



EXPLANATION OF COMMON SPECIFICATIONS

Tubing

UL224/CSA C22.2 No. 198.1

Materials: [105C](#), [HS105C](#), and most [polyolefin](#)

Underwriters Laboratories (UL) and Canadian Standards Association (CSA) standard for extruded electrical insulating tubing in a variety of materials. These two standards were merged into one common standard which became effective Dec. 2001. Standard includes dimensional and physical properties.

Temperature Rating – tubing is rated as 90°C or 105°C for PVC, 105° or 125°C for polyolefin, and other temps for other materials.

Flame Rating – VW-1 (CSA had called this OFT) is an optional requirement for flammability (Vertical Wire flame test).

Voltage Rating – Tubing may be rated 150V, 300V or 600V depending on wall thickness (150V does not apply to PVC).

ASTM D922

Materials: [105C](#), [9848](#)

American Society for Testing and Materials specification for nonrigid PVC tubing. Standard includes dimensional and physical properties.

Grade A – General-purpose, brittle point $\leq -30^{\circ}\text{C}$ (9848)

Grade B – Low temperature, brittle point $\leq -55^{\circ}\text{C}$

Grade C – High temperature, brittle point $\leq -10^{\circ}\text{C}$ (105C)

ASTM D3150

Materials: None ([HS105C](#) is compliant with key performance requirements but has not been fully tested to all requirements and does not comply with all dimensional requirements.)

American Society for Testing and Materials specification for heat shrinkable PVC tubing. Standard includes dimensional and physical properties.

Type I – Non-cross-linked PVC, shrinks at 135°C

Type II – Cross-linked PVC, shrinks at 175°C

Ford ES-2U5A-1A263-AA

Materials: [9848](#)

Ford Engineering Specification for flexible insulating tubing. This spec. says it supersedes all previous specs. This spec is much more detailed then Ford ESB-M4D103-A. It includes dimensional, physical properties and color.

Type A - 85°C (9848)

Type B - 105°C

Type C - 125°C

Type D - 135°C+



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Ford ESB-M4D103-A

Materials: [73A](#)

Old Ford Engineering specification (last issued 1978) for PVC tubing. Includes basic physical properties.

MIL-I- 631

Materials: [105C](#), [631](#)

US Military specification for plastic electrical insulation tubing. Covers a variety of materials and includes dimensional and physical properties.

Type F – PVC,

Form U – Tubing,

Grade a – General purpose (631) Grade b – Low temp. (631)

Grade c – High temp. (105C)

Class I – Fungal resistant, (631, optional on 105C)

Class II – Not fungal resistant

Category 1 – Flame resistant

JIS C 2410-1975

Materials: [JIS-85](#)

Japanese Industrial Standard for electrical insulating tubing. This standard was “withdrawn” 3/1/94. Includes dimensional and physical properties.

SAE-AMS-I-7444 (was MIL-I-7444)

Materials: [7444](#)

Society of Automotive Engineers, Aerospace Materials Specification for flexible electrical insulation sleeving (very low temp.). SAE took over this spec after the US Military “inactivated” MIL-I-7444 as of 7/30/87.

Type I - Clear

Type III – Colored (there is no Type II)

Class I – brittle point -67.8°C & self extinguishing within 45 sec. (7444)

Class II – brittle point -55°C & self extinguishing within 15 sec.



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SAE-AMS-DTL-23053 (was MIL-DTL-23053)

Materials: /1:[NHS](#); /4:[AL2X](#), [AL3X](#), [ML251](#); /5:[SL125](#), [SL2535](#), [SL2535CL](#) /8:[PVDF](#); /13:[MF392](#)

Society of Automotive Engineers, Aerospace Material Specification. This is a multipart spec (/1 thru /18) for a variety of plastic electrical insulation tubing. SAE took over this spec after MIL-DTL-23053 was canceled on 9/16/99. Includes dimensional and physical properties, and color.

- /1 HS cross-linked chlorinated polyolefin – for heavy duty cables and harness systems. Oil and chemical resistant.
 - Class 1 - -55°C to 90°C
 - Class 2 - -70°C to 121°C ([NHS](#))
- /2 HS PVC – This spec is marked as Inactive for new designs. Grayline does not meet all dimensional requirements.
 - Class 1 – crosslinked
 - Class 2 – non-crosslinked (this would be [HS105C](#) if we listed it)
- /4 HS cross-linked polyolefin – adhesive lined (dual wall) – for one step potting, encapsulation, or moisture sealing and corrosion protection.
 - Class 1 – Semi-rigid, non flame retardant ([ML251](#))
 - Class 2 – Flexible, flame retardant, 2:1 ([AL2X](#))
 - Class 3 – Flexible, flame retardant, 3:1 ([AL3X](#))
- /5 HS flexible cross-linked polyolefin – for light duty harness jackets, wire color coding, marking or identification.
 - Class 1 – Flame resistant, wide operating temp. range ([SL2535](#) colors)
 - Class 2 – Flammable (clear only) ([SL2535CL](#))
 - Class 3 – Highly flame resistant ([SL125](#))
- /8 HS semi-rigid, cross-linked Polyvinylidene fluoride – for wire or termination strain relief at elevated temps. ([PVDF](#))
- /13 HS flexible Fluoroelastomer – for elevated temp applications or where exposure to elevated temp solvents ([MF392](#))

FMVSS302

Materials: [105C](#), [9848](#), [631](#), [7444](#), [HS105C](#)

Federal Motor Vehicle Safety Standard – also known as 49 CFR 571.302

This is a federal safety standard for the flammability of materials used in occupant compartments of motor vehicles.



EXPLANATION OF COMMON SPECIFICATIONS

Environmental

EU Directive 2000/53/EC (ELV – End-of-Life Vehicles)

This is a law passed by the European Union Parliament that pertains to recycling of motor vehicles. The part that applies to Grayline is that after 7/1/03, new motor vehicles can not be sold in the EU that contain lead, mercury, cadmium or hexavalent chromium except for a few specifically defined applications which do not include tubing. Since vehicles produced in the US are also sold in Europe, the US manufactures have in most cases applied the same rules to vehicles manufactured here. All tubing sold by Grayline conforms to this directive except for some specialty colors which contain lead.

EU Directive 2000/95/EC (ROHS – Restriction of Hazardous Substances)

European law that restricts the use of hazardous substances in electronic equipment. This law was passed along with another mandating recycling of electronic equipment. As of 7/1/06, new electronic equipment can not be sold in the EU if it contains lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, or polybrominated diphenyl ethers except for a few specifically defined applications which do not include tubing. Electrical equipment is defined as anything that uses electricity to work. All tubing sold by Grayline conforms to this directive except for some specialty colors which contain lead.

2000/95/EC was amended on 10/13/05 to allow DecaBDE in polymeric applications.

EU Directive 2003/11/EC

European law that prohibits the sale of pentabromo-diphenylether and octabromo-diphenyl ether derivatives or the sale of products containing more than 0.1% by weight of these flame retardants in the EU after 8/15/04. No materials sold by Grayline are known to contain these materials.

California Prop 65

In 1986, California passed a law (proposition 65). This law requires companies that sell products in California to provide a “clear and reasonable” warning before knowingly and intentionally exposing anyone to a chemical that’s on a special list of chemicals that the state has determined to cause cancer, birth defects, or other reproductive harm. This list includes the following substances which are used in some of our tubing: lead, antimony trioxide, hexavalent chromium, some phthalate plasticizers and vinyl chloride. We have a section on our Material Safety Data Sheets that address this law.



EXPLANATION OF COMMON SPECIFICATIONS

Braided Sleeving

MIL-Y-1140

Materials: [HT, AS, CC-1](#)

US Military specification for Yarn, Cord, Sleeving, Cloth and Tape-Glass.

- Class C – Continuous Filament
- Class S – Staple Fiber
- Form 1 – Yarn
- Form 2 – Cordage
- Form 3 – Sleeving ([HT, AS, CC-1](#))
- Form 4 – Cloth
- Form 5 – Tape

MIL-I-3190

Materials: /2:[VC](#), /3:[AC](#), /6:[SR](#)

US Military specification for Coated, Flexible Fiberglass Insulating Sleeving.

- Grade A – 7000 volt min. avg.
- Grade B – 4000 volt min. avg.
- Grade C – 2500 volt min. avg.
- /2 Class 130°C, Type B – Vinyl plastisol coated ([VC](#))
- /3 Class 155°C, Type A – Acrylic resin coated ([AC](#))
- /5 Class 200°C, Type C – Silicone resin coated
- /6 Class 200°C, Type D – Silicone rubber coated ([SR](#))
- /7 Class 200°C, Type E – Fluoroelastomer coated
- /8 Class 220°C, type D – Silicone rubber coated
- /9 Class 240°C, Type D – Silicone rubber coated

UL1441/ CSA C22.2 No. 198.3

Underwriters Laboratories (UL) and Canadian Standards Association (CSA) standard for Coated Electrical Sleeving.

NEMA TF1

National Electrical Manufacturers Association standard for Coated Electrical Sleeving

- Type 1 organic based fibers impregnated or coated, 105°C
- Type 2 inorganic, impregnated or coated, 103°C
- Type 3 inorganic, impregnated or coated (such as PVC), 105°C
- Type 4 inorganic, impregnated or coated (such as silicone resin or PTFE), 200°C
- Type 5 inorganic, impregnated or coated (such as silicone elastomer), 200°C
- Type 6 inorganic, impregnated or coated (such as epoxies, polyesters or acrylics), 155°C
- Type 7 inorganic, impregnated or coated, 180°C
- Grade A 7000V Dielectric breakdown average
- Grade B 4000V Dielectric breakdown average
- Grade C 2500V Dielectric breakdown average

Information given here is for reference only. Please consult the current specification for exact details and current datasheets for listed products.

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EXPLANATION OF COMMON SPECIFICATIONS *Braided Sleeving*

NEMA TF2

National Electrical Manufacturers Association standard for Uncoated Treated Fiberglass Sleeving

- Type 1 nominal 0.008" wall
- Type 2 nominal 0.006" wall
- Type 3 AWG sizes, wall varies with ID
- Type 4 AWG IDs with 0.031" wall