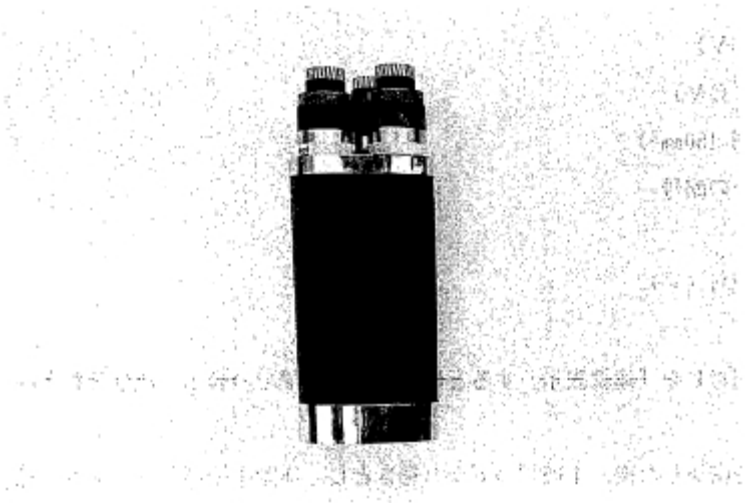
(Reference translation)

6A-17 6600V CVT cable



Enforcement in October 1972
December 1998 (revised 04)

Distribution Department
Tokyo Electric Power Company, Incorporated

1. General provisions

1.1 Scope of application

This product is used for an underground distribution cable for the lead-out parts of substations of general power distribution lines including high-capacity power distribution, cable tunnels, pipelines, directly embedded types, raising parts of telephone poles, etc.

1.2 Related standards

(1)	C 2023	6600V triplex type cross-linked polyethylene insulated vinyl sheathed power cable
(2)	JIS C 3005-1993	Test methods for rubber and plastic insulation wires
(3)	JIS C 3102-1984	Electrical annealed copper wire
(4)	JIS C 3606-1993	High voltage cross-linked polyethylene cable
(5)	JEC-3403-1990	Plastic sheath for power cables
(6)	JEC-3408-1997	High voltage tests for extra high voltage (11kV-275kV) cross-linked polyethylene cables and connection parts
(7)	IEEE Std. 383 - 1974	Vertical Tray Flame Test
(8)	ASTM E 662-1983	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
(9)	JIS K O105-1982	Analysis method of fluorine compounds in exhaust gas
(10)	JIS K O107-0995	Analysis method of hydrogen chloride in exhaust gas

1.3 Types and symbols

The symbol of a product is CVT. Types are classified based on conductor cross-sectional areas, as follows.

(Note) CVT is the abbreviation for Cross-Linked Polyethylen Insulated Vinyl Sheathed Triplex Type Power Cable.

Symbol	The number of wire cores	Sheath type	Nominal cross-section (mm^2)
CVT	Triplex type	Flame-retardant type	60, 100, 150, 200, 250, 325, 400, 500, 600

1.4 Cable display

Items a-e shall be displayed at an appropriate position on a cable. Furthermore, an item f shall be displayed continuously on the vinyl sheath surface of each wire core so that it is not erased easily for a long period of time.

a Nominal voltage (6600 V)

b Cable symbol (CV)

c Nominal cross-section (Example 150 mm^2)

d Name of manufacturer or its abbreviation

e Date of production

f Symbols for flame retardancy (F)

[Commentary]

When it is said that the symbol of flame retardancy F is ‘displayed continuously’, it has the same meaning as displaying flame retardancy at the interval of approximately 30 cm or something equivalent.

1.5 Packing

(1) After both ends of a cable are sealed, each strand of the cable shall be wound around a drum, and it shall be transported in an appropriate way to avoid any damages.

(2) Packing display

In the packing, the following items shall be displayed in an appropriate way.

a Name
b Nominal voltage
c The number of wire cores
d Nominal cross-sectional area
e Length
f Net mass
g Total mass (in the case of a drum-wound package only)
h Name of manufacturer or its abbreviation
i Date of production

1.6 Naming of a product

The naming of a product is based on its name or symbol, the type of a sheath and its nominal cross-sectional area.

Example 6600V triplex cross-linked polyethylene insulated vinyl sheath power cable 3 x 150 mm^2 or 6600V flame retardant CVT 3 × 150 mm^2

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2. Structure and materials

2.1 General matters

This product is a 6600V flame retardant triplex type cross-linked polyethylene insulated vinyl sheathed power cable. For the product, conductors are insulated by cross-linked polyethylene, and compounds mainly consist of vinyl chloride resin as a protective coating.

2.2 Conductors

As for conductors, annealed copper wires prescribed in JCS C 3102 (annealed copper wires for electricity) or other similar kinds shall be used. The conductors shall be based on a round compression strand, and the direction of an outermost layer twisting shall be right (S) with sufficient flexibility. The outer diameter tolerance of the conductors shall be ± 0.2 mm when it is 60 to 150 mm^2 and ± 0.3 mm when it is 200 to 600 mm^2.

[Commentary]

'Having sufficient flexibility ' means from a conventional knowledge, a conductor pitch of the outermost layer is not 20 times bigger than the outer diameter or something equivalent.

2.3 Insulators

Cross-linked polyethylene is coated on the concentric surface of conductors with a thickness as in the attached table. However, an extruded internal semiconductive layer shall be installed at a part where conductors are touched as an internal semiconductive layer. In addition, a surface where insulators and internal and external semi-conductive layers touch shall be smooth and should not be separated.

The average value of thickness of insulators (not including thickness of an internal semiconductive layer) shall be more than a value shown in the attached table, and a minimum measured value must be more than 90% of the value from the attached table.

The outer diameter tolerance of insulators is within ± 0.7mm of a value in the attached table.

[Commentary]

‘A surface where insulators and internal or external semi-conductive layers touch shall be smooth and should not be separated’ means that from a conventional knowledge, the simultaneous extruded structure of insulators and internal and external semi-conductive layers or a structure having the same characteristics is formed.

2.4 External semiconductive layer

An extrusion extruded semiconductive layer shall be installed on insulators.

Furthermore, the extruded external semiconductive electric layer shall be peeled off easily.

The minimum measuring value of thickness of the extruded external semiconductive electric layer shall be 0.5 mm or more.

2.5 Shielding

By sufficiently winding of a soft copper tape on an external semiconductive layer, each core shall be shielded.

[Commentary]

'Sufficiently winding', means from a conventional knowledge, the tape is wound with overlapping about

one-sixth of its width or the equivalent of that.

2.6 Identification of wire cores

Wire core identification shall be performed with 3 colors, that is, white, red and blue.

2.7 Sheath

Vinyl coating shall be applied on the top of shielding with a thickness described in the attached table. The color of a sheath shall be black. The average value of thickness of a sheath is more than a value in the attached table, and a minimum measured value must be more than 95% of the value from the attached table.

2.8 Wire stranding

Each vinyl sheathed wire core shall be twisted toward the right (S) at a suitable pitch.

[Commentary]

From a conventional knowledge, a ‘suitable pitch’ means one that is not more than 30 times the diameter of a layer core or the equivalent of that.

2.9 Terminal treatment

Both ends of a cable shall be sealed sufficiently in an appropriate way.

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3. Performance

Performance of a cable is based on Table 1 when it is tested by test items described in Section 4.

Table 1

Item		Performance			Test method applied section
Conductor resistance		Value in the attached table or less			5.3
Commercial-frequency withstand voltage		A test voltage from the attached table shall be withstood for 10 minutes.			5.4
Insulation resistance		Value in the attached table or more.			5.5
Electrostatic capacitance		Value in the attached table or less.			5.12
Dielectric loss tangent		Less than 0.1%			5.13
Commercial-frequency partial discharge		10 pC or less at 6.9 kV (when a voltage increases) and at 5.3 kV (when a voltage drops)			5.14
Commercial-frequency long-time withstand voltage		35 kV An hour shall be withstood.			5.15
Thunder impulse withstand voltage		95 kV Three times shall be withstood.			5.16
Sheath withstand voltage		A withstand voltage value in Table 4 from Section 6. Performance of JEC-3403 shall be withstood.			5.17
Tensile strength		Insulator	10MPa (1.02kgf／mm^2) or more		5.6
		Sheath	10MPa (1.02kgf／mm^2) or more		
Elongation		Insulator	More than 350%		5.6
		Sheath	More than 120%		
Thermal resistance	Tensile strength	Insulator	More than 80% of a value before heating		5.7
		Sheath	More than 85% of a value before heating		
	Elongation	Insulator	More than 80% of a value before heating		
		Sheath	More than 80% of a value before heating		
Thermal deformation resistance		Insulator	Thickness reduction rate is 40% or less.		5.8
		Sheath	Thickness reduction rate is 50% or less.		
Cold resistance		Sheath	A test specimen shall not be broken.		5.9
Flame retardant		Based on IEEEstd.383, etc.		Based on Table 5	5.10
Oil resistance	Tensile strength	Sheath	More than 80% of a value before oil immersion		5.11
	Elongation	Sheath	More than 60% of a value before oil immersion		
Peeling-strength of an extruded external semiconductive layer		At room temperature	5-40N (0.51-4.08kgf)／12.7mm width		5.18
		Low-temperature	One can strip off by hands.		
		After heating and aging	One can strip off by hands.		
Foreign substances and voids of insulators Projection of a semiconductive layer		Void 70 μm or less			5.19
		Foreign substances	Amber	Less than 250 μm	
			Black metal	Less than 100 μm	
		Projection	Less than 250 μm		

4. Tests and inspections

Tests and inspections are performed for the following prescribed items by methods described in Section 5.

4.1 Model test

To confirm manufacturer's quality standards, a model test shall be carried out as in the following test items and must conform to the provisions of Sections 2 and 3. Furthermore, a sample is a drum whose cable length is 100 m or more.

(1) Appearance test
(2) Structure test
(3) Conductor resistance test
(4) Commercial-frequency withstand voltage test
(5) Insulator resistance test
(6) Tensile test
(7) Heating test
(8) Heating deformation test
(9) Cold resistant test
(10) Flame retardation test
(11) Oil resistance test
(12) Electrostatic capacitance test
(13) Dielectric loss tangent test
(14) Commercial-frequency partial discharge test
(15) Commercial-frequency long-time withstand voltage test
(16) Thunder impulse withstand voltage test
(17) Sheath withstand voltage test
(18) Peeling-strength test of an extruded external semiconductive layer
(19) Tests for foreign substances of insulators, voids, projection of semiconductive layers

5. Test and inspection methods

5.1 Appearance test

An appearance test shall be performed by Section 3 of JIS C 3005 (test methods for rubber and plastic insulation wires).

5.2 Structure test

A structure test shall be performed based on Section 5 of JIS C 3005.

5.3 Conductor resistance test

A conductor resistance test shall be performed based on Section 6 of JIS C 3005.

5.4 Commercial-frequency withstand voltage test

A commercial frequency withstand voltage test shall be performed based on Section 8 (2) of JIS C 3005.

5.5 Insulator resistance test

An insulator resistance test shall be performed based on Section 9.1 of JIS C 3005.

5.6 Tensile test

This test shall be performed based on Section 18 of JIS C 3005. In this case, a tensile speed is based on Table 4-B (for a cross-linked polyethylene insulator), Table 4-A (for a vinyl sheath) from Section 18 of JIS C 3005 .

5.7 Heating test

This test is performed based on Section 19 of JIS C 3005. The heating temperature and time of the test are based on Table 5-E (for a cross-linked polyethylene insulator), Table 5-B (for a vinyl sheath) from Section 19 of JIS C 3005 .

5.8 Heating deformation test

A heating deformation test shall be performed based on Section 25 of JIS C 3005.

Table 2

Type	Insulator	Vinyl sheath
Heating temperature	120 ± 3 ° c	120 ± 3 ° c

Table 3

Type	Nominal cross-section (mm^2)	Load N (kgf)
Insulator	60	34 (3.47)
	100-400	44 (4.49)
	500-600	49 (5.0)
Sheath	60-600	10 (1.02)

5.9 Cold resistant test

A cold resistant test is performed for a vinyl sheath based on Section 24 of JIS C 3005 at -15 ± 0.5 ° c.

5.10 Flame retardation test

A flame retardation test shall be performed with respect to the following three test items.

(1) Combustion test

This is performed by a vertical tray flame test (vertical tray combustion test) of IEEEstd.383. Details are based on Table 4.

(2) Fuming test

This test shall be performed by a radiation and combustion method (non-framing technique) of ASTM E 662 (NBS method), and details are given in Table 4.

(3) Test for measuring the amount of hydrogen halide produced

This test shall be performed based to Table 4 and Table 5.

(The section below is intentionally left blank)

Table 4

Test type	Combustion test	Smoke test	Test for measuring amount of hydrogen halide produced	Test procedure for measuring amount of hydrogen halide produced
Test method	Place a cable vertically on a tray by intervals of half of its diameter and ignite it by a burner. Keep the temperature of the burner at approximately 815 ° c, and quench flames of the burner in 20 minutes from its ignition start time. Observe until the ignited flames are quenched.	A sample whose horizontal and vertical sizes and thickness are 76 mm, 76 mm and 0.5 mm ± 0.1 mm is prepared with the same marial as the sheath constituing material. Heat up the smaple in an electric furnace in a way that the average energy of 2.5w/cm² is radiated within a circular region whose diameter is 38 mm of a centeral part of the sample. Measure the minimum value of a light transmittance due to smoke generation and convert it into a smoke density.	Make a smaple of 0.5 g from a sheath. If a sheath component contains chlorine, bromine or iodine, this test is performed by (1)-(5). If a sheath component contains fluorine, this test is performed by (1)-(4) and (6). As for (1)-(6), see the right column for reference.	(1) 50 ml of 1 / 5 N sodium hydroxide solution is added into an absorption bulb, each of a dry air supplying unit, combustion and absorption parts is connected. (2) The temperature of a central part of an electric furnace shall be adjusted to become 300 to 400 ° c. (3) Air is taken at 500 ml/ min ± 100 ml / min, and after a sample is heated for approximately 5 minutes without reaching at an ignition temperature, let the furnace temperature rise up to 800 ° c ± 30 ° c for 30 minutes. (4) A sample is prepared by using an absorption liquid of the absorption bulb diluted to 200ml by water. (5) A sample of 100 ml is taken, and 2ml of concentrated nitric acid (JIS special grade), 20ml of 1 / 10 N silver nitrate and 1ml of ferric ammonium nitrate solution are added to the sample, and titration is performed by 1 / 1 O N ammonium thiocyanate solution.

Table 5

Test type	Combustion test	Smoke test	Test for measuring amount of hydrogen halide produced	Test procedure for measuring amount of hydrogen halide produced
Criteria	After performing a combustion test twice, a sample shall not be burned to its upper end for each test. (However, in the case when a combustion length is less than 1500 mm from the lower end, the sample is taken to be acceptable.)	After performing a smoke test five times for a cable, if the avarage value of each smoke density is 400, the cable is taken to be acceptable. However, during the consecutive three trials, if the maximum smoke concentration is less than 400, the cable is considered to be acceptable.	After a test for measuring the amount of hydrogen halide (except for hydrogen fluoride) produced is performed for three times, if its produced amount is less than 350 mg / g for each trial, and if the produced amount of hydrogen fluoride is less than 200 mg / g, such a cable is taken to be acceptable.	(6) Take a sample of 10 ml, add 90 ml of water to it, add 1 / 10 N hydrochloric acid whose pH level is more than 5.0 to make a fluoride ion containing sample of 250 ml, and measure a fluoride ion concentration in the following ways. i) Take two sets of a fluoride ion containing sample of 50 ml, put each in a beaker, and add a solution of JIS KO105 (10 μm gF／ml) to each beaker to draw a valibration curve for fluoride ions. Add 40 ml of an ion intensity adjustment buffer solution (I) of JISK O105 to one of those beakers and call it as A. Add 40 ml of an ion intensity adjustment buffer solution (II) of JISK O105 to the other beaker and call it as B. ii)By using a potentiometer prescribed in JIS K 0105, potential is measured for A and B.

				iii) In the case when a potential difference between A and B is within 3mV, a fluoride ion concentration is found by using the calibration curve of B drawn by JIS K 0105. iv) In the case when a potential difference between A and B is more than 3mV, based on JIS K 0105, interfering ions shall be removed for a fluoride ion containing sample of 50 ml or more, and then B is adjusted to carry out iii).

5.11 Oil resistance test

An oil resistance test is performed for a vinyl sheath based on Section 20 of JIS C 3005.

5.12 Electrostatic capacitance test

An electrostatic capacitance test shall be performed based on Section 10 of JIS C 3005.

5.13 Dielectric loss tangent test

A dielectric loss tangent test shall be performed based on Section 11 of JIS C 3005, and a commercial-frequency withstand voltage of 3.8 kV shall be applied at room temperature.

5.14 Commercial-frequency partial discharge test

For a commercial-frequency partial discharge test, first of all, cut out a sample with an appropriate length from a finished product. After performing a sufficient treatment to avoid partial discharge from its end part, an AC voltage at a frequency of 50Hz or 60Hz with a waveform close to a sine wave shall be applied between a conductor and a shielding at room temperature along the circumference whose diameter is 10 times bigger than a wire core diameter in a 180 degree-bent state. Apply an AC voltage up to 9.3kV gradually, and then drop the AC voltage to 5.3kV gradually. Measurements are only taken at 9.3kV (when voltage increases) and 5.3kV (when voltage decreases). Furthermore, a measuring instrument shall have an accuracy of measuring a discharge charge amount less than and equal to10pC.

5.15 Commercial-frequency long-time withstand voltage test

A commercial-frequency long-time withstand voltage test shall be performed based on Section 12 of JIS C 3005.

5.16 Thunder impulse withstand voltage test

A thunder impulse withstand voltage test shall be performed by Section 13 of JIS C 3005. Conductors shall have a negative polarity.

5.17 Sheath withstand voltage test

A sheath withstand voltage test shall be performed by Section 7.2.2 (1) of JEC-3403.

5.18 Peeling-strength test of an extruded external semiconductive layer

(1) Testing at room temperature

A test sample shall be prepared by cutting out a wire core from a finished product with an appropriate length and exposing an extruded external semiconductive layer, and two cut lines shall be formed with putting a space of 12.7mm in between along the major axis direction of the sample at any position on its circumference. Then, the tip end of an external semiconductive layer whose width is 12.7 mm is stripped with an adequate length, and it is grabbed and pulled almost in the perpendicular direction to the major axial direction for 100mm or so at a speed of 500-800 mm/min to measure a force required for stripping. Furthermore, the major axial direction of the sample and its pulling direction shall be almost always perpendicular each other in the course of pulling. A peeling-strength is measured by taking the average of the maximum and minimum values within a normal section except an abnormal portion such as values at the beginning and ending of pulling. Here, the ambient atmosphere temperature shall be 20±15° c.

(2) Testing at a low temperature

A test sample shall be prepared by cutting out a wire core from a finished product with an appropriate length and exposing an extruded external semiconductive layer, and the sample shall be cooled down for an hour or more in a cooler box whose temperature is below 0 ° c. After cooling, the sample shall be taken out of the box, and immediately a cut line without reaching an insulator shall be formed with a stripping tool and other suitable tools before testing.

(3) Heating test

A test sample shall be prepared as in (2). The sample shall be heated at 120±2° c for 96 hours, and it shall be left in a thermostatic box whose temperature is more than 50 ° c for an hour or more. After that, the sample shall be taken out of the box, and immediately a cut line without reaching an insulator shall be formed with a stripping tool and other suitable tools before testing.

5.19 Tests for foreign substances of insulators, voids, projection of semiconductive layers

This test shall be performed by Section 6.4 from ‘high voltage testing method for extra high voltage (11kV-275kV) cross-linked polyethylene cables and connection parts’ of JEC-3403 or Section 7.2 Foreign substance, void and semiconducting layer projection tests.

6. Matters explained and specified by manufacturers

6.1 General matters

When a manufacturer applies for inspection, a specification that explains or specifies the following items and other

necessary matters shall be submitted to our company, and the specification shall require our approval.

Furthermore, if a manufacturer wishes to change contents of this specification or an approved specification, explanation for changed items and their reasons shall be specified to obtain our approval.

(1) Conductor : Constituent

(2) Insulation : Structure (semiconductive layer thickness, insulation thickness), materials, performance

(3) External semiconductive layer: Structure (thickness of an extruded semiconductive layer), material

(4)Copper shielding tape : Structure (tape width, thickness and general estimated values for overlap values), material

(5) Securing tape : Yes / No,

For Yes, structure (tape width, thickness and general estimated values for overlap values), material

(6) Vinyl sheath : Thickness

(7) Wire core identification and display: Wire core identification and display method

(8) Finished outer diameter : (wire core diameter, wire stranded outer diameter)

(9) Wire stranded pitch

(10)Design mass : (value par a cable of 1km)

(11) Sheath insulation resistance value *

(12)Commercial-frequency long-time breakdown voltage

(13)Lightning impulse withstand voltage failure value

* Sheath insulation resistance shall be measured in according to the measurement in Section 9.1 (1) 'Underwater' of JIS-C-3005. An insulation resistance between a copper tape and water infiltration shall be measured.

(The section below is intentionally left blank)

7. Incidental matters

7.1 General matters

If necessary, providing with a sample product is requested for model inspection at our company.

7.2 Finished product inspection

Deliverers shall conduct inspection for finished products to determine their quality. Also, inspection items and a sampling rate are consulted separately.

7.3 Submission of in-house inspection reports

Deliverers shall submit us in-house inspection reports every delivery when they deliver products to our company. Also, inspection items, a sampling rate, a report format, etc. are consulted separately.

(The section below is intentionally left blank)

Attached table 6600V triplex cross-linked polyethylene

Nominal cross-sectional area (mm^2)	Conductor shape	Conductor outer diameter (mm)	Insulation thickness (mm)	Insulator outer diameter (mm)	Sheath thickness (mm)	Wire stranded outer diameter About (mm)	Maximum conductor resistance 20 ° c (Ω ／km)	Minimum insulator resistance (M Ω-km)	Electrostatic capacitance (μF／km)	Test voltage (kV)	Approximate mass (kg / km)
60		9.3	2.7	17.3	2.1	52	0.311	2000	0.37	17	2970
100		12.0	2.7	20.0	2.3	59	0.187	1500	0.45	17	4340
150		14.7	2.7	22.7	2.4	66	0.124	1500	0.52	17	5980
200	Round	17.0	3.2	26.0	2.6	74	0.0933	1500	0.51	17	7720
250	compre	19.0	3.2	28.0	2.7	79	0.0754	1500	0.55	17	9320
325	ssion	21.7	3.2	30.7	2.9	86	0.0579	1000	0.61	17	11600
400		24.1	3.2	33.1	3.1	92	0.0471	1000	0.68	17	14000
500		26.9	3.2	35.9	3.2	98	0.0376	900	0.74	17	17000
600		29.5	3.6	39.5	3.4	107	0.0314	900	0.71	17	20200