

ZZ-H-428D

May 8, 1974

SUPERSEDING

Fed. Spec. ZZ-H-428C

December 17, 1964

## FEDERAL SPECIFICATION

HOSE; NON-METALLIC AND HOSE; PREFORMED:  
(FOR THE COOLANT SYSTEMS OF AUTOMOTIVE AND  
OTHER LIQUID-COOLED ENGINES)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

## 1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers preformed (curved) and straight hose; and wire-reinforced hose, for the coolant systems and heaters of automotive and liquid-cooled engines (see 6.1).

## 1.2 Classification.

1.2.1 Types and grades. Coolant-system and heater hose covered by this specification shall be of the following types and grades as specified, (see 6.1, 6.2, and 6.6):

Type I	- Heavy and moderate duty, light wall.
Type II	- Heavy and moderate duty, heavy wall.
Type III	- Normal service.
Type IV	- Heater hose.
Type V	- Wire-reinforced.
Grade A	- Suitable for extreme low temperature service down to minus 65°F., and fungus resistant.
Grade B	- Suitable for low temperature service down to minus 40°F.

1.2.2 Material. Material used in the hose shall be of the following classes as specified, (see 3.2, 6.2, 6.3, 6.3.1, and table I).

Class 1	- Oil resistant, low volume swell.
Class 2	- Oil resistant, medium volume swell, and ozone resistant.
Class 3	- Nonoil resistant, high quality.
Class 4	- High temperature resistant, nonoil resistant, and ozone resistant.

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1.2.2.1 Applicability of classes to types and grades. On hose covered by this specification, classes shall be applicable to types and grades as shown in table I.

Table I - Applicability of classes to types and grades

Types	Grades	Classes
I	A	2,4
	B	1,2,3,4
II	A	2,4
	B	1,2,3,4
III	A	2,4
	B	2,3,4
IV	A	2,4
	B	2,3,4
V	A	2,3
	B	1,2,3,4

## 2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

### Federal Standards:

Fed. Std. No. 123 - Marking for Domestic Shipment (Civil Agencies).

Fed. Test Method Std. No. 601 - Rubber: Sampling and Testing.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D.C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain copies of Federal Specification, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

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Military Specifications:

- MIL-P-116 - Preservation, Methods of.  
 MIL-H-775 - Hose, Rubber or Fabric (Including Tubing);  
 and Fittings, Nozzles and Strainers, Packaging  
 of.  
 MIL-F-13927 - Fungus Resistance Test; Automotive Components.

Military Standards:

- MIL-STD-105 - Sampling Procedures and Tables for Inspection  
 by Attributes.  
 MIL-STD-166 - Visual Inspection Guide for Rubber Hose.  
 MIL-STD-417 - Rubber Compositions, Vulcanized, General  
 Purpose, Solid (Symbols and Tests).  
 MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking,  
 and Waterproofing with Appropriate Test  
 Methods.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

U.S. Treasury Department:

- Internal Revenue Service Regulations, 26-CFR-212 - Formulas for Denaturation of Alcohol.

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Orders should cite "26-CFR 212".)

3. REQUIREMENTS

3.1 Qualification. The hose furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable qualified products list (see 4.2, 6.4, and Appendix).

3.2 Materials. Hose furnished under this specification (see 6.1) shall be composed of elastomeric material. This material shall be used in conjunction with a fabric, yarn, or wire reinforcement as applicable (see 3.3.4).

3.3 General construction.

3.3.1 Types I through IV hose. Types I through IV hose shall consist of an inner tube, an intermediate textile reinforcement, and an outer cover. When

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required, and as applicable (see table I), hose with one class in the tube and another in the cover may be specified (class 2 tube and class 3 cover as an example). When class 4 is specified, both the tube and cover are normally of the same class. When different classes for the tube and cover are specified, the physical properties specified for the respective parts shall apply. Adhesion requirements shall be based on the class for which the lower value is specified.

3.3.2 Type V hose. Hose shall consist of an inner tube, a helical, wire reinforcement, an outer cover, and shall have a preformed cuff (soft end) on each end of the hose. In addition to the wire reinforcement, a fabric, a cord, or a fabric and cord reinforcement may be used in the entire length of the hose.

3.3.3 Inner tube. The inner tube shall be a seamless, continuous extrusion of elastomeric material extending the full length of the hose. Minimum thickness of inner tubes of types I through IV and of grade B of type V hose shall be 0.062 inch; that of type V, grade A hose shall be 0.085 inch.

#### 3.3.4 Reinforcement.

3.3.4.1 Types I through IV hose. The reinforcement shall consist of multiple plies of woven or cord fabric, or ply or plies of braided or knitted yarn. The reinforcement in grade A hose shall be fungus resistant.

3.3.4.1.1 Woven or cord fabric. The layer or layers of fabric shall be well frictioned with elastomeric material which shall firmly join the plies to the tube and cover, and to each other.

3.3.4.1.2 Braided or knitted yarn. The ply or plies of reinforcement shall be braided or knitted over the tube and the cover stock shall adhere firmly to the tube stock. In multiple-ply construction there shall be a distinct layer of elastomeric material between the plies to insure that the plies adhere to both the tube and cover and to one another. In single ply hose the reinforcement shall adhere firmly to both tube and cover or shall permit the tube and cover to adhere to one another through the interstices.

3.3.4.2 Type V hose. Hose shall be reinforced with a helical, high-carbon, steel wire (SAE 1040 or above). In addition to the wire reinforcement, a fabric, a cord, or a fabric and cord reinforcement may be used in the entire length of the hose.

3.3.5 Cover. Covers for types I through IV hose shall have 0.032-inch minimum thickness, and minimum thickness for type V hose shall be sufficient to adequately cover the reinforcing wire without any exposure of wire through cover.

3.3.6 Cuffs (for type V hose). The preformed cuffs shall be built up

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with plies of elastomeric material or elastomeric material-impregnated fabric and shall be of uniform thickness.

3.4 Dimensions.

3.4.1 Sizes. Hose shall be furnished in the nominal inside diameters for which minimum burst values are shown in table II (see 6.2).

3.4.2 Diameter tolerances. Tolerances on hose diameters shall be as shown in tables III, IV, and V.

3.4.3 Wall thickness.

3.4.3.1 Types I through III. Hose wall thickness shall be within the limits shown in table VI.

3.4.3.2 Type IV. Wall thickness shall be controlled by table IV.

3.4.4 Lengths.

3.4.4.1 Tolerances on lengths. Tolerances for specified lengths shall be as shown in table VII.

3.4.4.2 Cuff length (type V). The cuff length on each end hose shall be  $1\text{-}1/2 \pm 3/8$  inches.

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Table II - Applicability and minimum burst values of hose by types and sizes

Type I		Type II		Type III		Type IV		Type V	
Nom ID	Min burst press	Nom ID	Min burst press	Nom ID	Min burst press	Nom ID	Min burst press	Nom ID	Min burst press
Inch	P.s.i.	Inch	P.s.i.	Inch	P.s.i.	Inch	P.s.i.	Inch	P.s.i.
3/8	475	1 1/4	500	3/8	90	3/8	200	1 1/4	90
1/2	425	1 1/2	450	1/2	90	1/2	200	1 1/2	90
5/8	360	1 3/4	400	5/8	90	5/8	140	1 3/4	90
3/4	325	2	350	3/4	90	3/4	140	2	90
7/8	300	2 1/4	350	7/8	90	7/8	130	2 1/4	90
1	275	2 1/2	300	1	90	1	125	2 1/2	90
1 1/8	250	2 3/4	250	1 1/8	90	---	---	3	75
1 1/4	225	3	250	1 1/4	90	---	---	---	---
		---	---	1 1/2	90	---	---	---	---
1 3/8	210	---	---	1 3/4	80	---	---	---	---
		---	---	2	70	---	---	---	---
1 1/2	200	---	---	2 1/4	60	---	---	---	---
1 5/8	185	---	---	---	---	---	---	---	---
1 3/4	175	---	---	---	---	---	---	---	---
1 7/8	165	---	---	---	---	---	---	---	---
2	150	---	---	---	---	---	---	---	---
2 1/8	140	---	---	---	---	---	---	---	---
2 1/4	125	---	---	---	---	---	---	---	---
2 3/8	115	---	---	---	---	---	---	---	---
2 1/2	100	---	---	---	---	---	---	---	---
2 5/8	95	---	---	---	---	---	---	---	---
2 3/4	90	---	---	---	---	---	---	---	---
2 7/8	85	---	---	---	---	---	---	---	---
3	75	---	---	---	---	---	---	---	---
3 1/8	70	---	---	---	---	---	---	---	---
3 1/4	65	---	---	---	---	---	---	---	---
3 3/8	60	---	---	---	---	---	---	---	---
3 1/2	50	---	---	---	---	---	---	---	---
3 3/4	50	---	---	---	---	---	---	---	---
4	50	---	---	---	---	---	---	---	---
4 1/2	50	---	---	---	---	---	---	---	---

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Table III - Hose diameter tolerance (types I through III)

Inside diameter		Tolerances	
Over	To and including	Straight hose	Curved hose
Inches	Inches	Inch	Inch
3/8	3/4	$\pm 1/64$	$\pm 1/32$
3/4	2	$\pm 1/64 - 1/32$	$\pm 1/32$
2	3 1/2	$\pm 1/32$	$\pm 1/32$

Table IV - Hose diameter tolerance (type IV)

Nom. inside diameter	Tolerance	Nom. outside diameter	Tolerance
Inch	Inch	Inch	Inch
3/8	$\pm 1/64 - 3/64$	11/16	$\pm 1/32$
1/2	$\pm 1/64 - 3/64$	13/16	$\pm 1/32$
5/8	$\pm 1/64 - 3/64$	15/16	$\pm 1/32$
3/4	$\pm 1/64 - 3/64$	1-1/16	$\pm 1/32$
7/8	$\pm 1/64 - 3/64$	1-5/16	$\pm 1/16$
1	$\pm 1/64 - 3/64$	1-7/16	$\pm 1/16$

Table V - Hose diameter tolerances (type V)

Inside diameter (hose and cuff)	Tolerance	Outside dia. (cuff only)	Tolerance
Inches	Inch	Inches	Inch
1 1/4	$\pm 1/32$	1 5/8	$\pm 1/16$
1 1/2	$\pm 1/32$	2	$\pm 1/16$
1 3/4	$\pm 1/32$	2 1/4	$\pm 1/16$
2	$\pm 1/32$	2 1/2	$\pm 1/16$
2 1/4	$\pm 1/32 - 3/64$	2 7/8	$\pm 1/16$
2 1/2	$\pm 1/32 - 3/64$	3 1/8	$\pm 1/16$
3	$\pm 1/32 - 3/64$	3 3/4	$\pm 1/16$

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Table VI - Wall thickness limits

Designation	Thickness	
	Min.	Max.
Types I and III	$\frac{11}{64}$ Inch	$\frac{7}{32}$ Inch
Type II	$\frac{15}{64}$	$\frac{9}{32}$

Table VII. Tolerance on hose lengths

Over Inches	To and including Inches	Tolerance Inch or percentage
--	12	$\pm \frac{1}{2}$ inch
12	30	$\pm \frac{3}{4}$ inch
30	48	$\pm 1$ inch
48	--	$\pm 2$ percent

## Curved (preformed)

Each end (measured from end to intersection of nearest centerline)	$\pm \frac{3}{16}$ inch - $\pm \frac{1}{8}$ inch
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Table VIII - Physical properties requirements (types I through V)

Physical properties	Tube requirements							
	Applicable types				Classes			
	I and II	III	IV	V	1	2	3	4
Original properties:								
Hardness, durometer, Shore A	X	--	--		55 to 80	55 to 80	55 to 80	55 to 80
	--	X	X		NA	55 to 80	55 to 80	55 to 80
				X	55 to 80	55 to 80	55 to 80	55 to 80
Tensile strength, min., p.s.i.	X	--	--		1000	1000	1000	1000
	--	X	X		NA	1000	1000	1000
				X	800	800	800	800
Elongation, min., percent	X	X	--		250	250	250	225
	--	X	X		NA	200	225	225
				X	225	225	225	225
Heat aging at temperatures noted: Temperature °F.	X	--	--		212	212	212	212
	--	X	X		NA	212	212	250
				X	212	212	212	250
(Changes after 70 hours)								
Hardness, durometer, Shore A	X	--	--		0 to / 20	0 to / 20	0 to / 15	0 to / 15
	--	X	X		NA	0 to / 20	0 to / 15	0 to / 15
				X	0 to / 20	0 to / 20	0 to / 15	0 to / 15
Tensile strength, max., percent	X	--	--		-20	-15	-25	-40
	--	X	X		NA	-15	-25	-40
				X	NA	-15	-25	-40

\*NA -- Not applicable

Table VIII - Physical properties requirements (types I through V (Cont'd))

Physical properties	Tube requirements							
	Applicable types				Classes			
	I and II	III	IV	V	1	2	3	4
Elongation, max., percent	X	--	--		-50	-40	-40	-40
	--	X	X		NA	-40	-40	-60
				X	-50	-50	-50	-60
Oil immersion (change): Volume, max., percent	X	--	--		-5 to / 25	/ 100	NA	NA
	--	X	X		*NA	/ 100	NA	NA
				X	-5 to / 25			
Coolant immersion (change): Volume, max., percent	X	--	--		0 to / 20	0 to / 20	0 to / 15	0 to / 15
	--	X	X		NA	0 to / 20	0 to / 15	0 to / 15
				X	0 to / 20	0 to / 20	0 to / 15	0 to / 15
Hardness, durometer, Shore A	X	--	--		-10 to / 10	-20 to / 10	-10 to / 20	-10 to / 20
				X	-10 to / 10	-10 to / 10	-10 to / 20	-10 to / 20
Tensile strength, max., percent	X	--	--		-20	-20	-20	-20
	--	X	X		NA	-20	-20	-20
				X	-20	-20	-20	-20
Elongation, max., percent	X	X	X		-40	-40	-40	-40
				X	-40	-40	-40	-40

\*NA -- Not applicable.

Table VIII - Physical properties requirements (types I through V (Cont'd))

Physical properties	Cover requirements							
	Applicable types					Classes		
	I and II	III	IV	V	1	2	3	4
Original properties:								
Tensile strength, min., p.s.i.	X	--	--		1000	1000	1000	1000
	--	X	X		NA	1000	1000	1000
				X	800	800	800	800
Elongation, min., percent	X	--	--		225	225	225	225
	--	X	X		NA	200	225	225
				X	225	225	225	225
Heat aging at temperatures noted:								
Temperature, °F.	X	--	--		212	212	212	250
	--	X	X		NA	212	212	250
				X	212	212	212	250
(Changes after 70 hours)								
Tensile strength, max., percent	X	--	--		-20	-20	-25	-40
	--	X	X		NA	-20	-25	-40
				X	-20	-20	-25	-40
Elongation, max., percent	X	--	--		-60	-50	-50	-60
	--	X	X		NA	-55	-60	-60
				X	-55	-55	-55	-60
Oil immersion (change):								
Volume, max., percent	X	--	--		-5 to /	/100	NA	NA
	--	X	X		25			
					NA	/100	NA	NA
				X	-5 to /	/100	NA	NA
					25			

\*NA -- Not applicable.

Table VIII - Physical properties requirements (types I through V (Cont'd))

Physical properties	Cover requirements							
	Applicable types					Classes		
	I and II	III	IV	V	1	2	3	4
Tensile strength, max., percent.	X	--	--		-45	-65	NA	NA
	--	X	X		NA	-65	NA	NA
				X	-50	-50	NA	NA
Adhesion, min., pounds: Tube to ply or cover	X	--	--		10	10	10	10
	--	--	--		NA	8	8	8
	--	X	--		NA	10	8	8
	--	--	X		NA	8	6	6
				X	10	10	10	10
Ply to ply	X	--	--		10	10	10	10
	--	X	--		NA	8	8	8
	--	--	X		NA	8	6	6
Cover to ply				X	10	10	10	10

\*NA-- Not applicable.

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Table IX - Applicable tests

Paragraph number	Test	Qualification	Acceptance	Control
4.5.1	Burst pressure	X	X	
4.5.1	Hardness, durometer	X	X	
4.5.3	Tensile strength and elongation	X	X	
4.5.4	Resistance to heat	X		
4.5.5	Resistance to oil	X		X
4.5.6	Resistance to coolant	X		X
4.5.7	Friction (adhesion)	X	X	
4.5.8	Low temperature flexibility	X		X
4.5.9	Ozone resistance	X		
4.5.10	Fungi resistance	X		
4.5.11	Proof pressure	X	X	
4.5.12	Resistance to vibration	X		X
4.5.13	Packaging		X	
4.5.14	Packing		X	

### 3.4.4.3 Types I and III.

3.4.4.3.1 Sizes 3/8 through 1 1/8 inch inside diameter. Normally these sizes shall be furnished in bulk length in accordance with paragraph 3.4.4.6 below.

3.4.4.3.2 Sizes 1 1/4 inch inside diameter and greater. Normally these sizes shall be furnished in 36 inch lengths.

3.4.4.4 Type II. Unless otherwise specified (see 6.2), hose shall be furnished in 36 inch lengths.

3.4.4.5 Type IV. Unless otherwise specified (see 6.2), hose shall be furnished in bulk length in accordance with paragraph 3.4.4.6 below.

3.4.4.6 Bulk Hose. Bulk Hose shall be furnished in lengths of 12, 25 or 40 feet, or multiples thereof, except that on such orders up to 10 percent may be furnished in random lengths over 15 feet and an additional 10 percent may be furnished in random lengths over three feet.

### 3.5 Physical requirements.

3.5.1 Burst pressure. When tested as specified in 4.5.1, hose shall not burst at any pressure below that specified in table II.

3.5.2 Durometer hardness When tested as specified in 4.5.2, the durometer hardness of the hose tube specimens shall be as specified in table VIII, as applicable.

3.5.3 Tensile strength and elongation. When tested as specified in 4.5.3, hose shall meet the tensile strength and elongation requirements specified in table VIII, as applicable.

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3.5.4 Resistance to heat. When tested as specified in 4.5.4, and as applicable (see table I), types I through IV, classes 1, 2, and 3; and type V covers and tubes shall be oven aged at 212°F. Types III and IV, class 4 covers and tubes shall be oven aged at 250°F. Oven aging shall be for a period of 70 hours. Hose shall conform to changes in physical properties as specified in table VIII.

3.5.5 Resistance to oil. When tested as specified in 4.5.5, hose shall conform to the changes in physical properties specified in table VIII, as applicable.

3.5.6 Resistance to coolant. When tested as specified in 4.5.6, hose shall conform to changes in physical properties as specified in table VIII, as applicable.

3.5.7 Friction (adhesion). When tested as specified in 4.5.7, the force required to separate tube from cover or ply, ply from ply, or cover from ply, shall be not less than that specified in table VIII.

### 3.5.8 Low-temperature flexibility.

3.5.8.1 Types I through IV. Hose specimens shall show no evidence of cracks or breaks when tested as specified in 4.5.8.1.

3.5.8.2 Type V. When tested as specified in 4.5.8.2, hose shall show no cracks or breaks.

3.5.9. Ozone resistance. Classes 2 and 4 hose covers shall be ozone resistant. After hose has been tested as specified in 4.5.9.1.1 or 4.5.9.1.2, as applicable, the cover shall show no evidence of cracking.

3.5.10 Fungus resistance. Grade A hose shall be fungus resistant. After being tested as specified in 4.5.10, hose shall meet the requirements of 3.5.11.

3.5.11 Proof pressure. When tested as specified in 4.5.11, hose shall show no leakage.

3.5.11.1 Pulsating proof pressure. When tested as specified in 4.5.11.1, hose shall not bulge, separate, or show evidence of leakage.

3.5.12 Resistance to vibration (type V). When tested as specified in 4.5.12, type V hose shall show no leakage or other failure.

### 3.6 Marking for identification.

3.6.1 For types I through IV. Unless otherwise specified (see 6.2), each piece of hose not greater than 36 inches in length shall be marked on the outer surface in contrasting color, by stencil or printed type, with the following information (more than one line may be used):

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Federal stock number  
 "OZ" (for ozone-resistant cover of class 2 or 4)  
 Fed. Spec. ZZ-H-428  
 Type  
 Grade  
 Class (if cover and tube are of different classes,  
 both classes shall be indicated and separated  
 with a hyphen with cover class preceding tube  
 class)  
 Manufacturer's name or trademark  
 Month and year of manufacture

Pieces of hose no greater than 4 inches in length may be identified by having a label carrying the required information taped around the individual pieces of hose in lieu of either of the above methods of marking. On pieces of hose greater than 36 inches in length the marking shall be applied continuously, using one or more lines of print, if necessary, at intervals of not more than 36 inches.

3.6.2 For type V. Unless otherwise specified (see 6.2), the outer surface of one or both cuffs of each hose shall be marked in contrasting color, by stencil or printed type, with the following information:

Federal stock number  
 Nominal size (ID)  
 "OZ" (to denote ozone resistant cover of class  
 2 or 4)  
 Fed. Spec. ZZ-H-428  
 Grade and class  
 Manufacturer's name or trademark  
 Month and year of manufacture

3.7 Date of manufacture. Hose shall be not more than one year old when submitted for acceptance.

3.8 Workmanship. The workmanship shall be such as to produce hose free from looseness of cover, exposed reinforcements (wire, cords, or fabric), cuts, bruises, blisters, breaks, pitting, wrinkles in cover, loose foreign matter and excess mandrel lubricant, and any other defects which affect hose service-ability and appearance.

#### 4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. 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.

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4.2 Qualification inspection. Hose submitted for qualification (see 3.1, 6.4, and appendix) shall be examined for the defects listed in 4.3.2.3 and then the hose and platen press sheets shall be subjected to the applicable tests specified for qualification in table IX.

4.2.1 Failure. Failure of a qualification test specimen to pass any specified test may be cause for refusal by the Government to conduct additional tests until it has been proved to the satisfaction of the Government activity conducting the test that the faults revealed by such test have been corrected.

### 4.3 Quality conformance inspection.

#### 4.3.1 Sampling for hose.

##### 4.3.1.1 Nonmilitary.

4.3.1.1.1 Lot formation. Unless otherwise specified in the invitation for bid (see 6.2), the lot shall be formed as described in Fed. Test Method Std. No. 601.

4.3.1.1.2 Sampling for quality conformance examination. Unless otherwise specified in the invitation for bids (see 6.2), the sample for examination inspection shall be taken as described in Fed. Test Method Std. No. 601.

4.3.1.1.3 Sampling for quality conformance testing. Unless otherwise specified in the invitation for bid (see 6.2), the sample for tests shall be taken as described in Fed. Test Method Std. No. 601. Sampling plan B shall be used except that for lot sizes of 50 to 1000 units the number of test units under the first sample shall be 3 and the rejection number 2; under the second sample the number of units shall be 3; and under the combined samples the number of test units shall be 6, acceptance number 1 and rejection number 2.

##### 4.3.1.2 Military.

4.3.1.2.1 Lot formation. Unless otherwise specified (see 6.2), a lot of hose shall consist of one type, grade, size, and class of rubber or rubber combination, as applicable (see 3.3), conforming to the requirements of this specification, from an identifiable production period from one manufacturer, submitted at one time for acceptance.

4.3.1.2.2 Sampling for quality conformance examination. Unless otherwise specified, (see 6.2), the Government inspector shall select a representative sample from each lot in accordance with inspection level II of MIL-STD-105, for examination inspection purposes.

4.3.1.2.3 Sampling for quality conformance testing. Samples for testing shall be selected in accordance with inspection level S-4 of MIL-STD-105.

#### 4.3.2 Examination inspection.

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4.3.2.1 Nonmilitary. Each unit in the sample for examination inspection (see 4.3.1.1.2) shall be inspected for construction, marking and workmanship. Dimensional measurements shall be made as specified in Fed. Test Method Std. No. 601.

4.3.2.1.1 Length. The length shall be determined as described in method 2411 of Fed. Test Method Std. No. 601.

4.3.2.1.2 Diameter. The average diameter shall be determined as described in method 2221 or 2231 of Fed. Test Method Std. No. 601, except that two sets of two measurements, as applicable, shall be made on each test unit. If method 2231 is used, methods 2341 and 2351 shall be used for determining the inner and outer circumferences respectively.

4.3.2.2 Military.

4.3.2.2.1 Acceptable quality levels. Each sample hose selected in accordance with paragraph 4.3.1.2.2 shall be examined for characteristics listed in the classification of defects in 4.3.2.3 to determine conformance to (AQL) on the basis of percent defective.

<u>Classification</u>	<u>AQL</u>
Major	2.5
Minor	4.0

4.3.2.3 Classification of defects. Using MIL-STD-166 as a guide for examination purposes, defects shall be classified as follows:

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## Classification of defects

Categories	Defects	Method of inspection
Critical	None defined	
Major:	AQL 2.5 percent	
101	Dimensions not within specified tolerances (see 3.4.2, 3.4.3, 3.4.4)	Standard inspection equipment
102	Incorrect cover thickness (see 3.3.5)	Standard inspection equipment
103	Nonuniform thickness of cuffs	Standard inspection equipment
104	Illegible, improper, or missing marking (see 3.6)	Visual
105	Foreign matter or mandrel lubricant in inner tube (see 3.8)	Visual
106	Looseness of cover (see 3.8)	Visual
107	Exposed reinforcements (see 3.8)	Visual
108	Cuts and bruises (see 3.8)	Visual
109	Breaks (see 3.8)	Visual
110	Blisters (see 3.8)	Visual
111	Pitting (see 3.8)	Visual
Minor:	AQL 4.0 percent	
201	Wrinkles in cover (see 3.8)	Visual

#### 4.3.3 Testing inspection.

4.3.3.1 Quality conformance tests. Each test unit in the sample specified in 4.3.1.1.3 and 4.3.1.2.3 shall be subjected to the applicable tests shown in table IX, using an AQL of 6.5 on the basis of percent defective.

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4.3.3.1.1 Failure. Failure of the samples to pass inspection or any quality conformance test shall be cause for rejection of the lot represented. A test may be repeated at the request and expense of the contractor, in which case twice the original number of specimens shall be tested. Failure of any of the retest specimens shall be considered cause for rejection of the entire lot.

4.3.4 Sampling for packaging and packing. In lieu of the quality assurance provisions specified in MIL-H-775, the following paragraphs, 4.3.4.1 through 4.3.6.2 and paragraphs 4.5.13 and 4.5.14, shall apply.

4.3.4.1 Lot formation. A lot shall consist of all packs prepared for shipment in accordance with one level (see 5.1), from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.3.4.2 Sampling for quality conformance examination. Sampling for examination shall be performed in the manner specified in 4.3.1.2.2.

4.3.4.3 Sampling for quality conformance testing. When MIL-H-775 specifies packaging of the hose, one package and one complete pack shall be selected; when packaging is not specified, only one complete pack shall be selected from each lot.

4.3.5 Examination inspection for packaging and packing.

4.3.5.1 Acceptable quality level. Each sample selected in accordance with 4.3.4.2 shall be examined for conformance to the following acceptable quality levels (AQL) on the basis of percent defective:

<u>Classification</u>	<u>AQL</u>
Major	2.5
Minor	4.0

4.3.5.2 Classification of defects. For examination purposes, defects shall be classified as follows:

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## Classification of defects

Categories	Defects	Method of inspection
Critical	None defined	
Major:	AQL (2.5 percent)	
101	Parts improperly cleaned (see 5.1)	Visual
102	Improper wrap (see 5.1.1)	Visual
103	Wrap improperly secured (see 5.1.1)	Visual
104	Improper interior container (see 5.1.1)	Visual
105	Improper exterior container (see 5.1.1)	Visual
106	Exterior container improperly sealed (see 5.1.1)	Visual
107	Hose coiled in an unsafe diameter (see 5.1.1)	Visual
108	Illegible marking (see 5.1.1)	Visual
109	Incorrect marking (see 5.1.1)	Visual
Minor:	None defined	

#### 4.3.6 Testing inspection for packages and packs.

4.3.6.1 Quality conformance testing. When level A or B is specified (see 5.1), the samples selected in accordance with 4.3.4.3 shall be tested as specified in 4.5.13 and 4.5.14.

4.3.6.2 Failure. Failure of the package or pack to pass any specified test may be cause for the Government to refuse to accept the lot until it has been proved to the satisfaction of the Government that the faults revealed by the test have been corrected.

#### 4.4 Control tests.

4.4.1 Sampling for control tests of hose with class 2 or class 4 cover. Two-foot lengths of hose with class 2 or class 4 cover shall be selected and

subjected to the applicable tests shown in table IX. The first sample shall be taken at or near the start of production and thereafter as deemed necessary by the Government.

4.4.2 Failure. Failure of the control sample to pass any test shall result in discontinuance of acceptance by the Government until evidence satisfactory to the Government has been submitted by the contractor that corrective action has been taken to eliminate the condition that caused the failure.

4.5 Test procedures. Except as otherwise specified herein, tests shall be made in the ambient air temperature specified in Fed. Test Method Std. No. 601.

4.5.1 Burst pressure. To determine conformance to 3.5.1, hose test specimen shall be subjected to the burst pressure test specified in method 10011 of Fed. Test Method Std. No. 601. Length of the type V hose specimen shall be 24 inches.

4.5.2 Durometer hardness. To determine conformance in 3.5.2, a test specimen from the tube of the hose being tested shall be subjected to the durometer hardness test specified in method 3021 of Fed. Test Method Std. No. 601.

4.5.3 Tensile strength and elongation. To determine conformance to 3.5.3, tensile strength and elongation tests shall be conducted in accordance with methods 4111 and 4121 of Fed. Test Method Std. No. 601. Tube and cover test specimens shall be taken from one or more samples of hose being tested. If cover sample is less than 0.031 inch in thickness, sample shall be taken from the platen press sheet for testing.

4.5.4 Resistance to heat. To determine conformance to 3.5.4, hose shall be subjected to the aging tests specified in either method 7221 or method 7231 of Fed. Test Method Std. No. 601, at the applicable temperatures and for the periods of time shown in table VIII. Test specimens shall be taken as specified in 4.5.3.

4.5.5 Resistance to oil. To determine conformance to 3.5.5, specimens of classes 1 and 2 tubes and covers shall be subjected to the tensile strength portion of the immersion test specified in method 6111 and the volume change test specified in method 6211 of Fed. Test Method Std. No. 601. Immersion shall be for 70 hours at 212°F. The test liquid shall be medium 3, specified in method 6001 of Fed. Test Method Std. No. 601.

4.5.6 Resistance to coolant. To determine conformance to 3.5.6, tube specimens shall be subjected to the immersion tests specified in methods 6111 and 6211 of Fed. Test Method Std. No. 601. Immersion period during the tests shall be 70 hours and the liquid shall be maintained at the boiling point under a water-cooled, reflux condenser. The immersion liquid shall be as follows:

1/3 by volume, distilled water

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- 1/3 by volume, alcohol (special denatured grade No. 1) conforming to the requirements of the Appendix to Regulations No. 3, Formulac for completely and specially denatured alcohol, issued by the U. S. Treasury Department, Bureau of Internal Revenue
- 1/3 by volume, ethylene glycol (refined grade) conforming to the following:

Acidity -----	Not more than 0.01 percent acetic acid
Specific gravity -----	1.1150 to 1.1158 20°C.
Color -----	Water white
Boiling range (760-MM pressure):	
above 210°C. -----	None
above 190°C. -----	None
below 195°C. -----	5 percent maximum distillation
below 202°C. -----	95 percent minimum distillation
Water -----	Not more than 0.5 percent by weight
Ash -----	Not more than 0.005 gram per 100 cubic centimeters
Color -----	Mild, nonresidual
Average weight -----	9.28 pounds per gallon at 20°C.

4.5.7 Friction (adhesion). Hose specimen shall be subjected to the friction test specified in method 8011 of Fed. Test Method Std. No. 601 to determine conformance to 3.5.7.

#### 4.5.8 Low-temperature flexibility.

4.5.8.1 Types I through IV. To determine conformance to 3.5.8.1, a one-inch section of hose of full circumference shall be placed in a cold box and held for 5 hours at minus 65° ± 2°F. for grade A hose and at minus 40° ± 2°F. for grade B hose. The cooling medium shall be air. While still at the specified temperature, the specimen shall be compressed between 2 parallel plates to 50 percent of its original inside diameter. The testing fixture shall be in the cold box during the entire test.

4.5.8.2 Type V. To determine conformance to 3.5.8.2, one complete hose shall be conditioned for 5 hours at a temperature of 65° ± 2°F. for the grade A hose and at minus 40° ± 2°F. for the grade B hose. While still at this temperature, the specimen shall be bent over a curved surface having a radius equal to one and one-half times the outer diameter of the hose. Bending shall be at the rate of 15 to 18 degrees per second. Specimen shall then be straightened and bent in the opposite direction over the same curved surface at the same rate of speed. Time consumed in bending shall be held, as far as possible, to a maximum of thirty seconds.

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4.5:9 Ozone resistance .4.5.9 1 Preparation of specimens.

4.5.9.1.1 Types I through IV hose. Hoses with class 2 or class 4 cover only shall be tested. Cover shall be removed from tube and buffed to  $0.075 \pm 0.005$  inch thickness if necessary, or to smooth surface on thin covers. Duplicate specimens shall be cut out from buffed cover stock with a 2-inch, T50 die. The T50 specimens (two together) shall be inserted in a 2-1/4-inch wide slotted, aluminum holder designed to obtain 12-1/2 percent specimen elongation.

4.5.9 1.2 Type V hose. Hose with class 2 or 4 cover only shall be tested. A specimen 3/4-inch wide and 6 inches long shall be cut from the platen press sheet of hose cover (see 4.2.2) and attached to a specimen holder such as shown in method 7311 of Fed. Test Method Std. No. 601. Specimen shall then be elongated 12-1/2 percent.

4.5.9.2 Procedure. The test specimens, while still elongated, shall be conditioned for 45 minutes in air at room temperature and then placed in a test chamber, maintaining air mixed with ozone, in the proportion of 50  $\pm$  5 parts of ozone per 100,000,000 parts of atmospheric air by volume. The specimen shall be exposed to the mixture of ozone and air for 168 hours, at a temperature of  $100^{\circ} \pm 2^{\circ}$  F. At the end of the 168-hour period, the specimen shall be examined under 9 power magnification to determine conformance to 3.5.9.

4.5.10 Fungi resistance. To determine conformance to 3.5.10, grade A hose shall be tested in accordance with MIL-F-13927, after which it shall be subjected to the test specified in 4.5.11.

4.5.11 Proof pressure. To determine conformance to 3.5.11, hose specimens shall be subjected to the test for proof pressure specified in method 10211 of Fed. Test Method Std. No. 601. Proof pressure shall be 1/2 of the burst value for similar size hose shown in table II.

4.5.11.1 Pulsating proof pressure. To determine conformance to 3.5.11.1, the hose shall be tested as specified in method 10211 of Fed. Test Method Std. No. 601. Lengths shall be as specified on applicable drawings, and the pressure shall be 40 psi applied internally at pulsating intervals of 5 seconds (2 seconds "on" and 3 seconds "off") for 15 minutes.

4.5.12 Resistance to vibration.

4.5.12.1 Test specimen. Type V hose only shall be tested. Each specimen shall consist of a 24-inch long hose which has been conditioned for 24 hours at  $80^{\circ} \pm 9^{\circ}$  F.

4.5.12.2 Procedure. The specimen shall be installed on the vibration equipment in a manner incorporating a 90-degree bend in the hose specimen. Vibration of the specimen shall be for 50 hours at 30  $\pm$  10 cycles per second (cps) at 1/4-inch double amplitude, and in an ambient air temperature of  $80^{\circ} \pm 9^{\circ}$  F.

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During the vibration period, water shall be circulated through the specimen at a pressure equal to  $1/4$  of the burst value for similar size hose shown in table II to determine conformance to 3.5.12.

4.5.13 Packaging test. To determine conformance to method of packaging specified in MIL-H-775, the package shall be subjected to the test specified in MIL-P-116 for the method of packaging used.

4.5.14 Packing test. To determine conformance to the method of packing specified in MIL-H-775, the level A packs shall be subjected to the interior packing test of MIL-STD-1186. Level B packs shall be subjected in the same test, except the height of the drop shall be 75 percent of the height of the drop specified therein.

## 5. PREPARATION FOR DELIVERY

5.1 Packaging and packing. Packaging shall be level A or C and packing shall be levels A, B, or C as specified, (see 6.2).

5.1.1 Packaging and packing. Cleaning, packaging, and packing shall conform to MIL-H-775. When tested as specified in 4.5.13 the package shall meet the requirements specified in MIL-P-116 for the method of packaging used. When tested as specified in 4.5.14, level A packs shall meet the requirements of the interior packing test of MIL-STD-1186. Level B packs shall meet the requirements of the same test, except the height of the drop shall be 75 percent of the height of the drop specified therein.

### 5.1.2 Marking.

5.1.2.1 Civil agencies. In addition to any special marking required by the contract or order, shipping containers shall be marked in accordance with Fed. Std. No. 123.

5.1.2.2 Military activities. In addition to any special marking required by the contract or order, shipping containers shall be marked in accordance with MIL-H-775.

## 6. NOTES

6.1 Intended use. The hose covered by this specification is intended for the following uses:

- (a) Types I and II hose are primarily intended for severe service such as on heavy-duty, military and commercial trucks, military combat vehicles, and off-the-road, earth-moving equipment.
- (b) Type III hose is intended for normal service in passenger cars and light trucks.
- (c) Type IV hose is intended for connecting hot water heaters to the coolant-circulating systems of ground vehicles.

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- (d) Type V hose is intended for use in engine-coolant systems in passenger cars, trucks, military-combat vehicles and off-the-road earth-moving equipment, usually to replace faulty hose of other types.

6.1.1 Other uses. The applicable provisions of this specification may be used in the procurement of coolant system hose required for installation on industrial or marine engines.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- (a) Title, number, and date of this specification.
- (b) Type and grade of hose, and class of rubber required (see 1.2, 1.2.1, 1.2.2, 6.3, and 6.7).
- (c) Size and length required (see 3.4.1, 3.4.4, and table II).
- (d) If marking other than specified for types I through IV is required (see 3.6.1).
- (e) If marking other than specified for type V is required (see 3.6.2).
- (f) If lot formation (nonmilitary) for sampling for hose other than specified is required (see 4.3.1.1.1).
- (g) If sampling for quality conformance examination (nonmilitary) other than specified is required (see 4.3.1.1.2).
- (h) If sampling for quality conformance testing (nonmilitary) other than specified is required (see 4.3.1.1.3).
- (i) If lot formation (military) for sampling for hose other than specified is required (see 4.3.1.2.1).
- (j) If sampling for quality conformance examination (military) other than specified is required (see 4.3.1.2.2).
- (k) If sampling for quality conformance testing (military) other than specified is required (see 4.3.1.2.3).
- (l) Selection of applicable level of packaging and packing (see 5.1).

6.3 Classes. The classes, as specified in 1.2.1, are described generally as follows:

- Class 1 - Compounds having low volume swell in petroleum hydrocarbons. These compositions are normally made from copolymers containing acrylonitrile.
- Class 2 - Compounds having medium volume swell in petroleum hydrocarbons and having ozone-resistant properties. These compounds are normally made from polychloroprene as the base material.

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- Class 3 - Compounds that are nonoil-resistant. These compounds are normally made from natural, reclaimed or synthetic rubber, or mixtures thereof.
- Class 4 - Compounds having high-temperature-resistant and ozone-resistant properties. These compounds normally are made from a copolymer of isoprene and isobutylene.

6.3.1 Classes. Comparable classes described in MIL-STD-417(Ord) are as follows:

ZZ-H-428c	MIL-STD-417(Ord)
Class 1	Class SB (Suffixes E <sub>3</sub> and E <sub>5</sub> )
Class 2	Class SC (Suffixes C <sub>1</sub> and E <sub>3</sub> )
Class 3	Class RN/RS
Class 4	Class RS (Suffixes A <sub>1</sub> and C <sub>2</sub> )

6.4 Qualification. With respect to products requiring qualification (see 3.1, 4.2, and appendix), awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is Headquarters, U.S. Army Tank-Automotive Command, Warren, Michigan 48090.

6.5 Military hose. Types I through IV grade A, classes 2 and 4 hose, in any applicable combination of type and class (see tables I and II), and type V, grade A hose (see MS 51008), are intended to be used for military service.

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6.6 Classification cross reference. The following is a cross reference of the classification of ZZ-H-428c and this revision.

ZZ-H-428c 17 Dec. 1964			This specification ZZ-H-428d		
Type	Grade	Class	Type	Grade	Class
I	A	2	I	A	2
(Not Applicable)			I	A	4
(Not Applicable)			I	B	1
I	B	2	I	B	2
I	B	3	I	B	3
I	B	4	I	B	4
II	A	2	II	A	2
(Not Applicable)			II	A	4
II	B	1	II	B	1
II	B	2	II	B	2
II	B	3	II	B	3
(Not Applicable)			II	B	4
III	A	2	I	A	2
III	A	4	I	A	4
(Not Applicable)			I	B	1
III	B	2	I	B	2
III	B	3	I	B	3
III	B	4	I	B	4
IV	A	2	II	A	2
IV	A	4	II	A	4
(Not Applicable)			II	B	1
IV	B	2	II	B	2
IV	B	3	II	B	3
IV	B	4	II	B	4
V	A	2	III	A	2
V	A	4	III	A	4
V	B	2	III	B	2
V	B	3	III	B	3
V	B	4	III	B	4
VI	A	2	IV	A	2
VI	A	4	IV	A	4
VI	B	2	IV	B	2
VI	B	3	IV	B	3
VI	B	4	IV	B	4
VII	A	2	V	A	2
VII	A	3	V	A	3
VII	B	1	V	B	1
VII	B	2	V	B	2
VII	B	3	V	B	3
VII	B	4	V	B	4

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6.7 Certain provisions (table III tolerances on straight hose) of this specification are subject of international standardization agreement (NATO STANAG NO. 4043 and ABC-Army-STD-133). When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Offices so that the appropriate action may be taken respecting the international agreements concerned.

**MILITARY CUSTODIANS:**

Army - AT

Navy - YD

**Preparing activity:**

Army - AT

**Reviewer interest:**

Navy - YD

DSA-CS

**Civil Agency Coordinating Activities:**

DOT-ACO

GSA-FSS

HEW-FEC

NASA-JFK

TREASURY - IRS

USDA-ARS

**User interest:**

Army - MJ

## APPENDIX

## 10. SCOPE

10.1 This appendix covers by types, the requirements for submittal of hose for qualification.

20. Submittal plans.

20.1 Types I through IV . For each type and grade of straight hose and class of rubber the manufacturer wishes to qualify (see 3.1, 4.2, 6.4, 30, and table X), he shall submit 18 feet of hose and six platen press sheets (three each of tube and cover). Each sheet shall be 6 by 6 by 0.075  $\pm$  .005 inches. Platen press sheets shall be certified as having come from the same batch as the tube and cover of the hose submitted and as having a curing time equivalent to that of the finished products. When curved hose is being submitted for qualification, pieces of curved hose equal to 18 feet shall be furnished. Hose submitted shall be representative of that intended to be furnished under contract by the manufacturer.

20.2 Type V hose . For each grade and size of type V hose and class of rubber the manufacturer wishes to qualify (see 3.1, 4.2, 6.4, 30, and table X), he shall submit a sample consisting of eight complete 24-inch lengths of hose, and six platen press sheets as specified in 20.1.

## 30. SPECIAL PROVISIONS FOR ESTABLISHING QUALIFICATION.

3.1 Qualification of types, grades, classes, and sizes of hose tabulated under "Hose qualified" in table X, submitted by one manufacturer, will be recognized as establishing qualification of the applicable types, grades, classes and sizes of hose of the same manufacturer, tabulated under "Qualification established for" in table X.

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Table X - Establishing qualification

Hose qualified				Quantity for test		Qualification est. for			
Type	Grade	Classes	Size*			Types	Grades	Classes	Size
I	A	2	1 1/2	18 feet		I	A and B	2,4	All sizes
I	B	1,3	1 1/2	18 feet		I	B	1,2,3,4	All sizes
II	A	2,4	1 1/2	18 feet		II	A and B	2,4	All sizes
II	B	3	1 1/2	18 feet		II	B	1,2,3,4	All sizes
III	A	2,4	1 1/2	18 feet		III	A and B	2,4	All sizes
III	B	3	1 1/2	18 feet		III	B	3	All sizes
IV	A	2,4	5/8	18 feet		IV	A and B	2,4	All sizes
IV	B	3	5/8	18 feet		IV	B	3	All sizes
V	A	2,3	2 1/2	8, 2 1/2-inch pcs.		V	A and B	2,3	All sizes
V	B	1,4	2 1/2	8, 2 1/2-inch pcs.		V	B	1,4	All sizes

\*Submittal of any other size shall be subject to the approval of the qualifying activity.

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