



**CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
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**DISTRIBUTION ENGINEERING
DISTRIBUTION CABLE SYSTEMS**

SPECIFICATION EO – 18

**REVISION 9
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OCTOBER 15, 2014**

**PURCHASE AND TEST SPECIFICATION
FOR INSULATED NETWORK
POWER CABLE 600 VOLTS**

FILE: PURCHASE AND TEST MANUAL NO.6, SECTION 3

TARGET AUDIENCE	ELECTRIC CONSTRUCTION DISTRIBUTION ENGINEERING REGIONAL ENGINEERING
NESC REFERENCE	ALL SECTIONS

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1.0 PURPOSE

This specification details manufacturing and procurement requirements for power cables used primarily on the underground secondary network system.

2.0 APPLICATION

This specification applies to power cables used primarily on the underground secondary network system and purchased subsequent to implementation of this specification. Unless otherwise specified in the Appendix, power cables are to be insulated with Filled Ethylene Alkene (EAM).

3.0 SPECIFICATION REFERENCES

Cable shall meet or exceed the latest requirements of the following industry standards.

ICEA S-95-658 Nonshielded Power Cables Rated 2000 Volts or Less For the Distribution of Electrical Energy

ICEA T-22-294 Test Procedures for Extended Time-Testing of wire and Cable Insulations for Service in Wet Locations

ICEA T-26-465 Guide for Frequency of Sampling Extruded Dielectric, Power, Control, Instrumentation, and Portable Cables for Test

ICEA T-33-655 Low Smoke, Halogen-Free Polymeric Jackets

ASTM Standards (as applicable)

B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B33 Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

Con Edison [EO-6068](#) Fire and Heat Resistance Tests on 600V and Control Cable and Switchboard Wire

4.0 INSULATED CONDUCTOR

The copper conductors specified for these cables shall conform to ICEA Publication No. S-95-658. The stranding requirements are given in the Appendix.

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5.0 UNINSULATED GROUND CONDUCTOR

Where a bare copper ground conductor is specified for use with copper insulated conductors, the uninsulated ground conductor shall be tin coated copper in accordance with ASTM B33. The stranding requirements are given in the Appendix.

6.0 CONDUCTOR COVERING

No semi-conducting strand shield is required. The conductors of all power cables of #6 AWG and larger shall be covered by a suitable opaque polyester tape separator at least 1.0 mils thick with a 10% overlap. This tape is used over the conductor so no deposits from the insulation material remain when the latter is removed.

7.0 DUAL LAYER LOW SMOKE CONSTRUCTION

7.1 Insulation - Flame Retardant Filled EAM Insulation, this includes FR-Ethylene Propylene Rubber (FR-EPR), shall be used for cable having a low smoke zero halogen jacket. Filled EAM Insulation shall meet all requirements of Type E-2 insulation per ICEA S-95-658, except as modified below. Tests designated with an asterisk (*) shall be made for qualification or when changes are made to the insulation and at least once per calendar year that cable is supplied. Other tests shall be performed at least as frequently as called for in ICEA T-26-465.

7.1.1 Physical Properties:

Unaged (original):

Tensile strength, minimum PSI at 15.6°C: 1,400
Elongation, minimum percentage: 200

*Tensile Stress at 100% elongation, PSI 500min/
1200 max

After Aging – Air oven test (168 hours at 136°C):

Tensile strength, min. percent of unaged value: 80
Elongation, min. percent of unaged value: 70

7.1.2 Electrical Properties:

*Insulation Resistance Constant (K), min. at 15.6°C: 20,000

*SIC at 75°C, maximum 3.5

*Power Factor at 75°C, maximum 2.4

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7.1.3 *Cold Bend

8 x OD Mandrel No cracks at minus 40°C

7.1.4 *Specific Surface Resistivity

Minimum megohms 200,000

7.1.5 *Oil Resistance after 18 hours at 121°C

Tensile strength, min. percent of unaged value: 50
Elongation, min. percent of unaged value: 50

7.1.6 Heat Distortion per ASTM D-2220, 60 minutes under load

4/0 and smaller, percent distortion, maximum 30
(Insulation removed from cable)
Larger than 4/0, percent distortion, maximum 10
(Buffed samples of insulation)

7.1.7 Insulation Thickness

The average thickness of the insulation wall shall not be less than the value indicated in the Appendix. The minimum spot thickness shall not be less than 90 percent of this value.

7.2 Low Smoke Zero Halogen Jacket

Jacket for dual low smoke constructions shall meet all requirements of Type II Thermoset per ICEA T-33-655, except as modified below. Tests designated with an asterisk (*) shall be made for qualification or when changes are made to the insulation and at least once per calendar year that cable is supplied. Other tests shall be performed at least as frequently as called for in ICEA T-26-465.

7.2.1 *Physical Properties - Jacket

Tensile Stress at 100% elongation - jacket, psi 800min/
1400 max

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7.2.2	<u>Physical Properties – Composite Insulation/Jacket</u>	
	Unaged (original):	
	Tensile strength, minimum psi at 15.6°C:	1,300
	Elongation, minimum percentage:	170
	*Tensile Stress at 100% elongation, psi	800min/ 1600 max
	After Aging – Air oven test (168 hours at 136°C):	
	Tensile strength, min. percent of unaged value:	80
	Elongation, min. percent of unaged value:	70
7.2.3	<u>*Oil Resistance after 18 hours at 121°C</u>	
	Tensile strength, min. percent of unaged value:	60
	Elongation, min. percent of unaged value:	60
7.2.4	<u>*Gravimetric Water Absorption</u>	
	7 days at 70°C, maximum mg/square inch	15
7.2.5	<u>*Tear Resistance</u>	
	Maximum mg/square inch	40
7.2.6	<u>Heat Distortion (Composite Insulation/Jacket)</u>	
	1 hour at 121°C, maximum percent distortion	30
7.2.7	<u>Hot Creep Test at 150°C (Composite Insulation/Jacket)</u>	
	Elongation, percent maximum	100
	Creep Set, percent maximum	10
7.2.8	<u>Cold Bend (Completed Cable)</u>	
	8 X OD Mandrel	No cracks at minus 25°C
7.2.9	<u>*Lead TCLP</u>	
	Maximum mg/liter	5
7.2.10	<u>*Tracking Resistance (Per ASTM D-2132)</u>	
	Minimum Time to Failure	200 Hours
7.2.11	<u>*Specific Surface Resistivity</u>	
	Minimum megohms	200,000

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7.2.12 Jacket Adhesion - The insulation and jacket shall adhere to such a degree that a manual separation of the jacket from the insulation shall show definite adhesion between the insulation and the jacket at all points along the line of separation.

7.2.13 Jacket Thickness - The average thickness of the jacket wall shall not be less than the value indicated in the Appendix. The minimum spot thickness shall not be less than 90 percent of this value.

8.0 DUAL LAYER CHLORINATED OR CHLOROSULPHONATED POLYETHYLENE (CPE OR CSPE) JACKETED CONSTRUCTION

8.1 Insulation - Standard Filled EAM Insulation, such as Ethylene Propylene Rubber (EPR), shall be used for cables with Chlorinated or Chlorosulphonated Polyethylene (CPE or CSPE) cover. Standard Filled EAM Insulation shall meet all requirements of Type E-1 insulation per ICEA S-95-658, except as modified below. Tests designated with an asterisk (*) shall be made for qualification or when changes are made to the insulation and at least once per calendar year that cable is supplied. Other tests shall be performed at least as frequently as called for in ICEA T-26-465.

8.1.1 *Electrical Properties:

Insulation Resistance Constant (K), min. at 15.6°C:	20,000
SIC at 75°C, maximum	4.0
Power Factor at 75°C, maximum	2.00

8.1.2 Cold Bend

8 X OD Mandrel No cracks at minus 40°C

8.1.3 *Specific Surface Resistivity

Minimum megohms 200,000

8.1.4 Heat Distortion per ASTM D-2220, 60 minutes under load

4/0 and smaller, percent distortion, maximum (Insulation removed from cable)	30
Larger than 4/0, percent distortion, maximum (Buffed samples of insulation)	10

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8.2 Chlorinated or Chlorosuphonated Polyethylene Jacket

8.2.1 General Requirements - When a Chlorinated or Chlorosulphonated Polyethylene jacket is specified, it shall meet all requirements of ICEA S-95-658 and the requirement below.

8.2.2 Specific Surface Resistivity

Minimum megohms 200,000

8.2.3 Jacket Adhesion - On single conductor (including multiplexed) cable, the insulation and jacket shall adhere to such a degree that a manual separation of the jacket from the insulation shall show definite adhesion between the insulation and the jacket at all points along the line of separation.

9.0 NORMAL AND EMERGENCY TEMPERATURES

The insulation shall perform satisfactorily over a conductor which has a normal continuous operating temperature of 90°C for conductors of 350 kcmil or less and at 110°C for conductors of 500 kcmil or greater. The insulation shall also perform satisfactorily at an emergency operating temperature of 130°C and a short circuit rating of 250°C. Operation at the emergency operating temperature shall not exceed 100 hours per year.

10.0 PRODUCTION TESTS

10.1 General – Production runs of cable shall be tested with a frequency per ICEA T-26-465 to ensure cable meets all requirements of 4.0, 5.0, 7.0, and 8.0, as applicable.

10.2 High Voltage Tests

Single conductor power cables shall be tested upon completion, or completion of multiplexing if applicable, in the standard water bath after a minimum six hour immersion for single conductor cables or after a minimum one hour immersion for multiplexed cables.

11.0 QUALIFICATION TESTS

New suppliers wishing to qualify for these insulations and/or jackets shall furnish test data showing conformance to all requirements of this specifications and the referenced specifications. They also must conform to the following requirements:

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11.1 Long Term Aging - Elongation

Aging data shall be submitted on an Arrhenius-type plot to establish the time to loss of 40 percent of the elongation of the insulation at various temperatures. A minimum of three data points at least ten degrees different in temperature shall be used to plot the curve. By extrapolation it shall be demonstrated that the time to a 40 percent loss in the unaged elongation at 90°C shall not be less than 40 years and at 110°C not be less than 35,000 hours.

11.2 Electrical Moisture Absorption – 14 Day

	<u>Standard EAM Insulation</u>	<u>Fire Retardant EAM Insulation</u>
Electrical Method: (ICEA S-68-516, EM-60)		
Dielectric constant after 1 day, maximum:	4.0	3.5
Increase in capacitance:		
1-14 days, maximum percent:	3.0	4.0
7-14 days, maximum percent:	1.5	2.0
Stability factor after 14 days, maximum:	1.0	1.0

11.3 Electrical Moisture Absorption – Long Term

Samples of #14 AWG or #12 AWG copper wire covered with a 0.030 inch thickness of insulation shall be immersed in water maintained at 90°C ± 2°C for a period of six months. One sample shall be continuously energized with 600 volts, 60 Hz and one sample shall be continuously energized with negative 600 volts DC (except when electrical measurements are being made). At the end of six months the samples shall meet the following:

After six months in 90°C water with continuous 600 volts AC:

- Dielectric constant, maximum: 4.0
- Percent power factor, maximum: 2.5
- Stability factor, maximum: 0.8
- 3,000 VAC one minute voltage withstand,
every two weeks during the six months: pass

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11.4 Dielectric Breakdown Tests – Impulse, Step-Time, and Rapid Rise

Impulse, step-time and rapid rise test data generated in accordance with standard ICEA practice, except the conductor shall be heated to 90°C ± 1°C. Test data shall be submitted on five samples with a minimum conductor size of #14 AWG insulated with a 0.045 inch, ± 10 percent, thickness of insulation. The minimum acceptable level of maximum stress at the conductor surface (S maximum, calculated by the maximum stress theory) for each of these tests shall be:

Basic Impulse Level ... 500 volts per mil
Step-Time Level 500 volts per mil
Rapid Rise Level 500 volts per mil

11.5 Oil Immersion Test

In addition to the requirements of paragraph 7.1.5 and 7.2.3 of this specification, the cable jacket and Flame Retardant Filled EAM insulation of cables of new suppliers shall be subjected to ten cycles of oil immersion as follows:

The samples shall be immersed in 121°C oil for eight hours and allowed to dry in air for 16 hours. The tensile strength and elongation of one or more samples shall be measured after each eight hour cycle as per the referenced specification ICEA S-95-695.

Jacket

Tensile strength, min. percent of unaged value: 60
Elongation, min. percent of unaged value: 60

FR-EAM Insulation

Tensile strength, min. percent of unaged value: 50
Elongation, min. percent of unaged value: 50

11.6 Cold Bend

8 x OD Mandrel 5 Min Withstand, 80 volts/mil
No cracks at minus 40°C

11.7 Flame Test

In addition, Con Edison may wish to perform the flame tests of EO-6068 and samples of cables for these tests will be required.

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11.8 Regualification

Approved suppliers will also be subject to re-test of qualification requirements and flame tests if their insulating and/or jacket compound is changed.

12.0 MARKINGS

12.1 Printed Marking - All cable shall have the following imprinted or stamped in legible indelible ink along the outer surface of the cable at two foot maximum intervals in the following sequence order:

- Name of the "MANUFACTURER" and the "FACILITY" in which the cable core was made.
- "Year of Manufacture"
- The words, "Property of Consolidated Edison"
- The size of the conductor, the voltage rating, and the type of insulation (EPR, EAM, etc.) and jacket (LSNH, CPE, CSPE)
- "Sequential Footage #" on single conductor cable and on one leg of a multiplexed construction.

12.2 Marker Tape

12.2.1 All cables larger than one-half inch in diameter shall contain a laminated polyester marker tape containing:

- A sequential footage (for manufacturing traceability)
- The name of the manufacturer and facility
- The year in which the cable was manufactured
- The words, "For Con Edison"

All to appear at two foot maximum intervals. Single conductor (including multiplexed cables) shall have the tape immediately over the conductor.

12.2.2 Difference between beginning and ending sequential marking shall be within +/- 2% of the actual cable length.

12.3 Center Strand Stamp

All conductors larger than #6 AWG, excluding flexible stranding, shall have the center strand stamped with the following marking at approximately one foot intervals:

- The manufacturer's name
- The year of manufacture
- "FOR CON EDISON"

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13.0 MOISTURE

There shall be no water in the strands or between the insulation and jacket of the cable when received. Each end of each single conductor or multiple conductor cable shall be made watertight as per paragraph 15. Free water present anywhere in the cable is grounds for rejection of the cable.

14.0 END SEALS

Single conductor cables (including each leg of multiplexed cables) shall be made watertight with a thick wall heat shrinkable cap per EO-13118-B and EO-5022.

15.0 MANUFACTURER'S PROPOSAL

15.1 Each manufacturer shall submit a proposal in compliance to this specification. Any exceptions to this specification shall be included in the proposal, on a separate list. Exceptions must be approved prior to placement of an order.

15.2 During the term of the order, the manufacturer must obtain approval from the Company in writing of any changes he intends to make in the design or materials previously submitted.

16.0 INSPECTION

16.1 The manufacturer shall be responsible for the performance of all inspections and tests. The Company reserves the right to witness any of these inspections and tests and to assure conformity with its requirements.

16.2 Access to all manufacturing and testing facilities shall be granted to the Company representatives at all reasonable times. Failure of the Company to call attention to any defect in material or workmanship shall not relieve the manufacturer of responsibility.

17.0 CERTIFIED TEST REPORTS

The Manufacturer shall maintain records permitting traceability of each shipped length of cable, by means of shipping reel number and Purchaser's order number, to the Manufacturer's records and tests of the original insulated length produced. Retention shall be for a minimum of 5 years.

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18.0 SHIPPING REELS

The outside of both flanges of non-returnable wood reels shall be indelibly stenciled, minimum six inch tall lettering, with the appropriate Con Edison EO specification number. Reel labels shall include sequential footage markings from marker tape.

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APPENDIX TO EO-18 Active Cable Specifications

Specification Number	Class and Stock	Insulation	Number of Conductors	Size of Conductor (AWG or kcmil)	Stranding (Number and Dia-mils)	Insulation Thickness (mils)	Jacket Thickness (mils)	Maximum OD (mils)	Approx. Weight Single Cond (lb/Ft)	Approx. Copper Weight Single Cond (Lb/Ft)	HV Test Cond – Grd 5 Min KV- AC	Minimum Insulation Resistance Megohm-1000'
EO-693	561-0951	EP/CPE	1	#2	665/10	55	30	575	0.28	0.211	5,500	3,000
EO-694	561-1074	EP/CPE	1	2/0	1323/10	65	45	780	0.55	0.425	5,500	2,700
EO-695	561-1165	EP/CPE	1	4/0	2107/10	65	45	695	0.84	0.676	5,500	2,200
EO-7657	561-4698	FR-EAM/LSNH	1	#6	7/61.2	45	30	390	0.12	0.081	5,500	3,400
EO-7664	561-0489	FR-EAM/LSNH	3	#6	7/61.2	45	30	390	0.12	0.081	5,500	3,400
EO-7651	561-4672	FR-EAM/LSNH	1	#2	7/97.4	45	30	475	0.26	0.205	5,500	2,300
EO-7665	561-0488	FR-EAM/LSNH	3	#2	7/97.4	45	30	475	0.26	0.205	5,500	2,300
EO-7681	561-4995	FR-EAM/LSNH	4	#2	7/97.4	45	30	475	0.26	.205	5,500	2,300
EO-7652	561-4623	FR-EAM/LSNH	1	2/0 (TS)	19/83.7	55	45	650	0.52	0.411	5,500	2,000
EO-7682	561-5000	FR-EAM/LSNH	4	2/0 (TS)	19/83.7	55	45	650	0.52	0.411	5,500	2,000
EO-7653	561-4607	FR-EAM/LSNH	1	4/0 (TS)	19/105.5	55	45	770	0.78	0.653	5,500	1,600
EO-7683	561-4615	FR-EAM/LSNH	4	4/0 (TS)	19/105.5	55	45	770	0.78	0.653	5,500	1,600
EO-7654	561-4631	FR-EAM/LSNH	1	500	61/90.5	65	50	1105	1.76	1.544	10,000	1,300
EO-7656	561-4680	FR-EAM/LSNH	3	500	61/90.5	65	50	1105	6.65*	5.993*	10,000	1,300
EO-7658	561-4649	FR-EAM/LSNH	4	500	61/90.5	65	50	1105	1.76	1.544	10,000	1,300
EO-7655	561-4656	FR-EAM/LSNH	1	750	61/110.9	65	50	1300	2.58	2.316	10,000	1,100
EO-7659	561-4664	FR-EAM/LSNH	4	750	61/110.9	65	50	1300	2.58	2.316	10,000	1,100

Insulation Types:
 EP/CPE: EP Insulation with Chlorosulphonated or Chlorinated Polyethylene Jackete
 FR-EAM/LSNH: Fire Retardant EAM with Black Low Smoke Zero Halogen Jacket

* - Weights shown for EO-7656 are for completed assembly
 TS – Tin Coated Copper Strands

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George Murray (Signature on File)
 George Murray
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Thomas Campbell

<p><u>REVISION 9:</u></p> <p>Added reference to ICEA T-26-465.</p> <p>Removed multiconductor, control cable and DC cable requirements.</p> <p>Deleted references to aluminum conductors.</p> <p>Eliminated requirements for “Integral” Filled EAM Insulation</p> <p>Added tracking resistance requirement to low smoke zero halogen jacket</p> <p>Added Chlorinated Polyethylene Jacket</p> <p>Added “ For Con Edison” to Center Strand Stamp</p> <p>Removed EO-580 (moved to CE-ES-4175)</p> <p>Deleted require that CTRs be sent at time of shipment.</p> <p>Revised table</p>	<p><u>FILE:</u></p> <p>Purchase and Test Manual No. 6</p>
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