



**CONSOLIDATED EDISON CO. OF NEW YORK, INC.  
4 IRVING PLACE  
NEW YORK, NY 10003**

**DISTRIBUTION ENGINEERING  
CABLE**

**SPECIFICATION EO-17  
REVISION 11  
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**EFFECTIVE DATE  
DECEMBER 5, 2014**

**PURCHASE AND TEST SPECIFICATION  
FOR SHIELDED POWER CABLES  
5,000 TO 35,000 VOLTS**

**FILE: PURCHASE AND TEST MANUAL No. 6**

<b>TARGET AUDIENCE</b>	<b>PURCHASING</b>
<b>NESC REFERENCE</b>	<b>None</b>

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## 1.0 **PURPOSE**

This specification details manufacturing and procurement requirements for single conductor cable insulated with Ethylene Alkene (EAM) for operation at voltages from 5,000 to 35,000 volts, inclusive.

## 2.0 **APPLICATION**

This specification applies to all equipment leads and primary underground and aerial cable purchased subsequent to implementation of this specification.

## 3.0 **SPECIFICATION REFERENCES**

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

AEIC CS8 Specification For Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ICEA S-94-649 Concentric Neutral Cables Rated 5 Through 46 kV

ICEA S-97-682 Utility Shielded Power Cables Rated 5,000 – 46,000 Volts

ASTM Standards (as applicable)

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

B496 Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

B609 Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

B231 Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors

D1248 Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable

D2240 Standard Test Method for Rubber Property—Durometer Hardness

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3.2 The requirements of this specification shall supersede those of any referenced standard. AEIC CS8 shall take precedence over any referenced ICEA standards. Where a particular product requirement or characteristic is specified in more than one referenced document, the most stringent requirement will apply. Wherever reference is made to an industry specification or standard it shall be understood to mean the latest edition of that document.

**4.0 CONDUCTOR**

The conductors specified for these cables shall conform to ICEA Publication No. S-94-649 or S-97-692 with the following additions:

4.1 **Copper Conductors** – Copper conductors shall be annealed, uncoated and Class B stranded. When compact stranding is specified, the conductor shall conform to the number of wires according to the requirements of ASTM B496 for compact conductors and B8 for compressed conductor.

4.2 **Aluminum Conductors** – Aluminum conductors shall be aluminum 1350 either half hard or three quarter hard in accordance with ASTM B609. The conductors shall conform to ASTM B231 for Class B, compressed stranding. Unilay stranding is not permitted.

**5.0 STRAND SHIELDING**

5.1 The strands shall be completely shielded with a layer of semi-conducting extruded thermoset material compatible with the insulation. The strand shielding shall be in intimate contact with the strands and shall be completely free stripping from the strands. No tape shall be applied under the extruded shield without permission of the Section Manager, Distribution Cables Systems.

5.2 For 5 kV designs a 105 mil “Discharge Resistant Insulation System” with non-conducting conductor shield (“Permashield”) and discharge resistant insulation meeting the requirements of AEIC CS8 may be substituted for the strand shield.

**6.0 INSULATION**

6.1 **Non-Shielded Cable** – The insulation for non-shielded cables shall consist of a Type I thermosetting ethylene propylene rubber having a maximum shore A hardness of 65 in accordance with ASTM D2240 and shall meet the requirements of ICEA Pub. No. S-96-659. Shore A hardness shall be demonstrated prior to initial supply of cable and any time changes are made to the insulation compound.

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**6.2 Shielded Cable** – The insulation for shielded cables shall consist of a thermoset ethylene alkene (EAM) such as ethylene propylene rubber (EPR) meeting the requirements of the referenced AEIC specification with the additional requirements listed below. The insulation shall be compounded and extruded in a closed system to ensure maximum cleanliness.

**6.2.1 Physical Properties:**

Unaged (original):

Tensile strength, minimum PSI at 15.6°C: 700

Elongation, minimum percentage: 250

After Aging – Air oven test (168 hours at 121°C):

Tensile strength, min. percentage of unaged value: 75

Elongation, min. percent of unaged value: 75

**6.2.2 Electrical Properties:**

Insulation Resistance Constant (K),

min. at 15.6°C: 20,000

**6.2.3 Accelerated Water Absorption (75°C water as per ICEA T-27-581 EM-60 Test):**

Dielectric constant after 24 hours, maximum: 4.0

Increase in capacitance, maximum, percent:

1-14 days: 3.5

7-14 days: 1.5

Stability factor after 14 days, maximum: 1.0

Alternate to stability factor after 14 days, maximum: 0.5

Compliance to this requirement shall be demonstrated prior to initial supply of cable, any time changes are made to insulation material, and at least once per calendar year that cable is supplied.

**6.2.4 Cold Bend:**

Per ICEA S-94-649 No cracks at minus 40°C

Compliance to this requirement shall be demonstrated prior to initial supply of cable, any time changes are made to insulation material, and at least once per calendar year that cable is supplied.

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### 6.2.5 Insulation Color:

The insulation shall be a contrasting non-black color, so that semi-conducting material on the insulation can be visually detected.

## 7.0 INSULATION SHIELDING (SHIELDED CABLES)

### 7.1 5 kV Single Conductor Cable

7.1.1 The insulation shall be completely shielded with a layer of semi-conducting tape of a material compatible with the insulation. The tape shall be smoothly applied in intimate contact with the insulation with no wrinkles. Minimum overlapping shall be 12 ½ percent. It shall be completely free stripping with no residue remaining on the insulation after removal.

7.1.2 The legend "SEMI-CONDUCTING SHIELDING, REMOVE BEFORE SPLICING" shall be printed in white indelible non-conducting ink along the entire surface of the semi-conducting tape. Yellow print may be used only with written permission of the Section Manager, Distribution Cables Systems.

### 7.2 All 13kV to 35 kV Cables

7.2.1 The insulation shall be completely shielded with a layer of extruded semi-conducting thermoset material compatible with the insulation and have a minimum thickness of 24 mils and a maximum thickness of 60 mils.

7.2.2 The compound shall have a maximum volume resistivity of 100 ohm-meters at 90°C.

7.2.3 It shall be in intimate contact with the insulation and shall be stripped with three to twenty-four pounds of tension for 1/2 inch wide strips at room temperature.

7.2.4 The legend "SEMI-CONDUCTING SHIELDING, REMOVE BEFORE SPLICING" shall be printed in white indelible non-conducting ink along its entire surface.

7.2.5 The cable shall be produced with the conductor shield, insulation and insulation shield all applied in the same extrusion operation. The insulation and insulation shield shall be applied in a common extruder head to eliminate any possible interface contamination.

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### 7.3 **METALLIC INSULATION SHIELDING**

All single conductor cables shall be provided with a layer of tin coated copper concentric flat straps over the insulation shield. The configuration shall be as shown in the Appendix. It shall cover not less than 75 percent of the insulation shielding surface and be applied helically. The length of lay shall be not less than three nor more than seven times the diameter over the straps. The edges of the straps shall be rounded.

## 8.0 **JACKETS**

**8.1 Polypropylene Jacket** - Unless otherwise specified in the table in the Appendix, single and multiplexed conductor shielded non-URD cables shall have an encapsulated, free stripping polypropylene (PP) jacket having the properties noted 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.

- Black Color
- Physical Properties, Unaged (original):
  - Tensile strength, psi, min. 2500
  - Elongation 350
- Physical Properties, after 7 Day Air Oven at 121°C
  - Tensile percent retained, min. 75
  - Elongation, percent retained, min. 75
- 1 Hour cold bend at -25°C: No cracks.
- 96 hour oil immersion at 100°C\* – ASTM#2-
  - Tensile percent retained, min. 60
  - Elongation, percent retained, min. 60
- 1 hour deformation at 136°C (ICEA), percent max.15
- Vapor transmission rate\* per ASTM E96-80, procedure E at 38°C and 90% relative humidity: less than 3.0

**8.2 Polyethylene Jacket** - The jacket applied over URD cables shall be Linear Low Density Polyethylene (LLDPE) complying with ASTM D1248 Type 1, Class C, Category 4, Grades E4, E5, J1 and J3.

**8.3 Chlorinated or Chlorosulphonated Polyethylene Jacket** – Unless otherwise specified in the individual cable specifications, the jacket applied over non-shielded equipment lead cable shall be Heavy Duty Chlorinated or Chlorosulphonated Polyethylene complying with ICEA S-96-659.

**8.4 Red Stripes** - Except for cables designated as equipment leads, jacket to be identified with three (3) equally spaced extruded red stripes.

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## 9.0 TESTS ON COMPLETED CABLE

The following tests shall be run on all completed cables.

- 9.1 Partial Discharge Test** – The following partial discharge level test must be made on completed shielded single conductor cable after multiplexing and on completed three-conductor cable on long length factory reels. Certified test reports shall be submitted only for cut lengths although the actual values reported are those for the completed long lengths.

The partial discharge values shall comply with the maximum discharge in picocoulombs specified in the following tables with a detection sensitivity of 5 pC and using the method specified in the referenced AEIC specification.

### 9.1.1 Cables with Semi-Conducting Tape Insulation Shield

Rated Circuit Voltage Phase-To Phase (Volts)	Insulation Thickness (Mils)	Discharge in Picocoulombs At Percent of Rated Voltage to Ground			
		125	150	175	200
<b>5,000</b>	90	5	5	5	10

### 9.1.2 Cables with Extruded Semi-Conducting Insulation Shield

Cables having extruded semiconducting insulation shield shall be tested for partial discharge in accordance with ICEA S-94-649.

- 9.1.3** Partial Discharge Testing is not required on 5kV rated cable having an optional Discharge Resistant Design per 5.2.

- 9.2 AC Voltage Tests** – Completed cables on shipping reels shall be tested at the AC voltages specified in the individual cable specifications and in the referenced AEIC specification. Testing of completed long length manufactured factory reels will be accepted in lieu of testing shipping reels only after the manufacturer has provided data demonstrating consistent quality cable before and after reeling onto shipping reels.

## 10.0 QUALIFICATION TESTS

New suppliers wishing to be approved or current suppliers wishing to change materials or processes must submit satisfactory data for the qualification tests listed in the referenced AEIC specification.

## 11.0 WITNESSING OF TESTS

Con Edison reserves the right to inspect a manufacturer's facility during the time of cable manufacture and has the option to pick out samples for testing.

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## 12.0 **MARKING**

Cables shall be marked as follows:

**12.1 Printed Marking** - Three conductor and single conductor cables shall have the following stamped or printed in legible indelible ink along the lead sheath or outer jacket with 3/16" minimum letters 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"
- "Cable Spec"
- "Sequential Footage #" on the three conductor cable and on one leg of a triplexed or paralleled cable construction.
- Lightning bolt symbol per Rule 350 of the National Electric Safety Code.

In addition, on each single conductor cable when shipped triplexed or paralleled, there shall be a unique series of "111", "222" or "333" for phase/leg identification. The series of numbers shall be placed immediately preceding the name of the "MANUFACTURER". Each of the legs on any reel shall have a unique series of numbers.

A second phase/leg identification shall be printed on each leg approx. 180 degrees from the first.

## 12.2 **Marker Tape**

14.2.1 All cables shall contain a laminated polyester marker tape containing sequential footage (used for traceability in manufacturing/test documentation reports), the name of the manufacturer, the facility in which the cable core was made, the year in which the cable core was manufactured and the identification "for Con Edison", all to appear at intervals of two foot maximum.

14.2.2 On lead covered cables, the tape shall be placed along the core and immediately under the lead sheath.

14.2.3 On non-leaded single conductor cables, the tape shall be immediately under the flat straps or ground wires. The tape shall be along the core and under the binder tape on three conductor cables.

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

**12.3 Center Strand Stamp** – All #2 AWG and larger conductors including compact conductors shall have the center strand stamped with the following marking at approximately one foot intervals:  
Manufacturer's name and year of manufacture and "PROPERTY OF CON ED".

**13.0 PULLING BOLTS AND END SEALS**

**13.1** Non-leaded shielded single conductor network cables shall be equipped with a compression type pulling bolt in accordance with [EO-15503-B](#) on the leading end. An approved pulling bolt is required on the leading end of three conductor non-leaded cables. The trailing end of all non-leaded cables shall be sealed with an approved thick wall heat shrinkable end cap in accordance with [EO-14621-B](#).

**13.2 URD and Non-Shielded** – URD cables and non-shielded cables shall be sealed on the leading and trailing ends with an approved thick wall heat shrinkable end cap in accordance with [EO-14621-B](#).

**14.0 MANUFACTURER'S PROPOSAL**

**14.1** 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.

**14.2** 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.

**15.0 SHIPPING REELS**

**15.1** Steel reels shall be permanently stenciled with the reel tare weight

**15.2** Reels shall not be shipped with reel wrap or lagging.

**16.0 CERTIFIED TEST REPORTS**

**16.1** One set of certified test report on completed cable shall be e-mailed (preferred) or mailed to the Section Manager, Distribution Cables Systems within one week after the cable has been shipped.

**16.2** Reels shall be identified on the CTR by marker tape sequential footage.

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George Murray (Signature on File)  
George Murray,  
Section Manager  
Distribution Cable Systems  
Distribution Engineering

T. Campbell

<p><b><u>Revision 11:</u></b> Modified Appendix to show 15 kV 750 and 500 kcmil conductors (EO-7558 and EO-7561) as being compact round.</p>	<p><b><u>Filed In</u></b> Purchase and Test Manual No. 6</p>
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## Active Cable Specifications

Specification Number	Class and Stock	Voltage	Number of Conductors	Size of Cond. (AWG or kcmil)	Stranding (Number and Diam-ils)	Insulation Thickness (mils)	Flat Strap Neutral* #x thickness x width (mils)	Jacket Thickness (mils)	Max. O.D (mils)	Approx. Weight Single Cond (lb/Ft)	Approx. Copper Weight Single Cond (Lb/Ft)	HV Test Cond – 5 Min kV-AC	Minimum Insulation Resistance Megohm-1000'
EO-76235W	561-2817	Equip Lead	1	#2	7/97.4	175 SS	-	45 CPE	845	0.50	.205	33	6,800
EO-7636W	561-2825	Equip Lead	1	#6	7/61.2	175 SS	-	45 CPE	720	0.30	0.081	33	7,800
EO-7637W	561-2916	Equip Lead	1	2/0	19/83.7	175 SS	-	45 CPE	980	0.80	0.411	33	5,700
EO-7638W	561-2924	Equip Lead	1	4/0	19/105.5	175 SS	-	45 CPE	1100	1.00	0.653	33	4,825
EO-7640W	561-2005	Equip Lead	1	300	61/701	175 SS	-	65 CPE	1220	1.40	4.250	33	4,250
EO-7581E	563-2302	5 kV	3-Parallelled	#2	7/97.4	90	8 x 20 x 150	50 LLDPE	755	0.47	0.312	18	6,400
EO-7587E	563-2310	5 kV	3-Parallelled	2/0	19/83.7	90	10 x 20 x 150	50 LLDPE	895	0.71	0.523	158	5,000
EO-7583E	563-2328	5 kV	3-Parallelled	4/0	19/105.5	90	12 x 20 x 150	50 LLDPE	1015	1.02	0.807	18	4,200
EO-7584E	563-2336	5 kV	3-Triplexed	350	37/97.3	90	14 x 20 x 150	50 LLDPE	1195	1.54	1.263	18	3,500
EO-7586E/EO-680	563-2377	5 kV	3-Phase + 500 Tinned Neutral	500	37/116.2	115	16 x 25 x 150	80 LLDPE	1454	2.22	1.795	23	3,800
EO-7238EJ	563-1296	15 kV	1	1/0 Al	19/74.5	175	#2 AWG Equivalent	70 LLDPE	900	0.60	0.205	35	7,400
EO-7555E	563-2153	15 kV	3-Triplexed	2/0	19/83.7	175	12x 25 x 175 (#2 AWG)	40 PP	1125	1.00	0.643	35	5,440
EO-7551E	563-1833	15 kV	3-Triplexed	350 CR	37	165	12 x 20 x 225 (#2 AWG)	40 PP	1240	1.70	1.317	33	3,395
EO-7558E	563-1841	15 kV	3-Triplexed	500 CR	37	175	16 x 20 x 165 (#2 AWG)	40 PP	1390	2.30	1.785	35	7,800
EO-7568E	563-1981	15 kV	3-Triplexed	500 CR	37	165	16 x 20 x 165 (#2 AWG)	25 PP (min point)	1315	2.20	1.785	33	2,920
EO-7561E	563-1973	15 kV	3-Triplexed	750 CR	61	165	20 x 25 x 175 (1/0 AWG)	25 PP (min point)	1555	3.30	2.697	33	2,480
EO-7575E	563-2260	15 kV	3-Triplexed	1000	61/128	175	23 x 25 x 175 (1/0 AWG)	60 PP	1930	4.27	3.522	35	4,000

All Conductors are Copper unless otherwise specified

CR – Compact Round (Alternate stranding may be provided for compact conductors as allowed by ASTM B496)

SS – Strand Shield required on Equipment Lead wire

\* - Alternate equivalent neutral may be provided with approval of Section Manager, Distribution Cable

CPE – Chlorinated or Chlorosulphonated Polyethylene

LLDPE – Linear Low Density Polyethylene

PP - Polypropylene

## Active Cable Specifications (cont.)

Specification Number	Class and Stock	Voltage	Number of Conductors	Size of Cond. (AWG or kcmil)	Stranding (Number and Dia-mils)	Insulation Thickness (mils)	Flat Strap Neutral* # x thickness x width (mils)	Jacket Thickness (mils)	Max. O.D (mils)	Approx. Weight Single Cond (lb/Ft)	Approx. Copper Weight Single Cond (Lb/Ft)	HV Test Cond – 5 Min kV-AC	Minimum Insulation Resistance Megohm-1000'
EO-7556E	563-2138	27 kV	3-Triplexed	2/0	19/83.7	275	16x 25 x 175 (#2 AWG)	40 PP	1350	1.26	0.700	55	7,380
	563-1965	27 kV	3-Triplexed	500 CR	37	260	20 x 25 x 175 (#2 AWG)	25 PP (min point)	1555	2.90	1.918	52	4,400
EO-7576E	563-2278	27 kV	3-Paralleled	750	37	275	23 x 25 x 175 (#2 AWG)	60 PP	1980	3.75	2.750	55	6,200
	563-2476		3-Triplexed										
EO-7589E	563-2385	27 kV	3-Triplexed	750 CR	37	260	23 x 20 x 165 (#2 AWG)	60 PP	1770	3.65	2.750	52	6,400
EO-7577E	563-2286	35 kV	3-Triplexed	4/0	19/105.5	345	16 x 25 x 175 (1/0 AWG)	25 PP (min point)	1587	1.77	0.945	69	11,180
EO-7578E	563-2294	35 kV	3-Triplexed	500 CR	37	345	22 x 25 x 175 (1/0 AWG)	60 PP	1847	2.99	1.959	69	9,000
EO-7579E	563-2453	35 kV	3-Triplexed	750	61/110.9	345	16 x 25 x 175	60 PP	2136	3.87	2.642	69	7,300
EO-7580E	563-2461	35 kV	1	1000	61/128	345	17 x 25 x 175	60 PP	2306	4.80	3.409	69	6,600

All Conductors are Copper unless otherwise specified

CR – Compact Round (Alternate stranding may be provided for compact conductors as allowed by ASTM B496)

SS – Strand Shield required on Equipment Lead wire

\* - Alternate equivalent neutral may be provided with approval of Section Manager, Distribution Cable

CPE – Chlorinated or Chlorosulphonated Polyethylene

LLDPE – Linear Low Density Polyethylene

PP - Polypropylene

## APPENDIX