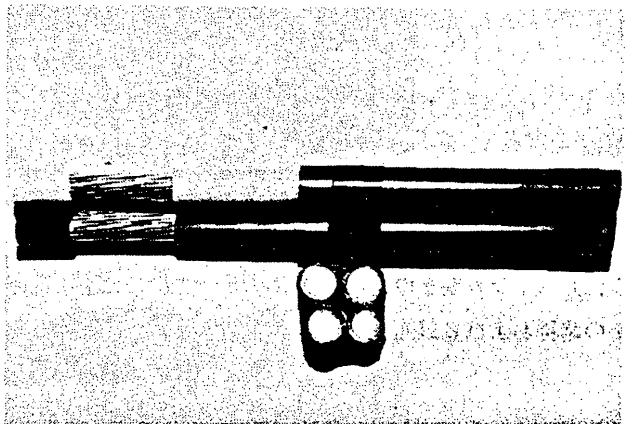
(Reference translation)

6A-31 600V CVQ cable

(C rank)



Enactment in July 1977
Approved on June 27, 2008 (revised 02)
Enforcement on July 28, 2008

Distribution Department

Tokyo Electric Power Company, Incorporated

1. Scope of application

This product shall be used for a trunk cable for low voltage underground construction works and incoming electrical line for our customers.

2. Type

Copper conductors are used, and the following types are classified based on the number of wire cores and conductor cross-sectional areas.

Table 1

Conductor	The number of wire cores	Conductor cross-sectional area (mm^2)
Copper	4	4 × 22 3 × 60 ＋ 1 × 38 3 × 100 ＋ 1 × 60 3 × 150 ＋ 1 × 100 3 × 250 ＋ 1 × 150

3. Structure and materials

3.1 General matters

This product is a 600V single-core 4 wire-stranding type cross-linked polyethylene power cable. For the product, copper conductors are insulated by cross-linked polyethylene, and compounds (hereinafter ‘vinyl’) mainly consist of vinyl chloride resin as a protective coating. An insulation layer shall have sufficient insulation, and there shall not be any cracks, air bubbles, etc. on the layer.

A protective coating shall have flexibility, high insulation, high waterproofness and durability, and any cracks, peelings and abrasions shall not be observed.

3.2 Conductors

As for conductors, annealed copper wires prescribed in JCS C 3102 (annealed copper wires for electricity) or other similar kinds shall be used. A round compression strand shall be mainly made by twisting a strand concentrically and compression-molding it in a circular shape. The direction of an outermost layer twisting shall be right (S).

3.3 Insulators

Cross-linked polyethylene is covered concentrically on conductors with a thickness of the attached table. However, dropping of cross-linked polyethylene into conductors shall be avoided. In this case, a separator can be installed in a part where cross-linked polyethylene touches to conductors. The average thickness of insulators must be more than 90% of a value from the attached table, and a minimum measured value must be more than 80% of the value from the attached table.

Furthermore, thermoplastic materials by using cross-linked polyethylene coating materials from the removed parts of power distribution equipment of our company (in the rest, we called them as XLPE recycled materials) mixed with polyethylene raw material shall be used for insulators. However, the mixing rate of XLPE recycled materials shall be 25%.

3.4 Identification of wire cores

By coloring insulators in ink or other appropriate methods, wire core identification shall be performed as in the following.

4 core cables black, white, red and green

(However, green is used for the color of neutral lines.)

3.5 Sheath

Black vinyl shall be coated on wire cores with a thickness shown in the attached table. The average sheath thickness must be more than 90% of a value from the attached table, and a minimum measured value must be more than 85% of the value from the attached table.

3.6 Wire stranding

Each vinyl sheathed wire core shall be twisted toward the right (S). The pitch of wire stranding is less than 20 times of a finished outer diameter.

3.7 Terminal treatment

Both ends of a cable shall be sufficiently sealed by using molded caps made of vinyl.

3.8 Naming of a product

Naming of a product is shown as in the following example.

Example: '600V single-core 4 wire-stranding type cross-linked polyethylene insulated vinyl sheath power cable 3 x 250 + 1 × 150 mm^2' or '600VCVQ 3 x 250 + 1 × 150 mm^2'

3.9 Dimensions

Dimensions are based on the attached table as a standard.

(The section below is intentionally left blank)

4. Performance

Cable performance is as in Table 2 when tests in Section 6 are carried out.

Table 2

Item			Performance	
Conductor resistance			Value in the attached table or less	
Withstand voltage			A test voltage from the attached table shall be withstood for 1 minute.	
Insulation resistance			Value in the attached table or more	
Tensile strength and elongation	Cross-linked polyethylene insulator	At room temperature	Tensile strength	10 MPa
			Elongation	More than 350%
		Retention after heating	Tensile strength	More than 80% of a value before heating
			Elongation	More than 80% of a value before heating
	Vinyl sheath	At room temperature	Tensile strength	10 MPa
			Elongation	More than 120%
		Retention after heating	Tensile strength	More than 85% of a value before heating
			Elongation	More than 80% of a value before heating
Thermal deformation resistance		The decreasing rate of thickness	Insulator	Less than 40%
			Vinyl sheath	Less than 50%
Cold resistance			Vinyl	A test specimen shall not be broken.
Flame retardant			Vinyl	Disappearing in less than 15 seconds without burning
Oil resistance	Retention after oil immersion	Tensile strength	Vinyl	More than 80% of a value before oil immersion
		Elongation	Vinyl	More than 60% of a value before oil immersion

5. Wire display

The following items shall be continuously displayed on wire cores in an appropriate way that they cannot be erased easily. Furthermore, in the case of using XLPE recycle materials, ‘CVQ/R’ shall be displayed.

a. Nominal voltage: Example: '600 V'
b. Product name and its abbreviation: Example: ' CVQ'
c. The number of wire cores and a conductor cross-sectional area: Example: '3 x 150 + 1 x 100 mm^2'
d. Name of manufacturer or its abbreviation
e. Date of production Example : '2008'
f. A product to which electrical appliances and materials safety act applies shall display type certification.

6. Tests and inspection methods

6.1 Appearance inspection

One shall examine a scratch, the smoothness of a surface, a color display, etc. by eyes, textures, etc.

6.2 Structure inspection

A sample whose length is about 200mm is taken, and this test shall be performed by Section 4.3 of JIS C 3005 (test methods for rubber and plastic insulation wires).

6.3 Conductor resistance test

This test shall be performed by Section 4.4 of JIS C 3005 (test methods for rubber and plastic insulation wires).

6.4 Insulation resistance test

This test shall be performed by Section 4.7 of JIS C 3005 (test methods for rubber and plastic insulation wires).

6.5 Withstand voltage test

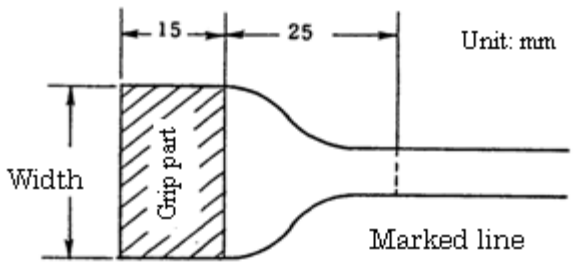
This test shall be performed by Section 4.6 (a) ‘Underwater’ of JIS C 3005 (test methods for rubber and plastic insulation wires).

6.6 Insulator test

(1) Tensile test

a. Testing at room temperature

This test is performed by Section 4.16 of JIS C 3005 (test methods for rubber and plastic insulation wires). Furthermore, a strain rate is as in Table 4-B.



The grip part of a dumbbell-like test piece

b. Heating test

This test shall be performed by Section 4.17 of JIS C 3005 (test methods for rubber and plastic insulation wires). Furthermore, a strain rate is as in Table 4-B. After heating a test piece for 96 hours in the circulating air at 120±3 ° c, take it out, leave it for 4 hours at room temperature, and perform a test described in Section 6.6 (1) a within 96 hours.

(2) Heating deformation test

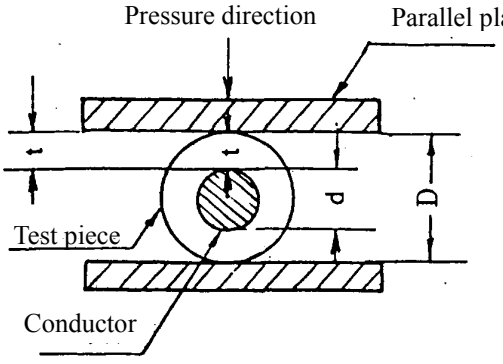
a. Preparation of a test piece

A test piece shall be prepared by cutting out a wire core whose length is about 30mm from a finished product. However, the length of a conductor can be more than 30mm.

b. Test method

Measure the thickness t of a test piece as in the following figure. Heat up the test piece and a heat deformation testing machine in advance for 30 minutes at 120±3° c. After that, place the test piece between parallel plates, and add a load as described in the following table. After 30 minutes, at the same condition and temperature, measure the thickness of a test piece. Calculate the decreasing rate of thickness by using thickness before heating and thickness after heating as follows.

Conductor cross-sectional area (mm^2)	Load (N)
22-38	14.7
60	19.6
100-200	24.5
250	29.4



t = Insulator thickness
d = Conductor diameter
D = Insulator outer diameter

$$t = \frac{D - d}{2}$$

6.7 Sheath test

(1) Tensile test

a. Testing at room temperature

This test shall be performed based on Section 6.6 (1). However, a strain rate shall be 500 mm/min.

b. Heating test

The test shall be performed based on Section 6.6 (1). However, a sample is heated at 100 ± 2 ° c for 48 hours.

(2) Heating deformation test

The test shall be performed based on Section 6.6 (2). However, a test piece and a load are as below.

a. Test piece

Take a piece whose length is approximately 30 mm from a finished product. Place the piece parallel to a wire axis direction and cut it in the shape of an arc to form a test piece.

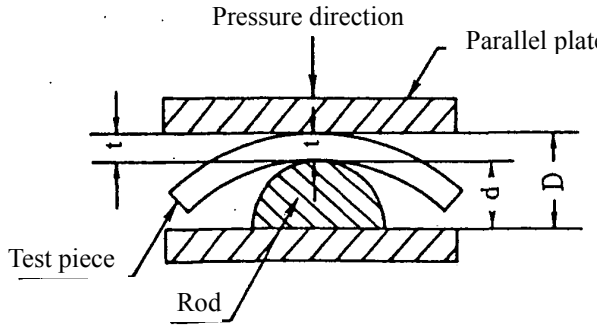
b. Preparation of a test piece

Place a test piece on a rod whose length is about 35mm and sectional shape is semicircular with the same diameter as the diameter of a conductor or wire core before a test piece cutting out. (See a figure below)

c. Load

Loads described in the following table shall be applied.

Conductor cross-sectional area (mm^2)	Load (N)
22	7.35
38-250	9.81



t = Sheath thickness
d = Diameter of semicircular rod
D = d + t
t = D - d

(3) Cold resistant test

a. Preparation of a test piece

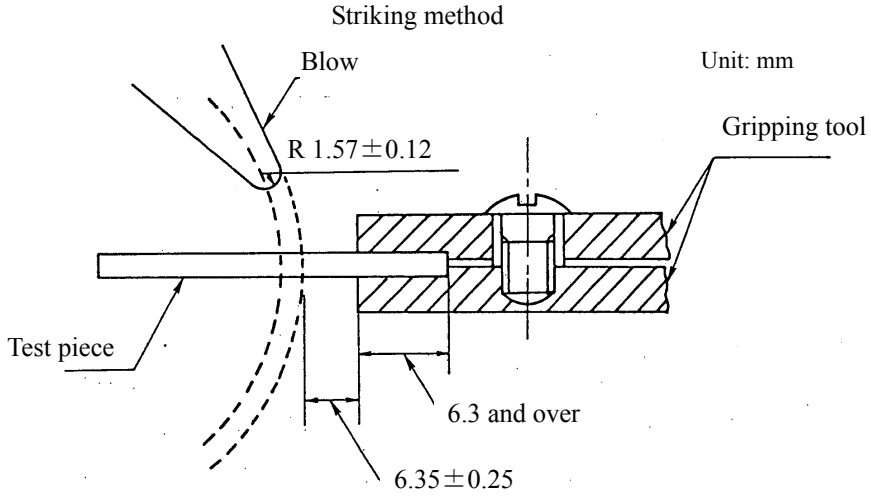
A test piece whose length, width and thickness are 38.0±2.0mm, 6.0±0.4mm and 2.0±0.2mm shall be prepared. However, in the case when it is impossible or inappropriate to sample a test piece from a finished product, take a compund whose quality is same as that of the product and prepare a test piece.

b. Cold resistant testing machine

This machine consists of a striking tool that gives a blow to a test piece gripping tool and a test piece at a constant speed and a thermostatic chamber that keeps the temperature of the test piece constant.

As in the figure below, a test piece gripping tool can hold a test piece tightly as a cantilever, and it needs to pick up a test piece whose length is more than 6.3mm at least. Also, a diameter for the tip of a striking tool is 1.57±0.12mm, and when a blow is given to a test piece as well as after that at least, the striking tool must operate at a uniform linear velocity of 1.97±0.15mm/sec while a distance of 6mm approximately is traversed. As for the relative position of the striking tool and the gripping tool, a distance between the central line of the striking tool and the edge of the gripping tool must be 7.92±0.25mm as shown in the following figure. During and soon after striking, a space between the striking tool and the gripping edge must be always 6.35±0.25mm.

A thermostatic chamber can maintain the prescribed temperature of a medium uniformly.



c. Test method

In this method, take a liquid that does not affect on a test piece at -15±0.5° as a heat transmitting medium (hereinafter 'medium'). Put the medium in a testing machine in advance and adjust it at -15±0.5° c. Install a test piece gripping tool and soak the test piece into the medium for 2.5±0.5 minutes. After that, record a temperature, give a blow, and examine if it is damaged or not. Here, a test piece is damaged means that it is cracked into more than two pieces, and the generation of a chink or a break does not include for that.

(4) Oil resistance test

In this test, take a test piece prepared by Section 5.6 (1) and soak it in the oil (#2) of JIS K 6301 at 70±3℃ for 4 hours. After that, take out the piece, wipe surplus oil attached to its surface lightly, and leave it at room temperature for 4 hours. Then, within 96 hours, measure a tensile strength and elongation by using Section 5.6 (1), and calculate retention by the following equation. However, a cross-sectional area is a value calculated by Section 5.6 (1) before oil immersion, and a reference line shall be marked after oil immersion.

(5) Flame retardation test

In this test, take a test sample whose length is about 300mm, and hold it horizontally. The central part of the test sample shall be combusted from the bottom for 30 seconds by the oxidizing flame of a spirit-lamp whose length is about 50mm or the tip of the reducing flame of a Bunsen burner whose length is about 130mm. After the flame is put off gently, examine if the ignited flame on the sample is quenched or not within 15 seconds.

Furthermore, take an appropriate way to prevent a flame from flickering in a breeze.

6.8 Test for the degree of cross-linking

When XLPE recycled materials are used for insulators, a test for the degree of cross-linking shall be performed to the XLPE recycled materials after heat plasticization. The test shall be performed based on Section 4.25 of JIS C 3005, and the degree of cross-linking shall be 40% or less.

7. Test and inspection

7.1 General matters

Section 7.2 Model test, Section 7.3 Manufacturing process inspection and Section 7.4 Acceptance inspection shall

be performed by using Section 6 Test method, and this product must pass all the above provisions.

7.2 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 3 and 4. Furthermore, a sample is a drum whose cable length is 100 m or more.

(1)Appearance inspection
(2)Structural inspection
(3)Conductor resistance test
(4)Insulation resistance test
(5)Withstand voltage test
(6)Insulator test
a. Tensile test
(a)Testing at room temperature
(b)Heating test
b. Heating deformation test
(7)Sheath test
a. Tensile test
(a) Testing at room temperature
(b) Heating test
b. Heating deformation test
c. Cold resistant test
d. Oil resistance test
e. Flame retardation test
(8)Cross-linking degree test (for XLPE recycled materials)

7.3 Manufacturing process inspection

In performing a model test, to confirm that the exactly same product as a model test product is produced in a production process, a series of inspections such as materials used, quality management items of each production process, quality control methods, defect countermeasures, quality management systems, etc. shall be generally carried out.

7.4 Acceptance inspection

Acceptance inspection shall be performed by a method described in 'Section 7.2 Model test' under supervision if it is directed by product delivery destination. Also, specific test items and a sampling rate are consulted with customers at delivery destinations. If the acceptance inspection is carried out without any supervision, manufacturers shall perform an in-house test predetermined after consultation with our company and submit a test report to customers at delivery destinations.

8. Other

8.1 General matters

(1) Except items prescribed in this specification, necessary items to satisfy product performance and functionality shall be determined after consultation with our company.

(2) This specification can be changed with our company's approval if substantial profits are expected for use and in manufacturing by changing a part of it.

(3) When deemed necessary by our company, process on-site and material inspections, etc. can be performed.

8.2 Packing

A strand of cables shall be wound around a tough drum, and its starting part is held outside of the drum. The drum must have strength so that its winding frame etc. perfectly withstands by a fall from the height of 50cm on a wooden board. (The body diameter of a drum is more than 12 times of the outer diameter of a finished cable.)

Also, the following items shall be displayed on the side of a drum in an appropriate way that they cannot be erased easily.

a. Name
b. Nominal voltage
c. The number of wire cores
d. Nominal cross-sectional area
e. Length
f. Net mass
g. Total mass
h. Name of a manufacturer or its abbreviation and a registered trademark
i Date of production

8.3 Load of testing products

A product used for testing, specimens and implementation costs shall be paid by a deliverer or an applicant for inspection.

8.4 Documents to be submitted

8.4.1 Production specification

In order that our company evaluates compliance with this specification, the following (1)-(5) and necessary items shall be stated in a production specification specifically, and a figure with dimensional tolerances and materials shall be attached. Also, technical references according to the production specification shall be attached if necessary.

(1)Conductor : Materials, configurations, outer diameter, performance, pitch
(2)Insulator : Guarantee limit of materials, performance, scratches and bubbles on the surface of coating, etc.
(3)Display : Display method
(4)Finished outer diameter : Wire core outer diameter
(5)Packing : Method, dimension, display

8.4.2 Test result list

A model test described in Section 7.2 shall be carried out, and its result and test conditions shall be stated.

8.4.3 Quality management report

Contents concerning to materials used, quality control items for each production process, quality control methods, defect countermeasures, quality management systems, etc. shall be specifically described in ‘quality management process diagram’, ‘outsourced supplier management’, etc. Furthermore, in the case when main production processes are outsourced, outsourced process control documents (that show the status of outsourced process managements and is described as in the format of a management process diagram) shall be submitted. The scope of a specific description shall be consulted with our company.

8.4.4 Technical references

For the model review, to determine product performance and quality adequately and properly, the following technical references shall be submitted. Also, submission of technical references other than the below is sometimes requested.

(1) In the case of using XLPE recycling materials for insulators, the technical description of the following items shall be reported individually.
   (a) Conditions for thermoplasticity
   (b) Quality assurance after repeatedly recycling
   (c) Technical references on removing foreign substances and impurities of recycled materials and quality control methods

Attached table the structure table of a 600V copper conductor single-core 4 wire-stranding CVQ cable.

The number of wire cores		4	3 ＋ 1		3 ＋ 1		3 ＋ 1		3 ＋ 1	
Conductor	Nominal cross-sectional area mm^2	22	60	38	100	60	150	100	250	150
	Shape	Round compression	Round compression		Round compression		Round compression		Round compression	
	Outer diameter (mm)	5.5	9.3	7.3	12.0	9.3	14.7	12.0	19.0	14.7
Insulator thickness (mm)		1.2	1.5	1.2	2.0	1.5	2.0	2.0	2.5	2.0
Outer diameter after insulation (mm)		7.9	12.3	9.7	16.0	12.3	18.7	16.0	24.0	18.7
Sheath thickness (mm)		1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.8	1.6
Outer diameter with a sheath (approx. mm)		10.9	15.3	12.7	19.0	15.3	21.9	19.0	27.6	21.9
Finished (wire stranding) outer diameter (approx. mm)		27	36		44		52		64	
Electric test	Conductive resistance 20° (Ω ／km)	0.849	0.311	0.491	0.187	0.311	0.124	0.187	0.0754	0.124
	Testing voltage (V.1 min.)	2000	2500	2500	3000	2500	3000	3000	3000	3000
	Insulation resistance (M Ω.km)	1500	1000	1500	1000	1000	900	1000	900	900
Approximate mass (kg/km)		1230	2630		4180		6160		9850	