PUBLIC POWER CORPORATION S.A.
T/NPRD/SUBSTATION AND EHV-SUBSTATION SPECIFICATIONS
AND EQUIPMENT SECTION

April 2008

TECHNICAL DESCRIPTION TD –55/3

24 KV OUTDOOR CIRCUIT BREAKERS TO BE USED FOR BUS BAR COUPLING PURPOSES IN AIR INSULATED OUTDOOR (20 KV BAYS INCLUDED) SUBSTATIONS

I. SCOPE

This hereby technical description covers PPC's requirement with regard the characteristics, design features and testing of 24 KV outdoor circuit breakers.

II. KEYWORDS

Circuit breakers, SF6 circuit breaker, vacuum circuit breakers, switching devices.

III. STANDARDS

All technical characteristics and testing of the circuit breakers shall be in accordance with IEC – 62271 – 100 latest revision and IEC – 60694 (edition 2-2).

IV. USE

The circuit breakers are to be used in 150 / 20 KV air insulated for 20KV bus-bar coupling purposes and isolation of the bus on which the fault happens to be at (all types of faults).

V. ELECTRICAL CHARACTERISTICS OF PPC's 20 KV SYSTEM

1. Nominal Voltage : 20 KV
2. Maximum Operating Voltage : 24 KV
3. Number of phases : 3
4. Number of conductors : 3
5. Nominal Frequency : 50 Hz
6. Short Circuit Level : 10 KA

7. Basic Insulation Level (Impulse level) : 150 KV

8. Method of earthing (grounding) : The 20 KV system is earthed through a 12Ω resistor.

9. Available D.C. auxiliary supply voltage : 110V D.C.

10. Available A.C. auxiliary supply voltage : 220 / 380V A.C.

VI. OPERATING CONDITIONS

1. Installation : Outdoors

2. Limits of ambient temperature : -25^{o} C to $+45^{o}$ C

3. Altitude : Up to 1000m above sea level

4. Pollution level : Moderate

5. Other weather conditions : Snow, ice and fog.

VII. REQUIRED DESIGN FEATURES OF THE BREAKER

1. Type of tank

The tank of the circuit breaker shall either be live tank or dead tank.

a. By live tank is meant that the each interrupter unit (chamber) is inside an insulator. The interrupter unit is at high potential and is thus "live". The flashover distance of the insulator both for the interrupter unit and the support column is determined by the specified lightning impulse voltage of the circuit breaker.

b. By dead tank is meant that each interrupter unit (chamber) is installed inside an earthed (grounded) metallic enclosure which thus is regarded as "dead" or that the three interrupter units (chambers) are installed inside a common earthed metallic enclosure which thus is regarded as "dead". In this arrangement the SF6 gas filling provides the insulation between the components of the interrupter unit and the metallic enclosure. Outdoor bushings connect the interrupter units to the high voltage terminals. The SF6 used for filling shall be in accordance with IEC – 60376 standard.

2. Interrupting medium of the interrupter unit (chamber)

The interrupting medium for arc extinction and insulation shall be either vacuum or SF6.
In case of SF6, the SF6 shall be in accordance with IEC – 60376 standard and the interrupting technology shall be of the puffer type or derivatives of puffer such as self – puffer, or self blast.

3. Method of operation of the circuit breaker

Three - pole operation.

4. Number of interrupter units (chambers)

Each pole of the circuit breaker shall contain one (1) interrupter unit (chamber).

5. Number of operating mechanisms

The circuit breaker shall be equipped with one (1) operating mechanism common to the three poles which must be suitable for triple pole operation. The operating mechanism shall be inside a cabinet located underneath the "live" or "dead" tank of the breaker.

6. Installation environment of the circuit breaker

Outdoors, in air – insulated 150 / 20 KV distribution substations.

7. Operating mechanism's characteristics

a. Type : Spring charged type driven by an electrical motor installed in a cabinet or in the dead tank of the breaker or magnetic actuator mechanism of low energy, based on solenoid plunger, held in the tripped or closed position by a permanent magnet, the whole being installed in the dead tank of the breaker.

b. Type of tripping : Free – trip as per IEC – 60050 (441)

c. Auxiliary supply voltages

1. For the tripping, opening and closing circuits : 110 V DC

2. For all the other control and signaling circuits : 110 V DC

3. For the motor of the spring charged mechanism (if applicable) : 110 V DC

4. For the actuator coil (if applicable) : 110 V DC

5. For the anticondensation heaters (resistors) and lighting : 220 V AC

6. Tolerances of the auxiliary DC supply voltage except for the tripping coil : +10 % / -15 %

7. Tolerances of the auxiliary DC supply voltage for the tripping / opening coil : -30%, +10%

8. Circuit breaker's operating mechanism and control cabinet

The circuit breaker shall be equipped with a cabinet which shall contain the operating mechanism of the breaker and all other control devices associated with it or the breaker itself. This cabinet which shall be of class protection of IP55 as per IEC – 60144, shall be located below the tank for the dead tank type of circuit breaker and below the support (isolating) columns of the three poles for the live tank type of circuit breaker. In both cases the cabinet shall be mounted on the circuit breaker's steel support frame. This cabinet shall contain besides other components and the following:

a. The cabinet shall be equipped with anti – condensation heaters controlled via thermostat.

b. The cabinet shall be equipped with position indicator which will clearly indicate the open and close position of the circuit breaker in accordance with IEC – 60694.

c. The cabinet shall be equipped with an operations counter which shall indicate the number of operations of the breaker.

d. The cabinet shall be equipped with a selector switch with three (3) operating positions "Off – Local – Remote" and with as many stages as needed for the control circuits of the breaker. In the "off" position no circuit breaker operation would be allowed.

   The "local" position and in conjunction with two (2) push – buttons (open – close) or a control switch, will be used to control the breaker locally, that is, from the control cabinet, for maintenance purposes only. When the circuit breaker is under local control, the bay associated with the circuit breaker will be out of service.
   The "Remote" position will be used to control (opening – closing) the breaker from the control building of the substation or from the distribution's peripheral control center and also for tripping purposes.

e. The "off – local – remote" selector switch shall be equipped with an additional number of stages, beyond those which are normally needed for all the control circuits, which shall be used to be inserted to both positive (+) and negative (-) 110 V DC buses of the control circuits.

f. The cabinet shall be equipped with two (2) push – buttons or a control switch of two positions for local closing and opening of the circuit breaker as all ready has been indicated above.

g. The cabinet shall contain the following number of breaker auxiliary free of voltage contacts :
   - Seven (7) N.O
   - Seven (7) N.C

h. The cabined shall be equipped with terminal blocks suitable to be wired with 2.5mm^2 size conductors with the exemption of the terminal blocks associated with CTs and the motor of the operating mechanism or the actuator coil which must be suitable for 4mm^2 and the 10mm^2 cables respectively. The terminal blocks shall preferably be of the screw type. There must be some spare terminal blocks installed in the cabinet.

i. The cabinet shall be equipped with an antipumping relay as to prevent constant opening and closing in the event of simultaneously applied "Open" and "Close" commands.

j. Number of closing and Tripping circuits :

1. Number of closing circuits : One (1)
2. Number of tripping circuits : One (1)

k. The cabinet shall be equipped with a socket outlet for 220V A.C.

l. The cabinet shall be equipped with a padlock

m. The cabinet shall be equipped and with a light bulb (220V A.C.)

n. The cabinet shall be equipped with SF6 pressure sensor or sensors for both live tank and dead tank breakers.

9. <u>Housing of the isolating column and of the interrupter chamber (For live tank type of breaker).</u>

a. The isolating housing of the breaker's columns and interrupter chambers shall either be of extra strength porcelain or silicon rubber or EPDM rubber. The porcelain shall comply in all relevant respects with IEC – 60233 standard "Tests on hollow insulators for electrical equipment".
The silicon rubber and the EPDM rubber housing shall be in accordance with IEC – 61142 standard "Composite insulators – Hollow insulators for use in outdoor and indoor electrical equipment".

b. The creepage distance of the columns and interrupter chambers housing shall be as follows:
1. Between live parts and earth (ground): 25mm / KV (600mm)
2. Across breaker terminals: 25mm / KV (600mm)

With the voltage used for the determination, being that of 24 KV (rated voltage).

10. <u>Bushings (For the dead tank type of circuit breaker)</u>

The dead tank type of circuit breaker shall be equipped with bushings of the following characteristics and in accordance with IEC – 60137 standard "Insulated bushings for alternating voltages above 1000 V".

a. Type : Outdoor – immersed bushings dry or liquid filled type

b. Rated Voltage : 24 KV

c. Rated phase – to – earth voltage : 13.85 KV

d. Rated current : 2000 A

e. Rated thermal short – time current for one sec : 18042 A

f. Rated dynamic current : 45105 A

g. Creepage distance : ≥ 600mm

h. Insulating envelope : The insulating envelope of the bushings shall be with sheds and be either of porcelain or silicon rubber or EPDM rubber.
Porcelain insulating envelope shall comply with IEC – 60233 standard "Tests on hollow insulators for electrical equipment".
The silicon and EPDM rubber shall be in accordance with IEC – 61142 standard.
"Composite insulators-Hollow insulators for use in outdoor and indoor electrical equipment".

VIII. ADDITIONAL REQUIRED DESIGN FEATURES OF THE CIRCUIT BREAKER

1. Wiring requirements

The wiring of various circuits of the breaker shall be carried out with at least 1.5mm^2 size conductors, unless, is differently needed by the power requirements of the circuit. Conductors must bear rings with markings.

2. Lifting and handling of the circuit breaker

The offer shall include either drawings or instructions which in detail shall indicate the method or the way the lifting and handling of the circuit breaker is to be carried out.

3. Circuit Breaker's terminals

a. For the live tank type of circuit breaker
The terminals shall be of aluminium or nickel plated copper, rectangular in shape and with dimensions of about 100mm x 100mm x 15mm.

b. For the dead tank type of circuit breaker
The terminals shall be cylindrical in shape either from nickel plated copper or aluminium with dimensions suitable for the current rating characteristics of the circuit breaker.

4. Circuit Breaker's Support Structure

a. The circuit breaker is to be installed on a steel support structure for both live tank and dead tank type of circuit breaker.

b. The steel support structure for the live tank circuit breaker shall be such as to allow the installation of six (6) outdoor current transformers on it as it is described in detail in paragraph IX – B.

c. The steel support structure shall be part of the supply.

d. All necessary anchoring bolts for fastening the steel support structure must be part of the supply.

e. The steel support structure and the anchoring bolts must be hot – dip galvanized.

f. Enough information for the steel support structure must be provided so that the support structure's concrete steel reinforced base can be calculated and constructed by PPC S.A.

5. Pressure relief device (For the dead tank type of circuit breaker)

The tank of the dead tank circuit breaker shall be equipped with a pressure relief device (disk) in accordance with IEC – 60298, Appendix AA.

6. Wind speed withstand capability of the circuit breaker

The circuit breaker installed on its support steel structure together with the six (6) CTs depending on tank type shall be able to withstand a wind speed of 150 Km / h which corresponds to a wind pressure of 180 Kg / m^2 (with coefficient of dynamic pressure = 1.5)

7. Earthling (grounding) of the circuit breaker

a. For the live and dead tank type of a circuit breaker
The frame of the circuit breaker shall be provided with a reliable earthling terminal for connection to an earthling conductor suitable for 10 KA fault current. The connecting point shall be marked with the "protective earth symbol".

IX. REQUIRED CURRENT TRANSFORMERS IN RELATION TO THE CIRCUIT BREAKER

A. For dead tank type circuit breakers

1. The circuit breaker shall be equipped with six (6) bushing toroidal (ring) type current transformers. The six (6) current transformers shall be of ratio 1440-1900/0,58A and shall be installed in the bushings at both sides of the circuit breaker, three (3) per each side of the circuit breaker (one per phase).

2. The secondary leads of these six (6) current transformers shall be brought to the circuit breaker's operating mechanism and control cabinet or to a separate hot – dip galvanized box, mounted close to the breaker's operating mechanism and control cabinet.

3. The ratio, rated output power of secondaries, accuracy class and rated primary current of these CTs will be as follows:

   a. Six (6) CTs with two (2) sections in the primary winding and one secondary winding
   - Ratio : 1440-1900/0,58A
   - Rated output power : 30 VA
   - Rated secondary current (In) : 0,58A

- Accuracy class : 5P
- Accuracy limit factor : 20
- Rated primary current (In) : 1440-1900A

4. Additional technical characteristics of all six (6) CTs

a. Highest voltage : 24 KV
b. Power frequency withstand voltage of primary : 60 KV
c. Lightning impulse withstand voltage of primary : 150 KV
d. Power frequency withstand voltage of secondary : 3 KV
e. Rated continuous thermal current : 1.2 x In
f. Rated short –time thermal current : $\geq$ 25 KA
g. Rated dynamic current : $\geq$ 62.5 KA

5. The current transformers shall be located within the bushing design, external to the gas enclosure, to allow for easy changing.

B. <u>For live tank type circuit breakers</u>

1. The circuit breaker shall be equipped with six (6) outdoor dry type current transformers with the insulating housing to be consisted of cycloaliphatic resin and in accordance with IEC – 60044 – 1.

2. The primary terminals of the current transformers shall be of nickel plated copper or brass. These terminals shall be rectangular in shape and shall be installed diametrically opposite on the head of the CTs.

3. The secondary terminals together with an earthling terminal shall either be installed inside the circuit breaker's operating mechanism and control cabinet or to a separate hot - dip galvanized box. These terminals shall be of the screw type.

4. All six (6) current transformers and the circuit breaker shall be installed on a common hot-dip galvanized steel support structure. The arrangement and dimensions of this common steel structure is indicated in the attached drawing SK – CB / CT – 3.
All necessary materials, bolts and flexible copper strips with suitable cross-section for the connection of CTs with the circuit breaker, shall be part of the supply.

5. The ratio, rated output power of secondaries, accuracy class and rated primary current of these CTs will be as follows:

a. Six (6) CTs with two (2) sections in the primary winding and one secondary winding
- Ratio : 1440-1900/0,58A
- Rated output power : 30 VA
- Rated secondary current (In) : 0,58A
- Accuracy class : 5P
- Accuracy limit factor : 20
- Rated primary current (In) : 1440-1900A

6. Additional technical characteristics of all six (6) CTs

a. Highest voltage : 24 KV
b. Power frequency withstand voltage of primary : 60 KV
c. Lighting impulse withstand voltage of primary : 150 KV
d. Power frequency withstand voltage of secondary : 3 KV
e. Rated continuous thermal current : 1.2 x In
f. Rated short – time thermal current : ≥ 25 KA
g. Rated dynamic current : ≥ 62.5 KA
h. Minimum creepage distance of the housing : ≥ 600mm

X. CIRCUIT BREAKER'S REQUIRED RATED CHARACTERISTICS

1. Rated Voltage : 24 KV

2. Rated Frequency : 50Hz

3. Rated normal current : 2000 A

4. Rated insulation levels
   a. Rated power frequency withstand voltage
      - Common value : 60 KV r.m.s

   b. Rated lighting impulse withstand voltage
      - Common value : 150 KV peak

5. Rated short circuit breaking current at voltages below or equal to the rated voltage
   - A.C component, r.m.s value : 25 KA r.m.s

6. Rated duration of short circuit : 3 sec

7. First – pole – to – clear factor : 1.5

8. Rated short circuit making current
   (2.5 X the short circuit breaking current) : 62.5 KA peak

9. Rated short – time withstand current : 25 KA r.m.s

10. Rated peak withstand current : 62.5 KA peak

11. Rated operating sequence : O-0,3s-CO-3min-CO

12. Rated single capacitor bank breaking current : 400A r.m.s

13. Rated single capacitor bank inrush making current : 5KA peak

14. Mechanical endurance class : M2 (10000 operations)

15. Electrical Endurance class : E1

16. Restrike class during capacitive current breaking : C1

17. Rated break time : ≤ 80 ms

18. Rated closing time : ≤ 75 ms

19. Rated opening time : ≤ 70 ms

20. Rated transient recovery voltage for terminal faults
    - Peak value : 41 KV
    - Rate of rise of recovery voltage (RRRV) : 0.47 KV / μς
    - First – pole – to – clear factor : 1.5

It should be noted that circuit breakers of North America manufacturing with:
- Rated normal current : 2000 A
- Rated voltage : 25.8 KV
- Rated short circuit breaking current at 25.8 KV : 24 KA r.m.s
- Rated short circuit making current : 60 KA peak
- Rated short – time withstand current : 24 KA r.m.s
- Rated peak withstand current : 60 KA peak

and with all other rated characteristics equal to the rated characteristics indicated above, can also be accepted subject to the judgment of PPC.

XI. TESTS FOR THE CIRCUIT BREAKER

A. Routine Tests

Testing shall be in accordance with IEC – 62271 – 100 and IEC – 60694 (edition 2.2, 2002 – 10). The routine testing shall include the following:

1. Power frequency voltage dry test on the main circuit

Test voltage: 60kV r.m.s, 50 Hz, for 1 minute for phase to earth, phase-to-phase and across open circuit breaker contacts.

2. Tests on auxiliary and control circuits

a. Inspection of auxiliary and control circuits and verification of conformity to the circuit diagrams and wiring diagrams.
b. Functional tests of all low voltage circuits
c. Verification of protection against electrical shock
d. Power frequency voltage test

Test voltage: 1 kV, 50 Hz with duration of 1 sec.

3. Measurement of the resistance of the main circuit

- The test current : any value between 50 A and 1250 A
- The measured resistance shall not exceed 1.2 Ru, where Ru is equal to the resistance measured before the temperature – rise test.

4. Tightness test

5. Design and visual checks

The following shall be checked:

- The language and data on the name plates
- Identification of any auxiliary equipment
- The colour and quality of paint and corrosion protection of metallic surfaces.
- The values of the resistors and capacitors connected to the main circuit.

6. Mechanical operating test

a. At maximum supply voltage of the operating devices and of the auxiliary and control circuits and at maximum pressure for operation.
   - Five closing operations
   - Five opening operations

b. At specified minimum supply voltage of the operating devices and of the auxiliary and control circuits and at minimum functional pressure for operation.
   - Five closing operations
   - Five opening operations

c. At rated supply voltage of the operating devices and of the auxiliary and control circuits and at rated pressure of operation.

Five close – open operating cycles with the tripping mechanism energized by the closing of the main contacts.

Moreover, five open-close operating cycles O – t – C where t shall be not more than the time interval specified for the rated operating sequence.

Finally for all required operating sequences all inspections, measurements and functional tests shall be performed as specified in IEC – 62271 – 100.

B. Type tests

The type tests shall be carried out in accordance with IEC – 62271 – 100 and IEC – 60694 (Edition 2.2, 2002 – 01).
The following tests are required

1. Dielectric Tests

a. *Power frequency voltage tests*

Test voltage : 60KV r.m.s for One (1) minute applied between phase-to-earth, between phases and across open circuit breaker contacts.

The tests shall be performed in dry and wet conditions.

NOTE: In the case of the dead tank circuit breakers if the bushings have been previously tested according to IEC – 60137 standard, tests under wet conditions can be omitted.

b. Lightning impulse voltage tests

The circuit breaker shall be subjected to lighting impulse voltage tests in dry conditions only.
The tests shall be performed with voltages of both polarities using a lightning impulse of 1.2/50 μς.

The test voltage shall be : 150 KV peak, applied between phase-to-earth, between phases and across open circuit breaker contacts.

c. Dielectric tests on auxiliary and control circuits

The tests involve

- Impulse voltage withstand test and
- Power frequency voltage withstand test

Each test shall be performed

1. Between the auxiliary and control circuits connected as a whole and the frame of the breaker.

2. If practicable, between each part of the auxiliary and control circuits, which in normal use may be insulated from the other parts, and the frame. The other parts being connected together.

The impulse voltage withstand value shall be 5 KV and the test shall be performed in accordance with IEC-60255-5.
The power frequency test shall be performed according to IEC-61180-1. The test voltage shall be 2 KV with duration of 1 min.

2. Measurement of the resistance of the main circuit

The measurement shall be made with a D.C. current by measuring the voltage drop or resistance across the terminals of each pole.
The current during the test shall have a value between 50A and rated normal current of the breaker.

3. Temperature – rise tests

a. The test shall be made at rated normal current of the breaker in an environment substantially free from air currents and this condition is satisfied when the air velocity is ≤ 0.5 m/s

b. The test shall be made over a period of time sufficient for the temperature rise to reach a stable value. This condition is declared to be obtained when the increase of temperature rise does not exceed 1K in 1 h.

c. The ambient air temperature during tests shall be more than $+10^{o}$C but less than $+40^{o}$C.

d. The auxiliary equipment shall be tested at its rated supply voltage or its rated current.

e. The temperature rise of the various parts of the circuit breaker or auxiliary equipment, for which limits are specified, shall not exceed the values specified in table 3 of IEC – 60694.

4. Sort –time withstand current and peak withstand current tests

a. The test current shall be equal to the A.C. component of the rated short – time withstand current of the breaker. The peak current test shall be equal to the rated peak withstand current of the breaker.

b. The test time shall be 3 seconds.

c. The tests shall be made on the three phase breaker at rated frequency with a tolerance of ±10% at any suitable voltage.

d. After the test the switchgear shall not show significant deterioration, shall be capable of operating normally, carrying its rated normal current continuously without exceeding the temperature – rise limits specified in table 3 of IEC – 60964 and withstanding the voltages specified under dielectric tests.

5. Tightness test

6. Electromagnetic compatibility test (EMC)

a. The tests are only for the secondary systems of the circuit breaker. For the main circuit of the breaker, no electromagnetic compatibility test is required.

b. Electronic equipment, which is part of the secondary system, shall fulfill the requirements with regards to emission, as defined in CISPR II for group II, class A equipment.

c. Secondary systems of the breaker shall be subjected to electromagnetic immunity tests if they include electronic equipment or components. In other cases no tests are required.
The following immunity tests are specified:
- Electric fast transient / burst test with normal EMC severity class test voltages
- Oscillatory wave immunity test with normal EMC severity class test voltages.

7. Mechanical operation test at ambient temperature

The mechanical operation test shall consist of 10000 operating sequences. The circuit breaker should be tested preferably as a complete multipole circuit breaker. However, for convenience or owing to limitations of the dimensions of the test bay, one single – pole unit of the circuit breaker may be tested, provided that it is equivalent to the complete multipole circuit breaker over the range of tests, for example in respect of

- reference mechanical travel characteristics
- power and strength of closing and opening mechanism
- rigidity of structure.

The circuit breaker shall be tested as follows:

Operating sequence	Supply voltage and operating pressure	Number of operating sequences
		Circuit breaker for auto – reclosing
C – ta – O – ta	Minimum	500
	Rated	500
	Maximum	500
O – t – CO – ta – C – ta	Rated	250
O = opening C = closing CO = closing followed immediately by an opening ta = time between two operations which is necessary to restore the initial conditions and / or to prevent undue heating of parts of the breaker t = 0.3 s Repetition rate of the operating sequence = 5 times		

8. <u>Short circuit current making and breaking tests</u>

a. The circuit breaker shall be capable of making and breaking the specified three – phase symmetrical and asymmetrical currents between 10% and 100% of the rated short – circuit breaking current at rated voltage.

b. The breaker shall be capable at making and breaking single–phase short–circuit currents between 10% and 100% of the rated short–circuit breaking current at phase–to–earth voltage.

c. The applied voltage, current, transient and power frequency recovery voltages may all be obtained from a single power source (direct tests) or from several sources where all of the current, or a major portion of it, is obtained from one source, and the transient recovery voltage is obtained wholly or in part from one or more separate sources (synthetic tests).

Synthetic testing shall be in accordance with IEC – 60427.

9. <u>Single capacitor bank current switching tests.</u>

a. For direct three-phase tests and for single-phase tests, the test voltage between the phases at the circuit breaker location immediately prior to opening shall be 24KV.

b. For direct single-phase laboratory tests, the test voltage measured at the circuit breaker location immediately before opening shall be 19.4KV.

c. The test current shall be : 400A for single capacitor bank.

d. Capacitor current switching tests for class C1 circuit breakers shall be made after performing test-duty T60 as a preconditioning test.
As an alternative, the preconditioning test may consist of the following.
- Same current as test – duty T60
- Low voltage and no specified TRV
- Three opening operations
- Arcing time as for T60 or expected T60 arcing time values given by the Manufacturer.
- Rated or lock – out conditions.

e. The capacitor current switching tests shall consist of the test duties as indicated in the table below:

Class C1 test duties

Test duty	Operating voltage of the releases	Pressure of operation and interruption	Test current as percentage of the rated capacitive breaking current	Type of operation or operating sequences
BC1	Maximum Voltage	Minimum Functional pressure	10 to 40	O
BC2	Maximum Voltage	Rated pressure	Not less than 100	CO

f. For three-phase single capacitor bank current switching tests.
The test duty 1 (BC1) shall comprise of total of 24 O tests and test duty 2 (BC2) shall comprise a total of 80 CO tests as indicated below:
Test duty 1 (BC1)

- 4 O distributed on one polarity (step: 15^0)
- 6 O at minimum arcing time on one polarity
- 4 O distributed on the other polarity (step: 15^0)
- 6 O at minimum arcing time on the other polarity
- Additional tests to achieve 24 O, distributed (step: 15^0)

Test duty 2 (BC2)

- 4 CO distributed on one polarity (step: 15^0)
- 32 CO at minimum arcing time on one polarity
- 4 CO distributed on the other polarity (step: 15^0)
- 32 CO at minimum arcing time on the other polarity
- Additional tests to achieve 80 CO, distributed (step: 15^0)

g. For single-phase capacitor bank (single or back-to-back) current switching tests.
The test duty 1 (BC1) shall comprise of total of 48 O tests. Test duty 2 (BC2) shall comprise a total of 120 CO tests as follows.

Test duty 1 (BC1)

- 12 O distributed on one polarity (step: 15^0)
- 6 O at minimum arcing time on one polarity
- 12 O distributed on the other polarity (step: 15^0)
- 6 O at minimum arcing time on the other polarity
- Additional tests to achieve 48 O, distributed (step: 15^0)

Test duty 2 (BC2)

- 12 CO distributed on one polarity (step: 15^0)
- 42 CO at minimum arcing time on one polarity
- 12 CO distributed on the other polarity (step: 15^0)
- 42 CO at minimum arcing time on the other polarity
- Additional tests to achieve 120 O, distributed (step: 15^0)

10. High temperature tests

High temperature = $+45^{o}$ C

XII. CURRENT TRANSFORMERS TESTS

Tests shall be in accordance with IEC – 60044 -1. The circuit breaker manufacturer is required to present to the PPC inspector, when the inspector is at the manufacturer's premises for circuit breaker inspection and testing, test reports for the following routine and type tests, for checking purposes. Type test reports may not be presented if they have been originally submitted in the technical offer and have been found to be satisfactory.

A. Routine Tests

1. Verification of terminal markings
2. Power–frequency voltage withstand test on primary winding
3. Partial discharge measurement
4. Power–frequency voltage withstand test on secondary windings
5. Power–frequency voltage withstand tests between sections of primary and secondary windings
6. Inter–turn overvoltage test
7. Determination of errors

B. Type tests

1. Temperature rise test
2. Short –time current tests
3. Lightning impulse test
4. Wet test for outdoor type current transformers (Not applicable to bushing type CTs)
5. Determination of error

XIII. BUSHING TESTS

The tests shall be in accordance with IEC – 60137. The circuit breaker manufacturer is required to present to the PPC inspector, when the inspector is at the manufacturer's premises for circuit breaker inspection and testing, test reports for the following routine and type tests. Type test reports may not presented if they have been submitted originally in the technical offer and have been found to be satisfactory.

A. Routine tests

1. Dry power frequency voltage withstand test
2. Measurement of the partial discharge quantity
3. Visual inspection and dimensional check

B. Type tests.

1. Wet power – frequency voltage withstand test
2. Dry lightning impulse withstand test
3. Temperature rise test
4. Verification of thermal short – time current withstand
5. Cantilever load withstand
6. Verification of dimensions

XIV. NAMEPLATES

The circuit breaker and its operating mechanism along with the CTs for the live tank type of circuit breaker shall be equipped with name plates of no corrosive material, which shall bear on them the following information.

A. Circuit Breaker

1. Manufacture
2. Type designation and serial number
3. Rated voltage, in KV
4. Rated lightning impulse withstand voltage in KV
5. Rated frequency in Hz
6. Rated normal current in A
7. Rated duration of short circuit in sec
8. Rated short circuit breaking current in KA
9. DC component of the rated short circuit breaking current in %
10. First – pole – to – clear factor
11. Rated single capacitor bank breaking current in A
12. Rated SF6 filling pressure for interruption in MPa
13. Rated SF6 filling pressure for operation in MPa
14. Mass of the breaker in kg
15. Rated operating sequence
16. Year of manufacture
17. Temperature class
18. Relevant standard with date of issue

B. Operating mechanism

1. Manufacturer
2. Type designation and serial number
3. Rated supply voltage of closing and opening devices
4. Rated supply voltage of auxiliary circuits
5. Relevant standard with date of issue

C. Outdoor type CTs (for the live tank breaker)

All CT's shall bear a rating plate of non – corrosive material with the following markings:

1. The manufacture's name
2. Serial number and type
3. Rated primary and secondary current
4. Rated frequency
5. The rated insulation level (lightning impulse level)
6. Rated output and corresponding accuracy class for the secondary windings
7. The highest voltage of the CT
8. The rated short – time thermal current
9. The rated dynamic current

XV. DATA WHICH MUST BE SUBMITTED BY ALL BIDDERS

1. Outline drawing of the breaker with its support structure, in which the physical dimensions of the breaker and its support structure are clearly depicted (For the dead tank type of breaker).

2. Brochures, technical pamphlets and any other information which are deemed necessary for the technical evaluation process.

3. Outline dimensional drawing of the breaker, the CTs and their steel support structure for the live tank type of circuit breaker.

4. All bidders are required to answer all items of Attachment "A". Failure to comply or partial filling of the attachment will constitute sufficient reason for rejection of the offer.

5. Any test certificates for the circuit breaker's type tests specified in this hereby technical description. Acceptance or not of these certificates lies on PPC's judgment.

6. Any type test certificates for the CTs (both for live and dead tank breaker) and for bushings (for the dead tank breaker only).
   Acceptance or not of these certificates lies on PPC's judgment.

XVI. DATA WHICH MUST BE SUBMITTED BY THE SUCCESSFUL BIDDER

1. Complete schematic and wiring drawings of the breaker for approval before the construction of the breaker (3 sets).

2. Terminal markings of primary and secondary terminals of the current transformers either for bushing type or for outdoor type (3 sets).

3. Complete physical drawings of the breaker with its structure (dead tank type) with dimensions for approval prior to construction (3 sets).

4. Complete physical drawings of the breaker with CTs and their common steel support structure (live tank type) with dimensions for approval prior to construction (3 sets).

5. Technical brochures describing in detail the breaker itself, the operating mechanism, current transformers and bushings (for dead tank only).

6. Assembly instructions of the breaker, the support structure and bushings (if applicable).

7. Maintenance instructions for the breaker and its operating mechanism and for the current transformers and bushings (if applicable).

XVII. WARRANTY

The supplier must provide a warranty of three (3) years, beginning from the date of delivery of the circuit breaker for damages by faulty design or by unreliable components or by combination of the two.

XVIII. PACKING

1. Each circuit breaker must be delivered enclosed inside a robust wooden box with all of its parts numbered and easily identifiable.

2. Outdoor type CTs shall be packaged inside robust wooden boxes, three (3) CTs per box.

3. The steel support structure for the live tank type of breaker shall be also packaged inside robust wooden boxes with all of its parts numbered and easily identifiable.

4. The steel support structure of the dead tank type of circuit breaker shall be delivered in the same wooden box with the breaker, if possible. Otherwise it will be in its own robust wooden box with all of its parts numbered and easily identifiable.

ATTACHMENT "A"
24 KV OUTDOOR CIRCUIT BREAKERS
TO BE USED FOR BUS BAR COUPLING PURPOSES IN AIR INSULATED OUTDOOR (20 KV BAYS INCLUDED) SUBSTATIONS

All bidders must provide the following data. Failure to comply in full shall constitute sufficient reason for rejection of the offer

1. Type and manufacture : ……
2. Ambient temperature range : ……
3. Type of tank : ……

   ……..
4. Interruption medium of the interrupter unit (chamber) : ……
5. Number of interrupter units (chambers) per pole : ……
6. Method of operation of the circuit breaker : ……
7. Number of operating mechanisms : ……
8. Is the SF6 gas in accordance with IEC – 60376? : ……
9. Type and description of the operating mechanism : ……

   ……...

   ……...

   ……...

   ……...

   ……...
10. Type of tripping : ……
11. Auxiliary supply voltages

    a. For the tripping, opening and closing circuits : ……

    b. For all other control and signaling circuits : ……

    c. For the motor of the spring charged mechanism (if applicable) : ……

    d. For the permanent magnet (if applicable) : ……

e. For the anti condensation heaters (resistors) and light : ……

f. Tolerances of the auxiliary D.C. supply voltage : ……

12. Is the operating mechanism and control cabinet in accordance with the requirement of paragraph VII – 8 – a up to n? : ……...

……..

……..

……..

……..

13. Type of housing of the isolating column and of the interrupter chamber (For the live tank breaker) : ……

……..

……..

……..

14. Bushings characteristics (For the dead tank breaker)

a. Type : ……...

b. Rated voltage : ……...

c. Rated phase – to –earth voltage : ……...

d. Rated current : ……...

e. Rated thermal short – time current : ……...

f. Rated dynamic current : ……..

g. Creepage distance : ……...

h. Type of insulating envelope : ……...

……

……..

15. Creepage distance of the isolating column and interrupting chamber (for the live tank circuit breaker)

a. Between live parts and earth : ……

b. Across breaker terminals : ……

16. Size of wires (cables) used in the various circuits of the breaker's operating mechanism and control cabinet : …….

……...

……...

17. Is a drawing provided in which the method of the handling and lifting of breaker is indicated? : …….

18. Describe the material and shape of the breaker's terminal : …….

……

……

19. Indicate wind speed withstand capability of the breaker when installed on its support structure : ……

20. Indicate point of earthling of the offered circuit breaker : ……

……..

……..

21. Does the steel support structure of the live tank breaker satisfy the requirements of paragraph VIII – 4 – b? : ……

22. With regard the steel support structure, does the offer comply with the requirements of paragraph VIII – 4 a, c, d, e and f ? : ……

……..

23. Current transformer characteristics

a. Type

: …….

b. Indicate exactly where the CTs are located at : …….

……...

……...

……...

c. For the 1440-1900 / 0.58A

For the protection winding

1. Ratio : …….

2. Rated output power : …….

3. Accuracy class : ……

4. Accuracy limit factor : ……

5. Rated primary current : ……

6. Number of CTs : ……

d. Additional data for the CTs

1. Highest voltage : ……

2. Power frequency withstand voltage of primary : ……

3. Lightning impulse withstand voltage of primary : ……

4. Power frequency withstand voltage of secondary : ……....

5. Rated continuous thermal current : ……....

6. Rated short – time thermal current : ……

7. Rated dynamic current : ……

24. Creepage distance of the housing for the outdoor type of CTs : ……

……..

……..

25. Indicate material and shape of current transformer terminals for the live tank type of breaker : ……

26. Indicate secondary terminal box material and location for the current transformers : …….

……...

……..

27. Is the steel support structure of the breaker hot – dip galvanized ? : ……

28. Is the secondary terminal box of the CTs hot – dip galvanized? (if applicable) : ……...

29. Is a steel support structure as per sketch SK – CB / CT-3 used for the CTs of the live tank type of circuit breaker ? : …….

……..

30. Circuit breaker's rated characteristics

a. Rated voltage : ……

b. Rated frequency : ……...

c. Rated normal current : ……...

d. Rated insulation levels

1. Rated power frequency withstand voltage – common value : ……

2. Rated lightning impulse withstand voltage – common value : ……

e. Rated short circuit breaking current, A.C. component : ……..

f. Rated short circuit breaking current, D.C. component in % : ……

g. Rated duration of short circuit : ……

h. First – pole – to – clear factor : ……

i. Rated short – circuit making current : ……

j. Rated short – time withstand current : ……

k. Rated peak withstand current : …….

l. Rated operating sequence : …….

m. Rated single capacitor bank breaking current : ……

n. Rated single capacitor bank inrush making current : ……

o. Mechanical endurance class : …….

p. Electrical endurance class : …….

q. Restrike class during capacitive current breaking : ……

r. Rated break time : ……

s. Rated closing time : ……

t. Rated opening time : ……

u .Rated transient recovery voltage for terminal faults

1. Peak value : ……

2. Rate of rise of recovery voltage : ……

3. First – pole – to – clear factor : ……

31. Dead time between closing and opening or vise – versa : ……

32. Simultaneity difference between poles (ON / OFF) : ……

33. Type of the main contacts : ……

……..

34. Material of the main contacts : …….

35. For SF6 gas in the interrupter chamber (if applicable)

a. Rated pressure of SF6 in bar or MPa : ……

b. SF6 alarm pressure in bar or MPa : ……

c. SF6 lockout pressure in bar or MPa : …….

d. SF6 loss – rate / year : …….

e. Mass of SF6 : ……

f. Minimum operating pressure : …….

36. SF6 gas of the dead tank (if applicable)

a. Rated pressure of SF6 in bar or MPa : …….

b. Minimum operating pressure of SF6 in bar or MPa : …….

c. SF6 lockout pressure in bar or MPA : …….

d. SF6 loss – rate / year : …….

e. Mass of SF6 : ……

37. Class protection of the breaker's operating mechanism and control cabinet : …….

38. Number of auxiliary free contacts : ……

……..

39. Number of tripping coils : …….

40. Number of closing coils : …….

41. Power consumption

a. Closing coil : ……

b. Trip coil : …….

c. Anticondensation heaters : ……

d. Light bulb : …….

42. Spring type operating mechanism data (if applicable)

a. Motor voltage : ……

b. Motor power when running : ……

c. Motor power during starting : ……

d. Voltage motor tolerances : …….

43. Magnetic actuator mechanism data (if applicable)

a. Permanent magnet voltage : ……

b. Power of the permanent magnet : …….

c. Voltage supply tolerances : ……

44. Description of the vacuum interrupter chamber (if applicable) : …….

……...

……...

……...

45. Weight of the breaker complete with SF6 and its support structure (dead tank breaker) : …….

46. Weight of the breaker complete with SF6 (live tank breaker) : …….

47. Weight of the live tank breaker's support structure : …….

48. Weight of the two types of CTs for the live tank type of breaker : …….

……

……

49. Dimension of the circuit breaker along with its steel support structure : …….

……

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50. Is the breaker's steel support structure hot – dip galvanized? : …….

51. Is the dead tank of the breaker equipped with a pressure relief disk? : …….

……

……

52. For the dead tank type of circuit breaker, indicate whether each interrupting unit is inside each own dead tank or whether all interrupting units are inside a common dead tank : …….

53. Tolerances of the auxiliary voltage for the tripping coil : ……

54. Are all necessary materials (bolts and flexible copper strips with suitable cross-section) for the connection of CTs with the live tank circuit breaker, part of the supply? : ……

IIδ/ mt/AG/November 2004
IIδ/πμ/ΑΓ/January 2006
IIδ/πμ/ΑΓ/June 2006
IIδ/p.t/ΑΓ/April 2008