.

Hose size in	Bowl size in	Weight for 100 ft lb	Service test psi	Proof pressure psi	Burst pressure psi
3/4	1-1/16	16.0	300	600	1,800
1	1-5/16	20.5	300	600	1,800

Note: Hose and bowl size are to manufacturer's specifications.

Performance Testing

Hardline hose performance is tested for abrasion resistance, bend radius, and proof pressure. An evaluation regarding manufacturing workmanship was also conducted (table 3).

Table 3—Hardline hose data comparison table.

Hose type	Hose size-id in	Coupling size NH or NPSH in	Weight for 50 ft coupled hose lb	FM abrasion resistance (no. of cycles)	Bend radius	Materials	Proof pressure psi	Burst pressure psi
REELTEX®	3/4	1	8.4	13,017	pass	polyester	600	2,400
Cotton-synthetic	1	1	10.2	340	NA	Cotton-synthetic	600	900
Specification	3/4	1	27.9	40,000	pass	rubber wire	1,200	2,400 rubber wire
5100-185, HOTSTOP™	1	1	8.4	40,000	pass	ARAMID	600	1,800

Note: Manufacturer states HOTSTOP™ is capable of withstanding a minimum of 65,000 cycles on the FM abrasion test stand.

All the hardline hoses in this study are capable of withstanding a minimum 600 psi of hydrostatic proof pressure with no leaks from the threaded connection, cracks, breaks, permanent deformation, mechanical damage, or structural failure.

With the exception of the cotton-synthetic hose, all hoses are subjected to the bend radius test with no indication of collapse or failure. Each is flexed five times through a 180-degree arc starting at one end of the hose. The radius of the arc is six times the inside diameter of the hose.

All of the hardline hose rubber or plastic components are even, fully formed, uniform in thickness, and circular throughout. There are no blisters, pinholes, pits, sink marks, crazing, wrinkles, voids, foreign material, or cracks. The surface of the material is tack free. The fabric or wire reinforcement did not protrude through the outer or inner surfaces, but is completely embedded in the rubber or plastic material.

Abrasion resistance testing is conducted using the Factory Mutual (FM) abrasion test machine and test method. Abrasion testing is held after 40,000 cycles without failure, as was noted with rubber wire-braided and HOTSTOP™ hose (figure 3).

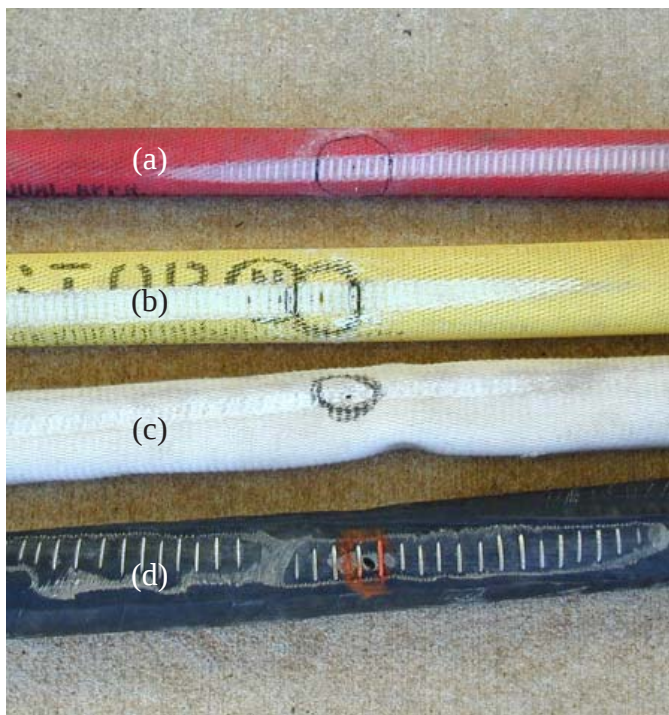


Figure 3—(a) REELTEX®, (b) HOTSTOP™, (c) cotton-synthetic, and (d) rubber-braided abrasion test samples.

All woven fire hose jackets were seamless. Jackets are even and firm in texture, flexible, and free from dirt, knots, lumps, irregularity of twist, or other defects that may affect the appearance or serviceability of the hose.

A hardline hose with a liner is constructed from flat stock, extrusion, or a coated reinforced construction using a thin cambric or other reinforcing material. When a lap joint was used, it was as small and smooth as practicable. The liner extended the full length of the hose, providing a smooth waterway with no ribs, ripples, indentations, overlapping material, or any uneven surface.

Field Evaluation

The strongest comments provided during the field evaluation for the various constructions of lightweight hardline hose focused on the benefits provided by the reduction in weight. Comments also focused on the likelihood for dirt and debris, especially “stickers,” to collect on the lightweight hose constructions due to the rough fabric surface. This serves as a reminder to wear required personal protective equipment at all times.

Findings

REELTEX®, HOTSTOP™, and cotton-synthetic hoses are comparable in weight. The more heavily constructed rubber wire-braided hardline hose weighs over three times more than the average lightweight hose. Lightweight hose averages 8.4 lb per 50 ft for uncoupled length. The rubber wire-braided hose weighs 27.9 lb for a 50-ft length.

The best abrasion resistance is achieved by rubber wire-braided and HOTSTOP™ hoses, at over 40,000 cycles on the FM abrasion test machine. The abrasion resistance of the cotton-synthetic hose is minimal at 0.1 percent of the rubber-braided and HOTSTOP™ hose. REELTEX® has one-third the abrasion resistance of the rubber-braided or HOTSTOP™ hose.

Due to the reduction in weight, abrasion resistance, and burst pressures, REELTEX® and HOTSTOP™ hoses provide a positive contribution to hardline hose technology as used in wildland firefighting. In addition, HOTSTOP™ has superior lightweight characteristics and abrasion resistance. However, the burst pressure for HOTSTOP™ is 1,800 psi, 25 percent lower than rubber-braided and REELTEX®. On the lightweight hose constructions, REELTEX® has improved burst pressure and HOTSTOP™ has improved abrasion resistance.

Rubber wire-braided, REELTEX®, and HOTSTOP™ hose provide hardline hose performance characteristics that are appropriate for wildland firefighting.

Due to the low burst pressure and low abrasion resistance, 1-in cotton-synthetic is not recommended as a hardline hose.

Cost

Pricing for all lengths is provided in table 4. The costs are comparable between the rubber wire-braided, REELTEX®, and HOTSTOP™ hoses with a 7 to 10 percent difference. HOTSTOP™ is 17 percent more expensive than REELTEX®.

The cotton-synthetic hose is less than 50 percent of the price of the other hose constructions. This is probably due to the fact that cotton-synthetic is not a true hardline hose with a semirigid construction and is not designed for abrasion resistance. Both of these design parameters increase the pricing of hardline hose.

Table 4—Hardline hose cost comparison.

Hose type	Coupling size NH or NPSH in	Material	Length ft	Cost (dollars)
Specification 5100-185, rubber wire	3/4	rubber wire	50	134
Specification 5100-186, cotton-synthetic	1	cotton-synthetic	100	62
REELTEX®	3/4	polyester with ENCAP®	50	126
REELTEX®	3/4	polyester with ENCAP®	100	238
REELTEX®	1	polyester with ENCAP®	50	141
REELTEX®	1	polyester with ARAMID	100	235
HOTSTOP™	3/4	polyester with ARAMID	50	148
HOTSTOP™	3/4	polyester with ARAMID	100	250
HOTSTOP™	1	polyester with ARAMID	50	168
HOTSTOP™	1	polyester with ARAMID	100	298

Procurement Information

Rubber wire-braided hardline hose is available in 50-ft lengths in the GSA catalog as National Stock Number 4210-00-595-1838.

REELTEX® and HOTSTOP™ hoses are available through Wildfire, a subsidiary of Tyco. Direct product inquiries to Wildfire at 800-426-5207 or through <http://www.wildfire-equipment.com>. Wildfire is in the process of adding these products to the GSA Federal Supply Schedule 42, under GSA Contract Number GS-07F-5128A. The manufacturer of REELTEX® and HOTSTOP™, Niedner Fire Hose, can be contacted at <http://www.niedner.com>.

For further information, please contact the San Dimas Technology and Development Center fire program leader at 909-599-1267.

Appendix A

REELTEX® Field Repairable Couplings Instructions

Niedner's REELTEX® field repairable coupling is designed to give long service life, providing it is properly installed and maintained. It may be detached and reattached many times and used as either an end coupling or as a means of splicing two or more damaged sections of hose together.

Make sure you have the following parts and tools before proceeding:

- 4 Half collars
- 1 Male shank
- 1 Female shank
- 8 3/4-in long stainless steel Allen head cap screws, 10 to 24 thread
- 1 5/32-in Allen head wrench or screwdriver
- 1 O-ring for each male and female coupling shank (two each for 1-in coupling shanks).

Allen head
attaching
screws

Half collars

Half collars

Female shank

Male shank

Installation of REELTEX® field repairable couplings:

1. With a sharp knife, trim the ends of the REELTEX® hose square. (The helical reinforcement may have to be cut with a wire cutter.)
2. Verify that the rubber O-rings on each shank are not cut or damaged. If so, they must be replaced. Slip the hose over the shank of either the male or female coupling. It should extend no farther than three grooves beyond the rubber O-rings. If the hose is difficult to slide onto the shank, a little petroleum jelly may be used.

IMPORTANT: DO NOT use oil or grease for this purpose. It will attack the inner tube and cause eventual leakage.

3. Place two of the half collars over the hose and thread the four 10 to 24 cap screws into place finger tight. Note that the chamfered end of the collars goes towards the back of the coupling.
4. Tighten each of the four bolts gradually in a crisscross pattern until all are snug. Do not overtighten as this may strip the threads in the aluminum half collars. When properly tightened, there should be a very slight gap between the collars. This is normal providing the gap is the same on each side. It is important that the bolts be tightened alternately and evenly.

In order to detach the coupling set, remove the four bolts and the two half collars. The hose will be difficult to remove from the shank and will probably need to be cut off. In doing so, pay careful attention not to damage the rubber O-rings.

IMPORTANT: The REELTEX® field repairable coupling is designed to be installed only on Niedner REELTEX® hose of the appropriate size. No attempt should be made to attach it to any other brand of hose. Attachment to another type of hose could result in coupling slippage or blow off, which could cause serious injury. Niedner assumes no responsibility for any coupling assembly that does not respect the above installation instructions.

Replacement parts may be ordered as required. Please refer to the following part numbers when ordering.
 Note: Parts, such as bolts and O-rings, are priced per piece. When ordering, please stipulate the required number of pieces. Refer to the parts list below:

Part Description	Part No.
3/4-in coupling set (complete) with a 1-in NST thread	C09FAB05XXS
3/4-in coupling set (complete) with a 1-in NPSH thread	C09FAA05XXS
3/4-in half collar (two pieces)	C09FAZ05CLS
3/4-in male shank with a 1-in NST thread	C09FAB05XXM
3/4-in male shank with a 1-in NPSH thread	C09FAA05XXM
3/4-in female shank with a 1-in NST thread	C09FAB05XXF
3/4-in female shank with a 1-in NPSH thread	C09FAA05XXF
3/4-in O-ring (one piece)	C09GNZ05BOG
3/4-in half collar stainless steel bolt (one piece)	C10FAZ07VIS
1-in coupling set (complete) with a 1-in NST thread	C10FAB07XXS
1-in coupling set (complete) with a 1-in NPSH thread	C10FAA07XXS
1-in half collar (two pieces)	C10FAZ07CLS
1-in male shank with a 1-in NST thread	C10FAB07XXM
1-in male shank with a 1-in NPSH thread	C10FAA07XXM
1-in female shank with a 1-in NST thread	C10FAB07XXF
1-in female shank with a 1-in NPSH thread	C10FAA07XXF
1-in O-ring (one piece)	C10GNZ07BOG
1-in half collar stainless steel bolt (one piece)	C10FAZ07VIS

Approximate English to Metric System Conversion Factors

To Change	To	Multiply by
inches	millimeters	25.4
feet	meters	0.305
pounds	kilograms	0.454
pounds/ square inch	kilopascal	6.894

Information contained in this document has been developed for the guidance of employees of the Forest Service, United States Department of Agriculture (USDA), its contractors, and co-operating Federal and State agencies. The USDA assumes no responsibility for the interpretation or use of this information by other than its own employees. The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.



The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410 or call 202-720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.