NATIONAL TRANSMISSION AND DESPATCH COMPANY

NTDC SPECIFICATION P-78:2010

SINGLE PHASE SHUNT CAPACITOR, 12/√3kV, 100 & 200KVAR

DESIGN DEPARTMENT NTDC

CONTENTS

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NTDC SPECIFICATION P-78:2010

SINGLE PHASE SHUNT CAPACITOR, 12/√3kV, 100 & 200KVAR

0.0 FOREWORD

0.1 This specification has been prepared by Standards & Research Directorate of the Design Department NTDC. This fourth edition cancels and replaces the earlier editions published in 1971, 1982 & 1993 and its amendments.

0.2 This specification is intended for the procurement of material but does not include all the necessary provisions of the contract.

0.3 This specification is subject to revision as and when required by S&R directorate of Design NTDC only. No other department is authorized to make/issue amendment in the said specification.

1.0 SCOPE

1.1 This specifications is applicable for outdoor, non-enclosed, externally fused, 12/√3kV, single Phase shunt capacitors intended for use on 11.5kV bus of Grid Station to be mounted on capacitor racks to form capacitor banks for power factor correction and improvement of voltage. The specification of rack for mounting of capacitors to form a 2400KVAR capacitor bank with control equipment is covered under NTDC specification P-165 amended to date.

2.0 REFERENCE STANDARDS

2.1 The capacitors shall generally be designed, constructed and tested in accordance with the International Electro-technical commission publication 60871-1 & 60871-2 amended to-date.

2.2 In case the requirements laid down herein differ from those given in the IEC 60871 in any particular aspect, the requirements listed herein shall prevail.

3.0 DEFINITIONS

The definitions of IEC 60871 shall apply. Some of them are reproduced here for ease of reference.

3.1 Capacitor Element

A device consisting essentially of two electrodes separated by a dielectric.

3.2 **Capacitor Unit**

An assembly of one or more capacitor elements in the same container with terminals brought out.

3.3 **Discharge device of a Capacitor**

A device which may be incorporated in a capacitor, capable of reducing the voltage between the terminals practically to zero, within a given time, after the capacitor has been disconnected from a network/supply system.

3.4 **Rated Capacitance of a Capacitor (Cn)**

The capacitance value derived from the values of rated output, voltage and frequency of the capacitor.

3.5 **Rated Output of a Capacitor (Qn)**

The reactive power for which capacitor has been designed.

3.6 **Rated Voltage of a Capacitor (Un)**

The r.m.s value of alternating voltage for which the capacitor has been designed.

3.7 **Rated Current of a Capacitor (In)**

The r.m.s value of the alternating current for which capacitor has been designed.

3.8 **Capacitor Loss**

The active power dissipated in the capacitor, i.e, losses produced from all components for example: dielectric, internal discharge resistor, connections, internal fuse if available, etc.

3.9 **Tangent of Loss Angle (tan δ)**

The ratio between the equivalent series resistance and capacitive reactance of the capacitor at specified sinusoidal alternating voltage and frequency.

3.10 **Steady State Condition**

Thermal equilibrium attained by the capacitor at a constant output and at constant ambient temperature.

3.11 **Residual Voltage**

The voltage remaining on the terminals of capacitor at a certain time following disconnection.

4.0 **SERVICE CONDITIONS**

The shunt capacitors shall be suitable for satisfactory operation under the following service conditions:-

4.1 **Climatic Conditions**

4.1.1 **Ambient Temperature**

Maximum	50°C.
Maximum mean over any 24 hours	45 °C.
Mean in any year	30 °C
Minimum	-10 °C

4.1.2 **Relative Humidity**

The relative humidity may range from 0 to 100 percent. The maximum value of the ambient temperature and humidity, however, do not occur simultaneously. During the monsoons, high humidity may persist for many days at a time along with temperatures ranging from 30°C to 40°C.

4.2 **Altitude**

The capacitors shall be suitable for installation up to 1000 m above sea level.

4.3 **Atmospheric Conditions**

It may be assumed that the air is not normally heavily polluted by dust, smoke, aggressive gases, vapours or salt spray. However, at certain times of the year severe dust storms may be experienced.

4.5 **Supply System**

4.5.1 The shunt capacitors shall be installed in three phase Y connected capacitor banks having the following characteristics;

Nominal single phase voltage	$11.5/\sqrt{3}$kV
Nominal voltage line to line	11.5kV
System highest line to line voltage	12 kV
Frequency	50 Hz.

4.5.2 The neutral of 11.5kV systems is solidly earthed at the power transformer. The capacitors may be used in grounded or ungrounded Y connection.

5.0 RATINGS AND CHARACTERISTICS

5.1 The shunt capacitors shall be so designed as to comply with the following ratings, characteristics:

Sr. No.	Description	
i.	Rated Output, Qn	100/200 KVAR
ii.	Rated Voltage, Un	$12/\sqrt{3}$kV
iii.	Rated Frequency, fn	50 Hz
iv.	Rated current, In	14.43/28.86A
v.	Rated capacitance, Cn	6.63/13.26μF
vi.	Lightning Impulse Voltage withstand, 1.2/50μs to 5/50μs.	95 kV, peak
vii.	AC Voltage withstand between bushing terminals	2.0Un for 10s
viii.	AC voltage withstand between bushing terminals and container.	38kV for 60s
ix.	AC voltage withstand between bushing terminals and container with rain	38kV for 60s
x.	Residual voltage	50V within 300s
xi.	Standard Temperature category.	-10 °C to 55°C.
xii.	Material of bushing.	Porcelain
xiii.	Rated voltage.	12kV
xiv.	Power frequency withstand voltage.	38kV for 60s
xv.	Lightning Impulse Voltage withstand, 1.2/50μs.	95 kV, peak
xvi.	Creepage distance of Bushing.	350mm
xvii.	**Melting point of solid dielectric**	≥140°C
xviii.	**Characteristic of Dielectric fluid**	
	i) Density at 20°C, g/cm³	0.99—1.02
	ii) Flash point	≥135°C
	iii) Dielectric dissipation factor, tan δ at 90 °C	≤0.005
	iv) Pour point, °C	≥- 40°C
	v) Dielectric strength, min.	≥40kV

5.2 PERMISSIBLE OVERLOADS

5.2.1 Maximum Permissible AC Voltage

Capacitor unit shall withstand the following over voltage levels for specified durations:

Voltage Level	Duration
1.0 Un	Continuous, the highest average value during any period of capacitor energization.
1.10Un	12 hour in every 24h due to system voltage regulation and fluctuations.
1.15Un	30 Minutes in every 24 h due to system voltage regulation and fluctuations.
1.20Un	5 Minutes due to voltage rise at light load
1.30Un	1 Minute

5.2.2 Maximum Permissible Current

Capacitor units shall be suitable for continuous operation at an rms current of 1.30 times the current that occurs at rated sinusoidal voltage and rated frequency excluding transient.

5.2.3 Tolerance in KVAR Output

Capacitors units shall be designed to give output between –5% and +10% of rated value at rated voltage and frequency.

6.0 CONSTRUCTIONAL REQUIREMENTS

6.1 The capacitor units shall consist of flattened rolls of dead soft, annealed Aluminum foil between sheets of high strength all film or film/paper dielectric.

6.2 The element shall be suitably supported in a stainless steel tank of welded constructions whose dimensions are shown in Drawing No. PDW/DF-386. The tank shall be capable of withstanding the maximum stress likely to be encountered during short circuit conditions without bursting.

6.3 The grade of stainless steel shall be such that welding does not cause deterioration of its rust resistant properties around the weld.

6.4 The bushings shall be made from good commercial grade wet process porcelain conforming to relevant IEC/international standard. The entire surface of the bushing with exception of a firing surface shall be smoothly glazed and shall be free from imperfections. The bushings shall be hermetically sealed (solder/weld) to the tank cover to prevent ingress of moisture and air. Rubber or synthetic materials, gaskets or washers shall not be used for sealing.

6.5 The capacitors shall be hermetically sealed and completely filled with a stable, non-toxic, high dielectric liquid. The liquid shall be non-PCB i.e. shall not contain any chlorine or mixture of chlorinated benzenes and shall be easily and safely disposable.

6.6 The capacitors shall be dehydrated under high vacuum and temperature. The manufacturer shall ensure complete impregnation of the film and the insulation oil shall be completely refined and degasified, not to leave any gas or impurities in the case, which may cause deterioration of the dielectric.

6.7 The terminals leads shall be brought out to terminal studs through top mounted porcelain bushings.

6.8 Each terminal shall be provided with a tinplated parallel groove clamp, spring washer nut. The clamp shall be capable of accommodating two Aluminum/Copper conductors of 7-10 mm dia. The tin used in the coating shall conform to relevant BS, ASTM standards. The minimum average thickness of tin coating shall be 0.05mm.

6.9 The capacitors shall be fitted with a discharge device inside the tank. The resistor of discharge device shall be capable of draining the residual charge to 50 volts or less within 5 minutes after the capacitor is disconnected from the supply voltage of $\sqrt{2}$Un.

6.10 The tank of the capacitor shall have two mounting brackets – one on each narrow side of the tank welded solidly to it and shall be suitable for mounting in capacitor racks standardized as per NTDC specification P-165 and also used as lifting the capacitor.

6.11 The tank and bracket shall be painted with a suitable primer and a durable, light grey/silver grey finish coat, resistant to severely corrosive atmosphere and having excellent heat dissipation. A bonding surface shall be provided on the underside of each support bracket to electrically bond the case to the cross arm hanger.

7.0 CAPITALIZATION OF CAPACITOR LOSS

7.1 The manufacturers shall furnish guaranteed losses of the offered capacitors measured at 20 °C ambient temperature and at rated voltage and frequency. For purpose of bid evaluation, the capitalized cost @ US$ 1200 per KW of capacitor losses (including losses in discharge resistor) shall be added to the quoted bid price.

7.2 The average value of losses measured during acceptance test under clause 9.3 shall be used for verification of values declared by the manufacturer/supplier in Schedule of Technical Data to be submitted as per clause 13. In case the measured average losses exceed the guaranteed losses, a penalty at twice the rate of

capitalized cost of losses indicated above shall be payable by the manufacturer/supplier for the losses in excess of guaranteed losses.

8.0 RATING/WARNING PLATE

The following information shall be given on the rating plate of capacitor unit;

i.	Description,	------- SHUNT CAPACITOR.
ii.	Type/designation,	-------
iii.	Rated output, Qn	--------KVAR.
iv.	Rated Voltage, Un	--------kV.
v.	Residual Voltage, Ur	--------V.
vi.	Discharge Resistor, R	-------MΩ.
vii.	Discharge Time,	-------Minutes.
viii.	Rated Frequency,	-------Hz.
viii.	Temperature category,	------ -10 °C to 55°C.
viii	1 min. AC withstand Voltage,	-------kV.
ix.	Lightning Impulse Voltage,	-------kV .
x.	Measured Capacitance,	-------µF.
xi.	NTDC Specification No.	-------P-78:2010
xii.	Serial No. of the capacitor,	--------
ix	Weight of the capacitor,	-------kg.
xiii.	Manufacturers Name,	---------
xiv.	Supplier's Name,	---------
xv.	Purchase Order/Contract No. & date,	---------

8.2 A warning indicating **" NON - PCB"** viewable from the ground shall be printed on the tank preferably on the side containing the rating plate.

9.0 TESTS

9.1 Type Tests

9.1.1 Type tests are carried out in order to ascertain that, as regards design, size, material and manufacture, the capacitor complies with the specified characteristics and operational requirements. The type tests shall be carried out by the manufacturer and a certificate detailing the results of such tests shall be submitted to Purchaser/NTDC. However, the type tests reports of the following tests shall be accepted only if the tests were witnessed by the representative of NTDC/Purchaser. Further, the type tests reports of these tests shall be valid for five years.

i) Over voltage withstand test.
ii) AC voltage test between terminals and container with rain.
iii) Lightning Impulse Voltage test between terminals and container.
iv) Thermal Stability test.
v) Measurement of Capacitance and Tangent of Loss Angle (tan δ) at Elevated Temperature

9.1.2 The following type tests in accordance with IEC 60871-1 shall be made on shunt capacitors having same current & voltage ratings to be supplied. If the facility of any test is not available at manufacturer's premises, the type tests shall be got carried out at a laboratory acceptable to purchaser. It is not essential that all type tests be carried out on the same capacitor unit, they may be carried out on different units having same characteristics. The ambient temperature for test/measurements shall be in the range +5°C to +35°C.

i) Visual examination test.
ii) Dimensional verification.
iii) Voltage test between terminals.
iv) AC voltage test between terminals and container.
v) Measurement of Capacitance.
vi) Measurement of Tangent of Loss Angle (tan δ).
vii) Test of internal discharge device /Discharge resistance test.
viii) Short circuit Discharge test.
ix) Sealing test.
x) Over voltage withstand test.
xi) AC voltage test between terminals and container with rain.
xii) Lightning Impulse Voltage test between terminals and container.
xiii) Thermal Stability test.
xiv) Measurement of Capacitance and Tangent of Loss Angle (tan δ) at Elevated Temperature

9.2 **Routine Tests**

9.2.1 The manufacturer shall carry out following routine tests as per IEC 60871-1 on every capacitor before delivery and a certificate detailing the results of such tests shall be supplied to the Purchaser. The ambient temperature for test/measurements shall be in the range +5°C to +35°C.

i) Measurement of Capacitance.
ii) Measurement of Tangent of Loss Angle (tan δ).
iii) Voltage test between terminals.
iv) AC voltage test between terminals and container.
v) Test of internal discharge device/Discharge resistance test.
vi) Sealing test.

9.3 **Acceptance Tests**

9.3.1 The following acceptance tests shall be performed on 5% of the quantity of ordered shunt capacitors to be selected randomly from the total lot of capacitors in presence of representative (s) of Purchaser/NTDC at the cost and arrangement of the manufacturer/supplier including travel expenses, boarding, lodging and daily allowance for the representative (s) to prove compliance with the requirements as listed in this specification. The ambient temperature for test/measurements shall be in the range +5°C to +35°C.

i) Visual examination test.
ii) Dimensional verification.
iii) Voltage test between terminals.
iv) AC voltage test between terminals and container.
v) Measurement of Capacitance.
vi) Measurement of Tangent of Loss Angle (tan δ).
vii) Test of internal discharge device/Discharge resistance test.
viii) Short circuit Discharge test.
ix) Sealing test.

9.3 SPECIAL TEST

Endurance test

The endurance test is a test on elements (their dielectric design and composition), and on the manufacturing process of these elements when assembled in a capacitor unit. An endurance test covers a range of capacitor designs as per IEC 60871-1. The type test carried out on other rating capacitor having same dielectric design and composition of the capacitor elements may be accepted in lieu of actual test otherwise manufacturer shall have to arrange this test at an independent lab. and submit the test report to the NTDC/Purchaser.

10.0 TEST METHODS

10.1 Visual Examination

Examination	DEFECTS
Material	i. The parts of capacitor e.g. tank, bushing, terminal connectors, lifting lugs are not made of specified material or damaged or missing. ii. Any leakage in the capacitor tank.
Finish	iii. Not painted thoroughly or not finished properly, shows abrasions, wrinkles, runs, blisters, scratches and uncoated spots. iv. Poor adhesion of paint when scrapped with a knife peels off in chips or flakes instead of ribbons. v. The terminal connectors not tin plated. vi. Tank welds not ground off properly.
Marking	viii Name plate markings missing, incomplete, incorrect, illegible not permanent. ix "NON-PCB" marking missing or not viewable from ground as required.
Packing	x. Packing not as specified

10.2 **Dimensional Verification**

The dimensions shall be measured for verifying of conformance to figure 1/ approved drawings.

10.3 **Voltage Test Between Terminals.**

The capacitor units shall withstand either AC voltage of 2.0Un or DC voltage of 4.0Un for 10s between terminals. The Capacitance shall be measured before and after the test. The change in capacitance shall not be more than ±2%.

10.4 **AC Voltage Test Between Terminals And Container.**

The capacitor units having all terminals insulated from the container shall withstand AC voltage of 38kV for 60s between terminals (joined together) and the container for type and acceptance tests.

10.5 **Measurement of Capacitance**

The capacitance of the capacitor units shall be measured at 0.9Un, 1.0Un and 1.1Un after voltage test between terminals. The capacitance of the capacitor unit shall not differ from the rated capacitance by more than – 5% to + 10%.

10.6 **Measurement of Tangent of Loss Angle (tan δ)**

The capacitor loss (tan δ) of the capacitor unit shall be measured at 0.9Un, 1.0Un and 1.1Un after voltage test between terminals. The measured value shall not be more than the value measured at the end of thermal stability test.

10.7 **Test of Internal Discharge Device/Discharge Resistance Test**

The capacitor unit shall be applied a voltage of $\sqrt{2}$Un. The resistor of discharge device of a capacitor unit shall be capable of draining the residual charge to 50 volts or less within 5 minutes after the capacitor unit is disconnected from the supply voltage. The Capacitance shall be measured before and after the test. The change in capacitance shall not be more than ±2%. The resistance of the internal discharge device shall be calculated from the following formula:-

$$R \leq \frac{t}{C \ln (Un\sqrt{2}/Ur)}$$

Where,

t is the time for discharge from $Un\sqrt{2}$ to Ur in seconds,
R is the discharge resistance in Mega ohm,
C is the capacitance in µF,
Un is the rated voltage of capacitor unit in volts,
Ur is the permissible residual voltage in volts.

10.8 **Sealing Test.**

The capacitor unit shall be placed in an oven for at-least 2 h at a temperature of 75 °C. No leakage shall occur in the capacitor tank.

10.9 **Short Circuit Discharge Test.**

The Capacitor unit shall be charged by mean of DC voltage at 2.5Un and then discharged through a gap situated as close as possible to the capacitor. The process was repeated five times within 10 minutes i.e, discharge after every two minutes. Within 5 minutes after the test, the capacitor unit shall be subjected to voltage test between terminals. The Capacitance shall be measured before the discharge test and after the voltage test. The change in capacitance shall not be more than ±2%.

10.10 **AC Voltage Test Between Bushing Terminals And Container with rain.**

A capacitor unit having all terminals insulated from the container shall withstand AC voltage of 38kV for 60s between terminals (joined together) and container with artificial rain.

10.11 **Lightning Impulse Voltage Withstand tests**

Fifteen impulses of positive followed by fifteen impulses of negative polarity having a wave of 1.2/50μs to 5/50μs having a crest value of 95kV shall be applied between bushings joined together and the container of the capacitor. The capacitor is considered to have passed the test if:

- no puncture has occurred:
- not more than two external flashovers occurred at each polarity:
- the wave shape has revealed no irregularities or no significant deviation from recordings at reduced test voltage

Alternatively the capacitor unit may be subjected to three impulses with no flashover permitted.

10.12 **Over Voltage Withstand Test.**

Apply the over voltages to terminals of a capacitor unit for specified durations as mentioned at clause 5.2.1. The Capacitance shall be measured before and after the over voltage test. The change in capacitance shall not be more than ±2%.

10.13 **Thermal Stability test.**

Place the three capacitor units into the constant temperature oven with static air. The separation between two capacitor units shall be 100mm. Keep the air temperature in the oven at 55 °C. Put the thermoelectric couple among elements

which is 2/3 to the bottom of the large side of case. Apply AC voltage calculated from the measured capacitance of 1.44 times its rated output for at-least 48h. During the last 6 hours, measure the container temperature near the top for 4 times. The temperature rise in the last 6 hours shall not increase by more than 1K. The capacitance and tangent of loss angle shall be measured before and after test at ambient temperature. The change in capacitance shall be less than ±2%.

10.14 **Measurement of Capacitance and Tangent of Loss Angle at Elevated Temperature**

After finishing thermal stability test, measure Capacitance and Tangent of Loss Angle (tan δ) at elevated high temperature. The measuring voltage shall be that of the thermal stability test. The measured values shall not be more than the values declared by the manufacturer.

10.15 **Endurance Test.**

The endurance test is a time consuming test. The procedure and requirements are indicated in IEC 60871-2.

10 PACKING

Each capacitor shall be sealed in plastic or other suitable moisture proof material and then 15 to 20 units packed in wooden boxes lined with moisture proof material. The packing shall be suitable for outdoor storage at sites having hot, wet, humid and dusty conditions and shall be capable of withstanding the rigors of rail, road and ocean shipment. Special precaution may be essential for protection of capacitors during transport to prevent moisture absorption due, for instance, to rain, snow or condensation. In every package of shipment, two copies of installation and maintenance and operation instruction book in English language enclosed in water proof material shall be provided.

11 MARKING

12.1 The following information shall be labeled on each wooden box;

i. Manufacturers name and trade mark.
ii. Capacitor Rating in KVAR.
iii. Name and address of Consignee.
iv. Purchase Order/Contract No. & date.
v. Weight of the capacitor in kg.
vi. No. of capacitors in Package/wooden box.
vii. Gross weight of the package.
viii. Instructions for lifting and handling of wooden box.

13.0 DRAWINGS AND DESCRIPTIVE DATA

13.1 Data and drawing to be submitted with the bid

13.1.1 Supply record of offered type, KVAR capacity & voltage rating of the capacitor for last five years on the following format:

Sr. No.	Contract/Purchase Order No. & date	Capacitor Type	Quantity	Voltage rating	Delivery period	Client Address/ Phone/ Fax No./ E-mail, etc.

13.1.2 The schedule of technical data duly filled-in attached hereto along with Type test report of the offered type, voltage rating of the capacitor and Manufacturer's catalogues/drawings as required in the schedule of technical data.

13.1.3 Non submission of completely filled-in schedule of technical data and supply record on the above format or submission of incomplete information/data as mentioned above with the bid may render the bid non-responsive.

13.2 Data and drawings to be submitted for approval

The following drawings/descriptive data shall be submitted for approval of Design Department NTDC before manufacturing the equipment/prior to mass production.

a. The schedule of technical data duly filled-in along with type test report of the offered type, voltage rating of the capacitor unit and Manufacturer's catalogues/drawings as required in the schedule of technical data.

b. Name/warning plate data of the capacitor.

c. Detailed drawings of the bushings and its mounting arrangements.

d. Details of lifting lugs, hanging arrangements and terminal connectors.

e. Curve or table showing the capacitance as well as losses (tan δ) under steady state condition at rated output as a function of ambient temperature.

f. Overall assembly drawing showing front, side and plan view of capacitor, details of interconnection of series & parallel packs. Cross section shall be indicated to clearly show main constructional features. All leading dimension including thickness of tank walls, material used in construction, method of connecting electrodes, thickness and material of insulations shall also be submitted.

14.0 ENCLOSURES

Following drawings and data sheets are attached herewith:

i. Schedule of technical data for shunt capacitor
ii. Capacitor Drawing No. PDW/DF-386 (revised on 24-11-2010)

SCHEDULE OF TECHNICAL DATA
SINGLE PHASE SHUNT CAPACITOR, 12/√3kV, 100 & 200KVAR

Sr. No.	DESCRIPTION	Unit	Guaranteed Data
	GENERAL		
1.	Manufacturers' name and address. (Attach manufacturer's Catalogue)		
2.	Manufacturers Type/designation.		
3.	Year of manufacture.		
4.	Rated Voltage, Un.	kV	
5.	Rated Frequency, fn.	Hz	
6.	Rated Output, Qn.	KVAR	
7.	Rated Current, In	A	
8.	Rated Capacitance, Cn.	µF	
9.	Tolerance in KVAR Output.	%	
10.	AC voltage withstand for 60s between bushing terminals and container with rain.	kV	
11.	AC Voltage withstand for 10s between bushing terminals.	kV	
12.	AC Voltage test for 60s between bushing terminals and containers, dry.	kV	
13.	Lightning Impulse Voltage Withstand, 1.2/50µs to 5/50µs.	kV, peak	
14.	Max. continuous working voltage..	kV	
15.	Max. permissible over voltage for 10s.	kV	
16.	Max. permissible over voltage for 1minute.	kV	
17.	Max. permissible over voltage for 5minutes.	kV	
18.	Max. permissible over voltage for 30minutes.	kV	
19.	Max. permissible current at rated voltage and frequency.	Amp	

20.	Standard Temperature category.		°C	
21.	Internal discharge resistor drains residual charge to 50 V.		Sec.	
22.	Capacitor losses (inclusive of loss in discharge resistor) at 20 °C.		W/KVAR	
23.	Energy handling capacity.		Joules	
24.	Whether externally fused.			
25.		**Internal arrangements**		
	i.	KVAR, Voltage rating of individual pack.		
	ii.	No. of series pack.		
	iii.	No. of parallel packs.		
	iv.	Details of inter-connection. (attach diagram)		
26.		Life expectancy.	Years	
27.		Rated altitude above sea level.	Meter	
28.		**Bushing characteristics**		
	i.	Manufacturers' name and address. (Attach manufacturer's Catalogue)		
	ii.	Type designation.		
	iii.	Material of bushing.		
	iv.	Rated voltage.	kV	
	v.	Power frequency withstand voltage.	kV	
	vi	Impulse withstand voltage.	kV	
	vii.	Creepage distance.	mm.	
	viii.	Mechanical characteristics. (attach sheet)		
29.		**Solid Dielectric**		
	i.	Material.		
	ii.	Manufacturer name.		
	iii.	Type designation.		
	iv.	Melting point.	°C.	

30.		**Characteristic of Dielectric fluid**		
	i.	Specific gravity.		
	ii.	Flash point.	°C.	
	iii.	Kinematics viscosity at 40°C.	mm≤/g	
	iv.	Fire point.	°C.	
	v.	Pour point.	°C.	
	vi	Neutralization value.	Mg KOH/g	
	vii.	Dielectric strength @2.5 mm gap.	KV	
	viii.	Dielectric constant at 80 °C.		
	ix.	Power factor at 80 °C.		
	x.	Specific resistivity Ω-CM at 80 °C.		
31	Effects of dielectric fluid on physical and electric properties of polypropylene film as regards its:			
	i.	Dielectric strength.		
	ii.	Resistivity.		
	iii	Power factor.		
	iv.	Tensile strength,		
	v.	Melting point.		
32.		**Capacitor Tank**		
	i.	Material of tank.		
	ii.	Colour of Paint.		
	iii	Thickness of paint.		
	iv.	Lifting lug arrangements. (attach drawings)		
	v.	Supporting/hanging arrangements		
33.	Tin plated parallel groove clamp accommodates conductor of dia.		mm	
34.	Capacitors of the offered type have been in service for the period.		Years	
35.	Weight of capacitor.		Kg	

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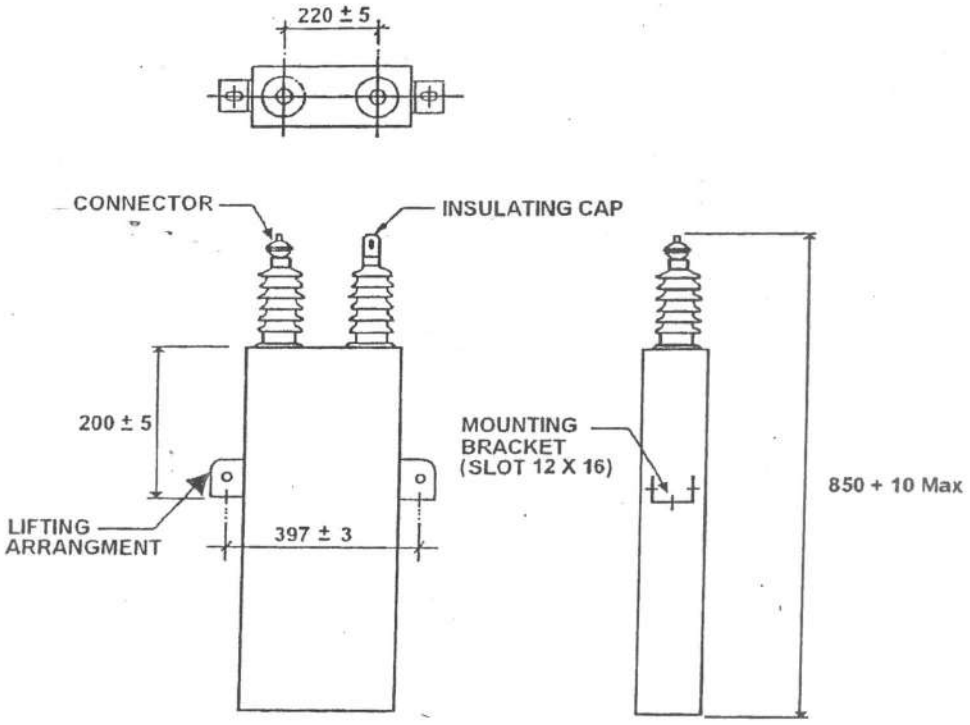

Note: - All dimensions are in millimeters.

	NATIONAL TRANSMISSION AND DESPATCH COMPANY			DESIGN DEPTT NTDC
	DRAWN	DAZ MEHMOOD		SHUNT CAPACITOR (NTDC SPECIFICATION: P-78:2010)
Revised On : 24-11-2010	CHECKED	A. LATIF		
(Pervaz Iqbal) Manager Design (S&R) NTDC	ASSTT: DIR:	M. NAEEM		
	DY: DIR:	MASOOD IQBAL		
(Nazar Abbas) Chief Engineer (Design) NTDC	DIRECTOR	R. A. BAIG		DATE: 2-10-82
	CHIEF ENGINEER	M. A. SHEIKH		DWG. NO. PDW/DF-386