Standard 5100-500e
July 1991
& Amendment 1
Superseding
Standard 5100-500d
July 1989

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

STANDARD FOR

ACCESSORIES, EXTERNAL-LOADING, HELICOPTER

1. Purpse and Scope. The helicopter external-Ioading accessories covered herein are established as standard in the USDA Forest Service. External accessories are those systems which are used when attached to the cargo hook of a helicopter, or support such systems use.

There are three weight classes of helicopters, light, medium, and heavy. The helicopter accessories covered in this Standard are for use on only light and medium helicopters.

2. Applicable Documents

2.1. Government Documents. The following documents, of issue in effect of the date of invitation for bids, form a part of this specification to the extent herein specified:

Federal Aviation Administration

AC 43.13-1A	Acceptable Methods, Techniques, and Practices-Aircraft Inspection and Repair
AC 43.13-2A	Acceptable Methods, Techniques, and Practices-Aircraft Alterations

Federal Standards

751	Sewn Seams

Federal Test Method Standards

191	Textile Test Methods

Military Specifications

MIL- T -52983	Tanks, collapsible, 3000, 10'000' 20,000, and 50,000 gallon, petroleum
MIL-W-5086	Electric Connectors and Wires
MIL-W-16878D	Electric Connectors and Wires

MS-31078-24-11 P Plug

Military Standard

MIL-C-20696C Low Temperature Resistance

OSHA

Vol.lll, Subpart N, Section 1926.551, Construction Standards and Interpretations, Helicopters.

Commercial Specifications

National Electrical Manufacturers Association Standards (NEMA)
Standard WD 6-1988
Wiring Devices Dimensions-Requirements

Underwriters Laboratory, Inc. (UL) Standard # 62
Standard for flexible cords and cables
Underwriters Laboratory, Inc. (UL) Standard # 498
Standard for safety for attach plugs and receptacles

Copies of Government documents and other publications required by contractors in connection with specific procurement functions should be obtained from the procurement activity or as directed by the contracting officer. Copies of National Electrical Manufacturers Association publications can be obtained by writing to NEMA, 2101 "L" St. N. W ., Washington D.C. 20037. Underwriters Laboratory publications can be obtained by writing UL, Publications Stock, 333 Pfingsten Road, Northbrook, III. 60062-2096.

3. General Requirements.

3.1. Performance. Except for remote hooks, multiple cargo hooks (carousels) and light cargo nets, all accessories used in connecting external loads to light/medium helicopters shall have a safe working load of at least 3,000 Ib (1,360 kg), and an ultimate load-carrying capability of at least 11,250 Ib (5,100 kg) when new. Accessories covered by this Standard shall be capable of performing as designed throughout the temperature range of 0°F (-18°C) to 140°F (60°C). The operation of the accessories shall not be impaired by adverse environmental conditions such as dust, moisture, chemicals, etc., found in general firefighting conditions.

3.1.1. Leadlines and Swivels. Leadlines and swivels shall demonstrate a proof test of 6,000 Ib (26.7 kN).

3.1.2. Remote Hooks. Remote hook system hardware shall have a safe working load of 1.5 times the safe working load of the remote hook or multiple remote hook used (see 4.4). Remote hook system suspension cables shall demonstrate a proof test of 3 times the safe working load.

3.1.3. Multiple Remote Cargo Hooks (Carousels). Multiple remote cargo hooks (carousels) shall have a minimum 600 Ib (272 kg) safe working load per hook and ultimate load-carrying capability for the whole system of at least 3,600 Ib (1,636 kg) when new. If a greater safe working load is desired, the user shall so specify.

3.1.4. Light cargo nets. Light cargo nets and high-volume light cargo nets shall have a minimum safe working load of 300 Ib (136 kg) and ultimate load-carrying capability of 450 Ib (204 kg).

3.2. Parts and Materials.

3.2.1. Component Parts. All component parts (including metallic and non-metallic parts) shall be new and not reprocessed or reworked. When commercially available or standard parts used as components require modification, evidence of engineering data or laboratory test shall be supplied to verify that the modified part meets the requirements of 3.1. and 3.3.

3.2.2. Materials. All materials used shall be unaffected by exposure to desert sunlight or outdoor storage periods of 1 year. All materials used shall be unaffected in their physical properties by exposure to dust, moisture, herbicides, pesticides, other chemicals, etc., found in general firefighting and forestry work conditions, or to fuels, oils, and additives used for and around helicopters.

3.3. Construction and Workmanship. All accessories shall be manufactured by current standard production processes to provide a clean, finished quality product. Workmanship shall be equal to the best commercial practices consistent with the highest engineering standards in the industry and shall be free from any defect which will impair serviceability or detract from the appearance of the product. (See Federal Aviation Administration Advisory Circulars AC 43.13-1A and 43.13-2A.) Each component and system shall be appropriate to its intended function considering the nature and adverse conditions involved in helicopter firefighting operations.

3.4. Electrical. The electrical system shall be compatible with and not to exceed the capacity of a 28-volt aircraft system, and be in accordance with OSHA; Vol. Ill, Construction Standards and Interpretations, Subpart N, Section 1926.551, Helicopters. Electric connectors and wires shall comply with Military Specifications MIL-W-5086 and MIL-W-16878D or Underwriter Laboratories, Inc., Standards, as appropriate. All electric wiring shall be enclosed or tied in a harness and be resistant to wind, water, retardants, and petroleum products. All electrical plugs, except as otherwise specified herein, shall comply with MS-31 078-24-11 P. Plugs shall be wired so that pin "D" is ground and 28V DC power is applied to pin "E" to actuate the accessory. On carousel hooks, the reset function shall be wired to pin "C".

3.5. Provisions Applicable to Leadlines and Remote Hook Systems Suspension Cable Systems.

3.5.1. Leadline Materials. Leadline material shall be flexible steel cable of a minimum diameter of 5/16-in (7.94 mm). If it is to be plastic coated, at the user's option, it shall be coated to 1/32-in (0.79 mm) minimum depth, polyvinyl chloride, ultra-violet stabilized

plastic. Such coating shall be clear to the extent that the inspection of the cable under such coating is visually possible. Unless specified by the user the plastic coating shall be green.

3.5.2. Splices and Thimbles. Splices shall incorporate a minimum of four tucks. All thimbles shall be rated "extra heavy."

3.5.3. Swaged Terminations. If swaged terminations in leadlines or remote hook suspension cable sections are used, such swages shall be stainless or carbon steel or copper. Aluminum swages shall not be used. Swages shall be painted for slippage check. Swages shall not be covered.

3.6. Provisions Applicable to Nets.

3.6.1. Thimbles. The extremities of heavy cargo nets shall be fitted with metal or plastic thimbles spliced or swaged to the ends of the net strands. (Note: Thimbles are optional on light cargo nets.) Thimbles shall not crack or break when the net on which they are installed is stressed to maximum safe working load, 3,000 Ib (1 ,360 kg) for heavy cargo nets and 300 Ib (136 kg) for light cargo nets. Other hardware or design features which perform the same function as thimbles may be used provided these strength requirements are met.

3.6.2. Perimeter Ropes. The perimeter ropes of cargo nets shall be made of nylon or Dacron. The perimeter ropes of heavy cargo nets shall be treated for abrasion resistance by a minimum of two coats of solvent-carried polyurethane, 20 to 30 percent solids or equal.

3.7. Product Marking. Each item shall be marked showing rated capacity, date of and load applied during proof test, if such a test is required, manufacturer, date of manufacture or date of first service, and service life or strike data where applicable. Markings shall be permanently stamped or embossed on all metal items or on a metal that shall be secured by a small metal cable. Fabric items shall be securely tagged or marked.

4. Item Requirements. The items referred to in this standard are typical configurations of accessories considered standard in the Forest Service. The illustrations in this standard are for general information only, except that limitations in dimensions shown are mandatory.

4.1. Rings, Links, and Hooks. Minimum and maximum permissible dimensions for rings, links, and hooks used in leadlines, remote hook and carousel suspension cables, and to attach other accessories to either the helicopter cargo hook or any remote hook or carousel, are shown in figure 1. All hooks shall employ a safety latch.

4.2. Cargo Swivel. A cargo swivel consists of a ring or link on the upper end, a hook on the lower end, and a swivel section in between. The ring or link and hook may be integral with or detachable from the swivel body. Figure 2 illustrates a cargo swivel. Except for dimensions shown in figure 2, other dimensions shall be in accordance with figure 1. If detachable, components shall be replaceable and attached by bolts secured with self-locking nuts, or some other system that provides equivalent safety.

The swivel body shall incorporate a permanently lubricated and sealed thrust-type ball or roller bearing. Free swivel rotation shall be maintained for all loads up to the safe working load. The swivel shall be designed for minimum maintenance without special tools and equipment.

ALL	***RING***	***OBLONG LINK***		***PEAR LINK***			***HOOK***		
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
5/8" max (15.8 mm)	3" min (76 mm) 4" max (102 mm)	3" min (76 mm) 4" max (102 mm)	1-1/2" min (38 mm) 3" max (76 mm)	3" min (76 mm) 4" max (102 mm)	3" max (76 mm)	1/2" min (12 mm)	1.5" max (38 mm)	0.65" min (17 mm)	1.0" min (25 mm)

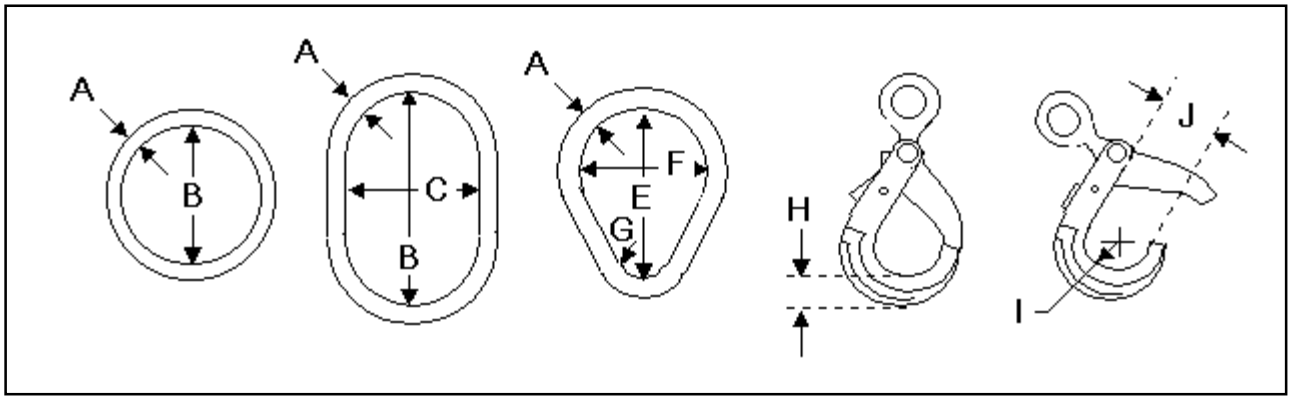

Figure 1. Ring, link, and hook limiting dimensions.

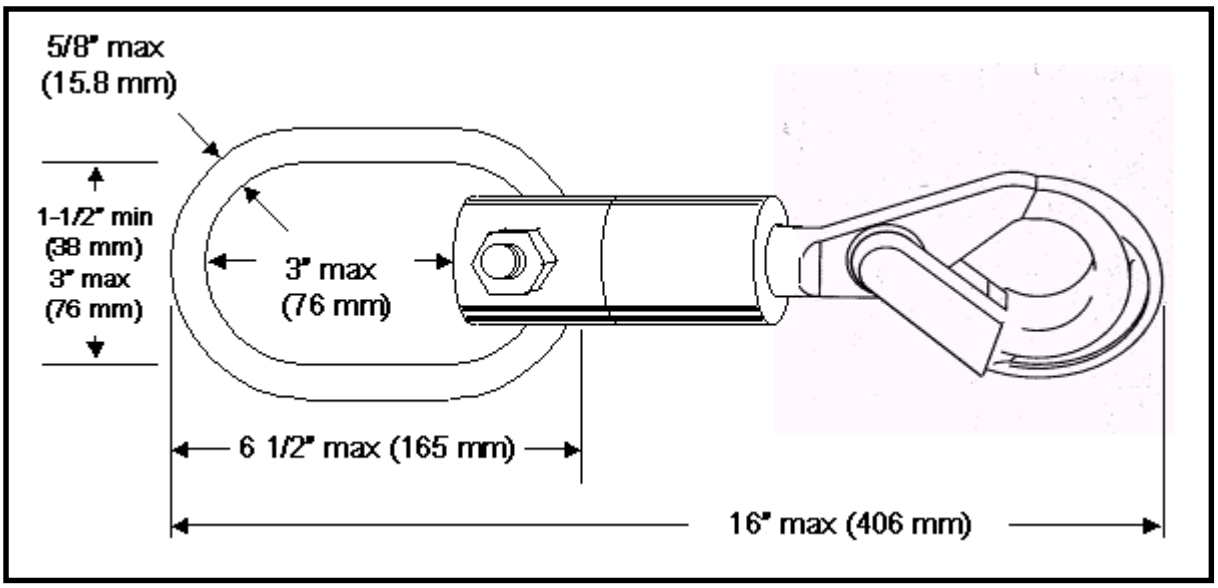

Figure 2. Cargo swivel

4.3. <u>Leadline.</u> Figure 3 illustrates a typical leadline. This is not illustrative of the suspension cable sections used with remote hook systems (see 4.4.). The leadline consists of a cable, as specified in 3.5.1., with a ring or link on one end, and a hook on the other end. All end loops for cables shall be formed around extra heavy metal thimbles and spliced or swaged as specified in 3.5.2. and 3.5.3. The user may specify the different

lengths of 12 ft ± 3 in, 25 ft ± 3 in, or 50 ft ± 3 in (3.66 m ± 76 mm, 7.6 m ± 76 mm, 15.2 m ± 76 mm). The length shall be measured from the center to center of the thimbles, with the leadline taut, in a straight line, on a flat surface. The "length" measurement is shown in figure 3.

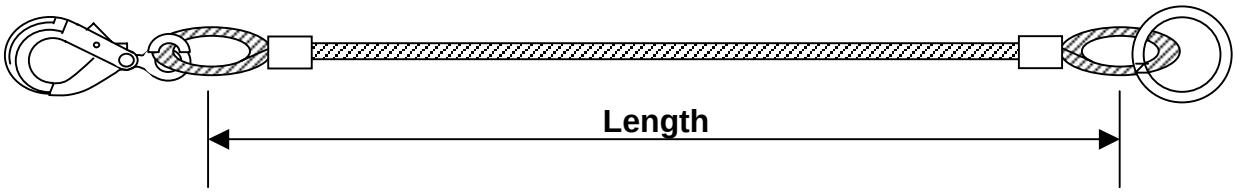

Figure 3. Leadline

4.4. Remote Hook System. A remote hook system consists of suspension cable sections, a remote hook, a remote hook guard and handgrip, electrical leads for the operations of the remote cargo hook, appropriate matching attaching hardware, and an electrical pigtail. The system has an overall working length of 150 ft nominal.

Figure 4 illustrates on configuration of a remote hook system with one 50 ft (15.24 m) electrical lead and one 100 ft (30.48 m) suspension cable section with a total of three sets of attachments. This 100 ft cable section may be substituted with two 50 ft cable sections for a total of four sets of attachments.

Figure 4 also shows one 50 ft (15.24 m) electrical lead and one 100 ft (30.48 m) electrical lead with a total of three sets of connectors. This 100 ft electrical lead may be substituted with two 50 ft electrical leads for a total for connector sets.

Remote hook systems are described I Project Record “Remote Hook Systems for Helicopters”, No. 8457 1203, USDA Forest Service, Technology and Development Center, San Dimas, CA 91773.

4.4.1. Remote Hook Guard. Since remote hook guards are custom fit to each model of remote hook, it is impossible to provide detailed specifications until the remote hook is selected.

A guard for the Eastern Rotorcraft 2A 15E hook has been developed, and drawings, Nos. F111-01 and F111-02, are available from the USDA Forest Service, Technology & Development Center, San Dimas, CA 91773. If an Eastern Rotorcraft 2A 15E hook is used, the remote guard shall conform to the latest drawing revision.

The general requirements for the remote hook guard are:

1. Provide a medium to attach remote hook to the remote hook system suspension cable.

2. Provide protection to the remote hook when the hook is placed on the ground and inadvertently dragged.

3. Provide a hand-hold for the crew member using the remote hook from the ground.

4. Provide adequate weight to insure good flying qualities of the remote hook and leadline.

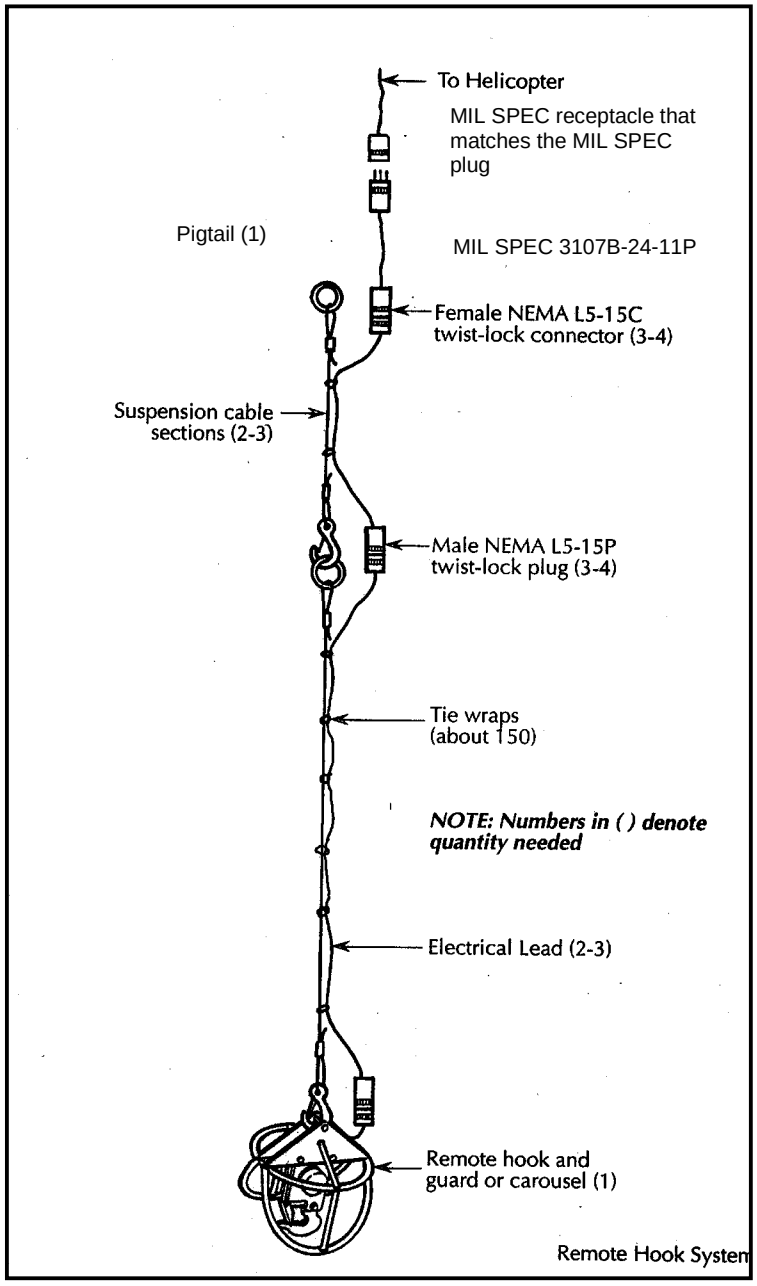

Figure 4. Remote hook system.

4.4.2. <u>Remote Hook.</u> The remote hook shall securely carry its rated load with no electrical load, and release the load with an electrical current draw of not more than 20 amps. The hook shall be self-locking, that is, it shall return to "latched" position after the "release" signal is removed.

4.4.3. <u>Suspension Cable Sections, Remote Hook System.</u> The suspension cable sections used with the remote hook system shall be 50-ft working length, i.e., 50 ft – 1 inch + 0 inches (15.24 m – 2.5 cm + 0 cm) or 100 ft working length, i.e., 100 ft – 1 inch + 0 inch (30.48 m – 2.5 cm + 0 cm) from the inside loaded surface of the hook to the inside loaded surface of the link. The overall configuration shall be in accordance with 4.4. They shall be constructed of 3/8-in (9.5 mm) diameter, 9 x 17 counter wound anti-rotating cable, or equal. The user shall specify galvanized coating before winding, or a coating of polyvinyl chloride, ultraviolet stabilized, clear florescent orange 1/32-in (0.79 mm) minimum depth. If polyvinyl chloride is specified, the manufacturer shall strip polyvinyl chloride before swaging. Cable may be bare for up to 2 inches (51 mm) from swage. To one end a hook as specified in figure 1 of this standard shall be attached; to the other end, a ring or link per figure 1 of this standard shall be attached, per 3.5.2. and 3.5.3. NOTE: These suspension cable sections are not for use with the Helitorch. See Forest Service Technology & Development Tech Tips (to be issued late in 1991), "Helitorch Longline".

4.4.4. Electrical Lead. Electrical lead shall be 50-ft ± 1 in (15.24 m ± 2.5 cm) or 100 ft ± 1 in (30.48 m ± 2.5 cm) long measured from the face to the connectors, with the electrical lead taut, in a straight line, and on a flat surface. Wire shall be 14 gauge, two or three conductor, rubber or neoprene-jacketed power cord, of the Underwriter's Laboratory, Inc. approved type SJ or type SO. On one end twistlock NEMA L 5-15 type male plug shall be attached (see figure 5). On the other end, twistlock NEMA L 5-15 female receptacle shall be attached. Plug and receptacle shall be nylon bodied or molded-on plastic, high visibility color, UL listed and shall provide adequate strain relief to the cord. The positive (+) (black wire) conductor of the wire shall be connected to the brass-colored (uncoded) terminal of the NEMA L 5-15 plug and receptacle. The negative (-) (white wire) conductor shall be connected to the silver-colored (W) terminal of the NEMA L5-15 plug and receptacle. If used, the reset (green wire) conductor shall be connected to the green (G) terminal of the NEMA L 5-15 plug and receptacle.

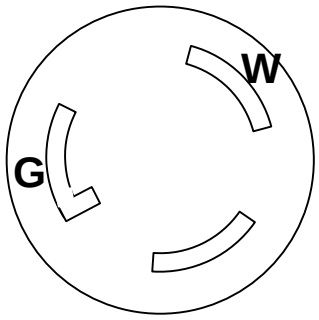

Figure 5. NEMA L5-15 receptacle outlet.

The pigtail shall be 9 ft (2.7 m) in length and shall be fabricated with a twistlock NEMA L5-15 female receptacle attached at one end, and to the other end, an MS 31078-24-11P, wired per paragraph 3.4. of this Standard. (This pigtail is used to carry electrical power from the upper end of the remote hook system to the helicopter remote power plug.)

4.4.5. Assembly. The electrical cord shall be attached to the suspension cable using plastic cable ties (tie wraps), with a minimum breaking strength of 30 Ib (13 kg). The electrical lead shall be anchored with two tie wraps at each end, and one tie wrap every foot. The electrical leads shall be wrapped around the suspension cable once every 10 ft (3.05 m). The female receptacle shall be located at the hook end of the suspension cable, and the male plug shall be at the ring or link end of the suspension cable. Tie wraps shall be snugged up tight and trimmed carefully, or heat-seared, to avoid sharp edges.

4.5. Multigle Remote Cargo Hook System (Carousel). This system is identical to the remote hook system, except that an integrated multiple cargo hook device (carousel) is substituted for the remote hook and remote hook guard. The carousel shall include cargo hooks, firing system, and electrical connectors assembled on a frame with a hemispheric guard of tubing, and clevis for suspension from a suspension cable section. (See Figure 6 for an example of a carousel.)

Carousels and light cargo nets are described in an Equip Tips "Four Hook Carousel and Light Cargo Net System", USDA-Forest Service, San Dimas Technology & Development Center, San Dimas, CA 91773.

4.5.1. <u>Carousel General Requirements.</u> The carousel shall meet the same requirements as specified for Remote Hook System with the following exceptions:

Hooks -four in number, minimum safe working load of 600 Ib (272 kg), ultimate load-carrying capability of 1.5 times safe working load.

Height -26 in (66cm) maximum, 23 in (58cm) minimum.

Width -21-1/2 in (55cm) diameter maximum, 19-1/2 in (50cm) minimum.

Weight -less than 35 Ib (16kg).

All electrical components shall be protected from dust and impact. The release system shall be controlled from the helicopter cockpit by a three-wire system (one release, one reset and one ground wire). The release system shall function so that when the release switch is depressed for less than 0.3 seconds, the system advances to the next hook. If the switch is depressed longer than 0.3 seconds, the system advances to the next hook and releases. Pressing the reset button shall automatically ready the No.1 hook for firing and turn on the red indicator light, if so equipped, on the carousel.

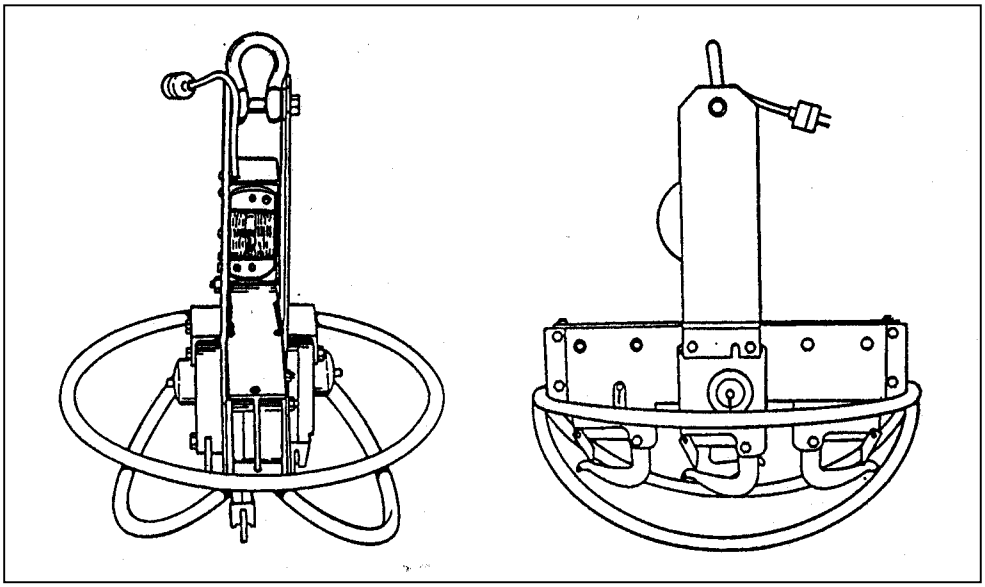

Figure 6. Multiple remote cargo hook (carousel).

4.6. <u>Cargo Nets.</u>

4.6.1. <u>Heavy (3,000 Ib) Cargo Nets.</u> Figures 7 and 8 illustrate round and square heavy cargo nets. The cargo net is used to transport freight suspended beneath helicopters, permitting delivery without landing. Each consists of a net mesh and a perimeter rope with tethering rings connecting the segments of the perimeter rope. The perimeter ropes shall perform as a drawstring when the load is lifted, enclosing the top of the net during transport.

The perimeter rope shall be divided into segments of equal length with rings at the segment junctions. The ring shall provide a means of shortening the length of the resulting line when the top of the net is closed.

The net mesh cord intersections shall be fastened. The only allowable movement of the intersecting cords shall be such that the distance between centers of adjacent intersections shall not exceed 7 in (178 mm) with no additional tolerance.

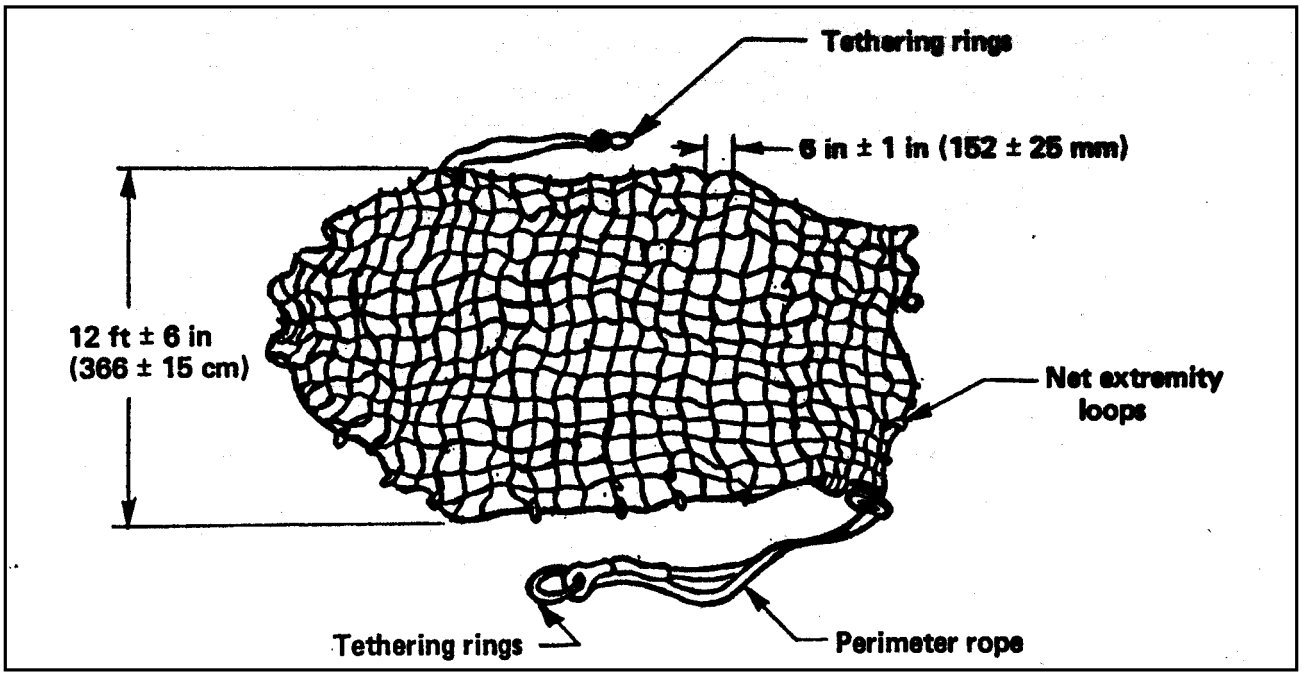

Figure 7. Round heavy cargo net.

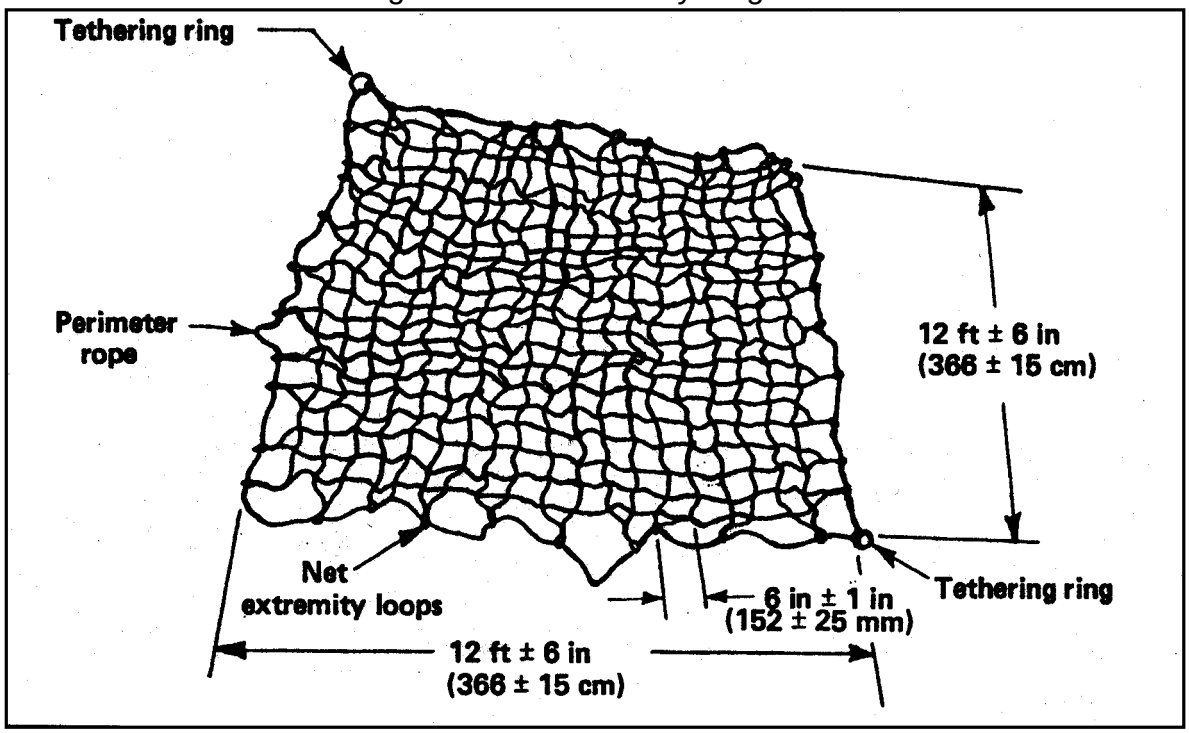

Figure 8. Square heavy cargo net.

4.6.2. <u>Light (300 lb) Cargo Net.</u> The light cargo net shall be constructed of lightweight synthetic cord. Either a perimeter rope or drawstring may be used, and shall be specified by the user. See Figures 9 and 10. The light cargo net shall meet the requirements of Section 3, General Requirements and 4.6.1. Heavy Cargo Net with the following exceptions:

The net may be of any polygonal shape, or round or oval. Size of the net shall be 10 ft (3.1 m) minimum to 12 ft (3.7m) maximum diameter or side dimension. The only allowable movement of the intersecting cords shall be such that the distance between centers of adjacent intersections shall not exceed 4 inches (102 mm) with no additional tolerance.

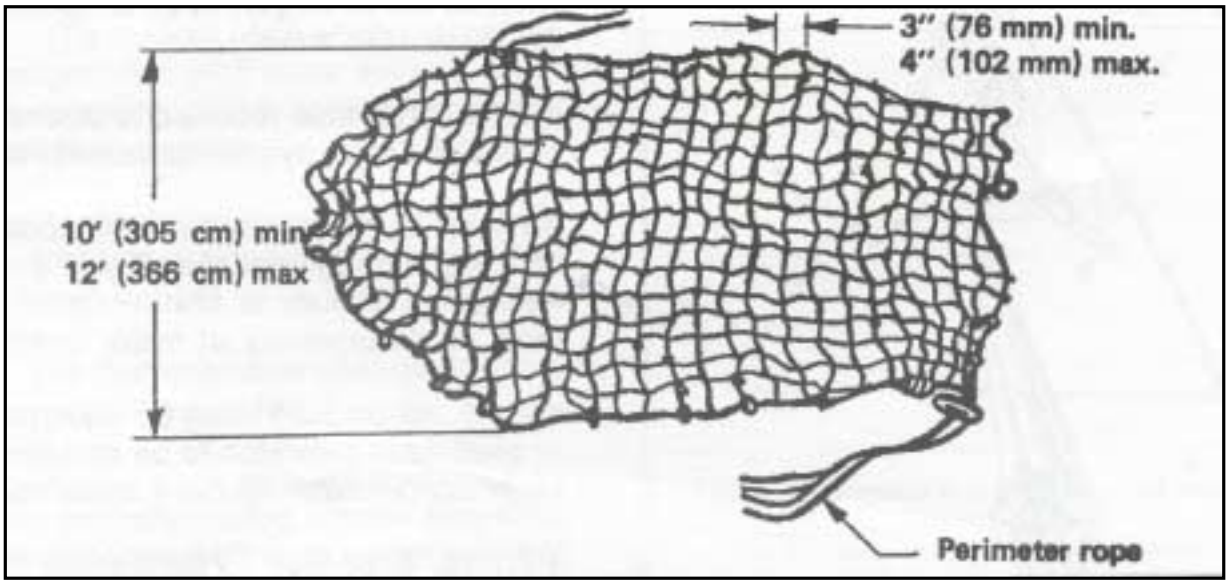

Figure 9. Round light cargo net.

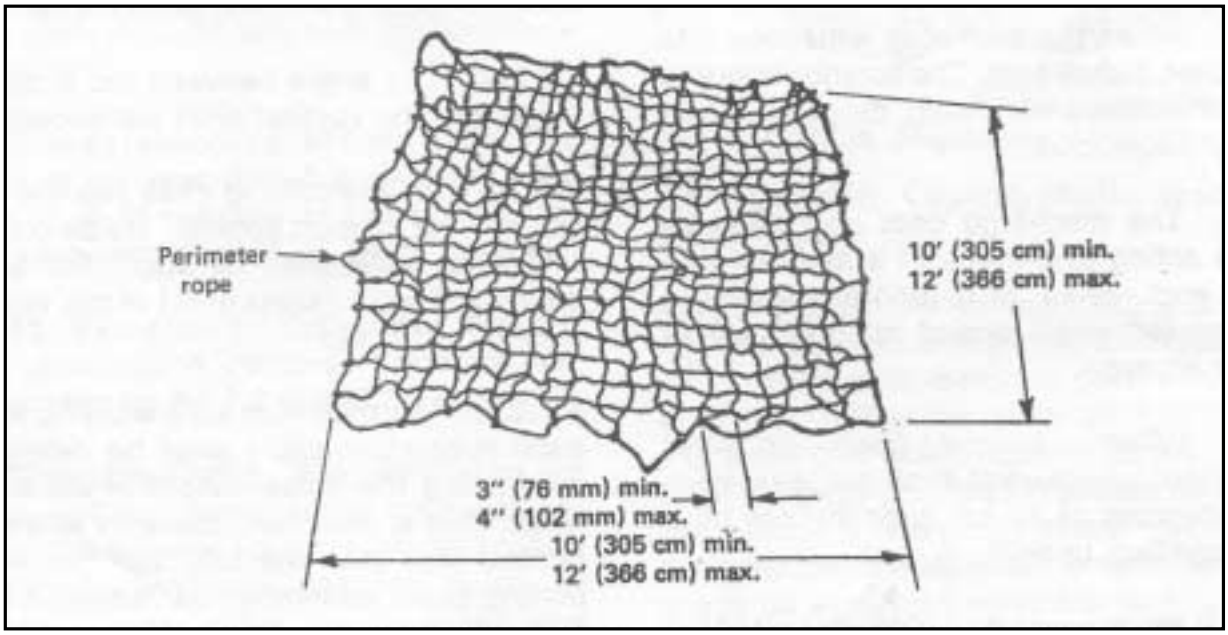

Figure 10. Square light cargo net.

4.6.3. <u>High-volume Light (300 lb) Cargo Net.</u> The high-volume light cargo net is identical to the light cargo net, except that its side dimension shall be between 15 ft. (4.6m) and 20 ft. (6.1 m). This type net is used to transport low-density cargo.

4.7. <u>Helicopter Bucket.</u> A helicopter bucket consists of an open top shell or sack, a bottom discharge door, control mechanism, support cable and fittings (an example is shown in Figure 11).

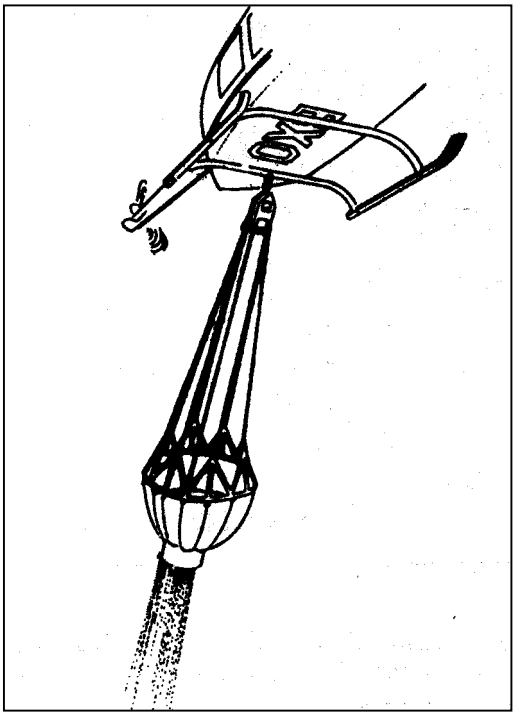

Figure 11. Helicopter Bucket

4.7.1. <u>Operational Features.</u>

4.7.1.1. When the bucket is jettisoned into deep water, it shall float. The flotation features shall not interfere with filling, dropping, or air ferrying the bucket.

4.7.1.2. The discharge door seal shall be positive acting and made of a material that will not stick, seize, or deteriorate when the door has remained closed for one year at outdoor storage.

4.7.1.3. When completely filled with water or retardant, the bucket shall not leak more than 1 percent of its full capacity per hour while standing upright.

4.7.1.4. Buckets exceeding 500 U.S. gallon (1893 L) capacity shall be equipped with discharge doors that can be opened and closed and held in intermediate positions while hover-filling and while in flight.

4.7.1.5. Bucket shall be a highly visible color.

4.7.1.6. The bucket shall be capable of air ferry without adverse flight characteristics, whether full or empty, at all airspeeds up to 60 knots (111 km/h).

4.7.1.7. The time required to discharge the bucket's full capacity shall not exceed 6 seconds.

4.7.1.8. Buckets may be either collapsible or rigid, although collapsibility is preferred. Collapsible buckets shall not require special tools or disassembly of major components

4.7.1.9. All buckets shall be equipped with, or shall have provision to be equipped with, foam concentrate injection systems.

4.7.1.10. Exception for Collapsible Buckets. At the users option, collapsible buckets may be exempted from 4.7.1.1., 4.7.1.3.,4.7.1.4., and 4.7.1.6.

4.7.2. Bucket Design.

4.7.2.1. A minimum of three cables shall be used to support the bucket below the helicopter.

4.7.2.2. The angle between the supporting cable and the vertical shall not exceed 30°.

4.7.2.3. An apex fitting shall join the upper ends of the support cables. Inside diameter of the ring or link shall be such that a hook meeting the provisions of 4.1 of this standard may be attached.

4.7.2.4. The minimum safe working load of each supporting cable shall be determined by dividing the gross weight of the bucket, when filled to maximum capacity with water, by one less than the total number of supporting cable assembly, as indicated in the following formula:

$$\text{Minimum leg capacity} = \frac{\text{Maximum bucket weight}}{\text{(No. of support cables-1)}}$$

4.7.2.5. The bucket shall be capable of sustaining and shall be fully functional under a dynamic load of 2.5 times the maximum gross weight of the bucket filled to capacity with water.

4.7.2.6. The bucket base shall support its gross weight filled with water without structural failure while sitting in its loading position on a flat level surface.

4.7.2.7. The discharge door shall be operable and the contents drainable while the bucket is positioned upright on a level surface.

4.7.2.8. The discharge door shall be actuated by a pilot-operated switch.

4.7.2.9. If port caps or plugs are used as part of the capacity limiting system, they shall be fastened to the bucket to prevent loss or damage.

4.7.2.1 0. Buckets may be equipped with a metering and injection system for additives. If so equipped, the capacity limiting system shall be permanently marked showing capacity. Injection of additives shall be accomplished by a power-driven pump actuated by the pilot, through use of a spring-return-to-off-switch.

The additives reservoir shall have a minimum volume of not less than 0.2 percent of the maximum fluid capacity of the bucket, but in no case less than 1 qt (0.95 L).

4.7.2.11. Exception for Collapsible Buckets. At the users option, collapsible buckets may be exempted from 4.7.2.6., 4.7.2.7., 4.7.2.10.

4.8. Slingable Tanks. Slingable tanks are flexible, self-supporting tanks for the transport and storage of liquids such as potable water, firefighting water, gasoline, diesel, jet fuel, etc. Such tanks are designed and constructed to be transportable by attachment to a leadline, which is in turn attached to the cargo hook 'Of a helicopter. Figure 12 shows a slingable tank of less than 160 U.S. gallons nominal. Figure 13 shows a slingable tank of greater than 160 U.S. gallons nominal.

4.8.1. Capacity. Capacity shall be as specified by the user.

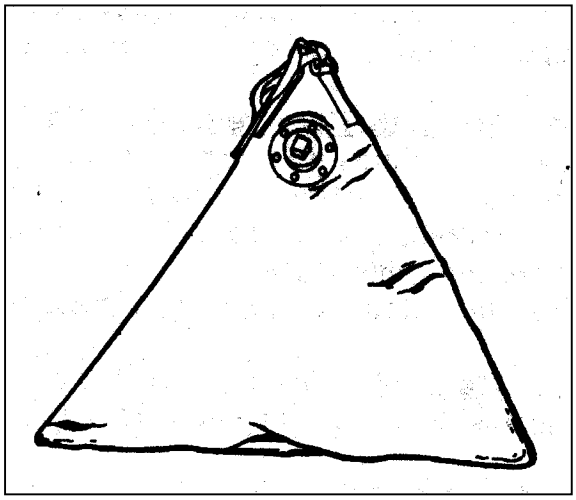

Figure 12. Slingable tank – less than 160 U.S. gallons nominal.

4.8.2. Shape. All tanks of 160 U.S. gallon nominal capacity or less shall be in the shape of a regular tetrahedron or polyhedron, with an altitude within the range of 0.75 times to 1.5 times the base. Larger tanks may be of any regular polyhedron shape, as long as the altitude is in a range of one-half to three times the projected base dimension. All shapes are to be evaluated when the tank is loaded to capacity and suspended from its suspension system. The suspension system is not to be considered in the shape evaluation. Tanks with frameworks that support the tank on the ground are exempt from this requirement.

4.8.3. Suspension System. Each tank shall have suspension system which allows the tank to be lifted and carried by a single point on that suspension system. The point of the suspension system that is attached to the helicopter leadline shall comply with all provisions of 4.7.2.3 of this standard. Hardware that attaches the suspension system to the tank shall be appropriate to its intended purpose, but need not comply with 4.1.

4.8.4. Strength Requirements. Each tank shall have a safe working load in pounds of at least 12.5 times its rated capacity in US gallons, and an ultimate load-carrying capability in pounds of 47 times its rated capacity in US gallons. (These figures represent 1.5 times the weight of the tank's capacity of water, and 3.75 times that figure.) These strength criteria apply to the entire tank, including -the suspension system. The strength requirements may be substantiated by tests or calculations.

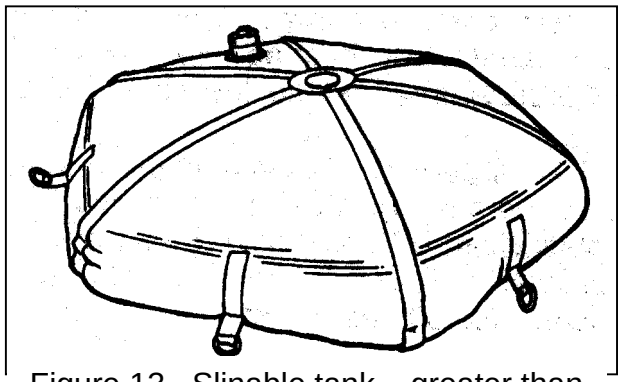

Figure 13. Slinable tank – greater than 160 U.S. gallons nominal

4.8.5. Material. The body of the tank shall be made of a flexible, coated material that meets the following minimum requirements.

4.8.5.1. Substrate. For all water tanks, the substrate shall be polyester, heat-set, 7.5 + 0.5-0.0 oz/sq yd. For fuel tanks, the substrate shall be polyester or nylon between 7.5 and 13 oz/sq yd. A rip-stop thread or other rip-stop feature shall be incorporated in the substrate. The substrate shall have a minimum breaking strength in any direction of 450 lb per inch, at all temperatures between 0°F (-18°C) and 140°F (60°C). The rip-stop feature shall prevent the substrate from tearing in a straight line. The warp and fill count shall be equal, and such counts shall be no less than 20 per inch.

4.8.5.2. Coating. The coating material shall be applied in liquid form (laminated fabrics are not permitted). Coating application shall fully penetrate the substrate. The coating shall be plasticized U.V. stabilized PVC for all water tanks. The coating shall be a non-extractable plasticizer compound compatible with all gasolines, includes those containing alcohol, and jet fuels, for all fuel tanks.

4.8.5.3. Finished Material. The finished material shall conform to the following specifications:

Tests per Federal Standard 191

Total weight	28 + 2.0 -0.0 oz/sq yd
Coating Compound Adhesion Method 5970	10 lb min, 15 lb max
Grab tensile Method 5100	600/600 lb (min)
Tear strength, 8 inch x 10 inch Method 5134	200/200 lb (min)
Blocking resistance Method 5872	Rating not more than 2
Hydrostatic resistance Method 5512	500 psi
Strip tensile Method 5102	450/450 lb/in
Trapezoid tear Method 5136	80/80 lb
Uniaxial elongation (30 lb/in load, 4 hours, 75° F)	warp1.5% max fill 3.5% max

.

Test per Federal Test Method 5804

U. V. stabilization	1,500 hr minimum carbon arc exposure with no apparent change and no reduction in tensile strength greater than 15% of original.

Test per Military Standards

Low temperature resistance MIL-C-20696C Para 4.4.6.	No crack, 20ºF (94 hr exposure)

4.8.6. Fabrication. All seams shall be electronically or hot wedge welded. Glued, solvent cemented, or hot-air welded seams are not permitted. Seams shall not be sewn or taped. Reinforcing tapes may be used only if they are welded. Straps used in the suspension system may be sewn. All such sewn seams shall conform to applicable provisions of Federal Standard 751. Seams shall be loaded in shear only when the tank is being transported or is resting on a flat, level surface, when filled to capacity. No seam shall be designed so that it is loaded in tension. The use of fell or french fell seams to accomplish this requirement is permitted.

4.8.7. Fittings. Tanks of less than 160 U.S. gallon nominal capacity shall have a least the following inlets and outlets:

One fill port, 4 in. nominal minimum, screw closure.
One drain port, standard garden hose (male 3/4 in 11-1/2 NH)

Tanks of greater than 160 U.S. gallon capacity shall have at least the following inlets and outlets:

One fill port, 4 in. nominal minimum, screw closure.
One drain port, 1-1/2 in fire hose (male 1-1/2 -9 NH).

Each drain shall be fitted with an appropriate sized ball valve or other suitable quick-turn closure. Fittings shall be so arranged that tanks are self-filling, that is, no support shall be required to fill the tank through the fill port to its rated capacity, and so that tanks are self-draining, that is, no support shall be required for the tank to drain 95% of its contents through the drain fitting. Self-filling and self-draining features shall be demonstrated with water, with the tank sitting on a level, flat, hard surface.

4.8.8. Suspension System. Each tank shall be equipped with a suspension system which allows the tank to be transported by helicopter leadline. The suspension system shall have the strength characteristics specified in 4.8.4. Each suspension system shall have a single ring or link for attachment to the leadline which meets the requirements of 4.7.2.3 above. Each suspension system shall have at least three elements which attach the ring or link to the tank. The suspension system shall be capable of maintaining the tank in a flyable suspended orientation, when the tank is filled to capacity with water, with no more than 2/3 of the suspension system members attached to the tank. This capability shall be demonstrated by severing at least 1/3 of the adjacent suspension system members, and hoisting the filled tank clear of the ground.

4.8.9. Hold Down System. Each tank of greater than 160 U.S. gallon nominal capacity shall be equipped with a total of at least three suitable securing devices of the following types, webbing straps, "D" rings, etc. These rings do not need to meet the provisions of section 4.1 above, but must have a minimum inside dimension of 1.5 inches nominal.

4.8.10. Marking and Color. In addition to the requirements of 3.2 each tank shall be permanently, legibly, and prominently labeled with at least the following information:

Working capacity in US gallons, maximum capacity, if different from working capacity in US gallons, net weight at capacity(s}, and any limitations on service.

Tanks limited to potable water shall be marked in letters at least 1 in tall, on a surface not the bottom, and in a contrasting color, "Potable Water Only". Such tanks shall be blue in color.

Tanks for fuel use shall be marked in letters at least 1 in tall on a surface not the bottom, and in a contrasting color, "No water", and "Gasoline Only", or "Jet Fuel Only", or "Diesel Only", as applicable, and shall be red or black in color.

Tanks for use with firefighting water shall be marked in letters at least 1 in tall, "Bad Water-Do Not Drink", in a contrasting color on a surface not the bottom.

4.8.11. Drop Test. Each tank model shall demonstrate a drop test from a height of five feet, measured from the lowest part of the tank, filled to working capacity, onto a smooth, flat, hard surface, such as turf or concrete. Any failure of a seam, or the appearance of any pinhole, tear, obvious strain, puncture, or leakage shall constitute failure.

4.8.12. Additional Requirements. Any tank intended for use with potable water shall be manufactured only from materials approved by the U.S. Food and Drug Administration for such use. Any tank intended for use with fuel shall meet the standard specified in U.S. Military Specification 52983C, Section IV-2, Detailed Summary of Fabric Properties and Test Methods.

4.9. Self-Supporting Open Top Water Tanks. Self-supporting open top water tanks come in many sizes and are intended to hold fire fighting water for use in helicopter bucket dipping and other fire fighting operations. Such tanks are designed and constructed to be transportable in a collapsed state, then by a buoyant collar or similar device to allow filling through the wide diameter top with hydrostatic pressure providing the only support. Tanks which use additional supporting framework are not covered by this specification. Figure 14 shows a typical portable tank being filled.

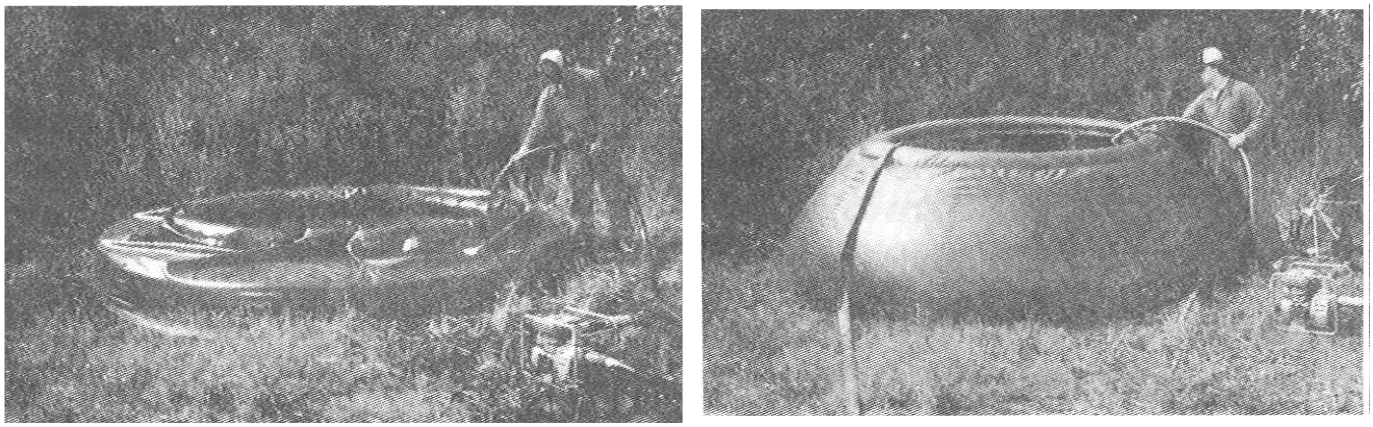

Figure 14. Self-supporting open top water tank being filled.

4.9.1. Capacity. Capacity shall be as specified by the user.

4.9.2. Shape. All tanks shall be in the shape of a regular polygon or circular, with an altitude within the range of 0.4 to 0.7 times the base. The large diameter fill mouth shall be in a range of 0.5 to 0.8 times the base. All shapes are to be evaluated when the tank is filled to capacity. Tanks shall be stable on uneven ground.

4.9.3. Fill System. Each tank shall have, in addition to the top fill capacity additional fill fittings as specified by the user.

4.9.4. Material. The body of the tank shall be made of a flexible, coated material that meets the following minimum requirements.

4.9.4.1. Substrate. The substrate shall be polyester, heat-set, of weights 7.5 +0.5 -0.0 oz/sq yd or 10.0 +0.5 -0.0 oz/sq yd. A rip-stop thread or other rip-stop feature shall be incorporated - in the substrate. The substrate shall have a minimum breaking strength in any direction of 450 Ib per inch, at all temperatures between 0°F (-18°C) and 140°F (60°C). The rip-stop feature shall prevent the substrate from tearing in a straight line. The warp and fill count shall be equal, and such counts shall be no less than 20 per inch.

4.9.4.2. Coating. The coating material shall be applied in liquid form (laminated fabrics are not permitted). Coating application shall fully penetrate the substrate. The coating shall be plasticized, U. V. stabilized PVC for all water tanks.

4.9.5.3. Finished Material. The finished material shall conform to the following minimum specifications:

Tests per Federal Standard 191	
Total weight	For 7.5 oz/sq yd, 28 +2.0 -0.0 oz/sq yd For 10.0 oz/sq yd, 32 +2.0 -0.0 oz/sq yd
For either fabric:	
Coating Compound Adhesion Method 5970	10 Ib min, 15 Ib max
Grab tensile Method 5100	600/600 Ib
Tear strength, 8 inch x 10 inch Method 5134	250/250 Ib
Blocking resistance Method 5872	Rating not more than 2
Hydrostatic resistance Method 5512	500 psi
Strip tensile Method 5102	450/450 Ib/in
Trapezoid tear Method 5136	80/80 Ib
Uniaxial elongation (30 Ib/in load, 4 hours, 75° F)	warp 1.5% max fill 3.5% max
Test per Federal Test Method 5804	
U. V. stabilization	1,500 hr minimum carbon arc exposure with no apparent change and no reduction in tensile strength greater than 15% of original.
Test per Military Standards	
Low temperature resistance MIL-C-20696C Para. 4.4.6.	No crack, 20ºF (94 hr exposure)

4.9.5. Fabrication. All seams shall be electronically or hot wedge welded. Glued, solvent cemented, and hot-air welded seams are not permitted. Seams shall not be sewn or

taped. Reinforcing tapes may be used only if they are welded to the tank fabric. Attachments must be externally mounted so no sewn area pierces through the tank.

4.9.6. Fittings. Tanks of nominal capacity of 4000 U.S. gallons or less shall have at least the following outlets:

> Two drain ports, of at least 2 in diameter 180° apart for rapid dumping. User shall specify port configuration, i.e., flange size, port threads, etc.
>
> Tanks of greater than 4000 U.S. gallon nominal capacity shall have at least the following outlets:
>
> Four drain ports, of at least 2 in diameter 90º apart for rapid dumping. User shall specify port configuration.

Each drain port shall be fitted with an appropriate suitable closure. Fittings shall be so arranged that tanks are self-filling, that is, no support shall be required to fill the tank through the fill port to its rated capacity, and so that tanks are self-draining, that is, no support shall be required for the tank to drain 95% of its contents through the drain fittings. Self-filling and self-draining features shall be demonstrated with water, with the tank sitting on a level, flat, hard surface.

4.9.7. Hold Down System. Each tank shall be equipped with at least three suitable securing devices, i.e., webbing straps, "D" rings, etc. The securing devices are utilized during initial helicopter bucketing operations and must be sufficiently strong and secure to stabilize the tank when a medium helicopter hovers 10 ft over it. If used, these rings do not need to meet the provisions of section 4.1 above, but shall have a minimum inside dimension of 1.5 inches (dimension B of figure 1).

4.9.8. Collar Construction. Those designs which use a buoyant collar to accomplish self-filling must have collars which meet the following requirements. Tanks which meet the self-filling requirement in another way are not covered by this section.

4.9.8.1. Spread Attachments. Collar shall have attachments to spread large fill opening when filling tank from empty with a helicopter bucket.

4.9.8.2. Separately Sealed Sections. Collar must be compartmentalized to prevent water transfer around the circumference in case of collar puncture. In tanks up to 3000 U.S. gallon capacity there shall be at least two separately sealed sections of equal dimensions. In tanks of larger than 3000 U.S. gallon sizes there shall be at least four sealed sections of equal dimensions.

4.9.8.3. Puncture Resistance. Collar flotation shall be constructed of closed cell foam.

4.9.8.4. Height. Collar shall be at least 6 inches tall when measured from the high water mark on a tank filled to full working capacity. (This is to knock down waves during heavy filling and bucketing.)

4.9.9. Marking and Color. Each tank shall be permanently, legibly, and prominently labeled with at least the following information:

Working capacity in US gallons, maximum capacity, if different from working capacity in US gallons, net weight at capacity(s), and any limitations on service.

Tanks for use with fire fighting water shall be marked in letters at least 1 in tall, "Bad Water-Do Not Drink", in a contrasting color on a surface not the bottom.

5. Notes.

5.1. Pregaring Activity. USDA-Forest Service, Technology & Development Center, 444 East Bonita Avenue, San Dimas; CA 91773.