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

October 2015

TECHNICAL DESCRIPTION TD-7/2
20kV, 150A DRY TYPE DAMPING REACTORS

I. SCOPE

This technical description covers the characteristics, design features and testing of 20kV, 150A dry-type damping reactors.

II. KEYWORDS

Reactors, damping reactors, dry-type reactors, inrush currents.

III. STANDARDS

Unless otherwise described herein, all material, equipment, fabrication and testing shall conform to the latest revision of IEC-60076-6 Standard.

IV. OPERATING CONDITIONS

1.	Installation	:	Outdoor
2.	Ambient Temperature	:	Minimum (-20°C) Maximum (+45°C)
3.	Altitude	:	Up to 1000m above sea level
4.	Other Conditions	:	Snow and Ice
5.	Pollution Level	:	Moderate

V. USE AND CONNECTION

The damping reactors are to be used for limiting the inrush currents occurring during the switching of double-wye ungrounded, 4MVAR capacitor banks.
They are to be connected in series with the capacitors.

VI. ELECTRICAL CHARACTERISTICS OF THE SYSTEM

1.	Nominal Voltage	:	20kV
2.	Maximum Operating Voltage (phase-to-phase)	:	24kV
3.	Number of phases	:	3
4.	Nominal Frequency	:	50 Hz
5.	Short Circuit Level	:	10kA

6. Basic Insulation Level : 150kV crest
7. Grounded neutral via a 12Ω resistor.

VII. AVAILABLE ELECTRIC AUXILIARY SUPPLY CHARACTERISTICS.

1. Auxiliary A.C. Voltage: 3-phase, 4-wire, 230/400V, 50Hz.
2. Auxiliary D.C. Voltage: 110V available from the station battery. (For control and signalling).

VIII. DAMPING REACTOR REQUIRED CHARACTERISTICS

1. Design Characteristics

a. Dry-Type.
b. Air core.
c. Single-phase.
d. Naturally (self) cooled.
e. For outdoor installation.

2. Basic Rated Characteristics

a. Rated Voltage (phase-to-phase) : 20 kV
b. Maximum Operating Voltage (phase-to-phase) : 24 kV
c. Rated Continuous Current : 150 A
d. Rated Inrush Current : 10000 A
e. Rated Inrush Frequency : 4000 Hz
f. Rated Inductance : 80 μH
g. Rated insulation levels of winding and terminals :

   - Lightning impulse withstand voltage, 1.2/50μs wave : 150kV crest

h. Short circuit current withstand for 1 sec : 10 kA

3. Temperature Rise Limits

The temperature rise limits must be in accordance with the following table:

Part	Cooling method	Temperature class of insulation	Maximum temperature rise (°C)
Windings and other parts	Air,	A E	60 75

(temperature rise measured by the resistance method).	natural	B F	80 100

4. Short Circuit Withstand Capability

The damping reactors shall be designed so as to withstand without damage the mechanical and thermal stresses produced by external short circuits.

5. Tolerances

+10% of rated inductance.
0

6. Additional Design Features

a. The reactors shall be cylindrical in shape and encapsulated and bonded with epoxy impregnated fiber glass.

b. The reactors shall be equipped with lifting lug.

c. The reactors shall be designed in such way as to be installed side by side (three per capacitor bank) on a steel support structure and mounted on the support structure via 20kV porcelain insulators .

d. The reactor input - output terminals must be of aluminum nickel or tin plated, rectangular in shape.

e. The dimension of the reactors will be the following:
- Diameter:350mm maximum
- Height including insulator: 700mm maximum

IX. INSULATORS

Each damping reactor shall be installed on an appropriate insulator so that it can be mounted on a steel support structure.
Insulator characteristics :

- Nominal Voltage : 20kV
- Maximum Operating Voltage : 24kV
- Impulse Withstand Voltage : 150kV crest
- Total height : ≈ 350 mm
- Surface diameter on which the reactor will be mounted : Ø 108 mm
- Shape of insulator surface on which the reactor will be placed on :

X. NAME PLATE MARKINGS

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

1. Type of reactor.
2. Manufacturer's name.
3. Year of manufacture.
4. Rated Voltage.
5. Rated Current.
6. Rated Frequency.
7. Maximum operating voltage.
8. Inductance.
9. Total mass of the reactor.
10. Insulation level (BIL).

XI. TESTS

The following tests shall be carried out for the damping reactors in accordance with IEC-60076-6 Standard.

A. Routine Tests

1. Measurement of winding resistance.

2. Measurement of inductive reactance (inductance).

3. Winding over voltage test

4. Measurement of losses.
   The measurement shall be carried out at rated current and rated frequency or the measurement may be made at any current and corrected to rated current. The correction will be done by multiplying the measured losses by the square of the ratio of rated current to measured current.

   - The measurement shall be carried out by the bridge method.
   - The measurement shall be carried out with an ambient temperature between 10 ^{o}C and 40 ^{o}C.

B. Type tests

1. Temperature - rise test

2. Lightning impulse test
   - The impulse test shall be a 1.2/50μs wave of negative polarity.
   - The test sequence shall be as follows:
     One impulse between 50% and 75% of 150kV.
     Three (3) subsequent impulses at 150kV.

XII. DATA TO BE SUPPLIED BY BIDDER

1. Bidders must provide all information requested by "ATTACHMENT 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, the arrangement of terminals as well as any information, sketches and data necessary for the complete description of the reactor.

3. Mounting details for the reactor on the insulator and also for the insulator on the steel support structure.

4. Bidders are required to submit a drawing in which the minimum magnetic clearances among the reactor and metallic structures or metallic parts are indicated and also the minimum magnetic clearances among the reactors given the fact that they will be installed side by side (three in the same row)

5. Providing that a contract has been awarded, the seller shall furnish three (3) copies for approval and five (5) copies of final approved drawings before the shipment of the reactors:

   These drawings shall include the following :

   - Reactor outline drawing, detail dimensions and arrangement of the terminals and details for mounting the reactor on the insulator.

XIII. ECONOMIC COMPARISON OF THE OFFERS

The economic comparison of the offers shall be based on the reactor total first cost and the cost per kW of the guaranteed losses. The total 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. It shall include also any custom duties.

For this reason all bidders must fill paragraph 1-c of attachment “B” only , and submit this along with all other technical informations in the technical offer.

If during inspection, the losses exceed the guaranteed ones, a penalty shall be imposed on Seller consisting of 1819€ per kW of losses in excess.

The guaranteed capacitor losses in W/KVAR must be clearly indicated in attachment “A” as well.

TECHNICAL DESCRIPTION TD-7/2

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ATTACHMENT "A"

INFORMATION REQUIRED BY THE SELLER

1.	Applicable Standards	:	----------
2.	Nominal Inductance	:	---------- µH
3.	Rated Voltage of the reactor	:	---------- kV rms
4.	Maximum Operating voltage of the reactor	:	---------- kV rms
5.	Rated Power	:	---------- MVAR
6.	Rated Frequency	:	---------- Hz
7.	Rated Continuous Current	:	---------- -- A
8.	Rated Reactance	:	---------- Ω
9.	Method of Cooling	:	----------
10.	Single - phase (Yes / No)	:	----------
11.	Type of core design	:	----------
12.	Rated inrush current	:	----------kA
13.	Rated inrush frequency	:	---------- Hz
14.	Acoustic Sound Level	:	---------- dB

15. Mechanical Vibration Level : ---------- µm

16. Winding resistance : ---------- Ω

17. Winding and other parts temperature rise limits
- Temperature class of insulation : ----------
- Maximum temperature rise : ---------- °C

18. Lightning Impulse winding withstand voltage : ---------- kV crest

19. Total losses
- At rated voltage (20 kV) (guaranteed value) : ---------- kW

20. Terminals
- Type of metal : ----------

21. Mechanical data
- Total mass of reactor : ---------- kg
- Over-all height of the reactor including insulator : ---------- mm
- Total diameter of the reactor : ----------mm
- Colour of the reactor : ----------

22. Minimum magnetic clearance to metallic structures to avoid forming closed loops : ----------

23. Minimum distances among reactors (for installation side by side) : ----------

24. Magnetic coupling (if known, for reactors placed side-by-side) : ---------- -----

25. Tolerances : ----------%

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

27. Short circuit withstand of the reactor for one (1) second : ----------

28. Deviations, if any, from the present specification and the reasons thereof : ----------

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ATTACHMENT "B"

DATA WHICH MUST BE PROVIDED BY THE SUPPLIER

1. INITIAL COST AND LOSSES

a. Reactor rating : 80μH

b. Reactor first cost (The reactor total 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.
This cost will also include the corresponding custom duties and any other charge which Purchaser will consider necessary) : K=.....€

c. Total reactor losses : A=.....kW

2. Reactor annual cost

a. at (9,37% per cent) : $\frac{9{,}37.K}{100}$ = ……..€

b. Power cost : Power cost.A =.....€
(in €/ kW)

c. Energy cost : Energy cost. A. 1080hours =.....€
(in €/ kWh)

Total annual cost **:sum of (a+b+c) =.....€**