

Exone XR 110°  
Hypalon 90° less cost

AMTRAK  
SPECIFICATION  
FOR  
HIGH PERFORMANCE WIRE AND CABLE  
SPECIFICATION #Q-78-7

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NATIONAL RAILROAD PASSENGER CORPORATION

REVISION	APPROVED	DATE	Approved By	Date
A	LRB	2/13/79	J.R. Bates	5/10/78
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RELEASED BY:	Initials	Date
EQUIPMENT ENGINEERING	LRB	5/25/78
PROCUREMENT	<i>[Signature]</i>	5/25/78

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This document describes the physical and electrical properties for 110°C rated wire and cable used on Amtrak Rolling Stock.

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## GENERAL

All wire and cable procured under this specification must exhibit the properties outlined in the specification and must either be on Amtrak's approved source list, (paragraph 7.0) or must be approved, in writing, by Amtrak Equipment Engineering Department.

## WIRE CONSTRUCTION

Conductor: Soft Annealed Copper  
Coating: Tin  
Stranding: Per AAR 589 (See paragraph 5.0)  
Insulation: Crosslinked Polyolefin

## PROPERTIES

## APPLICABLE DOCUMENTS

The wire and cable manufactured under this specification shall be tested and inspected in accordance with the latest issues of the following standards, as applicable or as modified herein:

ASTM B-33 - Tinned Soft or Annealed Copper Wire

ASTM D-149 - Test for Dielectric Breakdown Voltage & Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies

IPCEA S-19-81 - Rubber Insulated Wire & Cable

IPCEA S-66-524 - Cross-Linked-Thermosetting-Polyethylene Insulated Wire & Cable for the Transmission & Distribution of Electrical Energy

UL 44 - Standard for Rubber Insulated Wire & Cable

IEEE Std. 383-1974 - Type Test of Class 1E Electrical Cable, Field Splices & Connectors for Nuclear Power Generating Stations

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#### 4.2 ELECTRICAL

Dielectric Strength per ASTM D-145	700V/Mil Minimum
Insulation Resistance	5000 megohms Minimum
Insulation Resistance K	17,500 Minimum
Accelerated Water Absorption	
Gravimetric 7 days @ 70°C	8MG/i <sup>2</sup> Maximum
Electrical SIC 24 hours @ 75°C	6.0 Maximum
Increase in Capacitance	
1-14 Days (% of Original)	7.5 Maximum
7-14 Days (% of Original)	1.5 Maximum
Stability Factor after 14 days	1.0

#### 4.3 PHYSICAL

##### Unaged

Tensile Strength, Min. PSI	2000 Minimum
Elongation at Rupture, Min. %	250 Minimum

##### Aged

After air oven 7 days @ 158°C ± 2°C	
Tensile Strength (% of original)	90 Minimum
Elongation (% of original)	55 Minimum

Heat Distortion, 1 hour @ 200°C	20% Maximum
Clause 4.3.6.1 CSA Std. C22.2 No. 0.3	

Cold Bend, 120 hours @ -55°C	* 6KV-5 Minutes
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Cold Bend, 2 inch Mandrel - 85°F (per Paragraph 4.7.4.15 MIL-C-22759)	* Pass
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#### 4.4 QUALIFICATION

Tension Set: Test per IPCEA-S-66-524, Paragraph 6.4.11.4  
(Except with gauge marks 4" apart). Requirement: 30%  
Maximum

Ozone Resistance: After 24 hours exposure to an ozone  
concentration of 0.03% by volume at 90°C ± 2%, there shall  
be no insulation cracks.

Flammability Requirements: Insulated conductors shall pass  
the flame tests described in Paragraph 6.19.6 of IPCEA  
S-19-81 and the VW-1 vertical flame test described in UL  
Subject 44. The maximum afterburn after each flame  
application shall be no greater than 3 seconds.

\* Must Not Exhibit Cracking

#### 4.4 Qualification (continued)

##### Corrosion Tests:

- A. Copper Mirror. (Ref. ASTM 2671) A 0.4 gram sample of insulation shall be placed in the bottom of a 1/2 inch x 12 inch test tube. A copper coated glass mirror shall be suspended 6 inches over the sample by a thin copper wire. The lower two inches of the test tube shall be heated to 175°C for 16 hours. Requirements: Shall not remove more than 5% of the copper film.
- B. Acid Gas Detection. A 1.0 mg sample shall be heated to combustion in a closed quartz tube. The resulting gases shall be drawn through a detector tube (MSA #91636) using a special air sampling pump manufactured by Mine Safety Apparatus Company. The amount of acid gas shall be determined by measuring the length of the color change in the detector tube. Requirement: 300 PPM/MG maximum average. (350 PPM/MG maximum any single sample)

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Oil Resistance: Hot Oil Swell Tests - Insulated wires shall be premeasured and immersed in a hot oil bath. After the required exposure time, they shall be removed and measured for the amount of swell.

##### Requirement:

- A. ASTM No. 1-Oil 100 hours @150°C Max. % Swell 20  
B. ASTM No. 2-Oil 100 hours @150°C Max. % Swell 40  
C. ASTM No. 3-Oil 100 hours @150°C Max. % Swell 50  
D. Diesel Oil 120 hours @ 60°C Max. % Swell 15

NOTE: When tested in accordance with AAR589 (ASTM #2 oil at 121°C for 18 hours) the retention of tensile and elongation shall be: Tensile - 70% Minimum, Elongation - 90% Minimum.

Smoke Emission: The test shall be performed in an N.B.S. Smoke Chamber using #12 AWG wire insulated with 45 mils of insulation. The procedures shall be per NFPA Standard 258 in the flaming (F) and non-flaming (N) modes.

	<u>Dm</u>	<u>T16</u>	<u>T.9DM</u>
(F) Flaming plus Radiant Furnace	447	1.05	7.15
(N) Non-Flaming Radiant Furnace	199	11.6	27.1

Dm = Max. Specified Optical Density

T16 = Time to reach critical Ds (Specified Optical Density)

T.9DM = Time to reach 90% of Dm

#### 4.4 Qualification (continued)

**Abrasion Resistance:** Rotating Scrap Abrader (Ref. MIL-C-915). A 24 inch specimen shall be draped over an 8 inch rotating drum with two (2) 90° vee edge abrading tools 180° apart. Failure shall be detected by electrical contact between abrading tool and conductor. The cable shall be weighted with a 450 gram mass. Requirement: 2500 cycles minimum.

**Cut-Through Penetration:** Specimen of insulated wire shall be preconditioned at 125°C for 1 hour. While at this temperature, a weighted (1000 gm) 90° chisel cutting edge shall be applied perpendicular to the longitudinal axis of the specimen. Detection of cut-through shall be monitored with a 12 volt lamp circuit connected in series with the plunger and conductor in the specimen. Requirement: 10 minutes minimum.

**Crush Resistance:** A wire sample shall be placed between two (2) parallel flat plates and compressed until electrical contact is detected across conductor to the plate. Requirement: 7500 lbs. minimum.

APPROX. AREA (CM)	APPROX. SIZE AWG	NO. & SIZE EACH WIRE IN STRAND	TYPE OF STRANDING	CONDUCTOR DIAMETER (INCHES)	INSULATION THICKNESS (MILS)		MAXIMUM CABLE DIAMETER (INCHES)	
					600V	2000V	600V	2000V
1900	18	19/30	Conc.	.052	30	45	.120	.150
2601	16	19/.0117	Conc.	.060	30	45	.130	.160
3831	14	19/27	Conc.	.070	30	45	.145	.175
6088	12	19/25	Conc.	.090	30	45	.165	.195
10910	10	27/24	Bunch	.123	30	45	.200	.230
14950	8	37/24	Conc.	.140	45	55	.250	.270
24640	6	61/24	Conc.	.180	45	55	.310	.330
36760	5	91/24	Rope	.220	45	55	.345	.365
42420	4	105/24	Rope	.240	45	55	.365	.385
50500	3	125/24	Rope	.260	45	55	.390	.410
60600	2	150/24	Rope	.325	45	55	.430	.450
90900	1	225/24	Rope	.390	55	65	.515	.535
111100	1/0	275/24	Rope	.420	55	65	.565	.585
131300	2/0	325/24	Rope	.460	55	65	.605	.630
181800	3/0	450/24	Rope	.565	55	65	.695	.715
222200	4/0	550/24	Rope	.590	55	65	.750	.770
262600		650/24	Rope	.660	65	75	.810	.835
313100		775/24	Rope	.740	65	75	.880	.900
373700		925/24	Rope	.790	65	75	.960	.980
444400		1100/24	Rope	.870	65	75	1.025	1.045
535300		1325/24	Rope	.970	80	90	1.155	1.175
646400		1600/24	Rope	1.060	80	90	1.245	1.265
777700		1925/24	Rope	1.120	80	90	1.325	1.345
929200		2300/24	Rope	1.230	80	90	1.435	1.455
1111000		2750/24	Rope	1.370	95	110	1.595	1.625

#### 6.0 IDENTIFICATION

The surface of the cable shall be printed with the following information at intervals not greater than two feet: Manufacturer, Insulation Type, Conductor Size, and Voltage Rating.

#### 7.0 APPROVED VENDORS

1. ITT Suprenant Exane per Specification DAA1048A
2. Brand Rex Polyrad XT per Specification #BR-780
3. Haveg Industries, Inc. 113-25-2 per Specification #2754

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Figure 6.1  
ELECTRICAL WIRE

ITEM	QTY	DESCRIPTION	MFG	MFG #	AMT	AMTS
1	16 AWG	(.030) 600V EXANE	ITT	FXE1929U	25X9009094	
2	14 AWG	(.030) 600V EXANE	SURPRENANT	FXE1927U	25H9009092	
3	12 AWG	(.030) 600V EXANE	"EXANE"	FXE1925U	25D9009093	
4	10 AWG	(.030) 600V EXANE	OR	FXE2724U	25L9009091	
5	8 AWG	(.045) 600V EXANE		FXE3724U	25B9009085	
6	6 AWG	(.045) 600V EXANE	EQUAL	FXE6124U	25P9009087	
7	4 AWG	(.045) 600V EXANE		FXE10524U	25X9009086	
8	2 AWG	(.045) 600V EXANE		FXE15024U	25L9009080	
9	1/0 AWG	(.055) 600V EXANE	PER SPEC	FXE27524U	25P9009090	
10	2/0 AWG	(.055) 600V EXANE		FXE32524U	25N9012029	
11	4/0 AWG	(.055) 600V EXANE	N-78-7	FXE55024U	2' 19009089	
12	12 AWG	Coated Copper 19x25 600V Insrinsul 200°C HI Temp (Floor Heat)			25A9005273	
13	10 AWG	Copper 600V Silicone 180°C HI Temp (Floor Heat)			25D9007621	
14	8 AWG	Copper 600V Silicone 180°C HI Temp (Floor Heat)			25T9011879	
15	16/2 AWG	600V Neoprene Jacket Type "SN" (Wheel Slide)	Alpha	1935	25P9011647	
16	16/2 AWG	Type "SN" Extra Flex Unk (Eyeball Light Fixture)			49A9000259	
17	12/2 AWG	Type "SN" 600V (Standby Recept)			5P9004942	
18	10/3 AWG	Type 50 Extra Flexible Spec 562.1			25X9006521	
19	3/3 AWG	Type W 600V (Standby Recept)			25K9011528	
20	16/2 AWG	Shielded Twisted Pair (Wheel Slide)	Beldon	8719	25T9011686	
21	16/2 AWG	Shielded Twisted Pair (Wheel Slide)	Alpha	3241	25X9012294	
22	16/2 AWG	2 Cond. Twisted, One Black, One White "Exane" (PA Speakers)	ITT		25H9011408	
23	14/2 AWG	2 Cond. Twisted and Shielded (Train Line)	ITT		25X9011811	
			SURPRENANT			