



October 2014

**TECHNICAL DESCRIPTION TD-77/3**  
**170 KV COMPACT INTEGRATED SUBSTATION MODULES**

**I. SCOPE**

This technical description covers PPC's requirements with regard the design features, rated characteristics and testing of 170kV compact integrated substation modules.

**II. REQUIRED TYPE OF THE 170kV COMPACT INTEGRATED SUBSTATION MODULES**

The compact integrated substation modules consists either of components of air insulated switchgear (AIS) or of a combination of air insulated switchgear and gas insulated switchgear (GIS), so called mixed technology switchgear (MTS) or hybrid insulated switchgear.

The module consists of at least one switching device directly connected to, or sharing components with, one or more other devices, such that there is an interaction between the functions of the devices.

**III. KEYWORDS**

Air insulated compact integrated modules, air insulated compact switching modules, hybrid insulated compact integrated switching module, pre-fabricated modules.

**IV. STANDARDS**

For the compact integrated modules the applicable standards shall be.

- IEC 62271-1
- IEC 62271-100
- IEC 62271-102
- IEC 62271-203
- IEC 62271-205
- IEC 62271-300
- IEC 61869-1
- IEC 61869-2
- IEC 61869-3
- IEC 61869-4

## **V. USE**

The 170kV compact integrated substation modules are to be used mainly in 150kV transmission line incoming bays of air insulated 150/20kV substations, where there is not sufficient space for the deployment of conventional air insulated equipment.

Also, they can be used in cases where erection time is limited and of major concern.

## **VI. SERVICE CONDITIONS**

- |                              |   |
|------------------------------|---|
| 1. Installation              | : Outdoors                                |
| 2. Ambient temperature range | : Maximum +45°C                           |
|                              | : Minimum -25°C                           |
| 3. Altitude                  | : Up to 1000m above sea level             |
| 4. Relative humidity         | : ≤ 95%                                   |
| 5. Ice coating               | : 10mm mm                                 |
| 6. Pollution level           | : moderate to heavy depending on location |
| 7. Wind speed                | : 150Km/h                                 |
| 8. Other conditions          | : Snow and fog                            |

## **VII. 150kV ELECTRICAL SYSTEM CHARACTERISTICS**

- |  |  |
|--|--|
| 1. Nominal Voltage                     | : 150KV  |
| 2. Maximum Operating Voltage           | : 170KV  |
| 3. Lightning impulse withstand voltage | : 750KV peak                                     |
| 4. Short circuit level                 | : 31KA   |
| 5. Number of phases                    | : 3  |
| 6. Nominal Frequency                   | : 50 Hz  |
| 7. Earthing (grounding) method         | : The 150KV system is solidly earthed (grounded) |
| 8. Auxiliary voltages                  | : 110V DC, 3Φ 400V AC<br>or 1 Φ 230VAC           |

## **VIII. COMPACT INTEGRATED SUBSTATION MODULE REQUIRED BASIC DESIGN FEATURES**

### **1. Components of the module**

The compact integrated substation module shall consist of the following electrical power system equipment.

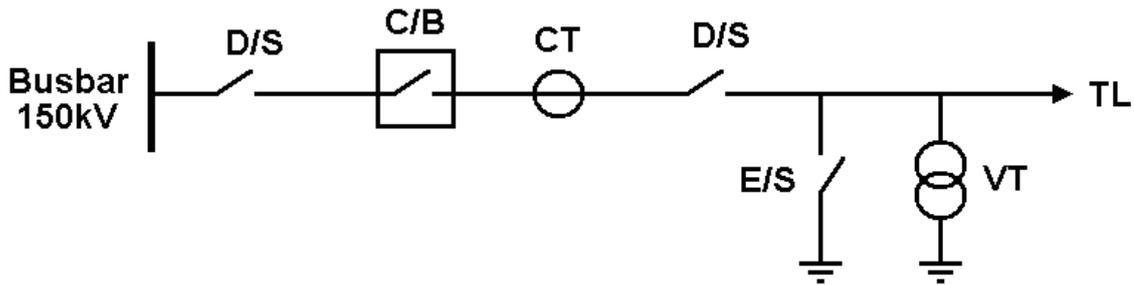
- a. One (1) 3-pole circuit breaker or three (3) single pole circuit breakers suitable however for 3-pole operation.
- b. Two (2) three-pole disconnectors for isolating completely the circuit breaker at both sides (up-stream and down-stream)
- c. One (1) three-pole earthing switch or three (3) single-pole earthing switches manually operated. Electrically operated earthing switches can be accepted if it is called by the design of the module.
- d. Three (3) current transformers.
- e. Three (3) voltage transformers

### Notes

- Instead of 3 CTs and VTs, a combined instrument transformer consisting of a voltage and current transformer (3 sets) can be offered.
- A compact integrated module can on request, to be consisted only of items (a) and (b) as indicated above. If this is the case, it will be indicated in the inquiry.

### 2. Configuration of the modules components

The configuration of the module's components shall be that the single busbar as indicated in Fig. No.1 below



**Fig No.1** Configuration of the module (single-line diagram)

If the compact integrated module consists only of circuit breaker and disconnectors, the above scheme shall be modified accordingly.

### 3. Visual confirmation of the disconnector's position

The disconnectors' position (open or closed) must be easily and clearly distinguishable from ground level. Modules which are not equipped with this particular feature shall be rejected.

### 4. Method of achieving the disconnection function

Either by rotation of each pole of the circuit breaker (pivoted circuit breaker) or by the movement of a trolley truck on which the circuit breaker is mounted on. Alternatively, the disconnector – circuit breaker assembly shall be of GIS type. In any case independent isolating gaps shall be provided. No disconnecting circuit breaker is allowed.

### 5. Required type of mode of operation for achieving the disconnection function

- a. In the case where the disconnection function is achieved by the rotation of the poles of the circuit breaker, the rotation shall be achieved by a electric motor-driven mechanism and in case of emergency, manually, by a hand-crank.
- b. In the case where the disconnection function is achieved by the movement of a trolley truck, the movement shall be obtained by an electric motor-driven mechanism and in case of emergency manually, by a hand-crank.
- c. In the case where the disconnector is of GIS type, its operation shall be obtained by an electric motor driven mechanism and in case of emergency manually, by a hand-crank.

#### 6. Support structure or structures of the module

The support structure or structures shall be part of the supply and shall be made of hot-dip galvanized steel. It should be made sure that all parts of the module shall be mounted on a common base and be connected via metallic frame which may be encased in concrete. The connecting frames, anchoring bolts, nut, washers and grover shall be of hot dip galvanized steel and shall also be part of the supply.

#### 7. Earthing of the structure or structures of the module

The structure or structures shall be equipped with screws or a copper strip of current capability of 31,5 KA ending in a rectangular in shape terminal which shall be used for connection to the earthing (grounding) mat of the substation.

#### 8. Required dimensions of the module

1. The maximum acceptable dimensions of the module consisting of disconnectors, earthing switch, circuit breaker, CTs and VTs shall be as follows:
  - a. Length (L): 8,2m with the earthing switch in the open position
  - b. Width (W): 5,7m
  - c. Height (H): 6,5m (terminals)
2. The maximum acceptable dimensions of the module consisting of disconnectors and circuit breaker shall be as follows:
  - a. Length (L): 5,8m
  - b. Width (W): 5,7m
  - c. Height (H): 6,5m (terminals)

#### 9. Required interlockings for the module

- a. An interlocking shall exist which shall prevent the operation of the disconnectors (opening or closing) when the circuit breaker is in the closed position.
- b. An interlocking shall exist which shall prevent operation of the earthing switch when the disconnectors are not in the off position

#### 10. Seismic Requirements

The module shall be capable for AF5 seismic level as per IEC 62271-300 (severity levels: horizontal 0,5g and vertical 0,25g). To prove the AF5 seismic level capability, either test certificates must be submitted in the technical offer or a mathematical modal analysis.

#### 11. Terminals

The terminals of the module which shall be used to connect the module with the rest of the equipment the substation shall be suitable for connection via bronze connectors (supply of IPTO) with copper tubes of 30mm in diameter.

#### 12. Auxiliary Contacts

At each terminal strip for connection to other equipment, out of the compact substation module, 10% free terminals shall be provided.

## **IX. REQUIRED RATINGS AND FEATURES OF THE CIRCUIT BREAKER OF THE MODULE**

|   |  |
|---|--|
| 1. Type   | : SF6 puffer or auto-puffer type (live tank for air insulated modules) |
| 2. Rated Voltage  | : 170KV  |
| 3. Rated frequency  | : 50Hz   |
| 4. Rated normal current   | : 1250A  |
| 5. Rated short circuit breaking current - a.c. component  | : 31,5 KA rms  |
| 6. Rated short circuit making current   | : 79 KA peak   |
| 7. Rated short-time withstand current   | : 31,5 KA rms  |
| 8. Rated peak withstand current   | : 79 KA peak   |
| 9. Rated duration of short circuit  | : 3 sec  |
| 10. Rated power frequency withstand voltage   | : 325KV rms  |
| 11. Rated lightning impulse withstand voltage   | : 750KV peak   |
| 12. First pole-to clear factor  | : 1,5  |
| 13. Rated transient recovery voltage for terminal faults  |  |
| a. Rated transient recovery voltage   | : 291KV peak   |
| b. First pole-to-clear factor   | : 1,5  |
| c. RRRV   | : 2KV/ $\mu$ s   |
| 14. Rated transient recovery voltage for short-line faults  |  |
| a. Rated transient recovery voltage   | : 194KV peak   |
| b. First pole-to-clear factor   | : 1  |
| c. RRRV   | : 2KV/ $\mu$ s   |
| 15. Rated line-charging breaking current  | : 63A  |
| 16. Rated cable-charging breaking current   | : 160A   |
| 17. Rated break time  | : $\leq$ 60ms  |
| 18. Rated opening time  | : $\leq$ 40ms  |
| 19. Rated closing time  | : $\leq$ 100ms   |
| 20. Type of material of the housing of the isolating column and of the breaking chamber (for air insulated modules) | : Either porcelain, grey in color or silicon rubber                    |
| 21. Type of material of the bushings (for the hybrid insulated modules)   | : Silicon rubber   |
| 22. Creepage distance across terminals (for the air insulated modules)  | : 4250mm   |
| 23. Creepage distance to earth (for the air insulated modules)  | : 4250mm   |
| 24. Creepage distance of bushings (for the hybrid insulated modules)  | : 4250mm   |
| 25. Rated operating sequence  | : O-0,3sec-CO-3min-CO  |
| 26. Type of operating mechanism   | : Spring type  |
| 27. Rated supply voltage of the motor for spring charging   | : 110V DC  |
| 28. Rated supply voltage for the auxiliary circuits of the operating mechanism                                      | : 110V DC  |
| 29. Number of operating mechanism   | : one or three (one per pole)  |

|   |  |
|---|--|
|   | (no single-pole operation capability required)   |
| 30. Number of auxiliary contacts free of voltage                                  | : Seven (7) make and seven (7) break   |
| 31. Class protection of the operating mechanisms housing                          | : IP44 as per IEC 60529  |
| 32. Anti condensation heaters for the housing of the operating mechanism          | : Anti condensation heaters are required and shall be controlled with a thermostat   |
| 33. SF6 loss per year   | : $\leq 1\%$   |
| 34. Static horizontal terminal load   | : 1000N  |
| 35. Size of the terminal blocks used in the operating mechanism's panel (cubicle) | : $4\text{mm}^2$ for control and $10\text{mm}^2$ for supply conductors   |
| 36. Rated supply voltage for the anti-condensation heaters                        | : $1\Phi$ , 230V AC  |
| 37. Number of tripping coils  | : 2  |
| 38. Local/Remote control switch for the panel of the operating mechanism          | : A selector control switch with three (3) positions 'manual-Local-Remote' must be provided and with as many stages as needed for the control circuits of the breaker. In the 'manual' position the circuit breaker shall be operated by the hand crank. The 'Local' position and in conjunction with two (2) push-buttons or a control switch, will be used to control the CB from the operating mechanism cabinet for maintenance purposes only. When the CB is under local control, the CB bay will be out of service. The 'Remote' position will be used to control the CB from a remote place and for tripping purposes. The Local/Remote switch shall be equipped with an additional number of stages beyond those needed for the control circuits which shall be used to be inserted to both positive (+) and |

|  |  |
|--|--|
|  | negative (-) 110 V DC buses of the control circuits.   |
| 39. Open/close push-buttons or a two (2) position control switch (local control) | : The panel of the operating mechanism shall be equipped with one (1) push button for opening and one (1) for closing or instead with a control switch of two (2) positions (open-close) |
| 40. Mechanical endurance class   | : M2   |
| 41. Restrike class during capacitive current breaking (line and cable charging)  | : C1   |
| 42. Emergency manual operation   | : The circuit breaker must be equipped with capability for manually opening without the use of DC auxiliary supply voltage (by hand-crank).  |
| 43. Color of the tank in the case of air/gas insulated module                    | : grey   |

## **X. REQUIRED RATINGS AND FEATURES OF THE DISCONNECTORS**

|  |  |
|--|--|
| 1. Rated voltage   | : 170KV  |
| 2. Number of poles   | : Three (3)  |
| 3. Rated frequency   | : 50Hz   |
| 4. Rated current   | : 1250A  |
| 5. Rated insulation levels   |  |
| a. Power frequency withstand voltage   |  |
| - Phase to earth and between phases  | : 325 KV rms   |
| - Across the isolating distance  | : 375 KV rms   |
| b. Lightning impulse withstand voltage   |  |
| - Phase to earth and between phases  | : 750 KV peak  |
| - Across the isolating distance  | : 860 KV peak  |
| 6. Rated short-time withstand current  | : 31.5 KA rms  |
| 7. Rated peak withstand current  | : 79KA peak  |
| 8. Rated duration of short circuit   | : 3sec   |
| 9. Trickiness of ice coating for which operation shall be possible (if applicable) | : 10mm   |
| 10. Mechanical endurance class   | : M1   |
| 11. Type of the driving (operating) mechanism                                      | : Three-pole or one per pole to either rotate the poles of the circuit breaker or the special contacts (for the air/gas insulated module) or to move the trolley truck |

- |   |  |
|---|--|
| 12. Number of auxiliary contacts free of voltage                          | : 5 make, 5 break and<br>2 make – early closing,<br>2 break – late opening   |
| 13. Class protection of the housing<br>(cabinet) of the driving mechanism | : IP44 as per IEC 60529  |
| 14. Anticondensation heaters  | : Anticondensation<br>heaters are required<br>controlled by thermostat   |
| 15. Anticondensation heaters<br>supply voltage                            | : 1Φ, 230VAC   |
| 16. Supply voltage of the auxiliary<br>circuits of the driving mechanism  | : 110V DC  |
| 17. Selector switch for the panel of the driving<br>mechanism             | : The driving mechanism must<br>by equipped with<br>a selector switch of three<br>(3) positions. In position<br>No.1 only manual operation<br>shall be allowed via the<br>hand-crank. In position<br>No.2 only electrical local<br>operation shall be allowed.<br>The local electrical<br>operation shall be achieved<br>via local push-buttons or<br>control switch for starting<br>and stopping. In position<br>No.3 only electrical remote<br>operation shall be allowed. |
| 18. Size of the terminal blocks of the panel<br>of the driving mechanism  | : The size of the terminal<br>blocks shall be such as to<br>allow the use of 4mm <sup>2</sup><br>control and 10mm <sup>2</sup> supply<br>conductors.   |
| 19. Emergency operation   | : The emergency operation<br>shall be achieved via a<br>hand-crank manually.<br>This operation is already<br>being described above.  |

## **XI. REQUIRED RATINGS AND FEATURES OF THE EARTHING SWITCH**

- |                      |  |
|----------------------|--|
| 1. Type              | : three pole   |
| 2. Type of operation | : manual by hand-crank or<br>by electric motor if the<br>design of the module<br>foresees electrical<br>operation. |

|   |  |
|---|--|
| 3. Rated voltage  | : 170kV  |
| 4. Rated frequency  | : 50Hz   |
| 5. Rated insulation levels                                      |  |
| a. Power frequency withstand voltage                            | : 325kV rms  |
| b. Lighting impulse withstand voltage                           | : 750kV peak   |
| 6. Rated short-time withstand current                           | : 31.5KA rms   |
| 7. Rated peak withstand current                                 | : 79KA peak  |
| 8. Rated duration of short circuit                              | : 3sec   |
| 9. Mechanical endurance class                                   | : M0   |
| 10. Electrical endurance class                                  | : E0   |
| 11. Induced current switching class                             | : B  |
| 12. Thickness of ice coating for<br>which operation is possible | : 10mm (class 10)  |
| 13. Auxiliary circuits supply voltage<br>(if applicable)        | : 110V DC  |
| 14. Size of terminal blocks                                     | : terminal blocks shall be<br>suitable for 4mm <sup>2</sup> size<br>control conductors |
| 15. Auxiliary contacts free of voltage                          | : 2 make and 2 break   |

## **XII. REQUIRED RATINGS AND FEATURES OF THE CURRENT TRANSFORMERS**

|   |  |
|---|--|
| 1. Type   | : Outdoor, or bushing type<br>(ring), single-phase with<br>one (1) primary winding<br>with two (2) sections and<br>three (3) secondary<br>windings each with its<br>own magnetic core.         |
| 2. Ratio  | : 1000-500/1-1-1A  |
| 3. Primary current                                  | : 1000-500A  |
| 4. Secondary current                                | : 1A   |
| 5. Insulating medium                                | : Mineral or synthetic oil<br>which must be not-toxic<br>and biodegradable. The<br>oil shall be free from<br>toxic agents such as PCBs<br>or PCTs. CTs insulated in<br>SF6 are also acceptable |
| 6. Insulating housing of the CTs<br>(if applicable) | : The housing shall either<br>be from high grade<br>porcelain, grey in colour<br>or from silicon rubber.   |
| 7. Creepage distance of housing<br>(if applicable)  | : 4250mm   |

|   |   |
|---|---|
| 8. Bellows<br>(if applicable)   | : Any oil volume changes due to temperature fluctuations shall be accommodate by bellows, preferably metallic |
| 9. Secondary terminals  | : The secondary terminals shall be suitable for 4mm <sup>2</sup> size conductors                              |
| 10. Highest voltage   | : 170kV   |
| 11. Rated frequency   | : 50Hz  |
| 12. Temperature category  | : -25° C/+45°C  |
| 13. Rated continuous thermal current  | : 1,2 x I <sub>N</sub>  |
| 14. Secondary windings use and required characteristics                                   |   |
| a. Winding for metering purposes  |   |
| - Number of windings  | : 1   |
| - Rated power output  | : 30VA  |
| - Accuracy class  | : 0,5   |
| - Instrument security factor  | : F <sub>s</sub> ≤ 5  |
| b. Winding for protection purposes<br>(phase+earth overcurrent +distance protection)      |   |
| - Number of windings  | : 1   |
| - Rated power output  | : 30VA  |
| - Accuracy class  | : 5P  |
| - Accuracy limit factor   | : 20  |
| c. Winding for protection purposes<br>(bus-bar differential protection)                   |   |
| - Number of windings  | : 1   |
| - Rated output  | : 30VA  |
| - Accuracy class  | : 5P  |
| - Accuracy limit factor   | : 20  |
| 15. Rated short-time thermal current  | : 40KA for one (1) second   |
| 16. Rated dynamic current   | : 100KA peak  |
| 17. Rated power frequency withstand voltage<br>(Not applicable for bushing type CTs)      | : 325kV rms   |
| 18. Rated lightning impulse withstand voltage<br>(Not applicable for bushing type CTs)    | : 750kV peak  |
| 19. Chopped lightning impulse withstand voltage.<br>(Not applicable for bushing type CTs) | : 863kV   |
| 20. Partial discharge level<br>(Not applicable for bushing type CTs)                      | : 5pC at 118kV  |
| 21. Power frequency withstand voltage<br>for the secondary terminals                      | : 3kV   |
| 22. Dielectric dissipation factor (tanδ)<br>(Not applicable for bushing type CTs)         | : ≤0,005 at 10kV - 98kV   |
| 23. Radio interference voltage level<br>(Not applicable for bushing type CTs)             | : ≤2500μV at 108kV  |
| 24. Transmitted overvoltage peak limit  | : ≤1,6kV at pulse of 222kV  |

25. Accessories

- : The CT will be equipped with
- Oil level indicator (if applicable)
- filling and draining plug (if applicable)
- Earthing terminal (if applicable)
- A special terminal for measuring  $\tan\delta$  (if applicable)

**XIII. REQUIRED RATINGS AND FEATURES OF THE VOLTAGE TRANSFORMERS**

- 1. Type : Outdoor, or GIS, single-phase, inductive type with one (1) primary winding and three (3) separate secondary windings.
- 2. Insulating medium : Mineral or synthetic oil which must be non-toxic and biodegradable. The oil shall be free from toxic agents such as PCBs and PCTs. VTs insulated in SF6 are also acceptable.
- 3. Ratio :  $16000\sqrt{3} / 120\sqrt{3} - 120\sqrt{3} - 120\sqrt{3} \text{ V}$
- 4. Primary voltage :  $16000\sqrt{3} \text{ V}$
- 5. Secondary voltage :  $120\sqrt{3} \text{ V}$
- 6. Insulating housing of the VTs (if applicable) : The housing shall either be from high grade porcelain, grey in colour or from silicon rubber
- 7. Creepage distance of the housing (if applicable) : 4250mm
- 8. Bellows (if applicable) : Any oil volume changes due to temperature fluctuations shall be accommodate by bellows, preferably metallic.
- 9. Secondary terminals : The secondary terminals must be suitable to be wired with  $4\text{mm}^2$  size conductor Furthermore, all secondary phase leads

|  |   |
|--|---|
|  | shall be protected by 2A explosion type fuses and the neutral leads by links. All these fuses and links shall be installed inside the secondary terminal box.   |
| 10. Accessories  | : The VTs shall be equipped with the following<br>Oil level indicator (if applicable)<br>- Filling and draining plug (if applicable)<br>- A special terminal for measuring $\tan\delta$ (if applicable) |
| 11. Secondary windings use and required characteristics                    |   |
| a. Windings for metering purposes  |   |
| - Number of windings   | : 2   |
| - Rated power output   | : 25VA  |
| - Accuracy class   | : 0,5   |
| - Percentage voltage error   | : $\pm 0,5$   |
| - Phase displacement   | : $\pm 20$ minutes  |
| b. Windings for protection purposes (distance protection)                  |   |
| - Number of windings   | : 1   |
| - Rated power output   | : 10VA  |
| - Accuracy class   | : 3P  |
| - Percentage voltage error   | : $\pm 3,0$   |
| - Phase displacement   | : $\pm 120$ minutes   |
| 12. Rated frequency  | : 50Hz  |
| 13. Number of secondary windings   | : 3   |
| 14. Partial discharge level  | : $\leq 5$ pC at 118kV  |
| 15. Power frequency withstand voltage of the primary                       | : 325kV rms   |
| 16. Lighting impulse withstand voltage of primary                          | : 750kV peak  |
| 17. Power frequency withstand voltage of the neutral primary terminal      | : 3kV   |
| 18. Power frequency withstand voltage of secondary windings                | : 3kV rms   |
| 19. Chopped lightning impulse withstand voltage of primary (if applicable) | : 863kV peak  |
| 20. Temperature category   | : $-25^{\circ}\text{C} / +45^{\circ}\text{C}$   |
| 21. Dielectric dissipation factor ( $\tan\delta$ ) (if applicable)         | : $\leq 0,005$ at 10kV - 98kV   |
| 22. Rated voltage factors  | : 1,2 continuous<br>1,5 for 30sec   |
| 23. Radio interference voltage level                                       | : $\leq 2500\mu\text{V}$ at 108kV   |

24. Transmitted overvoltage peak limit :  $\leq 1,6\text{kV}$  at pulse of 222kV

**NOTE**

If a combined instrument transformer consisting of a VT and a CT shall be offered, it shall have the characteristics and features described in the above paragraphs of XII and XIII of this hereby technical description

**XIV. TESTS**

All testing shall be in accordance with the applicable IEC standards relevant to the equipment involved unless it is indicated otherwise.

**A. Routine tests**

The 170kV compact integrated substation module shall be subjected to the following routine tests.

1. Functional tests on auxiliary and control circuits of the module.
2. Mechanical function tests on all moving parts of the module, including any mechanical interlocks. In hybrid insulated modules also verification of proper functioning of the disconnectors' and earthing switches' mechanical position indication devices.
3. Visual checks of the entire module consisting of the following.
  - a. Language on the name plates.(which must be English)
  - b. The color and quality of paint and corrosion protection of the metallic surfaces Furthermore, the checking of the galvanization shall be carried out with the magnetic method in accordance with ISO-2178 standard.
4. Power frequency voltage test for all primary equipment of the module.
  - a. Phase-to - earth : 325kV rms
  - b. Phase-to - phase : 325kV rms
  - c. Across the isolating distance for the disconnectors : 375kV rms
  - d. Phase-to-earth for the neutral primary terminal of the VT : 3kV rms(Not applicable for the bushing type CTs)
5. Power frequency voltage test on all control auxiliary circuits for the circuit breakers, disconnector and earthing switch (IEC 62271-1, IEC 62271-100 and 62271-102) : 1kV for 1 s
6. Measurement of the resistance of the main circuit
7. Power frequency voltage test for the CTs, VTs or the combination of the CT/VT

on secondary winding : 3kV rms  
between sections of primary winding : 3kV rms

8. Inter-turn overvoltage test for the CTs or the CT part of the CT/VT combination
9. Verification of terminal markings for the CTs, VTs or the combination of the CT/VT
10. Partial discharge measurements for the CTs, VTs or the combination of the CT/VT (Not applicable for bushing type CTs).
11. Accuracy tests for the CTs, VTs or the combination of the CT/VT
12. Gas tightness test for all gas insulated devices and compartments.
13. Pressure test for the vessel and for the partitions of the hybrid insulated module in accordance with IEC 62271-203.

## **B. Type Tests**

Since the compact integrated substation modules are based on well established and tested components, bidders are required to submit with the technical offer all type test certificates that they have at their disposal. These type test certificates shall cover the following type tests per module component.

1. For the circuit breaker (as per IEC 62271-100 and IEC 62271-1)
  - a. Power frequency voltage test
  - b. Lightning impulse voltage test
  - c. Dielectric test on auxiliary and control circuits (AC=2kV)
  - d. Radio interference voltage test
  - e. Tightness test
  - f. Verification of IP degree of protection for the control enclosures
  - g. Environmental temperature tests (max-min temperature)
  - h. Measurement of the resistance of the main circuit
  - i. Temperature-rise test
  - j. Short-time and peak current withstand tests
  - k. Mechanical operation tests
  - l. Short-circuit current making and breaking tests
  - m. Short-line fault test
  - n. Single-phase fault test
  - o. Line-charging current switching test
  - p. Cable-charging current switching test
2. For the disconnectors and earthing switches  
(as per IEC 62271-102 and IEC 62271-1)
  - a. Power frequency voltage test
  - b. Lightning impulse voltage test
  - c. Dielectric test on auxiliary and control circuits (AC=2kV)
  - d. Radio interference voltage test
  - e. Verification of IP degree of protection for the control enclosures
  - f. Measurement of the resistance of the main circuit

- g. Temperature-rise test
  - h. Short-time and peak current withstand tests
  - i. Mechanical operation tests
  - j. Environmental temperature tests (max-min temperature)
  - k. Induced current switching test  
(applicable only for line and cable earthing switches)
  - l. Operation test under 10mm (class 10) ice coating  
(not applicable for gas insulated disconnectors and earthing switches)
  - m. Functional test of mechanical position indicating device  
(applicable only for gas insulated disconnectors and earthing switches)
3. For the CTs (as per IEC 61869-2 and IEC 61869-1)
- a. Short-time current test
  - b. Temperature rise test
  - c. Lightning impulse test (Not applicable for bushing type CTs)
  - d. Power frequency voltage wet test for outdoor type CTs (Not applicable for bushing type CTs)
  - e. Radio interference voltage test (Not applicable for bushing type CTs)
  - f. Accuracy tests
  - g. Verification of IP degree of protection for the terminal box
  - h. Gas tightness test (applicable only for SF6 insulated CTs)
4. For the VTs (as per IEC 61869-3 and IEC 61869-1)
- a. Temperature rise test
  - b. Short-circuit withstand capability test
  - c. Lightning impulse test
  - d. Power frequency voltage wet test for outdoor type VT
  - e. Radio interference voltage test (if applicable).
  - f. Accuracy tests
  - g. Verification of IP degree of protection for the terminal box
  - h. Gas tightness test (applicable only for SF6 insulated VTs)

For a CT/VT combination transformer, the tests indicated in above paragraphs XIV-B-3 and XIV-B-4 are applicable.

5. Tests on combinations of devices

As mentioned in par. II, there are interactions between the devices comprising the substation module, meaning the transfer of electrical, mechanical and thermal stresses between them during normal operation or during faults. Following IEC 62271-205, the interacting devices of the module shall be type tested in combination, at least as far as the exchange of mentioned stresses is concerned. The required combined type tests are the following:

- a. Dielectric tests
- b. Radio interference voltage test
- c. Measurement of the resistance of the main circuits
- d. Temperature-rise test
- e. Short-time and peak current withstand tests

6. For the hybrid insulated module

For the GIS part of the module, all the tests indicated in above paragraphs XIV-B-1 to XIV-B-5 are applicable, as modified in IEC 62271-203. Additionally the following type tests for the GIS part are required:

- a. Pressure tests for the vessel and for the internal partitions (proof tests)
- b. Tightness tests for the internal partitions
- c. Thermal cycle test for the internal partitions and insulators

If any of the type test certificates mentioned in par. XIV-B is not submitted with the technical offer, IPTO maintains the right to ask for the execution of the test or tests for which no test certificate or certificates has or have been submitted. Furthermore, the economic offer shall be charged with the test or tests which have not been submitted. Therefore, for this reason in the economic offer, prices for all the above indicated type tests must be submitted.

## **XV. NAMEPLATES**

The module shall be equipped with a name plate or plates of anti-corrosion material on which the following information shall be marked.

1. Name of manufacturers
2. Type
3. A list with all of its components
4. Rated power frequency withstand voltage
5. Rated lightning impulse withstand voltage
6. Rated frequency
7. Rated normal current
8. Rated short circuit breaking current
9. Rated duration of short-circuit
10. Rated supply voltage of control and auxiliary circuits
11. Rated supply voltage for all operating and driving mechanisms
12. Mechanical endurance class of the CB and disconnectors
13. Electrical endurance class for the earthing switch
14. Ratio of the CT
15. Rated output and corresponding accuracy class of the secondary windings of the CT
16. Rated short-time thermal current of the CT
17. Rated dynamic current of the CT
18. Ratio of the VT
19. Rated output and accuracy class of the secondary windings of the VT
20. Rated voltage factor and corresponding rated times for the VT

## **XVI. DATA TO BE SUBMITTED BY ALL BIDDERS**

1. Outline physical drawings of the module
2. Technical brochures of the offered module and of its components
3. Any seismic test certificates for AF5 seismic level or a mathematical modal analysis

4. All type test certificates listed in paragraph XIV-B of this hereby technical description
5. A preliminary drawing of the steel support structure or structures of the module
6. Attachment "A" of this hereby technical description completely filled. Failure to comply or partial filling will constitute sufficient reason for rejection of the offer.
7. A list of conductors or bus-bars and connectors that may be needed for the interconnection of the various components of the module among themselves.

These conductors or bus-bars and connectors must be furnished as part of the supply.

#### **XVII. DATA WHICH MUST BE SUBMITTED BY THE SUCCESSFUL BIDDER**

1. Complete physical drawings of the module for approval before the construction of the module (3sets)
2. Complete schematic and wiring drawings of the module for approval before the construction of the module (3sets)
3. A detailed drawing of the modules support structure or structures which will enable IPTO to construct its or their steel reinforced concrete base or bases
4. Maintenance and assembly instructions in detail

#### **XVIII. WARRANTY**

A warranty of three (3) years must be provided beginning from the date of delivery of the module for damages caused either by faulty design or by unreliable components or by combination of both.

#### **XIX. PACKING**

Every transport unit of the module shall be packaged inside robust wooden boxes of at least 20mm thickness. The boxes will be of "pallet type", with strengthened base. Every module shall be contained in a separate set of boxes. All boxes shall be properly labeled and the label shall contain explicit information as to what each box contains.

The equipment must be delivered with the appropriate for operation quantity of SF6 gas.

**ATTACHMENT “A”**

**170 KV COMPACT INTEGRATED SUBSTATION MODULES**

*This attachment shall be completely filled. Failure to comply will constitute sufficient reason for rejection of the offer.*

1. Type :.....  
.....
2. Manufacturer :.....  
.....
3. Is an air insulated module offered or an air/gas insulated module? :.....  
.....
4. List all the components of the module and indicate total number of each component. :.....  
.....  
.....
5. Show the configuration of the module. :.....
6. Can the position of the disconnectors be visually confirmed from ground level? :.....
7. Describe how the disconnection function is achieved :.....  
.....
8. Is the disconnection function achieved by an electric motor driven mechanism and also by hand-crank? :.....
9. Indicate type of steel used for the support structure or structures of the module :.....
10. Is the steel support structure or structures hot-dip galvanized :.....
11. Are the parts of the integrated module mounted on a common base connected

- via metallic frame ?  
 Is the frame included in the supply? :.....
12. Described the earthing of the support structure or structures of the module :.....  
 :.....  
 :.....
13. Indicate the dimensions of the offered module (LXWXH) :.....
14. List all required interlocking of the offered module :.....  
 :.....  
 :.....  
 :.....
15. Is the module as it is mounted on its support structure capable of AF5 seismic level :.....
16. Describe the type of material and shape of terminals employed at the entrance and exit of the module :.....  
 :.....
17. Ratings and features of the circuit breaker
- a. Type :.....
  - b. Rated voltage :.....
  - c. Rated normal current :.....
  - d. Rated short circuit breaking current-A.C. component :.....
  - e. Rated short circuit making current :.....
  - f. Rated short-time withstand current :.....
  - g. Rated peak withstand current :.....
  - i. Power frequency withstand voltage :.....

|  |        |
|--|--------|
| j. Lightning impulse withstand voltage .....   |        |
| k. First pole-to-clear factor  | :..... |
| l. Transient recovery voltage of terminal faults   |        |
| - Transient recovery voltage   | :..... |
| - First pole-to-clear factor   | :..... |
| - RRRV for terminal faults   | :..... |
| m. Rated transient recovery voltage for short-line faults  | :..... |
| - Rated transient recovery voltage   | :..... |
| - RRRV   | :..... |
| - First pole-to-clear factor   | :..... |
| n. Rated line-charging breaking current  | :..... |
| o. Rated cable-charging breaking current .....   |        |
| p. Rated break time  | :..... |
| q. Rated opening time  | :..... |
| r. Rated closing time  | :..... |
| s. Type of material of the housing of the insulating column and breaking chamber (if applicable) | :..... |
| t. Type of material of bushings (if applicable)  | :..... |
| u. Creepage distance across terminals (if applicable)  | :..... |
| v. Creepage distance to earth (if applicable)  | :..... |
| w. Creepage distance of bushings (if applicable)   | :..... |
| x. Rated operating sequence  | :..... |

- y. Type of the operating mechanism :.....
- z. Supply voltage for the motor of the spring charging :.....
- a1. Supply voltage for the auxiliary and control circuits of the operating mechanism :.....
- b1. Number of the operating mechanisms :.....
- c1. Number of auxiliary contacts free of voltage :.....
- d1. Class protection of the operating mechanism's panel as per IEC-60529:.....
- e1. Are anti-condensation heaters controlled by thermostat provided for the operating mechanisms housing? .....
- f1. SF6 loss per year :.....
- g1. Static horizontal terminal load :.....
- h1. Are the terminal blocks suitable for 4mm<sup>2</sup> size control and 10mm<sup>2</sup> supply conductors? :.....
- i1. Supply voltage of the anti-condensation heaters :.....
- j1. Number of tripping coils :.....
- k1. Is the operating mechanism equipped with an off/local/remote selector switch? :.....
- l1. Is the operating mechanism equipped with two (2) push-buttons for local opening and closing? :.....
- m1. Is the off/local/remote switch equipped with enough stages even and for the insertion to both positive (+) and negative (-)110V DC buses of the control circuits? :.....
- n1. Mechanical endurance class :.....

o1. Restrike class during capacitive current breaking (line and cable charging) :.....

p1. Is the breaker equipped with emergency manual operation :.....

q1. Color the housing of the isolating column and breaking chamber if porcelain. :.....

r1. Color of the tank of the air/gas insulated module :.....

18. Ratings and features of the disconnectors

a. Rated voltage :.....

b. Number of poles :.....

c. Rated frequency :.....

d. Rated current :.....

e. Power frequency withstand voltage

- Phase to earth and between phases :.....

- Across the isolating distance :.....

f. Lightning impulse withstand voltage

- Phase to earth and between phases :.....

- Across the isolating distance :.....

g. Rated short-time current :.....

h. Rated peak withstand current :.....

i. Rated duration of short circuit :.....

j. Thickness of ice coating for which operation is possible :.....

k. Mechanical endurance class :.....

l. Type of driving mechanism :.....

- .....
- m. Number of auxiliary contacts free of voltage :.....
- n. Class protection of the housing of the driving mechanism :.....
- o. Is the housing of the driving mechanism equipped with anti-condensation heaters controlled by thermostat? :.....
- p. Supply voltage of the anti-condensation heaters :.....
- q. Supply voltage of the auxiliary circuits :.....
- r. Is a selector switch of four (4) positions off/electrical-local/electrical-remote/manual provided? :.....
- s. Are two (2) bush-buttons for local opening and closing provide? :.....
- t. Are the terminal blocks suitable for 4mm<sup>2</sup> size control and 10mm<sup>2</sup> supply conductors? :.....
- o. Is the emergency operation achieved by a hand-crank :.....

19. Ratings and features of the earthing switch

- a. Type :.....
- b. Type of operation (manual by hand-crank or by electric motor) :.....
- c. Rated voltage :.....
- d. Rated frequency :.....
- e. Power frequency withstand voltage :.....
- f. Lightning impulse withstand voltage :.....

- g. Rated short-time withstand current :.....
- h. Rated peak withstand current :.....
- i. Rated duration of short circuit :.....
- j. Electrical endurance class :.....
- k. Induced current switching class  
(IEC 62271-102, Annex C) :.....
- l. Thickness of ice coating for  
which operation is possible :.....
- m. Auxiliary supply voltage  
(if applicable) :.....
- n. Are the terminal blocks suitable  
for 4mm<sup>2</sup> size control conductors :.....
- o. Auxiliary free of voltage contacts :.....

20. Ratings and features of the current transformers

- a. Type :.....  
:.....  
:.....
- b. Ratio :.....
- c. Primary current :.....
- d. Secondary current :.....
- e. Insulating medium :.....
- f. Type of insulating housing of the  
CTs (if applicable) :.....
- g. Color of the insulating housing  
if porcelain :.....
- h. Is the CT equipped with bellows? :.....
- i. Are the bellows metallic? :.....
- j. Are the secondary terminals  
suitable for 4mm<sup>2</sup> size conductors? :.....

- k. Highest voltage : .....
- l. Rated frequency : .....
- m. Temperature category : .....
- n. Rated continuous thermal current : .....
- o. Number of secondary windings and use : .....
- p. Winding for metering purposes
  - Number of windings : .....
  - Rated power output : .....
  - Accuracy class : .....
  - Instrument security factor : .....
- g. Winding for protection purposes (phase+earth overcurrent+distance)
  - Number of windings : .....
  - Rated power output : .....
  - Accuracy class : .....
  - Accuracy limit factor : .....
- r. Winding for protection purposes (bus-bar differential protection)
  - Number of windings : .....
  - Rated power output : .....
  - Accuracy class : .....
  - Accuracy limit factor : .....
- s. Rated short-time thermal current : .....
- f. Rated dynamic current : .....

- u. Power frequency withstand voltage (if applicable) :.....
- v. Lightning impulse withstand voltage (if applicable) :.....
- w. Chopped lightning impulse withstand voltage (if applicable) :.....
- x. Partial discharge level :.....
- y. Power frequency withstand voltage for the secondary windings :.....
- z. Dielectric dissipation factor ( $\tan\delta$ ) :.....
- a1. Radio interference voltage level :.....
- b1. Transmitted over voltage peak limit :.....
- c1. Accessories (if applicable)
  - Oil level indicator (yes or no) :.....
  - Filling and draining plug, (yes or no) :.....
  - Earthing terminal, (yes or no) :.....
  - A special terminal for measuring  $\tan\delta$ , (yes or no) :.....

21. Ratings and features of the voltage transformers

- a. Type :.....  
.....  
.....  
.....
- b. Insulating medium :.....
- c. Ratio :.....
- d. Primary voltage :.....
- e. Secondary voltage :.....
- f. Type of insulating housing of the VT (if applicable) :.....
- g. Color of the insulating

- housing if porcelain (if applicable) :.....
- h. Creepage distance of the insulating housing (if applicable) :.....
- i. Is the VT equipped with bellows? (if applicable) :.....
- j. Are the bellows metallic? (if applicable) :.....
- k. Are the secondary terminals suitable for connection to 4mm<sup>2</sup> size conductors? :.....
- l. Are the secondary phase leads protected by 2A explosion type fuses? :.....
- m. Are the secondary neutral leads protected by links? :.....
- n. Accessories (indicate with yes or no) (if applicable)
  - Oil level indicator :.....
  - Filling and draining plug :.....
  - A special terminal for measuring tanδ :.....
- o. Number of secondary windings :.....  
:.....
- p. Windings for metering purposes
  - Number of windings :.....
  - Rated power output :.....
  - Accuracy class :.....
  - Percentage voltage error :.....
  - Phase displacement :.....
- q. Winding for protection purposes
  - Number of windings :.....
  - Rated power output :.....

- Accuracy class :.....
- Percentage voltage error :.....
- Phase displacement :.....
- r. Rated frequency :.....
- s. Partial discharge level :.....
- t. Power frequency withstand voltage :.....
- u. Lightning impulse withstand voltage :.....
- v. Power frequency withstand voltage  
for the secondary windings :.....
- w. Chopped lightning impulse withstand  
voltage of the primary winding :.....
- x. Temperature category :.....
- y. Dielectric dissipation factor :.....
- z. Rated voltage factors
  - continuous :.....
  - 1,5 for 30 seconds :.....
- a1. Radio interference voltage level :.....
- b1. Transmitted over voltage peak limit :.....
- c1. Power frequency voltage withstand  
of the neutral (earthed) primary terminal
- 22. Total weight of the module :.....
- 23. Is a combined CT/VT provided?  
or separate CTs and VTs? :.....
- 24. Are the anchoring bolts nuts and  
washers for the steel support structure  
or structures part of the supply? :.....
- 25. Is the steel support structure or structures  
part of the supply? :.....
- 26. Indicate if any conductors

or bus-bars are needed for the connection of the various components of the modules among themselves

:.....  
.....  
.....

27. Are the interconnecting conductors or bus bars and connectors for the interconnection of the components of the module provided?

:.....

28. Are the anchoring bolts, nuts and washers of the steel structure or structures of hot dip galvanized steel

:.....

29. Is the SF<sub>6</sub> gas equipment delivered with the appropriate for operation quantity of gas?

:.....