



PROVINCIAL ELECTRICITY AUTHORITY

TECHNICAL SPECIFICATION DIVISION

COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Specification No.: RPRO-027/2560

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(8) Three (3) pieces of fuse per transformer, for use as spare, having the same size and rating as those use in the transformer feeder, kept inside the transformer compartment preferable in the box/bracket fixed on the door.

(9) Other necessary accessories according to manufacturer's design.

1c.5 Transformer

1c.5.1 General

The transformer shall be three-phase, oil-immersed, permanently sealed and completely oil filled system (without gas cushion), natural self-cooled type.

1c.5.2 Rating

(1) Rated output

The rated output, for transformers shall be of 630 kVA and 1000 kVA

(2) Rated voltage

Rated Primary Voltage	Rated Secondary Voltage
22 kV	400/230 V
33 kV	400/230 V

(3) Rated frequency: 50 Hz

1c.5.3 Core and winding

The cores and copper windings of transformers shall be according to manufacturer's standard.

1c.5.4 Taps

The primary windings of transformers shall be provided with full capacity of externally-operated off-circuit tap changers.

Tap voltage: $\pm 2 \times 2.5\%$ of rated primary voltage

The externally-operated off-circuit tap changer shall be designed for de-energized operation with the operating handle brought out through the cover of the tank. The operating handle shall have provision for locking and shall give visual indication of the tap position without unlocking.

1c.5.5 Vector group: Dyn 11

1c.5.6 Losses and impedance voltage

The specified or guaranteed losses plus positive tolerance, for each transformer unit, shall not be more than the figures in the **Table 3** below.

Impedance voltage of the offered transformer shall be as specified in the table below and have tolerance according to the relevant standards.

Table 3

Losses and impedance voltage of the transformers

Transformer rating (kVA)	Watt losses (Watts)			Percent impedance voltage at 75°C
	No-load loss for system voltage of :		Load loss at 75°C	
	22 kV	33 kV		
630	1,010	1,050	5,850	4
1000	1,270	1,300	12,150	6

1c.5.7 Limits of temperature-rise, above 40°C ambient temperature

Of top oil : not exceeding **50** K

Of winding : not exceeding **55** K

1c.5.8 Insulation level

The insulation level of H.V. windings and connected parts of transformers shall be as follows:

Nominal system voltage (kV r.m.s.)	Insulation level	
	Impulse test voltage full wave (kV peak)	Power frequency test voltage, 1-min (kV r.m.s.)
22	125	50
33	170	70

1c.5.9 Bushings

Each transformer shall have three (3) high-voltage bushings of cone-shaped, protruding type and shall be suitable for plug-in terminations/elbow connectors of 200 A continuous current rating and four (4) or eight (8) low-voltage bushings located on the cover of the tank.

Secondary neutral point of transformer shall be brought out by separated-insulated bushing(s) and loaded with rated current.

1c.5.10 Terminal connectors

L.V. bushings shall be equipped with terminal pad connectors (stud type connectors are preferable), of high conductivity bronze and hot-tin dipped. The terminal pads shall be drilled in accordance with NEMA standards (9/16" holes on 1 3/4" centers); each hole shall be furnished with one (1) bolt M 12 x 60 mm (of at least 50 mm thread length), one (1) nut, two (2) flat washers, and one (1) lock washer; details of terminal pads shall be according to Drawing No. **SA4-015/47002**.

1c.5.11 Tank cover and tank finish

The transformer tank cover shall be bolt tightened to the tank with suitable gasket sealing.

Interior surface shall be finished with oil resistant paint.

Exterior surface shall be painted with a primer coat and not less than two (2) finish weather-resistant coats of grey.

1c.5.12 Marking

PEA's code number shall be painted, in orange, on the rear side of the door of the transformer room at the position that enables a clear observation. The code number and dimensions of each letter to be marked shall be given by PEA after the final of bid consideration.

1c.5.13 Accessories

The transformers shall be furnished and equipped with the following accessories:

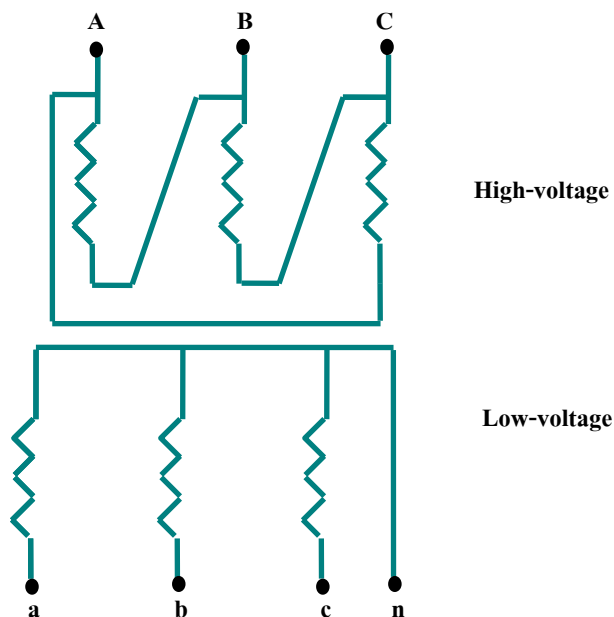
- (1) H.V. bushings and L.V. bushings with terminal connectors
- (2) Tap changer
- (3) Thermometer pocket
- (4) Nameplate and two (2) sets of rating plate with connection diagram
- (5) Oil drain valve with plug or cap, installed at the lower part of the tank
- (6) Sludge drain plug, installed at the bottom of the tank
- (7) Earthing terminal, with solderless clamp type connector suitable for copper conductor diameter of 12.6 mm (size 95 mm²); complete with lockwasher of stainless steel, or better
- (8) Lifting lugs
- (9) Lifting eyes on the cover
- (10) Pressure relief vent (explosion vent) with metal bursting plate
- (11) Other necessary accessories according to manufacturer's design

1c.5.14 Initial oil filling

The transformers shall be supplied with initial oil filling. The oil shall be high-quality, clean and dry.

1c.5.15 Terminal markings and connection diagrams

(22 or 33 kV)



(400/230 V)



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The symbols, A, B, C, a, b, c, and n, shall be durable marked on transformer tank beside bushings consequently;

Mark by painting shall not be accepted.

1c.6 Low-voltage switchgear

The incoming feeder and outgoing feeder shall be equipped with a three-pole molded case circuit-breaker (MCCB) having overload and short-circuit protection as shown in the enclosed Drawings No. SA5-015/48001 and No. SA5-015/48002. The MCCB shall be manufactured and tested in accordance with the IEC 60947-2. These MCCB shall have auxiliary contacts for remote status monitoring.

The digital power meter with appropriate current transformer, class 1 accuracy, shall be provided to measure at least the following values:

- 3 phase currents (Ia, Ib and Ic)
- 3 phase voltages (Van, Vbn and Vcn) and 3 line-line voltages (Vab, Vbc and Vca)
- Apparent power (kVA)
- Active power (kW)
- Reactive power (kVAR)
- Power factor (P.F.)
- Energy (kW-h)

The digital power meter shall be designed to operate in environment as follows:

- Ambient temperature : up to 60 °C
- Relative humidity : up to 100 %

and shall be tested in accordance with the relevant IEC, ANSI or equivalent :

- Insulation properties
- Electromagnetic compatibility (EMC)
- Others according to manufacturer's standard

All current carrying parts are touch safety covered.

All cable connections shall be made of screw-clamping terminals.

1c.7 Cable connector

1c.7.1 General

Cable connectors for 22 kV and 33 kV XLPE copper cable shall be manufactured and tested in accordance with ANSI/IEEE 386; or VDE and DIN Standards, particular DIN 47636 Part 1 to Part 7, EN-50181, IEC 60137, or equivalent, unless otherwise specified in these specifications.

The cable connectors shall be designed and constructed to connect the XLPE cable to the bushing of the equipment (ring main unit and transformer).

1c.7.2 Ratings

The cable connector shall have ratings as specified in **Table 4**.

Table 4
Ratings of the cable connectors

Rated voltage	kV	22	33
Rated current, continuous			
- for cable feeder	A	600	400
- for transformer feeder/transformer	A	200	200
Rated short-time current (1 sec), at rated voltage			
- for cable feeder	kA	16	16
- for transformer feeder/transformer	kA	10	10
Rated short-circuit making current, at rated voltage	kA	40	40

1c.7.3 Construction

The cable connector shall be suitable for single-core cross link polyethylene insulation, copper wire screen, polyethylene sheath, H.V. power cable copper conductor. The insulator body of the termination shall be of premolded type made from silicone rubber or EPDM with integrated stress control electrodes and an earthed conductive outside shield. The cable connectors shall be neutral to environmental influences, maintenance-free and suitable to be even flooded.

For cable feeder

The cable connectors for cable feeder of ring-main unit shall be of bolted-on touchable T-shaped type and shall be suitable for cone-shaped protruding bushing according to DIN 47636 Part 5 and Part 6, EN-50181, IEC 60137 or equivalent with screwed contact.

The T-shaped plug-in termination shall be able to connect a test bushing for cable testing in place of the sealing piece of the backside. The cone for the test bushing shall have the same dimensions as the bushing of the ring-main unit.



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For transformer/transformer feeder

The cable connectors for transformer feeder of ring-main unit shall be touchable elbow shaped type and shall be suitable for cone-shaped protruding bushing according to DIN 47636 Part 1 to Part 4, EN-50181, IEC 60137 or equivalent with plugged contact.

The cable connectors for transformer shall be bolted-on touchable T-shaped type and shall be suitable for cone-shaped protruding bushing according to DIN 47636 Part 5 and Part 6, EN-50181, IEC 60137 or equivalent with screwed contact.

1c.7.4 Marking

The cable connectors shall have indication mark (e.g. ink stamp, brand, or molded in) with the following information:

- Manufacturer's name or Trade mark
- Continuous current rating
- Maximum voltage rating
- Cable insulation diameter range

1c.8 Local control panel

The compact unit substation shall be furnished with local control panel for initiating control actions and viewing the status indicators of the Switches. As minimum, the local control shall be included the following:

- (1) Separate pushbuttons for opening and closing the switches.
- (2) A Remote/Local switch. While this switch is in the "Local" position, control shall be permitted only from the local control panel (i.e. remote control shall be prohibited). While the Switches are in "Remote" position, control shall be permitted from either the DMS or the control panel.
- (3) Separate "Open" (green) and "Close" (red) status LED super bright pilot lamps or better for the switch.
- (4) Fault Indication reset: a local push button will allow global Fault Indications reset
- (5) Other according to manufacturer's design

The local control panel shall be installed in low-voltage room

1c.9 Distribution Management System (DMS) interfacing

The Compact unit substation shall have capabilities to be controlled and monitored by the telecommunication system of the DMS in the future by communication with DMS via a Multiple Address Radio System (MARS) (provided by PEA) to the Feeder Remote Terminal Unit (FRTU).

The Compact unit substation shall have provisions for opening and closing the Switches using output from the FRTU and also supply analog and status signals to the FRTU for monitoring the conditions of the primary circuit and the components of Compact unit substation.



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The compact unit substations required to interface with the DMS which are specified in **C3 Schedule of detailed requirement** and **Table 1** shall be of:

- (1) Type AXX-X-XXXX compact unit substations shall be provided with the facilities for future interfacing as follows:
 - Terminals in low-voltage room with wiring all input/output points according to **Table 7, 8, and 9**.
 - Adequate spare terminal in low-voltage room for analog signal points and external control points.
 - Ample space for FRTU and Radio installation. (See detailed on **1c.9.9**)
 - Antenna support.
 - Communication cable entrance
 - In this type, the mechanism shall be supplied power via DC rectifier (No Battery Back-up) or according to manufacturer's design.
- (2) Type BXX-X-XXXX compact unit substations shall be provided with the facilities for DMS interfacing as follows:
 - Current Transformers
 - Voltage Transformers
 - Power Supply (see detailed on **1c.9.7**)
 - FRTU
 - Terminals in low-voltage room with wiring all status points, analog signal points and external control points according to **Table 7, 8 and 9** in **1c.9.8**
 - Ample space for Radio future installation. (Provided by PEA)
 - Antenna support
 - Communication cable entrance

1c.9.1 Feeder Remote Terminal Unit (FRTU)

The FRTU shall be installed in the low-voltage room. The FRTU shall include a high-resolution Sequence-of-Events (SOE) reporting capability. As a minimum, the status input points shown in **Table 7, 8 and 9** shall be able to be assigned to SOE reporting in addition to normal status reporting.

The FRTU shall detect changes in the state of SOE points, record the date and time of change with a resolution of ± 1 ms relative to the FRTU internal clock, inform the DMS that SOE data has been recorded, and report SOE data to the DMS upon request.

Time delays introduced by Contractor-supplied auxiliary relays used to acquire SOE status inputs from control circuits shall be consistent between devices to prevent time tag "skewing".

To ensure that SOE data is not lost or overwritten until the DMS acknowledges receipt of the data, a FRTU buffer capable of storing a minimum of 256 events shall be provided. The FRTU shall be able to retransmit stored SOE data if requested by the DMS.



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As a minimum, The Contractor shall be provided two (2) RS-232 ports (one for Local User Interface, another for DMS). Each RS-232 port shall be individually selectable for operation at 300 – 19,200 bits per second, and for communications in either synchronous or asynchronous data formats. The ports shall function independently such that the performance of each port shall not be degraded by simultaneous activity on all other ports.

The RS-232 ports shall be capable of supporting multiple protocols on and individually assigned basis. As a minimum, the protocols shall include DNP 3.0 Level 2.

The FRTU shall be designed to prevent false control actions from being executed and erroneous data from being transmitted due to communication channel errors. In addition, the FRTU shall incorporate the following fail-safe design criteria in their control output logic:

- (1) No false output shall result from a single point of failure in any equipment
- (2) No false output shall result during power up or power down of the FRTU
- (3) No false output shall result from inadvertently inserting a circuit card into a wrong slot within the FRTU

The built-in type FRTU equipped in same case of control unit (CU) shall be accepted, but in this case, the input/output signal from primary equipment to control unit (CU) shall be followed by the FRTU input/output type. The FRTU shall have input/ output types as follows:

1c.9.1.1 Analog Inputs

The FRTU shall acquire the ac inputs directly from current transformers (CTs) and voltage transformers (VTs) without transducers and shall use these inputs to calculate true RMS, 50 Hz phasor, and power data shown in **Table 7, 8 and 9**.

The FRTU shall accept voltage input signals with a normal input signal of 110 V AC.

The sampling rate for AC quantities shall be at least 32 samples per cycle.

The FRTU analog-to-digital (A/D) converters shall have a digital resolution of at least 12 bits plus sign. The overall accuracy of the analog input system shall be at least ± 0.2 % of full scale over the temperature range 0 to 60 °C. Linearity shall be better than ± 0.05 %.

The FRTU shall be capable of reporting analog values to the DMS by exception. The FRTU shall be able to report all analog values that have changed by more than a programmable dead-band from the last value, which was successfully reported to the DMS. The dead-band shall be specified for each point individually. In addition, the ability of the FRTU to alarm analog high and low limit violations is desirable.



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1c.9.1.2 Status Inputs

The wetting voltage for each input contact shall be the same as the primary control voltage used within the local control panel which the status point is acquired. The status input points shall connect directly into primary equipment without interposing devices.

The following types of status input points shall be provided:

- a. Single contact, two-state status input (SC-2S): For single contact, two-state status input points; a single contact shall represent both states of the monitored device. One position of the contact shall indicate an alarm or failure condition, while the opposite state of the contact shall indicate the normal condition.
- b. Double contact, two-state status (DC-2S): The double contacts shall be provided for representing each state of the monitored device. One contact shall indicate an open condition of the monitored device. The other shall indicate a closed condition. The contacts shall be treated as a complimentary pair. Conflicting contact positions shall be labeled INVALID.
- c. Two-State Status but Slowly Change (SLOW DC-2S): These status points shall be provided to indicate the current state of devices that rapidly change from one state to another. The status of such devices shall be provided by a complimentary pair of contacts (contact "1" and contact "2") as shown on **Table 5**.

Table 5

Two-State Status but slowly change Input Operation

State of Monitored device	Contact "1"	Contact "2"
Closed	Closed	Open
Open	Open	Closed
Changing State	Open	Open
Invalid	Closed	Closed

The state of each status point shall be reported to the DMS on an exception basis. That is a status point shall not be reported to the DMS during normal scanning unless the point state has changed from the last normal scan. The FRTU shall also report the state of selected status points upon receipt of a demand scan request from the DMS.

1c.9.1.3 Control Outputs

The FRTU shall include the following control points to support control actions initiated by the DMS master stations.

The FRTU shall perform on/off control actions using complimentary pairs of contact outputs. One contact output shall perform the "On" control action, and a second output contact shall perform the



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“Off” control action. The FRTU shall be designed such that only one output in a complimentary pair can be activated at a time.

To support the above capabilities, the FRTU shall include momentary control outputs and latching control outputs. Each momentary control output shall provide a contact closure (pulse) that shall have programmable pulse duration. The pulse duration shall be adjustable on an individual point basis from 0.1 to 60 seconds in increments of 0.1 seconds. In contrast, latching outputs shall remain in a given state until a subsequent command changes the control output state.

All control points shall follow a Select-Check back-Before-Operate (SCBO) procedure for control operation. Control point selection by the DMS shall be canceled if the operate command is not received within a programmable time period measured at the FRTU by a “Command Receipt” timer. The FRTU’s Command Receipt timer shall be in addition to the “Select Verification” timer in the DMS. The Command Receipt timer shall be adjustable between 10 to 60 seconds. The time period shall initially be set at 10 seconds.

The voltage rating of the control output contacts shall be the same as the primary control voltage used within Local Control Panel for the controlled device. The output relays shall be designed for 10^6 operations.

The Authority reserves the right to require the bidder to fully demonstrate conformance to the above requirement, on the proposed FRTU, prior to acceptance of the Bid. Such demonstration shall be required within one (1) month of a request issued by PEA. Failure to conform to this requirement would constitute grounds for rejection of the Bidder’s proposal.

1c.9.2 Electric surge protection

All necessary measures shall be taken to ensure proper functions and component safety of the control panel, the Power supply, and all other components connect to wiring external to the control cabinet with respect to switching voltage transients and all regular atmospheric, electrical, and magnetic disturbances, whether induced or directly coupled.

In particular, the equipment shall be constructed and tested to meet the applicable standards of IEC 60255-5, or ANSI/IEEE C37.90.1 and ANSI/IEEE C37.1 and be capable of withstanding the tests described in these standards without damage, false control output, or loss of internally stored data and parameters.

The electric surge protection shall be separated from print circuit board (PCB).



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1c.9.3 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the proposed FRTU shall satisfy the requirements for insulation, isolation, and immunity from electromagnetic interference, radiated disturbance and electrostatic discharge. The ability to meet these requirements shall be verified by Type tests.

1c.9.3.1 Minimum Insulation of Equipment

The enclosure equipment, including the connection cables with the electrical operating mechanisms and the fault detectors, must be able to withstand between all the terminals connected with one another and with the frame, as well as between each galvanically separate circuit and all the other circuits connected with one another and with the frame:

The FRTU shall meet or exceed the requirements contained in **Table 6**.

Table 6
Minimum insulation requirements

Characteristics	Exposed Equipment Terminals	Controlled Exposure Equipment Terminals	Non-Exposed Equipment Terminals
Rated insulation voltage	500 V	60 V	As Req'd
Dielectric test voltage (IEC 255-5, Table III)	Series B	Series C	As Req'd
Dielectric test voltage (IEC 255-5, Table I)	2.0 kV r.m.s.	1.0 kV r.m.s.	As Req'd
Dielectric test voltage between open contacts (IEC 255-5, Table I)	1.0 kV r.m.s.	0.5 kV r.m.s.	--
Insulation resistance test	Required	Required	--
Creepage and clearance distances (IEC 255-5 Table IV & V) (see Note 1)	According to IV & V	According to IV & V	--
Impulse Voltage Test (IEC 255-5 Section 8, Test C)	5 kV 1.2/50 us 0.5 J	5 kV 1.2/50 us 0.5 J	--

Note: Data communication ports shall be demonstrated to withstand disturbance test without permanent corruption of data, and subsequent delay of data transfer. The equipment shall be constructed and tested to meet the applicable standard of IEC 60255-5.

1c.9.3.2 Immunity to conducted electrical disturbance

All measures must be taken so that on the appearance of conducted transient over voltages on any of the enclosure input or output circuits, such as the 230 V power supply, the electrical operating mechanism circuits, the fault sensors or the external indicator light:

- No device or component is damaged or affected;
- No failure or temporary loss of quality interferes with the operation of the subassemblies;
- No untimely orders or remote indications are transmitted to the electrical operating mechanisms.

Protection must be provided for:

- Damped oscillating waves according to the IEC 61000-4-12 publication with the following characteristics: Level 3 (CM : Common Mode 2.5kV, DM : Differential Mode 1kV) and ring wave Level 4
- Rapid transient/burst voltages according to the IEC 61000-4-4 standard with the following characteristics: level 4: AC supply and sensors: 4kV, other I/O circuits: 2 kV

1c.9.3.3 Immunity to electrostatic discharges

All measures must be taken to ensure normal operation of enclosure and operating mechanism devices when they are exposed to a electrostatic discharges ≤ 6 kV at contact and ≤ 8 kV in the air (level 3 of IEC 61000-4-2).

1c.9.3.4 Immunity to magnetic fields

All measures must be taken to ensure normal operation of enclosure and electrical operating mechanism devices when they and their connections are exposed to a permanent sinusoidal electromagnetic field with a frequency of 80 MHz to 1 GHz and whose electrical component has a severity level of 10 V/m (IEC 61000-4-3).

1c.9.3.5 Immunity to 50 Hz electromagnetic fields

All measures must be taken to ensure normal operation of enclosure and operating mechanism devices when they are exposed to the following electromagnetic fields coming from 50 Hz currents flowing in adjacent conductors:

- Surge immunity according to the IEC 61000-4-5 publication with the following characteristics: Level 4 2 kV/4 kV
- Conducted immunity according to the IEC 61000-4-6 publication with the following characteristics: Level 3 10 V



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- Power Frequency Magnetic Field Immunity according to the IEC 61000-4-8 publication with the following characteristics: Level 4 30 A/m permanent (i.e. generated by current in normal operating conditions) and 300 A/m from 1 to 3 s. (i.e. generated by current in fault conditions, before the protection devices trip).
- Pulse Magnetic Field Immunity according to the IEC 61000-4-9 publication with the following characteristics: Level 5 1.000 A/m
- Damped Oscillatory Magnetic Field Immunity according to the IEC 61000-4-10 publication with the following characteristics: Level 4 30 A/m

1c 9.4 Normal operating condition

The FRTUs shall be suitable for continuous operation in Thailand's tropical monsoon climate and shall also be subject to severe thunderstorms, heavy industrial pollution and high levels of airborne dust. The FRTUs shall be conformably coated to meet the specified climatic conditions, and shall have been type tested for continuous operation over the following environmental conditions:

Temperature	:	Nominal operating range	:	- 15 °C to + 60 °C
		Extreme storage limits	:	- 20 °C to + 70 °C
Salt spray	:	168 h according to IEC 60068-2-11		
Humidity	:	less than 95 % at 40 °C		
Vibrations	:	from 10 to 500 Hz: 1g peak to peak, according to IEC 60068-2-6		

The degree of protection is IP3X. All cables should enter the enclosure through cable glands or any appropriate mechanism so that to guarantee this degree of protection with all cables installed.

1c.9.5 Current Transformers

The current transformers shall be able to measure continuous and fault currents through the Compact unit substation on each phase and supply current input to the Feeder Remote Terminal Unit (FRTU)

The output of the current transformers shall be either 5 A or 1 A at the rated normal current.

The current transformers shall be installed at cable compartment of the source-side ring main unit.

The current transformers shall have an accuracy of ± 3 % or better at the rated normal current and ± 10 % or better at twenty (20) times of the rated normal current.

The above accuracy shall be maintained while connected to the FRTU current input card and other equipment according to manufacturer's design.

The current transformers shall be protected against open secondary circuits. For bidding purpose, bidders shall assume that FRTU current input card shall have the burden of 1.0 VA on the current transformers.

The current transformers (CT) shall also be accepted as current sensors.



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1c.9.6 Voltage sensors

The voltage transformers shall be of plug-in type and connected at high voltage side of transformer. The output of the voltage sensors shall be 110 V AC or $110/\sqrt{3}$ VAC sinusoidal wave form at the rated normal voltage of the line.

The voltage transformers shall be provided as three (3) units of single-phase VT with star connection. The voltage transformers shall be installed in transformer room and supply voltage input to the FRTU. The voltage transformers shall have an accuracy of $\pm 3\%$ or better at the rated normal voltage. The above accuracy shall be maintained while connected to the FRTU voltage input card and other equipment according to manufacturer's design.

For bidding purpose, bidders shall assume that the FRTU voltage input card shall have the burden of 1.0 VA on the voltage transformers

The capacitor coupling potential transformers (CCPT) shall not be accepted as voltage sensors.

1c.9.7 Power Supply (For Type BXX-X-XXXX only)

The Power Supply shall be provided for supplying AC/DC power to the operating mechanism, and the local control panel. The bidders shall provide power supply follow by Type of Compact unit substation that defined on **C3 Schedule of detailed requirement** and **Table 1**.

In addition, the contractor shall be provided the supply 12 V DC power to the radio (provided by PEA in the future). For bid purposes, the Bidders shall assume that the radio will require power consumption approximately 50 VA in Transmit mode and 10 VA in receive mode.

Under normal condition, the Power Supply shall be powered from the transformer. In case of AC power failure, it shall provide DC power to the compact unit substation and associated equipment from a backup power supply system.

The backup power supply system shall be of maintenance free rechargeable battery pack. The batteries shall have sufficient capacity to sustain operation of the equipment including FRTU and radio for not less than twelve (12) hours if AC power supply failure, while supplying power for not less than two (2) open-close cycles of all associated switches with the ambient temperature at the maximum expected service conditions. For bid purposes, the Bidders shall assume that the DMS radio will be transmit mode for at least 20% of the time during this period. The batteries shall have a minimum lifetime of three (3) years at 40 °C. The battery voltage shall be 24 V DC.

The battery charger shall be fully temperature compensated. The battery shall be of sealed lead acid or dry type.



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To prevent deep discharge of the batteries on loss of AC power source, the battery charger shall automatically disconnect all circuitry fed by the batteries following a user-adjustable time period or when the battery voltage falls below a preset value. If the battery voltage discharged below the preset value, the time to fully recharge the whole batteries shall not exceed twenty-four (24) hours.

In order to prevent serious batteries discharging, the direct current power will be cut off when ever one of the following occurs:

- 230 VAC voltage failure exceeds batteries autonomy
- Voltage stays under the minimum preset value (as specified on previous paragraph)
- Consumption of the transmission equipment exceed 3 A for more than 5 minute

Each set of battery chargers shall be provided with at least the following alarms:

- Battery voltage alarm
- Others according to manufacturer's design

Each alarm indicators shall be displayed on the local control panel.

1c.9.8 Interfacing data and control

The compact unit substation shall have capabilities to be controlled and monitored by the telecommunication system of the DMS in the future.

All supply, control and data circuits as required shall be wired to the terminals in LV room.

The control of the compact unit substation shall communicate with DMS via a Multiple Address Radio System (MARS) (provided by PEA) to the FRTU.

A typical list of the input/output points of the analog and status signals of the compact unit substation shall be as stated in **Table 7, 8 and 9** below:

Table 7

I/O point counts for 22 or 33 kV Compact unit substation type BXX-1-XXX interface

Analog Signal Points:	Description	Signal
Current Phase A	Amp	0-1 A or 0-5 A
Current Phase B	Amp	0-1 A or 0-5 A
Current Phase C	Amp	0-1 A or 0-5 A
Voltage A-B	Volts	0-110 VAC
Voltage B-C	Volts	0-110 VAC
Voltage C-A	Volts	0-110 VAC



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External Control signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 1 Command	Open	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Open	Dry Contact
Status Points: (Discrete) Signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 2 Status	Open / Closed	Dry Contact
LB Switch with fuse No. 1 Status	Open / Closed	Dry Contact
MCCB INC. Status	Open / Closed	Dry Contact
MCCB OUT. F1 Status	Open / Closed	Dry Contact
MCCB OUT. F2 Status	Open / Closed	Dry Contact
MCCB OUT. F3 Status	Open / Closed	Dry Contact
MCCB OUT. F4 Status	Open / Closed	Dry Contact
MCCB OUT. F5 Status	Open / Closed	Dry Contact
MCCB OUT. F6 Status	Open / Closed	Dry Contact
Fault Indicator	Alarm / Normal	Dry Contact
E/F over current relay (MCCB Inc.)	Trip / Normal	Dry Contact
Tr. Winding temp.	Alarm / Normal	Dry Contact
HRC Fuse No.1	Alarm / Normal	Dry Contact
AC Power Supply (MCB)	Fail / Normal	Dry Contact
Low Battery Voltage	Alarm / Normal	Dry Contact
High Battery Voltage	Alarm / Normal	Dry Contact
Battery Charger Overvoltage	Alarm / Normal	Dry Contact
Enclosure Door Open	Alarm / Normal	Dry Contact



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Table 8

I/O point counts for 22 or 33 kV Compact unit substation type BXX-2-XXX interface

Analog Signal Points:	Description	Signal
Current Phase A	Amp	0-1 A or 0-5 A
Current Phase B	Amp	0-1 A or 0-5 A
Current Phase C	Amp	0-1 A or 0-5 A
Voltage A-B	Volts	0-110 VAC
Voltage B-C	Volts	0-110 VAC
Voltage C-A	Volts	0-110 VAC
External Control signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 1 Command	Open	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Open	Dry Contact
Status Points: (Discrete) Signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 2 Status	Open / Closed	Dry Contact
LB Switch with fuse No. 1 Status	Open / Closed	Dry Contact
LB Switch with fuse No. 2 Status	Open / Closed	Dry Contact
MCCB INC. Status	Open / Closed	Dry Contact
MCCB OUT. F1 Status	Open / Closed	Dry Contact
MCCB OUT. F2 Status	Open / Closed	Dry Contact
MCCB OUT. F3 Status	Open / Closed	Dry Contact
MCCB OUT. F4 Status	Open / Closed	Dry Contact
MCCB OUT. F5 Status	Open / Closed	Dry Contact
MCCB OUT. F6 Status	Open / Closed	Dry Contact
Fault Indicator	Alarm / Normal	Dry Contact
E/F over current relay (MCCB Inc.)	Trip / Normal	Dry Contact
Tr. Winding temp.	Alarm / Normal	Dry Contact
HRC Fuse No.1	Alarm / Normal	Dry Contact
HRC Fuse No.2	Alarm / Normal	Dry Contact
AC Power Supply (MCB)	Fail / Normal	Dry Contact
Low Battery Voltage	Alarm / Normal	Dry Contact
High Battery Voltage	Alarm / Normal	Dry Contact
Battery Charger Overvoltage	Alarm / Normal	Dry Contact
Enclosure Door Open	Alarm / Normal	Dry Contact



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Table 9

I/O point counts for 22 or 33 kV Compact unit substation type BXX-3-XXX interface

Analog Signal Points:	Description	Signal
Current Phase A	Amp	0-1 A or 0-5 A
Current Phase B	Amp	0-1 A or 0-5 A
Current Phase C	Amp	0-1 A or 0-5 A
Voltage A-B	Volts	0-110 VAC
Voltage B-C	Volts	0-110 VAC
Voltage C-A	Volts	0-110 VAC
External Control signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 1 Command	Open	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Command	Open	Dry Contact
xxxxx-xx / LB Switch No. 3 Command	Closed	Dry Contact
xxxxx-xx / LB Switch No. 3 Command	Open	Dry Contact
Status Points: (Discrete) Signal	Description	Signal
xxxxx-xx / LB Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 1 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Switch No. 2 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 2 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Switch No. 3 Status	Open / Closed	Dry Contact
xxxxx-xx / LB Ground Switch No. 3 Status	Open / Closed	Dry Contact
LB Switch with fuse No. 1 Status	Open / Closed	Dry Contact
MCCB INC. Status	Open / Closed	Dry Contact
MCCB OUT. F1 Status	Open / Closed	Dry Contact
MCCB OUT. F2 Status	Open / Closed	Dry Contact
MCCB OUT. F3 Status	Open / Closed	Dry Contact
MCCB OUT. F4 Status	Open / Closed	Dry Contact
MCCB OUT. F5 Status	Open / Closed	Dry Contact
MCCB OUT. F6 Status	Open / Closed	Dry Contact
Fault Indicator	Alarm / Normal	Dry Contact
E/F over current relay (MCCB Inc.)	Trip / Normal	Dry Contact
Tr. Winding temp.	Alarm / Normal	Dry Contact
HRC Fuse No.1	Alarm / Normal	Dry Contact
AC Power Supply (MCB)	Fail / Normal	Dry Contact
Low Battery Voltage	Alarm / Normal	Dry Contact
High Battery Voltage	Alarm / Normal	Dry Contact
Battery Charger Overvoltage	Alarm / Normal	Dry Contact
Enclosure Door Open	Alarm / Normal	Dry Contact



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1c.9.9 Ample space

1c.9.9.1 For TYPE AXX-X-XXXX, The contractor shall provide the ample space at the Low-voltage room for future installation by PEA. A minimum contiguous space of 430 mm (height) x 600 mm (width) x 300 mm (depth) shall be provided for mounting the Power Supply, FRTU and radio.

1c.9.9.2 For TYPE BXX-X-XXXX, the contractor shall provide the ample space at the Low-voltage room for future installation by PEA. A minimum contiguous space of 200 mm (height) x 450 mm (width) x 300 mm (depth) shall be provided for mounting the radio

1c.9.10 Antenna support

For radio communication, the antenna support shall be provided for clamping the antenna's pole (1"–2" in diameter) at the appropriated position without modification in future.

1c.9.11 Communication cable entrance

The weather-sealed holes with cable glands, at least 15 mm in diameter, shall be provided at low-voltage room for communication cable wiring from L.V. room to Antenna.

1c.9.12 Terminal Block

Heavy-duty terminal blocks shall be provided for all metallic cable terminations. All terminal block shall be designed for conductors with a cross-section of 1.5 mm^2 . Self-extinguishing, fireproof vinyl marking strips shall be used to identify all external connection blocks. Marking tags shall be read horizontally. All terminals to which battery or other high voltages are connected shall be provided with fireproof covers.

All individual status input, AC voltage input and control output points shall be isolatable without the need to remove wiring, by means of individual terminal blocks of the removable link type. In order to avoid open circuit on secondary side of CTs, termination blocks with bypass bridge shall be provided for all AC current inputs.

1c.10 Rating plates and nameplates

Each compact unit substation and equipment shall be provided with rating plates and nameplates.

(1) Nameplates

The nameplate for each room, for each electrical equipment installed in room, and for each power and control circuit shall be made of laminated plastic material, black on the surface with a white internal layer. Lettering shall be machine-engraved into the nameplate to form white letters against the black background.

The nameplate lists shall be provided by PEA.



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(2) Rating plates

Each compact unit substation shall have a rating plate with the following details:

- Manufacturer's name
- Type and serial number
- Year of construction
- Rated voltage
- Rated frequency
- Rated operating current of busbar
- Rated operating current of feeder
- Rated lightning impulse withstand voltage
- Rated peak withstand current
- Degree of protection
- Rated service pressure of SF₆ gas, if any
- Applied standard

This rating plate shall be fixed inside the housing preferable in the rear side of the door of each compartment.

Each ring main unit shall have its own rating plate. The following details shall be given:

- Manufacturer's name
- Type and serial number
- Year of construction
- Rated voltage
- Rated frequency
- Rated normal current
- Rated lightning impulse withstand voltage
- Rated one-minute power frequency withstand voltage
- Rated short time current (1 sec)
- Rated short-circuit making current
- Rated service pressure of SF₆ gas
- Applied standard

Each transformer shall have its own rating plate. The following details shall be given:

- Manufacturer's name
- Manufacturer's serial number
- Year of manufacture
- Number of phases
- Rated frequency in Hz



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- Rated output in kVA
- Rated voltage in V
- Rated current in A
- Tap voltages in V
- Impedance voltage in %
- Connection diagram
- Type of cooling
- Oil quantity in liter
- Total weight in kg
- Applied standard

1c.11 Corrosion protection, painting, and finishing

All steel surfaces which are not galvanized or not stainless steel shall receive a standard protection against corrosion. As a minimum painting standard the following shall be applied:

- Cleaning to the bare material by mechanical and/or chemical means
- Phosphatizing or priming with at least one coat of zinc or lead based primer
- Finishing coat shall be gray with high scratch resistance. RAL-code will be agreed upon with the successful bidder. The coat thickness shall be at least 50 μm .

1c.12 Special tools

Special tools and accessories required for the installation, commissioning/testing/proper operation, and maintenance of the compact unit substation shall be quoted separately with itemized prices.

1c.13 Spare parts

Spare parts, if required or recommended by the bidder for two-year operation shall be quoted separately. PEA reserves the right to purchase spare parts by some or all items, or to adjust the quantities.

1c.14 Training

1c.14.1 Operation Training

The three (3) days operation training course shall be provided at the Authority's head office. The objective of this course is to train the Authority personnel in how to use the compact unit substation. The Authority intends that the personnel receiving this training will become operators. The training materials shall include the compact unit substation user's manual. The cost of operation training course and material shall be included in the cost of proposed training course, not in a separate item.

The operation training course will be attended by twelve (12) people.



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1c.14.2 Maintenance Training

Training is required to prepare the Authority's personnel to assume full responsibility for future Authority maintenance of the compact unit substation, including their repair. All training shall be conducted in English and/or Thai, at Authority head office or at manufacturer. All training material and facilities including maintenance tools and another special tool shall be provided by the Contractor. The Authority shall be permitted to reproduce any of the training materials and to tape training sessions for internal use.

The Bidders have to quote recommended training course with their lists of quantities and itemized prices. The maintenance training will be attended by four (4) people.

1d Packing

The compact unit substation, accessories, special tools, and spare parts, shall be seaworthy packed separately in suitable boxes / crates / cases / bundles / drums / or pieces of loose material which will not be returned.

Each individual package (e.g. box, crate, case, bundle, drum, or piece of loose material) of each shipment/delivery shall be clearly tagged or marked to show the contents and the gross weight corresponding to the Invoice and Packing list for easy identification.

Each package shall contain a copy of the packing list in a waterproof envelope.

In case of supplying more than one compact station, parts belonging to different switchgear shall not be packed in the same package. The packages shall be lettered and numbered by the Contractor to designate station, package number and total number of packages of each station being shipped/delivery; for example when two stations are supplied,

A-1/5, A-2/5, A-5/5 for the station A.

B-1/7, B-2/7, B-7/7 for the station B.

The letters designate the station, the first digit designates the package number, and the second digit the total number of packages.

Special tools and spare parts if ordered shall be separately packed in other packages on which the words "SPECIAL TOOLS" or "SPARE PARTS" and package number/total number of packages being shipped/delivered shall be marked.



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1e Tests and test report

1e.1 Routine Tests

The compact unit substation and equipment shall pass the manufacturer's standard routine tests and also pass the routine tests in accordance with the relevant reference standards. The test report of the equipment shall state the following items:

Ring main unit

- (1) Power frequency voltage tests on the main circuit
- (2) Dielectric tests on control and auxiliary circuits
- (3) Measurement of resistance of main circuit
- (4) Mechanical operation tests
- (5) Test of interlocking system
- (6) Verification of correct wiring and labeling

Transformer

- (1) Measurement of winding resistance
- (2) Measurement of voltage ratio and check of phase displacement
- (3) Measurement of short-circuit impedance and load loss
- (4) Measurement of no-load loss and current
- (5) Short-duration induced AC withstand voltage test (ACSD)
- (6) Separate source AC withstand voltage test
- (7) Oil dielectric strength test

1e.2 Type tests

Compact unit substation

The compact unit substation shall have passed the type tests in accordance with IEC 62271-202: 2006 or later edition at least the following items:

- (1) Dielectric test
- (2) Temperature-rise tests
- (3) Functional tests
- (4) Verification of the degree of protection
- (5) Mechanical tests
 - a) Wind pressure
 - b) Roof loads
 - c) Mechanical impacts
- (6) Internal arc test



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The type test certificates or test reports of the compact unit substation shall be submitted with the bid or within fifteen (15) calendar days after the bid closing date.

PEA will also accept the type test certificates or test reports after signing the contract. In this case the Bidders have to submit test plan including information i.e. test procedure, laboratory and test date to PEA for consideration instead and the complete type test certificates and/or test reports shall be submitted for approval before shipment.

Ring main unit

The ring main unit shall have passed the type tests in accordance with the IEC 62271-200: 2003 or later edition, IAC type A for both busbar and cable compartment. The bidder shall provide type test certificate of an independent institute to prove that the offered ring main unit shall meet the above requirements. These type test certificates shall be enclosed with the bid.

Transformers

The following type tests in accordance with the relevant IEC shall be made on one transformer of identical unit

- (1) Temperature-rise test
- (2) Impulse withstand voltage test

The type tests may be omitted if a record of the tests made on identical units can be supplied.

1e.3 Acceptance tests

The one unit of complete compact unit substation per type for each contract shall be sampled to carry out the acceptance tests with PEA's representative witness before delivery.

The acceptance tests item shall be at least as follows:

- (1) Temperature rise test to prove enclosure class
- (2) Sound level test

1e.4 Costs of tests

The costs of all tests and test reports shall be borne by the Contractor.



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C2 Material and packing data to be given by bidder

The bidders have to submit with the bid following data and details of compact unit substation and equipment:

2a Design data and guarantee of:

- Compact unit substation for 22 & 33 kV 50 Hz underground distribution systems (see **Annex C2-1**)
- SF₆ - insulated ring main unit (see **Annex C2-2**)
- Three-phase transformer (see **Annex C2-3**)
- Low-voltage switchgear (see **Annex C2-4**)

2b Drawings of each type of compact unit substation housing with dimensions in mm, showing particulars of normal construction details

2c Drawings of compact unit substation layout with dimensions in mm of the whole station

2d Drawings of the compact unit substation erection including a general concrete pad/foundation plan

2e Bill of Material for each compartment

2f Details, catalogues and drawings, with main dimensions in mm, of:

- (1) Ring main unit
- (2) Operating mechanism of the ring main unit
- (3) Transformer
 - (3.1) H.V. and L.V. bushings
 - (3.2) Terminal connectors, with description of materials used for the component parts
 - (3.3) Rating plate with connection diagram
 - (3.4) Earthing terminal connector
 - (3.5) Dial type thermometer
 - (3.6) Specifications of transformer oil
- (4) L.V. switchgear
- (5) Local control panel
- (6) Cable connector, for ring-main unit and transformer
- (7) Interlocking system
- (8) Voltage transformer and current transformer, if any
- (9) Secondary wiring system
- (10) Lock and locking facilities
- (11) Rating plate
- (12) Corrosion protection, painting, and finishing
- (13) Distribution Management System (DMS) interfacing
- (14) Accessories according to manufacturer's design



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- 2g List of routine tests**
- 2h Type tests reports and/or certificates**
- 2i List of special tools with itemized prices**
- 2j List of spare parts with itemized prices**
- 2k Recommended maintenance periods of ring main unit based on time in normal service or number of operation in normal service, as follows :**
- Rated breaking current
 - Rated making current
 - Mechanical ON/OFF
- 2l Operation and maintenance manual**
- 2m Packing details:**
- Packing method (shown by drawings and describe packing material)
- Type of storage facility required (indoor, outdoor)
- Number of packages
- Dimensions (L x W x H) of each package in mm
- Volume of each package in m³
- Gross weight of each package in kg
- Number of packages

Note: Conditions for documentation and consideration

The Contractor has to supply the following documents in English and/or Thai, before shipment/delivery, for each ordered station, to the following address:

Technical Specification Division
Engineering Department
Provincial Electricity Authority
200 Ngam Wong Wan Road, Chatuchak
Bangkok Metropolis 10900
Thailand

All drawing shall be in accordance with the IEC 60113 and sized as follows:

- A1 594 mm x 841 mm
- A2 420 mm x 594 mm
- A3 297 mm x 420 mm
- A4 210 mm x 297 mm



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1. Drawings and data for approval

The Contractor shall supply six copies each of at least the drawings and data listed below, for approval by The Authority, within fifteen calendar days after the date of effectiveness of the Contract.

- (1) Complete compact unit substation arrangement drawings showing the details of equipment layout.
- (2) Foundation frame plans with fastening details. Earthing arrangement and access points to earthing bus. Details of conduit/bushing for control wiring between compartment.
- (3) Detail drawings and specifications for all equipment to be supplied including the characteristic curves of current transformers.
- (4) Complete internal connection and elementary diagrams (AC and DC schematic), of control for operating mechanism and auxiliary equipment, including power requirements for all operating coils, motors, electrically operating devices.
- (5) Complete interlocking scheme of the whole compact unit substation.
- (6) All other drawings considered necessary for the installation, operation and maintenance of the compact unit substation equipment.

Generally, if no more details are required, one approved copy of each drawing/document will be returned to the Contractor within fifteen calendar days after receipt by The Authority. If The Authority requires additional information, the Contractor cannot regard the lost time as a reason for extending the delivery time without penalty.

When the drawings have been returned for correction, the Contractor shall make the necessary revisions on them and shall submit the corrected drawings and data for approval within thirty (30) calendar days.

Any manufacturing done before approval of the drawings and data will be at the Contractor's risk. The Authority shall have the right to require the Contractor to make any changes in the design which may be necessary in the opinion of The Authority, to make the equipment conform to the requirements and intent of this Contract Documents without additional cost to The Authority. Approval of the Contractor's drawings shall not be held to relieve the Contractor of any part of his obligation to meet all of the requirements of this Contract Documents or of the responsibility for the correctness of his drawings.



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2. Final approved drawings

The Contractor shall furnish six copies each and one transparent reproducible copy each of the final approved drawings.

3. Three sets of instruction book in English and Thai for installation, operation and maintenance of compact unit substation and equipment

4. Three sets of instruction book in English and Thai for installation, operation, and maintenance of all instruments, meters, switches, indicators, alarms, and relays, if any

5. Reports of type tests and routine tests of the equipment



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2a Design data and guarantee of Compact unit substation for 22 & 33 kV 50 Hz underground distribution system (Annex C2-1)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
		22 kV	33 kV	22 kV	33 kV
Manufacturer	-	-	-		
Country of origin	-	-	-		
Type designation	-	-	-		
Indoor or outdoor installation	-	Outdoor	Outdoor		
Applied standard, publication number and year	-	-	-		
Rated power	kVA	-	-		
Number of phases	-	3	3		
Rated frequency	Hz	50 Hz	50 Hz		
Arc-fault test	Yes/No.	Yes	Yes		
Class of Enclosure	-	20	20		
Degree of protection of enclosure : excluding oil pan					
- High voltage room/compartment	-	IP 34 or better	IP 34 or better		
- Transformer room/compartment	-	IP 34 or better	IP 34 or better		
- Low voltage room/compartment	-	IP 34 or better	IP 34 or better		
Overall dimensions :					
- Length, maximum	mm	3,400	3,500		
- Width, maximum	mm	2,300	2,300		
- Height, maximum (excluding oil pan)	mm	2,300	2,400		
I					



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2a Design data and guarantee of Compact unit substation for 22 & 33 kV 50 Hz underground distribution system (Annex C2-1)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
Net weight	kg	-	-		
Confirm to provide lifting facilities	Yes/No	YES	YES		
Fault indicators :					
- Manufacturer	-	-	-		
- Catalog number (to be attached)	-	-	-		
- Range of suitable overall diameter of cable	mm	-	-		
Net weight	kg	-	-		
Catalog number (to be attached)	-	-	-		
Dimensional drawing number (to be attached)	-	-	-		
Packing detailed drawing number (to be attached)	-	-	-		
I					

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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)**Invitation to Bid No.:**

Description	Unit	Required Data		Proposed Data	
		22 kV	33 kV	22 kV	33 kV
Manufacturer	-	-	-		
Country of origin	-	-	-		
Type designation	-	-	-		
Indoor or outdoor installation	-	IEC, VDE, DIN, or equivalent			
Applied standard, publication number and year	-	-	-		
Catalogue number (to be attached)	-	-	-		
Dimensional drawing number (to be attached)	-	-	-		
Single-line diagram number (to be attached)	-	-	-		
Degree of protection of enclosure					
- High voltage live parts except fuse compartment	-		IP 65		
- Fuse chamber	-		IP 54		
Material of switch container/tank	-	Stainless steel or nickel chromium steel			
Colour of outside-painting	-	-	-		
Material of drive-mechanism	-	-	-		
I					

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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)**Invitation to Bid No.:**

Description	Unit	Required Data		Proposed Data	
Principle of drive-sealing	-	-	-		
Principle of drive-moving (turn/push)	-	-	-		
Insulating medium	-		SF ₆		
Arc quenching medium	-		SF ₆		
Principle of arc quenching	-	-	-		
Rated SF ₆ gas pressure	PSI	-	-		
Rated voltage	kV	24	36		
Rated lightning impulse withstand voltage					
- To earth and between pole	kV, peak	125	170		
- Across the isolating distance	kV, peak	-	-		
Rated power frequency withstand voltage, at rated SF ₆ gas pressure					
- To earth and between pole	kV, rms	-	-		
- Across the isolating distance	kV, rms	-	-		
I					



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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
Rated power frequency withstand voltage, at atmospheric pressure					
- To earth and between pole	kV, rms	50	70		
- Across the isolating distance	kV, rms	-	-		
Number of phase	-	3	3		
Rated frequency	Hz	50	50		
Rated normal current					
- Cable feeder	A	600	400		
- Transformer feeder	A	200	200		
Rated short-time current (1 sec), at rated voltage	kA	16	16		
Rated short-circuit making current	kA, peak	40	40		
Contact					
- Type	-	-	-		
- Material	-	-	-		
- Surface treatment	-	-	-		
- Maximum temperature rise at A	K	-	-		
I					



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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
High voltage fuses - Manufacturer - Country of origin - Applied standard, publication number and year - Catalogue number (to be attached) - Outline drawing number (to be attached) - Rated voltage of HRC fuses - Interrupting capacity - Length	-	-	-	-	-
Cable connector at cable feeder of RMU - Manufacturer - Country of origin - Type - Applied standard, publication number and year - Catalogue number (to be attached)	kV kA mm	-	DIN - bolt-on touchable T-shaped type ANSI/IEEE 386 or VDE/DIN particular DIN 47636 Parts 5 & 6 or EN-50181, IEC 60137 -	-	-



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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
<ul style="list-style-type: none"> - Outline drawing number (to be attached) - Range of conductor diameter to be accommodated with - Range of diameter over insulation of cable to be used with - Range of overall diameter of cable to be used with - Phase spacing 	<ul style="list-style-type: none"> mm mm mm mm 	<ul style="list-style-type: none"> - - - - - 	<ul style="list-style-type: none"> - - - - - 		
Cable connector at transformer feeder					
<ul style="list-style-type: none"> - Manufacturer 	-	-	-		
<ul style="list-style-type: none"> - Country of origin 	-	-	-		
<ul style="list-style-type: none"> - Type 	-	plug-in termination of touchable elbow shaped type			
<ul style="list-style-type: none"> - Applied standard, publication number and year 	-	ANSI/IEEE 386 or VDE/DIN particular DIN 47636 Parts 1 to 4 or EN-50181, IEC 60137			
<ul style="list-style-type: none"> - Catalogue number (to be attached) 	-	-	-		
<ul style="list-style-type: none"> - Outline drawing number (to be attached) 	-	-	-		
<ul style="list-style-type: none"> - Range of conductor diameter to be accommodated with 	mm	-	-		
<ul style="list-style-type: none"> - Range of diameter over insulation of cable to be used with 	mm	-	-		
I					



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2a Design data and guarantee of SF₆ - insulated ring main unit of 22 and 33 kV (Annex C2-2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data	
- Range of overall diameter of cable to be used with	mm	-	-		
- Phase spacing	mm	-	-		
Confirm to provide :					
- Fault indicator(s)	(Yes/No)		Yes		
- Voltage indicator(s)	(Yes/No)		Yes		
- Gas pressure indicator	(Yes/No)		Yes		
- Facilities to test the cable feeder	(Yes/No)		Yes		
- Pressure relief vent with metal bursting plate	(Yes/No)		Yes		
- Lifting facilities	(Yes/No)		Yes		
- Earthing terminals	(Yes/No)		Yes		
Quality system certificate of the manufacturer	(Yes/No)		in accordance with ISO 9001/TIS 9001 or ISO 9002/TIS 9002		

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2a Design data and guarantee of 22 kV Transformer (Annex C2-3.1)**Invitation to Bid No.:**

Description	Unit	Required Data		Proposed Data
Manufacturer	-	-		
Country of origin	-	-		
Type designation	-	-		
Applied standard, publication number and year	-	-		
Rated output	kVA	630	1000	
Number of phase	-	3		
Rated frequency	Hz	50		
Rated primary voltage	V	22,000		
Rated secondary voltage	V	400/230		
Type	-	Oil-immersed, permanently sealed end completely oil filled system.		
Vector group	-	Dyn 11		
Operation duty : continuous operation (Type DB)	Yes/No	Yes		
Max. temperature rise of winding, at full load	K	55		
Max. temperature rise of top oil, at full load	K	50		
Primary tapping : off-circuit condition	Yes/No	Yes		
: Type	-	Externally operated		
Number of steps of primary tapping	Steps	± 2		
Per cent of rated voltage of each step	%	2.5%		



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2a Design data and guarantee of 22 kV Transformer (Annex C2-3.1)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data
		H.V.	L.V.	
<u>Winding</u>				
- Material : copper or aluminum	-	-	-	
- Resistance per phase at 75°C	Ohm	-	-	
- Full wave impulse withstand voltage, or BIL	kV, peak	125	-	
- Power-frequency test voltage, 1 min	kV, rms	50	3	
- Construction of winding	-	-	-	
Method of cooling	-	natural self-cooled		
Total cooling surface	m ²	-		
Brand of oil used for initial filling	-	-		
No-load current & Tolerance	% & %	- & -		
Impedance voltage at 75°C & Tolerance	% & %	4% (630 kVA) & - or 6% (1000 kVA) & -		
Losses, for transformer	kVA	630	1000	
- No-load loss plus positive tolerance	W	1,010	1,270	
- Load loss, at 75°C, plus positive tolerance	W	5,850	12,150	
Efficiency in %, at 75°C and at load :				
- 1/2 of rated power and P.F. = 1.0	%	-		
- 1 of rated power and P.F. = 1.0	%	-		
Voltage regulation at P.F. = 1.0	%	-		



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2a Design data and guarantee of 22 kV Transformer (Annex C2-3.1)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data
		H.V.	L.V.	
<u>Bushings</u>				
- Make	-	-	-	
- Country of origin	-	-	-	
- Applied standard	-	-	-	
- Type	-	cone-shape protruding type	-	
- Contact	-	plug contact	-	
- Rated current	A	200	-	
- Full wave impulse withstand voltage (BIL)	kV, peak	125	-	
- Low-frequency dry 1-minute test voltage	kV, rms	50	-	
- Low-frequency wet 10-second test voltage	kV, rms	-	-	
- Protection class	-	-	-	
- Colour of glazing	-	-	-	
- Stud thread size, Metric	-	-	-	
Secondary neutral point is loaded with rated current	Yes/No	-	-	
Completely assembled transformer shall withstand, without permanent deformation, a maximum pressure of	kg/cm ²		Yes	
Colour of tank : grey	Yes/No		Yes	
Tank finish conforms to PEA's requirement	Yes/No		Yes	
Quantity of oil filling	liter		-	



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2a Design data and guarantee of 22 kV Transformer (Annex C2-3.1)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Weight of core	kg	-	
Weight of winding	kg	-	
Weight of the part liftable from tank	kg	-	
Weight of complete transformer with oil	kg	-	
Terminal markings and connections conform to PEA's requirement	Yes/No	-	
<u>Cable connector at H.V. bushing</u>			
- Manufacturer	-	-	
- Country of origin	-	-	
- Type	-	-	
- Catalogue number (to be attached)	-	-	
- Outline drawing number (to be attached)	-	-	
- Range of conductor diameter to be accommodated with	mm	-	
- Range of diameter over insulation of cable to be use with	mm	-	
- Range of overall diameter of cable to be use with	mm	-	
- Phase spacing	mm	-	
I			



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2a Design data and guarantee of 22 kV Transformer (Annex C2-3.1)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
- Applied standard, publication number and year	-	ANSI/IEEE 386 or VDE/DIN, particular DIN 47636 Part 1 to Part 4 or EN-50181, IEC 60137	
<u>Dimensions of transformer</u>			
- Overall height	mm	-	
- Overall width	mm	-	
- Overall depth	mm	-	
- Height over cover	mm	-	



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2a Design data and guarantee of 33 kV Transformer (Annex C2-3.2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data
Manufacturer	-	-		
Country of origin	-	-		
Type designation	-	-		
Applied standard, publication number and year	-	-		
Rated output	kVA	630	1000	
Number of phase	-	3		
Rated frequency	Hz	50		
Rated primary voltage	V	33,000		
Rated secondary voltage	V	400/230		
Type	-	Oil-immersed, permanently sealed end completely oil filled system.		
Vector group	-	Dyn 11		
Operation duty : continuous operation (Type DB)	Yes/No	Yes		
Max. temperature rise of winding, at full load	K	55		
Max. temperature rise of top oil, at full load	K	50		
Primary tapping : off-circuit condition	Yes/No	Yes		
: Type	-	Externally operated		
Number of steps of primary tapping	Steps	± 2		
Per cent of rated voltage of each step	%	2.5%		
<u>Winding</u>		H.V.	L.V.	



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2a Design data and guarantee of 33 kV Transformer (Annex C2-3.2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data
- Material : copper or aluminum	-	-	-	
- Resistance per phase at 75°C	Ohm	-	-	
- Full wave impulse withstand voltage, or BIL	kV, peak	170	-	
- Power-frequency test voltage, 1 min	kV, rms	70	3	
- Construction of winding	-	-	-	
Method of cooling	-	natural self-cooled		
Total cooling surface	m ²	-		
Brand of oil used for initial filling	-	-		
No-load current & Tolerance	% & %	- & -		
Impedance voltage at 75°C & Tolerance	% & %	4% (630 kVA) & - or 6% (1000 kVA) & -		
Losses, for transformer	kVA	630	1000	
- No-load loss plus positive tolerance	W	1,050	1,300	
- Load loss, at 75°C, plus positive tolerance	W	5,850	12,150	
Efficiency in %, at 75°C and at load :				
- 1/2 of rated power and P.F. = 1.0	%	-		
- 1 of rated power and P.F. = 1.0	%	-		
Voltage regulation at P.F. = 1.0	%	-		
I				



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2a Design data and guarantee of 33 kV Transformer (Annex C2-3.2)

Invitation to Bid No.:

Description	Unit	Required Data		Proposed Data
		H.V.	L.V.	
<u>Bushings</u>				
- Make	-	-	-	
- Country of origin	-	-	-	
- Applied standard	-	-	-	
- Type	-	- cone-shape protruding type	-	
- Contact	-	- plug contact	-	
- Rated current	A	200	-	
- Full wave impulse withstand voltage (BIL)	kV, peak	170	-	
- Low-frequency dry 1-minute test voltage	kV, rms	70	-	
- Low-frequency wet 10-second test voltage	kV, rms	-	-	
- Protection class	-	-	-	
- Colour of glazing	-	-	-	
- Stud thread size, Metric	-	-	-	
Secondary neutral point is loaded with rated current	Yes/No	-	-	
Completely assembled transformer shall withstand, without permanent deformation, a maximum pressure of	kg/cm ²		Yes	
Colour of tank : grey	Yes/No		Yes	
Tank finish conforms to PEA's requirement	Yes/No		Yes	
Quantity of oil filling	liter		-	
Weight of core	kg		-	



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2a Design data and guarantee of 33 kV Transformer (Annex C2-3.2)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Weight of winding	kg	-	
Weight of the part liftable from tank	kg	-	
Weight of complete transformer with oil	kg	-	
Terminal markings and connections conform to PEA's requirement	Yes/No	-	
<u>Cable connector at H.V. bushing</u>			
- Manufacturer	-	-	
- Country of origin	-	-	
- Type	-	-	
- Catalogue number (to be attached)	-	-	
- Outline drawing number (to be attached)	-	-	
- Range of conductor diameter to be accommodated with	mm	-	
- Range of diameter over insulation of cable to be use with	mm	-	
- Range of overall diameter of cable to be use with	mm	-	
- Phase spacing	mm	-	
- Applied standard, publication number and year	-	ANSI/IEEE 386 or VDE/DIN, particular DIN 47636 Part 1 to Part 4	



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2a Design data and guarantee of 33 kV Transformer (Annex C2-3.2)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
<u>Dimensions of transformer</u> - Overall height - Overall width - Overall depth - Height over cover		or EN-50181, IEC 60137	
	mm	-	
	mm	-	
	mm	-	
	mm	-	



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2a Design data and guarantee of Low voltage switchgear (Annex C2-4)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
<u>Low-voltage switchgear</u>			
Manufacturer	-	-	
Country of origin	-	-	
Applied standard, publication number and year	-	IEC, VDE, DIN	
Catalog number (to be attached)	-	-	
Rated voltage	VAC	400/230	
Rated current of busbar	A	-	
Rated frequency	Hz	50	
Maximum asymmetrical 3-phase short-circuit withstand current	kA	-	
<u>Incoming feeder with circuit-breaker</u>			
Manufacturer	-	-	
Country of origin	-	-	
Applied standard, publication number and year	-	-	
Catalog number (to be attached)	-	-	
Rated voltage	V	-	
Rated current	A	-	
Maximum ambient temperature	°C	-	
I			



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2a Design data and guarantee of Low voltage switchgear (Annex C2-4)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Rated interrupting capacity	kA	-	
Range and material of conductor diameter to be accommodated with	mm	-	
<u>Outgoing feeder with circuit-breaker</u>			
Manufacturer	-	-	
Country of origin	-	-	
Applied standard, publication number and year	-	-	
Catalog number (to be attached)	-	-	
Rated voltage	V	-	
Rated current	A	-	
Maximum ambient temperature	°C	-	
Rated interrupting capacity	kA	-	
Range and material of conductor diameter to be accommodated with	mm	-	
I			



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2a Design data and guarantee of Low voltage switchgear (Annex C2-4)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
<u>Busbar</u>			
Manufacturer	-	-	
Country	-	-	
Catalog number (to be attached)	-	-	
Current carrying capacity	A	-	
Busbar material	-	-	
Busbar cross-section	mm ²	-	
Specify the insulation material	-	-	
<u>Power meter</u>			
Manufacturer	-	-	
Country	-	-	
Catalog number (to be attached)	-	-	
Accuracy class	-	-	
Measuring values			
- 3 phase currents (Ia, Ib and Ic)	-	yes	
- 3 phase voltages (Van, Vbn and Vcn) and 3 line-line voltages (Vab, Vbc and Vca)	-	yes	
- apparent power (kVA)	-	yes	
- active power (kW)	-	yes	
- reactive power (kVAR)	-	yes	
- power factor (P.F.)	-	yes	
- energy (kW-h)	-	yes	
I			



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2a Design data and guarantee of Low voltage switchgear (Annex C2-4)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Current transformer	-	-	
Manufacturer	-	-	
Country	-	-	
Rated primary current	A	-	
Rated secondary current	A	-	
Accuracy class	-	Class 1	



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2a Design data and guarantee of Compact unit substation for Distribution Management System (DMS) interfacing (Annex C2-5)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Manufacturer	-		
Manufacturer's type number	-		
Standards	-	IEC	
Type tested	Yes/No	Yes	
First commercial operation of the offered type	Year		
Electric surge protection	Yes/No	IEC 60255-5, or ANSI/IEEE C37.90.1 and ANSI/IEEE C37.1	
<u>Immunity to Electrical stress and Disturbance</u>			
Minimum Insulation of Equipment	-	IEC 255-5	
Immunity to conducted electrical disturbance	-		
Oscillatory Transient Immunity	-	IEC 61000-4-12	
Damped oscillating waves	-	Level 3 (CM : 2.5kV, DM : 1kV)	
Ring Wave	-	level 4	
Rapid transient/burst voltages	-	IEC 61000-4-4 (level 4)	
Immunity to electrostatic discharges	-	IEC 61000-4-2 (level 3)	
Immunity to magnetic fields	-	IEC 61000-4-3 (10 V/m)	
Immunity to 50 Hz electromagnetic fields	-		



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2a Design data and guarantee of Compact unit substation for Distribution Management System (DMS) interfacing (Annex C2-5)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
Surge immunity	-	IEC 61000-4-5 (Level 4)	
Conducted immunity	-	IEC 61000-4-6 (Level 3)	
Power Frequency Magnetic Field Immunity	-	IEC 61000-4-8 (Level 4)	
Pulse Magnetic Field Immunity	-	IEC 61000-4-9 (Level 5)	
Damped Oscillatory Magnetic Field Immunity	-	IEC 61000-4-10 (Level 4)	
<u>Normal operating condition</u>			
Temperature	°C	-15 ° C to + 60° C	
Salt spray	-	IEC 60068-2-11	
Humidity	%	less than 95% at 40° C	
Vibrations	-	IEC 60068-2-6	
<u>High-resolution Sequence-of-Events (SOE)</u>			
Resolution	ms	±1 ms	
Buffer capable	Events	256 events	
<u>Communication Port</u>			
Standard	Yes/No	RS 232	
Number	ports	2 ports	
Individually selectable (Baud rated)	bps	300 – 19,200 bits per second	



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2a Design data and guarantee of Compact unit substation for Distribution Management System (DMS) interfacing (Annex C2-5)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
<u>Communication Protocol</u>	Yes/No	DNP 3.0 Level 2	
<u>Type of FRTU</u>	-	Built-in type / Separated	
<u>FRTU input/output type</u>			
Analog Inputs			
Sampling rate	Yes/No	At least 32 samples per cycle	
Resolution	Yes/No	At least 12 bits plus sign	
Overall accuracy	%	At least $\pm 0.2\%$ of full scale	
Linearity	%	Better than $\pm 0.05\%$	
Status Inputs			
SC-2S	Yes/No	Yes	
DC-2S	Yes/No	Yes	
SLOW DC-2S	Yes/No	Yes	
Control Outputs			
Programmable pulse duration	Seconds	0.1 to 60 seconds	
Procedure for control operation	Yes/No	SCBO	
Command Receipt timer	Seconds	10 to 60 seconds	



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2a Design data and guarantee of Compact unit substation for Distribution Management System (DMS) interfacing (Annex C2-5)

Invitation to Bid No.:

Description	Unit	Required Data	Proposed Data
<u>Measurement Transformer</u>			
Current Transformers			
Accuracy	%	±3% or better	
Voltage sensors			
Type	Yes/No	Plug-in Type	
Accuracy	%	±3% or better	
<u>Power Supply</u>			
AC/DC Power Supply sizing and rated			
Battery Back-up sizing and rated			
Minimum lifetime	Years	3 years at 40°C	
<u>Interfacing data and control</u>			
	-	Shall be demonstrated	
I			



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C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
1	1040130012	set(s)	<p>Compact unit substation , TYPE A24-1-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>1.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p>1.1.1 <u>2 units</u> Cable feeder</p> <p>1.1.2 <u>1 unit</u> Transformer feeder</p> <p>1.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>1.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>1.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 1 of 12.</p>
2	1040130013	set(s)	<p>Compact unit substation , TYPE A24-1-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>2.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p>2.1.1 <u>2 units</u> Cable feeder</p> <p>2.1.2 <u>1 unit</u> Transformer feeder</p> <p>2.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>2.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>2.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 2 of 12.</p>



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Item	PEA Material No.	Quantity	Description
3	1040130014	set(s)	<p>Compact unit substation , TYPE A24-2-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>3.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">3.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">3.1.2 <u>2 units</u> Transformer feeder</p> <p>3.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>3.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>3.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 3 of 12.</p>
4	1040130015	set(s)	<p>Compact unit substation , TYPE A24-2-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>4.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">4.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">4.1.2 <u>2 units</u> Transformer feeder</p> <p>4.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>4.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>4.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 4 of 12.</p>



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Item	PEA Material No.	Quantity	Description
5	1040130016	set(s)	<p>Compact unit substation , TYPE A24-3-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>5.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">5.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 20px;">5.1.2 <u>1 unit</u> Transformer feeder</p> <p>5.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>5.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>5.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 5 of 12.</p>
6	1040130017	set(s)	<p>Compact unit substation , TYPE A24-3-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>6.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">6.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 20px;">6.1.2 <u>1 unit</u> Transformer feeder</p> <p>6.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1000 kVA.</p> <p>6.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>6.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 6 of 12</p>
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Item	PEA Material No.	Quantity	Description
7	1040130100	set(s)	<p>Compact unit substation , TYPE A36-1-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>7.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">7.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">7.1.2 <u>1 unit</u> Transformer feeder</p> <p>7.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>7.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>7.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 1 of 12.</p>
8	1040130101	set(s)	<p>Compact unit substation , TYPE A36-1-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>8.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">8.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">8.1.2 <u>1 unit</u> Transformer feeder</p> <p>8.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>8.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>8.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 2 of 12</p>
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Item	PEA Material No.	Quantity	Description
9	1040130102	set(s)	<p>Compact unit substation , TYPE A36-2-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>9.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">9.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">9.1.2 <u>2 units</u> Transformer feeder</p> <p>9.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>9.3 <u>1 lot</u> Low-voltage switchgear and metering.</p> <p>9.4 <u>1 unit</u> Local control panel.</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 3 of 12.</p>
10	1040130103	set(s)	<p>Compact unit substation , TYPE A36-2-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>10.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">10.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">10.1.2 <u>2 units</u> Transformer feeder</p> <p>10.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>10.3 <u>1 lot.</u> Low-voltage switchgear and metering</p> <p>10.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 4 of 12.</p>
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Item	PEA Material No.	Quantity	Description
11	1040130104	set(s)	<p>Compact unit substation , TYPE A36-3-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>11.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">11.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">11.1.2 <u>1 unit</u> Transformer feeder</p> <p>11.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>11.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>11.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 5 of 12.</p>
12	1040130105	set(s)	<p>Compact unit substation , TYPE A36-3-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>12.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">12.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">12.1.2 <u>1 unit</u> Transformer feeder</p> <p>12.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>12.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>12.4 <u>1 unit</u> Local control panel</p> <p>Complete with control and data terminal and wiring; ample space for FRTU and radio; antenna support; Communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 6 of 12.</p>
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Item	PEA Material No.	Quantity	Description
13	1040130018	set(s)	<p>Compact unit substation , TYPE B24-1-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>13.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p>13.1.1 <u>2 units</u> Cable feeder</p> <p>13.1.2 <u>1 unit</u> Transformer feeder</p> <p>13.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>13.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>13.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>13.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>13.6 <u>1 lot</u> Power supply</p> <p>13.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 7 of 12.</p>
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Item	PEA Material No.	Quantity	Description
14	1040130019	set(s)	<p>Compact unit substation , TYPE B24-1-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>14.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">14.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 40px;">14.1.2 <u>1 unit</u> Transformer feeder</p> <p>14.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>14.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>14.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>14.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>14.6 <u>1 lot</u> Power supply</p> <p>14.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 8 of 12.</p>
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Item	PEA Material No.	Quantity	Description
15	1040130020	set(s)	<p>Compact unit substation , TYPE B24-2-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>15.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p>15.1.1 <u>2 units</u> Cable feeder</p> <p>15.1.2 <u>2 units</u> Transformer feeder</p> <p>15.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>15.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>15.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>15.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>15.6 <u>1 lot</u> Power supply</p> <p>15.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 9 of 12.</p>
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Item	PEA Material No.	Quantity	Description
16	1040130021	set(s)	<p>Compact unit substation , TYPE B24-2-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>16.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">16.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 40px;">16.1.2 <u>2 units</u> Transformer feeder</p> <p>16.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>16.3 <u>1 lot</u> Low-voltage switchgear and metering.</p> <p>16.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>16.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>16.6 <u>1 lot</u> Power supply</p> <p>16.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 10 of 12</p>
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Item	PEA Material No.	Quantity	Description
17	1040130022	set(s)	<p>Compact unit substation , TYPE B24-3-630, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>17.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">17.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">17.1.2 <u>1 unit</u> Transformer feeder</p> <p>17.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 630 kVA.</p> <p>17.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>17.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>17.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>17.6 <u>1 lot</u> Power supply</p> <p>17.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 11 of 12.</p>
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Item	PEA Material No.	Quantity	Description
18	1040130023	set(s)	<p>Compact unit substation , TYPE B24-3-1000, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>18.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">18.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">18.1.2 <u>1 unit</u> Transformer feeder</p> <p>18.2 <u>1 unit</u> Transformer, 22,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>18.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>18.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>18.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>18.6 <u>1 lot</u> Power supply</p> <p>18.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48001 page 12 of 12.</p>
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Item	PEA Material No.	Quantity	Description
19	1040130106	set(s)	<p>Compact unit substation , TYPE B36-1-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>19.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p>19.1.1 <u>2 units</u> Cable feeder</p> <p>19.1.2 <u>1 unit</u> Transformer feeder</p> <p>19.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>19.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>19.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>19.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>19.6 <u>1 lot</u> Power supply</p> <p>19.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 7 of 12.</p>
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Item	PEA Material No.	Quantity	Description
20	1040130107	set(s)	<p>Compact unit substation , TYPE B36-1-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>20.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">20.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">20.1.2 <u>1 unit</u> Transformer feeder</p> <p>20.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>20.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>20.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>20.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>20.6 <u>1 lot</u> Power supply</p> <p>20.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 8 of 12.</p>
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Item	PEA Material No.	Quantity	Description
21	1040130108	set(s)	<p>Compact unit substation , TYPE B36-2-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>21.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">21.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 40px;">21.1.2 <u>2 units</u> Transformer feeder</p> <p>21.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>21.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>21.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>21.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>21.6 <u>1 lot</u> Power supply</p> <p>21.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 9 of 12.</p>
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Specification No.: RPRO-027/2560 : COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Page 16 of 19

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
22	1040130109	set(s)	<p>Compact unit substation , TYPE B36-2-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>22.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 20px;">22.1.1 <u>2 units</u> Cable feeder</p> <p style="padding-left: 20px;">22.1.2 <u>2 units</u> Transformer feeder</p> <p>22.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>22.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>22.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>22.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>22.6 <u>1 lot</u> Power supply</p> <p>22.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 10 of 12.</p>
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PROVINCIAL ELECTRICITY AUTHORITY

TECHNICAL SPECIFICATION DIVISION

Specification No.: RPRO-027/2560 : COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Page 17 of 19

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
23	1040130110	set(s)	<p>Compact unit substation , TYPE B36-3-630, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>23.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">23.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">23.1.2 <u>1 unit</u> Transformer feeder</p> <p>23.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 630 kVA.</p> <p>23.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>23.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>23.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>23.6 <u>1 lot</u> Power supply</p> <p>23.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 11 of 12.</p>
	I		



PROVINCIAL ELECTRICITY AUTHORITY

TECHNICAL SPECIFICATION DIVISION

Specification No.: RPRO-027/2560 : COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Page 18 of 19

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
24	1040130111	set(s)	<p>Compact unit substation , TYPE B36-3-1000, for 33 kV 50 Hz underground distribution system, outdoor installation, consisting of :</p> <p>24.1 <u>1 unit</u> 36 kV SF₆ - insulated ring main unit, consisting of :</p> <p style="padding-left: 40px;">24.1.1 <u>3 units</u> Cable feeder</p> <p style="padding-left: 40px;">24.1.2 <u>1 unit</u> Transformer feeder</p> <p>24.2 <u>1 unit</u> Transformer, 33,000-400/230 V, 50 Hz, 1,000 kVA.</p> <p>24.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>24.4 <u>1 set</u> Current sensors. (1 set = 3 units of 1-& CT)</p> <p>24.5 <u>1 set</u> Voltage sensors. (1 set = 3 units of 1-& VT)</p> <p>24.6 <u>1 lot</u> Power supply</p> <p>24.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SA5-015/48002 page 12 of 12.</p>
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PROVINCIAL ELECTRICITY AUTHORITY

TECHNICAL SPECIFICATION DIVISION

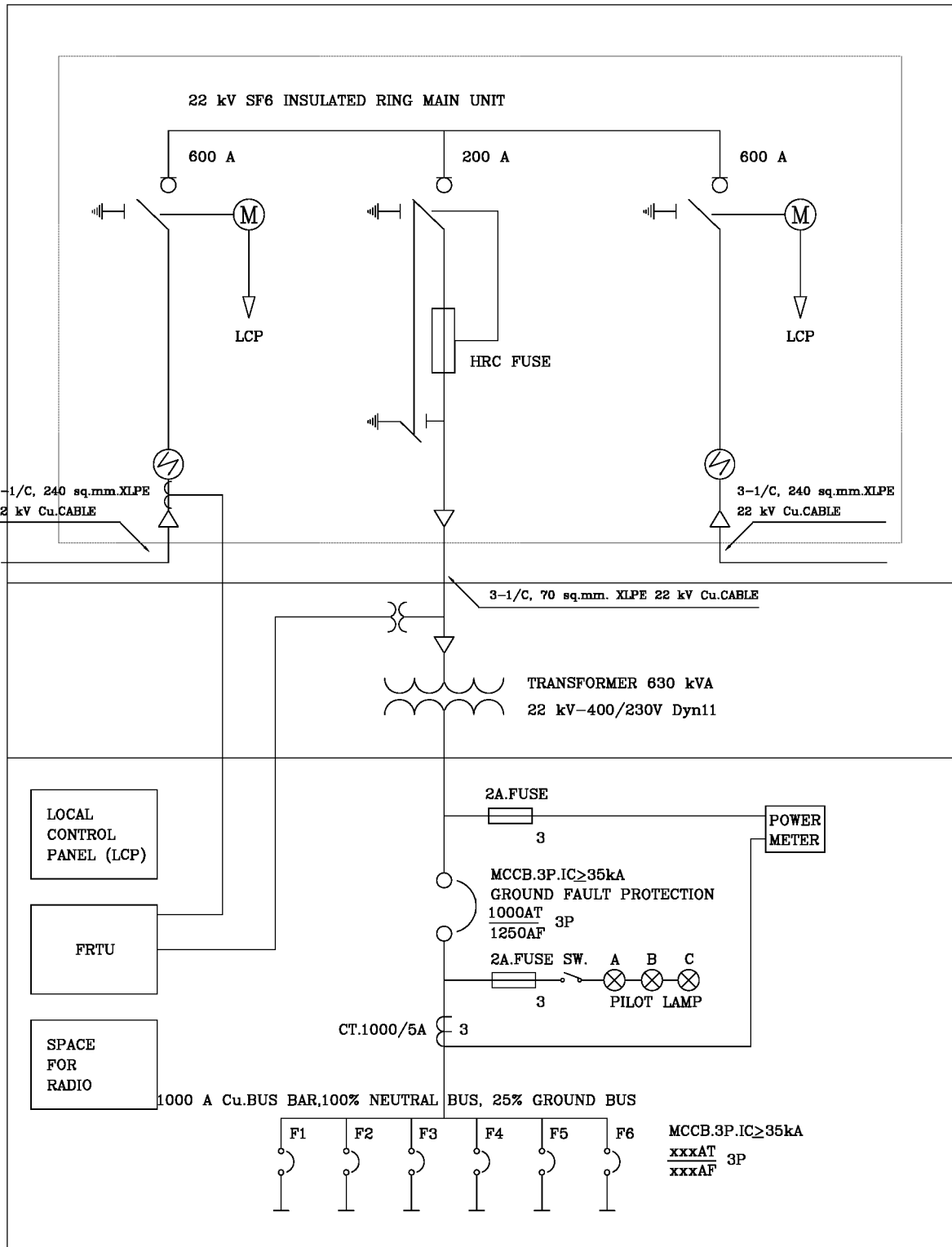
Specification No.: RPRO-027/2560 : COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Page 19 of 19

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
25	-	.....lot(s)	Special tools for 24 kV compact unit substation (Give details)
26	-	.....lot(s)	Spare parts for 24 kV compact unit substation (Give details), for two-years operation
27	-	.....lot(s)	Operation training course including on-site training for 24 kV compact unit substation
28	-	.....lot(s)	Maintenance training course for 24 kV compact unit substation
29	-	.....lot(s)	Supervisor(s) for 24 kV compact unit substation
30	-	.....lot(s)	Special tools for 36 kV compact unit substation (Give details)
31	-	.....lot(s)	Spare parts for 36 kV compact unit substation (Give details), for two-years operation
32	-	.....lot(s)	Operation training course including on-site training for 36 kV compact unit substation
33	-	.....lot(s)	Maintenance training course for 36 kV compact unit substation
34	-	.....lot(s)	Supervisor(s) for 36 kV compact unit substation
			<p><u>Note :</u></p> <ol style="list-style-type: none"> 1. Enclosed Drawings No. SA5-015/48001, SA5-015/48002 2. For each item offered, the bidder has to quote the unit cost. 3. Bidders have to offer recommended spare parts, special tools, training courses and supervisor(s) with a list of quantities and their itemized prices, if any; the Authority reserves the right to purchase them by some or all of items, to adjust their quantities, or to cancel them. Evaluation and comparison of bid price shall be of main Item only (Compact Unit Substation) 4. Supervisor(s) shall be provided for installation the compact unit substations until ready for operation at PEA's site(s). PEA shall provide and arrange civil work, workmen, and general tools for installation.
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HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

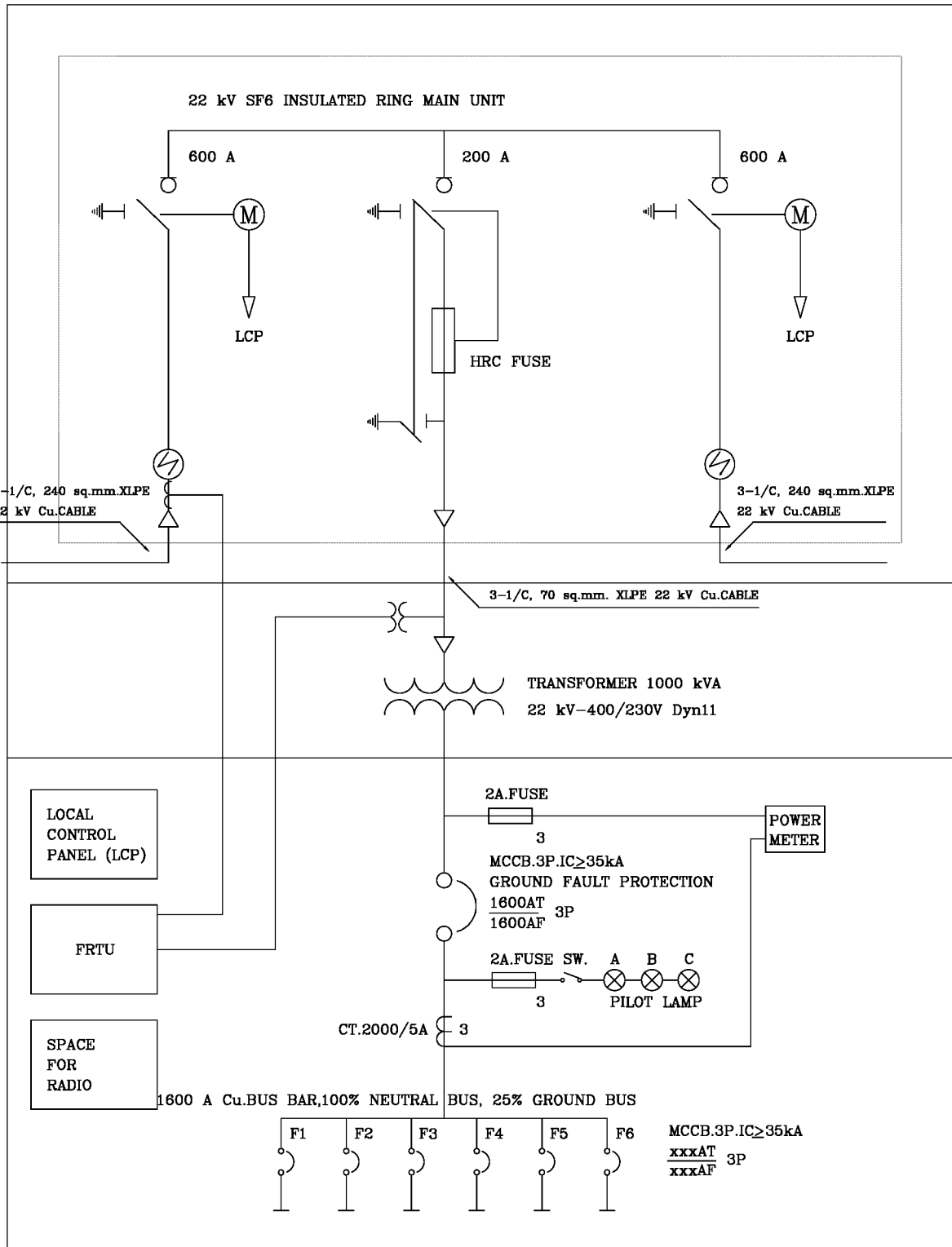
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A24- 1-630

แผ่นที่ 1 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

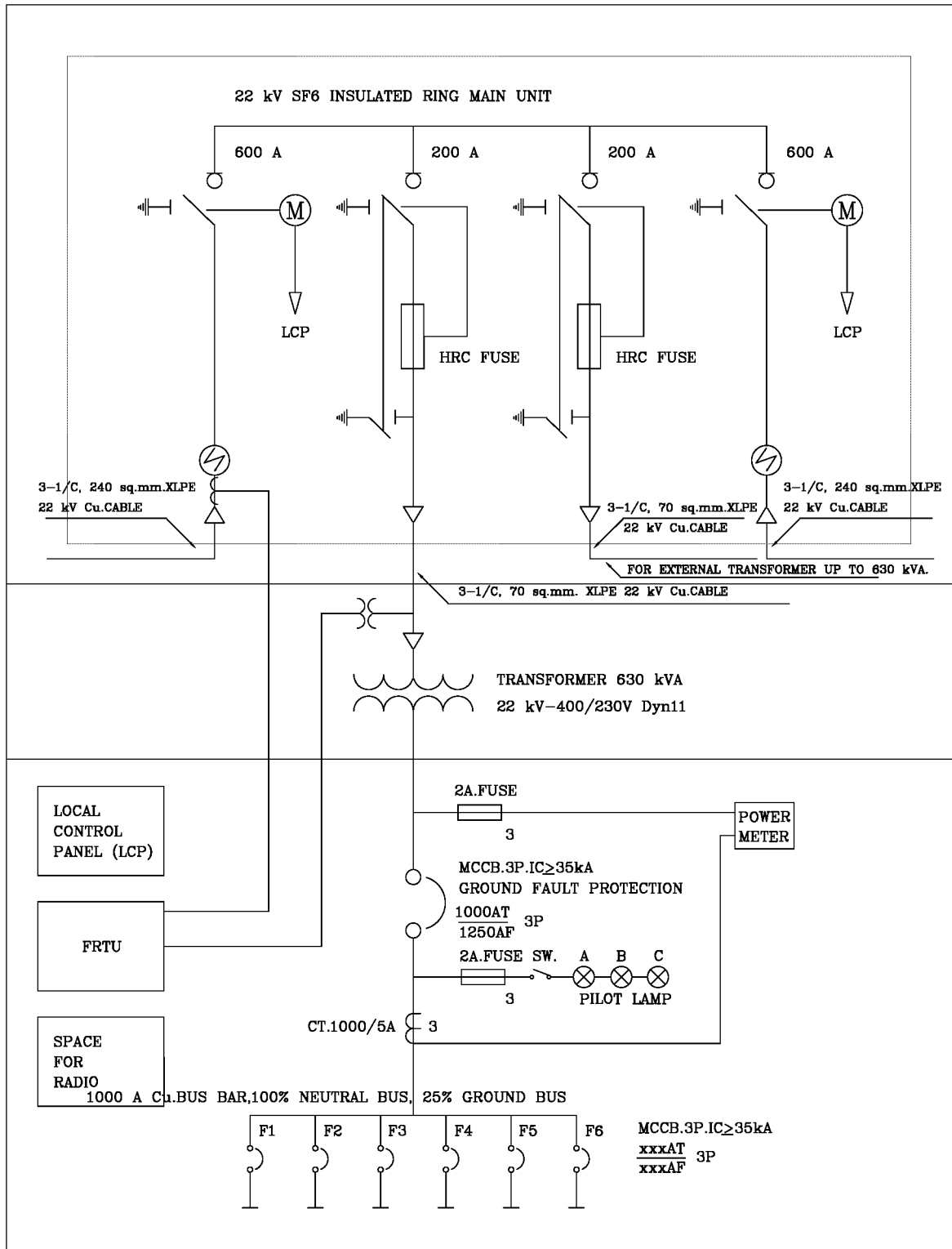
มิติเป็น -

วันที่ 13 มิ.ย. 2548

SINGLE LINE DIAGRAM
COMPACT UNIT SUBSTATION TYPE A24- 1-1000
1000 kVA. 22 kV.-400/230 V.

แบบเลขที่ SA5-015/48001.

แผ่นที่ 2 ของจำนวน 12 แผ่น



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

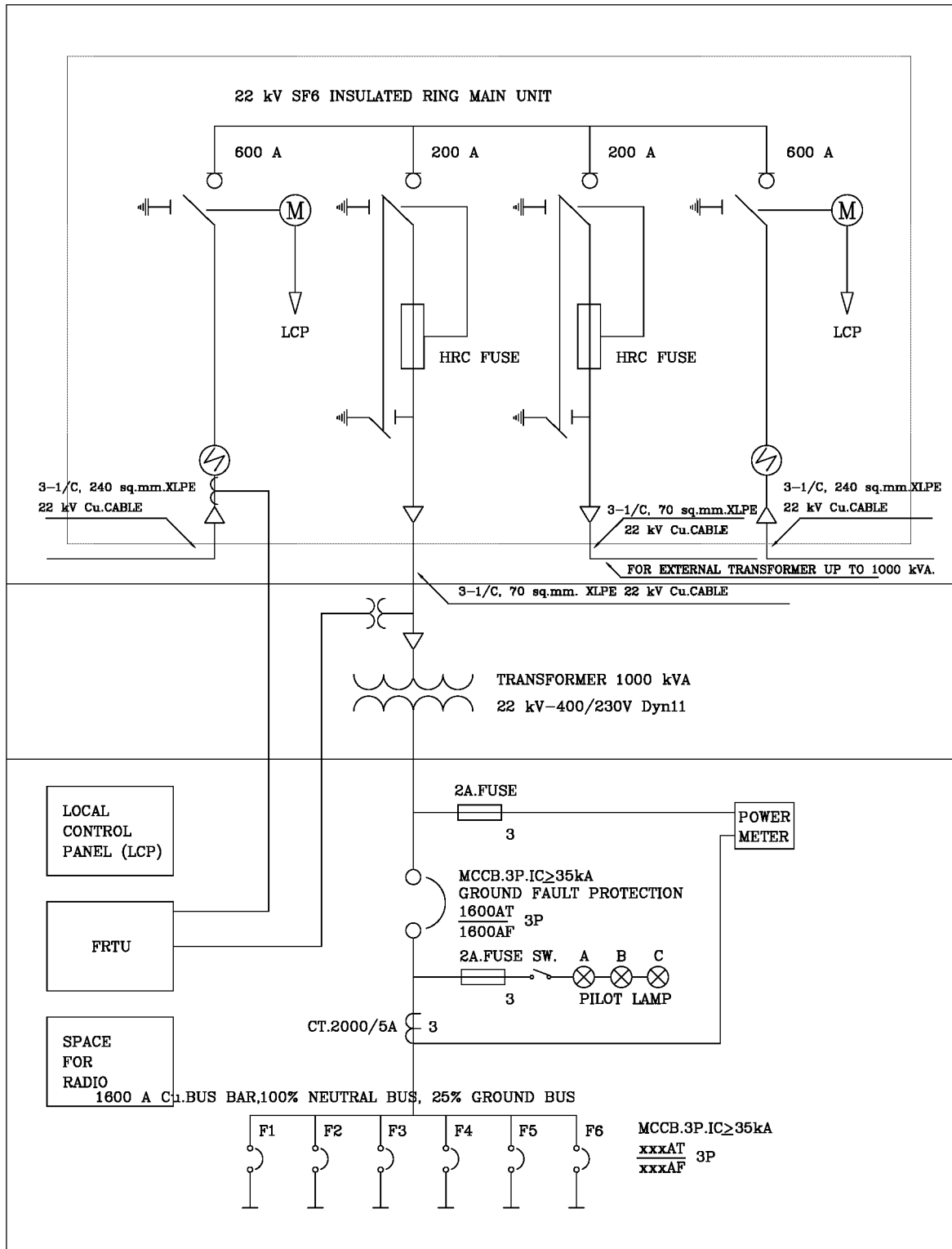
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A24- 2-630

แผ่นที่ 3 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

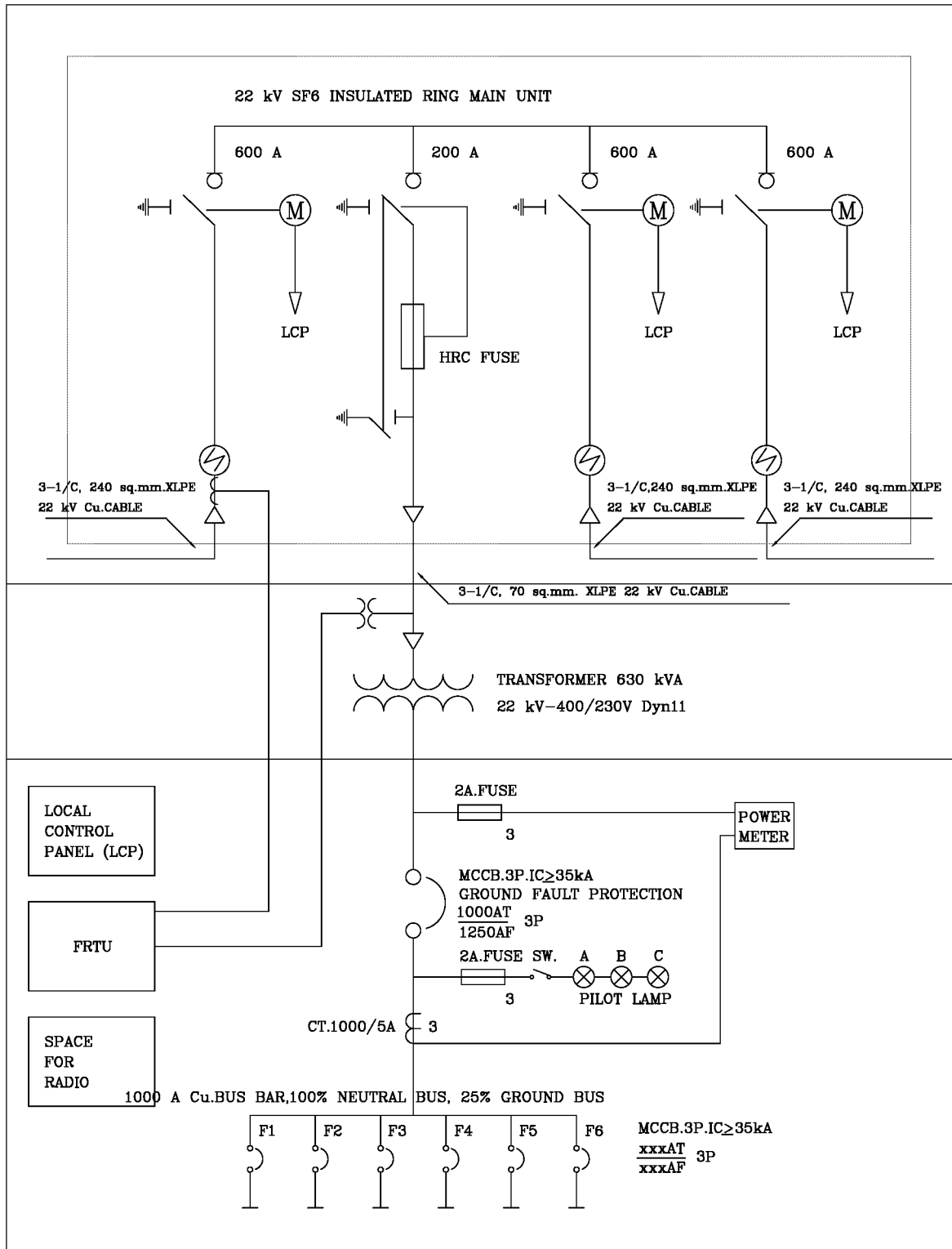
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A24- 2-1000

แผ่นที่ 4 ของจำนวน 12 แผ่น

1000 kVA. 22 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

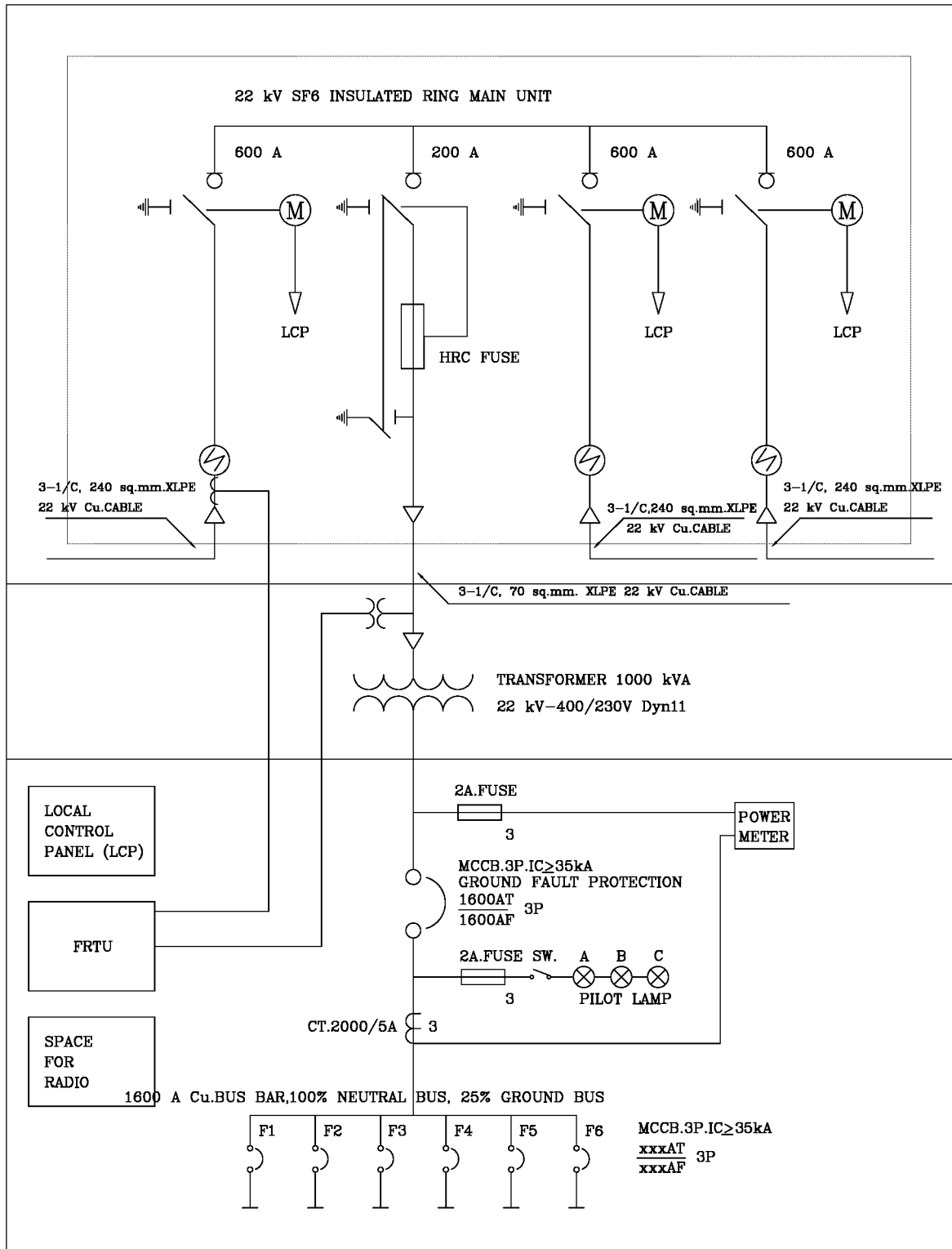
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A24- 3-630

แผ่นที่ 5 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

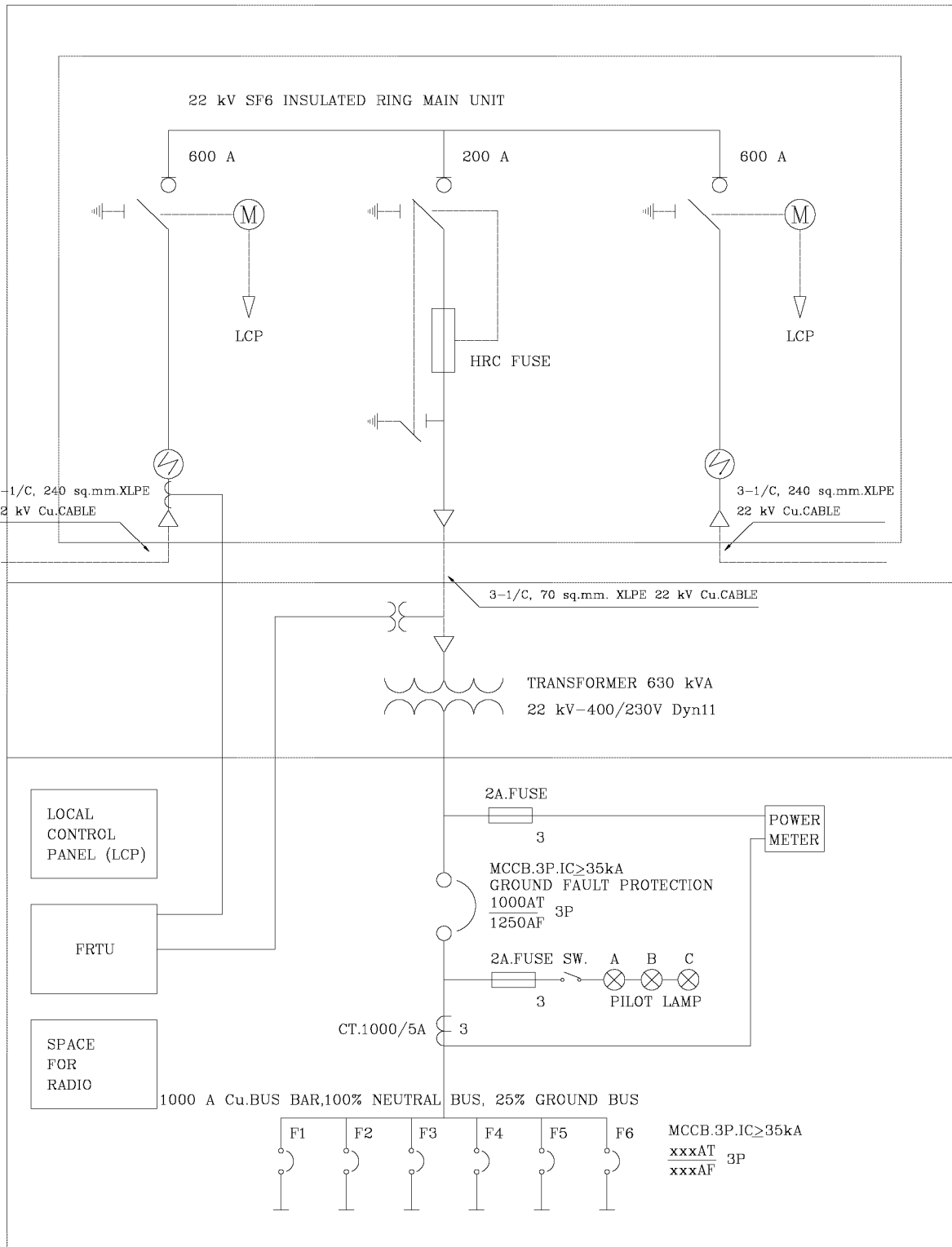
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A24- 3-1000

แผ่นที่ 6 ของจำนวน 12 แผ่น

1000 kVA. 22 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

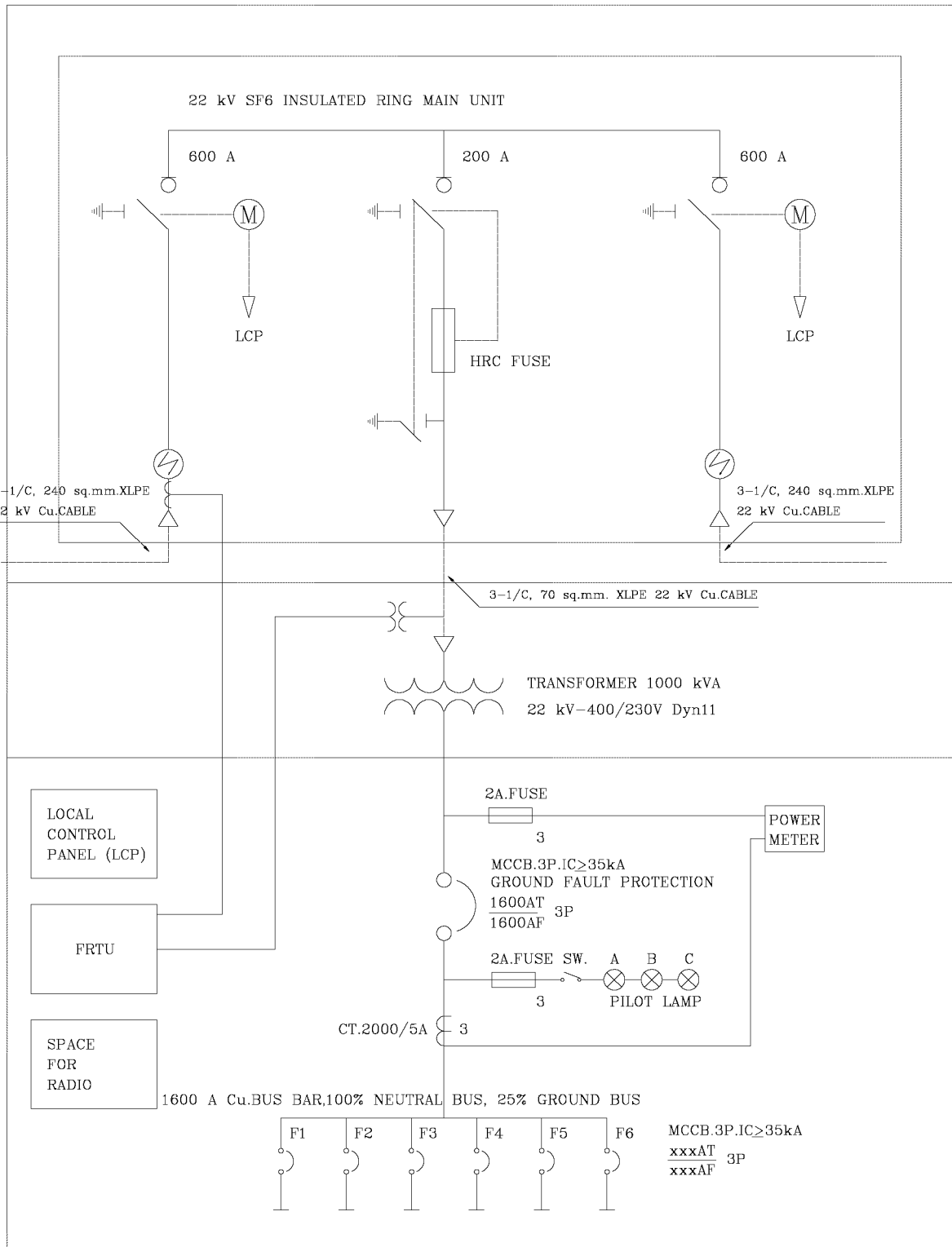
แบบเลขที่ SA5-015/48001.

วันที่ ..13.. มิ.ย. 2548....

COMPACT UNIT SUBSTATION TYPE B24- 1-630

แผ่นที่ 7 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

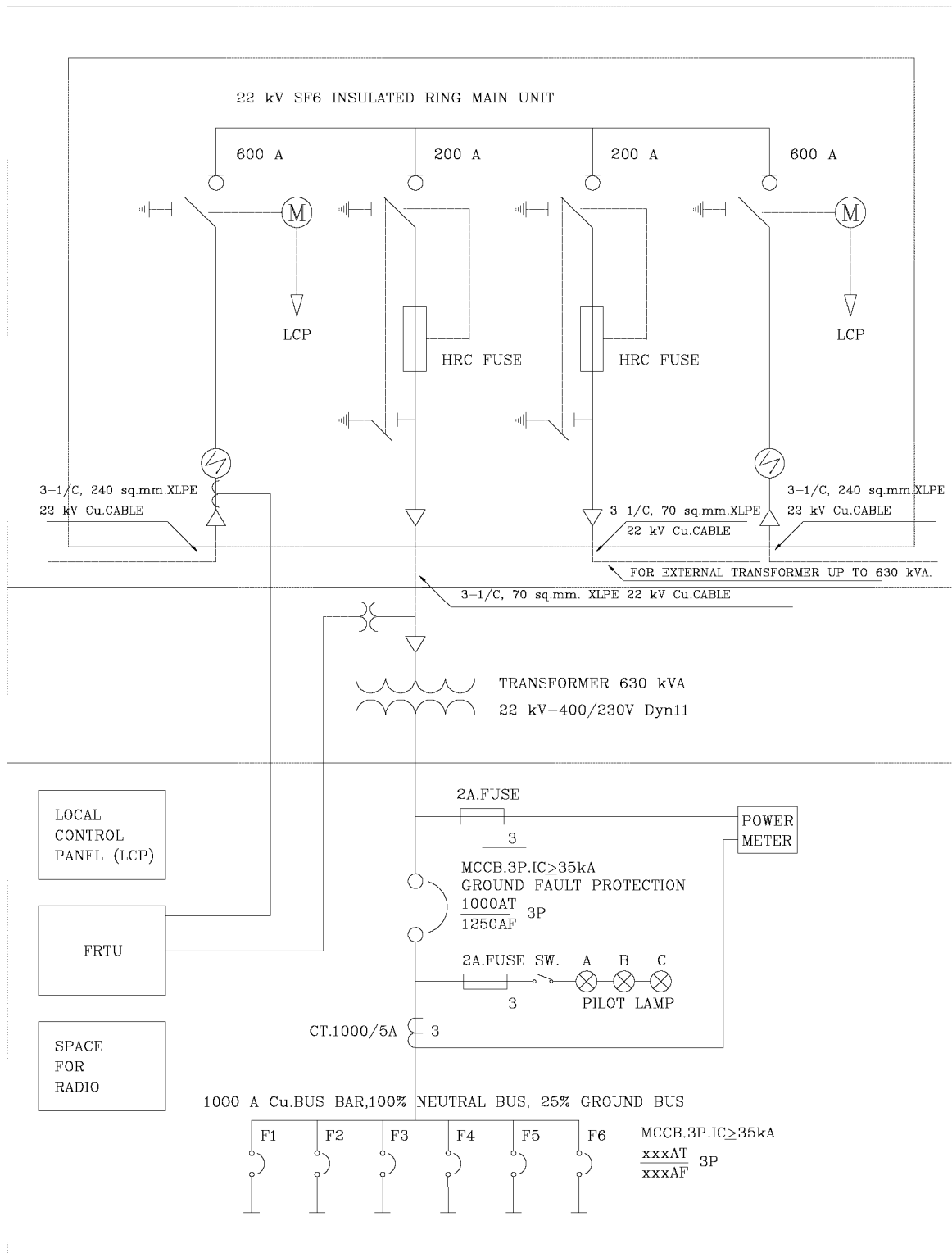
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B24- 1-1000

แผ่นที่ 8 ของจำนวน 12 แผ่น

1000 kVA. 22 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

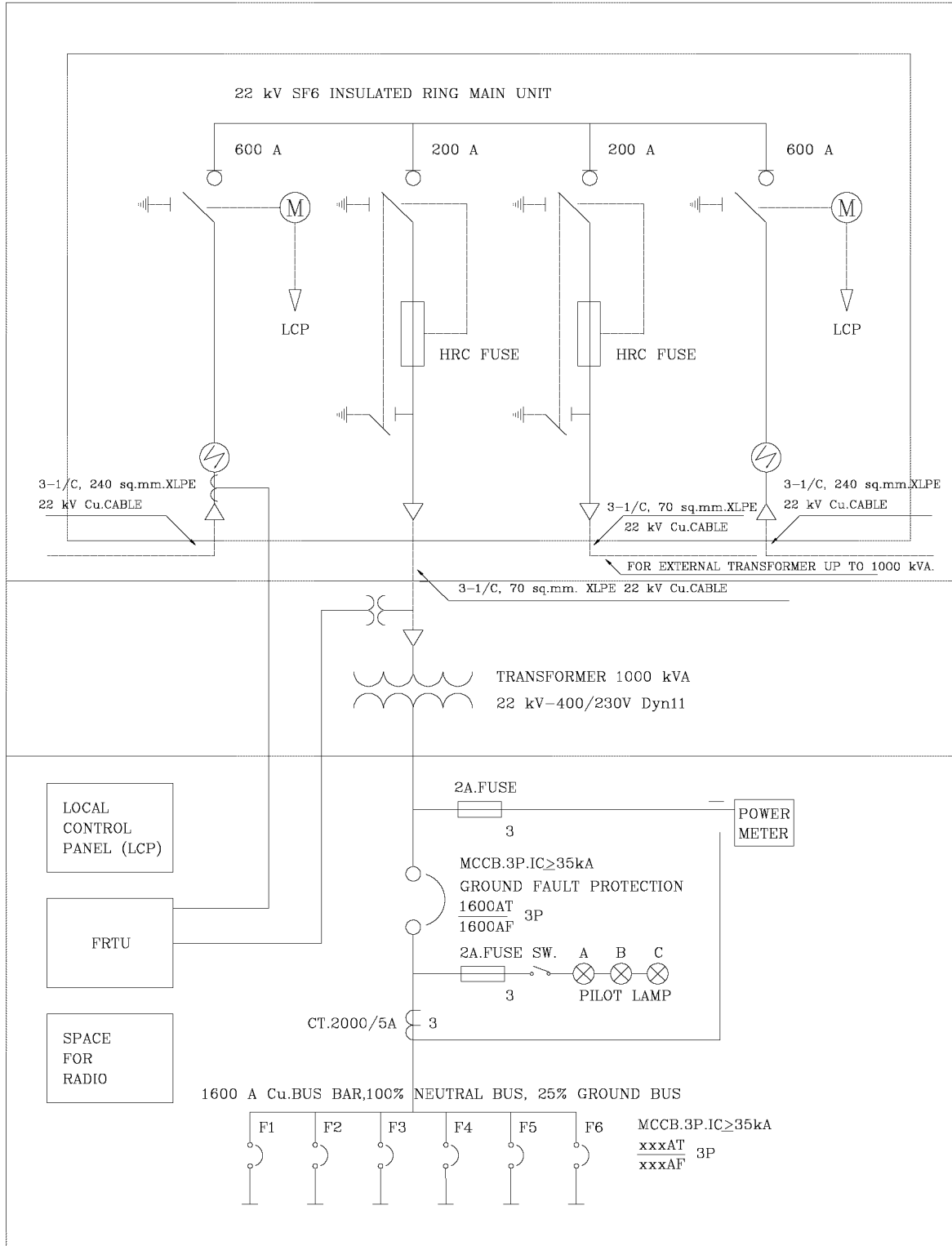
แบบเลขที่ SA5-015/48001.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B24- 2-630

แผ่นที่ 9 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



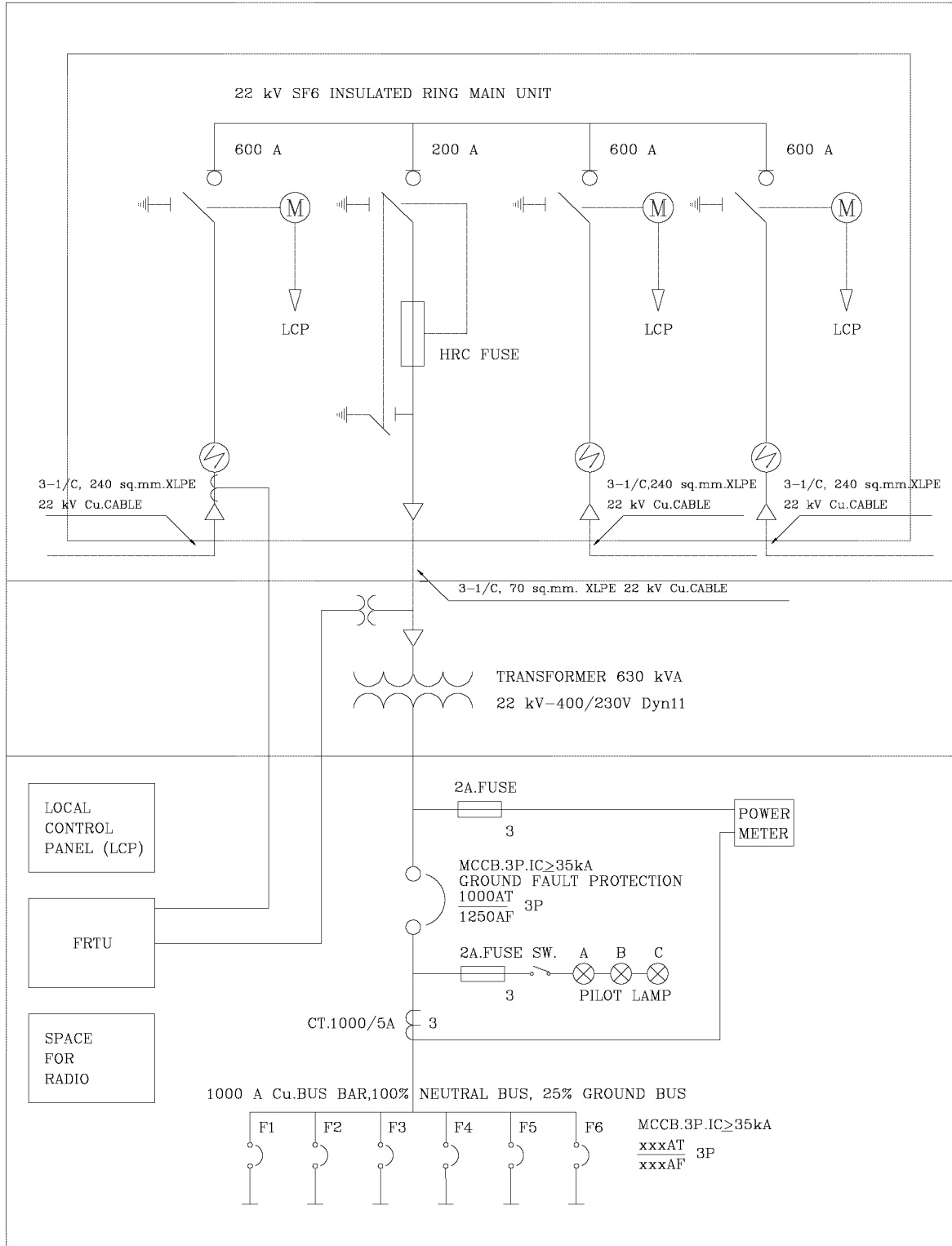
PRELIMINARY

กองข้อกำหนดทางเทคนิค
ฝ่ายวิศวกรรม
การไฟฟ้าส่วนภูมิภาค

มิติเป็น
 วันที่ 13 มิ.ย. 2548

SINGLE LINE DIAGRAM
 COMPACT UNIT SUBSTATION TYPE B24- 2-1000
 1000 kVA. 22 kV.-400/230 V.

แบบเลขที่ SA5-015/48001.
 แผ่นที่ 10 ของจำนวน 12 แผ่น



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

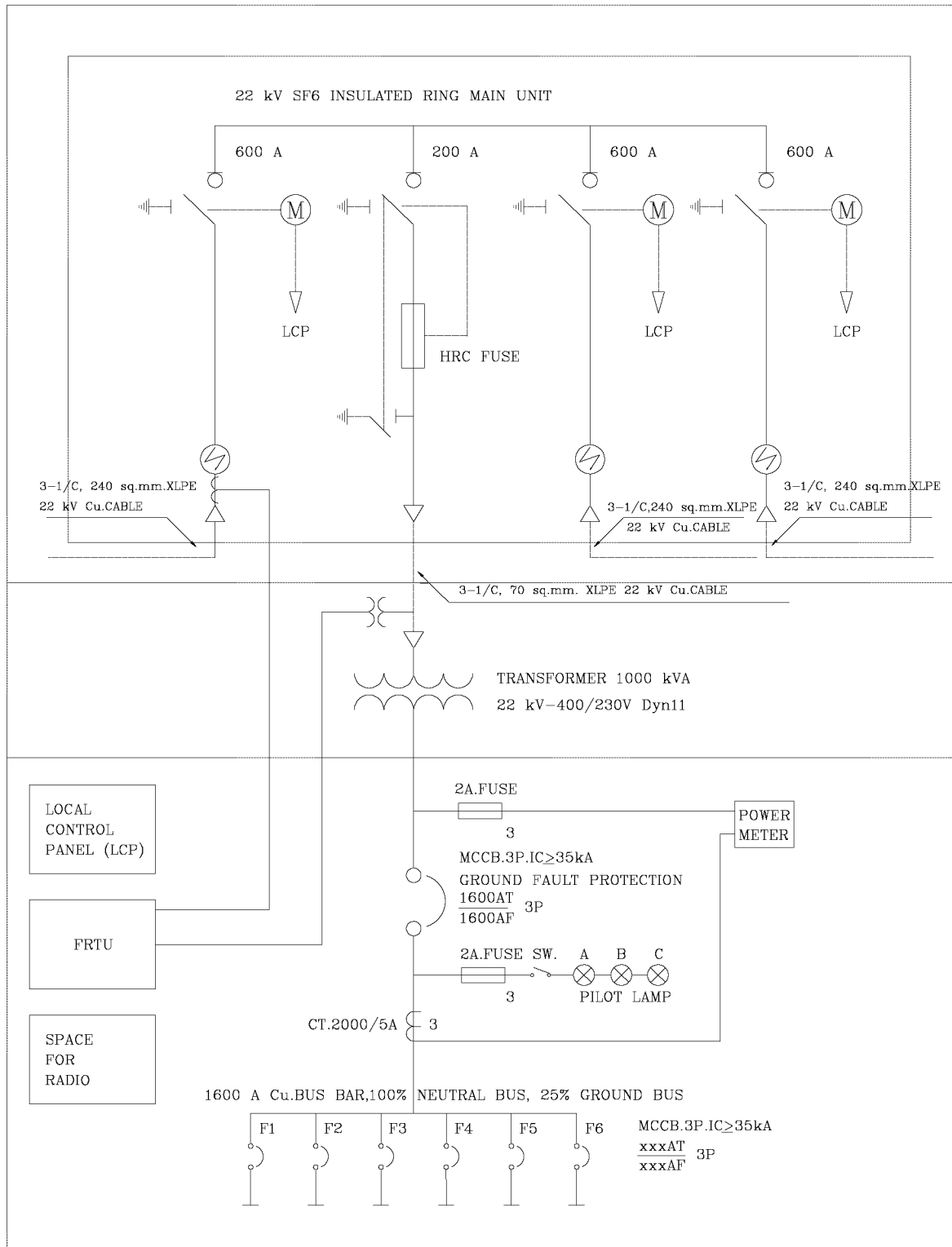
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วันที่ ..13.. มี.ย. 2548.....

COMPACT UNIT SUBSTATION TYPE B24- 3-630

แผ่นที่ 11 ของจำนวน 12 แผ่น

630 kVA. 22 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

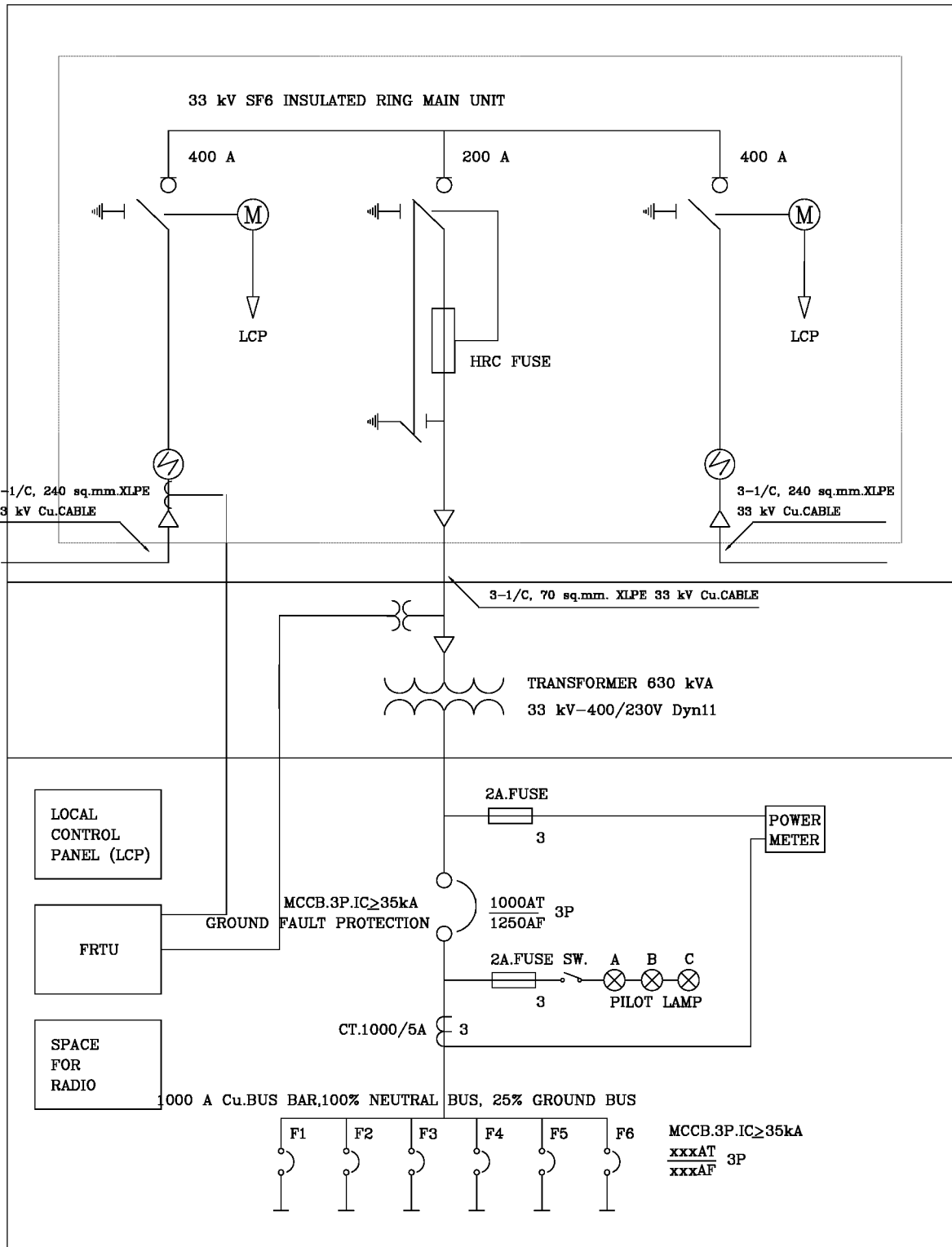
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วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B24- 3-1000

แผ่นที่ 12 ของจำนวน 12 แผ่น

1000 kVA. 22 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

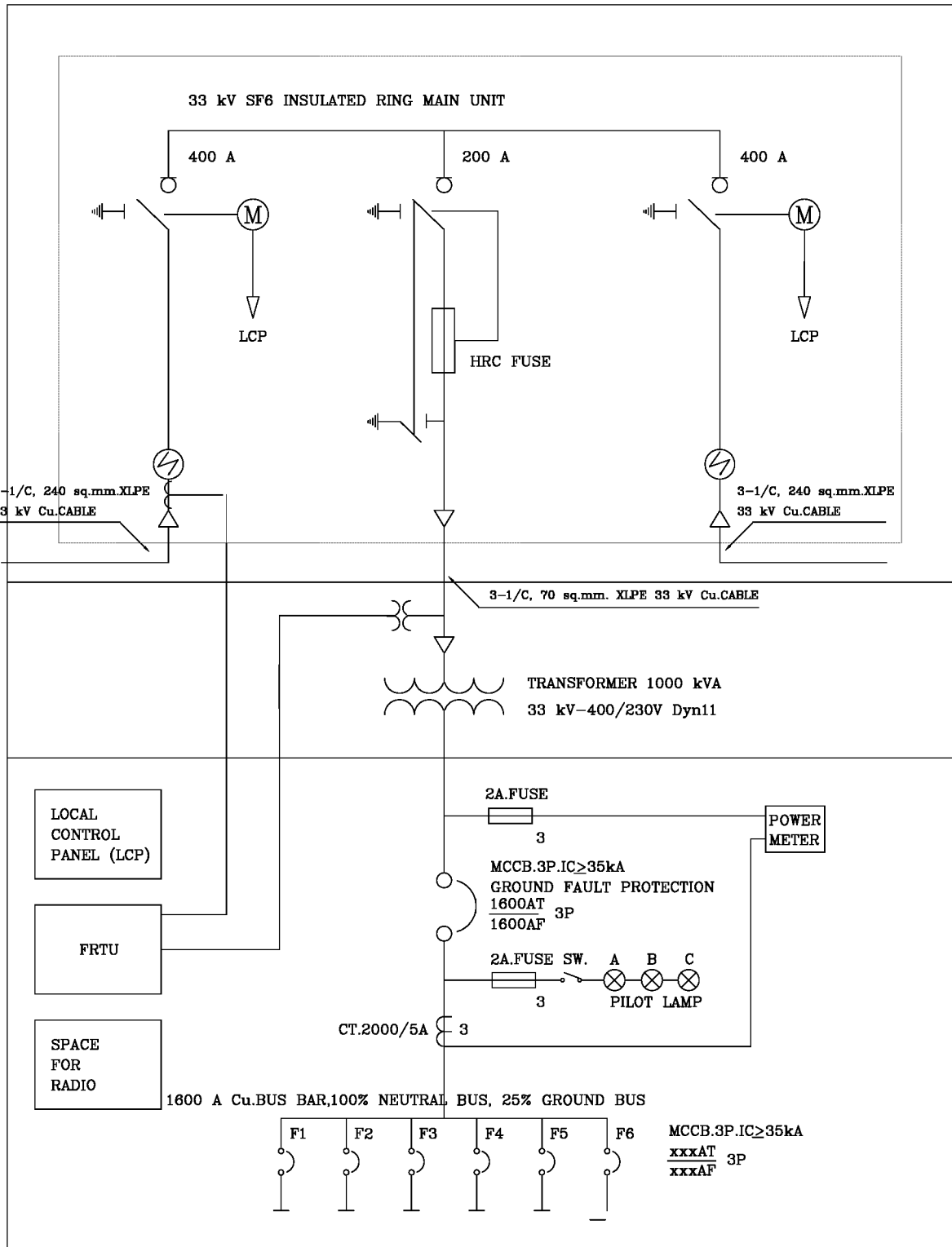
ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น
วันที่ 13 มิ.ย. 2548

SINGLE LINE DIAGRAM
COMPACT UNIT SUBSTATION TYPE A36- 1-630
630 kVA. 33 kV.-400/230 V.

แบบเลขที่ SA5-015/48002.
แผ่นที่ 1 ของจำนวน 12 แผ่น



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

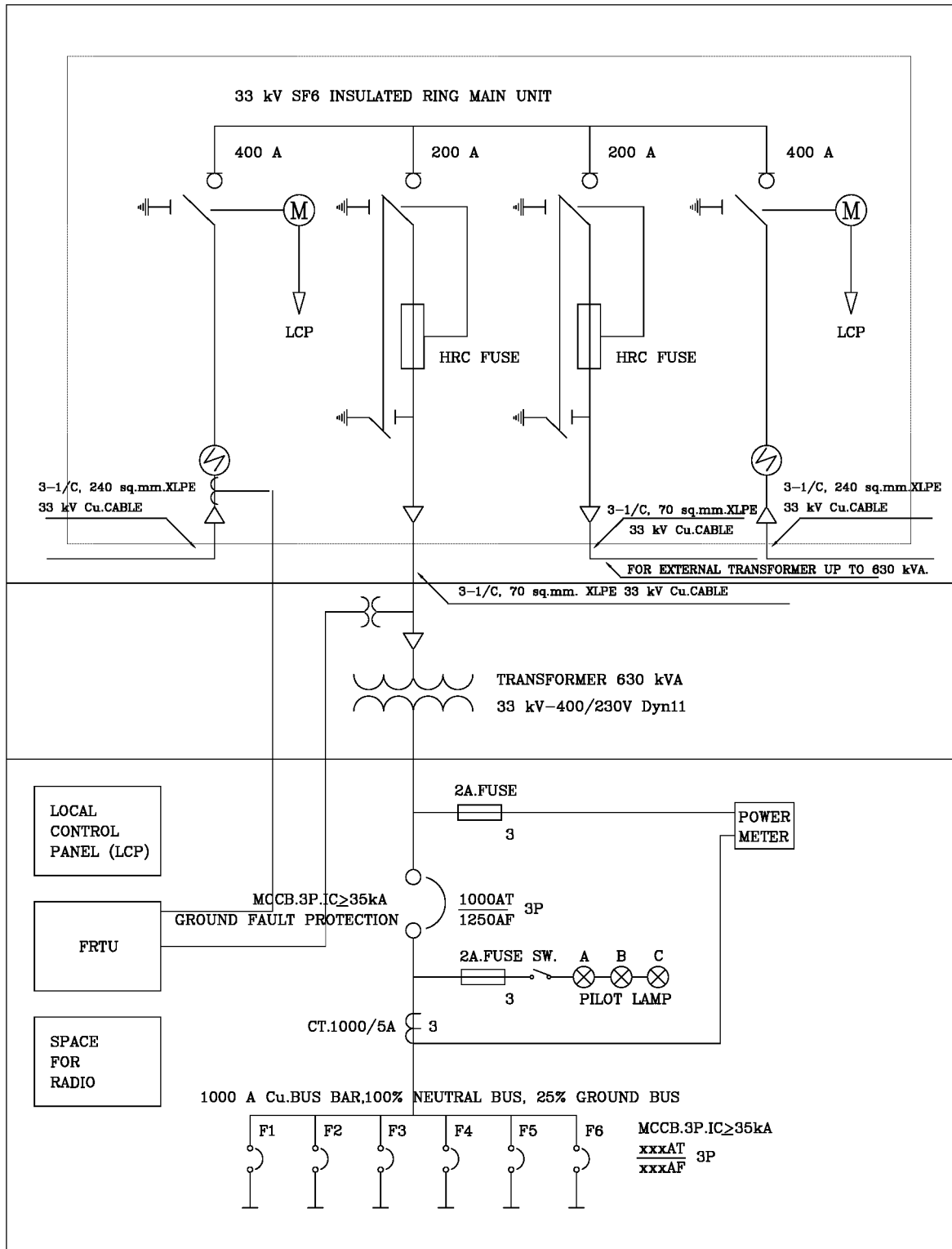
แบบเลขที่ SA5-015/48002.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A36- 1-1000

แผ่นที่ 2 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

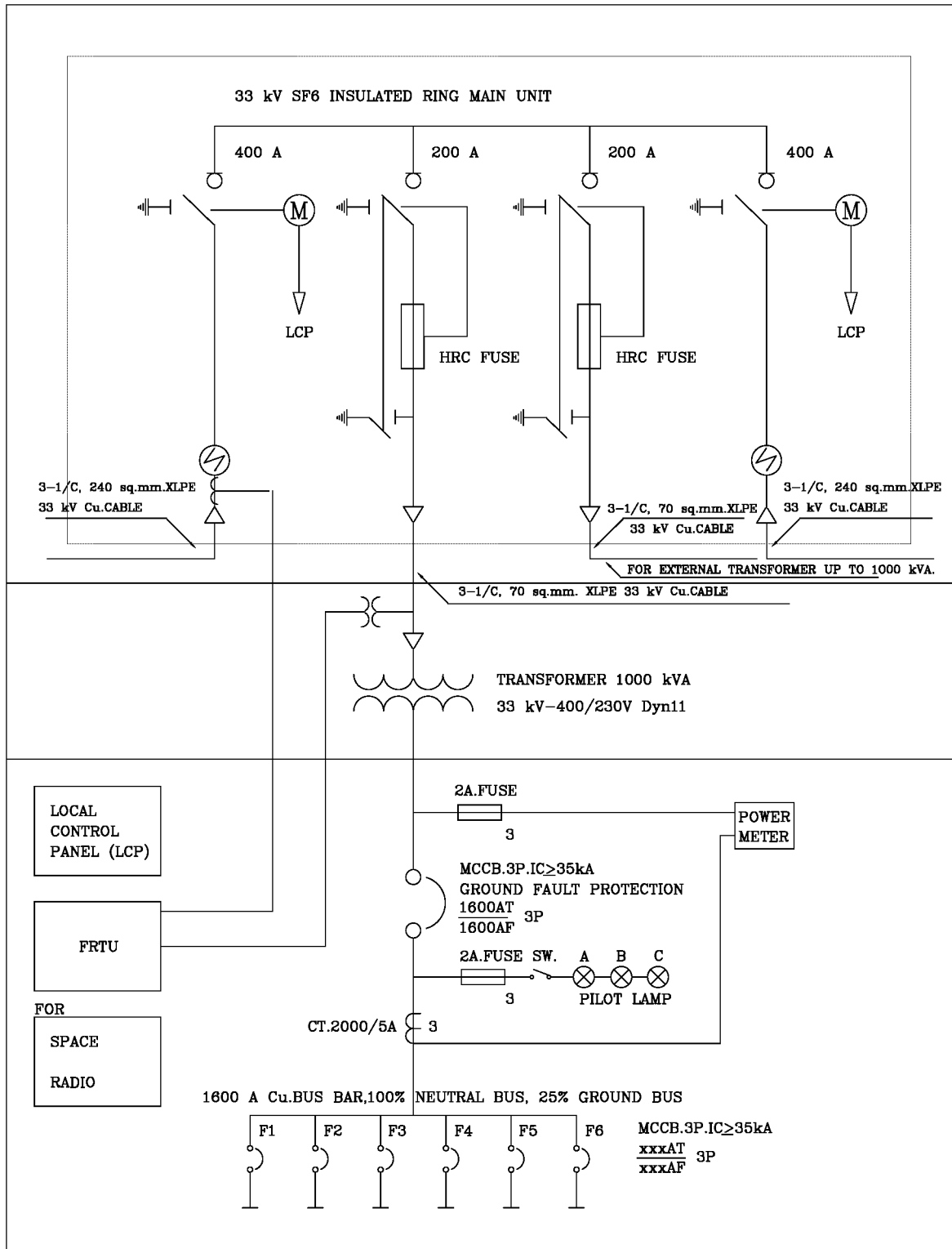
ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น
วันที่ 13 มิ.ย. 2548

SINGLE LINE DIAGRAM
COMPACT UNIT SUBSTATION TYPE A36- 2-630
630 kVA. 33 kV.-400/230 V.

แบบเลขที่ SA5-015/48002.
แผ่นที่ 3 ของจำนวน 12 แผ่น



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

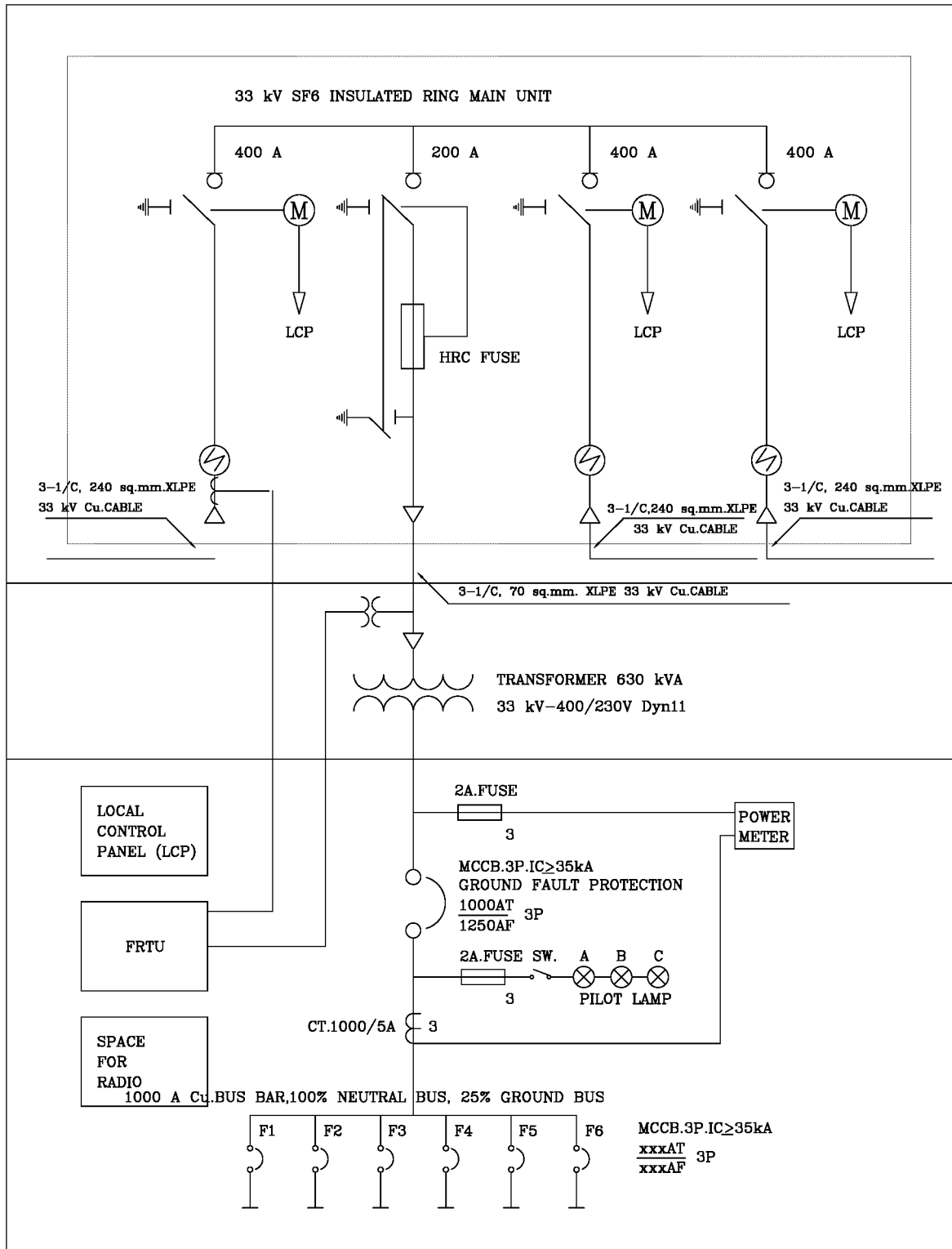
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วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A36- 2-1000

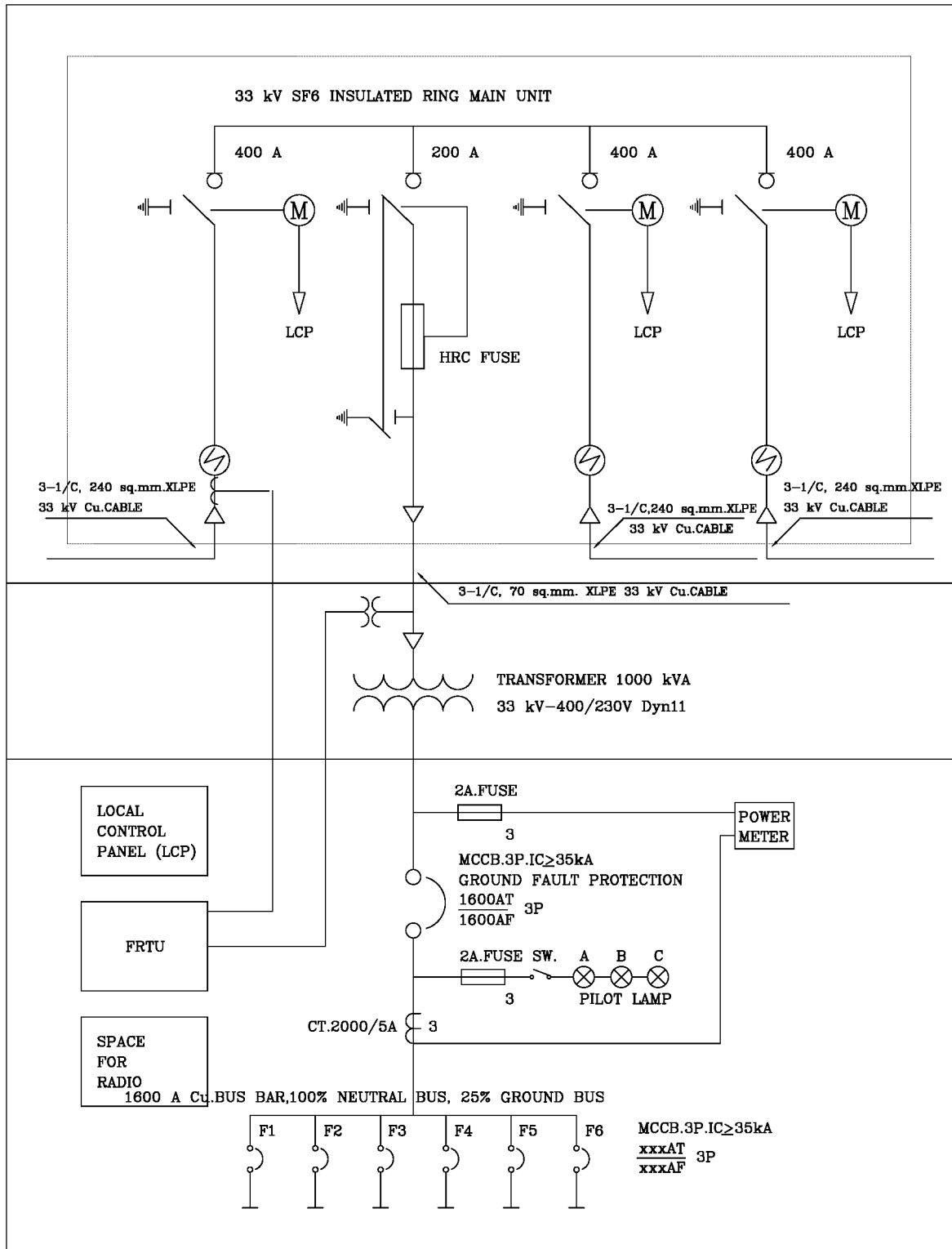
แผ่นที่ 4 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค	ฝ่ายวิศวกรรม	การไฟฟ้าส่วนภูมิภาค
มิติเป็น วันที่ 13 มิ.ย. 2548	SINGLE LINE DIAGRAM COMPACT UNIT SUBSTATION TYPE A36- 3-630 630 kVA. 33 kV.-400/230 V.	แบบเลขที่ SA5-015/48002. แผ่นที่ 5 ของจำนวน 12 แผ่น



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

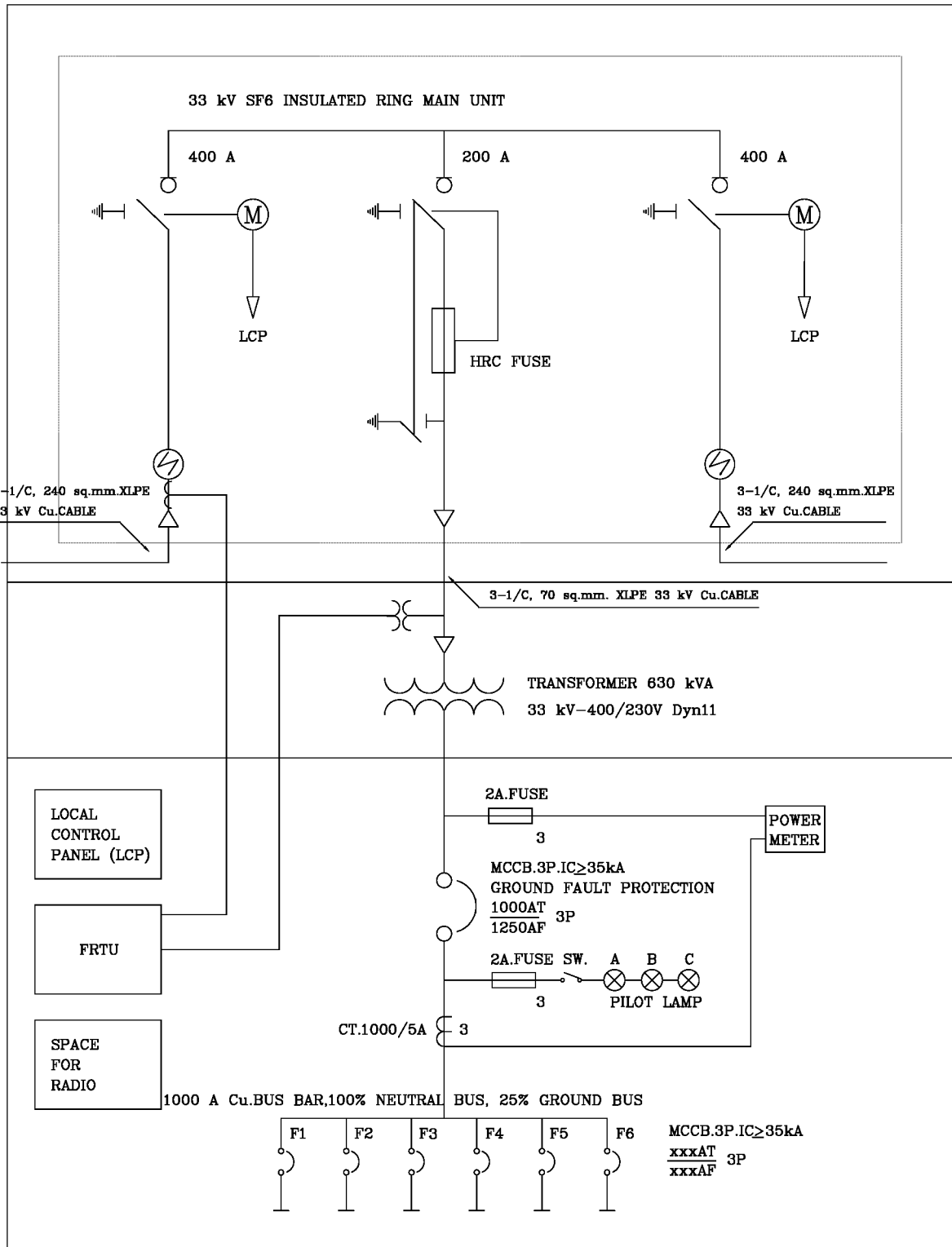
แบบเลขที่ SA5-015/48002.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE A36- 3-1000

แผ่นที่ 6 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

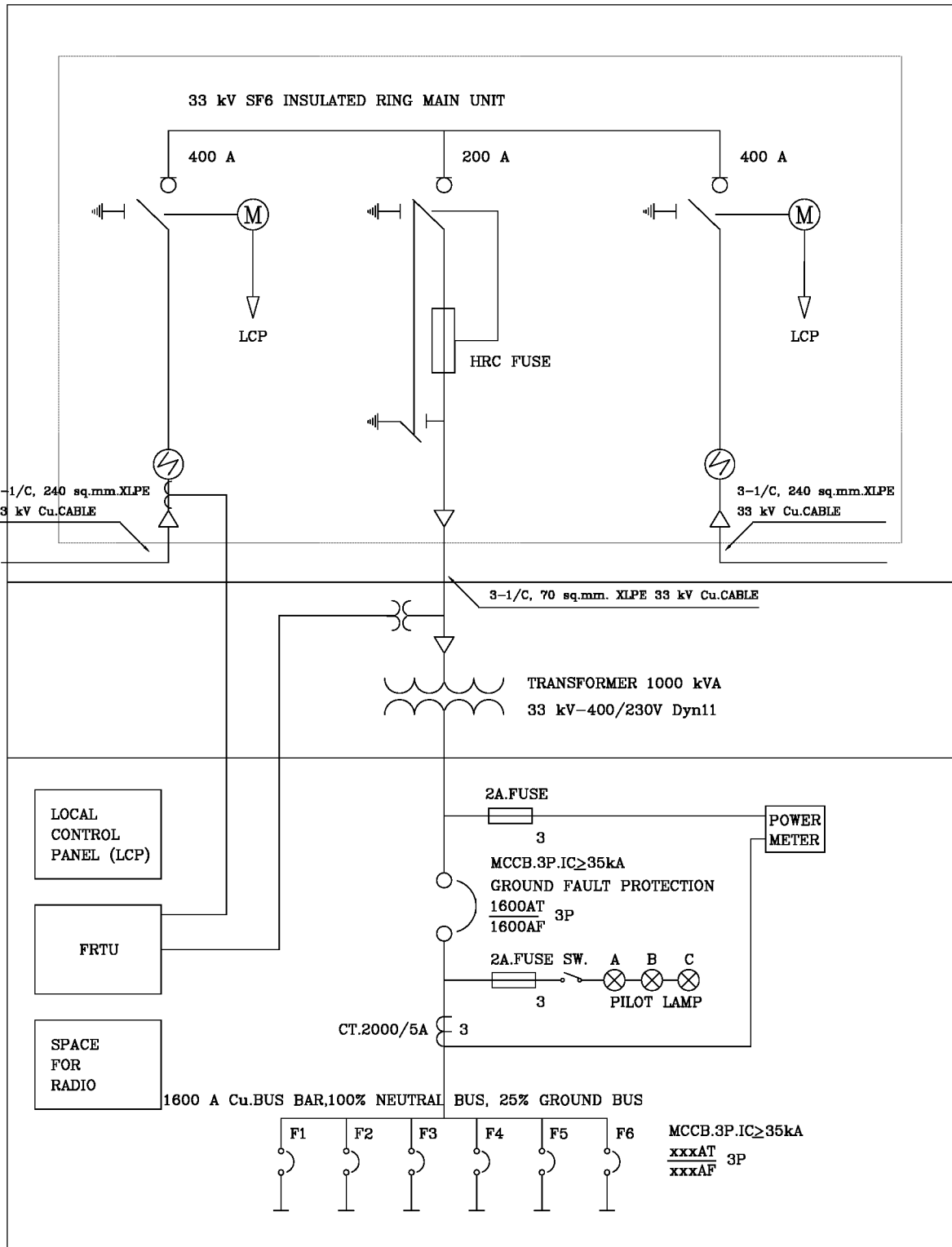
แบบเลขที่ SA5-015/48002.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B36- 1-630

แผ่นที่ 7 ของจำนวน 12 แผ่น

630 kVA. 33 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

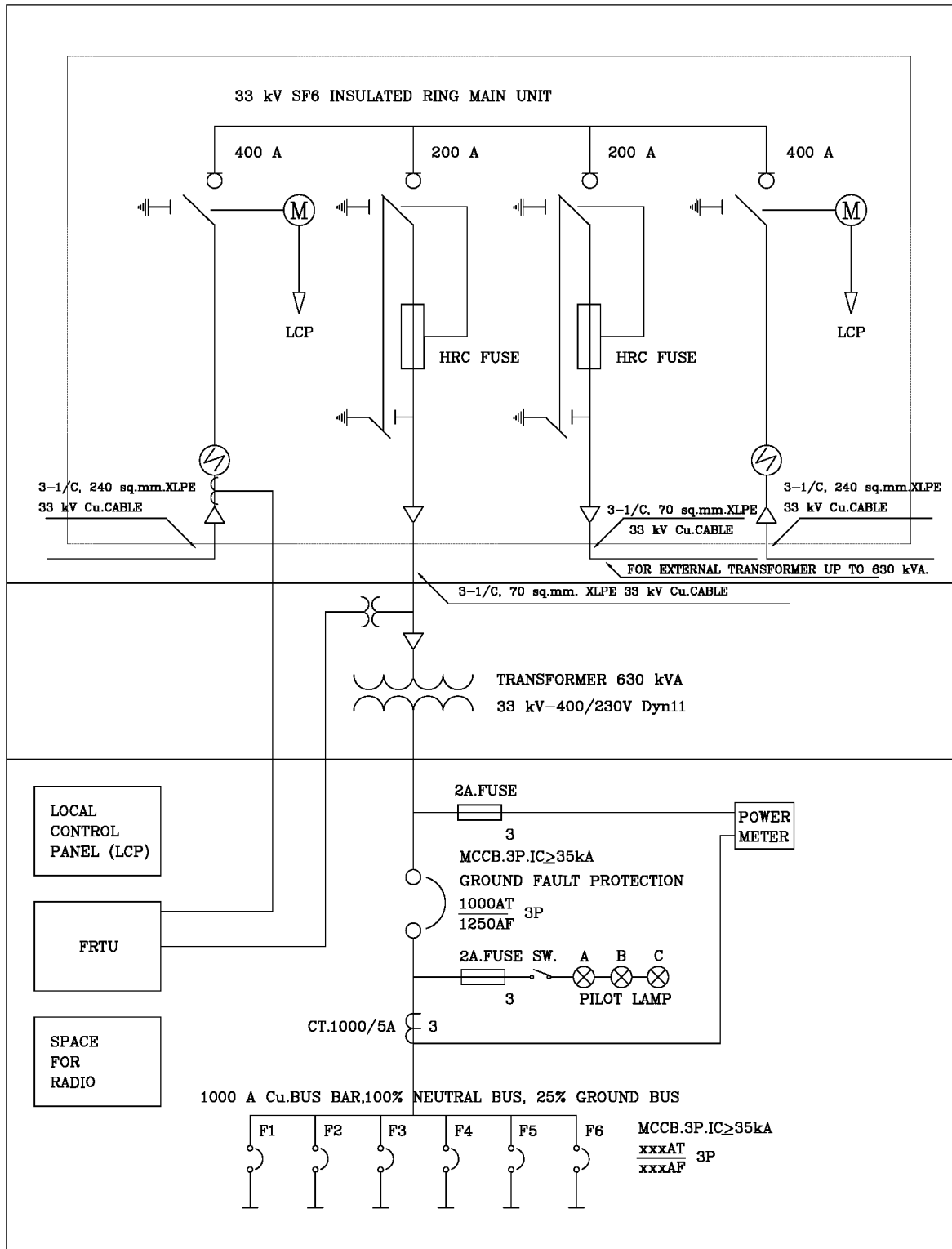
แบบเลขที่ SA5-015/48002.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B36- 1-1000

แผ่นที่ 8 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

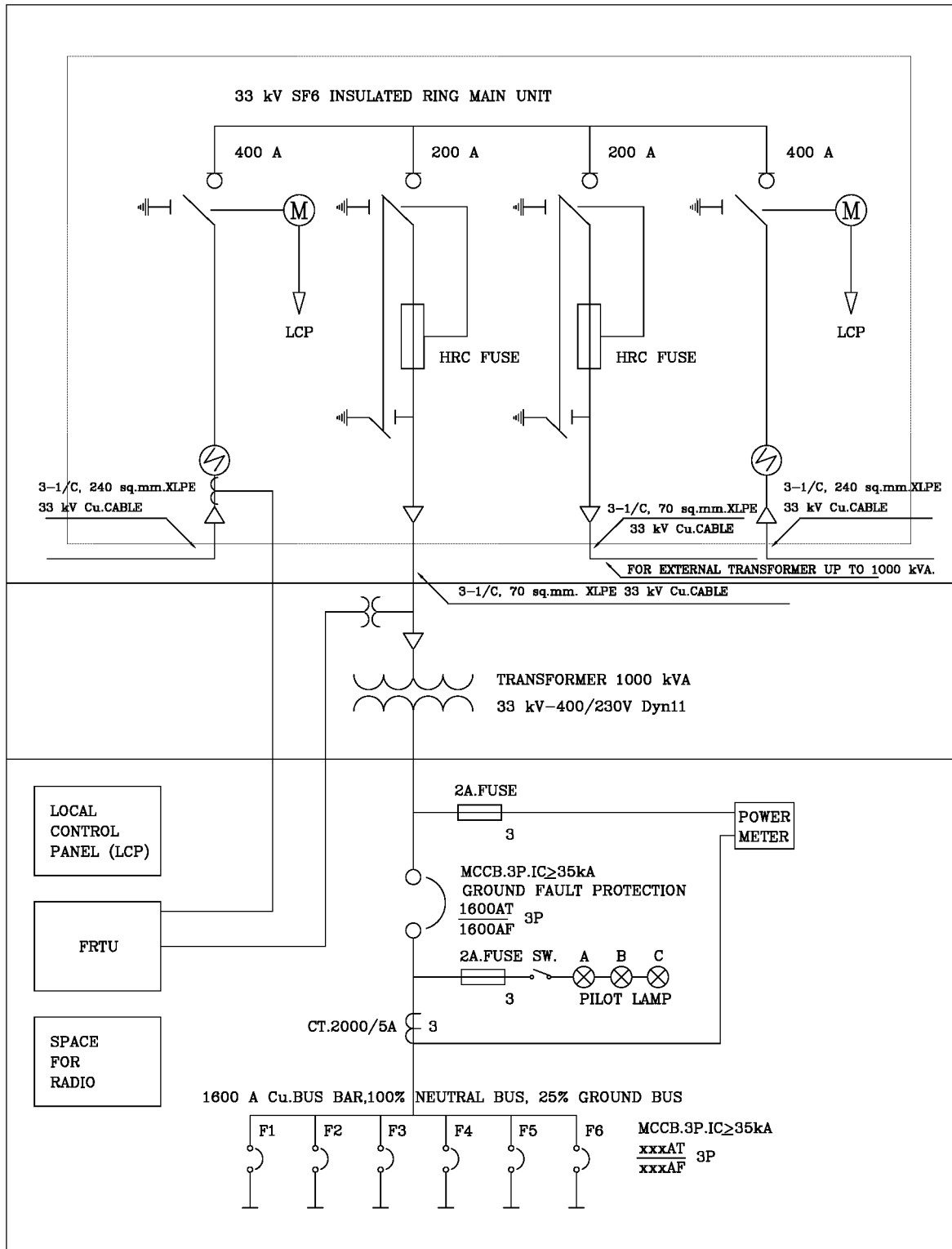
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วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B36- 2-630

แผ่นที่ 9 ของจำนวน 12 แผ่น

630 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น -

SINGLE LINE DIAGRAM

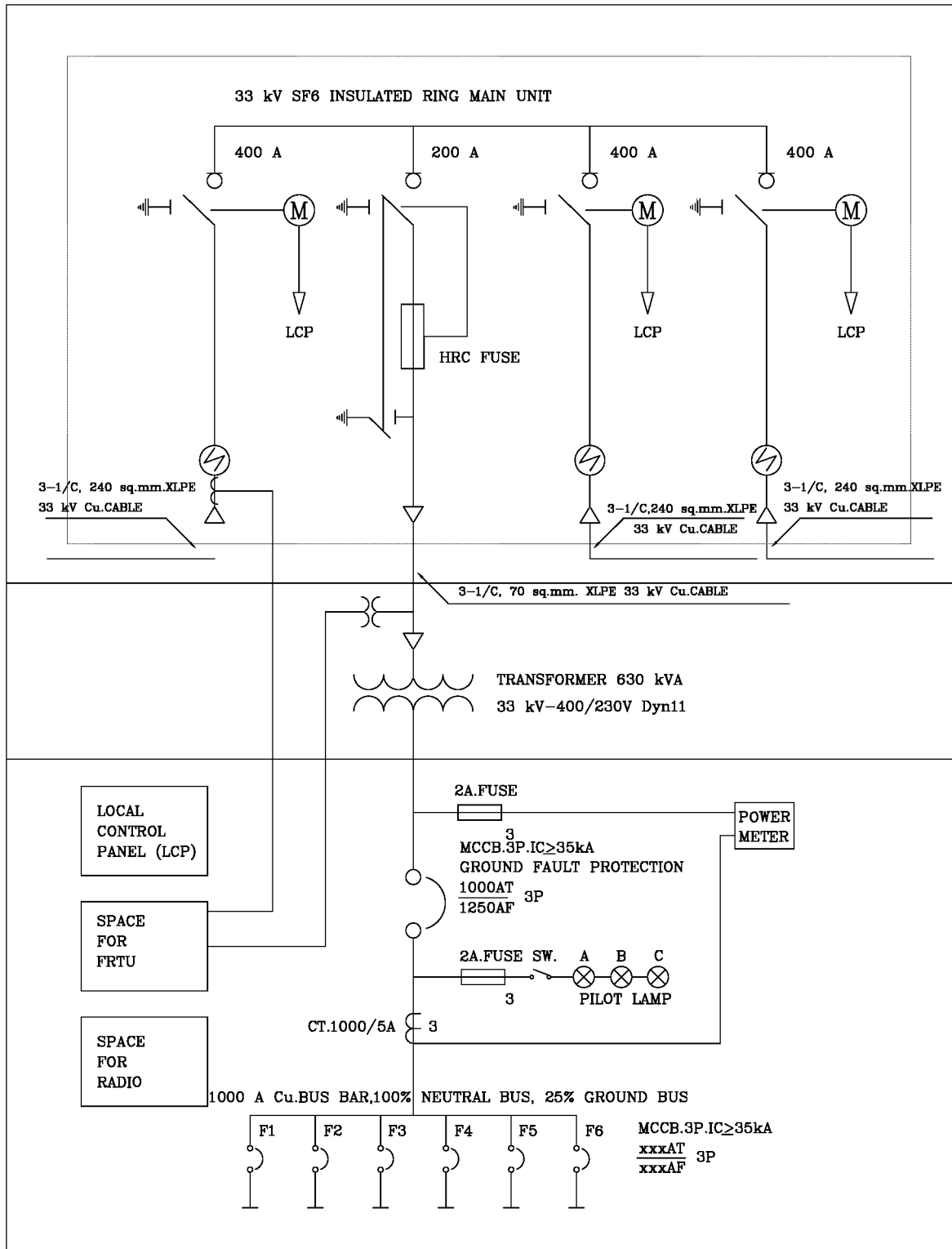
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วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B36- 2-1000

แผ่นที่ 10 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.



PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น

SINGLE LINE DIAGRAM

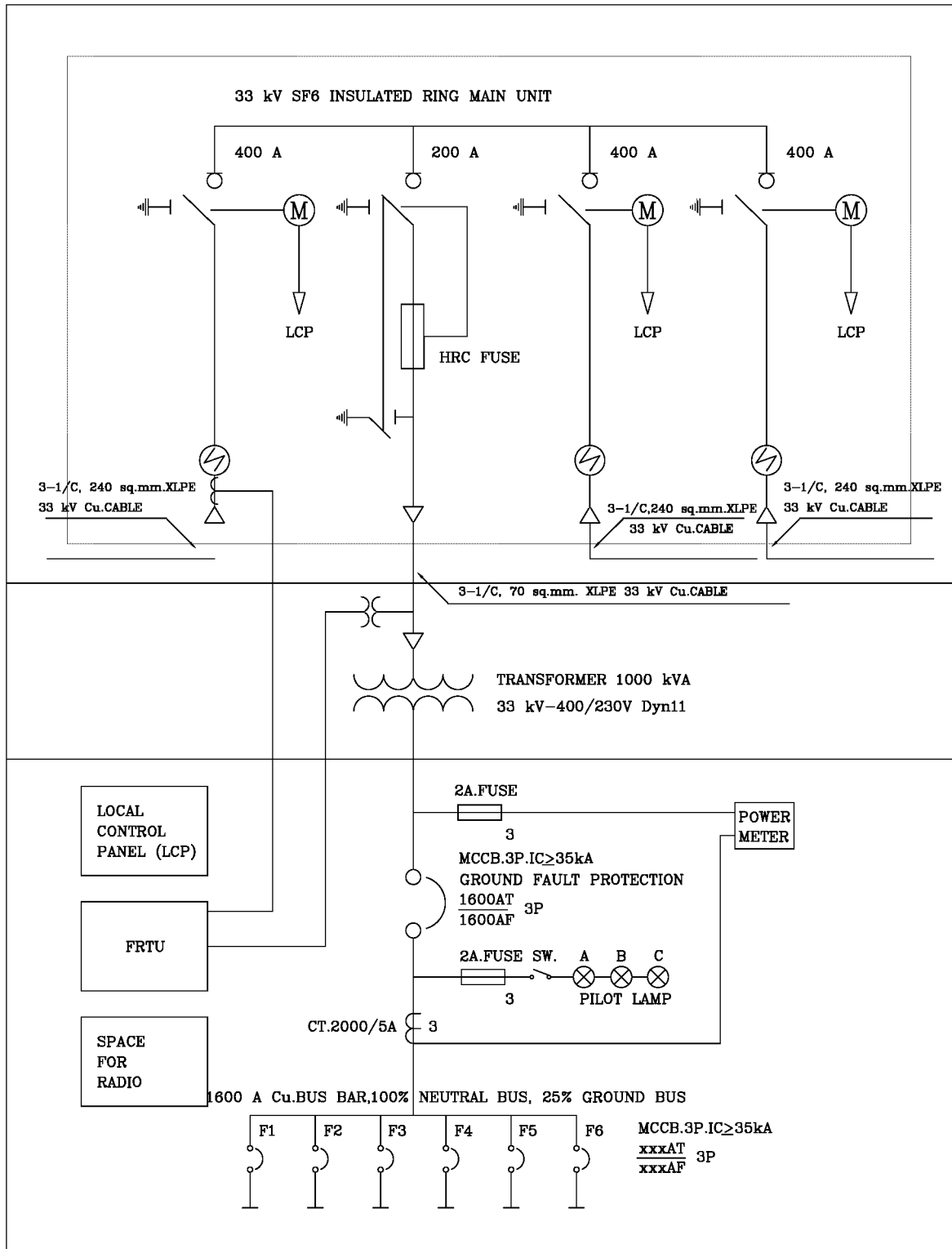
แบบเลขที่ SA5-015/48002.

วันที่ 13 มิ.ย. 2548

COMPACT UNIT SUBSTATION TYPE B36- 3-630

แผ่นที่ 11 ของจำนวน 12 แผ่น

630 kVA. 33 kV.-400/230 V.



HV.PART

TR.PART

LV.PART

PRELIMINARY

กองข้อกำหนดทางเทคนิค

ฝ่ายวิศวกรรม

การไฟฟ้าส่วนภูมิภาค

มิติเป็น-

SINGLE LINE DIAGRAM

แบบเลขที่ SA5-015/48002.

วันที่ ...13...มิ.ย...2548....

COMPACT UNIT SUBSTATION TYPE B36- 3-1000

แผ่นที่ 12 ของจำนวน 12 แผ่น

1000 kVA. 33 kV.-400/230 V.

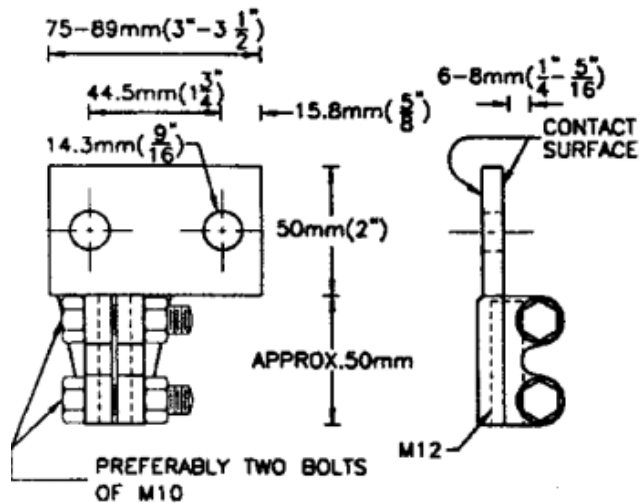


FIGURE 1

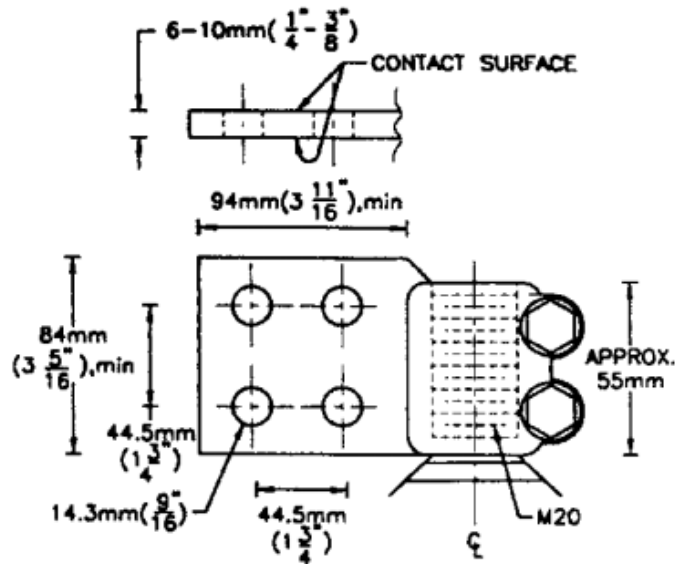


FIGURE 2

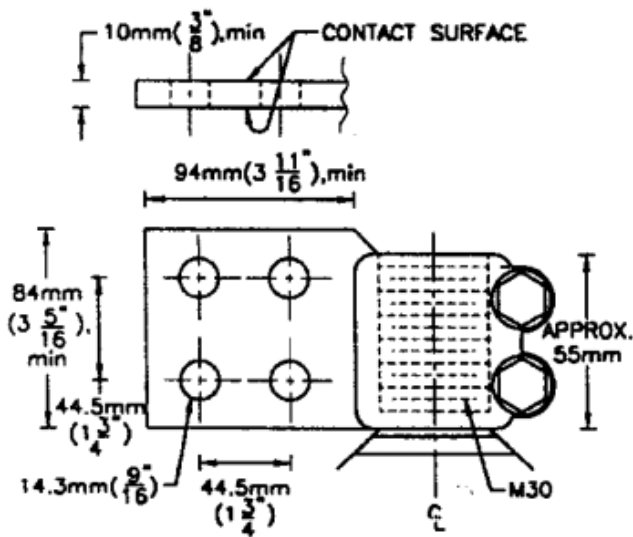


FIGURE 3

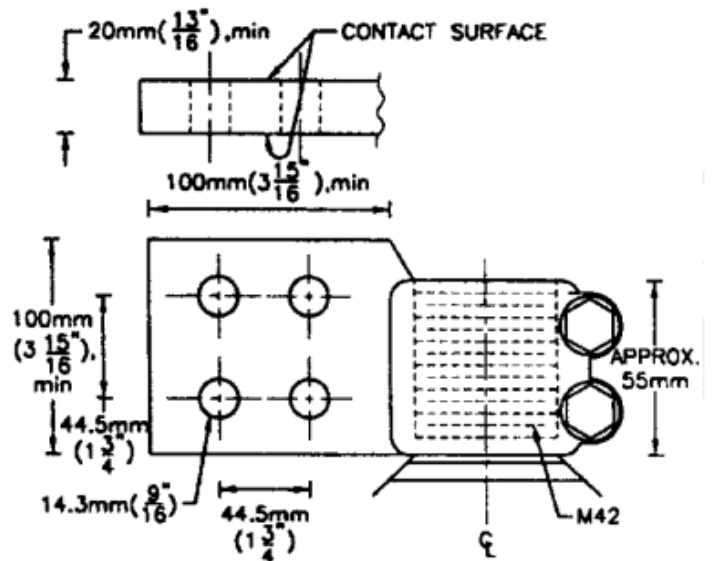


FIGURE 4

NOTES :

1. FIGURE 1 FOR 50-160 kVA TRANSFORMER
2. FIGURE 2 FOR 250-400 kVA TRANSFORMER
3. FIGURE 3 FOR 500-630 kVA TRANSFORMER
4. FIGURE 4 FOR 800-1,250 kVA TRANSFORMER

PRELIMINARY

กองข้อกำหนดทางเทคนิค ฝ่ายวิศวกรรม การไฟฟ้าส่วนภูมิภาค

มิติเป็น _____

DETAIL OF L.V. TERMINAL PADS

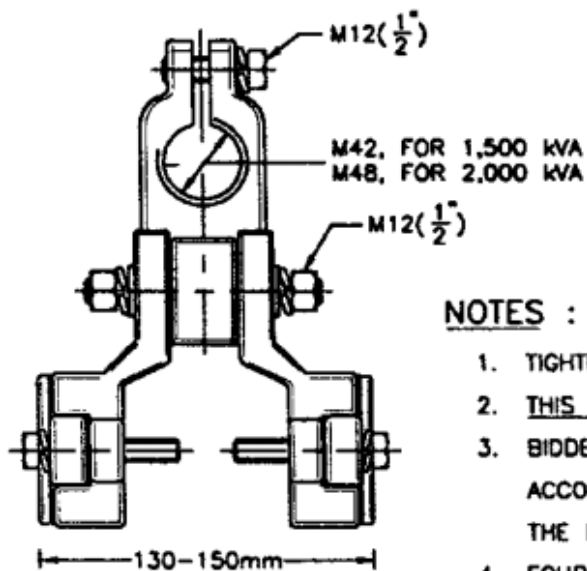
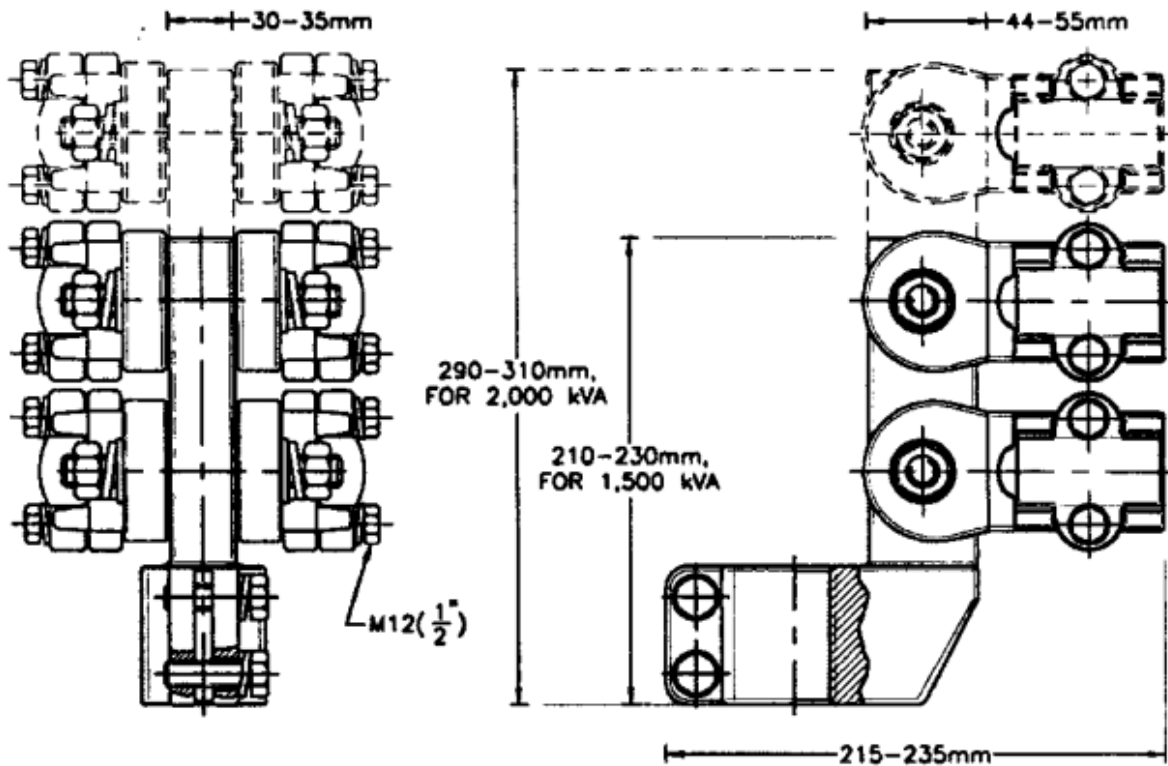
แบบเลขที่ SA4-015/47002

วันที่ 13 มิ.ย. 2548

FOR 50 - 1,250 kVA

แผ่นที่ 1 ของจำนวน 2 แผ่น

THREE-PHASE TRANSFORMER



NOTES :

1. TIGHTENING TORQUE LEVEL OF BOLTS $M12(\frac{1}{2})$: 5.5 kgf-m
2. THIS DRAWING IS ONLY GUIDING (NOT COMPELLING).
3. BIDDERS ARE AT LIBERTY TO QUOTE THE CONNECTOR ACCORDING TO MANUFACTURER'S DESIGN, BUT PEA RESERVES THE RIGHT TO CONSIDER.
4. FOUR (4) CIRCUITS FOR 1,500 kVA TRANSFORMER
5. SIX (6) CIRCUITS FOR 2,000 kVA TRANSFORMER

PRELIMINARY

กองข้อกำหนดทางเทคนิค ฝ่ายวิศวกรรม การไฟฟ้าส่วนภูมิภาค

มิติเป็น _____ วันที่ 13 มิ.ย. 2548	DETAIL OF L.V. TERMINAL PADS FOR 1,500 - 2,000 kVA THREE-PHASE TRANSFORMER	แบบเลขที่ SA4-015/47002 แผ่นที่ 2 ของจำนวน 2 แผ่น
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TECHNICAL SPECIFICATION DIVISION

COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV

Specification No. RRRO-027/2560

Approved date: 26 OCT 2021

Rev. No.: 1

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Page 1 of 5

ADDENDUM

This addendum is made to be part of Specification No.: RPRO-027/2560 (Rev. No. 1) **COMPACT UNIT SUBSTATION FOR 22 kV AND 33 kV.**

(1) Replace clause **1c.5 Transformer** (page 9 – 12 of 36) by the followings;

1c.5 Transformer

The transformer shall be according to PEA's Specification No.: RTRN-035/2561 (Rev. No. 5) **THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT** and its addendums, with the additional detail;

(1.1) Replace clause **1c.2 Oil preservation system** (page 2 of 32) of Specification No. RTRN-035/2561 by the followings;

1c.2 Oil preservation system

The transformers shall be permanently sealed and completely oil fill system (without gas cushion) type (usually corrugated tank). The transformer tank cover shall be bolt tightened to the tank with suitable gasket sealing.

(1.2) Replace clause **1c.10 Bushings** (page 5 – 6 of 32) of Specification No. RTRN-035/2561 by the followings;

1c.10 Bushings

Each transformer shall have three (3) high-voltage bushings of cone-shaped, protruding type and shall be suitable for plug-in terminations/elbow connectors of 200 A continuous current rating and four (4) or eight (8) low-voltage bushings located on the cover of the tank.

Secondary neutral point of transformer shall be brought out by separated-insulated bushing(s) and loaded with rated current

(1.3) Replace clause **1c.11 Terminal connectors** (page 6 of 32) of Specification No. RTRN-035/2561 by the followings;

1c.11 Terminal connectors

L.V. bushings shall be equipped with terminal pad connectors (stud type connectors are preferable), of high conductivity bronze and hot-tin dipped. The terminal pads shall be drilled in accordance with NEMA standards (9/16" holes on 1 3/4" centers); each hole shall be furnished with one (1)





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bolt M 12x 60 mm (of at least 50 mm thread length), one (1) nut, two (2) flat washers, and one (1) lock washer; details of terminal pads shall be according to Drawing No. SA4-015/47002.

(1.4) Replace clause 1c.15 Initial oil filling (page 13 of 32) of Specification No. RTRN-035/2561 by the followings;

1c.15 Initial oil filling

The transformers shall be supplied with initial oil filling. The oil shall be unused natural esters according to IEC 62270: 2013, or later edition.

(1.5) Add the following items in Note: (page 32 of 32) of Specification No. RTRN-035/2561;

5. PEA will also accept the type test certificates or test reports of the proposed transformers after signing the contract. In this case the Bidders have to submit test plan including information i.e. test procedure, laboratory and test date to PEA for consideration instead and the complete type test certificates and/or test reports shall be submitted for approval before shipment.

(2) Cancel the routine test items of Transformers in 1e.1 Routine Tests (page 31 of 36)

(3) Cancel the type test items of Transformers in 1e.2 Type tests (page 32 of 36)

(4) Cancel Item 2a Design data and guarantee of 22 kV and 33 kV Transformer (Annex C2-3.1 and Annex C2-3.2)

(5) Add a compact unit substation type in Table 1 Types of compact unit substations (page 5 of 36) as the following;

Item	Type	Rated Voltage (kV)	RMU construction		Transformer capacity (kVA)	DMS interfacing
			No. of cable feeder switch	No. of transformer feeder switch		
25	B24-1-500	24	2	1	500	Yes

(6) Add a compact unit substation type in 2a Design data and guarantee of Compact unit substation for 22 & 33 kV 50 Hz underground distribution system (Annex C2-1) as the following;





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2a Design data and guarantee of Compact unit substation for 22 & 33 kV 50 Hz underground distribution system (Annex C2-1) for Type B24-1-500

Invitation to Bid No.:

Description	Unit	Required data	Proposed Data
		22 kV	22 kV
Manufacturer	-	-	
Country of origin	-	-	
Type designation	-	-	
Indoor or outdoor installation	-	Outdoor	
Applied standard, publication number and year	-	-	
Rated power	kVA	-	
Number of phases	-	3	
Rated frequency	Hz	50	
Arc-fault test	Yes/No	Yes	
Class of enclosure	-	20	
Degree of protection of enclosure: excluding oil pan			
- High voltage room/compartment	-	IP 34 or better	
- Transformer room/compartment	-	IP 34 or better	
- Low voltage room /compartment	-	IP 34 or better	
Overall dimensions :			
- Length, maximum	mm	3,000	
- Width, maximum	mm	1,200	
- Height, maximum (excluding oil pan)	mm	2,700	
Net weight	kg	-	
Confirm to provide lifting facilities	Yes/No	Yes	
Fault indicators:			
- Manufacturer	-	-	
- Catalog number (to be attached)	-	-	
- Range of suitable overall diameter of cable	mm	-	
	kg	-	

EME
Net Weight
PEA



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2a Design data and guarantee of Compact unit substation for 22 & 33 kV 50 Hz underground distribution system (Annex C2-1) for Type B24-1-500

Invitation to Bid No.:

Description	Unit	Required data	Proposed Data
Catalog number (to be attached)	-	-	
Dimensional drawing number (to be attached)	-	-	
Packing detailed drawing number (to be attached)	-	-	

(7) Add an item of compact unit substation type in C3 Schedule of detail requirement as the following;

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
35	-	set(s)	<p>Compact unit substation, TYPE B24-1-500, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of:</p> <p>35.1 <u>1 unit</u> 24 kV SF₆ - insulated ring main unit, consisting of:</p> <p>35.1.1 <u>2 units</u> Cable feeders</p> <p>35.1.2 <u>1 unit</u> Transformer feeder</p> <p>35.2 <u>1 unit</u> Transformer, 22,000-416/240 V, 50 Hz, 500 kVA</p> <p>35.3 <u>1 lot</u> Low-voltage switchgear and metering</p> <p>35.4 <u>1 set</u> Current sensors, (1 set = 3 units of I-& CT)</p> <p>35.5 <u>1 set</u> Voltage sensors, (1 set = 3 units of I-& VT)</p> <p>35.6 <u>1 lot</u> Power supply</p> <p>35.7 <u>1 unit</u> Local control panel with FRTU</p> <p>Complete with control and data terminals and wiring; ample space for radio; antenna support; and communication cable entrance.</p> <p>Arrangement of the compact unit substation equipment shall be as shown on the Dwg. No. SB5-015/64001</p>





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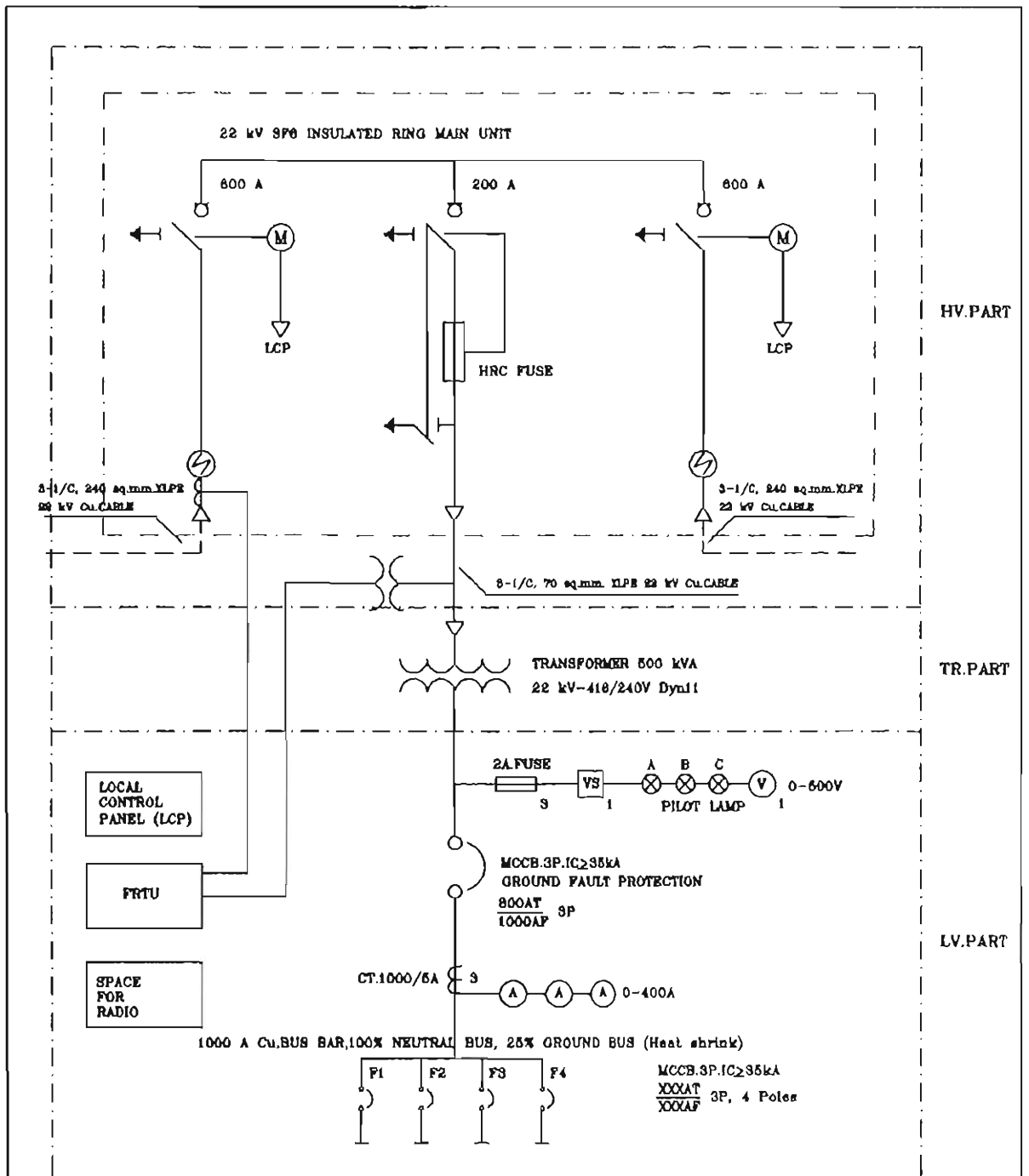
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(8) Add an item of compact unit substation type in C4 Price schedule as the following;

C4 Price schedule		Manufacturer:		Total Cost (see detail & conditions attached)
Invitation to Bid No.:		Country of origin:	Unit Cost (see detail & conditions attached)	
Item	PEA Material No.	Catalog No.	Description	Quantity
35	-		Compact unit substation, TYPE B24-1-500, for 22 kV 50 Hz underground distribution system, outdoor installation, consisting of: 35.1 1 unit 24 kV SF6 - insulated ring main unit, consisting of: 35.1.1 2 units Cable feeders 35.1.2 1 unit Transformer feeder 35.2 1 unit Transformer, 22,000-416/240 V, 50 Hz, 500 kVA 35.3 1 lot Low-voltage switchgear and metering 35.4 1 set Current sensors, (1 set = 3 units of I-& CT) 35.5 1 set Voltage sensors, (1 set = 3 units of I-& VT) 35.6 1 lot Power supply 35.7 1 unit Local control panel with FRTU	set(s)
				Total of item 35





PRELIMINARY

กองวิศวกรรมไฟฟ้าและเครื่องกล	ฝ่ายวิศวกรรม	การไฟฟ้าส่วนภูมิภาค
มิติเป็น	SINGLE LINE DIAGRAM	แบบเลขที่ สธ 5-015/64901
วันที่ 3.ก.ย. 2564..	COMPACT UNIT SUBSTATION (SLIM TYPE)	แผ่นที่
	500 kVA. 22 kV. - 416 / 240 V	จำนวน 1 แผ่น

2.4.11 Transformer for 22 kV



เอกสารเพิ่มเติมแนบท้ายรายละเอียดสเปค
(ADDENDUM)

เอกสารเพิ่มเติมแนบท้ายรายละเอียดสเปค (ADDENDUM) นี้ให้ถือเป็นส่วนหนึ่งของสเปคอ้างอิงเลขที่ RTRN-035/2561

การทดสอบ Lightning impulse test

กำหนดรายละเอียดการทดสอบ lightning impulse test เพิ่มเติมในหัวข้อ 1e.2.2 Test procedure of Type test and Short-circuit withstand test ข้อ (3) และ 1 e.5 Acceptance test items and acceptance test procedures ดังต่อไปนี้

(1) Test connections

For the lightning impulse test on the LV windings ($U_m \leq 1.1 \text{ kV}$), PEA will accept test connections as the following:

CASE 1:

The impulse test sequence is applied to each of line terminals of the tested winding in succession. The other line terminals of the transformer shall be earthed directly or through an impedance, or

CASE 2:

The impulse test is applied to all the LV terminals (including the LV neutral) connected together with the higher voltage terminals earthed.

(2) Test voltage

The standard lightning-impulse voltage and tolerances shall be in accordance with the IEC 60060-1 as the table below:

Description	HV	LV
Test voltage value	125 kV, peak $\pm 3\%$ (for 22 kV system) 170 kV, peak $\pm 3\%$ (for 33 kV system)	30 kV, peak $\pm 3\%$
Front time	1.2 μs $\pm 30\%$	
Time to half-value	50 μs $\pm 20\%$	
Relative overshoot magnitude	not exceed 10 %	

The minimum information on the waveshape in the test report shall consist of test voltage, front time (T1), time to half-value (T2) and overshoot.



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THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT

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เอกสารเพิ่มเติมแนบท้ายรายละเอียดสเปค 2

(ADDENDUM 2)

เอกสารเพิ่มเติมแนบท้ายรายละเอียดสเปค (ADDENDUM 2) นี้ให้ถือเป็นส่วนหนึ่งของสเปคอ้างอิงเลขที่ RTRN-035/2561

การทดสอบเพื่อการตรวจรับ (Acceptance test)

รายละเอียดการทดสอบเพื่อการตรวจรับนี้ ให้ใช้แทนหัวข้อ 1e.5.2 Acceptance test procedures ในสเปค

- (1) การทดสอบเพื่อการตรวจรับตามหัวข้อ 1e.5.1(1) ถึง (7) และหัวข้อที่ (11)

ให้สุ่มตัวอย่างจากหม้อแปลงที่จัดส่งในแต่ละงวด โดยสุ่มตัวอย่างแต่ละรายการ (Item) ที่มีหมายเลขรหัสผลิตภัณฑ์เดียวกัน เกณฑ์การพิจารณาให้เป็นไปตามตารางที่ 1 ดังนี้

ตารางที่ 1

จำนวนหม้อแปลงที่ จัดส่งแต่ละงวด ⁽¹⁾ (เครื่อง)	จำนวนตัวอย่าง ที่ส่งทดสอบเพื่อการตรวจรับ (เครื่อง)	จำนวนตัวอย่างสูงสุด ที่ยอมรับให้ทดสอบไม่ผ่าน (เครื่อง)
2 ถึง 15	2	0
16 ถึง 25	3	0
26 ถึง 90	5	0
91 ถึง 150	8	0
151 ถึง 500	13	1
มากกว่า 500	20	1

⁽¹⁾ จำนวนหม้อแปลงที่จัดส่งในแต่ละงวด แยกตามหมายเลขรหัสผลิตภัณฑ์

ทั้งนี้ หากจำนวนหม้อแปลงที่ไม่ผ่านการทดสอบมากกว่าจำนวนตัวอย่างสูงสุดที่ยอมรับให้ทดสอบไม่ผ่านตามตารางที่ 1 ให้คณะกรรมการตรวจรับพัสดุฯ ดำเนินการตามขั้นตอนการตรวจรับพัสดุในหลักเกณฑ์การตรวจรับพัสดุ กพภ.

- (2) การทดสอบเพื่อการตรวจรับตามหัวข้อ 1e.5.1(8), (9) และ (10) สำหรับงวดแรกของสัญญา ที่ผ่านการทดสอบในข้อ (1) มาแล้ว

2.1 ให้ทดสอบเพื่อการตรวจรับในแต่ละหัวข้อ โดยพิจารณาจากจำนวนหม้อแปลงทั้งหมดในสัญญาในแต่ละรายการ (Item) ที่มีหมายเลขรหัสผลิตภัณฑ์เดียวกัน ตามตารางที่ 2 ดังนี้



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THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT

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ตารางที่ 2

จำนวนหม้อแปลงทั้งหมด ในสัญญา ⁽²⁾ (เครื่อง)	หัวข้อการทดสอบเพื่อการตรวจรับที่ต้องทดสอบ		
	Temperature-rise test	Full wave lightning impulse test	Short-circuit withstand test
0 ถึง 9	ไม่ทดสอบ	ไม่ทดสอบ	ไม่ทดสอบ
10 ถึง 29	ทดสอบ	ไม่ทดสอบ	ไม่ทดสอบ
30 ถึง 189	ทดสอบ	ทดสอบ	ไม่ทดสอบ
190 ขึ้นไป	ทดสอบ	ทดสอบ	ทดสอบ

⁽²⁾ จำนวนหม้อแปลงทั้งหมดในสัญญา แยกตามหมายเลขรหัสพัสดุ

2.2 ให้ทดสอบเพื่อการตรวจรับกับหม้อแปลงที่ส่งในงวดแรกของสัญญา โดยสุ่มตัวอย่างแต่ละรายการ (Item) ที่มีหมายเลขรหัสพัสดุเดียวกัน และใช้ตัวอย่างเดียวกันกับตัวอย่างที่ผ่านการทดสอบตามหัวข้อ 1e.5.1(1) ถึง (7) และหัวข้อที่ 1e.5.1(11) มาแล้ว เพื่อลดระยะเวลาการทดสอบ ให้สามารถแยกทดสอบในแต่ละหัวข้อโดยใช้หม้อแปลงตัวอย่างที่แตกต่างกันได้ เช่น หากทดสอบหัวข้อ 1e.5.1(8) (9) และ (10) ให้สามารถใช้ 3 ตัวอย่าง (3 Serial numbers) ได้ โดยเกณฑ์การพิจารณาให้เป็นไปตามตารางที่ 3 ดังนี้

ตารางที่ 3

หัวข้อการทดสอบตรวจรับ (1e.5.1)	จำนวนตัวอย่าง ที่ส่งทดสอบเพื่อการตรวจรับ (เครื่อง)	จำนวนตัวอย่างสูงสุด ที่ยอมรับให้ทดสอบไม่ผ่าน (เครื่อง)
(8) Temperature-rise test	1	0
(9) Full wave lightning impulse test	1	0
(10) Short-circuit withstand test	1	0

ทั้งนี้ หากจำนวนหม้อแปลงที่ไม่ผ่านการทดสอบมากกว่าจำนวนตัวอย่างสูงสุดที่ยอมรับให้ทดสอบไม่ผ่านตามตารางที่ 3 ให้คณะกรรมการตรวจรับพัสดุฯ ดำเนินการตามขั้นตอนการตรวจรับพัสดุในหลักเกณฑ์การตรวจรับพัสดุ กฟภ.

หลังจากการทดสอบในแต่ละหัวข้อ คู่สัญญาจะต้องทำให้หม้อแปลงที่นำไปเป็นตัวอย่างทุกตัว สมบูรณ์พร้อมใช้งานเหมือนเดิมก่อนส่งคืนให้กับ PEA โดยไม่คิดค่าใช้จ่าย

หมายเหตุ

กรณีที กฟภ. เป็นผู้ประมาณการจัดหาหม้อแปลงที่มีพิกัดกำลังไฟฟ้าสูงกว่า 250 kVA ให้ทดสอบเพื่อการตรวจรับตามหัวข้อ 1e.5.1(1) ถึง (6) เท่านั้น



**THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS
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Invitation to Bid No.:

C Material, equipment, and specifications for THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT

C1 General material and packing instructions

Additional to the general instructions, the following shall be observed:

1a Scope

These specifications cover three-phase transformers, oil-immersed, natural self-cooled, power range from 50 kVA to 2,000 kVA, designed and constructed to withstand without damage the thermal and dynamic effects of external short circuits, suitable for outdoor installation on 22 kV and 33 kV 50 Hz distribution systems.

1b Standards

The transformers shall be manufactured and tested in accordance with the following standards:

Thailand Industrial Standard (TIS)

TIS 384: 2543 Power Transformers

International Electrotechnical Commission (IEC)

IEC 60076-1:2011 Power transformers– Part 1: General

IEC 60076-2:2011 Power transformers – Part 2: Temperature rise for liquid-immersed transformers

IEC 60076-3:2013 Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air

IEC 60076-5:2006 Power transformers – Part 5: Ability to withstand short circuit

IEC 60296: 2012 Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

International Organization for Standardization

ISO 12944-5:2007 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems

LV bushings shall be in accordance with the DIN 42530. HV bushings shall be in accordance with the DIN 42531.

And all other relevant standards, unless otherwise specified in these specifications.

PEA will also accept the transformers and accessories tested in accordance with the later edition of the above standards.



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PEA will also accept the type test report in accordance with the previous edition of the above standards, if there is no significant change in any test items or no additional test item(s) compared with the above standards. On the other hand, if there is significant change in any test items or there are any additional test items, the previous edition type test report with the additional test report(s) of the significant change test item(s) and/or additional test item(s) will be also accepted.

1c Principal requirement

1c.1 Service conditions and installation

The transformers shall be designed and constructed for outdoor installation and operation under the following conditions:

Altitude	: up to 1,000 m above sea level
Ambient air temperature	: 50°C, maximum
	: 40°C, monthly average, of the hottest month
Relative humidity	: up to 94 %
Climate condition	: tropical climate

Table 1 Transformer installation

Transformer Rating (kVA)	Installation
50 – 250	on concrete pole and on platform
315 – 1,500	on platform and on concrete foundation
2,000	on concrete foundation

1c.2 Oil preservation system

The transformers of **50 kVA to 500 kVA** shall be permanently sealed and completely oil filled system (without gas cushion) type (usually corrugated tank). The transformer tank cover shall be bolt tightened to the tank with suitable gasket sealing.

The transformers of **630 kVA to 2,000 kVA** shall be conservator system type.

1c.3 Rating

1. Rated power

The rated power, on continuous operation, for transformers shall be as follows:

50 kVA	250 kVA	500 kVA	1,000 kVA	2,000 kVA
100 kVA	315 kVA	630 kVA	1,250 kVA	
160 kVA	400 kVA	800 kVA	1,500 kVA	



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2. Rated voltages

The rated voltage of windings is given in **Table 2**.

Table 2 Rated voltage

Rated Primary Voltage	Rated Secondary Voltage
22 kV, 33 kV	416/240 V

3. Rated frequency: 50 Hz

1c.4 Core and windings

The cores and windings of transformers shall be as follows:

Table 3 Core and windings

Transformer Rating (kVA)	Construction of Core	HV and LV Windings shall be made of	Construction of Windings	
			HV winding	LV winding
50-2,000	According to manufacturer's standard	copper only	According to manufacturer's standard	According to manufacturer's standard

1c.5 Tappings

The primary windings of transformers shall be provided with full capacity of externally-operated off-circuit tap changers.

Tapping range: $\pm 2 \times 2.5\%$ of rated primary voltage

The externally-operated off-circuit tap changer shall be designed for de-energized operation with the operating handle brought out through the cover of the tank. The operating handle shall have provision for locking and shall give visual indication of the tapping position without unlocking.

The tap changer shall have a locking device to prevent improper use. The operating handle shall be rotated in clockwise direction from a high tap voltage to a lower tap voltage. The tap changer shall be provided with stops to identify the highest and lowest tap position. The tap changer positions shall be identified by the numbers in sequence. The number "1" shall be designated to the highest tap voltage. Consequently the number "5" indicates the lowest tap voltage. These identifications shall be in perfect correspondence to those indicated in the connection diagram on the nameplate. All five positions of the tap changer shall be operative positions.

The tap positions shall be indelibly marked with weather-proof paint and in a color which shall present distinctive contrast to the surrounding material.

The operating handle of tap changer shall be made from non-corrosion metal. Plastic is not acceptable.



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1c.6 Connection symbol

50 kVA to 2,000 kVA transformers shall have connection symbol Dyn 11.

1c.7 Losses and Short - circuit impedance

The specified or guaranteed losses plus positive tolerance, for each transformer unit shall not be more than the losses are shown in the **Table 4**.

Short-circuit impedance shall be measured on the principle tapping of 22 or 33 kV at ambient temperature then corrected to 75°C.

Short-circuit impedance of the offered transformers shall be as specified in the **Table 4** and have tolerance within $\pm 10\%$ except for transformer rating 500 kVA, the short-circuit impedance at 75°C of transformer rating 500 kVA shall be 6.5 or more.

Table 4 Losses and short circuit impedance

Transformer Rating (kVA)	Watt Loss (W)			Short-circuit Impedance at 75°C (%)
	No-load loss, for system voltage of :		Load loss at 75°C	
	22 kV	33 kV		
50	110	170	875	4
100	180	260	1450	4
160	260	370	2000	4
250	360	520	2750	4
315	440	630	3250	4
400	520	750	3850	4
500	610	900	4600	6.5 or more
630	680	1050	5600	6
800	800	1150	7000	6
1,000	940	1300	9000	6
1,250	1150	1530	11000	6
1,500	1380	1850	13200	6
2,000	1800	2140	18000	6

1c.8 Limits of temperature-rise, above 50°C ambient temperature

Of top oil : not exceeding 50 K

Of winding : not exceeding 55 K



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1c.9 Insulation level

The insulation level of HV windings, LV windings and connected parts of transformers shall be as specified in the **Table 5**:

Table 5 Insulation level

Nominal System Voltage (kV, r.m.s.)	Insulation Level	
	Impulse Test Voltage Full-wave (kV, peak)	Power Frequency Test Voltage, 1-min (kV, r.m.s.)
22	125	50
33	170	70
0.416/0.24	30	10

1c.10 Bushings

1. Number and location

Each transformer shall have three (3) high-voltage bushings and four (4) low-voltage bushings located on the cover of the tank.

Secondary neutral point of transformer shall be brought out by separate-insulated bushing(s) and loaded with rated current.

The HV bushings shall not be completed with the arcing horns.

2. Material

Transformer bushings shall be made of good commercial-grade wet-process porcelain.

The entire porcelain surface of the bushings that will be exposed after assembly shall be glazed.

The color of the glaze shall be brown.

3. Electrical characteristics

Transformer bushings shall be capable of withstanding the impulse and low-frequency voltage specified in the **Table 6**:

Table 6 Electrical characteristics

Bushing	Impulse Full Wave (kV, peak)	Low-frequency, 50 Hz (kV, r.m.s.)	
		Dry 1-minute	Wet 10-second
High-voltage bushings for 22 kV system	125	50	50
High-voltage bushings for 33 kV system	170	70	70
Low-voltage bushings	30	10	10



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4. Minimum Clearance

Safety clearance of Transformer bushings shall comply with minimum Clearance Criterion, which measurement between live part to live part or live part to ground shall be as follows.

- At least 225 mm for 22 kV System
- At least 320 mm for 33 kV System

5. Test report

The bidders have to submit the test report of bushing with the bid in order to confirm the electrical characteristic in **Table 6 Electrical characteristics**, the bidders who cannot submit will be rejected. The test of bushing can be conducted by manufacturer or third party laboratories.

1c.11 Terminal connectors

HV bushings shall be equipped with solderless clamp type connectors for aluminium conductor diameter range from 7.5 mm to 12.6 mm (sizes 35-95 mm²).

Only for 50 kVA to 1,250 kVA transformers: LV bushings shall be equipped with terminal pad connectors (stud type connectors are preferable), of high conductivity bronze and hot-tin dipped. The terminal pads shall be drilled in accordance with NEMA Standards (9/16" holes on 1 3/4" centers); each hole shall be furnished with one (1) bolt M12 x 60 mm (of at least 50 mm thread length), one (1) nut, two (2) flat washers, and one (1) lock washer; details of terminal pads shall be according to Drawing No. SA4-015/47002. The connectors shall be provided with mounting hardware (bolts, nuts, washers, and lock washers) of stainless steel or better.

Only for 1,500 kVA to 2,000 kVA transformers: LV bushings shall be equipped with solderless clamp type connectors (stud type connectors are preferable), of high conductivity bronze and hot-tin dipped, for aluminium and copper conductor sizes, and number of circuits take off shall be as **Table 7**:

Table 7 Terminal connectors for 1,500 kVA to 2,000 kVA transformers

Transformer Rating (kVA)	Applicable to Aluminium and Copper Conductors		Number of Circuits
	diameter range (mm)	sizes (mm ²)	
1,500	18.4 - 29.2	240 - 500	4
2,000	18.4 - 29.2	240 - 500	6

The connectors shall be provided with mounting hardware (bolts, nuts, washers, and lock washers) of stainless steel or better. The details of connectors shall be according to Drawing No. SA4-015/47002.



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1c.12 Tank and Tank finish

Tank and cover shall be constructed of welded steel plate suitable reinforced. The joints between the tank and cover shall be provided with suitable flanges properly bolted together with gaskets.

Tank cover shall have 90° downward bent edges on all sides to protect the gasket under the top cover from direct exposure to weather.

Gaskets between metal surfaces shall be set in grooves or held in position by retainers so arranged that all parts are bolted metal-to-metal. The gaskets shall be made of resilient material which will not deteriorate under the action of hot oil and will remain oil-tight. Gaskets of such material which can be easily damaged by overpressing are not acceptable.

The transformer tank shall be finished with mounting bracket for surge arrester (Surge arrester polymer housing type supplied by PEA) and shall be furnished with three (3) earthing terminal provided for ground leads of surge arrester, see Drawing No. SA4-015/50008.

The bidders have to give the transformer's tank dimensions which passed type test in **2a Performance data and guarantee of three-phase transformer (Page 29 of 32)**.

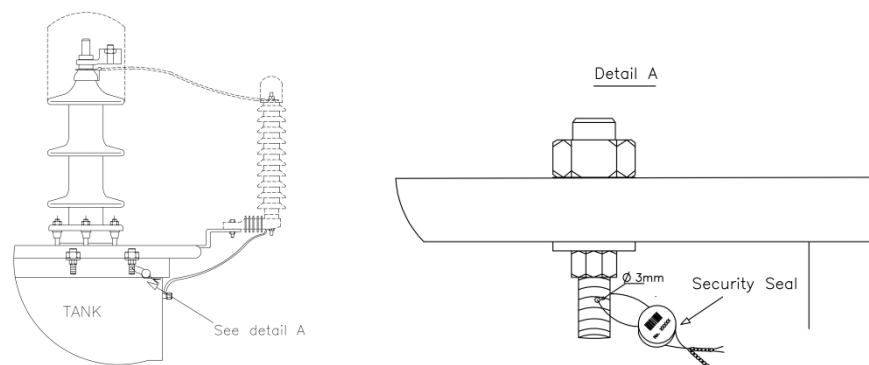
Tolerance of the transformer's tank dimensions for the purposed transformer shall be within ± 3 percent of the declared dimensions which given by the bidders in above information, Otherwise shall be rejected.

The distance between tank cover (Top plate) and fins which is installed the earthing terminal for surge arrester shall not less than 200 mm.

The manufacturer's serial number shall be dented on transformer tank cover.

The manufacture shall prepare 3 mm diameter holes for security seals threading. The first position, the hole shall be drilled at the right last bolt which fix tank and cover of transformer and the second position, the hole shall be drilled at the top right of transformer nameplate as **Figure 1**.

The security seals will be installed by PEA after any transformers pass the witness test or acceptance test or others depend on PEA's committee.





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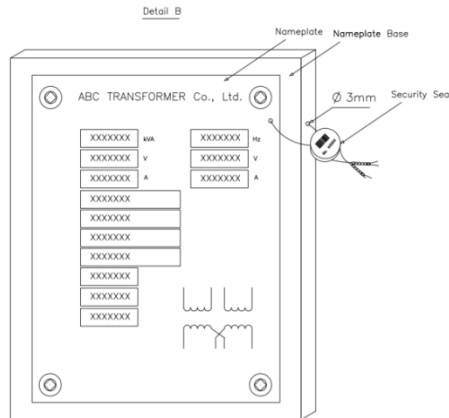
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Note : The hole shall be drilled by manufacturer and thread with security seal by PEA

Figure 1 Security seal installation

1c.12.1 Painting system

1. Interior surface

Interior surface shall be finished oil resistant paint or vanish.

2. Exterior surface

The painting system will be suitable for an exterior servicing at medium atmospheric-corrosivity category is as C3, and system number is as A.3.08 in accordance with ISO 12944-5 Table A.3.

The coating system shall be in accordance with the ISO 12944-5 as following:

- Primer coat: The number of coats is one (1) or two (2) coats of Epoxy (Misc) Anti-Corrosive Primer, the dry film thickness shall not less than 80 µm.
- Subsequent coat(s): The number of coats is two (2) to three (3) of Epoxy Intermediate and Polyurethane topcoat with RAL 7036 gray color.
- The total number of coats is two (2) to four (4) coats and the dry film thickness of coating system shall not less than 160 µm.

3. Dry film thickness test and test report

The dry film thickness shall be spot checked for each layer of coating. The position of spot checks is specified as **Figure 2** for transformers of permanently sealed type, and **Figure 3** for transformers of conservator system type.



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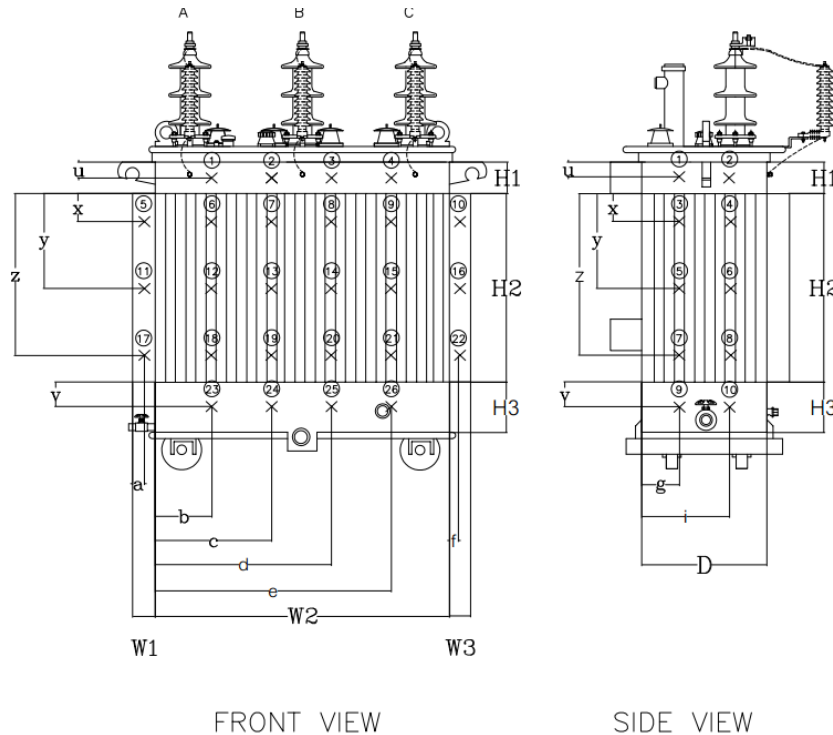


Figure 2 The position of spot checking for transformers of permanently sealed type.

The distance for spot checking of permanently sealed type is as **Table 8**:

Table 8 Distance for spot checking of permanently sealed type

Symbols	Length	Symbols	Length
a	About 1/2 of width (W1)	u	About 1/2 of height (H1)
b	About 1/5 of width (W2)	v	About 1/2 of height (H3)
c	About 2/5 of width (W2)	x	About 1/4 of height (H2)
d	About 3/5 of width (W2)	y	About 2/4 of height (H2)
e	About 4/5 of width (W2)	z	About 3/4 of height (H2)
f	About 1/2 of width (W3)		
g	About 1/3 of depth (D)		
i	About 2/3 of depth (D)		



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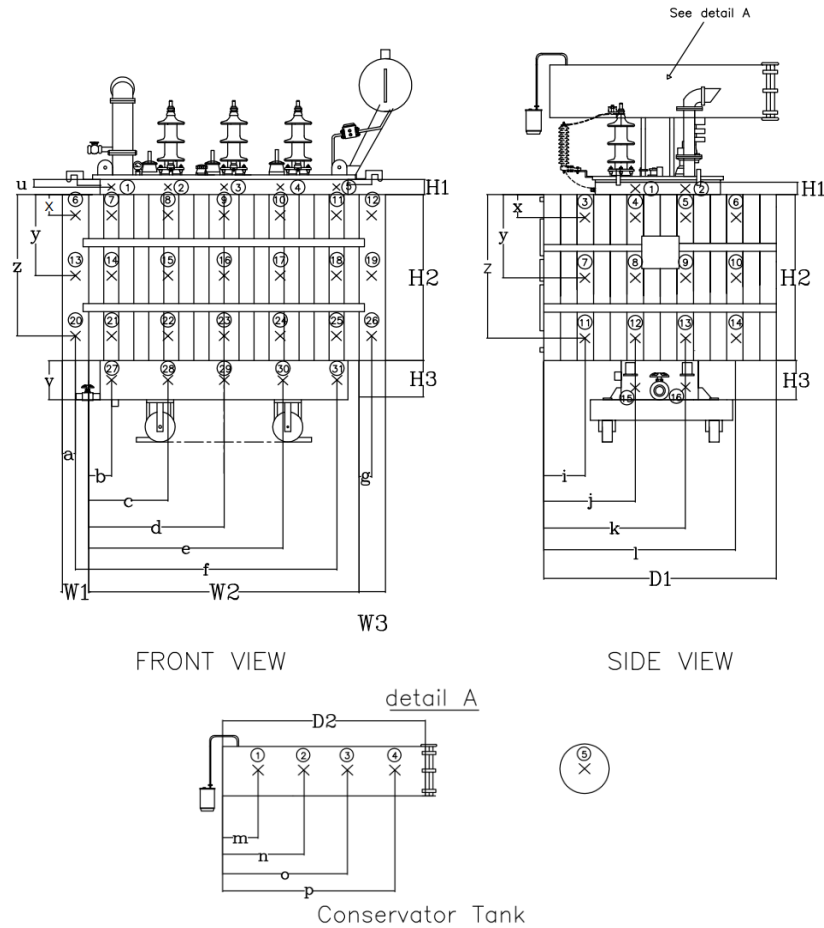


Figure 3 The position for spot checking for transformers of conservator system type.

The distance for spot checking of conservator system type is as Table 9:

Table 9 Distance for spot checking of conservator system type

Symbols	Length	Symbols	Length
a	About 1/2 of height (W1)	m	About 1/5 of depth (D2)
b	About 1/6 of height (W2)	n	About 2/5 of depth (D2)
c	About 2/6 of height (W2)	o	About 3/5 of depth (D2)
d	About 3/6 of height (W2)	p	About 4/5 of depth (D2)
e	About 4/6 of height (W2)	u	About 1/2 of height (H1)
f	About 5/6 of height (W2)	v	About 1/4 of width (H3)
g	About 1/2 of height (W3)	x	About 1/4 of width (H2)
i	About 1/5 of depth (D1)	y	About 2/4 of width (H2)
j	About 2/5 of depth (D1)	z	About 3/4 of width (H2)
k	About 3/5 of depth (D1)		
l	About 4/5 of depth (D1)		



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The bidders have to submit the test report, conducted by the acknowledged testing laboratories or manufacture, with the bid. The Item offered without submitting the dry film thickness test report shall be rejected.

The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.

1c.12.2 Dry film thickness test report

The required information in dry film thickness test report shall be at least the following items:

- (1) Transformer information
 - 1) Manufacturer's name
 - 2) Model
 - 3) Serial number
 - 4) Number of phase
 - 5) Rated voltage of the high-voltage winding
 - 6) Rated voltage of the low-voltage winding
 - 7) Rated frequency
 - 8) Rated power
 - 9) Rated current of the high-voltage winding
 - 10) Rated current of the low-voltage winding
- (2) Panted information
 - 1) Coating system (flow coating or spraying)
 - 2) The information for each coating (Primer coat, Subsequent coat, Top coat) minimum as following:
 - Type of material
 - Paint Manufacturer
 - Require minimum dry film thickness (μm) as specified
 - Actual dry film thickness (μm) (3 reading per 1 spot checks)
 - 3) Technical Data of coats
 - 4) Painting Procedure

1c.12.3 Acceptance test procedure of dry film thickness test

The total dry film thickness of coating shall be measured by contractor for acceptance testing and witness by the PEA's acceptance committee. Total dry film thickness shall be not less than 160 μm according to ISO 12944-5. PEA will randomly select the samples of transformer only from the first lot. The number of samples and criteria for consideration shall be according to **Table 10**.

PEA reserve the right to send representative to inspect and witness test.

The cost of all tests and reports shall be borne by the manufacturers/contractor.



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1c.13 Marking

PEA's code number and word "**SHORT CIRCUIT WITHSTAND**" shall be painted, in orange, on the transformer tank (for transformer having no conservator) or on the conservator tank (for transformer having conservator) at the position that enables a clear observation, and also be legibly and durably inscribed on the metal part of nameplate. The code number and dimensions of each letter to be marked shall be given by PEA after the final of bid consideration.

1c.14 Accessories

The 50 kVA to 2,000 kVA transformers shall be furnished and equipped with the following accessories:

1. HV and LV bushings, with terminal connectors
2. Bird guard cap (bushing cover), ultra-violet and track resistant material, e.g. polypropylene, neoprene, etc; which is suitable for exposure to sunlight
3. Earthing terminal for surge arrester, with solderless clamp type connector suitable for flexible copper insulated ground lead size 16 mm^2 , 430 mm long. (See Drawing No. SA4-015/50008)
4. Tap changer
5. Thermometer pocket, transformers shall have a thermometer pocket to allow the measuring of the top-oil temperature. This pocket shall be placed as shown in the EN 50216-4 (type A1). The pocket shall be provided with a corrosion-proof cap. The thread shall be protected with silicone-grease. Dimensions of the thermometer pocket in mm are shown as **Figure 4**.

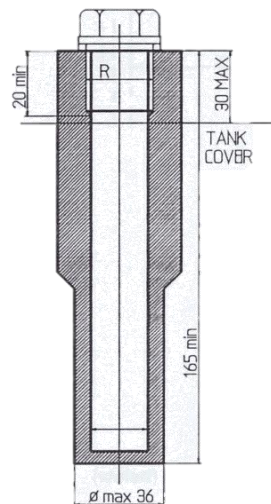


Figure 4 Dimensions of thermometer pockets

6. Nameplate with connection diagram
7. Oil drain valve with plug or cap, installed at the lower part of the tank
8. Sludge drain plug, installed at the bottom of the tank



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9. Earthing terminal, with solderless clamp type connector suitable for steel stranded conductor diameter of 9.0 mm (size 50 mm²); complete with lockwasher of stainless steel or better.
10. Lifting lugs
11. Lifting eyes on the cover
12. Oil level gauge
13. Compression type cable lug, for aluminium conductor diameter of 7.5-9.0 mm (sizes 35-50 mm²), suitable for connecting between HV bushing and surge arrester lead conductor.
14. Only for 50 kVA to 250 kVA transformers: Pressure relief valve on the tank cover, oil filling plug on the tank cover, and supporting lugs for hanging the transformer tank to pole by using two (2) M16 machine bolts.
The lugs shall have 600 mm spacing; 500 mm or 400 mm spacing may be used when tank height will not permit the 600 mm dimension. (See Drawing No. SA4-015/50008)
Only for 315 to 500 kVA transformers: Pressure relief valve on the tank cover, and oil filling plug on the tank cover.
Only for 630 kVA to 2,000 kVA transformers: Pressure relief valve on the tank cover, oil conservator with dehydrating breather and oil level gauge. The cylinder of dehydrating breather shall be of transparent glass. The dehydrating breather shall be easy replaced and filled with silica-gel not less than 1.0 kg.
15. Only for 315 kVA to 2,000 kVA transformers: Transport rollers
16. Only for 1,000 kVA to 2,000 kVA transformers:
 - (a) Dial type thermometer with adjustable contact(s)
 - (b) Double float Buchholz relay having two (2) contacts (for alarm and tripping)
17. Other necessary accessories according to manufacturer's design.

1c.15 Initial oil filling

The transformers shall be supplied with initial oil filling. The oil shall be according to IEC 60296, high-quality, clean and dry.

The oil shall be free from Polychlorinated biphenyls (PCB).

1c.16 Nameplate

The following minimum nameplate information shall be legibly and durably inscribed on the metal part of nameplate:

- (1) Manufacturer's name
- (2) Manufacturer's serial number
- (3) Year of manufacture
- (4) PEA's code number



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- (5) Contract number and/or PO number
- (6) Number of phases
- (7) Rated frequency in Hz
- (8) Rated power in kVA
- (9) Rated voltage in V
- (10) Rated current in A
- (11) Rated secondary short-circuit withstand current in kA r.m.s.
- (12) Tapping voltages in V
- (13) Connection symbol
- (14) Short-circuit impedance in %
- (15) Connection diagram
- (16) Type of cooling
- (17) Oil quantity in liters
- (18) Drain oil quantity in liters (for permanently sealed type)
- (19) Total weight in kg
- (20) Wording “**SHORT CIRCUIT WITHSTAND**”
- (21) Material of HV and LV winding such as copper winding, cooper foil etc.

1c.17 Bushing location and terminal markings

Bushing shall locate as shown in the figures below:

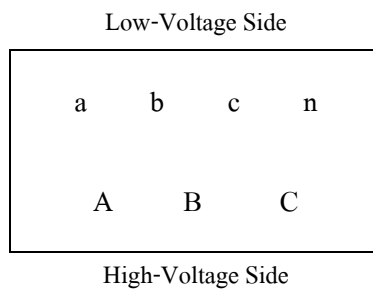


Figure 5 50-250 kVA Tank top view

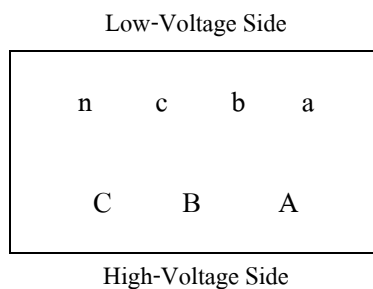


Figure 6 315 -2,000 kVA Tank top view



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The letters A, B, C, a, b, c, and n shall be durable marked on transformer tank beside bushings consequently. The height of the symbols shall not less than 30 mm.

Mark by sticker is not accepted.

1c.18 Mass

For 50 kVA to 160 kVA transformers: Mass of complete transformer with oil and accessories shall not be more than 1,000 kg.

For 250 kVA transformers: Mass of complete transformer with oil and accessories shall not be more than 1,200 kg.

Tolerance of the mass of proposed complete transformers with oil shall be within ± 5 percent of the declared mass of transformer which passed type test given by the bidders in 2a Performance data and guarantee of three-phase transformer (Page 28 of 32) but the maximum mass shall not exceed the above allowable mass.

If the mass of complete transformers with oil more than ± 5 percent of the declared mass or exceed the above allowable mass, the transformers shall be rejected.

1d Packing

For transformers manufactured outside the territories of Thailand, each transformer shall be seaworthy packed in individual export crate or wooden case which will not be returned.

For transformers manufactured within the territories of Thailand, each transformer shall be packed in individual crate or wooden case which will not be returned.

Only for 50 kVA to 160 kVA transformers for 22 kV systems and 50 kVA to 100 kVA transformers for 33 kV systems, each crate or wooden case shall be strong enough for stacking over with at least another one.

If the crate or wooden case is made of rubber wood (Yang-para), the wooden parts shall be treated with wood preservative.

The details of wood treatment shall be described.

1e Tests and test reports

1e.1 Routine test

Each transformer shall pass the manufacturer's standard routine tests, and also pass the following tests in accordance with the relevant standards:

- (1) Measurement of winding resistance (IEC 60076-1)
- (2) Measurement of voltage ratio and check of phase displacement (IEC 60076-1)
- (3) Measurement of short-circuit impedance and load loss (IEC 60076-1)
- (4) Measurement of no-load loss and current (IEC 60076-1)



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- (5) Applied voltage test (IEC 60076-1 and IEC60076-3)
- (6) Induced voltage withstand test (IEC 60076-1 and IEC60076-3)

The Item offered without submitting the list of routine test report shall be rejected.

1e.2 Type test and Short-circuit withstand test

For transformers rating of 50 kVA to 250 kVA and the reference transformers

For transformers rating of 50 kVA to 250 kVA and the reference transformers, these transformers shall be passed all items of type test and short circuit withstand test according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**. The test result shall be included in one (1) test report. The test report shall be issued or approved by the same acknowledged independent testing laboratory according to **1e.3 Acknowledged independent testing laboratories**, otherwise will be rejected.

For the others rating which are not the reference transformers

The transformers shall be passed the following type tests in accordance with the relevant standards:

- (1) Temperature-rise test (IEC 60076-2)
- (2) Full wave lightning impulse test (IEC 60076-1 and IEC 60076-3)
- (3) Measurement of no-load loss and current at 90 % and 110 % of rated voltage (IEC 60076-1)

Type test shall be made on only one (1) unit of each rating. The test result shall be included in one (1) test report. The test report shall be issued or approved by the same acknowledged independent testing laboratory according to **1e.3 Acknowledged independent testing laboratories**, otherwise will be rejected.

1e.2.1 Short-circuit withstand test

The transformers shall be designed and constructed to withstand without damage by the thermal and dynamic effects of the external short circuit in accordance with the IEC 60076-5.

The duration of the current I to be used for the calculation of the thermal ability to withstand short circuit shall be 2 s and the initial temperature for calculation shall be 105°C.

Test procedure of short-circuit withstand test shall be according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**.

The total number of tests shall be three made in a different position of the tap-changer according to IEC 60076-5. The duration of each test shall be 0.5 s



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1e.2.2 Test procedure of Type test and Short-circuit withstand test

Each transformer, as delineated by its own unique serial number, is required to pass a complete type test and short-circuit withstand test following the procedures listed below:

- (1) Prior to short circuit testing, each individual transformer must pass the routine test, measurement of no-load loss and current at 90 % and 110 % of rated voltage and temperature-rise tests. Criteria for the temperature-rise test is presented in **1c.8 "Limits of temperature-rise"**
- (2) Upon successfully passing the temperature-rise test, each transformer must then successfully pass a short circuit withstand test
- (3) Finally, lightning impulse shall be tested and all the routine tests including measurement of no-load loss and current at 90 % and 110 % of rated voltage shall be repeated. Each transformer shall pass the routine test, measurement of no-load loss and current at 90 % and 110 % of rated voltage and lightning impulse test.

The impulse test sequence is applied to each of line terminal of the tested winding in succession. The other line terminals of the transformer shall be earthed directly or through an impedance.

If the laboratories intend to use PEA's power system as power supply for the short-circuit withstand testing, the transformer's manufacturer or the laboratories shall submit technical documents of the test such as test procedure, test circuit diagram, test and protection equipment, testing date and calculation of voltage drop in PEA's power system caused by the test to PEA for consideration and approval before the tests are proceeded.

It is responsible of the laboratories to compensate all failure or damage occurred to PEA's power system caused by the test.

PEA reserves the right to send representatives to witness the test.

The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.

1e.2.3 Type test and short circuit test report

For 50 to 250 kVA transformers, the bidders have to submit the type test and short circuit test report of the identical transformer (purchased transformer) with the bid, otherwise shall be rejected

For transformers which rated power more than 250 kVA, the bidders have to submit the following document with the bid, otherwise shall be rejected.

- (1) The type test report of the identical transformer (purchased transformer), and
- (2) The short circuit test report of identical transformer (purchased transformer) or the reference transformer according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test**, and
- (3) The calculation report⁽¹⁾ and others information according to **APPENDIX 1**.

Note

- ⁽¹⁾ In case of the bidders submit the short circuit test report of the reference transformer, calculation report and others information shall be submitted.



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The type test and short-circuit withstand test report of the transformers which are conducted or inspected by Thailand's national laboratories/institutes shall be valid within five (5) years count from the issued date in the test reports to the bid closing date.

For the type test and short-circuit withstand test report of the transformers which are conducted or inspected by laboratories/institutes, with in other countries shall be valid within ten (10) years count from the issued date in the test reports to the bid closing date.

PEA will also accept other documents instead of the type test and short-circuit withstand test reports in the following conditions:

- (1) In case the proposed transformer has been supplied to PEA and get the order from PEA's Procurement Department or Substation Work Department or Transmission and Distribution System Work Department (from PEA's head office), the Purchase Order (PO) or Contract with List of suppliers or Proposal form can be submitted, or
- (2) In case the proposed transformer has been registered for PEA Product Acceptance, the not-expired registration certificate counted to the bid closing date can be submitted, or
- (3) In case the proposed transformer has been registered for Product lists for substation turnkey project, the not-expired registration certificate counted to the bid closing date can be submitted instead

However the document in case (1), (2) and (3) shall be proved that the transformer specified in the PO or Contract with List of suppliers or Proposal form or registration certificate shall be the same product, type/model and all ratings as the proposed transformer for this bid.

The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.

1e.3 Acknowledged independent testing laboratories

The type test and short-circuit withstand test shall be conducted or inspected by the acknowledged testing laboratories/institutes as follows:

- (1) Laboratories/institutes which are members of the Short-circuit Testing Liaison (STL) or independent laboratories/institutes which are accredited according to TIS 17025 or ISO/IEC 17025 with the scope of accreditation covered the relevant test items, standards and equipment. The certification and scope of accreditation of the independent laboratories/institutes shall be submitted with the bid for consideration.

The bidders or manufacturers who are accredited according to TIS 17025 or ISO/IEC 17025 preferring to carry out the type tests and short-circuit withstand test of the transformers with the laboratories or by the manufacturers themselves, the tests shall be inspected by Thailand's



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national laboratories, institutes, universities and electric utilities in (2) and other laboratories, institutes, universities or electric utilities approved by PEA.

- (2) Thailand's national laboratories, institutes, universities and electric utilities, as follow:
 - Electricity Generating Authority of Thailand (EGAT)
- (3) Other laboratories, institutes, universities or electric utilities approved by PEA. In this case, the detail of the test facilities of the laboratories shall be submitted to PEA for approval before proceeding the tests and before the bid closing date. PEA reserves the right to send representatives to inspect and witness the tests with the cost of the bidders or manufacturers.

1e.4 The information in the Test report

The minimum information of the transformer in the type test and short-circuit withstand test report shall be the following items:

1. Transformer information

- (1) Manufacturer's name
- (2) Model
- (3) Manufacturer's serial number
- (4) Number of phase
- (5) Rated voltage of the high-voltage winding
- (6) Rated voltage of the low-voltage winding
- (7) Rated voltage ratio
- (8) Rated frequency
- (9) Rated power
- (10) Rated current of the high-voltage winding
- (11) Rated current of the low-voltage winding
- (12) Short-circuit impedance at 75°C
- (13) Connection symbol
- (14) Cooling method
- (15) Total mass
- (16) Mass of core and winding
- (17) Oil quantity
- (18) Highest voltage for equipment applicable the high-voltage winding
- (19) Highest voltage for equipment applicable the low-voltage winding
- (20) Rated insulation level
- (21) Type of construction
- (22) High-voltage winding type and material



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- (23) Low-voltage winding type and material
- (24) Cross-section of the conductor in the high-voltage winding
- (25) Cross-section of the conductor in the low-voltage winding
- (26) Number of strands per turn of high voltage winding
- (27) Number of strands per turn of low voltage winding
- (28) Number of strands radially across the layer (for all turns) of high voltage winding
- (29) Number of strands radially across the layer (for all turns) of low voltage winding
- (30) Total number of turns per phase
- (31) Number of turns each tap

2. Drawing

- (1) Overall dimensions of transformer
- (2) Tank dimension
- (3) Drawing of cross section area of core
- (4) Drawing of active part
- (5) Drawing which show the core and coil information according to **Figure 7**

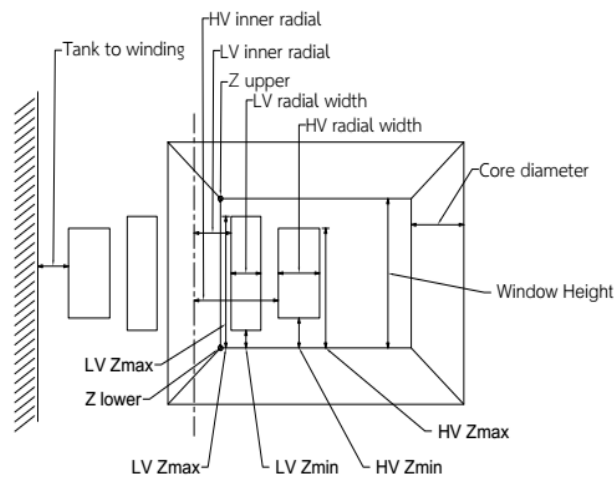


Figure 7: Core and coil constructions.

3. Photograph of transformers

The color photograph which reveal transformer construction for out-of-tank inspection before and after short-circuit withstand test shall be in the short-circuit withstand test report.

In case the information in the reports are not completed according to the above requirement, the bidders will be rejected.



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1e.5 Acceptance test items and acceptance test procedures

1e.5.1 Acceptance test items

The sample of transformers shall pass the following tests in accordance with the IEC 60076 and IEC 60156 standards:

- (1) Measurement of winding resistance (IEC 60076-1)
- (2) Measurement of voltage ratio and check of phase displacement (IEC 60076-1)
- (3) Measurement of short-circuit impedance and load loss (IEC 60076-1)
- (4) Measurement of no-load loss and current (IEC 60076-1)
- (5) Applied voltage test (IEC 60076-1 and IEC60076-3)
- (6) Induced voltage withstand test (IEC 60076-1 and IEC60076-3)
- (7) Oil Dielectric Breakdown voltage test (IEC 60156)
- (8) Temperature-rise test (IEC 60076-2)⁽¹⁾
- (9) Full wave lightning impulse test (IEC 60076-3)⁽¹⁾
- (10) Short-circuit withstand test (IEC 60076-5)⁽²⁾ (only for transformer rating of 50-250 kVA)
- (11) Dry film thickness test, the dry film thickness test procedure shall be according to **1c.12.1**

Painting system

Note

⁽¹⁾ The Items (8) and (9) shall be tested on one (1) unit for each contract at the PEA laboratory or Acknowledged independent laboratories approved by PEA as specified in **1e.3 Acknowledged independent testing laboratories** or manufacturer laboratories depending on PEA's acceptance committee

⁽²⁾ The Items (10) shall be tested on one (1) unit for each contract at Acknowledged Independent laboratories depend on PEA's acceptance committee approved by PEA as specified in **1e.3 Acknowledged independent testing laboratories**.

Any transformers which are out-of-tank for inspection in short-circuit withstand test, the insulating oil shall be dehydration at manufacture's factory and oil dielectric breakdown voltage shall be retested. The report of oil dielectric breakdown voltage test shall be submitted to PEA before shipment/delivery, for each ordered transformer.

1e.5.2 Acceptance test procedures

PEA's acceptance committee will select the sample of each lot, the number of transformer per lot according to **Table 10**. All sampling units shall be transported to PEA laboratory or Acknowledged independent laboratories for testing according to **1e.5.1 Acceptance test items**. The transportation shall be carried out by the contractor.



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Table 10 The number of sample and criteria for consideration

Number of transformer per lot (Unit)	Sample size of transformers for acceptance test (Unit)	Maximum number of sample failing in the acceptance test (Unit)
2 to 15	2	0
16 to 25	3	0
26 to 90	5	0
91 to 150	8	0
151 to 500	13	1
More than 500	20	1

The number of failing units shall not more than the maximum number of failing sample in the acceptance test according to **Table 10**. Otherwise, the transformers in that lot shall be rejected.

In case the failing units are not more than the maximum number of failing sample in the acceptance test according to **Table 10**, the contractor has to take responsibility as following procedure.

- (1) The contractor has to recheck all delivered transformers in that lot and repair or fix the defective transformers in that lot.
- (2) The contractor shall analyze the problem and send the report to PEA's acceptance committee before the lot accepted.
- (3) The transformers which are repaired or fixed in that lot shall be retested only in the relevant test items according to **1e.5.1 Acceptance test items**.

After the test, the transformers shall be rebuilt completely by the contractor with free of charge and send back to PEA with the same amount of the samples.

1f Inspection

To ensure about the quality of transformers, the inspection shall be carried out by the PEA's representative (PEA's witness committee) at following two stages:

- At anytime during receipt of raw material and manufacture/ assembly whenever the PEA desires.
- At finished stage i.e. transformers are fully assembled and are ready for dispatch.



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C2 Material and packing data to be given by bidders

The bidders have to submit the following data and details of transformers and accessories with the bid:

2a Performance data and guarantee of three-phase transformers. (See pages 26 to 30 of 32)

2b Drawing of inside tank and overall transformer with dimensions in mm showing of particulars of normal construction details.

2c Drawings, with dimensions in mm, of the following accessories:

1. HV and LV bushings
2. Terminal connectors, on HV and LV bushings, with description of materials used for the component parts
3. Nameplate with connection diagram
4. Valve, showing the internal construction
5. Earthing terminal connector
6. Dehydrating breather, and details of coupling (if any)
7. Bracket for surge arrester
8. Earthing terminal for surge arrester
9. Lifting lug
10. Lifting eye
11. Pressure relief valve
12. Thermometer pocket
13. Oil level gauge
14. Oil filling plug
15. Supporting lugs
16. Compression type of cable lug
17. Sludge drain plug
18. Accessories according to manufacturer's design, if any

2d Catalogues and/or drawings with details of the following accessories:

1. Dial type thermometer
2. Double float Buchholz relay
3. Pressure-relief valve
4. Bird guard
5. Core
6. HV and LV Winding
7. Off load tap changer



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8. Insulation paper
9. Gaskets
10. Oil drain vale
11. Accessories according to manufacturer's design, if any

2e Dry film thickness test report

2f Type test and Short-circuit withstand test report

2g List of routine test

2h Drawing of core and coil construction

2i Specifications of transformer oil and test report

2j HV and LV Bushing test report

2k Others necessary information in order to show that the special test report can prove the performance of the proposed transformers.

2l Bidders shall propose and quote for recommended spare part list with separate price for each offered item (e.g., bushings)

2m Packing details

Packing method (shown by drawing(s), and describe packing materials)

Number of transformers in one (1) crate or wooden case (one)

Overall dimensions (L x W x H) of each crate or wooden case in cm

Volume of each crate or wooden case in m³

Gross weight of each crate or wooden case in kg

Number of crates or wooden cases

2n Critical documents of the transformers (See page 25 of 32)

The lists of documents shall be fulfilled and submitted with the bid.



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The Critical documents of the transformers

No.	Required documents	Proposed technical document	Reference document (Page/Item)
1	HV and LV Bushing test report	<input type="checkbox"/> Yes <input type="checkbox"/> No	
2	Dry film thickness test report	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	List of routine test report	<input type="checkbox"/> Yes <input type="checkbox"/> No	
4	<u>For 50-250 kVA and the reference transformer</u> Type test and Short-circuit withstand test report <u>For transformer more than 250 kVA and is not the reference transformer</u> Type test report and calculation report and accessories information, or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	The copy of previous Purchase Order (PO) or Contract with List of suppliers or Proposal form, or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	PEA Product Acceptance registration certificate, or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Product lists registration certificate	<input type="checkbox"/> Yes <input type="checkbox"/> No	
5	The TIS 17025 or ISO/IEC 17025 certification and scope of accreditation of the independent laboratories/institutes (in case the independent laboratories/institutes are accredited according to TIS 17025 or ISO/IEC 17025)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
6	Performance data and guarantee of the three-phase transformers. (pages 26 to 30 of 32)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
7	Drawing of inside tank and overall transformer with dimensions in mm showing of particulars of normal construction details.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
8	Drawings, with dimensions in mm according to 2c	<input type="checkbox"/> Yes <input type="checkbox"/> No	
9	Catalogues and/or drawings with details according to 2d	<input type="checkbox"/> Yes <input type="checkbox"/> No	
10	Drawing of core and coil construction according to 2h	<input type="checkbox"/> Yes <input type="checkbox"/> No	
11	Specifications of transformer oil and test report according to 2i	<input type="checkbox"/> Yes <input type="checkbox"/> No	
12	Packing detail(s) according to 2m	<input type="checkbox"/> Yes <input type="checkbox"/> No	

I The items offered without submitting the critical documents shall be rejected



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Invitation to Bid No.:

2a Performance data and guarantee of three-phase transformers

Item

Manufacturer's name and country of origin		
Type or model		
Applied standard		
Rated power	kVA	
Rated frequency	Hz	
Rated primary voltage	V	
Rated secondary voltage	V	
Connection symbol	Dyn11	
Type of oil preservation system	-	
Operation duty: continuous operation (Type DB)	Yes/No	
Max. temperature rise of winding (at full load)	K	
Max. temperature rise of top oil (at full load)	K	
Primary tapping: off-circuit condition	Yes/No	
Number of steps of primary tapping	Steps	
Per cent of rated voltage of each tapping	%	
No-load current & Tolerance	% & %	&
Short-circuit impedance at 75°C & Tolerance	% & %	&
Losses , for each transformer unit		
No-load loss <u>plus positive tolerance</u>	W	
Load loss, <u>plus positive tolerance</u> , at 75°C	W	
Efficiency in %, at 75°C and at load:		
- 1/2 of rated power and P.F. = 1.0	%	
- 1 of rated power and P.F. = 1.0	%	
Voltage regulation at P.F. = 1.0	%	



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Bushings		HV	LV
		- Manufacturer's name	-
- Country of origin	-		
- Applied standard	-		
- Rated current	A		
- Full-wave impulse withstand voltage, or BIL	kV, peak		
- Low-frequency dry 1-minute test voltage	kV, r.m.s.		
- Low-frequency wet 10-second test voltage	kV, r.m.s.		
- Protection class	-		
- Colour of glazing	-		
- Stud thread size, Metric	-		
Secondary neutral point is loaded with rated current	Yes/No		
Terminal connectors on HV and LV bushings			
- Manufacturer's name	-		
- For copper conductor diameter range (HV side)	mm		
- For aluminium conductor diameter range (HV side)	mm		
- For copper conductor diameter range (LV side)	mm		
- For aluminium conductor diameter range (LV side)	mm		
- Number of circuits, take-off (LV side)	Circuits		
- Terminal pads are according to PEA's Drawing No. SA4-015/47002	Yes/No		
Winding		HV	LV
- Manufacturer's name (the bidders have to quote not more than three (3) manufacturers)	-		
- Country of origin	-		
- Material: copper	Yes/No		
- Type of enamel or insulating material of wire	-		
- Size of wire			
- for HV side (diameter)	mm		
- for LV side (dimension)	mm x mm		
- Resistance per phase at 75°C	Ohm		



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Item

- Full-wave impulse withstand voltage, or BIL	kV, peak	
- Power-frequency test voltage, 1 min	kV, r.m.s.	
- Construction of winding	-	
- Current density	A/mm ²	
- Number of layer per coil	-	
- Number of turns of each coil in tap No.3	Turns	
- Number of turns of each tapping position	Turns	
- Total turns of each coil	Turns	
Core		
- Manufacturer's name (the bidders have to quote not more than three (3) manufacturers)	-	
- Country of origin	-	
Pressure relief valve		
- Manufacturer's name	-	
- Country of origin	-	
- Type or model	-	
- Operating pressure	kg/cm ²	
- Flow rate at..... kg/cm ²	cc/sec	
Method of cooling	-	
Total cooling surface	m ²	
Brand of oil used for initial filling	-	
Completely assembled transformer shall withstand, without permanent deformation, a maximum pressure of	kg/cm ²	
Colour of tank: grey (RAL 7036)	Yes/No	
Tank finish conforms to PEA's requirement	Yes/No	
Quantity of oil filling	liters	
Mass of core	kg	
Mass of winding	kg	
Mass of the part liftable from tank	kg	
Mass of complete transformer with oil	kg	
Terminal markings and connections conform to PEA's requirement	Yes/No	



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Item

<p>Tank</p> <ul style="list-style-type: none"> - Thickness of side wall - Thickness of top plate - Thickness of bottom plate <p>Internal dimensions</p> <ul style="list-style-type: none"> - Height - Width - Depth 	<p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p>	
<p>Dimensions of transformer</p> <ul style="list-style-type: none"> Overall height Overall width Overall depth Height over cover 	<p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p>	
<p>Total dry film thickness</p>	<p>µm</p>	
<p>Fin</p> <ul style="list-style-type: none"> - Fin radiators or Corrugated thickness - Dimension of each fin (LxBxT) <p>Number of Fins per radiator</p> <ul style="list-style-type: none"> - Side of tank - Front of tank - Total number of fin 	<p>mm</p> <p>mm</p> <p>-</p> <p>-</p> <p>-</p>	
<p>Bushing clearance</p> <p>Please fill in the shortest of clearance</p> <ul style="list-style-type: none"> LV to earth HV to earth Between LV bushing Between HV bushing 	<p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p> <p>mm</p>	
<p>Detail documents of Item 1 on Page 31 of 32 shall be sent to PEA before shipment/delivery</p>	<p>Yes/No</p>	



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THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS

WITH ABILITY TO WITHSTAND SHORT CIRCUIT

Specification No. RTRN-035/2561

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Item

X/R ratio	-	
Rated short circuit current and withstanding duration		
- Current	kA	
- Duration	s	
Duration of overload		
- 25% overload	Minutes	
- 50% overload	Minutes	
Magnetic flux density	Tesla	
Other :		



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Note: Conditions for documentation and consideration

1. The Contractor has to supply the following documents in English and/or Thai, before shipment/delivery, for each ordered transformer:

1.1 Report of routine tests

1.2 Number of turns of each winding, each coil, and each tapping position

1.3 Mass of HV windings and of LV windings

1.4 Type of enamel, temperature class, and size of the enameled wire

1.5 Information for Reference (only one(1) unit per contract). The following information for each transformer shall be submitted for maintenance purpose.

- Coil height for each winding before assembly and after complete assembly.
- Torque value on clamping bolts or pressure for each winding before assembly and after complete assembly.
- Photograph of each coil for each phase and photograph of core and coils assembly. The photograph of each coil shall be taken from the final production process before placing to the core, top view and front view shall be provided. The photograph of core and coils assembly shall be taken just prior to place the completed core and coils assembly into the tank, top view, front view, right view, left view and rear view shall be provided for complete set of photographs. All photographs shall be 216 mm (8-1/2 in) by 280 mm (11 in) gloss prints properly labeled relevant to the view taken.

1.6 Invoice and Test report of the following material and accessories used in each supply shall be submitted.

- Transformer oil
- Silicon steel
- Copper conductor
- Insulation paper and pressboard
- Pressure relief
- Gaskets
- Bushing
- Transformer supervisory equipment



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The above documents shall be sent to the following address:

Transformer Division
Provincial Electricity Authority
200 Ngam Wong Wan Road, Chatuchak
Bangkok Metropolis 10900
Thailand

2. If the material and packing data given by bidders, which are mentioned on Pages 23 to 24 of 32 are estimated or approximated, the bid may be rejected.
3. Delivery time is also one of the important factors to be considered.
4. Partial shipment/delivery is allowed.



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APPENDIX 1

Comparison Method

In case the ability to withstand the dynamic short circuit is demonstrated by comparison between the reference transformer and similar transformer. In this case the bidders have to submit the short circuit test report of the reference transformer, calculation report of short circuit force which using Finite Element Method (FEM) software, all necessary information according to **Table 1** Design data of the reference transformers and the proposed transformers as well as the necessary information in order to show that the short-circuit withstand test report can prove the performance of the proposed transformers with the bid.

The short circuit test procedure of the reference transformer shall be according to **1e.2.2 Test procedure of Type test and Short-circuit withstand test.**

For the ability to withstand the dynamic effects of short circuit test, the total number of tests shall be three made in a different position of the tap-changer according to IEC 60076-5. The duration of each test shall be 0.5 s

The transformer is considered similar or representative to another transformer (proposed transformers) taken as a reference if it has the following characteristics in common with the latter:

- (1) Same type of operation, for example generator step-up unit, distribution, interconnection transformer and same rated voltage according to **Table 2**;
- (2) Same conceptual design, for example dry-type, oil-immersed type, core type with concentric windings, sandwich type, shell type, circular coils, non-circular coils;
- (3) Same arrangement and geometrical sequence of the main windings;
- (4) Same type of winding conductors, for example, aluminium, aluminium alloy, annealed or hardened copper, metal foil, wire, flat conductor, continuously transposed conductors and epoxy bonding, if used;
- (5) Same type of main windings for example, helical-, disc-, layer-type, pancake coils;
- (6) Absorbed power at short circuit (rated power/per unit short-circuit impedance) between 30% and 130% of that relating to the reference unit, see **Table 3**;
- (7) Axial forces, radial forces, axial winding stresses and radial winding stresses occurring at short circuit not exceeding 120% of those in the reference unit. (Force shall be calculated by Finite element program such as FLD12 etc., Hand calculation shall be rejected)
- (8) Same manufacturing processes;
- (9) Same clamping and winding support arrangement.

In case the comparison method, the short-circuit withstand test report of the reference transformer and a calculation report as a result of the comparison between the reference transformer and proposed transformer shall be submitted with the bid. The calculation report shall give evidence the force and stress according to item (7) and all necessary information according to item (1) to (9).



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Table 1

Type of operation and rated voltage of the proposed transformers similar to the reference transformers

Type and Rated voltage	The reference transformer	The proposed transformers
Type	3 Phase only	3 Phase
Rated primary voltage	22 kV	22 kV
Rated primary voltage	33 kV	33 kV
Rated secondary voltage (3 phase)	416/240 V	416/240 V

Table 2

Rated power of the proposed transformers similar to the reference transformers

	Rated power (kVA) of the reference transformers	Rated power (kVA) of the proposed transformers									
		315	400	500 ⁽¹⁾	630	800	1,000	1,250	1,500	2,000	
1	250	315		500 ⁽¹⁾							
2	315	315	400	500 ⁽¹⁾							
3	400	315	400	500 ⁽¹⁾							
4	500 ⁽¹⁾	315	400	500 ⁽¹⁾							
5	630	315	400	500 ⁽¹⁾	630	800	1,000				
6	800	315	400	500 ⁽¹⁾	630	800	1,000	1,250			
7	1,000	315	400	500 ⁽¹⁾	630	800	1,000	1,250			
8	1,250	315	400	500 ⁽¹⁾	630	800	1,000	1,250	1,500		
9	1,500	315	400	500 ⁽¹⁾	630	800	1,000	1,250	1,500		
10	2,000		400		630	800	1,000	1,250	1,500	2,000	

Note :

- ⁽¹⁾ Based on 6.5% short-circuit impedance. In case the impedance of 500 kVA transformer more than 6.5%, the bidders shall recalculate this table for PEA approval.



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Table 3

Design data of the reference transformers and the proposed transformers

Description	Design value of the reference transformers		Design value of the proposed transformers	
Rating (kVA)				
% Short circuit impedance				
Construction of Core				
HV Windings, made of				
LV Windings, made of				
Construction of HV Windings (Layer or disk)				
Construction of LV Windings (Layer or Foil)				
HV Current density (please enclosed the calculation sheet)				
LV Current density (please enclosed the calculation sheet)				
Axial force (please enclosed software calculation sheet)	<u>HV</u>	<u>LV</u>	<u>HV</u>	<u>LV</u>
Axial stress (please enclosed software calculation sheet)	<u>HV</u>	<u>LV</u>	<u>HV</u>	<u>LV</u>
Radial force (please enclosed software calculation sheet)	<u>HV</u>	<u>LV</u>	<u>HV</u>	<u>LV</u>
Radial stress (please enclosed software calculation sheet)	<u>HV</u>	<u>LV</u>	<u>HV</u>	<u>LV</u>
Same arrangement of main windings and geometrical sequence as the reference unit (Yes/No) (please enclosed the winding detail drawing)				
Same clamping and supporting arrangement. (Yes/No) (please enclosed the clamping detail drawing)				



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Addendum

The addendum is made to be a part of Specification No.: RTRN-035/2561 THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT

PEA also accepts the THREE-PHASE TRANSFORMERS FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS WITH ABILITY TO WITHSTAND SHORT CIRCUIT as following:

1. Tank and tank finish

The distance between tank cover (Top plate) and fins which is installed the earthing terminal for surge arrester shall not less than 200 mm according to **1c.12**, will be effective with bid invitation date from **1st July 2020**.

2. Type test report and Short-circuit withstand test report

During the bidding period in **2019**, PEA will also accept type test report and short-circuit withstand test report after signing the contract. In this case, the bidders have to submit test plan including information i.e. test procedure, laboratory and test date to PEA for consideration instead and the complete type test report and short-circuit withstand test report shall be submitted for approval before shipment.

2.1 Type test report

The following type tests shall be in accordance with the relevant standards:

- (1) Temperature-rise test (IEC 60076-2)
- (2) Full wave lightning impulse test (IEC 60076-1 and IEC 60076-3)
- (3) Measurement of no-load loss and current at 90 % and 110 % of rated voltage (IEC 60076-1)

Type test shall be made on only one (1) unit of each rating.

The transformers shall be passed all items of the type tests. The type test shall be conducted or inspected by the acknowledged testing laboratories/institutes as following:

- (1) Laboratories/institutes which are members of the Short-circuit Testing Liaison (STL) or independent laboratories/institutes which are accredited according to TIS 17025 or ISO/IEC 17025 with the scope of accreditation covered the relevant test items, standards and equipment. The certification and scope of accreditation of the independent laboratories/institutes shall be submitted with the bid for consideration.



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The bidders or manufacturers who are accredited according to TIS 17025 or ISO/IEC 17025 preferring to carry out the type tests and short-circuit withstand test of the transformers with the laboratories or by the manufacturers themselves, the tests shall be inspected by Thailand's national laboratories, institutes, universities and electric utilities in (2) and other laboratories, institutes, universities or electric utilities approved by PEA.

(2) Thailand's national laboratories, institutes, universities and electric utilities, as follows:

- National Metal and Materials Technology Center (MTEC)
- Electrical and Electronic Products Testing Center (PTEC)
- Thai Industrial Standards Institute (TISI)
- Electrical and Electronics Institute (EEI)
- Department of Science Service (DSS)
- Testing Laboratory, Electrical Engineering Department, Faculty of Engineering, Chulalongkorn University
- Electricity Generating Authority of Thailand (EGAT)
- Metropolitan Electricity Authority (MEA)
- Provincial Electricity Authority (PEA)
- Other laboratories, institutes, universities or electric utilities approved by PEA

The bidders have to submit the type test report with the bid

The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.

2.2 Short-circuit withstand test report

The transformers shall be designed and constructed to withstand without damage by the thermal and dynamic effects of the external short circuit in accordance with the IEC 60076-5.

The duration of the current to be used for the calculation of the thermal ability to withstand short circuit shall be 2 s and the initial temperature for calculation shall be 105°C.

The ability to withstand the dynamic effects of short circuit shall be demonstrated either:

1. By testing the identical transformer (purchased transformer). In this case the bidders have to submit the short circuit test report with the bid, or
2. By comparison between the reference transformer and similar transformer. In this case the bidders have to submit the short circuit test report of the reference transformer, calculation report of short circuit force which using Finite Element Method (FEM) software, all necessary information according to **Table A.3 Design data of the reference transformers and the proposed transformers** as well as the necessary information in order to show that the special test report can prove the performance of the proposed transformers with the bid.



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For the ability to withstand the dynamic effects of short circuit test, the total number of tests shall be three made in a different position of the tap-changer according to IEC 60076-5. The duration of each test shall be 0.5 s

The transformer is considered similar or representative to another transformer (proposed transformers) taken as a reference if it has the following characteristics in common with the latter:

- (1) Same type of operation, for example generator step-up unit, distribution, interconnection transformer and same rated voltage according to **Table A.2**;
- (2) Same conceptual design, for example dry-type, oil-immersed type, core type with concentric windings, sandwich type, shell type, circular coils, non-circular coils;
- (3) Same arrangement and geometrical sequence of the main windings;
- (4) Same type of winding conductors, for example, aluminium, aluminium alloy, annealed or hardened copper, metal foil, wire, flat conductor, continuously transposed conductors and epoxy bonding, if used;
- (5) Same type of main windings for example, helical-, disc-, layer-type, pancake coils;
- (6) Absorbed power at short circuit (rated power/per unit short-circuit impedance) between 30% and 130% of that relating to the reference unit, see **Table A.3**;
- (7) Axial forces, radial forces, axial winding stresses and radial winding stresses occurring at short circuit not exceeding 120% of those in the reference unit. (Force shall be calculated by Finite element program such as FLD12 etc., Hand calculation shall be rejected)
- (8) Same manufacturing processes;
- (9) Same clamping and winding support arrangement.

In case the comparison method, the short-circuit withstand test report of the reference transformer and a calculation report as a result of the comparison between the reference transformer and proposed transformer shall be submitted with the bid. The calculation report shall give evidence the force and stress according to item (7) and all necessary information according to item (1) to (9).

Table A.1

Type of operation and rated voltage of the proposed transformers similar to the reference transformer

Type and Rated voltage	The reference transformer	The proposed transformers
Type	3 Phase only	3 Phase
Rated primary voltage	22 kV	22 kV
Rated primary voltage	33 kV	33 kV
Rated secondary voltage (3 phase)	416/240 V or 400/230 V	416/240 V



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Table A.2

Rated power of the proposed transformers similar to the reference transformer

1	Rated power (kVA) of the reference transformer	Rated power (kVA) of the proposed transformers													
		50	100	160	250	315	400	500 ⁽¹⁾	630	800	1,000	1,250	1,500	2,000	
1	100														
2	160														
3	250														
4	315														
5	400														
6	500 ⁽¹⁾														
7	630														
8	800														
9	1,000														
10	1,250														
11	1,500														
12	2,000														

Note :

⁽¹⁾ Based on 6.5% short-circuit impedance. In case the impedance of 500 kVA transformer more than 6.5%, the bidders shall recalculate this table for PEA approval.

The transformers shall be passed the short-circuit withstand test according to IEC 60076-5 conducted or inspected by the acknowledged independent testing laboratories as follows:

(1) Laboratories/institutes which are members of the Short-circuit Testing Liaison (STL) or independent laboratories/institutes which are accredited according to TIS 17025 or ISO/IEC 17025 with the scope of accreditation covered the relevant test items, standards and equipment. The certification and scope of accreditation of the independent laboratories/institutes shall be submitted with the bid for consideration.

The bidders or manufacturers who are accredited according to TIS 17025 or ISO/IEC 17025 preferring to carry out the type tests and short-circuit withstand test of the transformers with the laboratories or by the manufacturers themselves, the tests shall be inspected by Thailand's national laboratories, institutes, universities and electric utilities in (2) and other laboratories, institutes, universities or electric utilities approved by PEA.

(2) Thailand's national laboratories, institutes, universities and electric utilities, as follow:
- Electricity Generating Authority of Thailand (EGAT)



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(3) Other laboratories, institutes, universities or electric utilities approved by PEA. In this case, the detail of the test facilities of the laboratories shall be submitted to PEA for approval before proceeding the tests and before the bid closing date. PEA reserves the right to send representatives to inspect and witness the tests with the cost of the bidders or manufacturers.

The short-circuit test reports of the representative transformer which are conducted by Thailand's national laboratories/institutes shall be valid within five (5) years count from the issued date in the test reports to the bid closing date, and valid within ten (10) years for conducting by other countries.

If the laboratories intend to use PEA's power system as power supply for the short-circuit withstand testing, the transformer's manufacturer or the laboratories shall submit technical documents of the test such as test procedure, test circuit diagram, test and protection equipment, testing date and calculation of voltage drop in PEA's power system caused by the test to PEA for consideration and approval before the tests are proceeded.

It is responsible of the laboratories to compensate all failure or damage occurred to PEA's power system caused by the test.

PEA reserves the right to send representatives to inspect and witness the test.

The Item offered without submitting the short-circuit withstand test report shall be rejected.

The cost of all tests and reports shall be borne by the bidders/manufacturers/contractor.

Table A.3

Design data of the reference transformers and the proposed transformers

Description	Design value of the reference transformers	Design value of the proposed transformers
Rating (kVA)		
% Short circuit impedance		
Construction of Core		
HV Windings, made of		
LV Windings, made of		
Construction of HV Windings (Layer or disk)		
Construction of LV Windings (Layer or Foil)		
HV Current density (please enclosed the calculation sheet)		