

MIL-S-16059B(SHIPS)
12 April 1961
SUPERSEDING
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MILITARY SPECIFICATION
SHAFTING, FLEXIBLE (CORE AND CASING COMPLETE)
(FOR THE REMOTE OPERATION OF VALVES)

1. SCOPE

1.1 This specification covers flexible steel shafting (core and casing) and couplings intended for, but not limited to the remote operation of valves for shipboard use.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids, form apart of this specification to the extent specified herein:

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and
Tables for Inspection by
Attributes

PUBLICATIONS

BUREAU OF SHIPS

NAV-SHIPS-250-648-2 - Design Manual for
Flexible Shafting
Valve Remote Control Systems

2.2 Other publications, - The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York 16, N. Y.)

3. REQUIREMENTS

3.1 Materials. - The materials of parts not specified herein shall be of high grade commercial standard suitable for the purpose intended, under conditions of vibration, shock, temperature and corrosion encountered. Choice of materials shall be such that the parts will not gall, corrode or stick, after long periods of inactivity at elevated or lowered temperatures.

3.2 General design. - Flexible shafting shall consist of a flexible core of steel wires and a flexible case which acts not only as a guide for the core and a grease retainer, but also as a suitable means for attaching supports for the whole unit. Shaft size is designated by the "nominal core diameter" (see table I).

3.3 Construction. - Flexible shafting shall be furnished either as stock lengths or mill run lengths, used for stock purposes, or assembled units furnished with fittings attached and of a specified overall length (see 6.1). The overall length of flexible shafting shall be measured to include the core with end fittings attached, disregarding the outside casing.

3.3.1 Casing. - The casing shall consist of interlocking type, asbestos-packed, flexible metallic hose conforming to table I.

3.3.1.1 The casing shall be made of galvanized steel or bronze having the following chemical composition: 98.75 percent copper, 1.25 percent tin, as specified (see 6.1),

3.3.1.2 Asbestos packing. - The asbestos packing used in the casing shall contain a minimum

Table I - Casing.

Nominal core diameter (inch)	3/8	1/2	3/4	1	1-1/4	1-5/8
Casing inside diameter (inches)	0.495	0.735	1.010	1.271	1.488	1.985
	0.510	0.760	1.035	1.296	1.513	2.010
Casing outside diameter (inches)	0.656	0.975	1.250	1.556	1.828	2.325
	0.657	1.000	1.275	1.581	1.853	2.350
Pitch per foot	59 - 61	40 - 42	40 - 42	31 - 33	28 - 30	28 - 30
Stock thickness (inch)	0.017	0.024	0.024	0.029	0.033	0.033

of 90 percent asbestos packing fiber. When used with metal O. 037 inch thick or lighter, as shown in

table I, the yarn shall not be heavier than 14 cut (1, 400 yards per pound). When used with metal

MIL-S-16059B(SHIPS)

heavier than 0.037 inch, as specified in table I, the yarn shall not be heavier than 8 cut (800 yards per pound). In all cases, the yarn shall be of a type constructed on card machines.

3.3.1.3 Galvanizing (zinc coated). - When the casing is galvanized (zinc coated) steel (see 3.3.1. 1), the coating shall be smooth and tight, free from pinholes, and of sufficient thickness to withstand the corrosion test specified in 4.4.2.3. The coating shall not decrease the flexibility of the hose.

3.3.2 Core. - The flexible core shall consist of several layers of helically wound, high strength, steel wires, each layer wound in opposite direction to the preceding layer. The number of wires in each layer, the wire sizes and wire material may vary between size of core and the manufacturer. The core shall conform to table II.

Table II - Size of core.

Nominal core diameter	Actual diameter
Inches	Inches
3/8	0.374 - 0.380
1/2	.537 - .544
3/4	.740 - .747
1	.990 - .997
1-1/4	1.292 - 1.299
1-5/8	1.611 - 1.618

3.4 Performance.

3.4.1 Casing. - The casing shall be flexible, and properly constructed to prevent leakage, excessive wear, and breakage due to actual service.

3.4.1.1 Hydrostatic pressure. - The casing shall withstand without leakage the hydrostatic test pressures of table III.

Table III - Casing performance.

Nominal core diameter (inches)	3/8	1/2	3/4	1	1-1/4	1-5/8
Nominal casing inside diameter (inches)	1/2	3/4	1	1-1/4	1-1/2	2
Bend diameter (inches) (minimum required)	18	24	30	36	42	48
Hydrostatic test pressure						
Straight (p. s. i.)	500	500	500	400	400	----
Bent (p. s. i.)	400	400	400	300	300	----

3.4.2 Assembled flexible shafting performance. -

3.4.2.1 Rated torque. - Flexible shafting, when assembled and mounted as indicated in 4.4.4 shall

be capable of sustaining the input static torques (rated torque) of table IV without permanent distortion or rupture in both directions of rotation.

Table IV - Assembled flexible shafting performance.

Nominal core diameter (inches)	3/8	1/2	3/4	1	1-1/4	1-5/8
Minimum radius of bends (inches)	9	12	15	18	21	24
Deflection (degrees/foot)	30	15	10	7	5	4
Input (rated) torque (pounds-foot)	10	20	40	80	160	250
Length (feet)	Output torque (pounds-foot)					
10	--	18	34	68	136	189
20	--	16	32	64	128	178
30	--	14	28	56	112	156
40	--	12	24	48	96	133
50	--	10	20	40	80	111
60	--	8	16	32	64	89

3.4.2.2 Torque transmission. - Flexible shafting when mounted as in 4.4.4 shall be capable of transmitting the static torques of table IV for the lengths indicated without permanent distortion or rupture in both directions of rotation.

3.4.2.3 Deflection. - Flexible shafting when mounted as in 4.4.4 shall have a torsional deflection per foot of core length not greater than that shown in table IV.

3.5 Assembling details. -

3.5.1 Flexible shafting remote control systems shall be designed, assembled, and installed in accordance with Publication NAVSHIPS-250-648 -2.

3.5.2 The assembly of the core and terminal fittings shall be capable of withstanding 200 percent of the rated torque capacity of the core (see table IV).

3.6 Workmanship. - The workmanship shall be first class in every respect.

4. QUALITY ASSURANCE PROVISIONS

4.1 The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections

are deemed necessary to assure supplies and services conform to prescribed requirements,

4.2 Lot acceptance inspection. -

4.2.1 Lot. - All mill lengths or assembled units of shafting of the same core diameter presented under one contract or order for delivery at one time shall be considered a lot.

4.2.2 Sampling for visual and dimensional examination. - A random sample of mill lengths or assembled units shall be selected in accordance with table V from each lot for visual and dimensional examination with lot acceptance based on sampling inspection requirements in accordance with standard MIL-STD-105.

Table V - Sampling for visual and dimensional inspection AQL (approx.) = 1.5 percent defective.

Number of units in inspection lot	Number of units in sample	Acceptance number (defectives)	Rejection number (defectives)
15 and under	7	0	1
16 to 40	10	0	1
41 to 110	15	0	1
111 to 300	25	1	2
301 to 500	35	1	2
501 and over	50	2	3

4.2.3 Sampling for tests (except torque test). - A random sample of units shall be selected from each inspection lot in accordance with table VI and shall be subjected to the tests specified in 4.4.1 through 4. 4.2.3 inclusive.

Table VI - Sampling for lot acceptance tests (except torque test).

Number of units in inspection lot	Number of units in sample	Acceptance number (defectives)	Rejection number (defectives)
10 or under	3	0	1
11 to 25	5	0	1
26 to 50	7	0	1
51 to 100	10	0	1
101 to 200	15	0	1
201 to 500	20	1	2
501 or over	25	1	2

4.2.4 Sampling for torque tests. - A random sample of units shall be selected from each inspection lot in accordance with table VII and shall be subjected to the torque tests specified in 4.4.3 and 4.4.4.

Table VII - Sampling for acceptance lot torque test.

Number of units in inspection lot	Number of units in sample	Acceptance number	Rejection number
50 or less	2	0	1
51 to 200	3	0	1
201 or over	4	0	1

4.3 Visual and dimensional examination. - Each of the sample units selected in accordance with table V shall be visually and dimensionally examined to verify compliance with this specification. Any unit in the sample containing one or more visual or dimensional defects shall be rejected, and if the number of defective units in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.4 Tests. -

4. 4.1 Inspection tests of the core. -

4. 4.1.1 Uniform condition of core wires. - All cores selected for inspection shall be placed in a position so that by the application of a slight twist applied to one end, the core may be made to roll. When it rolls, any spot along the core where the wires have been overstressed, or where the wire material has been hardened due to working or nonuniform material, a wave will form at that point (see figure 1); a section including this part of the core shall be removed before shipping.

4.4. 1.2 Uniform winding of the core. - All cores selected for inspection shall be placed in a position as indicated in 4.4. 1.1 Starting at one end, a loop shall be made to a minimum diameter without straining the core and rolled the whole length of the core. At all points where the loop diameter changes (see figure 2), the wires are not wound uniformly and this section shall be removed before shipping.

4.4.1.3 Core transverse flexibility test. - The sample, selected in accordance with table VI, shall be placed so that the end projects a distance equal to the bend radius shown in table IV over an edge so that the end drops free under its own weight. The vertical drop shall not be greater than that specified for the corresponding core size.

4.4.1.4 Assembled core. - All core fittings and their attachment to the core shall be capable of withstanding 200 percent of the rated torque capacity of the core (see table IV). The torque shall be applied while the core is held directly adjacent to

MIL-S-16059B(SHIPS)

the fitting without failure of the joint or distortion of the fittings.

4.4.2 Casing tests. -

4.4.2.1 Hydrostatic pressure and bend. - Each sample length or section of casing, when lying straight shall be subjected to the corresponding hydrostatic test pressure (see table III). After satisfactorily withstanding this test, the complete lengths shall be coiled into a circle of the diameter specified in table III, after which the coils shall be subjected to the corresponding bend pressure, No leakage shall be evident.

4.4.2.2 Resistance to season cracking of bronze casing. - A specimen the full diameter of the bronze casing shall be cut from each lot of 1000 feet or fraction thereof and immersed for 30 minutes, without cracking, in an aqueous solution containing 10 grams of mercurous nitrate and 10 cubic centimeters of nitric acid (specific gravity 1.42) per liter (1 percent). The sawed edges may be removed by machining or smoothed with a file but the specimens shall receive no annealing, bending, springing, polishing, or other preparation prior to this test. The specimen shall be left in the solution for 30 minutes and shall be examined for cracks immediately upon removal. If the specimen upon examination contains cracks, the lot represented shall be rejected.

4.4.2.3 Corrosion test for zinc coated (galvanized) casing. - Zinc coated (galvanized) casing shall be tested to determine if the coating is of sufficient thickness to resist atmospheric corrosion. From each lot of 1000 feet or fraction thereof, one piece about 3 inches in length, the full diameter of the hose, shall be subjected to a salt-spray test for 18 consecutive hours, using a 4 percent sea-salt solution. Indication of corrosion under this test shall be cause for rejection. Test specimens shall be properly cleaned with gasoline to remove grease and dirt.

4.4.3 Torque test. - Each of the sample units, selected in accordance with table VII, shall be capable of transmitting the output torque corresponding to the length (see table IV) when mounted with a 90 degree bend in the middle and with supports 10 feet apart, including the bend except immediately adjacent to the end fittings. The bend radius shall be in accordance with table IV.

4.4.4 Torque transmission test. - Each sample shafting shall be tested for deflection and torque transmission performance. The shafting shall be mounted with strap supports every 30 inches measured along the shaft length and one 90 degree bend with the required minimum radius (see table IV) having one support at the middle. The test sample shall have standard fittings and shall be statically

loaded in both directions of rotation up to 200 percent of rated torque (see table IV) on the input end without rupture of the core or failure of the fittings. The necessary data shall be taken during loading to plot the following curves:

- (a) Input vs. output torque.
- (b) Deflection vs. output torque.
- (c) Output torque vs. length of shaft (with rated torque as input).
- (d) Deflection vs. length of shaft.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation. -

5.1.1 Shafting, flexible (core and casing complete). -

5.1.1.1 Preservation and packing. - Preservation and packaging of assembled units shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation,

5.1.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier and will afford protection against physical and mechanical damage during handling and direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules and Regulations, or other carrier regulations as applicable to the mode of transportation.

5.1.1.3 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, contract or order number, contractor's name and destination.

5.2 Domestic shipment and storage or overseas shipment. - The requirements and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.1).

(5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made.

5.2.1.1 Preservation and packaging. -

5.2.1.1.1 Level A. - The assembled units and stock items shall be recessed in accordance with Specification MIL-P-116 and as specified herein.

5.2.1.1.1.1 Assembled units. - The core of assembled units shall be thoroughly coated with lubricant conforming to Specification MIL-L-3545. The ends, with end fittings attached, shall be capped with a double layer of greaseproof barrier material conforming to Specification MIL-B-121, grade A and held in place with pressure sensitive tape conforming to Specification PPP-T-60, type II or III, class 1. Unit protection shall be in accordance with method I of Specification MIL-P-116.

5.2.1.1.2 Stock items. -

5.2.1.1.2.1 Core. - Core shall be coated with preservative grease in accordance with Specification MIL-G-16908, and spirally wrapped with barrier material conforming to Specification MIL-B-121, grade A. Unit protection shall be in accordance with method I of Specification MIL-P-116.

5.2.1.1.2.2 Casing. - The ends shall be capped with a double layer of barrier material conforming to Specification MIL-B-121, grade A and held in place with pressure sensitive tape conforming to Specification PPP-T-60, type II or III, class 1. Unit protection shall be in accordance with method III of Specification MIL-P-116.

5.2. 1.1.3 Unit containers. - Unit containers shall conform to the following specifications at the option of the contractor.

<u>Specification</u>
PPP-B-
PPP-B-636
PPP-B-665
PPP-B-676

The gross weight of paperboard boxes shall not exceed 10 pounds. Fiberboard boxes shall not exceed 40 pounds. Box closure shall be as specified in the applicable box specification or appendix thereto.

5.2. 1.1.4 Level C. - Preservation and packaging of assembled units shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

5.2.1.2 Packing. - Lengths 10 feet or under need not be coiled. When coiled, the diameter of the smallest coil shall not be less than the bend diameter shown in table III. The coils shall be held in place by at least four flat steel galvanized straps placed equidistant from each other around the coil. Each container shall contain like items, be of minimum cube and weight and when practicable contain an identical number of items. Anchoring, blocking, bracing and cushioning of container contents to prevent damage from

handling shipment and storage, shall be in accordance with Specification JAN-P-100.

5.2. 1.2.1 Level A. - Material, packaged as specified, shall be packed in containers conforming to any one of the following specifications at the option of the contractor.

<u>Specification</u>	<u>Type or class</u>
PPP-B-585	Class 3 use
PPP-B-591	Overseas type
PPP-B-601	Overseas type
PPP-B-621	Class 2
PPP-B-636	Class 2
MIL-B-10377	Overseas type

Shipping containers shall have caseliners conforming to Specification MIL-L-10547. Caseliners shall be closed and sealed in accordance with the appendix to Specification MIL-L-10547. Caseliners for class 2 fiberboard boxes conforming to Specification PPP-B-636 may be omitted provided all corners and edge seams and manufacturer's joints are sealed with minimum 2 inch wide tape conforming to Specification PPP-T-76. Boxes shall be closed, strapped or banded in accordance with the applicable box specification or appendix thereto. The gross weight of wood or wood-cleated boxes shall not exceed 200 pounds.

5.2. 1.2.2 Level B. - Material, packaged as specified, shall be packed in boxes conforming to any of the following specifications at the option of the contractor:

<u>Specification</u>	<u>Type and class</u>
PPP-B-585	Class 1 or 2 use
PPP-B-591	Domestic type
PPP-B-601	Domestic type
PPP-B-621	Class 1
PPP-B-636	Class 1
MIL-B-10377	Domestic type

Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood or wood-cleated boxes shall not exceed 200 pounds.

5.2. 1.3 Marking. - In addition to any special marking required (see 6.1), interior packages and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129.)

6, NOTES

6.1 Ordering data. - Procurement documents should specify the following:

- (a) Title, number, and date of this specification

MIL-S-16059B(SHIPS)

- (b) Whether stock lengths, mill run lengths or assembled lengths are required (see 3.3)
- (c) Casing material required (see 3.3.1.1)
- (d) Preservation, packaging, packing or marking requirements if other than those required in 5.1 (see 5.2.).

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any

obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Preparing activity:
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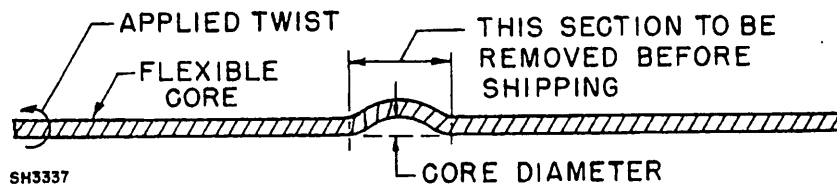


Figure 1.—Test for uniform condition of wire in core.

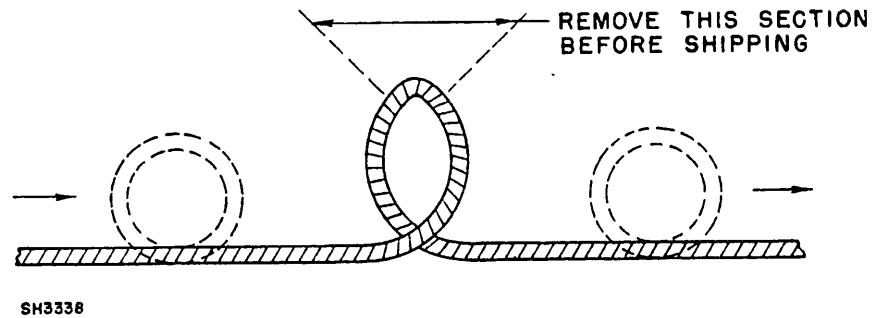


Figure 2.—Test for uniform winding.

MIL-S-16059B(SHIPS)

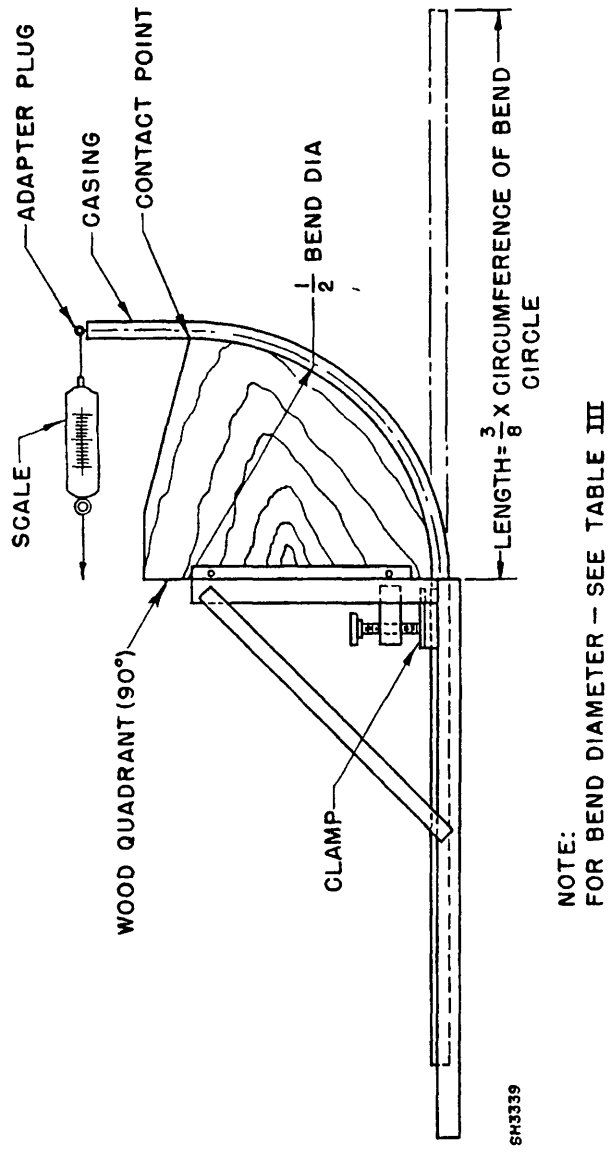


Figure 3.-Casing transverse flexibility test apparatus.