KINGDOM OF CAMBODIA

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ELECTRICITE DU CAMBODGE

TECHNICAL SPECIFICATION

EDC-DTS-MV017

Longitudinally Waterproof 22 kV Cable (copper screen) and Connecting Accessories

Version 2: August 2021

ELECTRICITE DU CAMBODGE

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FINAL	AD			13 Feb 2017
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Version 2: August 2021

Modifications from V1 December 2017

The modifications concerns the screens cross bounding at straight joint location that is cancelled.

- The last paragraph of clause 9.1.4 is modified.
- The clause 9.4 is modified.
- Cable accessories technical data sheet (paragraph 11.2 page 35) is modified accordingly.

Content

Longitudinally Waterproof 22 kV Cable (copper screen) and Connecting Accessories

1 Scope

This specification covers the design, manufacturing, supply, delivery, testing and performance requirement of longitudinally waterproof 24 kV cables with copper screen to be installed on the 22kV network of Electricité du Cambodge.

Three types of Cable are defined:

- 24 kV underground, unarmoured XLPE insulated single core,
- 24 kV underground, unarmoured XLPE insulated three single core twisted together cables,
- 24 kV unarmoured XLPE insulated three single core twisted together cables with a messenger to be installed on poles.

Terminating and jointing accessories that are installed on all cable type are also defined.

The cable copper screen (whatever the cross section) and its terminating and jointing accessories shall, withstand the following operating condition:

- 22 kV Neutral artificially created through Zn transformer and then grounded through a resistor at the HV/MV Substation. The fault Current is limited to 787 Ampere.

So considering the capacitive currents, the cable screen, all accessories and especially the metallic screen/earth connection device shall withstand a Phase to earth short circuit current of 2.5 kA/1s.

The life expectancy of all version of the 24 kV cable shall not be less than 30 years.

2 Standards

IEC : International Electro-technical Commission

IEC 60038	: IEC Standard Voltage
IEC 60060-1	: High – Voltage test technique
IEC 60183	: Guide to the selection of high - voltage cables
IEC 60228	: Conductors of insulated cables
IEC 60230	: Impulse tests on cables and their accessories
IEC 60386	: Guide to the short circuit temperature limits of electric cables with a rated voltage from 1.8/3 (3.6) kV to 18/30 (36) kV
IEC 60502	: Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV)

IEC 60502-2 : Cable for rated voltages of 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)

IEC 60502-4 : Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um = 36 kV)

IEC 60811 : Common test methods for insulating and sheathing materials of electric cables.

IEC 60885-2 : Electrical test methods for electric cables

IEC 60949 : Calculation of thermal Permissible Short Circuit Currents, taking into account non-adiabatic effects.

IEC 61238-1 : Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV.

ISO : International Standard Organization

ISO 48 : Rubber, vulcanized or thermoplastic. Determination of hardness (hardness between 10 IRHD and 100 IRHD).

ISO 9001 : Quality management systems – Requirements

Unless if standard year is specified, the latest version of the above standards apply.

The Supplier may propose alternative standards, provided it is demonstrated that they give an equivalent degree of quality as the referenced standard. Acceptability of any alternative standard is at the discretion of the Purchaser.

3 Definitions

The definition of the relevant IEC standards apply to this technical specification.

4 Testing and Inspection

4.1 General Notes for Test

Cables and accessories may be inspected at the manufacturer's factory by EDC's representatives.

The inspection and routine tests shall be carried out in accordance with the provisions of the relevant IEC or national recommendations.

The cable and all accessories shall be subjected to test as specified below.

4.2 Type Tests

All type tests required by the relevant IEC (60502-2, 60502-4) shall be carried out. Type tests carried out on very similar cables and accessories may be accepted.

Type test reports shall be carried out by internationally recognized electrical testing laboratories.

Full copies of type test reports shall be submitted within the bid of the manufacturer/supplier. Type test reports older than 10 years will not be accepted.

If the manufacturer is certified by EDC, it is not necessary to submit type test reports for the considered equipment.

Nevertheless, in case the testing laboratory is not internationally recognized, the testing laboratory shall be mandatorily accredited ISO/IEC 17025 by an international or national accreditation body specialized in testing laboratories accreditation/acceptance. In that case, the testing laboratory shall prove mandatorily its capability/capacity to carry out all type tests mentioned in the type tests reports by suppling: Full description of all tests the laboratory can carry out, list of testing equipment with full characteristics, drawing of testing rooms with location of testing equipment, ...etc., supported by pictures and copy of the ISO/IEC 17025 accreditation certificate.

Acceptability of any accredited testing laboratory is at the discretion of the EDC.

4.3 Routine Tests

The routine tests requested by relevant IEC standards shall carried out on all equipment. Routine test reports shall be sent to EDC prior the shipment for EDC acceptance.

4.4 Sample Tests

The sample tests as requested by paragraph 17 of IEC 60502-2 shall be carried out. Sample tests reports shall be sent to EDC prior the shipment for EDC acceptance.

5 Quality Management

Design, development and production of the proposed equipment shall be ISO 9001 certified. The ISO 9001 certificate shall be submitted within the bid.

6 Ambient Conditions

The underground versions of the cable will be laid directly in the ground at a depth of 800 mm to 1000mm with an average soil temperature of 25°C.The Soil Thermal Resistivity will have an Average of 1.2°K.m/W and a Maximum of 3.0°K.m/W. In some specific cases, underground cables could be installed inside plastic pipes.

The overhead version will be installed strength between poles.

The cable shall be suitable to operate in the ambient conditions described here after:

Altitude	Sea level to 1,000 meters
Climate	Tropical
Annual Rainfall	1,300 mm.140 days
Monsoon Period	June to November
Ambient Air Temperatures:	
Average	27.5°C
Minimum	13.3°C
Maximum	40.5°C
Relative Air Humidity	65-100%

Solar Emissivity	0.8
Solar absorption	0.8
Wind Velocity:	
Average	37 km/h (10.3 m/s)
Maximum	72 km/h (20 m/s)

7 Technical Requirements

7.1 Voltage Designations and Materials

The rated voltage of the cable Uo/U (Um) shall be 12.7/22 (24) kV

In the voltage designation of cables Uo/U (Um):

- Uo is the rated power frequency voltage between conductor and earth or metallic screen for which the cable is designed;
- U is the rated power frequency voltage between conductors for which the cables is designed;
- Um is the maximum value of the highest system voltage for which the equipment may be used (IEC 60038)

The rated voltage of the cable for given application shall be suitable for the operating conditions in the system in which the cable is used.

The system belongs to category A as per IEC 60502-2:

- Category A: This category comprises those systems in which any phase conductor that comes in contact with earth or an earth conductor, is disconnected from the system within 1 minute.

7.2 Maximum Permissible Temperatures

The maximum permissible temperature are as follows:

- Conductor:

- 90°C during normal operation
- 120°C under a short time overload (a total of 24 hours a year in separate of 3 hours at the most)
- 250°C under multi-phase short-circuit conditions during 5 second,

- Screen:

- 200°C under earth/phase fault conditions during 5 second.

These temperatures are based on the intrinsic properties of the insulting materials. The vales can be only used for calculation permissible current rating.

8 General Characteristics

8.1 Cable Types

The cable types defined in the present specification are as follows:

- Type 1: single core cable to be buried in a not rocky soil or use inside MV/LV substations,
- Type 2: bundle consisting of three single-core cables and to be buried in a not rocky soil,
- Type 3: bundle consisting of three single-core cables assembled around a messenger intended for use strength between poles.

In a bundle, the three single core may come from different batches. However, they should be equivalent with respect to their formation, to the components used and their manufacturing process.

The manufacturer shall declare the minimum and maximum vales of not joining twists.

8.2 Constitution of Each Single Core Cable

Each single core cable shall be constituted of:

- Conductor;
- Conductor screen;
- Insulation;
- Insulation screen;
- Metallic copper screen
- Device preventing any longitudinal propagation of water;
- outer sheath;

8.2.1 Conductors

The conductors shall be of class 2 (IEC 60228) compacted aluminium or copper. The cores shall be circular. The cable cross section area of the cable to be provided are:

Conductor Type	**Cross section (mm^2)**								
Aluminium	70	95	150	185	240	300	400	500	630
Copper					240	300	400	500	630

For each cross section, the manufacturer must declare the minimum and maximum diameters of the conductor. The manufacturer shall provide the average diameter of the core and shall declare, for information, the number of strands constituting the core and their diameter.

8.2.2 Conductor Screen

The conductor screen shall consist of extruded synthetic semi-conducting compound. Use of a separator on the conductor is allowed. In this case, the separator must be made of a semi-conducting material. The extruded semi-conducting compound shall be firmly bonded to the insulation.

8.2.2.1 Thickness

The thickness of the conductor screen shall not be less than 0.5 mm.

8.2.3 Insulation

Insulation shall be made of extruded cross-linked polyethylene (XLPE).

8.2.3.1 Thickness

The nominal thickness of cross-linked polyethylene (XLPE) insulation shall be 5.5 mm.

8.2.4 Insulation Screen

The insulation screen shall consist of a semi-conducting extruded directly upon the insulation and shall consist of strippable semi-conducting compound. It shall be easy to remove this insulation screen by hand without any tool. The maximum effort for removing the screen shall be less than 25 N. After stripping the insulation screen, the surface of the insulation shall be free of visible semi-conductor trace.

8.2.4.1 Thickness

The nominal thickness of the insulation screen shall be 0.5 mm.

8.2.5 Extrusion

The conductor screen, the insulation and the insulation screen shall be extruded simultaneously. Other extrusion method is not accepted.

8.2.6 Metallic Screen

The metallic layer shall be applied over the insulation screen.

8.2.6.1 Construction

The single core cables shall comprise a metallic screen surrounding the core.

The metallic screen shall be made of one or 2 copper tapes. They shall be overlapped of at least 5 mm.

8.2.6.2 Thickness

The thickness of the copper tape (s) shall not be less than 0.1 mm.

8.2.6.3 Electrical Requirement

The metallic screen characteristics shall allow the cable to withstand the following operating conditions:

Core cross section	Phase to earth short circuit current
70 mm²	≥ 1.25 kA, 1 sec
95 mm²	
150 mm²	≥ 2.5 kA, 1 sec
185 mm²	
240 mm²	
300 mm²	
400 mm²	
500 mm²	
630 mm²	

The manufacturer shall provide calculations based on IEC 60949 for Phase to earth short circuit current and the cross section and thickness of the metallic screen. In addition, a conductor metallic screen short circuit test shall be provided.

These data and test report shall be submitted within the bid.

8.2.7 Longitudinal Waterproofness Component

This cable component shall stop any longitudinal propagation of water. It shall be constituted of hygroscopic tape(s). The verification of the hygroscopic capacity of the tape (s) shall be checked by the water penetration test required by Annex F of IEC 60502-2 standard

8.2.8 Outer Sheath

The outer sheath shall be made of PVC (ST2) or HDPE (ST7) of black, grey or red colour for Type 1 and Type 2 cable (underground) and black colour with UV ray and weather protection only for type 3 cable (overhead).

This outer sheath shall be extruded.

Tests on sheath compound shall be carried out according the requirement of table 20, 21 and 22 of IEC 60502-2. Test reports shall be supplied within the offer.

Any cables with an outer sheath not proved to be made of PVC ST2 or PE ST7 compounds shall not be accepted.

8.2.8.1 Thickness

Unless otherwise specified the nominal thickness **ts** expressed in millimetres shall be calculated by the following formula: ts = 0,035 D + 1,0

where D is the fictitious diameter immediately under the over sheath, in millimetres (see Annex A of IEC 60502-2). The vale resulting from the formula shall be rounded off to the nearest 0,1 mm (see Annex C of IEC 60502-2).

In any case, the nominal thickness shall be not less than 2.5 mm for single-core cables.

8.3 Assembly of Single Core Cables

8.3.1 Type 2 Cable (underground three cores)

For type 2 cable, three single core cables shall be twisted together. The bundled is assembled at the factory. The direction of assembling lay shall be right and the twisting pitch shall be comprised between 35 and 45 times the minimal diameter of a single core cable.

8.3.2 Type 3 Cable (overhead three cores)

For type 3 cable the three single core shall be twisted around a messenger at the factory. The characteristics of lay and twisting pitch are identical to Type 2 cable.

8.3.2.1 Messenger

The core of the messenger shall be made of stranded galvanised steel wires. The cross section shall be 50 mm² with a nominal diameter of 9 mm. The core shall be insulated with black PVC or PE. The minimal thickness of insulation shall be 1.2 mm.

The minimal breaking load of the messenger shall be 64 kN.

8.4 Electrical characteristics of completed cables

Type 1 and Type 2 cables				
Cross Section	**Max DC resistance 20°C**	**Nominal current (1) (2)**	**Capacitance**	**Reactance (2)**
mm2	Ω/km	A	µF/km	Ω/km
Aluminum core				
70	0.443	186	0.189	0.148
95	0.320	224	0.209	0.141
150	0.206	283	0.240	0.132
240	0.125	373	0.286	0.123
300	0.100	421	0.316	0.120
400	0.078	481	0.345	0.115
500	0.0605	542	0.380	0.111
630	0.0469	603	0.704	0.084
Copper core				
240	0.0754	478	0.286	0.123
300	0.0601	537	0.316	0.120
400	0.0470	609	0.345	0.115
500	0.0366	680	0.380	0.111
630	0.0283	735	0.704	0.084

(1) Soil temperature 30ºC, soil thermal resistivity 1.2 ºKm/W, and depth of laying 80 cm (load factor = 0.8). Earthing of screens is on both ends

(2) Trefoil installation for type 1 cable. Earthing of screens is on both ends

Type 3 cables (ABC)				
Cross Section	**Max DC resistance 20°C**	**Nominal current (1)**	**Capacitance**	**Reactance (2)**
mm2	Ω/km	A	µF/km	Ω/km
Aluminum core				
70	0.443	197	0.189	0.148
95	0.320	239	0.209	0.141
150	0.206	310	0.240	0.132
240	0.125	418	0.286	0.123
Copper core				
240	0.0754	541	0.286	0.123

(1) Ambient temperature 45ºC (load factor = 0.8) where cables are protected from direct solar radiation.

8.5 Marking

Each phase conductor of bundled cable shall have the range of markings listed here below, **engraved or embossed** on the outer sheath surface at one meter intervals.

- Manufacturer's identification : YY
- Supplier : ZZZZ
- Manufacturing batch reference : XXXX
- Year of manufacture : four digits
- Cross section : for example, 240 mm²
- Designation of conductor type : AL or CO
- Rated voltage class : 12.7/22 (24) kV
- The phase number (Type 2 and 3 only) : P1, P2, P3
- Reference Standard : IEC 60502-2

The markings shall be made in the sequence indicated above. For example, if the manufacturer is YY and the cable is manufactured in 2015, the markings would be:

- YY – ZZZZ-XXXX-2015-240-AL-12.7/22 (24) kV - P1 - IEC 60502-2

Type 1 cables does not need phase marking. Nevertheless, special orders of very long type 1 single core cable length could request a specific marking of phases.

In addition, for all type of cable, a metric length marking shall appear every meter. This metric marking shall be mentioned on only one phase of a bundle or on the messenger of Type 3 cable. This marking shall be engraved, embossed on a different face than the main cable marking.

8.6 Protection for Storage and Delivery

Each element (phase conductor or barrier) must be fitted with an individual end device preventing the penetration of water or moisture during storage and delivery. This device can be a heat shrinkable end cap.

8.7 Drums and Marking

Underground Cables shall be delivered wound on strong wooden drums treated to an approved international standard by impregnation with copper-chrome-arsenate (CCA) preservative to resist rotting and termite and fungus attacks. Steel drums shall be also accepted. Drums with an outside diameter exceeding 2.5 meters and outside width exceeding 1.4 meter shall not be used except with the Purchaser's approval. The drum shall be no returnable. The central hole of the drums shall be reinforced with a steel plate of thickness not less than 10mm to fit an axle of size 95mm diameter.

The interior of the conductor drums shall be lined with bituminous paper to prevent the conductor being in contact with the timber. Waterproof paper and felt lining shall overlap at seams by at least 20 mm, and the seams shall be sealed.

Drums shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of steel tap bindings.

Cables shall be securely fastened around the periphery of the drum. Cables shall be supplied with both ends properly capped, and protected against damage and water penetration. Each drum shall bear a metal label detailing manufacturer's name, specified voltage, and type and length of conductor. Cable

drums shall be suitable for outside storage, for a minimum period of five years in the Cambodia climate, the inner cable end attached to the drum shall be capped and sealed in such a manner that the core screening and sheath are able to be merged from the outer cable end without removing the inner end cap.

All nails and metallic parts of the inner surfaces must be countersunk so that they cannot damage the cable.

The thread of bolts used to strengthen the cable drums shall be in such a way that the nut can be tightened but cannot readily removed.

Drums shall not be treated with chemicals injurious to the conductors.

The cable length per drum shall be:

Cable Type	**length**
Type 1	
from 70 to 300 mm²	1000 m ± 5m
above 300 mm²	On EDC request
Type 2 and 3	
from 70 to 300 mm²	300 m ± 5m
above 300 mm²	On EDC request

Specific drum length could be ordered.

Drums shall be marked with the indelible following information:

- Manufacturer's name
- Month/Year of manufacture
- Batch number
- Total gross weight and Net weight
- Distributor's name
- Cable references and cross section
- Length of cable (m)

9 Accessories

9.1 General

All accessories shall be suitable for the requested 22 kV MV cable. Accessories shall be strictly identical for all Type 1, Type 2 and Type 3 cables.

The following connecting accessories shall be supplied:

- Outdoor terminations
- Indoor terminations
- Straight joints
- Screened separable connectors.

With the exception of screened separable connectors, all connecting accessories shall be of **cold shrinkable type**. Screened Separable connectors shall be of EPDM pre-moulded type.

All accessories shall be type tested according the requirement of IEC 60502-4.

All the equipment offered for joints, terminations and separable connectors shall conform to the following requirements:

- Connecting accessories shall be supplied in complete kit form for 3 phases with all materials and components required to complete the installation. Connectors and terminal lugs shall also be included in each kit.
- Only cold shrink method for Joint and termination Kits shall be accepted.
- All components shall be capable of being stored without damage or deterioration at temperature up to 50°C. The material expiring date shall be marked on all packages, where appropriate.
- Details of all equipment, tools and protective clothing required to complete the joint, termination and screened separable connector shall be included with each set of accessories.
- Each kit shall include a complete instruction manual in English and Khmer languages for implementing the accessory on the here above specified cable.

9.1.1 Technical Characteristics

The rated voltage of the accessories Uo/U (Um) shall be 12.7/22 (24) kV.

Those accessories shall withstand at least the temperature conditions of the 22kV cables:

- Conductor:

- 90°C during normal operation
- 120°C under a short time overload (a total of 24 hours a year in separate of 3 hours at the most)
- 250°C under multi-phase short-circuit conditions during 5 second,

- Screen:

- 200°C under earth/phase fault conditions during 5 second.

Accessories shall be provided for the following cables cross section area:

Conductor Type	**Cross section (mm^2)**								
Aluminium	70	95	150	185	240	300	400	500	630
Copper					240	300	400	500	630

9.1.2 Components

Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable joint, termination and separable connectors and shall not increase the rate of corrosion of any metals with which they may come into contact.

Components supplied with adhesive coatings shall have means to prevent the coated surfaces from adhering to each other.

Accessories shall be designed to provide a complete moisture seal, and complete re-jacketing of the individual cables. These components shall be suitable for indoor and/or outdoor installation and they shall be resistant to ultra violet radiation and chemical attack.

Electric field stress control shall be provided on the joints, terminations and screened separable connectors.

9.1.3 Marking

Name of manufacturer as well as equipment reference shall be clearly mentioned on the equipment. In addition, the serial number of the accessory shall be permanently and clearly visible on the accessory.

9.1.4 Cable Metallic Screen Connection

Joints and Terminations Accessories shall reconstitute the continuity of the metallic screens of the cable or allow the connection of the cable metallic screen to the earth.

For that purpose, all cable connexion accessories shall be supplied with a device for cable screen connection

This cable screen connection device shall withstand the following operating conditions:

- Phase to earth short circuit current: 2.5 kA, 1s
- A permanent induction current of 10 A

For outdoor terminations, Indoor terminations and separable connectors, the flexible earthing braid of the cable screen connection device shall be tinned and shall be designed in order to avoid penetration of moisture inside the cable or the connection accessory. For this purpose; it could be massive tinned on 12mm. The end of the braid opposite to the cable metallic screen shall be rigid and designed to receive a 10 mm diameter bolt for connection to other braids and the earthing conductor.

For straight joints in case of general application (cable links of maximum length of 3 km) the continuity of each metallic screen shall be insured by construction.

In case of longer cables (more than 3km), other technical solution shall be implemented as for example RMU inside RMU cabinet.

9.1.5 Connector and Terminal Lugs

Connectors and terminal lugs shall be conformed to the requirement of IEC 61236 (class A)

Connectors and terminals lugs shall perform without distress under normal, cyclic loading and fault conditions, and shall not limit the rating of the cables that they joint.

They shall be of **mechanical tightening type**. Bolts shall be of metric size. The range of connectors and terminals lugs offered shall be suitable for tightening with shear off screw heads. The shear head breaking off shall always occur inside the connector body (never protruding) in order to reduce electrical stress.

The ends of connectors and terminals lugs shall be suitably chamfered coned to facilitate insertion of the conductors. Connectors shall have a solid central barrier to facilitate the insertion of the conductor to the correct depth. End of splices and connectors shall be fitted with plastic cap.

Compounds or greases for improving contact between the connector or terminal and the conductor are permitted. They must, however, be chemically neutral to the connector, terminal and conductor materials and must be present in the delivered connectors and terminals lugs.

Cable connectors and terminals shall be able to accommodate typical variations in dimensions of cable supplied by different manufacturers.

The palm of outdoor termination lugs shall be suitable to be connected onto another aluminium palm with an aluminium alloy 14 mm diameter metric bolt for cross section of 240 mm² and less and 16 mm for 300 mm² and 400 mm². For bigger cross section this shall be defined a tendering stage.

The palm of indoor termination lug shall be suitable to be connected onto a copper or copper allow pad with a copper 12 mm diameter metric bolt for cross section of 240 mm², 16 mm for 300 mm² and 400 mm². For bigger cross section this shall be defined a tendering stage.

9.2 Outdoor Terminations

The outdoor terminations shall be supplied within a complete kit for 3-phase.

It shall include all components for the complete implementation of the termination set. The Termination Kit shall include:

- End lugs for cable phases for connection on aluminium pad,
- Terminations of cold shrinkable type,
- Earthing connection for the metallic screens of the 3 single core cables,
- Galvanized steel orientable 3 x single core cable bracket for supporting terminations.

The minimum creepage distance for 24 kV outdoor termination shall be 600 mm.

The outdoor termination shall be designed in order to avoid any penetration of water or moisture inside the cable and more especially inside the metallic core.

The supporting steel bracket shall be hot dip galvanized and collars for attaching the single core cables shall be made of insulating material. The bracket shall be suitable for circular or rectangular shape concrete poles and it shall be possible to fix it on the pole either with bolts or stainless steel straps.

9.3 Indoor terminations

The indoor terminations shall be supplied within a complete kit for 3-phase.

It shall include all components for the complete implementation of the termination set. The Termination Kit shall include:

- End lugs for cable phases for connection on copper pad,
- Terminations of cold shrinkable type,
- Earthing connection for the metallic screens of the 3 single core cables.

The indoor termination shall be designed in order to avoid any penetration of water or moisture inside the cable.

Indoor terminations shall be suitable for installation in MV Circuit Breaker Cubicles of HV/MV Substations and in load break switches of Ring Main Units (RMU). For this purpose, the indoor termination shall be of "short" cold shrinkable type.

9.4 Straight Joint

The straight joints shall be supplied within a complete kit for 3-phase. It shall include all components for the complete implementation of the straight set. The straight joint kit shall include:

- Connectors of mechanical tightening type
- Straight joints of cold shrinkable type
- Metallic screens continuity for each phase cable

The cable route is subject to periodic flooding and sections of the cable and the cable joints may be submerged in water for long periods. The cable Joints must withstand these installation conditions. The recovered thickness of insulation over the connector of straight joints shall be uniform and equal to or greater than the cable insulation thickness as given in IEC 60502-2.

The Joint kits shall comprise all the items necessary to complete the functions including mechanical tightening splices. Joints shall provide waterproofing, mechanical and electrical protection, and they shall be completely sealed from cable jacket to cable jacket.

9.5 Screened Separable Connectors

The separable connectors shall be conformed to the requirement of EN 50180 and EN 50181 standards. They shall be of EPDM pre-moulded manufacturing. They shall be of screened type. The screened separable connectors shall be supplied within a complete kit for 3 phase. It shall include all components for the complete implementation. The kit shall include:

- Connectors of mechanical tightening type
- Pre-moulded body of screened separable connector
- Earthing connection for the metallic screens of the 3 single core cables

According EN 50180 and 50181, two type of screened separable connectors will be supplied:

- Interface A: to be used for connection of transformer inside MV/LV substation,
- Interface C: to be used on MV network for cable connection on RMU

Depending of the equipment to be connected, both interface type connectors can be of straight or elbow type.

Interface	Rated current	Type
A	250 A	Dead break Straight plug in / elbow plug in
C	630 A	M16 Bolted T type

For interface A screen separable connectors, the fixing bails shall be supplied within the kit.

The flexible earthing braid of the cable screen connection device shall be tinned and shall be designed in order to avoid penetration of moisture inside the cable or the screen separable connector. For this purpose; it could be massive tinned on 12 mm.

The end of the braid opposite to the Pin plate shall be rigid and designed to receive a 10 mm diameter bolt for connection to other braids and the earthing conductor.

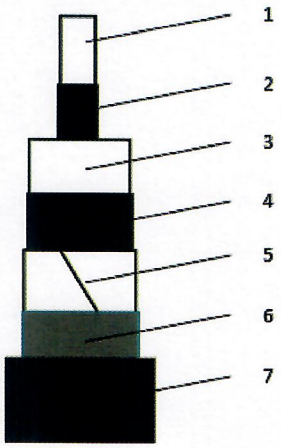
9.6 Accessories packing/marking

All connecting accessories kit shall be delivered individually packed in strong card box and card box properly stored on a pallet.

Each card box shall be clearly marked with:

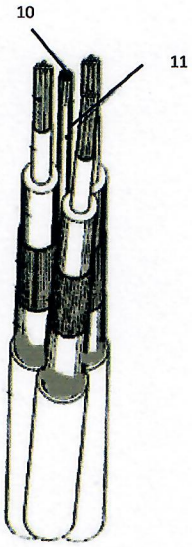
- Name / Logo of the Manufacturer
- The type of accessory
- The Cross section
- Packing date
- Distributor's name
- Expiring date (if appropriate)

10 Drawings



Type 1

Type 2



Type 3

1 : conductor
2 : conductor screen
3 : insulation
4 : Insulation screen
5 : copper tape(s) helically applied with overlap of 5 mm
6 : Longitudinal Waterproofness Component
7 : outer sheath
10 : galvanized steel core of messenger
11 : Messenger insulation sheath (PVC or XLPE)

11 Technical data sheets

11.1 22 kV Cable

No.	Description	Unit	Requirement	Supplier's Offer
1	Country		to be specified	
2	Manufacturer		to be specified	
3	Manufacturer's reference		to be specified	
4	Standard		IEC 60502-2	
5	Type test reports as per § 4.2 and IEC 60502		To be provided	
6	ISO 9001 for design, development and production		Yes. Certificate to be provided	
General				
1	Type: Type 1: single core Type 2: bundle consisting of three single-core cables Type 3: bundle consisting of three single-core cables assembled around a messenger		 □ □ □	
2	Life expectancy	Year	≥ 30	
3	Withstand the soil and ambient conditions required in §6		Yes	
4	Uo/U (Um)	kV	12.7/22 (24)	
5	Impulse Withstand Voltage 1.2/50 µs	kV	125	
6	Category A cable as per IEC 60502-2		Yes	
Construction and physical characteristics				
1	Maximum permissible temperature of conductor: During normal operation short time overload (a total of 24 hours a year in separate of 3 hours at the most) multi-phase short-circuit (5 second)	°C	 90 120 250	
2	Maximum permissible temperature of metallic screen: earth/phase fault (5 second).	°C	200	

3	**Conductors**			
	class 2 (IEC 60228)		Yes	
4	**Cross sections**			
	70 mm² Aluminum			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.1	**95 mm² Aluminum**			
	Min diameter		To be mentioned	
	Max diameter		To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands		To be mentioned	
	Compacted core		Yes	
4.2	**150 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.3	**240 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.4	**300 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	

	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.5	**400 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.6	**500 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.7	**630 mm² Aluminum**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.8	**240 mm² Copper**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.9	**300 mm² Copper**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	

	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.10	**400 mm² Copper**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.11	**500 mm² Copper**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
4.12	**630 mm² Copper**			
	Min diameter	mm	To be mentioned	
	Max diameter	mm	To be mentioned	
	Number of strands		To be mentioned	
	Diameter of strands	mm	To be mentioned	
	Compacted core		Yes	
5	**Conductor screen**			
	Extruded synthetic semi-conducting compound		Yes	
	Separator between core and screen		To be mentioned	
	Separator material (if any)		To be mentioned	
	Firmly bonded to the insulation		Yes	
	Thickness	mm	≥0.5	
6	**Insulation**			
	Cross linked polyethylene (XLPE)		Yes	
	Thickness	Mm	5.5	

	Diameter over insulation:			
	70 mm²	mm	To be mentioned	
	95 mm²	mm	To be mentioned	
	150 mm²	mm	To be mentioned	
	240 mm²	mm	To be mentioned	
	300 mm²	mm	To be mentioned	
	400 mm²	mm	To be mentioned	
	500 mm	mm	To be mentioned	
	630 mm²	mm	To be mentioned	
7	**Insulation screen**			
	semi-conducting extruded directly upon the insulation		Yes	
	strippable		Yes	
	maximum effort for removing the screen insulation free of visible semi-conductor trace after stripping	N	25	
			Yes	
	Nominal thickness of screen	mm	0.5	
8	**Extrusion**			
	Simultaneous extrusion of conductor screen, insulation and the insulation screen		Mandatory	
8a	Description of process		To be provided	
9	**Metallic Screen**			
	Applied over the insulation screen		Yes	
	Metal of tapes		Copper	
	Number of tapes		1 or 2	
	Thickness of tape (s)	mm	0.1	
	Tape (s)overlap of	mm	≥ 5	
	Phase to earth short circuit current metallic screen withstand (1 second):			
	70 mm² cable		1.25	
	150 mm² and more			

	Calculations based on IEC 60949	kA	2.5	
	Screen short circuit test	kA	Provided with bid	
			Provided with bid	
10	**Longitudinal waterproofness component**			
	Stop any longitudinal propagation of water		Yes	
	Hygroscopic tape(s)		Yes	
	Water penetration test as per Annex F of IEC 60502-2 standard		To be provided	
11	**Outer sheath**			
	Made of PVC (ST2) HDPE (ST7)		To be mentioned	
	Proof of ST2 or ST7		To be provided	
	Black, grey or red color for Type 1 and Type 2 cable		To be mentioned	
	Black color with UV ray protection for type 3 cable (overhead).		To be mentioned	
	The outer sheath is extruded.		To be mentioned	
	Nominal thickness calculated with: ts = 0,035 D + 1,0 but not less than 2.5 mm		Yes	
	Outer sheath nominal thickness:			
	70 mm²	mm	To be mentioned	
	95 mm²	mm	To be mentioned	
	150 mm	mm	To be mentioned	
	240 mm²	mm	To be mentioned	
	300 mm²	mm	To be mentioned	
	400 mm²	mm	To be mentioned	
	500 mm²	mm	To be mentioned	
	630 mm²	mm	To be mentioned	
12	**Diameter of completed core**			
	70 mm² AL	mm	To be mentioned	
	95 mm² AL	mm	To be mentioned	
	150 mm² AL	mm	To be mentioned	
	240 mm² AL	mm	To be mentioned	

	300 mm² AL	mm	To be mentioned	
	400 mm² AL	mm	To be mentioned	
	500 mm² AL	mm	To be mentioned	
	630 mm² AL	mm	To be mentioned	
	240 mm² CU	mm	To be mentioned	
	300 mm² CU	mm	To be mentioned	
	400 mm² CU	mm	To be mentioned	
	500 mm² CU	mm	To be mentioned	
	630 mm² CU	mm	To be mentioned	
13	**Assembly of single core Cables**			
13.1	**Type 2 cable (underground)**			
	Three single core cables twisted together		Yes	
	Assembled at the factory		Yes	
	Right direction of assembling lay		Yes	
	Twisting pitch comprised between 35 and 45 times the minimal diameter of a single core		Yes	
	Twisting pitch:	mm	To be mentioned	
	70 mm² AL	mm	To be mentioned	
	95 mm² AL	mm	To be mentioned	
	150 mm² AL	mm	To be mentioned	
	240 mm² AL	mm	To be mentioned	
	300 mm² AL	mm	To be mentioned	
	400 mm² AL	mm	To be mentioned	
	500 mm² AL	mm	To be mentioned	
	630 mm² AL	mm	To be mentioned	
	240 mm² CU	mm	To be mentioned	
	300 mm² CU	mm	To be mentioned	
	400 mm² CU	mm	To be mentioned	
	500 mm² CU	mm	To be mentioned	

	630 mm² CU			
13.2	**Type 3 cable (overhead)**		Yes	
	Three single core cables twisted around a messenger		Yes	
	Assembled at the factory		Yes	
	Right direction of assembling lay		Yes	
	Twisting pitch comprised between 35 and 45 times the minimal diameter of a single core			
	Twisting pitch:			
	70 mm² AL	mm	To be mentioned	
	95 mm² AL	mm	To be mentioned	
	150 mm² AL	mm	To be mentioned	
	240 mm² AL	mm	To be mentioned	
	240 mm² CU	mm	To be mentioned	
13.3	**Messenger**			
	Core made of stranded galvanized steel wires		Yes	
	Cross section	mm²	50	
	Nominal diameter	mm	9	
	Black PVC or PE		To be mentioned	
	thickness of insulation	mm	≥ 1.2	
	Minimal breaking load	kN	64	
14	**Electrical characteristics of completed cables** **Type 1 in trefoil formation and Type 2**			
14 a	DC resistance 20°C	Ω/km		
	70 mm² AL		0.443	
	95 mm² AL		0.320	
	150 mm² AL		0.206	
	240 mm² AL		0.125	

	300 mm² AL		0.100	
	400 mm² AL		0.078	
	500 mm² AL		0.0605	
	630 mm² AL		0.0469	
	240 mm² CU		0.0754	
	300 mm² CU		0.0601	
	400 mm² CU		0.0470	
	500 mm² CU		0.0366	
	630 mm² CU		0.0283	
	Nominal current type 1 and Type 2	A		
	Soil temperature 30ºC, soil thermal resistivity 1.2 ºKm/W, and depth of laying 80 cm (load factor = 0.8). Earthing of screens is on both ends			
	70 mm² AL		186	
	95 mm² AL		224	
	150 mm² AL		283	
	240 mm² AL		373	
	300 mm² AL		421	
	400 mm² AL		481	
	500 mm² AL		542	
	630 mm² AL		603	
	240 mm² CU		478	
	300 mm² CU		537	
	400 mm² CU		609	
	500 mm² CU		680	
	630 mm² CU		735	
	Nominal current Type 3 cable	A		
	Ambient temperature 45ºC (load factor = 0.8) where cables are protected from direct solar radiation.			
	70 mm² AL			

	95 mm² AL		478	
	150 mm² AL		537	
	240 mm² AL		609	
	240 mm² CU		680	
			735	
	Capacitance	µF/km		
	70 mm² AL		0.189	
	95 mm² AL		0.209	
	150 mm² AL		0.240	
	240 mm² AL		0.286	
	300 mm² AL		0.316	
	400 mm² AL		0.345	
	500 mm² AL		0.380	
	630 mm² AL		0.704	
	240 mm² CU		0.286	
	300 mm² CU		0.316	
	400 mm² CU		0.345	
	500 mm² CU		0.380	
	630 mm² CU		0.704	
	Reactance	Ω/km		
	Trefoil installation for type 1 cable. Earthing of screens is on both ends			
	70 mm² AL		0.148	
	95 mm² AL		0.141	
	150 mm² AL		0.132	
	240 mm² AL		0.123	
	300 mm² AL		0.120	
	400 mm² AL		0.115	
	500 mm² AL		0.111	
	630 mm² AL		0.084	
	240 mm² CU		0.123	

	300 mm² CU 400 mm² CU 500 mm² CU 630 mm² CU		0.120 0.115 0.111 0.084	
14	**Cable marking**			
	Marking on each core of bundle		Yes	
	Marking embossed or engraved		Yes	
	One-meter interval		Yes	
	Manufacturer's identification : YY		Yes	
	Manufacturing batch reference : XXXX		Yes	
	Year of manufacture : four digits		Yes	
	Cross section : for example 240 mm²		Yes	
	Designation of conductor type : AL or CU		Yes	
	Rated voltage class : 12.7/22 (24) kV		Yes	
	The phase number (Type 2 and 3 only) : P1, P2, P3		Yes	
	Reference Standard : (IEC xxxxxx)		Yes	
15	**Sequence marking**			
	- YY – XXXX-2015-240-AL-12.7/22 (24) kV - P1 - IEC xxxxxx-		Yes	
16	**Metric length marking**			
	Appear every meter		Yes	
	Mentioned on only one phase of a bundle (type 2 cable) or on the messenger of Type 3 cable.		Yes	
	Engraved, embossed or printed on a different face than the main cable marking		Yes	
17	**Protection for storage and delivery**			
	Each element (phase conductor or barrier) is fitted with an individual end device preventing the penetration of water or moisture during storage and delivery		Yes	
	Description of the device		To be mentioned	

18	**Drums and Marking** in accordance with requirement of paragraph 8.6 (any difference must be clearly mentioned)		Yes	

Supplier's offer column must be properly filled with the right figures. "Compliant, Yes, ", V , etc..." are not accepted.

Deviation from the technical specification:

The bidder shall list point after point and explain here in after all deviation from the requested technical specification.

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Full technical information shall be supplied within the bid. If not, the offer shall not be considered.

Bidder signature:

11.2 22 kV cable accessories

No.	Description	Unit	Requirement	Supplier's Offer
1	Country		to be specified	
2	Manufacturer		to be specified	
3	Manufacturer's references		to be specified	
4	Standard		IEC 60502-4	
5	Type test reports as per § 4.2 and IEC 60502-4		To be provided	
6	ISO 9001 for design, development and production		Yes. Certificate to be provided	
General				
1	All accessories are suitable for the requested 22 kV MV cable		Yes	
2	Accessories are strictly identical for all Type 1, Type 2 and Type 3 cables		Yes	
3	Outdoor terminations Indoor terminations Straight joints Screened separable connectors		□ □ □ □	
4	Cold shrinkable technology for: Outdoor terminations Indoor terminations Straight joints		 Yes Yes Yes	
5	EPDM pre-molded type for screened separable connectors		Yes	
6	Life expectancy	Year	≥ 30	
7	Type tests according the requirement of IEC 60502-4		To be provided	
8	Supplied in complete kit form for 3 phases with all materials and components required to complete the installation		Yes	
9	Connectors and terminal lugs included with each kit		Yes	

10	components shall be capable of being stored without damage or deterioration at a temperature up to 50°C		Yes	
11	Expiring date marked on all packages, where appropriate.		Yes	
12	Details of all equipment, tools and protective clothing required to complete the accessory is included with each kit		Yes	
12a	Packing list		To be supplied with the bid	
13	Each kit includes a complete instruction manual in English and Khmer languages for implementing the accessory on the here above specified cable		Yes	
Technical characteristics				
1	Uo/U (Um)	kV	12.7/22 (24)	
2	Minimum permissible temperature of accessories: During normal operation short time overload (a total of 24 hours a year in separate of 3 hours at the most) Multi-phase short-circuit (5 second)	°C	 90 120 250	
3	Available for : 70 mm² AL cable 95 mm² AL cable 150 mm² AL cable 240 mm² AL cable 300 mm² AL cable 400 mm² AL cable 500 mm AL cable 630 mm² AL cable 240 mm² CO cable 300 mm² CO cable 400 mm² CO cable		 Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	

	500 mm CO cable 630 mm² CO cable		Yes Yes	
4	Accessories designed to provide a complete moisture seal, and complete re-jacketing of the individual cables.		Yes	
5	Components are suitable for indoor and/or outdoor installation		Yes	
6	Components are resistant to ultra violet radiation and chemical attack		Yes	
7	Electric field stress control is provided for all accessories		Yes	
8	**Marking** Name of manufacturer Equipment reference Cross section range Serial number permanently and clearly visible		 Yes Yes Yes Yes	
9	**Cable Metallic Screen connection** **Terminations** Accessories shall allow the connection of the cable metallic screen to the earth. The **straight joints** shall reconstitute the continuity of each metallic screens of the cables. All cable **termination and separable connector**'s accessories are supplied with a device for cable screen connection with an earthing flexible braid. Cable screen connection device withstands: Phase to earth short circuit current: permanent induction current : The flexible earthing braid of the cable screen connection device is tinned and is designed in order to avoid penetration of moisture inside the cable or the connection accessory (**terminations and separable connector only**).	 kA 1s A 	 Yes Yes Yes 2.5 10 Yes	

	The end of the braid opposite to the Pin plate rigid and designed to receive a 10 mm diameter bolt. **(terminations and separable connector only** Description of the Design		Yes To be mentioned	
10	**Connector and Terminal lugs**			
	Connectors and terminal lugs are conform to the requirement of IEC 61236 (class A)		Yes	
	Connectors and terminals lugs perform without distress under normal, cyclic loading and fault conditions		Yes	
	They are not limiting the rating of the cables that they joint.		Yes	
	Mechanical tightening type.		Yes	
	Bolts of metric size.		Yes	
	The range of connectors and		Yes	
	Shear off screw heads.		Yes	
	The shear head breaking off always occur inside the connector body		Yes	
	The ends of connectors and terminals lugs are suitably chamfered		Yes	
	Connectors have a solid central barrier to facilitate the insertion of the conductor to the correct depth.		Yes	
	End of splices and connectors are fitted with plastic cap.		Yes	
	Compounds or greases		Yes	
	Description of compound or grease if any		Yes	
	Connectors and terminals are able to accommodate typical variations in core dimensions		Yes	
	The palm of outdoor termination lugs is suitable to be connected onto another aluminum palm with an aluminum alloy 14 mm diameter metric bolt for cross section of 240 mm^2 and less and 16 mm for 300 and 400 mm^2.		Yes	

	The palm of indoor termination lug is suitable to be connected onto a copper or copper alloy pad with a copper 12 mm diameter metric bolt for cross section of 240 mm^2 , 16 mm for 300 and 400 mm		Yes	
11	**Outdoor terminations**			
	Supplied within a complete kit for 3 phase.		Yes	
	Include all components for the complete implementation of the termination set:		Yes	
	End lugs for cable phases for connection on aluminum pad,		Yes	
	Terminations of cold shrinkable type,		Yes	
	Earthing connection for the metallic screens of the 3 single core cables,		Yes	
	Galvanized steel orientable 3 x single core cable bracket for supporting terminations.		Yes	
	Minimum creepage distance	mm	600	
	Designed in order to avoid any penetration of water or moisture inside the cable		Yes	
	and inside the metallic core		Yes	
	Hot dip galvanized supporting steel bracket		Yes	
	Suitable for circular or rectangular shape concrete poles		Yes	
	Possible to fix it on the pole either with bolts or stainless steel straps.		Yes	
	Collars for attaching the single core cables made of insulating material.		Yes	
12	**Indoor terminations**			
	Supplied within a complete kit for 3 phase.		Yes	
	include all components for the complete implementation of the termination set:		Yes	
	End lugs for cable phases for connection on copper pad,		Yes	
	Terminations of cold shrinkable type,		Yes	
	Earthing connection for the metallic screens of the 3 single core cables.		Yes	

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	Designed in order to avoid any penetration of water or moisture inside the cable.		Yes	
	Indoor terminations are suitable for installation in MV Circuit Breaker Cubicles of HV/MV Substations and in load break switches of Ring Main Units (RMU).		Yes	
	Are of "short" cold shrinkable type.		Yes	
13	**Straight joint**			
	Supplied within a complete kit for 3 phase.		Yes	
	Include all components for the complete implementation of the straight set:		Yes	
	Connectors of mechanical tightening type		Yes	
	Straight joints of cold shrinkable type		Yes	
	Earthing connection for the metallic screens of the 6 single core cables		Yes	
	The cable Joints can be submerged in water for long periods.		Yes	
	The recovered thickness of insulation over the connector of straight joints is uniform and equal to or greater than the cable insulation thickness as given in IEC 60502-2.		Yes	
	Joints provide waterproofing, mechanical and electrical protection, and they are completely sealed from cable jacket to cable jacket.		Yes	
	Cable screens continuity is fully insulated from the earth. The screens are not earthed at joint location.		Yes	
14	**Screened Separable Connectors**			
	Conform to the requirement of EN 50180 and EN 50181 standards.		Yes	
	EPDM pre-molded manufacturing.		Yes	
	Screened type.		Yes	
	Supplied within a complete kit for 3 phase. Connectors of mechanical tightening type		Yes	
	Pre-molded body of screened separable connector		Yes	

	Earthing connection for the metallic screens of the 3 single core cables above Interface A: for connection of transformer inside MV/LV substation, Dead break Straight plug in / elbow plug in Interface C: MV network for cable connection on RMU, M16 Bolted T type interface A screen separable connectors, the fixing bail is supplied within the kit		Yes Yes Yes Yes	
15	**Packing list**		Provided within the bid	
16	**Accessories packing/marking** All connecting accessories kit shall be delivered individually packed in strong card box and card box properly stored on a pallet. Each card box shall be clearly marked with: Name / Logo of the Manufacturer The type of accessory Type of MV cables The Cross section Packing date Distributor's name Expiring date (if appropriate)		Yes Yes Yes Yes Yes Yes Yes Yes	

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Bidder signature: