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Kenya Power

66KV SINGLE CORE XLPE INSULATED COPPER CABLES– SPECIFICATION

A Document of the Kenya Power & Lighting Co. Ltd.
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0.1 CIRCULATION LIST

COPY NO.	COPY HOLDER
1	Manager, Standards
2	Electronic copy (pdf) on Kenya Power server (http://172.16.1.40/dms/browse.php?fFolderId=23)

0.2 AMENDMENT RECORD

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
Issue 2 Rev 0	2021-10-25	1.Review the construction and Technical data Parameters of clause 4.3 added	Stephen Nguli	Dr. Eng. Peter Kimemia
		2.To update the ISO standards requirement		
		3.Cancels and replace specification no. KPLC1/3CB/TSP/05/009 dated 2010/02/19		

REVISION OF KPLC STANDARDS

To keep abreast of progress in the industry, KPLC Standards shall be regularly reviewed. Suggestions for improvements to approved Standards, addressed to the Manager, Standards department, are welcome.

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FOREWORD

This Specification has been prepared by the Standards Department in collaboration with Transmission Department both of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for 66kV single core XLPE insulated copper cables. It is intended for use by KPLC in purchasing the items.

The manufacturer shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

This specification stipulates the minimum requirements for 66KV single core copper cables acceptable for use in the company and it shall be the responsibility of the supplier and manufacturer to ensure that the offered design is of the highest quality and guarantees excellent service to KPLC.

The manufacturer shall exhibit good workmanship and good engineering practice in the manufacture of the 66KV single core copper XLPE insulated cables for KPLC.

Specifications in this series are:

KP1/6C/4/1/TSP/05/010: Specification for 132kV S/C Cu/Al XLPE Cable

Users of Kenya Power specifications are responsible for its correct interpretation and application.

The following are members of the team that developed this specification:

Name	Department
Stephen Nguli	Standards
Patrick Maguta	Network
Faith Gichugu	Standards

1. SCOPE

1.1. This Specification is for 66KV single core copper XLPE cables and it is intended to cover the design manufacture, assembly, testing at manufacturer's factory and supply of 66KV single core copper cables for efficient and trouble-free operation to achieve the intended purpose.

1.2. The 66KV single core copper cables shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the bidder's guarantee in a manner acceptable to the KPLC.

1.3. KPLC shall interpret the drawings and specifications and shall have the power to reject any work or material which in its judgment is not in accordance to the specification and relevant standards.

2. NORMATIVE REFERENCES

The following standards contain provisions which through reference in this text constitute provisions of this specification. For dated editions, the cited edition shall apply; for undated editions, the latest edition of the referenced document shall apply.

For this specification, the definitions and abbreviations given in the reference standards shall apply.

IEC 60840:	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um = 36kV) up to 150kV (Um = 170kV) – Test methods and requirements.
IEC 60228:	Conductors of insulated cables.
IEC/TS 60859:	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above - Fluid-filled and extruded insulation cables - Fluid-filled and dry type cable-terminations
IEC 60332-3:	Tests on electric cables under fire conditions - Part 3: Tests on bunched wires or cables.
IEC 60332-3-10:	Tests on electric and optical fiber cables under fire conditions - Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus.
IEC 60332-1-1:	Tests on electric and optical fiber cables under fire conditions — Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus.
IEC 60332-1:	Tests on electric cables under fire conditions - Part 1: Test on a single vertical insulated wire or cable.

IEC 61034-1:	Measurement of smoke density of cables burning under defined conditions - Part 1 Test apparatus.
IEC 61034-2:	Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements.
IEC 60754-1:	Test on gases evolved during combustion of materials from cables - Part 1: Determination of the amount of halogen acid gas.
IEC 60754-2:	Test on gases evolved during combustion of electric cables - Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity.
ISO 9001:2015:	Quality Management Systems — Requirements

3. DEFINITIONS

For the purpose of this specification the terms and definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1. SERVICE CONDITIONS

4.1.1. Cable Application

a) The cable shall be a transmission cable for use in outdoors installations and tropical conditions (temperature range of -1°C to +40°C, humidity of up to 95%, saline conditions and altitudes of up to 2200m above sea level).

b) The cable shall be suitable for laying in cable ducts and directly in the ground in switching stations, between stations and underground to overhead conversion.

c) The cable shall also be suitable for laying on slopes.

d) Permissible continuous loading operating temperature shall be 90°C.

e) Permissible emergency loading temperature shall be 130°C for at least 8 hours.

f) Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5s as per IEC 60840).

4.1.2. The cables shall be connected to underground system operating at a nominal voltage of 66kV, 50Hz and maximum system voltage of 72.5kV and are solidly earthed at the transformer neutrals. The short circuit level shall be taken as 40kA 3s.

4.1.3. The cables shall have suitable anti-termite protection to be approved by KPLC.

4.1.4. The cable shall have an oversheath with a fire performance that conforms to the requirements of IEC 60332-1 (Fire), IEC 60332-3A (Fire), IEC 61034 (Smoke) and IEC 60754 (Minimal Halogen).

4.1.5. The cable and accessories shall be designed for reliable service life of at least 30 years.

4.2. GENERAL REQUIREMENTS.

4.2.1. Construction

Stranded circular compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, nonconductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semiconducting layer as electrode for DC voltage sheath testing.

4.2.2. Design

4.2.2.1. The cable shall be designed and manufactured to IEC 60840, IEC 60228, other applicable IEC standards listed in clause 2 and the requirements of this specification.

4.2.2.2. All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).

4.2.3. Conductor

The cable shall be made from stranded circular plain copper conductors that conform to IEC 60228

4.2.4. Conductor Screen

4.2.4.1. A conductor screen consisting of an extruded layer of cross-linkable semi-conducting compound shall be applied over the conductor and cover the surface of the conductor completely.

4.2.4.2. The extruded conductor screen shall be applied in the same operation as the insulation and be fully bonded to the insulation.

4.2.5. Insulation

4.2.5.1. The insulation shall be cross-linked polyethylene (XLPE) conforming to the requirements of IEC 60840.

4.2.5.2. The insulation shall be applied by extrusion and cross-linked to form a compact and homogeneous layer.

4.2.5.3. The color of the insulation shall be such that it is easily distinguishable from the screening materials.

4.2.6. Insulation Screen

4.2.6.1. There shall be an insulation screen consisting of a cross-linked extruded semi-conducting layer in combination with a metallic layer.

4.2.6.2. The extruded semi-conducting layer shall consist of a strippable semi-conducting compound capable of removal for jointing and terminating. It shall be applied in the same operation as the insulation, directly over the insulation and shall cover the surface of the core completely.

4.2.6.3. A metallic screen shall be applied around the core. The screen shall consist of helically applied overlapped copper tape.

4.2.7. **Water Barriers**

Water barriers shall be provided to prevent water penetration between the various layers in the cable. A water impermeable barrier around the cable and longitudinal water barriers are required.

4.2.8. **Metallic Sheath**

4.2.8.1. There shall be a seamless metallic sheath consisting of corrugated aluminum.

4.2.8.2. The metallic sheath shall be impervious to water and shall be capable of carrying the earth fault current without exceeding 250°C.

4.2.8.3. The grain size of the sheath shall be uniform and the sheath shall exhibit no marked change after application, installation or in-service, particularly under extended periods of operation at elevated temperatures or under repeated cyclic variations of load.

4.2.8.4. In addition, the metallic sheath shall provide a radial watertight barrier to the ingress of moisture into the extruded cable core, provide protection against minor accidental damage caused by third party interference with the cable during installation or service, provide low resistance path for cable charging current and be capable of sustaining the specified earth fault currents for the time stipulated.

4.2.9. **Oversheath**

4.2.9.1. There shall be an extruded oversheath of suitable material for intended service conditions in 4.1.1.

4.2.9.2. The cable shall be embossed with the information required by IEC 60840 and with the following information throughout the length of the oversheath.

(i) 66000 VOLTS XLPE, POWER CABLE — PROPERTY OF KPLC;
(ii) Name of manufacturer;
(iii) Year of manufacture;
(iv) The number of cores, type and nominal area of conductors;

4.2.9.3. Letters and figures shall be raised and consist of upright block characters. Minimum size of characters shall be not less than 15% of average overall cable diameter and the distance between one set of markings and the next shall not exceed 500mm. All markings shall be clear

and permanent. An indelible marking shall also be given at every one-meter interval to assist field personal in cutting required length.

4.3. STANDARD SIZES AND CHARACTERISTICS

4.3.1. The standard sizes and characteristics of the cables shall be as follows:

Cross sectional area	mm	185	300	400
Voltage Designation Uo/U (Um)	kV	38/66/(72.5)		
Conductor shape	Stranded circular compact copper			
Maximum DC resistance of conductor at 20°C	Ω/km	0.0991	0.0750	0.0470
Maximum AC resistance of conductor at 90°C	Ω/km	0.100	0.0789	0.0629
Thickness of conductor screen	mm	1.0	1.0	1.0
Thickness of insulation (XLPE)	mm	10	10	10
Thickness of insulation screen	mm	1.0	1.0	1.0
Electrostatic Capacitance	µF/km	0.186	0.221	0.239
Impulse withstand Voltage and Power Frequency Withstand voltage of the cable	Vpk rms	1.2/50µs dry:325kV peak 50Hz Wet (60s):140kV rms		
Type of Earthing bonding system		Bonded at both ends		
No. of wires/ diameter	No./mm	50x1.43	50x1.43	50x1.43
Thickness of outer sheath	mm	3.5	3.5	3.5
Approx. outer diameter	mm	52.7	57.5	60.1
Approx. weight of cable	Kg/km	4075	5400	6260

***Note**: The thickness of insulation, thickness of metallic sheath, thickness of oversheath, minimum bending radius of cable, weight per km and the current carrying capacity of the cable underground and in air shall be stated by the manufacturer in the Guaranteed Technical Particulars as per Annex A. The declared values shall be verified during factory testing as per IEC 60840.*

4.3.2. The test voltages shall be as per IEC 60840.

APPENDICES

APPENDIX A: TESTS AND INSPECTION (NORMATIVE)

A.1. **Test standards**: The 66kV single core XLPE insulated copper cables shall be manufactured and tested in accordance with the requirements of this specification, IEC 60228, IEC 60840 and other applicable IEC standards listed in clause 2 and the requirements of this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.

A.2. **Factory acceptance Tests**: Test reports to IEC 60840 for the cables and accessories to be supplied shall be submitted to KPLC for approval before shipment of the goods. KPLC Engineers will witness the following tests (to IEC 60840) at the factory before shipment:

a) Conductor examination
b) Measurement of electrical resistance of conductor
c) Measurement of thickness of insulation and oversheath
d) Measurement of thickness of metallic sheath
e) Measurement of diameters
f) Hot set test for XLPE
g) Measurement of capacitance
h) Partial discharge test
i) Voltage test
j) Bending test followed by partial discharge test
k) Tan delta measurement
l) Heating cycle voltage test followed by partial discharge measurement
m) Impulse withstand test followed by a power frequency voltage test
n) Tests on accessories.

A.3. As per IEC 60840, if the sample from any length selected for the tests fails in any of the tests above, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this specification. If either fail, this batch of cables shall be regarded as having failed to comply and shall be rejected.

A.4. **Type Tests**: Copies of previous type test reports by the relevant International or National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 or ILAC accredited independent laboratory) shall be submitted with the tender for evaluation (all in English Language). Test reports shall be complete including all the pages as issued by the testing authority. Submission of only parts of test reports shall not be acceptable.

A.5. **Accreditation**: The test certificates shall be from an accredited reputable independent testing laboratory, acceptable to the purchaser. Proof of accreditation by a national/international authority shall be forwarded with the offer. A copy of accreditation certificate for the laboratory shall also be submitted.

APPENDIX B: QUALITY MANAGEMENT SYSTEM

B.1. The bidder shall submit a quality assurance plan (QAP) that will be used to ensure that the cable design, material, workmanship, tests, service capability, maintenance and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2015.

B.2. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2015 certificate shall be submitted with the tender for evaluation.

B.3. The bidder shall indicate the delivery time of the cables and accessories, manufacturer's monthly & annual production capacity and experience (not less than 10 years) in the production of the type and size of cable being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of cables sold in the last five years shall be submitted with the tender for evaluation

APPENDIX C: FACTORY ACCEPTANCE TESTS AND INSPECTION

C.1 Kenya Power shall conduct compulsory inspection of all major components and accessories at the manufacturer's factory, and thereafter post-delivery to selected sites, installation, testing, and commissioning.

C.2 Upon completion of manufacturing, the 66kV cables shall be subject to acceptance tests as per appendix A.2. at the manufacturer's works before dispatch. Acceptance tests shall be witnessed by two (2) or more Engineers appointed by The Kenya Power and Lighting Company Limited (PLC).

C.3 The manufacturer/supplier shall give one months' notice to Kenya Power on intended dates to conduct the Factory Acceptance Tests (FATs). The Supplier shall further provide letters of invitation to the Kenya Power Engineers nominated to attend the FAT.

APPENDIX D: INSPECTION AT DELIVERY POINT

D.1. On receipt of the equipment, KPLC shall inspect the 66kV cables for acceptance at stores and may perform or have tests performed to verify compliance of the equipment with this specification.

D.2. The supplier shall replace/rectify without charge to KPLC, any cable which upon examination, test or use, fail to meet any or all of the requirements in this specification.

APPENDIX E: WARRANTY

E.1. The supplier/manufacturer warrants the purchaser that all goods supplied under this contract shall have no defect arising from design, materials or workmanship.

E.2. A warranty of 60 months from the date of delivery of the 66kVcables to Kenya Power store shall be offered by the manufacturer.

APPENDIX F: MARKINGS AND NAME PLATE

F.1. The finished cable shall be wound on metallic drum such as to prevent damage during transportation and handling. The drums shall be protected against corrosion.

F.2. The actual length of cable shall not be less than the length indicated on the drum.

F.3. Both ends of every drum length of cable shall have been sealed (with end caps) to prevent the ingress of water during transportation, storage, handling and installation. Both ends shall be secured to the drum to prevent mechanical damage.

F.4. The following information shall be marked legibly and in a permanent manner on the flange of the drum:

a) The manufacturer's name;
b) The type and rating of cable;
c) The conductor cross-sectional area in mm^2;
d) The length of the cable, in metres;
e) The year of manufacture;
f) The gross mass and net mass, in kilogram;
g) The instructions for handling and use (in English Language);
h) The words "**PROPERTY OF KENYA POWER & LIGHTING CO.**"

***Note**: The cable itself shall have been marked in accordance with clause 4.2.9.2*

APPENDIX G: DOCUMENTATION (NORMATIVE)

G.1. The bidder shall submit its tender complete with technical documents required by Appendix H (Guaranteed Technical Particulars) for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

(i) Guaranteed Technical Particulars signed by the manufacturer;

(ii) Copies of the Manufacturer's catalogues, brochures, and technical data sheets for 66KV cables and installation layout drawings.

(iii) Detailed drawings and step by step procedure for safe installation and correct commissioning process of the 66kV cables. This shall include the recommended maximum earthing resistance values for safe operation of the cables.

(iv) Sales records for the last five years and at least four customer reference letters.

(v) Details of manufacturing capacity and the manufacturer's experience.

(vi) Copies of required type test reports by a third-party testing laboratory accredited to ISO/IEC 17025.

(vii) Copy of accreditation certificate to ISO/IEC 17025 for the third-party testing laboratory.

(viii) Manufacturers letter of authorization, ISO 9001:2015 or later certificate and other technical documents required in the tender.

G.2. The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

(i) Fully filled clause by clause Guaranteed Technical Particulars (GTP) signed by the manufacturer.

(ii) Design drawings and technical details.

(iii) Quality assurance plan (QAP) that shall be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation shall fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2015.

(iv) Detailed test program to be used during factory testing.

(v) Marking details.

(vi) Packaging details: The 66kV cables shall be packaged for outdoor storage in tropical conditions. The manufacturer shall state the maximum acceptable storage duration for the complete 66kV cables, taking cognisance of the service conditions defined in clause 4.1.

(vii) Manufacturer's undertaking to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the 66kV cables for The Kenya Power & Lighting Company.

G.3. The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the 66kV cables to KPLC stores.

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APPENDIX H: GUARANTEED TECHNICAL PARTICULARS (GTPS)

(to be filled, stamped and signed by the Supplier/manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records for previous five years, four customer reference letters, details of suppliers' capacity and experience; and copies of complete test certificates and test reports for tender evaluation or approval, all in English Language)

Tender No. .....

Bidder's Name.....

Clause	Description	KPLC Requirement	Supplier's Details/ Response
	Manufacturer's name	State	
	Manufacturer's letter of Authorization.	Provide a copy	
	Description of item on offer		
	Type or designation	State	
1	Scope:	State	
2	Reference standards	State	
3	Definitions		
4.1.1	Service conditions	Specify	
4.1.2	Maximum system voltage, Type of earthing of the cable Short circuit level	State	
4.1.3	Cable ant-termite protection	Specify	
4.1.4	Cable over sheath fire performance	Specify	
4.2	**General Requirements**		
4.2.1	Construction	Specify material for construction	
4.2.2	Design		
4.2.2.1	Standard of manufacture	Lists	
4.2.2.2	Continuous operating temperature	State	
	Short circuit temperature and duration	State	
4.2.3	Conductor	Specify material and standard of manufacture	
4.2.4	Conductor screen		
4.2.4.1	Material of conductor screen and mode of application	State	
4.2.4.2	Application and bonding of the conductor screen	Specify	
4.2.5.	**Insulation**		

4.2.5.1	Insulation	Material and standard of manufacture	State	
4.2.5.2		Mode of application	State	
4.2.5.3		The color of insulation	State	
4.2.5	**Insulation screen**			
4.2.6.1	Material of insulation screen		Specify	
4.2.6.2	Mode of application		Specify	
4.2.6.3	Material of metallic around the core		State	
4.2.7	Water barriers to prevent water penetration		Specify	
4.2.8	**Metallic Sheath**			
4.2.8.1	Material of Metallic sheath		Specify	
4.2.8.2	Earth fault rating and time of the metallic sheath and specify temperature rise.		Specify	
4.2.8.3	Homogeneity in application of metallic sheath		Specify	
4.2.8.4	Provision of radial water tight barriers and prevention of mechanical damage.		Specify	
4.2.9.1	Oversheath	Material	State	
4.2.9.2		Anti-termite protection	State	
4.2.9.3		Fire Resistance	State	
4.2.9.4		Mode of Marking and details to be marked on cable	Specify	
4.3.1	**RATINGS/CHARACTERISTICS**			
	Conductor nominal cross-sectional area		State	
	Voltage designation $U_o/U(U_m)$		State	
	Conductor shape		State	
	Maximum DC resistance of conductor at 20°C		State	
	Maximum AC resistance of conductor at 90°C		State	
	Thickness of conductor screen, mm		State	
	Thickness of insulation (XLPE),mm		State	
	Electrostatic Capacitance, µF/km		State	
	Impulse withstand Voltage and Power Frequency Withstand voltage of the cable, Vpk rms		State	
	Type of Earthing bonding system		State	
	No. of wires/ diameter, no/mm		State	
	Thickness of outer sheath, mm		State	
	Approx. outer diameter ,mm		State	
	Current carrying capacity	State	state	
		State	state	

	Minimum bending radius of cable	State	
	Weight per km (kg/km)	State	
4.3.2	Test Voltages (list all as per IEC 60840)	State	
	APPENDICES		
A	**TESTS AND INSPECTION (NORMATIVE)**	State	
A.1	Test standards and	List	
	Responsibility of testing	State	
A.2	Type test certificates submitted with tender for evaluation	List	
A.3	Sampling of cable to be testing and criterion for acceptance	State	
A.4	Copies of previous type test and routine test reports by the relevant independent /international testing laboratory submitted.	Provide	
A.5	Copies of valid accreditation certificates	Provide	
B	**QUALITY MANAGEMENT SYSTEM**		
B.1	QAP for the cable manufacture	Provide	
B.2	Copies of valid ISO 9001:2015 Quality Management System certifications	Provide	
B.3	Delivery time	State	
	Production capacity	State	
	Manufacturer's experience	State	
	Customer reference letters and address	Provide	
C:	**FACTORY ACCEPTANCE TESTS**		
C.1	KPLC to inspect the cables at manufacturers factory and post-delivery of delivered cables	State	
C.2.	FAT at factory before dispatch by two KPLC Engineers	State	
C.3	The Supplier shall further provide letters of invitation to the Kenya Power Engineers nominated to attend the FATs	State	
D	**Inspection At Delivery Point**		
D.1.	KPLC to inspect the cables at stores and may perform any tests necessary	State	
D.2	The supplier shall replace/rectify without charge to KPLC, any cable which upon examination, test or use, fail to meet any or all of the requirements in this specification	State	

E	**WARRANTY**		
E.1.	The supplier/manufacturer warrants the purchaser that all goods supplied under this contract shall have no defect arising from design, materials or workmanship.	State	
E.2.	Warranty period	State	
F	**MARKINGS AND NAME PLATE**		
F.1	Cable drumming and protection against corrosion	Specify	
F.2	Length of cable per drum (m)	State	
F.3	Sealing both ends of cable	State	
F.4	Marking on the drums	Specify	
G	**DOCUMENTATION**		
G.1	Documents to be submitted with tender for evaluation	List	
G.2	Documents to be submitted for approval before manufacture	List	
G.3	The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the 66kV cables to KPLC stores.	State	

******Note*** *Words like 'agreed', Yes; 'confirmed', 'As per KPLC specifications', etc. shall not be accepted and shall be considered non-responsive.*

.....

Manufacturer's Name, Signature, Stamp and Date