INDEPENDENT POWER TRANSMISSION OPERATOR S.A.
TNPRD/ SUBSTATION SPECIFICATION & EQUIPMENT SECTION

November 2012

TECHNICAL DESCRIPTION TD-95/3

400 KV, 30 MVAR OR 50 MVAR OR 60 MVAR SHUNT REACTORS

I. SCOPE

This technical description covers the characteristics, design features and testing of 400 kV, outdoor, oil-type shunt reactors.

II. KEYWORDS

Shunt Reactors, Capacitive Current Compensation, Voltage Control.

III. STANDARDS

Unless otherwise specified herein, all reactor characteristics and testing shall conform to the latest revision of IEC 60076-6, 60076-3, 60076-4 standards.

IV. OPERATING CONDITIONS

1.	Installation	:	Outdoor
2.	Ambient Temperature	:	Minimum (-25^{o}C) Maximum (+45^{o}C)
3.	Altitude	:	Up to 1000m above sea level
4.	Other Conditions	:	Snow and Ice
5.	Pollution Level	:	Moderate

V. USE

The shunt reactors are to be used on the system to compensate for capacitive current and also for compensating of reactive power.

VI. ELECTRICAL CHARACTERISTICS OF THE SYSTEM

1. Nominal Voltage : 400KV
2. Maximum System Voltage : 420KV
3. Minimum permissible operating voltage : 380KV
4. Nominal frequency : 50Hz
5. Number of phases and conductors : 3
6. Short Circuit level : 40KA
7. Rated duration of short circuit : 1sec.
8. Basic Insulation level : 1550KV (peak)
9. Switching impulse withstand voltage : 1175KV (peak)
10. Variations of nominal frequency : ±0.2Hz
11. Available auxiliary D.C. supply voltage : 220V D.C. (from substation batteries)
12. Available auxiliary A.C. supply voltage : 3 – phase, (4 – conductors 230/400V A.C.)
13. Power frequency withstand voltage (1min) : 680KV (r.m.s.)
14. Method of earthing (grounding) : Solidly grounded

VII. SHUNT REACTOR REQUIRED CHARACTERISTICS

1. Design Characteristics
   a. Type : Three-phase wye connected oil-immersed type with the neutral directly grounded.
   b. Rated Voltage (Ur) : 400 kV
   c. Highest voltage for equipment (Um): 420 kV
   d. Maximum operating voltage (Umax): 420 kV (105% of rated)
   e. Rated Power at 400 kV : 30 Mvar or 50 Mvar

			or 60 Mvar
f.	Rated Frequency	:	50 Hz
g.	Rated Current at 400 kV	:	43.3A or 72.2A or 86.6A
h.	Rated Reactance	:	5333 Ohm or 3200 Ohm or 2667 Ohm

Rated insulation levels for windings and bushings :

Lightning impulse withstand voltage 1,2 / 50µs wave		
	Line	**Neutral**
Terminal	1425kV crest	325kV crest
Bushing	1550kV crest	325kV crest

Switching impulse withstand voltage		
	Line	**Neutral**
Terminal	1050kV crest	--
Bushing	1175kV crest	--

Power frequency withstand voltage (50Hz, 1min)		
	Line	**Neutral**
Terminal	630kV rms	140kV rms

Bushing	680kV rms	140kV rms

i. The reactor tank will be of cover bolted type and shall be made so as to withstand full vacuum.

j. Method of cooling: Cooled by oil and air natural circulation (ONAN) with radiators.

k. Type of core: gapped iron core of 5 limbs, including side limbs. In general, the iron core shall be designed in such way so that no risk exists of ferroresonance or sub-harmonic oscillations due to system switching operations, overheating of any metal parts and natural resonance of any part of the structure at or near operating frequency.

2. Magnetic Characteristics

The shunt reactors must exhibit linear volt/ampere characteristic up to 120 percent (120%) of their rated voltage.

3. Zero-Sequence Reactance

The ratio of the zero-sequence to the positive sequence reactance (X_0/X_1) of the shunt reactors shall lie between 0.95 and 1.0

4. Temperature Rise Limits

The following temperature rise limits for continuous operation shall be:

- Average temperature rise of winding as determined by resistance : 65^{o}C
- Oil (top level) as determined by thermometer : 60^{o}C
- Reference ambient temperature : 40^{o}C

5. Harmonics

Shunt reactors shall be designed with particular attention to the suppression of harmonics, especially the second, third and fifth. The maximum permissible value of the third harmonic component of the reactor current shall be $\leq$ 3% of the crest value of the fundamental at rated sinusoidal voltage.

6. Voltage Variation

The reactors shall be designed to operate at 105% of their rated voltage continuously, without exceeding the specified temperature rise limits.

7. Acoustic Sound Level

The acoustic sound level of the reactors shall not be greater than 80dB(A) measured at 2m from the reactor tank.

8. Mechanical Vibration Level

Maximum vibration amplitude (peak to peak) on all sides of the tank walls shall be 200 μm.

9. Reactor's oil

The reactor's insulation oil will be mineral and in accordance with the latest IEC 60296 class II Standard. It shall be non-toxic and biodegradable without PCB's or PCTs etc.

10. Reactor's color

The reactor's color including radiators should be gray of 7040 RAL type and with color of thickness 120μm ± 20μm.

VIII. ACCESSORIES

1. Bushings

The design of bushings will be in accordance with the IEC 60137 Standard.

1.1 The bushings of each reactor's winding will be of outdoor – immersed capacitance graded oil insulated type with one end exposed in ambient air and the other end immersed in the reactor's oil.

1.2 The active part of the bushing will consist of an Oil Impregnated Paper (O.I.P.) condenser type core, impregnated with the reactor's oil.

1.3 The insulation housing of H.V. and neutral bushings will be of high grade porcelain and will be of gray color.
The porcelain housing will comply in all relevant respects with IEC 60233.
"Test on hollow insulators for use in electrical equipment".
The space between the active part (core) and the insulating envelope will be oil filled (liquid-insulated bushings).

1.4 The bushings are required to be of the following rating characteristics:

	H.V.	Neutral
1.Highest rated Voltage (phase to phase) (Um) (KV-r.m.s.)	420	72,5
2.Rated phase to earth operating voltage (KV - r.m.s.)	242	42
3.Rated current (Ir*)(A)	800	1250
4.Rated thermal short time current, 1 sec (Ith)	25Ir	25Ir

5.Rated dynamic current (Id)	2.5Ith	2.5Ith
6.Minimum cantilever withstand load during operation (N)	≥2000	≥1000
7. Creepage distance (mm)	12600	1820
8.Angle of mounting	≤30º from vertical	≤30º from vertical
9.Temperature limits – class of the insulating material in contact with metal parts	105º C Class A	105º C Class A
10. Dielectric dissipation factor (tanδ) at 1,05Um/√3 voltage	≤0.007	≤0.007
11. Maximum value of partial discharge quantity at Um operating voltage	≤10pC	≤10pC
12.Lightning impulse withstand voltage (KV)	1550	325
13.Switching impulse withstand voltage (KV)	1175	-
14. Power frequency withstand voltage (KV)	680	140

1.5 Additional characteristics of bushings.

a. Seismic withstand capabilities.

All bushings shall be capable of withstand the following seismic stresses as per IEC 61463 and IEC 60068-3-3.

1. Horizontally (axes x and y) :0.5g (5m/s^2)
2. Vertically (axe Z) :0.25g (2.5m/s^2)
3. The frequency range should be 1Hz to 35Hz.
4. Acceptable methods of seismic qualification are:
   - Qualification by vibration test or
   - Qualification by static calculation or
   - Qualification by dynamic analysis

Bidders are obliged to submit in their offers, test reports or calculation by dynamic analysis or static calculation. Approval or not of all the above lies on IPTO judgment.

b. Bushings shall be designed for operation at ambient temperature from -25ºC to +45ºC and an altitude not exceeding 1000m.

c. The maximum oil temperature under operating emergency conditions will be 115ºC.

d. (*) If after taking into consideration the above stated operating characteristics, the above indicated bushings rating current is less than what it should, then offerers must offer bushings with suitable rating.

1.6 Accessories:

Bushings will be equipped with the accessories below:

a. Oil level indicator.

b. Test tap (tanδ tap) suitable for measurement of the dielectric dissipation factor, capacitance and partial discharge value of the bushing. The test tap will be electrically isolated from the mounting flange and will be always earthed directly when it is not used.

c. Air release plug.

d. Oil expansion compensator.

e. Oil sampling and oil filling plugs.

f. Lifting lugs if required by the manufacturer and there are no other means of lifting the bushings.

1.7 Note

Bushings with insulating housing which consists of a resin impregnated fibre tube and silicon rubber covering can be accepted providing they cover the requirements of paragraph VIII-1

1.8 Rating plates – markings

The H.V and neutral bushings shall carry a rating plate including the following markings.

- Manufacture's name.
- Year of manufacture and serial number
- Maximum operating phase – phase voltage (Um) or rated operating phase to earth voltage and rated frequency.
- Operating rated current (Ir)

- Insulation levels BIL, SIL, P.F.
- Bushings capacitance, dielectric dissipation factor.
- Mass
- Angle of mounting

1.9 Tests

The manufacturer of the reactor is obliged to present to the IPTO inspector the bushings test reports while the inspector is at the manufacturer's premises for the inspection and testing.
The test reports which are to be presented shall include the following type, routine and special tests:

The tests will be in accordance with IEC – 60137 Standard

A. Type tests

1. Power – frequency voltage withstand test
2. Lightning impulse voltage withstand test
3. Switching impulse voltage withstand test (for H.V. bushings)
4. Thermal stability test

5. Electromagnetic compatibility test
6. Temperature rise test
7. Verification of thermal short – time current withstand
8. Cantilever load withstand test
9. Tightness test
10. Verification of dimensions.

B. Routine tests

1. Measurement of dielectric dissipation factor (tanδ) and capacitance at ambient temperature
2. Lightning impulse voltage withstand test
3. Power – frequency voltage withstand test
4. Measurement of partial discharge quantity
5. Test of tap insulation
6. Tightness test
7. Visual inspection and dimensional check

C. Special tests

1. Seismic test (IEC 61463)
2. Artificial pollution test (IEC 60507)

NOTE: Type and special test reports may not be presented if they have been previously submitted in the technical offer and have been found to be satisfactory.

1.10 The bushings shall be of MICAFIL of Switzerland or F+G or ABB or Haefely or Passoni-Villa.

2. Bushing Current Transformers

Each line bushing shall be equipped with two (2) current transformers. In addition, the neutral bushing shall be equipped with one (1) current transformer.

The above referenced current transformers must have the following characteristics:

Bushing	**Ratio**	**Total No. of CTs Cores**	**Burden**	**Accuracy class**
Line	100 / 1-1A	6	30VA	5P20
	100 / 1A	3	30VA	0.5
Neutral	100 / 1A	1	30VA	5P20

- Three (3) of the line bushings current transformer cores will be used for the implementation of the overcurrent phases-earth protection scheme.
- The other three (3) line bushing current transformer cores and also the current transformer core at the neutral, will be used for the implementation of the Restricted Earth Fault protection scheme for high impedance operation. For that scheme, a linear stabilizing resistor and a non-linear voltage limiter resistor are also used. These CTs shall have equal ratios, identical magnetizing characteristics and also identical secondary resistances. The magnetizing current shall be of a minimum value available in order to maximize the sensitivity of the relay. The saturation (knee-point) voltage must be the same for all CTs and twice the selected operating voltage setting of the relay that corresponds to maximum fault current.

Complete test reports including thermal and dynamic current tests as type tests and resistance measurement, ratio and phase angle tests and excitation curve tests as routine tests must be submitted.
Complete test protocols for the above bushing current transformers shall be available at the time of inspection of the reactors.
Also the secondary windings of CT's of bushings will be tested with the applying a power frequency voltage of 3KV to earth.

3. Terminals

Line and neutral terminals shall be of cylindrical rod shape of 30 mm in diameter and suitable for connection with aluminium clamps.

4. Supervisory and Protection Equipment.

Reactors shall be equipped with the following:

a. Earthquake proof Buchholz relay similar to type 10 VEM (Germany) with electrically separate contacts for alarm and tripping.
b. Oil level indicator with alarm contacts for minimum oil level.
c. Dial - type oil thermometer with alarm and trip contacts and also equipped with a transmitter device for remote oil temperature indication. The necessary panel instruments for remote indication shall also be furnished by the contractor.
d. Dial- type windings thermometer with alarm and trip contacts and also equipped with a transmitter device for remote oil temperature indication. The necessary panel instruments for remote indication shall also be furnished by the contractor.
e. Tank pressure relief device with alarm contacts.
f. Air drier with silica gel filling.

NOTE: Oil level indicator and Dial-type oil thermometer shall be of AKM or MESSKO make and also the pressure relief device will be of QUALITROL make.

5. Additional Accessories

Reactors shall be equipped with the following accessories and features:

a. The radiators shall be tank-supported and detachable from the tank by means of shut-off butterfly-type valves.
b. All steel parts will be hot dip galvanized as per the latest ASTM Standards.
c. Tank oil drain valve and other valves to connect the oil treatment equipment and oil sampling device.

d. Conservator or expansion tank composed of one piece ready for installation and will be equipped with a dehydrating breather containing absorbent material (silica-gel) and also a dry air cell floating on the oil surface as well as suitable drain valve.
e. Filling plug on the upper radiator header.
f. Gasketed joints for bushings, manholes and radiators shall be designed so that the gaskets will not be exposed to the weather and will be provided with mechanical stops to prevent crushing of the gasket.
g. Lifting eyes for the tank, pulling eyes for moving the reactor to any direction, lifting lugs for lifting the core and coil assembly and jacking pads for raising the complete shunt reactor.
h. Bi - directional rollers for movement on rails.
i. The tank will be grounded in two points at least diagonally near the bottom.
j. Plate of non-corrosive material bearing the electrical diagram of the reactor.
k. Nameplate made of non-corrosive material bearing the rated characteristics of the reactor and other essential data.
l. Weatherproof terminal box for termination of weather resistant 600 V, color-coded or marked for identification control and signal wiring.

IX. NAME PLATE MARKINGS

Each reactor shall be provided with a permanent nameplate that includes the following information.

1. Type of reactor.
2. Outdoor/indoor application.
3. Manufacturer's name.
4. Serial Number.
5. Year of manufacture.
6. Number of phases.
7. Rated Power.
8. Rated Frequency.

9. Rated Voltage.
10. Rated Current.
11. Maximum operating voltage.
12. Insulation level (BIL).
13. Winding connection.
14. Reactance at rated voltage (measured value).
15. Type of cooling.
16. Total mass.
17. Mass of insulating oil.
18. Transportation mass.
19. Untanking mass.
20. Zero-sequence reactance.
21. Mutual reactance.

X. TESTS

Any rectriction concerning the test performance capability (e.g due to the laboratory's sufficiency itself) will be stated along with the offer.
The following tests shall be carried out for the shunt reactors:

A. Routine Tests

1. Measurement of winding resistance

2. Measurement of reactance.

3. Measurement of losses at rated voltage and frequency (50 Hz)

4. Lightning Impulse Tests on Line Windings
   The impulse test-sequence is applied to each of the line windings.
   The other line windings and the neutral shall be earthed directly or through low impedance.
   The lightning impulse test shall precede the low frequency tests. The impulse test voltage shall be a 1.2/50 μs wave of negative polarity.
   The test sequence of the different impulses shall be as follows:
   - One reduced full impulse : For this test, the applied voltage wave shall have a crest value between 50% and 75% of 1425 kV.

- Three 100% full impulses : For this test the applied voltage wave shall have a crest value of 1425 kV.

Lightning Impulse Tests on Neutral

For this test, all line windings are earthed and with full wave of crest value of 325kV, one full impulse shall be applied directly to the neutral, with front time up to 13μsec.

5. Switching Impulse Test

A switching impulse test shall be carried out on all line windings using a voltage of 1050 kV. The test shall be carried out by applying to each phase in turn, from line winding to neutral with the neutral earthed, one reduced voltage wave and three full voltage waves. The reduced voltage wave shall have a crest value between of 50% and 75% of 1050 kV.
The test shall be performed with the waveshape:
100μsec/1000μsec (wave of negative polarity)

6. Separate - source Voltage Withstand Test

- A test voltage of 140 kV rms, 50 Hz shall be applied for 60 seconds between the line winding terminal under test and to all remaining winding terminals, as well as core, frame and tank of the reactor connected together to earth. This test will be carried out for all line winding terminals.
- A test voltage of 140 kV rms, 50 Hz shall be applied for 60 seconds between the neutral under test and all winding terminals, as well as core, frame and tank of the reactor connected together to earth.

7. Induced Over-voltage Withstand Test Long Duration (ACLD) and measurement of partial discharges.

This test and measurement of partial discharges will be executed in accordance with IEC 60076-3 and with three-

phase reactor to be tested phase-by-phase in a single-phase connection circuit.

B. Special Tests

The special tests shall be carried out on one (1) item of the order

1. Measurement of zero-sequence reactance.
2. Measurement of mutual reactance.
3. Measurement of acoustic sound level.
4. Measurement of vibrations.
5. Measurement of harmonics of the current.
6. Measurement of magnetic characteristics.
7. Measurement of linearity of reactance at 70%, 90% and 105% of rated voltage.
8. Test with lightning impulse chopped on the tail (LIC) (only on line terminals)

   The test will be carried out by the use of the same test equipment as of the lightning withstand impulse test with only the chopping gap to be added. During the full-wave impulse test and for each winding, application of chopped impulses with a peak value 10% greater than the amplitude of corresponding full impulse should be inserted, forming the test sequence as follows:

   1. Application of one reduced level, full wave impulse 1.2/50μs (50%÷70% of full impulse)
   2. Application of a full level, full wave impulse 1.2/50 μs
   3. Application of one or more reduced level, chopped wave impulses 1.2/50 μs

4. Application of two (2) full level, chopped wave impulses 1.2/50 μs
5. Application of two full level, full wave impulses 1.2/50μs

The chopping time of the chopped lightning impulse will be between 2 μs and 6 μs.

9. Inducad Over-voltage withstand test short duration (ACSD) and measurement of partial discharges

This test and measurement of partial discharges will be executed in accordance with IEC 60076-3 and with three-phase reactor to be tested phase-by-phase in a single-phase connection circuit.

C. Type Tests

Temperature-rise Test.

The temperature rise test will be carried out before the dielectric routine tests.
The test shall be carried out at 105% of rated voltage at 50Hz

XI. DATA TO BE SUPPLIED BY BIDDER

1. Bidders must provide all information requested by "SCHEDULE A" attached to this hereby technical description. Failure on the Bidder's part to comply in this respect will be taken as reasonable ground for the rejection of the offer.

2. Bidders are required to submit, along with the offer, drawings showing the outline dimensions of the reactor for erection purposes as well as any information, sketches and data necessary for a complete description of the reactor and related equipment offered.

3. Providing that a contract has been awarded, the seller shall furnish three (3) copies of the following drawings for approval and before the construction of the reactors :

a. Assembled reactor outline drawing.
b. Bushing outline drawing.
c. Name plate drawing.
d. Bushing current transformer control wiring diagrams.
e. Bushing current transformer characteristic curves showing open circuit secondary saturation, ratio and phase angle correction.
f. Wiring diagram of the reactor itself.

In addition the seller shall provide the following :

Five (5) copies of final drawings and five (5) copies of complete instruction books for erection and maintenance, all along with the shipment of the reactors.

XII. ECONOMIC COMPARISON OF THE OFFERS

The economic comparison of the offers shall be made according to the data requested by the "SCHEDULE B" of this hereby technical description.

XIII. SPARE PARTS

Bidders should quote the following spare parts giving item prices:

Item Nr.	Description
1.	One line-end bushing complete.
2.	One neutral-end bushing complete.
3.	Complete set of gaskets for all bushings, covers, radiator flanges, manholes and handholes for one reactor.
4.	Set of replacement parts for each type of part likely to be damaged upon operation such as relays, instruments, safety devices, etc.

The Purchaser reserves the right to determine, when signing the contract, the spare parts which seller shall furnish on the basis of the prices set forth in the proposal.

XIV. PACKING

The accessories of the reactors will be packet inside robust, entirely closed, wooden boxes, of at least 20mm thickness and maximum gross weight of 5 tons.
The boxes will be of pallet type and they will be protected internally by an insulating material (e.g.nylon).
The oil will be sent inside barrels and also the instruments, control and protection equipment will be sent inside separate boxes as above.

TECHNICAL DESCRIPTION TD-95/3

"SCHEDULE A"

400 kV, 30 MVAR or 50 MVAR or 60 MVAR SHUNT REACTORS

INFORMATION REQUIRED BY THE SELLER

1.	Applicable Standards	:	----------
2.	Type of the reactor	:	----------
3.	Rated Voltage of the reactor	:	----------kV rms
4.	Maximum Operating voltage of the reactor	:	----------kV rms
5.	Rated Power at 400 kV (continuous duty)	:	----------Mvar
6.	Rated Frequency	:	---------- Hz
7.	Rated Current at 400 kV	:	---------- A
8.	Rated Reactance	:	----------
9.	Method of Cooling	:	----------
10.	Phase Connection	:	----------
11.	Type of core design (number and type of limbs)	:	----------
12.	Type of oil used	:	----------
13.	Reactor identification with regard its magnetic characteristic (i.e. linear, non-linear, etc)	:	----------

14. Ratio of zero sequence reactance to positive sequence reactance (Xo/X1) : ----------

15. Acoustic Sound Level : ---------- dB

16. Mechanical Vibration Level : ---------- μm

17. Voltage Variation Capability : ----------

18. Harmonics of the current as per cent of the fundamental

2nd : ----------
3rd : ----------
5th : ----------

19. Winding temperature rise limits for 40°C ambient temperature (guaranteed values)

- Average by winding : ---------- °C

20. Oil (Top) temperature at 40°C ambient temperature : ---------- °C

21. Lightning Impulse withstand voltages:

- Line windings/bushings : -------/-----kV crest
- Neutral terminal/bushing : ------/------kV crest

22. Switching impulse withstand voltages

- Line windings/bushings : -------/-----kV crest

23. Power frequency withstand voltages (1 min, 50 Hz)

- Line windings/bushings : -------/-----kV rms
- Neutral terminal/bushing : -------/-----kV rms

24. Total losses

- At rated voltage (400 kV) (guaranteed value) : ---------- kW
- At 105% of rated voltage : ---------- kW

25. Bushings

a. Line bushings

- Type : ----------
- Manufacturer : ----------
- Lightning impulse withstand voltage : ---------- kV crest
- Switching impulse withstand voltage : ---------- kV crest
- 50 Hz withstand voltage (1 minute) : ---------- kV rms
- Creepage distance : ---------- mm
- Rated current : ---------- A
- Color of porcelain : ----------

b. Neutral Bushing

- Type : ----------
- Manufacturer : ----------
- Lightning impulse withstand voltage : ---------- kV crest
- Creepage distance : ---------- mm
- 50 Hz withstand voltage (1 minute) : ---------- kV rms
- Rated current : ---------- A
- Color of porcelain : ----------

26. Bushing Current Transformer

	Line		**Neutral**
	CT	**CT**	**CT**
Ratio			
Burden			
Accuracy class			
Manufacturer			
Type of protection			
Secondary resistance			

Magnetizing current			
Knee-point voltage			

27. Supervisory and Protection Equipment

a. Buchholz relay
- Type : ----------
- Manufacturer : ----------

b. Oil Level indicator
- Type : ----------
- Manufacturer : ----------

c. Dial-type oil thermometer
- Type : ----------
- Manufacturer : ----------

d. Dial-type windings thermometer
- Type : ----------
- Manufacturer : ----------

e. Tank pressure relief device
- Type : ----------
- Manufacturer : ----------
- Alarm contacts : ----------

28. Are the reactor's accessories in accordance with the requirements of paragraph VIII-5? : ----------

29. Is the reactor tank of cover bolted type? : ----------

30. Mechanical data
- Color of the reactor : ----------
- Mass of core and coils : ---------- kg
- Mass of oil : ---------- kg
- Total mass of reactor : ---------- kg
- Tank type and method of connection to the bottom plate : ----------

- Untanking weight : ---------- kg
- Over-all height : ----------
- Total shipping weight : ---------- kg
- Oil in tank for shipping : ---------- kg
- Describe with what the reactor's tank will be filled for transport purposes : ---------- kg

31. Is there any restriction concerning the test performance capability (e.g due to the laboratory's sufficient itself)? : ----------

32. Indicate acceptance of the specified tests (Yes of No) : ----------

33. Is the paching accordily to the paragraph XIV of the specification? : ----------

34. Deviation, if any, from the present specification and the reasons thereof : ----------

TECHNICAL DESCRIPTION TD-95/3

"SCHEDULE B"

400 kV SHUNT REACTORS

EVALUATION OF LOSSES

1. Reactor first cost and losses

1.1. The reactor first cost
(The reactor first cost will be computed by the Purchaser who will consider the Seller C+F price, as amended after the evaluation of the proposed terms of payment). K = --------- €

1.2. Total losses at rated voltage 400 kV
(guaranteed value) C = --------- kW

2. Reactor annual cost

1. Reactor carrying charges $\frac{9{,}37K}{100}$ = _____ €
2. Capacity loss
(at 116,7 € per kilowatt-year) _____ . C = _____ €
3. Energy loss (at 0,0438 € per kWh) ____ · C ·7500 h =____ €
4. Total annual cost (1+2+3) (the sum)= _____ €

3. Penalty for excess losses.

With regard to total losses, a reactor is considered as successfully inspected if the losses ascertained during inspection do not exceed the maximum tolerance, specified in the IEC Standards, versus the losses guaranteed by Seller. Otherwise the reactor shall be rejected.
On each successfully inspected reactor, any difference in the losses versus the guaranteed ones (without tolerance), shall be negative or zero. If such difference is positive, i.e. the losses ascertained during inspection exceed the guaranteed ones (without tolerance) penalty shall be imposed on Seller consisting of:
4751 €. per kW of total losses in excess.