



C.A. LA ELECTRICIDAD DE CARACAS SACA
DEPARTAMENTO DE INGENIERIA GENERAL

DIG

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Specification to

INDUCTIVE VOLTAGE TRANSFORMERS

Substation type: 245 kV and 72,5 kV

0. FOREWORD

This specification has been approved by the competent Authorities from Electricidad de Caracas (EDC) for the procurement of Inductive Voltage Transformers assigned to work at 69 kV and 230 kV EDC networks.

This specification may be revised as required. However, any revision must be approved by the above mentioned EDC Authorities.

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1. BASIC PRINCIPLES

- 1.1. The continued advancement of Inductive Voltage Transformers technology, combined with the expansion of EDC's operations over the last few years, justifies a complete revision of the previous technical specifications.
- 1.2 The principal objective of this specification is to :
- a) Assure thorough International Competitive Bidding (ICB) equal opportunities for all participants. This includes those companies and organisations who follow International Electrotechnical Commission (IEC), or American National Standards Institute (ANSI) recommendations, and all others who apply National Standards such VDE, NCF, etc. for the major part of their manufacturing programs.
 - b) Define the most reliable equipment that can meet expected realistic behaviours of the current and future EDC power system.
- 1.3 Tenderers are requested to strictly follow all of the requirements stipulated in this specification. All offers not complying with this request will be rejected.
- 1.4 Alternate proposals accompanied with proper justifications are welcome, but will be considered only after the Basic Proposal has been evaluated as the most favourable proposal
- 1.5 Proposal will use only the metric measurement system (SI).
- 1.6 Only Suppliers that have been prequalified by EDC are eligible to participate.

- 1.7 The guarantee period required by EDC is 5 years. This period begins from the date of Inductive Voltage Transformers commissioning. The Commissioning Date shall occur within a maximum of 6 (six) months after unloading the Inductive Voltage Transformer at a Venezuelan port.

During the Guarantee Period the Supplier will insure the Supply at one of the first-class Venezuelan banks by unconditional Performance Security to cover 10% (ten percent) of FOB Inductive Voltage Transformer Price. The banker's fees for such a Performance Security will be entirely paid by the Supplier.

- 1.8 For each Tender, the Particular Specifications are issued by EDC. All of EDC's specific requirements in the Particular Technical Specifications are related with numbering to certain clauses and subclauses of this document.

2. SCOPE

- 2.1. This specification covers the design, manufacture, testing, supply and transportation of inductive voltage transformers for external installation under the service conditions of Electricidad de Caracas hereinafter.
- 2.2. This issue is a complete specification related to the purchase of equipment both separate and to be used in the sub-station, turn-key contracts.
- 2.3. This specification covers the inductive voltage transformers with the following rated features:

- i) 230/ $\sqrt{3}$ kV /0.115/ $\sqrt{3}$ kV/0.115/ $\sqrt{3}$ kV/0.115/ $\sqrt{3}$
- ii) 69/ $\sqrt{3}$ kV /0.115/ $\sqrt{3}$ kV/0.115/ $\sqrt{3}$ kV/0.115/ $\sqrt{3}$

All transformers have two secondaries (one for measurement and one for protection) and one tertiary windings.

- 2.4. This specification shall be used as the framework of operations, interchangeability and safety of the equipment referred to, and to help make a proper assessment and selection of this equipment.
- 2.5. This specification covers the essential electric, size, and mechanical features, and takes into consideration the safety requirements and features to operate conditions of 72.5KV and 245 KV inductive voltage transformers used to measure, control, and protect the equipment linked with generation and transmission in the EDC power system.

3. SERVICE CONDITIONS

The inductive voltage transformers and all their fittings shall be adequate for a proper operation under the following weather conditions:

3.1. Normal Service Conditions

3.1.1. Elevation

Up to 1000 m above the mean sea level.

3.1.2. Humidity

The design relative humidity is 90 percent at a 40° C ambient temperature.

3.2. Special Service Conditions

3.2.1. Ambient Temperature

- Maximum	40° C
- 24-hour Daily Mean	30° C
- Annual Mean	25° C
- Minimum	0° C

3.2.2. Pollution Level 3

Specific leakage distance for insulators 25 mm/kV.

3.2.3. Wind Conditions

The inductive voltage transformers according to this specification shall be capable to withstand continuously mechanical stresses equivalent to winds of 150 km/h, that is equivalent to a wind pressure of 1100 N/m².

3.2.4 Seismic conditions

The inductive voltage transformers according to this specification shall be capable to withstand horizontal earth quake acceleration of at least 0,5 g. For design purpose, 70% of above value should be considered for vertical ground acceleration.

4. RATING

The following technical features are required by EDC for the inductive voltage transformers that shall be installed in his power system.

TABLE 4-1: Technical Features and Design Data of EDC-Standardized Inductive Voltage Transformers

IDENTIFICATION	72.5 kV	245 kV
1. Rated primary voltage (phase to neutral)	69/ $\sqrt{3}$ kV	230/ $\sqrt{3}$ kV
2. Rated voltage of the two secondary windings (phase to neutral)	0.115/ $\sqrt{3}$ kV	0.115/ $\sqrt{3}$ kV
3. Rated tertiary voltage	0.115/ $\sqrt{3}$ kV	0.115/ $\sqrt{3}$ kV
4. Rated frequency	60 +2%; -4% Hz	60 +2%; -4% Hz
5. Rated output capacity		
5.1. Measuring winding rated capacity (burden) (unloaded tertiary)	100 VA	100 VA
5.2. Tertiary winding full load burden at $1.9 \times U_m / \sqrt{3}$	100 VA	100 VA
5.3. Protection winding full load (burden)	100 VA	100 VA
6. Rated accuracy class		
6.1. Measuring winding	0.5	0.5
6.2. Tertiary winding	3 P	3 P
6.3. Protection winding	3 P	3 P

7. Voltage factor		
7.1. Continuous running	1.5	1.5
7.2. For 8 hours	1.9	1.9
7.3. For 4 hours	2.08	2.08
8. Temperature rise		
8.1. Winding (by resist..	60 K	60 K
8.2. Oil (maximum)	55 K	55 K
9. Insulation withstand level		
9.1. Impulse; primary winding	350 kV peak	1050 kV peak
9.2. Impulse; secondary and tertiary winding	10 kV peak	10 kV peak
9.3. At power frequency; primary winding	140 kV r.m.s.	460 kV r.m.s.
9.4. At power frequency; secondary winding	3 kV r.m.s.	3 kV r.m.s.
9.5. At power frequency; tertiary winding	3 kV r.m.s.	3 kV r.m.s.
9.6 At power frequency, between secondary and tertiary winding	3 kV r.m.s.	3 kV r.m.s.
9.7. Impulse; chopped waves (primary winding)	375 kV peak	1200 kV peak

10.Short-circuit withstand current. Primary winding		
10.1. Short-circuit impedance	0.5 %	0.5 %
10.2. Short-circuit time	3 sec.	3 sec.
11. Partial discharge level (under IEC 44-4, for firmly grounded instrumentation transformers)	10 pC	10 pC
12. Maximum RIV level	250 μ V	250 μ V
13. Thermic load (permissible thermic load) for a 35° C daily mean temperature at secondary rated voltage.	1000 VA	1000 VA
14. Insulating and cooling oil	IEC Class II Shell DialaDX	IEC Class II Shell DialaDX
15. Porcelain insulator minimum leakage distance (ref. to Um)	1812 mm	6125 mm

16. Packing and transportation versions (in case of unpaved roads)	Three units supplied in one sole packing. Vertical handling.	Only one transformer per packing. Vertical and horizontal handling to be ensured.
17. Primary winding neutral	External connection to the tank	External connection to the tank
18. Resistor for ferroresonance suppression to be connected on the open side of the tertiary winding (voltage cabinet)	Value to be chosen and ensured by manufacturer	Value to be chosen and ensured by manufacturer
19. B.T. arrester for voltage suppression on the A.T. side of the secondaries and tertiary (voltage cabinet)	Yes; features to be ensured by manufacturer	Yes; features to be ensured by manufacturer
20. Discharge capacity in lines and cables (10 discharges/hour)/applied U_m)	10A	125 A
20.1. For unloaded lines	125 A	250A
20.2. For unloaded cables	type test not required, but desired	type test required
21. High frequency stress (during disconnectors operation)		

22. A special equipment is used for ferroresonance detection other than resistor (Yes; No),	No	Yes
23. Stress during transportation (oscillation and single shocks while loading, unloading and transporting)		
23.1. Average vertical acceleration	1g/25Hz	1g/25Hz
23.2. Peak values to be considered (vertical acceleration)	4g	4g
23.3. Horizontal acceleration	0,8g/25Hz	0,8g/25Hz

23.2. Design values (shocks in unpaved roads)		
23.2.1. Vertical acceleration	7 g	7 g
23.2.2. Horizontal acceleration	7 g	7 g
23.3. Required testing (type certificates)		
23.3.1. Acceleration	3 g	3 g
23.3.2. Frequency	25 Hz	25 Hz
23.3.3. Length of time	2 h	2 h

5. DESIGN AND CONSTRUCTION

5.1. General

5.1.1. The voltage transformer shall be inductive, single-phase, oil-immersed, self-contained, airtight, for external installation; and it shall have a stainless-steel bellows system to offset the oil level variations (due to load or temperature changes.)

5.1.2. Prior conditions to meet the EDC requirements shall be fully defined by manufacturer during submittal of the tenders and upon completion of the contract.

Prior to the presentation of any tender, same shall be reviewed by the staff of manufacturer with enough experience to define whether the requirements herein shall be met.

5.1.3. Design engineering shall be carried out by the staff of manufacturer, who shall have the necessary data, namely design fundamentals and EDC specifications. The work carried out by manufacturer shall rely upon the experience from prior generations of similar equipment.

5.1.4. Reviewal and control of the design shall be made by qualified personnel who can influence on, and critically study the technical solutions that have been adopted. The staff of manufacturer -not directly involved in the design- shall also take part in such reviewal.

5.1.5. Some essential issues that shall be borne in mind as part of the design control and forwarded to EDC are as follows:

- Materials compatibility, particularly of oils and rubbers (rims, membranes, etc.), varnish, paints, and binders.
- Protection against corrosion in the outer area of the tank; the juncture between sealed parts, and the inner area of the tank to avoid insulation faults, etc.
- Coordination of dielectric insulation levels in the equipment insulation system.
- Equipment performance at low (0° C) and high (40° C) temperature and endurance test of the oil expansion system.
- Proving of all selected requirements based on the equipment accuracy.
- Dielectric stress on the insulation system.
- Special provisions regarding ferroresonance.
- Special transportation conditions.

5.1.6. Thermic Aging

5.1.6.1. Thermic aging shall be defined under IEC standard, Issue 216: "A Guide to Define the Thermic Endurance Qualities of Electric Insulating Materials."

5.1.6.2. Output is small in instruments transformers, and the loss in copper and iron is also small due to compliance with the class-accuracy requirements.

Under the aforesaid conditions, dielectric loss shall be defined and thoroughly studied by EDC.

5.1.7. Dielectric Stress

5.1.7.1. Dielectric stress at power frequency

A partial discharge test shall be regularly conducted to ensure a safe insulation of all the equipment components.

The partial discharge test shall be conducted immediately following the test at power frequency, which includes a pre-stress voltage.

5.1.7.2. Dielectric Stress at High Frequency

Manufacturer shall analyze the high-frequency pulses produced by the operation of disconnectors or conventional arresters with spark gaps.

EDC does require to conduct a life test as a type test, applying 600 chopped-wave pulses to a prototype of the inductive voltage transformer.

The results shall be assessed in accordance with the phase-to-ground current values and the difference in the oil gas content before and after the test.

5.1.7.3. Discharge Capacity of Lines, Cables, and Capacitor Banks.

EDC does requires as type test to apply 10 discharges for 1 hour, with the rated stress applied to high-voltage terminals. This test is shown in Table 4-1.

This test shall be conducted for the same transformer used in the high-frequency life test in Clause 5.1.7.2., and EDC shall not be further provided with this equipment.

5.1.7.4. Ferroresonance Suppression

Inductive voltage transformers shall be provided along with a tertiary winding in open delta, which shall be connected a damping passive device (resistor) in the case of 72.5 kV transformers, and an electronic active device (fault detector) in the case of 245 kV transformers.

This electronic device shall have an adjustment value of 5 percent of the set rated stress in order to avoid false alarms due to network unbalances.

5.1.7.5. Stress during Transportation

The inductive voltage transformers provided by EDC are subject to contingent oscillations or single shocks when carried.

The type test for this contingency shall have an acceleration of 3g and 25 Hz for no less than 2 hours.

This test shall precede the type tests for the same transformer, as stated in Clauses 5.1.7.2. and 5.1.7.3.

5.1.8. Influence of the Environment and the Sub-Station Structure

5.1.8.1. Influence of the Environment

High-pollution conditions shall be anticipated for the high-voltage equipment (25 mm/kV referred to the inter-phase network maximum voltage) provided for EDC. In the event of any particular condition (industrial pollution, saline fog, etc.), such shall be stated in the particular technical conditions that shall form an integral part of the tender.

Nevertheless, manufacturer shall thoroughly study the impact on the transformer head of Venezuelan characteristic factors; UV rays causing ionization; oxygen and ozone causing aging, etc.

5.1.8.2. Influence of the Sub-Station Structure

The following practices are involved in the current network structure of EDC:

- a) The power breaker grading capacitance is under 250 pF (the use of this capacitance to help interrupt short lines has been restrained by EDC.)
- b) The inductive voltage transformers are directly connected to the line.

c) The system is firmly grounded (avoiding the occurrence of three-phase ferroresonance through magnetic voltage transformers connected to an insulated neutral system with zero sequence low capacitance.)

5.2. Core

Transformers shall have a low magnetic flux density in the core, ensuring therefore their operation for 8 hours at 190 percent of the rated voltage and 4 hours at 208 percent of the rated voltage, as well as an additional "anti-ferroresonance" capacity in the equipment.

5.2.1. The core shall have an inserted yoke and a magnetic plate made up of normal degree magnetic steel (rather than high degree steel with oriented grain silicon) in order to avoid sharp elbows when the flux reaches the saturation point (EDC does require an additional device against ferroresonance.) The laminate shall be insulated with CARLITE and shall be firmly tight.

5.3. Windings

5.3.1. Primary Winding

The primary winding shall have a multiple coated insulation. The conductor shall be made up of double enameled copper and paper insulation in the layers.

Manufacturer shall pay special attention to the electric field configuration at the end of each winding layer.

Manufacturer shall submit to EDC for approval the calculations of the electric field configuration and of design proposals for a better reliability during operation.

Manufacturer shall propose to Electricidad de Caracas a design which avoids concentration of the electric field along the bushing. Manufacturer shall use any of the three proved methodologies - without using intermediate sheets to grade capacitive stress in the main insulation- namely:

- a design of the bushing with a small amount of capacitive stress gradation sheets in the toroidal electrode ends for field control; or
- a design of the bushing with a large amount of capacitive stress gradation sheets without electrodes; or
- a "cascade" design (for 245 kV.)

5.3.2. Secondary and Tertiary Windings

The tertiary winding shall be as near as possible to the core. Windings shall have double enameled copper conductors, and they shall be insulated from the core and the primary winding.

The heaters for the terminal box shall be connected to the tertiary windings (one per phase.)

5.3.3. Insulation Preparation Method

The insulation preparation of an inductive voltage transformer; drying, degasification, and oil impregnation of the insulating paper are essential for the electric quality and equipment reliability once under operation.

Humidity in the insulating material shall be removed in high-vacuum drying ovens.

A high-vacuum drying process shall be ensured at a 0.2 Torr maximum. The tenders of those manufacturers who do not have these facilities shall be denied.

The treated-oil filling shall also be high-vacuum.

The oil to be used shall be Class I in accordance with the standard IEC 296. Shell Diala DX.

5.4. Porcelain Insulator

5.4.1. The insulator shall be made up of humid-processed porcelain; homogeneous; without laminations, cavities or other physical flows, and it shall be well vitrified, sound and resistant to moisture absorption. The bushing shall be brown-colored.

5.4.2. One-piece insulators shall be only provided.

5.4.3. The porcelain shall be tighten with cement to a metallic clamp or frame. Manufacturer shall avoid any air bubbles in the junctures, which bubbles can cause inconveniences related to measuring during the partial discharge testing.

5.4.4. The external insulation level resulting from the insulator leakage distance shall be defined through the following test voltage values at power frequency:

Maximum Voltage (at 60 Hz)	Wet Conditions	Dry Conditions
72.5 kV	140 kVrms	165 kVrms
245 kV	460 kVrms	500 kVrms

5.4.5. Table 4.1 shows the leakage distance. In case of special environmental conditions, the Particular Technical Specification, which forms an integral part of the tender, shall be consulted.

5.5. Short-Circuit Features

5.5.1. The inductive voltage transformers shall be able to endure for 3 seconds the mechanical and thermic stress resulting from short-circuits in the terminals of the secondary or tertiary side with a 100-percent rating voltage in the terminals of the primary side.

5.5.2. Windings temperature under the aforesaid short-circuit conditions shall not exceed 250° C with an initial temperature in the copper of 95° C.

5.5.3. The short-circuit minimum secondary current shall correspond to a value of 0.5 ± 10 percent of the short-circuit impedance referred to the secondary windings power.

5.6. Temperature Rise

5.6.1. The temperature rise in the magnetic voltage transformer shall not exceed 60 K in the windings, and 55 K in the oil under any of the aforesaid conditions (at the output rated capacity):

- Continued voltage factor: 1.5
- Voltage factor for 8 hours: 1.9
- Voltage factor for 4 hours: 2.08

5.7. Tank

The tank of the equipment shall be resistant and stiff enough.

The complete assembly shall form a seal able to effectively endure the pressure, both over and under atmospheric pressure, developed inside said assembly in normal operational conditions and during drying of the active part (over pressure 1.0 bars and high vacuum up to 0.2 Torr.)

Windings and bushings shall be sealed so as to prevent moisture absorption or dielectric leakage with the equipment on service or during transportation.

An excellent protection of the inner part of the tank shall be provided in order to avoid any insulation fault due to paint dissolution.

The whole external area shall be hot painted.

5.8. Terminal Head

5.8.1. Primary terminals shall be at least 80 mm length and 300 mm in diameter. They shall be made up of an aluminium alloy. Also, an aluminium alloy, clamp type, 400 mm² terminal for aluminum conductor shall be supplied.

5.9. Ground Terminal

5.9.1. Two diagonally opposed ground terminals shall be supplied. Each terminal shall be able to effectively earth 100 percent of the short-circuit current, and shall be able to receive a copper segmental ground conductor from 95 mm²-120 mm².

5.10. Paint

5.10.1. All the exposed metallic parts shall be painted with the exception of those areas where paint can interfere with the equipment normal operation. In case of leaving unpainted areas for mounting reasons, these shall be duly protected to prevent oxidation while stored and shipped.

5.10.2. Following preparation and cleaning of the areas to be painted, those areas which are not in contact with oil shall be double coated with red lead, exposed priming paint. The areas shall be enamel double coated for an even and unspotted surface.

5.10.3. The external areas shall be gray mat painted. Light colors or aluminum paint shall not be used in any event.

5.11. Galvanization

All steel or malleable iron parts shall be hot galvanized.

6. TERMINAL BOX

- 6.1. All the secondary conductors shall be carried to an outlet box and terminated in the terminal box located in the airtight box near the transformer base.

The terminal box shall allow the entrance and connection of 8-10 copper core control cables. with a diameter of 2.5 mm²

- 6.2. Heaters for the terminal box shall be installed and duly protected by fuses.
- 6.3. The terminal box shall have an IP54 protection degree.

7. MARSHALING KIOSK

- 7.1. Manufacturer shall supply a weather resistant box with an IP54 protection degree with a view to collecting the cables from three terminal boxes (Clause 6.)
- 7.2. The marshaling box shall be installed on the central phase of the base structure.
- 7.3. Protection from overcurrent and short-circuit in the secondaries (protection and measuring) and tertiary of the three transformers in the section shall be made by three special mini-switches and by automatically blocking the distance protection.
- Thermic current control range: 3-10A
 - Adjustment range of the tripping device due to short-circuit current: 20-40A.
- 7.4. A damping resistor shall be installed to close the open delta tertiary winding. Selection of the damping resistor features shall be entrusted to, and shall be the sole responsibility of, manufacturer.
- 7.5. Low-voltage arresters shall be supplied and installed inside the terminal boxes in order to prevent possible high and low voltage.

8. TERMINALS MARKING

Marking of terminals shall be under Clause 18, IEC186 standard.

9. IDENTIFICATION PLATE

The tank shall bear a stainless steel plate with data logging. Such signaling shall be easily readable from the ground level. The identification plate shall have at least the following information:

- i) Name of manufacturer
- ii) Type designation according to manufacturer
- iii) Manufacturer serial number
- iv) Manufacture year
- v) Reference number of the EDC specification
- vi) Rated primary, secondary and tertiary voltage ----- kV
- vii) Rated frequency ----- Hz
- viii) Equipment maximum voltage (U_m) ----- kV
- ix) Protection/measuring/tertiary pulse voltage ----- kV_{peak}
- x) Primary/secondary/tertiary voltage at power frequency ----- kV
- xi) Primary/secondary/tertiary rated power
- xii) Protection/measuring/tertiary accuracy class
- xiii) Voltage and time rated factor 1.5_/1.9_/2.08

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- xiv) Rated thermic charge for 30° C (average daily temperature)
----- VA
 - xv) Chart of connections and polarity marking
 - xvi) Oil mass ----- Kg
 - xvii) Total mass including oil ----- Kg

10. TESTING

Magnetic voltage transformers shall be tested pursuant to IEC-186 and IEC-186A standards, as stated hereinbelow. Type and routine tests are as follows:

10.1. Routine Tests

The following routine tests shall be conducted in all the magnetic voltage transformers that shall be supplied.

- i) Verification of terminals marking.
- ii) Tests at power frequency in primary windings.
- iii) Tests at power frequency in secondary and tertiary windings.
- iv) Definition of voltage (ratio) and phase delay error percentages for the accuracy class of the given measure; at 80, 100, and 120 percent of the rated voltage, at rated frequency, for 25 and 100 percent of the measuring full load, and at a lag 0.8 power factor.
- v) Definition of voltage and phase delay error percentages for the accuracy class of the given protection; at 5 and 100 percent of the rated voltage multiplied by the voltage rated factor, for 25 and 100 percent of the protection full load, and at a lag 0.8 power factor.
- vi) Partial discharge test under the IEC-44-4 standard (1980), immediately following a 1-minute voltage test, at power frequency.

10.2. Type Tests

The following type tests shall be conducted on all the inductive voltage transformers that shall be supplied.

- i) Temperature rise test.
- ii) Pulse voltage test.
- iii) Definition of voltage (ratio) and phase delay error percentages.
This test shall be conducted at 80, 100, and 120 percent of the rated voltage, at rated frequency, for 25 and 100 percent of the measuring full load, and at a lag 0.8 power factor for the measure accuracy class.
- iv) Definition of voltage (ratio) and phase delay error percentages, at 5 and 100 percent of the rated voltage multiplied by the voltage rated factor, for 25 and 100 percent of the protection full load, and at a lag 0.8 power factor, for the protection accuracy class.

10.3. Special Tests

- i) Test in chopped pulse voltage.
- ii) High frequency life test.
- iii) Test in discharge capacity of lines, cables and condenser banks.
- iv) Test for stress during transportation.

11. PLANS AND DESCRIPTIVE DATA

11.1. Plans Submitted with the Tender

The following information shall be supplied alongside the tender:

- I) Information required in Clause 11.3, "List of Technical Data."
- ii) Descriptive data, literature, drawings, and photographs whereby the technical and structure features are spelled out, so that the quality and performance of the equipment can be assessed by an engineer.
- iii) Drafts which show the shape, size, weight, and location of fittings and connections alongside the plans of the terminal pins.
- iv) Drawing of the identification plate.
- v) Typical curves which show the voltage ratio and phase delay errors based on voltage, from 5-100 percent of the rated voltage for 25 and 100 percent of the full load stated in Clause 4, items (vi)a and (vi) b, respectively.
- vi) Typical curves which show the voltage ratio and phase delay errors based on the full load stated in Clause 4, items (vi)a and (vi)b respectively, from 0-100 percent for 80 and 120 percent of the rated voltage, and for a 80 and 100 percent power factor.

- vii) A list of references which include the countries provided with equipment, and the manufacture year.
- viii) For evaluation purposes, founding plans shall be provided, including such characteristic data as dynamic and static force, terminal load, etc., alongside the drawing of a typical foundation with its structure (in the absence of metallic brackets) and metallic brackets, by using a 10 ton/m² ground load capacity for seismic areas. Design calculations and related general guidelines shall also be provided.

11.2. Plans for Approval

These plans shall be submitted for their consideration following issuance of the order and before manufacturing the equipment. Such plans shall include the following:

- I) All the data and plans required in Clause 11.1. hereto.
- ii) Plans and size of the terminal pins.
- iii) Drafts on a great scale and plans to be copied of the inductive voltage transformers, detailing the base and its arrangement to install them in the steel and/or reinforced iron supporting structure.
- iv) Ten photocopies and one copy to be reproduced of the directions for erection, assembly, maintenance, and operation of the equipment.

11.3. List of Technical Data

The following information shall be supplied, as needed, alongside the tender for each inductive voltage transformer.

- i) Name of manufacturer
- ii) Designation
 - iii) Type
 - iv) Design certificate number
 - a) Issued by
 - b) Date
 - v) Primary rated voltage ----- kV_{rms}
 - vi) Secondary rated voltage ----- V_{rms}
 - vii) Tertiary rated voltage ----- V_{rms}
 - viii) Impulse voltage; 1.2/50 μ s
 - a) primary ----- kV_{peak}
 - b) secondary ----- kV_{peak}
 - c) tertiary ----- kV_{peak}

ix) Voltage at power frequency

- a) primary ----- kVrms
- b) secondary ----- kVrms
- c) tertiary ----- kVrms

x) Rated power

- a) secondary (measuring) ----- VA
- b) secondary (protection) ----- VA
- c) tertiary ----- VA

xi) Accuracy class

- a) measuring ----- VA
- b) protection ----- VA
- c) tertiary ----- VA

xii) Voltage factor

- a) continuous -----
- b) 4 hours -----
- c) 8 hours -----

xiii) Thermal load at a mean daily temperature of
30° C

----- VA

-
- xiv) Temperature rise (under any condition stated in xii)
- a) winding (by resistance) ----- K
 - b) oil (maximum) ----- K
- xv) Final temperature under short-circuit conditions (maximum voltage and I of short-circuit specified for the secondary), with an initial 95°C temperature in the windings
- a) winding (by resistance) ----- °C
 - b) oil (maximum) ----- °C
- xvi) Transformer inductivity on the primary side ----- H
- xvii) Leakage distance ----- mm
- xviii) Ferroresonance suppression resistor value (72.5 kV) ----- W ()
- xix) Value of the active damper device for ferroresonance suppression (245 kV)
- a) Type -----

b) Manufacturer	-----
c) List of features (Attach list)	-----
xx) Core flux density	
a) with a 1.0x maximum voltage	----- T
b) with a 1.5x maximum voltage	----- T
c) with a 1.9x maximum voltage	----- T
d) with a 2.08 maximum voltage	----- T
xxi) Magnetization current	
a) with a 1.0x maximum voltage	----- A
b) with a 1.5x maximum voltage	----- A
c) with a 1.9x maximum voltage	----- A
d) with a 2.08 maximum voltage	----- A
xxii) Guaranteed values of partial discharge during testing in accordance with IEC-44-4 (as modified by EDC)	----- pC
xxiii) N.A.	

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- xxiv) RIV top level (values in accordance with Table 4-1) ----- V
- xxv) Low voltage arrester features
- a) Rated voltage ----- V
 - b) Discharge current ----- A
 - c) Discharge voltage ----- V
- xxvi) Discharge capacity of lines, cables, and condenser banks
- a) current for vacuum lines ----- A
 - b) current for vacuum cables ----- A
 - c) agreement to conduct the type test in order to verify the former requirements without EDC having to incur additional expenses ----- Yes/No
- xxvii) Withstand high frequency stress: agreement to conduct the type test (600 chopped waves) without EDC having to incur additional expenses ----- Yes/No

xxviii) Resistance capacity to mechanical efforts
during transportation

a) transportation

1) average vertical acceleration ----- g

2) peak value ----- g

3) average horizontal acceleration ----- g

b) strikes, shocks

1) vertical acceleration ----- g

2) horizontal acceleration ----- g

c) agreement to conduct the mechanical
resistance test without EDC having to incur
additional expenses ----- Yes/No

xxix) Minimum guard distance ----- mm

xxx) Minimum inter-phase spacing ----- mm

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- xxxii) Weight of oil per pole ----- Kg
- xxxiii) Weight per pole ----- Kg
- xxxiv) Type of oil and reference details
- xxxv) Permissible short-circuit secondary current ----- A
- xxxvi) Total height ----- mm

12. PACKING

One copy of the directions for erection, assembly, maintenance, and operation of each equipment shall be supplied in each packing for transportation in a moisture-resistant polyethylene package.

Each 72.5 KV or 245 KV unit shall be packed in a high-quality wooden box with high quality, anti-corrosion tapes.

13. CRITERIA FOR ACCEPTANCE OF INDUCTIVE VOLTAGE TRANSFORMERS

A negative result in the type testing shall cause rejection of any and all inductive transformers in the tested lot.

EDC shall accept renewed testing provided that manufacturer proposes modifying the transformer design within a reasonable term, and repeating -without EDC having to cover any cost- all the tests set forth in Clause 10.3 hereto in two units from the new lot to be selected by EDC.

All routine tests shall prove positive within the permitted tolerance. In case that any negative result may impair the transformer operation, each faulty transformer shall be replaced or repaired without EDC having to cover any cost.

14. TESTING TO BEGIN OPERATIONS

The following tests shall be conducted during the process to energize the equipment:

- i) Verification of the oil level.
- ii) Visual inspection of the equipment
- iii) Verification of the bellows status.
- iv) Insulation endurance test by using a 2.5 kV megger with a 0-10000 M Ω reading.
- v) Measure of the DC resistance in the primary, secondary, and tertiary windings.