

INTERNATIONAL TRUCK AND ENGINE CORPORATION		
TMS (TRUCK MATERIAL SPECIFICATION)		NUMBER: TMS-6611
TITLE: Insulation, Heat Shrinkable Tubing		REVISION: A
WRITTEN/EDITED BY: Materials Engineering	APPROVED BY: Materials Engineering	DATE ISSUED: February 2006
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<i>This specification may involve hazardous materials, equipment, and procedures. This specification does not purport to address all of the safety issues associated with its use. The user is responsible to consult appropriate safety and health practices and to determine the applicability of regulatory limits prior to use.</i>		
Change Notice: Revised Section 9.0; added Section 2.1.		
Reference: File: 30-1	Keywords: Insulation, electrical insulation, plastic tube, heat shrinkable tube.	

1.0 APPLICATION

This material specification covers the sealing requirements of co-extruded, cross-linked polyolefin heat shrinkable tubing the diameter of which will reduce to a predetermined size upon heating. This tubing is used for insulating electrical splices.

2.0 SCOPE

This specification covers the material properties, performance requirements, production quality control, supplier's responsibility, source approval and quality control, general information, and sources for approved systems.

2.1 Restricted Chemical Substances

Effective January 1, 2007, all product supplied to the requirements of this specification must comply with the requirements of the CEMS B-50 specification.

3.0 REFERENCE DOCUMENTS

Unless otherwise specified the latest issue of all referenced standards shall apply. The following Specifications, Standards, and Regulations are referenced in this specification.

International Quality System Standard QS-9000 (ISO 9000 or TS-16949)	INTERNATIONAL TMS-6810	ASTM D471
INTERNATIONAL IQR Quality Standard	INTERNATIONAL TMS-6811	ASTM D570
INTERNATIONAL Manufacturing Std. D-13	INTERNATIONAL TMS-6812	ASTM D792
INTERNATIONAL Eng. Design Std. A-16	INTERNATIONAL TMS-9543	ASTM D2671
INTERNATIONAL CEMS B-1	CFR 29, Part 1910	SAE J1128
INTERNATIONAL CEMS B-38	ASTM D257	SAE J1703
INTERNATIONAL CEMS B-50		

4.0 GENERAL REQUIREMENTS

Material supplied to this specification shall insulate the intended substrates, where continuous operating temperatures can reach up to 135°C (275°F), when applied with due care. The Property and Performance requirements of these materials are listed in Table I. Each new substrate for any system shall be qualified and listed in Table III.

4.1 Construction

Materials supplied to this specification shall be uniform in color, texture, finish, physical, mechanical, and electrical properties. Materials shall be free from seams, cracks, porosity, blisters, pinholes, surface

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lubricants, and defects caused by processing, handling, or contamination. Approval of materials for compatibility to these materials is the responsibility of the heat shrinkable tubing supplier, the process manager and the process suppliers. Length and minimum wall thickness shall be determined by part drawing or supplier data.

4.2 Property and Performance Requirements

4.2.1 Extruded Tubing Requirements

Unless otherwise specified, a minimum of five samples shall be prepared for each condition tested. Extruded tubing samples shall be preshrunk by conditioning for 10 minutes in a $135^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($275^{\circ}\text{F} \pm 4^{\circ}\text{F}$) air circulating oven or at the proper conditions based on manufacturer's guidelines for sealing material and splice configuration. The samples are then allowed to stabilize for 3 hours at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 4^{\circ}\text{F}$) and $50 \pm 5\%$ relative humidity. The conditioning shall be as representative of production conditions as possible and will be fully described in the test report. These conditions will be listed in Table III and shall be reproducible for future testing.

Note: Oven temperatures should represent actual sample splice temperatures rather than the reported temperatures of the heating elements or the oven air temperature.

4.2.1.1 Specific Gravity

4.2.1.1.1 Method: ASTM D792

4.2.1.1.2 Required: See Table 1

4.2.1.2 Flammability

4.2.1.2.1 Method: ASTM D2671, Procedure B

4.2.1.1.2 Required: Self-extinguishing within 60 seconds, using mandrel size of 50% of expanded I.D.

4.2.1.3 Dimensional Recovery, Longitudinal Change

4.2.1.3.1 Method: Measure five samples of tubing, 152mm (6 in.), for length and I.D. per ASTM D2671. Condition samples for 10 minutes at $135^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($275^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$). Immediately after conditioning, quench samples in a water bath maintained less than $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($95^{\circ}\text{F} \pm 4^{\circ}\text{F}$) for 3 seconds. Wipe dry with a clean cloth and re-measure.

4.2.1.3.2 Required: Dimensions shall meet those specified in supplier specifications. Longitudinal change shall be measured as the difference in lengths expressed as a percentage of the original length. See Table I.

4.2.1.4 Heat Aging

4.2.1.4.1 Method: Condition samples in a mechanical convection oven at $135^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($275^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) with an air velocity of 30.5-61 M (100-200ft.) per minute. After conditioning, the samples are allowed to stabilize for 3 hours at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and $50 \pm 5\%$ relative humidity. The samples are then bent through 180° over a mandrel selected in accordance with Table II.

4.2.1.4.2 Required: Samples shall not exhibit any cracking.

4.2.1.5 Heat Shock

4.2.1.5.1 Method: Test per ASTM D2671 at $225^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($437^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) for 4 hours.

4.2.1.5.2 Required: Samples shall not crack, flow or drip.

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4.2.1.6 Tensile Strength, Ultimate Elongation

4.2.1.6.1 Method: Test per ASTM D2671. Jaw separation rate shall be 50mm (2 in.) per minute. Original cross section shall be that of the outer wall only.

4.2.1.6.2 Required: See Table I.

4.2.1.7 Dielectric Strength

4.2.1.7.1 Method: Test per ASTM D2671. Test outer wall only.

4.2.1.7.2 Required: See Table I.

4.2.1.8 Volume Resistivity

4.2.1.8.1 Method: Prepare per ASTM D2671. Test per ASTM D257

4.2.1.8.2 Required: See Table I.

4.2.1.9 Water Absorption

4.2.1.9.1 Method: Test per ASTM D570, procedure A.

4.2.1.9.2 Required: See Table I.

4.2.2 Splice Sealing Requirements: Table III

4.2.2.1 Sample Preparation

A minimum of twenty-five samples of each configuration shall be prepared for each condition tested unless otherwise specified. Splices shall be conditioned for 10 minutes in a 135°C ± 2°C (275°F ± 4°F) air circulating oven or at the proper conditions based on manufacturers guidelines for sealing material and splice configuration. The samples are then allowed to stabilize for 3 hours at 23°C ± 2°C (73°F ± 4°F) and 50% ± 5% relative humidity. The conditioning shall be as representative of production conditions as possible and fully described in the test report. These conditions will be listed in Table III and shall be reproducible for future testing.

4.2.2.2 Initial Current Leakage

4.2.2.2.1 Method: Immerse the center of each splice in a water bath maintained at 23°C ± 2°C (73°F ± 3.6°F) containing 5% by weight sodium chloride (NaCl) for 24 hours. Leave the ends of the samples a minimum of 50 mm (2 in.) above the water line. Measure the current leakage between the conductors in the sample and the water bath using an applied voltage of 50 volts DC.

4.2.2.2.2 Required: Current leakage shall be less than 0.25 microamps.

4.2.2.3 Heat Aging

4.2.2.3.1 Method: Place samples vertically in a mechanical convection oven at 135°C ± 2°C (275°F ± 3.6°F) with an air velocity of 30.5 - 61 M (100-200ft.) per minute. After conditioning, the samples are allowed to stabilize for 3 hours at 23°C ± 2°C (73°F ± 3.6°F) and 50 ± 5% relative humidity. The samples are then subjected to the current leakage test.

4.2.2.3.2 Required: Samples shall not crack, flow, or drip and current leakage shall be less than 0.25 microamps.

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