SPECIFICATION NO. 6201

24 kV POLE-MOUNTED LOAD BREAK SWITCH WITH VOLTAGE SENSOR AND TELECONTROL DEVICE

6201A Scope

6201A1 This specification describes the requirements with which the manufacturer shall comply in order to supply 24 kV pole-mounted load break switch for outdoor installation in the Metropolitan Electricity Authority (MEA) Bangkok, Thailand for use on 24 kV 3 phase 3 wire 50 Hz solidly grounded neutral at substation system.

24 kV pole-mounted load break switch with voltage sensor shall be supplied with telecontrol device completely wired and tested in control cabinet.

The built-in voltage sensor for voltage measurement shall be supplied and installed in 24 kV pole-mounted load break switch's tank.

6201A2 The following attached drawings are part of this specification:-

a) Drawing no. 631020 (sh.no.1-6) : Typical 24 kV SF_6 load break switch installation

b) Drawing no. 631021 (sh.no.1-3) : Typical control cabinet for distribution management system (DMS) project

c) Drawing no. 1 (sh.no.1) : Typical 24 kV load break switch for UG-OH system

6201B Site and Service Conditions

The 24 kV pole-mounted load break switch with voltage sensor and telecontrol device shall be installed in the Bangkok Metropolis, Thailand. The service conditions are as follows:-

a) Installation site : Outdoor under direct sunlight.

b) Altitude : approximately at mean sea level.

c) Maximum ambient temperature : 40°C.

d) Maximum temperature inside control cabinet : 70°C.

e) Average ambient temperature in any one year : 30°C.

f) Average relative humidity in any one year : 79%.

g) Average maximum relative humidity in any one year : 94%.

h) Installation site

- Type I : the load break switch shall be suitable for connection to overhead system.
- Type II : the load break switch shall be suitable for connection to underground-overhead system

The 24 kV pole-mounted load break switch with voltage sensor and telecontrol device shall be suitable for use in tropical climatic area and shall be capable of operating at its full ratings in the service conditions mentioned above.

6201C **Reference Standard**

Except otherwise specified elsewhere in the specification, all equipment required by MEA shall be manufactured and tested in conformity with the standards listed below.

- American National Standard Institute (ANSI)
- The Institute of Electrical and Electronic Engineers, Inc. (IEEE)
- International Electrotechnical Communication (IEC)

For Load Break Switch:

IEC 60265-1 (1998): High-voltage switches.

Note

1. The equipment tested in accordance with the later version of the above standard is also accepted.
2. The equipment tested in accordance with older version of the above standard is also accepted provided that the test report is conformed to standard and year mentioned above.
3. If there are any minor parts deviated from the standards, they shall be clearly mentioned in the "DEVIATION FROM MEA'S SPECIFICATION FORM" attached herewith.
4. The equipment complies with other national standards having similar characteristics and providing equal performance and/or quality to those specified may be proposed. In this case, the complete ENGLISH language copies of the standards shall be submitted with the quotation, otherwise such offer may not be considered.

6201D **Test, Inspection and Test Report**

6201D1 Bidder shall propose switches from the manufacturer who has his own type test report only. The proposed switch shall have successfully passed all the type tests in accordance with the reference standards.

All type tests shall be consisted of at least the following items:-

A. Load break switch

A1) Dielectric tests

A2) Temperature rise tests.

A3) Measurement of the resistance of the main circuit.

A4) Short time withstand and peak withstand current tests.

A5) Making and breaking tests.

A6) Mechanical endurance test at least 1,000 operating cycles.

A7) Operation with mainly active load at 600 A at least 100 operating cycles.

The above type tests shall be performed by test station which is member of Short Circuit Testing Liaison (STL) or independent test stations which are accredited according to ISO/IEC 17025 with certification are required; otherwise MEA will not consider such offer.

Test reports of type I load break switch are acceptable for the proposed type II load break switch and vice versa.

Type test report of load break switch without voltage sensor are acceptable for load break switch with voltage sensor.

B. Telecontrol device

The DNP3 conformance testing conducted between the telecontrol device and ASE2000 according to the test procedures specified in "DNP3 Intelligent Electronic Device (IED) Certification Procedure Subset Level 1 (or higher), Version 2.5 (or later)".

Except otherwise specified elsewhere in the bid, all test reports in clause A and B shall be attached to the bid.

In addition, the test reports in clause A and B, which are issued by Testing laboratory located in foreign countries, shall be certified true copy by Ministry of Foreign Affairs of the Kingdom of Thailand after being previously certified by Royal Thai Embassy or Consulate of the issuing countries according to Regulation of the Ministry of Foreign Affairs on Legalization Services B.E. 2539 (ระเบียบกระทรวงการต่างประเทศ ว่าด้วยการรับรองเอกสาร พ.ศ.2539); otherwise MEA will not consider such offer.

C. Immunity and environment test for control board, telecontrol device and power supply shall be done as listed in table 1.

Table 1 Immunity and Environment test

Requirements	Test standard	Class or Level	Specified or details
AC withstand - Exposed equipment - Control exposure equipments terminal	 IEC 60255-27 IEC 60255-27	 - -	 2 kV rms 0.5 kV rms
Impulse withstand - Exposed equipment - Control exposure equipments terminal	 IEC 60255-27 IEC 60255-27	 - -	 5 kV peak 1 kV peak
Fast transient bursts	IEC 61000-4-4	Level 4	4 kV
Ring waves	IEC 61000-4-12	Level 3	2 kV
Damp oscillatory waves	IEC 61000-4-18	Level 3	2.5 kV
Electrostatic discharges	IEC 61000-4-2	Level 3 (air) and Level 4 (contact)	8 kV
Power frequency magnetic field	IEC 61000-4-8	Level 4	30 A/m continuous
Damped Oscillatory magnetic field	IEC 61000-4-10	Level 4	30 A/m
Radiated electromagnetic field	IEC 61000-4-3	Level 3 (80 MHz – 1 GHz)	10 V/m
Dry heat test	IEC 60068-2-2	-	72 h 70 °C
Damp heat test	IEC 60068-2-30	6 cycles	25 °C to 55 °C 95% humid

Test report of the proposed control board, telecontrol device and power supply shall be submitted prior to the delivery. The test shall be done for the complete control board with telecontrol device and power supply installed; otherwise the switch shall not be accepted. For the manufacturer that is in the list and design is not changed, the tests shall not be required.

6201D2 Standard factory test shall be done in accordance with routine tests stated in reference standard and they shall be performed in accordance with procedure specified. The switches shall be tested as listed in table 2.

Table 2 Standard factory test

Test Items	Unit Tested
1. Load break switch and control cabinet - Power-frequency dry withstand voltage test on the main circuit. - Power-frequency dry withstand voltage test on the auxiliary and control circuits. - Measurement of the resistance of the main circuit. - Mechanical operation tests. - Tightness test. - Functional test including output signal to telecontrol device. - Measurement of contact timing (closing time and opening time).	All units
-Degree of protection (IP) of control cabinet (the test shall be done by independent test station) (see note)	3
2. Current transformer (CT). - Inter-turn overvoltage test. - Verification of terminal marking. - Accuracy test.	All units
3. Voltage sensor accuracy test	All units
4. Telecontrol device	All units

Note Notwithstanding the standard specifies, it is not allowed the water to enter the cabinet during the test; otherwise it shall be regarded as failed test.

6201D3 MEA reserves the right to send the representative at his expense to inspect and witness tests of the material and equipment during manufacturing, at the time of shipment or at any time he deems necessary. The supplier shall provide free access to the facilities where the equipment is being manufactured and shall satisfy the representatives that the material and equipment are in accordance with this specification and purchase contract.

6201D4 Prior to the shipment of the material and/or equipment from the factory, the supplier shall submit to MEA the complete and certified reports of all tests in clause 6201D2 made in 6 (six) copies. The test reports shall contain all data required for their complete understanding such as; diagrams, methods,

instruments, constants and values in the tests and the results obtained. If MEA has his own inspector, the supplier shall submit all the above test reports to the inspector and the inspector himself shall certify and/or review those test reports and submit to MEA.

6201D5 The acceptance test of load break switch and telecontrol device shall be as follow:

A. Load Break Switch

After the load break switches delivered in each lot, MEA will sample 2 (two) percent of the load break switch as following :-

- Dielectric test.
- Insulation resistance test.
- Contact resistance test.
- Operation test with telecontrol device.
- Bushing current transformer accuracy test.
- Dimension measurement and galvanizing test of crossarm, flat brace and angle steel.
- Dimension measurement of control cabinet.
- Dimension measurement of terminal lug (see Note).

Note: For the first lot, the additional 4 (four) terminal lugs shall be submitted to MEA for the following acceptance tests; dimensional measurement and compression test with MEA's die.

If the test sample fails at least 1 (one) sample, MEA shall reject all items in the lot. The supplier shall resend the new products with the report showing the improvement process and cause analysis or the revised products with the report showing details of revision and cause analysis. The supplier shall also be responsible for all expenses of the new acceptance test.

B. Telecontrol device

Before the load break switches delivered in the first lot, MEA will witness Factory Acceptance Tests (see clause 6201M12) of the telecontrol device as follow:

- Full Functional Test (FFT) : 1 (one) unit
- Factory Routine Test (FRT) : 2% of the first lot

The test results shall be submitted to MEA prior to the delivery in first lot.

6201E **Drawings and Instruction**

6201E1 Supplier shall furnish 7 (seven) copies each of the following items as soon as possible for the design approval by MEA.

Load Break Switch

a) Outline drawings and physical arrangement drawings showing the mounting details of the switch installed on MEA's concrete pole. The drawing shall state all dimensions, weights, bill of materials etc.
b) Schematic diagram, wiring diagram and circuit diagram.
c) Nameplate drawing.
d) Installation and operating instruction.
e) Production plan and shipments plan.
f) The calculation of CT load burden.
g) CT and voltage sensor mounting detail.
h) Piercing connector drawing and detail.

Telecontrol Device

a) Outline drawing and physical arrangement drawings showing the mounting details of the telecontrol device. The drawing shall state all dimensions and bill of materials etc.
b) Schematic diagram, wiring diagram and circuit diagram.
c) Nameplate drawing.
d) The DNP3 conformance testing conducted between the telecontrol device and ASE2000 according to the test procedures specified in Appendix A3.
e) Factory Acceptance Test (FAT) Procedure (see clause 6201M12)

If any of the drawings and data mentioned above are not submitted to MEA within 60 (sixty) days after the effective date of contract, the supplier shall be penalized at Baht 1,000.00 (one thousand only) per day until the date the supplier submits the above documents.

Generally, if the drawings require no more detail, they will be returned to the supplier within 45 (forty-five) days after receipt by MEA. If drawings for approval are not submitted within the time as mentioned above or MEA has to request for additional information, supplier cannot regard lost time as reason for extending delivery time without penalty.

6201E2 Supplier shall furnish 6 (six) copies each and 1 (one) transparent reproducible copy each of the following items, at least 30 (thirty) days prior to the first shipment of the equipment.

Load Break Switch

a) Final certified drawings of all items listed in clause 6201E1 above.
b) Complete installation, operating and maintenance instructions of all equipment including voltage sensor and telecontrol device.
c) Complete part lists of every equipment.

Telecontrol Device (see details in 6201M7 and 6201M8)

a) Field maintenance documents.

b) Repair shop documents.

c) User manual for the test system.

d) Communication equipment documents.

e) Telecontrol device configuration drawings.

f) Installation & commissioning documents.

g) Training documents.

MEA reserves the right to reject any document which is incomplete, incorrect, illegible, does not properly covers the subject matter, or when the writing is not according to acceptable standard. Any documents in this section that is rejected shall be corrected and resubmitted to MEA within 30 (thirty) days after being notified by MEA; otherwise the Supplier shall be penalized at Baht 1,000.00 (one thousand only) per day until the date the Supplier resubmits all the corrected documents. This condition shall cover all the contract period including the warrantee period.

6201E3 One complete set of drawings, instruction and diagrams shall be firmly attached to or boxed with each load break switch at the time of shipment.

6201E4 All drawings except standard shop drawings, characteristic curves and installations shall have the contract number marked thereon.

6201E5 All drawings and instructions shall be in ENGLISH. Information on drawing shall be engineering lettering. Instruction manual shall be machine printed or typed.

6201E6 All measurements and qualities shall be expressed in the unit of METRIC SYSTEM. If there are expressed in the other system, the metric equivalent shall also be shown.

6201F Ratings and Features

The pole-mounted load break switch shall have the minimum following ratings.

Rated voltage	:	24 kV
Number of poles	:	3
Rated frequency	:	50 Hz
Rated lightning impulse withstand voltage		
- To earth, between poles and across opening switching device	:	125 kV peak
- Across isolating distance	:	145 kV peak

Rated power frequency withstand voltage (1 min.)		
- To earth, between poles and across opening switching device	:	50 kV rms
- Across isolating distance	:	60 kV rms
Rated normal current, not less than	:	600 A
Rated short time current (1 sec)	:	10 kA
Rated peak withstand current	:	25 kA peak
Rated short-circuit making current	:	25 kA peak
IP Class		
- SF_6 Switch compartment	:	IP65
- Control Cabinet	:	IP54

6201G **General Requirements**

6201G1 The supplier shall furnish as follows

a) Three phase switch.

b) Control equipment.

c) Other accessories necessary for installation (see drawing no. 631020).

d) Telecontrol device.

e) Telecontrol device test and installation tools. See appendix A1.

6201G2 The switch and associated equipment shall be outdoor type and suitable for installation on concrete pole as shown in attached drawings no. 631020 sh.no. 1 of 6.

6201G3 The switch nameplate shall be provided with the voltage and current rating, CT ratio and burden, purchase contract number and information according to reference standard and QR code that stored MEA's serial number of switch, printed by laser marking method or equivalent, not less than 3 cm x 3 cm. (MEA will send MEA's serial number after the effective date of contract.)

6201G4 The width of load break switch shall not be more than 102 cm (see drawing 631020 sh. no. 1 of 6).

6201H **Three Phase Switch**

6201H1 The switch shall be SF_6 gas, puffer type, or combination of rotary arc and puffer arc quenching principle. The switch shall utilize SF_6 gas as arc-quenching and insulating medium.

Outdoor type vacuum switch or vacuum interrupter in SF_6 gas or vacuum interrupter in series with disconnecting switch can be offered if

a) All electrical characteristics are met with clause 6201F.

b) The switch can be remotely controlled and the result electrical values shall be according to clause 6201F.

c) The operating mechanism and control equipment shall be according to clause 6201I.

6201H2 The switch shall be operated both manually without power supply by using a NEMA-head hook stick, and electrically by using motor operated and control equipment.

Note - All operating handle shall be marked with label "ปลด" for OPEN and "สับ" for CLOSE respectively.

6201H3 The enclosure shall be stainless steel with minimum of two coats of paint. The first coat shall be a rust inhibiting primer. Final coat shall be outdoor grey according to RAL 7036 or equivalent. Other coating process may be accepted by MEA's approval.

6201H4 Each set of the switch shall be supplied with :

a) Manual operating handle, with operating hook(s) having inner diameter of not less than 26 mm, suitable for use with NEMA-head hook stick (7.2 meters long) from ground level.

b) Switch position indicator, CLOSE/OPEN.

Note - Switch position indications shall be showed at bottom side of LBS and marked with label "ปลด" for OPEN and "สับ" for CLOSE respectively.

c) Lock/Free (Manual/Electrical) selector handle, not required for the design that use mechanical interlock handle to block the operation of switch from manual and electrical.

d) Operating mechanism which shall be motor operated type.

e) Connecting terminals for remote "CLOSE" and remote "OPEN".

f) Two sets of normally open and normally close auxiliary contacts for CLOSE/OPEN status, for indicator lamps and telecontrol device interfacing which shall be 15 A, 250 V rating.

g) Auxiliary Contact(s) for Lock/Free (Manual/Electrical) status.

h) Pressure gauge and auxiliary contact for low gas pressure indicator. Pressure gauge shall be installed at the bottom side of LBS.

i) 1 (one) control cable with plug at both end, each 11 meters long.

j) Ground terminal, with solderless clamp type connector suitable for PVC insulated (MEA type A) copper conductor size 25 mm^2; complete with lock washer of stainless steel or better.

k) Gas pressure releasing device operating in case pressure builds up higher than permissible design pressure.

l) Safety locking device to prohibit switching operation in case SF_6 gas pressure drops below permissible minimum pressure, with red indicator easily to be seen from ground level.

m) Porcelain or silicone rubber bushings which shall be according to IEC 60137 or equivalent and having creepage at least 600 mm.
The terminal of bushing shall be NEMA 2 holes for connecting with aluminum alloy tin-plated terminal lug in clause 6201H4 x).

n) Lifting lug(s).

o) Nameplate of LBS.

p) Absorber to absorb moisture and de-composed product of SF_6 gas.

q) Weather proof control cabinet.

r) Operating mechanism shall be prevented from corrosion by one the following method:-

- using nitrogen-filled mechanism box or
- installing all mechanism inside SF_6 switches or
- using anti-corrosion stainless steel for all moving parts of mechanism (excluding motor).

s) Bushing CT in each phase, ring type, cast resin, mounted with metal or plastic polyamide 6.6 (Nylon 6.6), current ratio 600/1 A, accuracy class 1 or better as per IEC 61869-2. Rated burden shall be suitable for all connecting device.

t) The bushing CT terminal block with short link for connecting with telecontrol device.

u) The conductor of CT secondary side which shall be VCT with not less than 2.5 mm^2, 6 core, 11 meter long.

v) 6 (six) built-in voltage sensors (2 sensors / phase) installed in switch's tank, capacitive type with compensator circuit, accuracy class 1 or better according to IEC 61869-11 or equivalent. The voltage ratio shall be 24 kV/√3 to 2.4V/√3. The voltage sensor shall also be suitable for alternating current system with non-effectively earthed neutral system.

Note 1. Other voltage ratios shall be submitted to MEA for approval.

2. According to drawing no.631020 sh.no.1 of 6, voltage measurement for telecontrol device at VS1 shall be preferred. If VS1 do not have voltage, the telecontrol device shall be measured from VS2.

w) Operation counter, for recording the number of switching cycles.

x) 6 (six) set of terminal lugs and their accessories. Each set shall comprise of the following items:-

- Aluminum alloy terminal lug, NEMA 2 holes, for connecting to ASC 185 mm^2 (installed by MEA), shall be made of aluminum alloy tube and shall be tin-plated to provide durable long-lasting corrosion resistance. Terminal lug shall be according to drawing 631020 sh.no 3 of 6 and suitable for hydraulic compression tool Y35 and Burndy Die index no. 321 or 490; otherwise the terminal lug shall not be accepted.

  The proposed 185 mm^2 aluminum alloy terminal lugs shall have successfully passed the current cycle test with at least 500 cycles in according to ANSI C119.4-2004 or received the UL listed. For aluminum alloy terminal lugs, which have been used by MEA without any problem, can be accepted without current cycle test.

  For bidder who proposes aluminum alloy terminal lugs in accordance with ANSI C119.4-2004 or receive the UL listed, the certified current cycle test report or UL listed document of the proposed aluminum alloy terminal lugs shall be attached to the bid or submitted to MEA prior to the delivery; otherwise the aluminum alloy terminal lugs shall be rejected.

- two bolts, two nuts, two spring lock washers, four round washers
- cold shrinkable tube shall be silicone rubber, grey color, outdoor type, power frequency withstand voltage 30 kV 3 (three) minutes and suitable for covering terminal of bushings and lugs to protect short circuit from birds, squirrels and others.

Note See drawing.no. 631020 sh.no. 3 of 6 for details of connection.

y) Others equipment or accessories according to manufacturer's design.

6201I **Control Equipment**

6201I1 The control equipment shall be contained in a weatherproof control cabinet.

6201I2 The control cabinet shall be stainless steel. The cabinet shall be suitable for outdoor installation on the concrete pole at approximately 1.5 meters above ground level by using three 5/8 inch bolts, 40 cm spacing.

Each door of control cabinet shall have at least 3 (three) locking points. The space between door and door frame at the left and right side shall be at least 3 (three) cm to prevent water go into the cabinet.

The control cabinet shall have vent with metal screen to prevent condensation

620113 Control equipment shall be encased in control cabinet, the control cabinet shall be designed to protect unqualified person from operating of the switch. The cabinet shall be provided with the followings:-

a) Circuit breaker for the control circuit.

b) Surge protective device between L-N and N-G, shall be according to IEC 61643-11 (2001) : Low-voltage surge protective devices with the following ratings:

- Arrester class : class II
- Nominal voltage, Un : 230 V AC
- Maximum continuous operating voltage, Uc : 255 V AC
- Maximum temporary over voltage withstand, 5 s, UT (L-N) : 345 V AC
- Nominal discharge surge current, In (8/20 μs) : ≥ 5 kA per phase
- Maximum discharge surge current, Imax (8/20 μs) : ≥10 kA per phase
- Voltage protection level, Up : ≤ 2 kV

Mechanical specification as follows:

- Temperature range cover : 0 °C to 70 °C
- Mechanical protection level : IP20
- Connection Type : Screw terminal
- Conductor size : 1.5 – 2.5 mm^2

Surge protective device shall be Installed in parallel on Din rail 35 mm.

Surge protective device shall be manufactured by factory who receives ISO 9001 certified.

c) Power supply for control equipment and telecontrol device shall be meet the following requirement:

- Voltage input : 230 Vac, 50 Hz
- Voltage output : 24 Vdc.
- Current output : 15 A or better.

d) Backup battery shall be 24 V Lithium-ion or Ni-MH with at least 3 years life service at 50 °C. The maximum dimensions of the battery shall not exceed the minimum battery installation area of 180x200x180 mm (Height x Width x Depth) (see drawing no. 631021 sh. 2 of 3). The minimum capacity of backup battery shall be 15 Ah; otherwise MEA will not consider such offer. Battery test terminal shall also be supplied.

The battery charger with sufficient capacity for charging backup battery.

The battery charger shall be suitable for each type of battery and shall have alarm function when battery failure.

The battery charger shall also have a function to automatically charge/discharge with adjustable time to extend the life time of the battery.

The battery charger shall have battery cut-off function as the following conditions:-

- Higher or lower voltage than the designed operating voltage of the battery.
- Over current or battery short circuit.
- Over temperature of the designed limit of the battery.

Note 1. Back up capacity shall be at least 3 hours and enough for two (2) open-close cycles of the load break switch.

2. Battery shall not be used during normal operations.

e) Selector switch for:

e1) REMOTE / LOCAL.

e2) Switch OPEN operation (the switch type shall be push and turn with spring return), marked with label "ปลด". The color of the switch shall be green.

e3) Switch CLOSE operation (the switch type shall be push and turn with spring return), marked with label "สับ". The color of the switch shall be red.

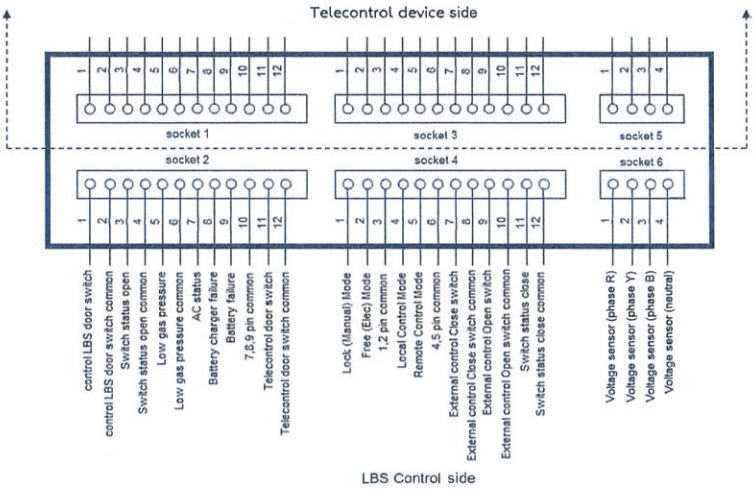
f) Indicator lamps for:

- DC ON
- AC ON
- Battery failure
- Battery charger failure
- Manual / ELEC (or FREE / LOCKED).
- Low gas pressure.
- REMOTE / LOCAL.

g) Switch position indicator lamps for OPEN (green) and CLOSE (red).

Note - Indicator lamps shall be marked with label "ปลด" for OPEN and "สับ" for CLOSE respectively.

h) The connection between telecontrol device and LBS control with industrial grade terminal socket or terminal board shall be as follows:



Note: Other terminal socket or terminal board design may be accepted by MEA's approval.

i) Humidity control anti-condensation heater. Fans or other electro-mechanical cooling devices shall not be used in the telecontrol device.

j) Weatherproof fitting, for control cable. Wiring shall be installed in wire duct (raceways). Wire and cable connectors and terminators shall be permanently labeled for identification. Connection points or external cables and wires shall be easily accessible for connection/disconnection.

k) All control cabinets shall be locked and operated by master keys model EuroKey 5333, for the upper door and the lower door. Once a manufacturer is awarded the contract, he, if awarded for the next contract in the future, shall also supply the same master keys as previously supplied for his preceding contract.

l) Operations counter, for recording the number of switching cycle.

m) Nameplate of telecontrol device. Schematic diagram, wiring diagram and circuit diagram shall be attached inside the cabinet

n) 5 (five) meters long of 3/4 inch liquid tight flexible conduit and patch cords.

o) Control circuit board and control cabinet which shall be easy for inspection and maintenance. Color of internal wiring cable between CT, VT, control circuit and telecontrol device circuit inside the control cabinet shall be brown, black and grey for phase R, phase Y and phase B respectively. The telecontrol board, local control board, and other accessories shall be installed on the supporting plate with the dimension (height x width) according to drawing no. 631021 sh.no. 2 of 3.

p) Output / Input terminal block for telecontrol device interfacing (see clause 6201J). For CT, Voltage sensor terminal block can be connected to banana jack.

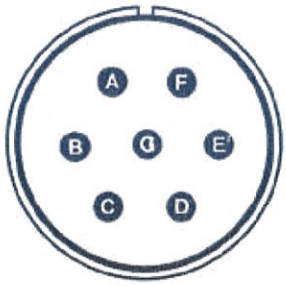
q) Socket(s) [receptacle connector(s)] at control cabinet for all control cable(s) in clause 6201H4 i) according to standard no. MIL-C-5015 model 28-11 (see detail in Figure 1).

Box Connector Receptacle	Function/Status
A	'OPEN' Contact Switch 1 from LBS
B	'CLOSE' Contact Switch 1 from LBS
C	'OPEN' Contact Switch 2 from LBS
D	'CLOSE' Contact Switch 2 from LBS
U	Signal from voltage sensor at VS2 side (phase R)
V	Signal from voltage sensor at VS2 side (phase Y)
W	Signal from voltage sensor at VS2 side (phase B)
X	Signal from voltage sensor at VS2 side (neutral)
L	+24 Vdc power supply for LBS
M	0 Vdc power supply for LBS
K	Negative terminal of Single direction LBS Motor
J	Positive terminal of Single direction LBS Motor
E	Positive terminal of Bi-Direction LBS Motor (Open)
F	Negative terminal of Bi-Direction LBS Motor (Open)
G	'Free/Lock' contact switch from LBS
H	'Low gas' contact switch from LBS
I	'NOT Low gas' contact switch from LBS (if used)
R	Signal from voltage sensor at VS1 side (phase R)
S	Signal from voltage sensor at VS1 side (phase Y)
T	Signal from voltage sensor at VS1 side (phase B)
N	Signal from voltage sensor at VS1 side (neutral)

Box Connector Receptacle	Function/Status
P	-

Figure 1

Socket(s) [receptacle connector(s)] at control cabinet for current signal from current transformer according to standard no. MIL-C-5015 model 24-2 (see detail in Figure 2).



Pin	Designation use signal from current transformer
A	Measuring winding (Phase R signal)
B	Measuring winding (Phase R loop back)
C	Measuring winding (Phase Y signal)
D	Measuring winding (Phase Y loop back)
E	Measuring winding (Phase B signal)
F	Measuring winding (Phase B loop back)
G	N/A

Figure 2

r) One duplex receptacle or equivalent for 230 Vac supply, shall be mounted on DIN rail in the lower part of the cabinet.

s) Lifting facilities.

t) Lamp circuit test.

u) Limiting switches for checking status of cabinet doors.

v) Telecontrol device (see clause 6201M).

w) Terminal blocks for connection telecontrol device (see clause 6201J for number of terminal)

x) Interior LED light controlled by door switch.

y) Isolating transformer 230/230 V at least 500 VA. The neutral at secondary side (control cabinet supply) shall be connected to ground bar inside the cabinet.

Note: See drawing.no. 631020 sh.no. 4 of 6 for details of connection.

z) Others according to manufacturer's design.

aa) Socket(s) [receptacle connector(s)] at control cabinet for LV power supply or voltage transformer according to standard no MIL-C-5015 model 20-15 (see detail in Figure 3)

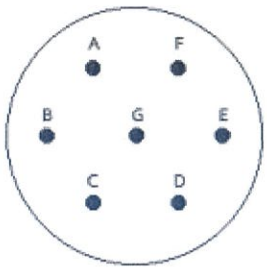


Figure 3 Socket for LV power supply or voltage transformer

For LV power supply connection, Pin E for Neutral wire and Pin F for Phase wire. Other pins (Pin A, B, C, D and G) are not available.

ab) LV power supply

One 2 x 2.5 mm^2 copper cable according to TIS 11 part 101-2559, table 4 with 6 meter length for connection between MEA's LV power line and control cabinet shall be supplied including connecting plugs (MIL-C-5015 model 20-15) at one end to connect with socket in clause 620113 aa) and 2 sets of piercing connector with 120-185 mm^2 run and 2.5 mm^2 tap. The cable shall be marked of Line and Neutral at the end of the wires. The following piercing connectors are approved by MEA:

a) SICAME, France
b) SIMEL, France
c) MICHAUD, France
d) Other equivalent.

ac) Control Cable for Voltage Transformer (if required)

One control cable for connection between voltage transformer and control cabinet having the following properties shall be supplied:-

a) 7 cores of 1.5 mm^2 copper conductor, copper or brass tape shield.
b) 11 meter length.
c) Connecting plugs at both end to connect to socket in clause 620113 aa).

Note The design of user interface panel shall be according to drawing no. 631021 sh. no. 3 of 3.

620114 The cabinet having dimensions more than those shown in MEA drawing no. 631021 sheet no.1 - 2 shall not be considered.

For the control equipments and telecontrol device designed with module plug

on control circuit board (plug and socket arrangement) plug and socket arrangement, the compartment of telecontrol and local control can be integrated in the same one.

Telecontrol device supporting structure inside the cabinet shall be also provided and submitted to MEA for approval.

6201J **Output / Input points for telecontrol device interfacing**

A typical list of the output / input points of the analog and status signals of the switches for telecontrol device interfacing shall be as follows:

Item	Signal	Quantity per switch
Output analog signals :		
Current-Phase R	0-1 A	1
Current-Phase Y	0-1 A	1
Current-Phase B	0-1 A	1
Voltage R-N	0-2.4/√3 VAC	1
Voltage Y-N	0-2.4/√3 VAC	1
Voltage B-N	0-2.4/√3 VAC	1
Output status (discrete) signal :		
Switch Open	Auxiliary contact	1
Switch Close	Auxiliary contact	1
Local Control Mode	Auxiliary contact	1
Remote Control Mode	Auxiliary contact	1
Lock (Manual) Mode	Auxiliary contact	1
Free (Elec) Mode	Auxiliary contact	1
Low gas pressure	Auxiliary contact	1
Battery failure	Auxiliary contact	1
Battery Charger failure	Auxiliary contact	1
Control LBS Door Switch	Auxiliary contact	1
Telecontrol door switch	Auxiliary contact	1
AC Status	Auxiliary contact	1
Input external Control Signals :		
Open Switch	Auxiliary contact	1
Close Switch	Auxiliary contact	1

Note Any signals measured by software and send to DMS by telecontrol device shall be accepted.

6201K **Other Accessories**

6201K1 The following accessories shall be provided :

a) Steel crossarm, brace, frame and other hardwares for installing on concrete pole. See drawing no.631020 sh.no.1 and 2.

b) Other accessories (if any).

6201K2 All exposed steel parts shall be hot dipped galvanized.

6201L **Requirement for Type II Load break switch**

6201L1 The number of main circuit leads shall be 3 (three) instead of 6 (six).

6201L2 The number of sets of copper terminal lugs and their accessories shall be 3 (three) instead of 6 (six).

6201L3 Load break switch shall be supplied with porcelain or silicone rubber bushings in overhead line side, and epoxy bushing in underground cable side which shall be suitable for connection to elbow connector. The bushings in overhead line side shall be in accordance with clause 6201H4 m). The epoxy bushing and elbow connector shall be manufactured and tested according to IEEE 386 or equivalent.

6201L4 Load break switch shall be supplied with 3 (three) sets of elbow connector which shall be connected to 12/20 kV single core copper cable of 400 mm^2 or 240 mm^2 as specified in description of supply and the current rating of the cable connector system shall be 600 A.

All parts required for cable connection shall be furnished. Cable connections of the load break switch shall meet the following requirements:-

- shall have voltage test point.
- Being disconnected and then reconnected without damaging any part of the connection systems. The connectors for cable feeder shall be bolt-on type only.
- Being suitable for 12/20 kV copper cable, cross-linked polyethylene insulated, copper wire screen and PE jacketed having the size and dimension as shown below.

Size (mm^2)	240 mm^2	400 mm^2
Conductor diameter (mm)	18.47±1%	23.39±1%
Diameter Over insulation (mm)	30.50-33.50	35.40-38.90
Overall diameter (mm)	39.00-42.20	44.50-48.00

Note see drawing.no.1 sh.no. 1 of 1 for details of the connection.

6201M Requirement for telecontrol device

Telecontrol device can be separated module plug on control circuit board (plug and socket arrangement). The design that telecontrol device permanently integrated to the main control circuit board shall not be accepted.

6201M1 General Requirement

The telecontrol device shall have IED (Intelligent Electronic Device) for distribution automation, which is a fully digitalized and microprocessor-based control device. Basic functions of the telecontrol device are controlling of LBSs (Load Break Switches), status monitoring, and measuring of electric values. All these functions are performed from remote DMS control center through communication.

The telecontrol device shall acquire inputs from and issue output (control) commands to power system devices located on MEA's feeders. Analog input, status input, and control output interfaces shall be provided, where the primary application is DMS control of the LBSs to be provided by others. In this regard, there shall be one telecontrol device per switch, such that the telecontrol device can be used to open and close the switch as well as monitor LBS analog and status signals representing the condition of the LBS and the primary power system. The telecontrol device input and output signals shall be wired to the terminal blocks inside the LBS control cabinet.

The telecontrol device must be of the latest, state-of-the-art design and microprocessor-based with at least 32 (thirty-two) bits addressing and 32 (thirty-two) bits data capability. It shall be possible to conduct all the routine telecontrol device management functions remotely from the master station; visits to the telecontrol device site shall be required only for hardware reconfiguration, upgrade and expansion, and for repair. It shall be possible to remotely run diagnostics, and download operational parameters, such as analog reporting deadbands. It shall also be possible for MEA to remote download/upload the configuration parameters of the telecontrol device and information on its operational status.

The telecontrol device shall automatically start or restart, without need for human intervention at either the telecontrol device itself or from the master station, after it is powered up or after a power outage. An appropriate message shall be sent to the master station when the telecontrol device completes its startup.

All telecontrol device shall be built of all new material of the best industrial grade. All components shall be of current production from reliable component manufacturers. To facilitate expansion and maintenance,

modularity shall be employed in the design of the equipment; all major subassemblies shall carry permanent labels which provide cross reference with the Supplier supplied documentation. Materials that may promote the growth of fungus or are susceptible to corrosion shall not be used.

All equipment shall be designed, manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Supplier. All goods and materials shall be new, unused, and of the most recent or current model. The telecontrol device shall incorporate all recent improvements in design and materials.

The telecontrol device shall incorporate a high-level language processing capability within an architecture that supports convenient installation, maintenance, and expansion features. The configuration shall include functional elements such as a central processing module, I/O module, and time and date facilities.

The central processing module shall handle all protocol emulation, perform data acquisition, and execute control requests. It shall accept commands from the DMS master station, perform address recognition, assemble response messages in accordance with the received command messages, and transmit these messages to the DMS master station. The central processing module shall also provide interfaces for a time standard and a test set.

The central processing module shall manage communications between all other functional modules of the telecontrol device and shall determine the integrity of the telecontrol device. The processor shall provide diagnostic information in the message structure that the DMS shall monitor. A flag shall be set if the telecontrol device performs a restart for any reason including power failure.

MEA shall be able to program the telecontrol device and manage the telecontrol device database from the telecontrol device test set and download parameters and configuration data from the MEA office.

Each I/O module shall be capable of interfacing with analog inputs, digital inputs, control output points, and combinations of point types. I/O modules shall be replaceable without reprogramming, redefinition of configuration parameters, or rewiring.

The telecontrol device shall have an internal clock for data collection coordination and time tagging. This shall include support for feeder fault detection and disturbance data reporting. The resolution of internal shall be 1 (one) millisecond or better, and the clock shall drift by no more than 250 (two-

hundred fifty) milliseconds per day. In addition, the telecontrol device internal clock time shall be maintained within 10 (ten) millisecond of the DMS's time reference. The telecontrol device shall be able to synchronize its internal clock with the DMS master station.

The telecontrol device shall be designed to prevent false control actions from being executed and erroneous data from being transmitted due to communication channel errors. All communications security features recommended by IEC 62351 and the authentication mechanism specified in the IEEE 1815 (DNP3) with Secure Authentication, Version 5.00 shall be provided. This shall include error control to ensure that the probability of undetected bit errors is no greater than 10^{-10} for data and 10^{-14} for control when the channel is operating within the limits of less than or equal to 1 (one) bit error in 10^{4} bits.

In addition, the telecontrol device shall incorporate the following fail-safe design criteria in their control output logic:

a) No false output shall result from a single point of failure in any telecontrol device.

b) No false output shall result during power up or power down of the telecontrol device.

c) No false output shall result from inadvertently inserting a circuit card into a wrong slot within the telecontrol device.

MEA prefers telecontrol device designs that do not require periodic preventive maintenance and inspections. If periodic maintenance is required, it shall be possible to perform all such work in the field without dismounting the telecontrol device and without requiring that the associated medium or high voltage circuit be de-energized.

6201M2 Communication interfaces and equipment

MPLS network shall be used for DMS-telecontrol device communications for most the telecontrol device sites. MEA will supply and install the Remote Front-Ends and necessary network equipment (such as Industrial Ethernet Switches) at the MEA's district offices and the Supplier will supply and install Industrial Ethernet Switches (IES) for each telecontrol device.

The particular type of telecontrol device proposed and supplied by the Supplier shall also be available to support the cellular communication systems (provided by MEA) which may be chosen on a case-by-case basis for communications between the DMS and the telecontrol device.

In order to make the communication equipment interchangeable, all types of communications equipment shall be connected to the telecontrol device via an RJ45 Ethernet port interface.

The telecontrol device shall be provided with multiple ports for data communications with external devices. These ports shall be assignable to different data categories, such as IEDs as well as the DMS, and shall be capable of supporting options for RJ45, RS232, RS485 or USB interfaces.

Each telecontrol device shall include 1 (one) RJ45 Ethernet port for Industrial Ethernet Switches (IES) or cellular router. Another 1 (one) RS232 port or RJ45 Ethernet port shall be used as configuration port. The design differing from the requirement above shall be submitted to MEA for approval. The Supplier shall supply his equipment and all of necessary communication devices for connection with MEA provided fiber optic cable (terminated at OFDF cabinet), which shall be connected to the IES and to the telecontrol device via the RJ45 Ethernet port interface.

Each telecontrol device shall also include a separate connector for the telecontrol device test system described in clause 6201M6.

The telecontrol device shall communicate with their respective DMS via MPLS system and cellular communication system.

The telecontrol device shall communicate with the DMS using the protocol IEEE 1815 (DNP3) protocol. Both DNP3 over TCP/IP and DNP3 serial shall be supported by the telecontrol device.

Bidders shall provide the completed IEEE 1815 (DNP3) Device Profile Document and Implementation Table to MEA in the bid proposal.

The IEEE 1815 (DNP3) Subset Level 1or higher Conformance Certificate shall be submitted to MEA before the 1st (first) batch of Factory Routine Test (FRT). The IEEE 1815 (DNP3) Subset Level 1 or higher Conformance Certificate shall be issued ONLY by the DNP Users Group's Authorized Testing Authorities, i.e.:-

1. Advanced Control Systems (Georgia, USA)

2. Reltronics (CANADA)

3. Subnet Solutions (Calgary, CANADA)

4. Other authorized testing authorities.

The 1st (first) batch of Factory Routine Test (FRT) shall not be started until the IEEE 1815 (DNP3) Subset Level 1 or higher Conformance Certificate is submitted to MEA.

The additional IEEE 1815 (DNP3) requirements over the Subset Level 1 shall be implemented by the supplier during the project implementation. IEEE 1815 (DNP3) masters and outstations shall implement the authentication mechanism specified in the IEEE 1815 (DNP3) with Secure Authentication, Version 5.00.

The Supplier shall provide all necessary equipment required to implement an Ethernet Fiber Optic Network for communication between supplied telecontrol device to MEA's existing DMS Front-End Processor (FEP). The communication between DMS FEP and telecontrol device will be either over point-to-point or point-to-multi-point IP-based communication channels.

6201M3 Industrial Ethernet Switches (IES)

Fiber Optic Industrial Ethernet Switches (IES) shall be provided for each telecontrol device, and shall be fully compatible and integrated with the MEA's fiber optic cables, MEA's communication topology and MEA's existing IES network and IES Network Management System (IES-NMS).

The Integration and network expansion of new supplied IES shall not be in anyway, degraded the system performance and functionalities of MEA's existing IES Network and associated IES-NMS. The Integration of supplied IES into MEA's existing IES network shall be tested as a part of the Full Functional Test (FFT). Addition, Adaption and/or Modification required for MEA's existing IES-NMS shall be the responsibility of the supplier.

The Industrial Ethernet Switches (IES) shall meet the Specification as per the following table.

IES Requirements	
1. Industrial type	IEC 61850-3, IEEE 1613 and FCC Certified
2. Ethernet switch type	Managed with SNMPv2C or later supported
3. Ethernet protocol supported	IEEE 802.3 and IEE 802.3u
4. Network operation topology	redundant rings
5. Interface	At least 6 RJ45 & 2 single mode fiber (ITU G.652 and ITU G.652D)
5.1 RJ45 ports	10/100Base-TX
5.2 Fiber optic port speed	100Base-FX
5.3 Fiber optic port wavelength	1310 nm
5.4 Fiber single mode optimal	9/125 um
5.5 Fiber distance	40 km or better
6. Installed switches in ring	up to 50 switches

IES Requirements	
7. Power input	At least 1 (one) set of 24 Vdc power input
8. Optical Power: Receiver Saturation Power	At least -12 dBm
9. Optical Output Level	At least -12 dBm
10. Receiver Sensitivity Level	At maximum -26 dBm
11. Fiber Optic Connector	SC
12. Operating Temperature Range	0 °C to 70 °C
13. Installation	Din rail

To implement the redundant rings topology the Industrial Ethernet Switches (IES) shall support the Rapid Spanning Tree Protocol (RSTP) standard defined in IEEE 802.1w.

6201M4 Input/Output Requirements

The following types of I/O are required:

- AC analog inputs
- DC analog inputs
- Status (contact) inputs
- Control (contact) outputs
- Pulse accumulator inputs
- Setpoint output (option)

The telecontrol device minimum point list to DMS master stations are summarized as follows:

Analog Points:

	Point Name	Units	Location
1	Current Phase R	Amp	TELE Cabinet
2	Current Phase Y	Amp	TELE Cabinet
3	Current Phase B	Amp	TELE Cabinet
4	Voltage Phase R-Y	kV	TELE Cabinet
5	Voltage Phase Y-B	kV	TELE Cabinet
6	Voltage Phase B-R	kV	TELE Cabinet
7	Real Power Phase R	MW	TELE Cabinet
8	Real Power Phase Y	MW	TELE Cabinet
9	Real Power Phase B	MW	TELE Cabinet
10	Real Power Total	MW	TELE Cabinet

11	Reactive Power Phase R	MVAr	TELE Cabinet
12	Reactive Power Phase Y	MVAr	TELE Cabinet
13	Reactive Power Phase B	MVAr	TELE Cabinet
14	Reactive Power Total	MVAr	TELE Cabinet
15	Power Factor (pf) Phase R	%	TELE Cabinet
16	Power Factor (pf) Phase Y	%	TELE Cabinet
17	Power Factor (pf) Phase B	%	TELE Cabinet
18	Power Factor (pf) Total	%	TELE Cabinet
19	Temperature	°C	TELE Cabinet

Status Points:

	Point Name	Units	Location
1	LBS status	Close/Open	TELE Cabinet
2	Control Mode	Remote/Local	LBS Cabinet
3	Control Lock/Free Status	Lock/Free	LBS Cabinet
4	Control Inhibit Status	Inhibit/Normal	TELE Cabinet
5	SF_6 Gas Low Pressure	Alarm/Normal	LBS Cabinet
6	Battery Failure	Alarm/Normal	LBS Cabinet
7	Reserve	Alarm/Normal	LBS Cabinet
8	Battery Charger Failure	Alarm/Normal	LBS Cabinet
9	AC Status	Alarm/Normal	LBS Cabinet
10	TELE's Enclosure Door Open	Alarm/Normal	TELE Cabinet
11	LBS's Enclosure Door Open	Alarm/Normal	LBS Cabinet
12	Positive Fault Indicator Phase R	Alarm/Normal	TELE Cabinet
13	Positive Fault Indicator Phase Y	Alarm/Normal	TELE Cabinet
14	Positive Fault Indicator Phase B	Alarm/Normal	TELE Cabinet
15	Negative Fault Indicator Phase R	Alarm/Normal	TELE Cabinet
16	Negative Fault Indicator Phase Y	Alarm/Normal	TELE Cabinet
17	Negative Fault Indicator Phase B	Alarm/Normal	TELE Cabinet
18	ATS Status	Disable/Enable	TELE Cabinet
19	ATS's Unbalance/Under Voltage	Normal/Alarm	TELE Cabinet
20	ATS's Over Current Status	Normal/Alarm	TELE Cabinet
21	ATS in Progress	Normal/Start	TELE Cabinet
22	ATS Transfer Success	Normal/Success	TELE Cabinet

	Point Name	Units	Location
23	ATS Transfer Fail	Normal/Fail	TELE Cabinet

Remarks: Point No. 18-23 are only applicable for the TELE with ATS Function.

Control Outputs:

	Point Name	Location
1	LBS Open Command	TELE Cabinet
2	LBS Close Command	TELE Cabinet
3	ATS Status Disable	TELE Cabinet
4	ATS Status Enable	TELE Cabinet

Remarks: Point No. 3-4 are only applicable for the TELE with ATS Function.

However, telecontrol device shall provide as minimum the number of hardwire points (calculated points not included) specified in the following table:

AC Analog Inputs:	Voltage sensors and CT (3 phases including neutral)
Digital Inputs:	32 points
Digital Outputs:	4 points
DC Analog Inputs:	For temperature (if needed)

Spare control points shall include external auxiliary control relays (if required for the proposed telecontrol device).

The spare points shall be wired from the telecontrol device I/O card to the associated terminal strips in the controlled device. Additional I/O points on the I/O card beyond that needed to satisfy the requirement for spare points need not be wired to the control cabinet terminal strips.

It shall be possible to expand the telecontrol device by an additional 10% (ten percent) of the initially delivered (including spare) I/O points by merely adding circuit cards and terminations.

The telecontrol device shall be able to report both status and analog data either by exception or completely, as requested by the DMS. For reporting by exception, an acknowledgment mechanism is required to ensure that change flags are not reset before receipt of the changes is acknowledged by the DMS.

In addition to the specific requirements stated below, the telecontrol device shall also comply, as applicable to this specification, with the requirements of Chapter 5.4, Data and Control Interfaces, of IEEE Standard C37.1-1994 or later.

AC analog inputs

AC analog inputs will be used for most of the power system telemetry. The telecontrol device shall acquire analog inputs from the I/O terminals in the LBS cabinet supplied by others or from voltage sensors and three-phase CTs.

The telecontrol device shall support the use of voltage sensors/CTs in Y/Y configurations. The supplier shall provide an telecontrol device designed to use transducerless inputs or IEDs with sufficient isolation and protection against switching surge and transient introduced from the power line which may jeopardize other complicated electronic part of the telecontrol device. The minimum precision of the analog to digital converter shall be at least 12-bit.

The AC analog input units of telecontrol device shall be designed for operation with voltage sensors and CTs. Many measurements will be taken from 230/400 Volt LV circuits, and the AC inputs shall impose a low burden that is commensurate with the capabilities of CTs and voltage sensors designed for LV circuits. The AC analog input units of telecontrol device shall be designed for operation with post sensors

The telecontrol device shall support the CTs and voltage sensor as specified ratings and features in Clause 6201H4.

The telecontrol device shall acquire the inputs from IEDs or directly without transducers and shall use these inputs to calculate true RMS, 50 Hz phasor, and other power quality data, such as harmonics, voltage sags, voltage swells, etc.

a. Three phase volts (RMS) (line – line and phase voltage)

b. Three phase and neutral current (RMS)

c. kW, kVAR, kWh, kVARh, by phase and total

d. Power factor (0-360 degree)

e. Direction of current flow

f. Fault indications

g. Harmonic distortion for the voltage and current of each phase.

Total Harmonic Distortion (THD) shall be calculated as the square root of the sum of the squares of RMS values for all the measured harmonics (up to 15th order).

It shall be possible to assign the various values provided by the AC analog input units to different groups of analog data, so that values such as THD can be read less frequently than values such as voltages and currents.

The resolution of analog values shall not be less than 12 (twelve) bits, including the sign bit for bipolar values. Real time values, items a and b above,

shall be reported with an accuracy of no more than 0.25% of the nominal full scale value (positive or negative for bipolar values) over the complete range of operating conditions specified for the telecontrol device.

The telecontrol device shall accept current input signals with normal signal ranges suitable for rated secondary current of CT. In addition, the telecontrol device shall be able to read current signals as high as 20 (twenty) times the maximum normal signal for up to 1 (one) second in order to detect fault current. The normal signal range for voltage inputs shall be suitable for rated secondary voltage of voltage sensor. The telecontrol device shall be able to read voltage signals up to 125% of the maximum normal voltage signal. The sampling rate for ac quantities shall be at least 32 (thirty two) samples per cycle.

The telecontrol device shall report analog values to the DMS by exception. The telecontrol device shall report all analog values that have changed by more than a programmable deadband from the last value that was successfully reported to the DMS. The deadband shall be specified for each point individually.

DC analog inputs

DC analog inputs shall be used to monitor 1-phase currents and available to support measuring telemeter ambient and transformer oil temperature which employed in the future.

The telecontrol device shall accept analog inputs in the range of 1 mA, 10 mA, 4-20 mA or +5 volts. For current inputs, the input impedance shall be such that the voltage across the input terminals does not exceed 10 (ten) volts with full scale input current, and no damage shall occur for sustained 100% (one hundred percent) overcurrent. For voltage inputs, the input impedance shall not be less than 10 (ten) MΩ. With only minor hardware changes it shall be possible to adapt each individual analog input terminal for any of these input ranges.

Analog to digital conversion shall be with a resolution of 12 bits, including the sign bit for bipolar conversion. The following performance requirements shall be met throughout the range of operating conditions specified for the telecontrol device:

a. A/D conversion linearity	1/2 LSB
b. A/D quantizing error	1/2 LSB
c. Overall accuracy, from input terminal to digital value	≤ 0.1% of full scale at 25°C with less than +0.005%/°C temperature error
d. Common mode rejection	90 dB, DC to 50 Hz

e. Normal (differential) mode rejection 60 dB, at 50 Hz

In the definition of accuracy above, "full scale" is the maximum positive or negative reading.

Each telecontrol device shall be calibrated at the factory with precise reference inputs at 0 and +/- 90 % of the full scale analog input. The long term stability of the references shall be better than 0.1% of full scale over the specified range of the operating environment. The references shall be used for calibration of the input and analog-to-digital conversion circuitry, and the converted analog values shall also be available to the master station. Analog reference points are not included in the count of analog points.

Status inputs

The Supplier shall supply the necessary sensing voltage, current limiting, input isolation, and bounce filtering for all status inputs. The debounce time period for each status input shall be individually configurable. The input circuits of the status input modules shall be optically isolated from the external signal. In addition, each input circuit shall include an LED indicator next to the circuit terminations to show the status of the associated input contact. Alphanumeric display(s) (with keypads or buttons) to indicate input circuit and module information are acceptable.

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 unless the point state has changed from the last scan. The telecontrol device shall also report the state of selected status points upon receipt of a demand scan request from the DMS.

For a free-contact(s), the Supplier shall provide all necessary optical isolator and bounce filter components to protect against contact bounce and transients in the power system. The input shall also be filtered so that a change of state shall last a minimum of 10 (ten) milliseconds before being detected. In each point of digital input, telecontrol device shall have LED (Light Emitter Diode) or LCD (Liquid Crystal Display) indicator (with a keypad or buttons) next to the circuit terminations to show the status of the associated input contact. For the LCD indicator, the screen saver facilities shall be included.

Status inputs will be used to monitor the state of devices and alarms through the sensing of the state of contacts. All status input circuits shall include optical isolation which not less than 2,000 V. All status inputs shall be digitally filtered to avoid false indications by contact bounce. They shall be scanned once every 1 (one) millisecond and status changes shall be reported if, and only if, they last 10 (ten) milliseconds or more. Status points shall be immune to 50

(fifty) Hz noise up to at least 3 (three) VAC.

It shall be possible to invert status inputs, on a per point basis, so that a "B" or normally closed contact can be reported as an "A" or normally open contact.

A multi change detection (MCD) capability is required for reporting of multiple status changes that may occur at fast switching devices between master station scans. Polling rate may be slow at some locations. Therefore the telecontrol device shall be able to report at least up to 8 (eight) status changes that occurred at a status point between two scans. In case of MCD buffers overflow, the existing data shall not be over-written by the new ones and the overflow shall be reported to the master station. MCD information or change and status flags shall not be reset without acknowledgment that they were received by the master station.

The telecontrol device shall include the following types of status input points:

a. Single Contact. Two-State Status: For single contact, two-state status 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: For double contact, two-state status input points, separate 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 (e.g., one contact indicates CLOSED and the other indicates OPEN) shall be labeled INVALID.

c. Sequence-of-Events: The telecontrol device shall include a sequence-of-events (SOE) reporting capability. It shall be possible to assign any status input point to SOE reporting in addition to normal status reporting. The telecontrol device shall detect changes in the state of SOE points, record the date and time of change with a resolution of plus or minus one millisecond (±1 ms) relative to the telecontrol device internal clock, inform the DMS that SOE data has been recorded, and report SOE data to the DMS upon request. To ensure that SOE data is not lost or overwritten until the DMS acknowledges receipt of the data, an telecontrol device buffer capable of storing a

minimum of 512 (five-hundred and twelve) events shall be provided. The telecontrol device shall be able to retransmit stored SOE data if requested-by the DMS.

Control outputs

The telecontrol device shall include the following types of control points to support control actions initiated from the DMS:

On/Off Device Control: The telecontrol device 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 "Off" control action. The telecontrol device shall be designed such that only one output in a complimentary pair can be activated at a time.

To support the above capabilities, the telecontrol device shall include momentary control outputs, latching control outputs, and analog control outputs, as required by the feeder device being controlled. 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.

Control point selection shall be canceled at the telecontrol device if the operate command is not received within a programmable time period measured at the telecontrol device by a "Command Receipt" timer. The telecontrol device'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 and 60 seconds. The time period shall initially be set at 10 seconds.

MEA prefers that the telecontrol device control outputs be equipped with high power relays that are integral to the telecontrol device so that external auxiliary control relays are not required. All control outputs shall be capable of driving a load of primary control voltage. These relays shall be supplied by the Supplier.

The operation time of each contact shall preferable be adjustable either at the DMS and then downloading to the telecontrol device or alternatively be predefined in the telecontrol device's nonvolatile EEPROM memory or equivalent. In each point of digital output telecontrol device shall have LEDs for indicating the active point. Alphanumeric display(s) (with keypads or buttons) to indicate input circuit and module information are acceptable.

A select-before-operate (SBO) procedure shall be employed between the DMS and the telecontrol device, and the output relays shall be operated only

upon confirmation by the DMS of the correct selection of both the controlled point and the commanded state in the telecontrol device. A complete SBO procedure is required for each control command sent to the telecontrol device, including commands associated with control procedures such as Raise/Lower, which may not require point reselection by the operator for each command. It shall be possible to operate only 1 control point at a time in an telecontrol device; attempts to operate additional points shall be rejected. Point selection shall be cancelled after a control is executed. Selections shall also be automatically cancelled when no execution command is received within 10 seconds from the time that a point is selected. Circuitry to monitor relay drivers and prevent their unintentional closures due to failures of hardware is required, and no false outputs shall be possible due to the failure of a single component in an telecontrol device. Any test pulse for the detection of hardware failures shall be less than 1 millisecond. The detection of hardware failures shall be reported to the master station.

A Control Disable switch mounted inside the telecontrol device shall inhibit all control outputs by disconnecting the power supply for the coils of the interposing relays; the inhibition shall not rely on electronic circuitry. The state of the Control Disable switch shall be monitored by 1 (one) of the status input points of the telecontrol device. If this Control Disable switch status input is not in the disable position, the local diagnostic test mode for the control output shall be inhibited and warning message should be displayed on the local diagnostic terminal.

6201M5 Feeder fault detection

The telecontrol device shall include equipment or have a function to determine if phase-to-phase or phase-to-ground faults have occurred on the load side or source side of the telecontrol device within 40 (forty) milliseconds. Feeder current data acquired by the telecontrol device shall be used to determine if fault current setpoints have been exceeded for a specified fault level and fault duration time period. If a fault is detected by the telecontrol device, this condition and its time of occurrence shall be reported to the DMS. The fault detection function shall be demonstrated by testing according to these types of faults

a. Three Phase Fault

b. Single Line to Ground Fault

c. Line to Line Fault

d. Line to Line to Ground Fault

Fault current setpoints and fault duration time periods shall be remotely

downloaded from the MEA office.

The feeder fault detection function shall work properly for all possible configurations of the circuit on which the telecontrol device is installed. The feeder fault detection function shall be designed to prevent misoperation due to magnetizing-inrush currents and other transient, no-fault conditions.

Feeder protection in MEA's substations includes automatic circuit breaker reclosing. The maximum fault current for 12 kV and 24 kV feeders is 16 kA and 8 kA respectively. A means shall be provided to ensure that the fault conditions encountered at the telecontrol device during the initial fault and on subsequent circuit breaker reclosers are stored and made available to the DMS. Fault data for the initial fault and earlier reclosers shall not be overwritten by subsequent reclosers.

6201M6 Test and installation equipment

MEA will assume responsibility for routine hardware, testing, and calibration of the telecontrol device, and for repair by trouble shooting and replacement of equipment down to the level of easily replaceable units and modules. MEA may also expand and reconfigure telecontrol device in response to future needs. The Supplier shall provide installation tools to support these activities.

Accidental disconnection of cards, or plug-in assemblies and sub assemblies shall not result in any misoperation of the telecontrol device control outputs and/or damage to the telecontrol device or other equipment.

Telecontrol device hardware test and installation tools

a. Supplier's tools

The instruments that have been developed and purchase for use by the Supplier's installation personnel and can assist MEA with the test and installation – related activities of the Telecontrol device shall be provided for MEA. Please see in Appendix A1 for Test and installation tools.

b. Recommended tools and instrument

The Supplier shall provide a list of commercially available test and installation tools and instruments that are required or desirable for the test and installation tools of the telecontrol device. The Supplier shall provide data sheets for this equipment and assist MEA in the selection and procurement of such test equipment.

Firmware/software development system

a. MEA may purchase a system for maintenance and development of telecontrol device firmware and software. The telecontrol device manufacturer shall either offer such a system to MEA or assist MEA to purchase it from its manufacturer. The Proposal shall therefore include a description of the recommended system and either a price quotation to furnish it or information to enable MEA to obtain quotations from its manufacturer(s).

b. The development system shall enable MEA to maintain and develop firmware and software for the telecontrol device, and also to maintain and upgrade the firmware and software of the telecontrol device test systems to maintain compatibility with telecontrol device upgrades. The development system shall include:

   - Software development facilities
   - Software development utilities and tools specified in IEC61131-3, such as source editors, compilers, software libraries, etc.
   - Development system documentation, including user's manuals, programmer's guides, etc.
   - EEPROM programming equipment and related documentation or better.

c. Documentation and training on the software/firmware development system, and detailed training on the telecontrol device software/firmware itself shall be included with this option.

Telecontrol device firmware and software sources

a. All sources and related files needed to maintain and upgrade the telecontrol device firmware and software, to develop new applications, and to perform corresponding activities on the telecontrol device test systems shall be supplied to MEA. Firmware and software shall not be modified after FFT. These shall include:

   - Sources for all firmware/software including, but not limited to, data flow diagrams, flow charts, design algorithms, etc.
   - Command files to compile and integrate the firmware/software
   - Tools for data-base maintenance
   - Applicable software libraries
   - Protocol listings.

b. Machine readable files on a medium compatible with the development system proposed or recommended in response to

clause 6201M6 are required.

c. MEA shall be permitted to make unlimited use of these sources for the maintenance and enhancement of telecontrol device owned by MEA. In the case that the supplier of the telecontrol device is no longer in business or no longer offers these telecontrol devices in its normal course of business, MEA shall also have the right to use these sources to solicit and purchase telecontrol device from another supplier.

Telecontrol device programmable logic capabilities

The telecontrol device shall provide software development utilities and tools specified in IEC61131-1 and IEC61131-3 such as source editors, compilers, software libraries, etc. Means shall be provided to allow the programmer to create, modify and configure the operation of the telecontrol device which shall preferably by uploading to and downloading from the MEA office and/or from telecontrol device test set. The points concerned in create, modify shall include analog and digital inputs, digital outputs, calculated values. The telecontrol device shall implement Automatic Transfer Switch (ATS) at least one site, consisted of 8 (eight) telecontrol devices, to prove its programmable capabilities. The Supplier shall provide at least 8 (eight) Unbalance Relay and 8 (eight) Overcurrent Relay, specified in Appendix A2 for ATS implementation. ATS function shall be including in telecontrol device (enabled or disabled). Detailed design shall be provided during the project implementation. Please see clause 6201M4 for the ATS minimum point counts.

6201M7 Documentation requirement

Field maintenance documents

Field maintenance documents shall include all information and instructions needed by MEA technicians to install telecontrol device and start them up, and to troubleshoot and repair telecontrol device to the level of replacing printed circuit boards and other easily replaceable modules and assemblies. Hard copies and soft files of field maintenance documents shall be included with the first shipment of each type of telecontrol device.

The field maintenance documents shall address the following topics:

a. Preventive Maintenance: Instructions including all visual checks, software and hardware tests, diagnostic routines, and resultant adjustments and calibrations necessary for periodic maintenance. Required schedules for preventive maintenance shall be included where applicable.

b. Troubleshooting: Instructions for quickly locating malfunctions to the module or assembly level using the telecontrol device test system. The discussions shall contain concise information on equipment operation, with block diagrams and simplified schematic diagrams of electrical, mechanical, and electronic circuits or systems. Troubleshooting guidelines shall be provided for the location of faults, identifying symptoms and probable causes, and instructions for remedying the problems shall be included.

c. Test Parameters: A tabulation of voltage, current, or power measurements as needed for servicing the telecontrol device. This tabulation shall list all test points and their nominal readings. This tabulation shall show nominal values and the acceptable range of deviations.

d. Configuration Drawings: Drawings which identify the location of printed circuit boards, other equipment assemblies, cables, etc.

e. Repair Instructions: Instructions for the removal, repair, adjustment, and replacement of all items. Schematic diagrams, parts-location information, photographs, interconnection cabling, intra-rack wiring data diagrams or tabular listings, and enlarged sectional views of mechanical assemblies shall be provided as necessary to supplement the test. Cautions and warnings to protect personnel and equipment shall be included as needed.

f. Theory of Operation: Tutorials detailing equipment operations.

g. Diagnostics: Use of the telecontrol device test system and other means to verify the proper operation of the telecontrol device.

h. Installation Instructions: User Manuals shall be included with the telecontrol device test system.

Repair shop documentation

Technical Manuals: Manuals with detailed theory operation for the hardware and all information, such as voltages, wave forms, etc., that is needed for trouble shooting and repair to the level of components that can be replaced under workshop conditions, including soldered components.

b. Schematic Diagrams: Detailed schematic diagrams of all printed circuit boards including all OEM equipment such as power supplies, transducers, modems, digital bridge, transceiver, controllers etc., supplied with the telecontrol device.

c. Parts and Components Information: Identification of each replaceable part or component, including electronic components mounted on

printed circuit boards. The parts lists shall identify each part and component to the level of detail sufficient for the procurement from an approved source.

d. Firmware/Software Diagnostics: Instructions for the use of any telecontrol device diagnostics internal to the telecontrol device, or that can be run using tools or instruments

e. Test System Maintenance Documentation: Documentation similar to that furnished for the maintenance of the telecontrol device shall also be provided for the telecontrol device test systems. This requirement does however not apply to standard documentation of commercially available computers included in the test system.

Users manual for the test systems

a. This manual shall cover all the user functions and procedures of the test system for the maintenance, diagnosing and trouble shooting, configuration, and expansion for the telecontrol device of all the classes/models and types supplied under the Contract. The User's Manual shall be well organized, and shall include both a table of contents and an exhaustive index for quick access to the detailed description of each function and procedure.

b. Displays associated with each function shall serve as the main means of explaining user procedures. Actual up-to-date display formats shall be used. User instructions for each function shall start with a brief overview of the purpose and capabilities of the function. This shall be followed by:

- Replicas of all relevant displays.
- A description of each displayed data field. Valid ranges of values or the set of possible legends shall be described.
- The purpose of each cursor selection target or field of dialogue menus.
- Operating procedures and sequences.
- Messages displayed to the operators and their interpretation.
- Error recovery procedures.
- Design and development presentation.
- Bill of quantity (BOQ)

Communications equipment documentation

OEM documentation, including user manuals, diagnostic test procedures, trouble shooting guides, and detailed schematic diagrams is required for the

communications equipment provided by the Supplier.

Telecontrol device configuration drawings

Each telecontrol device shall be delivered with a detailed configuration drawing that shows all replaceable cards/module and spare slots, and their wiring to terminal strips. Space shall be reserved for MEA to annotate the telecontrol device terminations to identify the field devices connected to them.

The configuration drawing shall be delivered in the special compartment that is required for it in the enclosure of the telecontrol device.

Installation & commissioning documents

The Installation & Commissioning documents shall include all information and instructions needed by MEA personnel for installation telecontrol device and commissioning test with the DMS. These documents shall cover, but not limited to, all the functions and procedures of the Site Acceptance Test (SAT).The SAT procedures shall include a full demonstration of the telecontrol device from the perspective of interoperating with its assigned DMS. These documents shall include, if needed, all necessary communication protocols such as the IEEE 1815 (DNP3) to verify that the telecontrol device is fully operational and capable of meeting or supporting all applicable DMS functional performance requirements. Furthermore, these documents shall include point-by-point checks to make sure that the database in the telecontrol device is properly mapped to the corresponding DMS database.

6201M8 Training

Training is required to qualify MEA's personnel to assume full responsibility for the installation, maintenance, and repair of the telecontrol device. telecontrol device test systems, maintenance tools, and test equipment delivered by the Supplier or purchased from other sources on the Supplier's recommendation shall be used in the telecontrol device maintenance training. All training material shall be provided by the Supplier, and MEA shall be permitted to reproduce any of them and to video tape training sessions for internal use.

Three training sequences are required:

a. Field Maintenance and Commissioning Training

b. Repair Shop Training

c. Operation training on LBS and Telecontrol device.

Supplier shall send the training outline course and documents to MEA for approval.

Field Maintenance and Commissioning Training will be attended by up to

20 (twenty) trainees. To better accommodate this number of people, 2 (two) training sessions shall be conducted, and each session will be attended by approximately 10 (ten) trainees. Up to 8 (eight) people will attend the Repair Shop Training. The Repair Shop Training shall be scheduled after the Field Maintenance Training so that its participants can first attend the Field Maintenance Training in preparation for the Repair Shop Training classes. Operation training will be attended by up to 40 (forty) trainees.

6201M9 Maintenance parts and assemblies

Supply of parts to MEA

Supplier-manufactured parts and assemblies which may be needed for the maintenance and repair of telecontrol device and telecontrol device test systems shall be offered for purchase by MEA. Availability of these parts shall be guaranteed for a period of no less than 5 (five) years from the date of the latest delivery of equipment containing these parts or assemblies. The Supplier shall commit to notify MEA at least 12 (twelve) months in advance of any part or assembly becoming unavailable for purchase, in order to enable MEA to stock up on those items.

Application specific components

All Application Specific Integrated Circuits (ASIC) and other custom designed components shall be noted as such in a parts and components information list for the telecontrol device, shall be made available for purchase by MEA, and shall be included in the proposed spare parts. All documentation needed to reproduce the ASICs and other components noted as custom designed shall be held in escrow and released for use by MEA in the event that a supplier fails to make them available for any reason.

6201M10 Factory Acceptance Testing (FAT) documents for approval

Prior to the testing of telecontrol device, the Supplier shall delivery Factory Acceptance Test procedure for the approval by MEA. Generally, MEA will approve the Test procedure within 30 (thirty) days after receipt.

6201M11 Preliminary Factory Acceptance Testing (Pre-FAT)

The Supplier shall conduct preliminary factory acceptance testing (Pre-FAT). In essence, this shall be a dry run of the procedures to be used during the formal factory acceptance testing described in clause 6201M12. The intent is for the Supplier to detect and correct all design, integration, database, performance, and test procedure problems prior to factory acceptance testing. The Supplier's project manager shall sign off on each test. A summary of the completed test results shall be sent to MEA for inspection before MEA's personnel travel to participate in FAT at the Supplier's facilities.

6201M12 Factory Acceptance Testing (FAT)

Responsibility for conducting factory acceptance testing (FAT) shall rest with the Supplier using MEA-approved test procedures prepared and submitted by the Supplier. This testing shall consist of two separate test phases described as follows.

Full Functional Test (FFT)

At least 1 (one) telecontrol device chosen and witnessed by MEA's acceptance committee as a prototype, shall be used to verify that the design of that type of telecontrol device is complete and meets all the requirements of the Contract. This test shall be performed on a fully expanded configuration of the tested type of telecontrol device. Telecontrol device tests shall include:

a. Visual inspection to confirm that construction and sizing requirements have been met.

b. Rigorous testing of each function of the telecontrol device as specified in these Technical Specifications, including all I/O functions. Test telecontrol device shall be used to verify I/O functions that are not included in any other telecontrol device.

c. Accuracy and timing tests, over the operating temperature range of the telecontrol device, including:

   - Accuracy of analog telemetry and analog output (if the setpoint option is chosen)
   - Verification of the timing accuracy for filtering of contact inputs and for the duration of contact closures for control output and pulse accumulator.

d. Verification that telecontrol device firmware and software support expansion of the telecontrol device's spare I/O points as specified in Clause 6201M4.

e. Verification of successful communications with a telecontrol device test system at all specified data rates.

f. Testing for secure operation, including verification that:

   - Communication error detection capabilities meet contract commitments
   - Proper operation of SBO control procedures for contact control outputs and for setpoint control outputs
   - Verification that no wrong control operations occur and no wrong data is generated when power is turned on or off, when AC power is lost and restored, and for operation on low battery voltage.

- Verification of protection against erroneous control output as the result of a single failure, including verification of the function to monitor relay drivers for short circuits.

Factory Routine Test (FRT)

a. The Supplier shall perform a Factory Routine Test (FRT) on each and every telecontrol devices when fully assembled, in readiness for transportation to MEA. The FRT shall demonstrate that all of the component parts and functions of the telecontrol devices are in good working order and properly configured for the telecontrol device's designated site including integration with the DMS. Where applicable, the FRT procedures shall make full use of the DAC Simulator software or third party software.

b. The FRT shall not take place until MEA is satisfied that the FFT corresponding to the telecontrol device that has been declared ready for FRT has been completed successfully.

c. The FRT shall be conducted at the factory where the final assembly and configuration of each telecontrol device shall take place. Transportation for MEA's acceptance committee scheduled to witness any of the FRTs shall be borne by the Supplier. The subsequent procedure shall be as follows:

   - A randomly selected 2% of the first lot shall be tested in the presence of the MEA's acceptance committee. If all telecontrol device selected successfully pass their witnessed FRT and MEA inspection, MEA will declare the entire batch as acceptable. If any of the 2% samples fails to satisfy its witnessed FRT, MEA shall declare the entire batch as unacceptable. Consequently, the Supplier shall make all necessary corrections and notify MEA when the entire batch is ready for retesting.
   - At MEA discretion, the Supplier shall be allowed to make corrections for minor variances associated with the witnessed FRTs without requiring further inspection and testing. Otherwise, all retesting shall take place in the presence of MEA. Furthermore, within this same context, MEA shall have the right to request the retesting of any hardware or software that may be affected by the Supplier's corrections.
   - The Supplier shall submit test reports for all witnessed FRTs. These reports shall be duly signed by the Supplier and approved by MEA prior to accepting any batch.

6201M13 Responsibilities of the supplier

The responsibilities of the Supplier shall include, but not be limited to, the following:

a. Supply according to a Documentation Plan approved by MEA of documentation and reports on telecontrol device functional design, testing, maintenance, upgrading, and operation, including data sheets and technical documentation for OEM equipment, and any other required documentation. Preparation of meeting minutes for MEA's review and approval.

b. Provision of environmental specifications, such as for power, grounding, containment of electro-magnetic interference, dust protection, etc., as necessary for the proper operation of the equipment, and/or to meet the conditions for the Supplier's compliance with the Contract's availability and warranty requirements.

c. Providing ground transportation for MEA's representatives to participate all the tests. All expenses incurred by MEA shall be borne by the Supplier.

d. Supporting the DMS Supplier during overall system commissioning activities. This shall include having the Supplier's personnel readily available to help resolve any problems directly or indirectly related to the telecontrol device during overall system commissioning. It shall also include any necessary modifications or adjustments to the installed telecontrol device.

e. Maintenance of an up-to-date version of the Contract documents, reflecting all the agreed upon change orders.

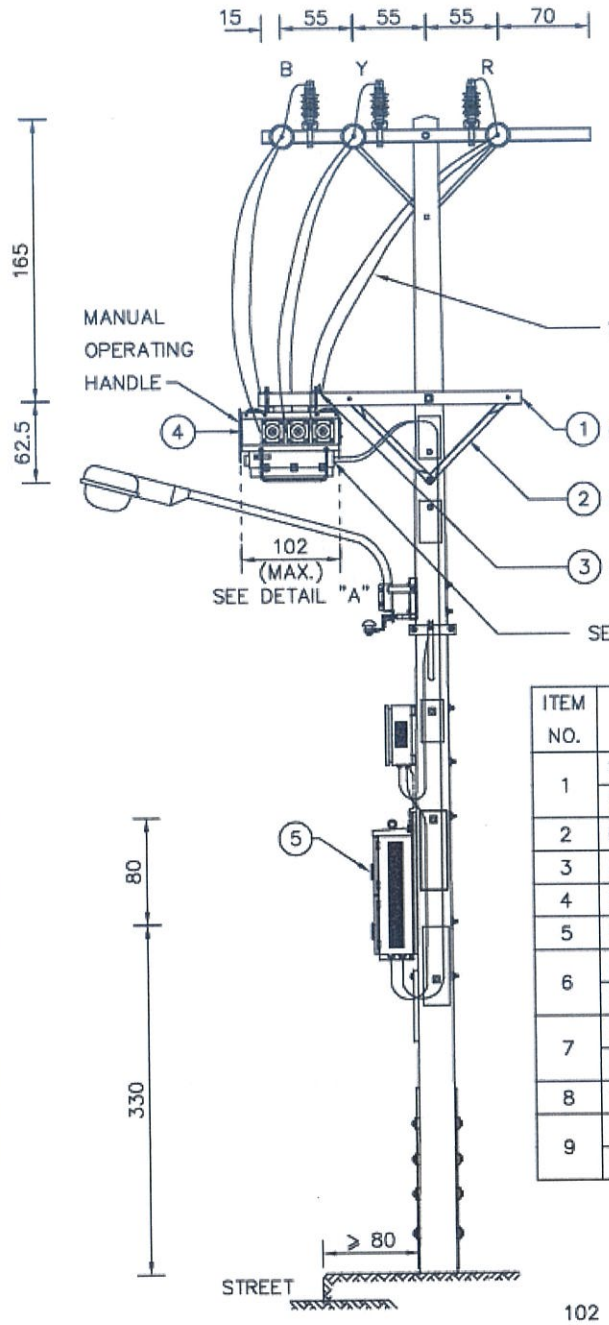
f. Correction of all defects covered by the Warranty.

6201N **Requirements for Marking and Packing**

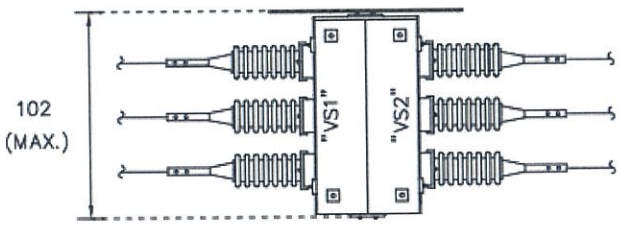
6201N1 All spare parts shall be shipped together with the first shipment of the switch in order to enable MEA to replace the parts which may be damaged during transit.

6201N2 Packing lists shall indicate clearly all loose materials such as spare bushings, spare connectors and etc. which are packed in any certain cases.

6201N3 If any parts are packed in the cartons for containerized shipment, the cartons shall be arranged into pallets so as to facilitate their movement by forklift trucks



ITEM NO.	MATERIAL TO BE SUPPLIED	QUATITY
1	STEEL CROSSARM, HOLLOW SQUARE 100 x 100 x 4 mm 2.00 m LONG	1
2	FLAT BRACE 30 x 8 mm 940 mm LONG	2
3	ANGLE STEEL 65 x 65 x 6 mm 250 mm LONG	2
4	SF_6 LOAD BREAK SWITCH	1
5	CONTROL CABINET	1
6	AL. ALLOY TERMINAL LUG 2-HOLE, NEMA PAD SUITABLE FOR AL. WIRE STRANDED 185 mm²	6
7	1/2" WITH 1-1/4 INCH LONG OR M12 WITH 32-36 mm LONG HEX-HEAD GALVANIZED STEEL BOLT WITH NUT	12
8	1/2" FLAT ROUND WASHER (IEEE C135.80 FIGURE 12)	24
9	1/2" HEAVY HELICAL SPRING LOCK WASHER (ASME B18.21.1 TABLE 2)	12



DETAIL "A"

BOTTOM VIEW

NOTE

1. DIMENSIONS ARE IN cm.
2. "VS1" STANDS FOR VOLTAGE SENSOR 1 AND "VS2" STANDS FOR VOLTAGE SENSOR 2.

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE	NONE
CHF.SEC. Ratchakorn	TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SUPERSEDING DATE :	20/2/2564
CHK.		SH.NO.	1 OF 6
DIR.DIV.		DWG. NO.	631020
DATE 15/2/2566			

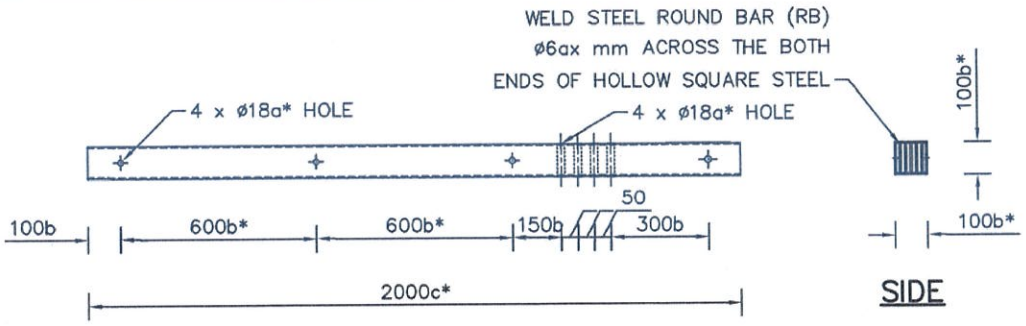


FIG. A CROSSARM, HOLLOW SQUARE STEEL, 100 x 100 x 4 mm, 2.0 m LONG

(CONFORM TO TIS. 107–2533 OR LATEST VERSION & SEE NOTE 2)

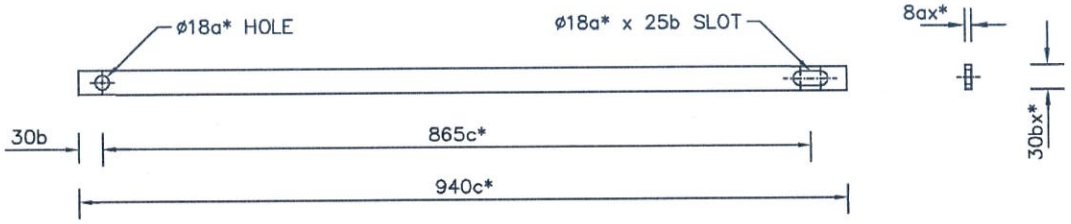


FIG. B CROSSARM FLAT BRACE, 30 x 8 mm., 940 mm. LONG

(CONFORM TO TIS. 55–2516 OR LATEST VERSION & SEE NOTE 2)

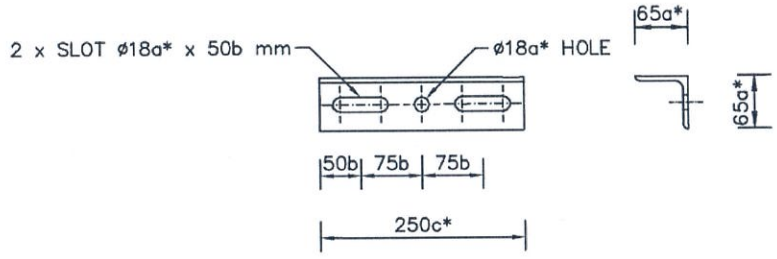


FIG. C ANGLE STEEL, 65 x 65 x 6 mm, 250 mm LONG

(CONFORM TO TIS. 1227–2539 OR LATEST VERSION & SEE NOTE 2)

ALLOWABLE VARIATIONS		
a...1 mm	b...2 mm	SINGLE LETTER INDICATES SAME +OR−, a = ±1 mm
c...5 mm	x...0 mm	TWO LETTERS INDICATE, FIRST+ SECOND−, ax = +1 mm −0 mm

NOTES

1. DIMENSIONS ARE IN mm.
2. GALVANIZE PER LATEST REVISION OF ASTM A 123
3. สำหรับการตรวจรับ ให้วัดขนาดมิติเฉพาะส่วนที่มีสัญลักษณ์ดอกจัน (*)

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant	ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn			SUPERSEDING DATE : 20/2/2564
CHK.		TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SH.NO. 2 OF 6
DIR.DIV.			DWG. NO. 631020
DATE 15/2/2566			

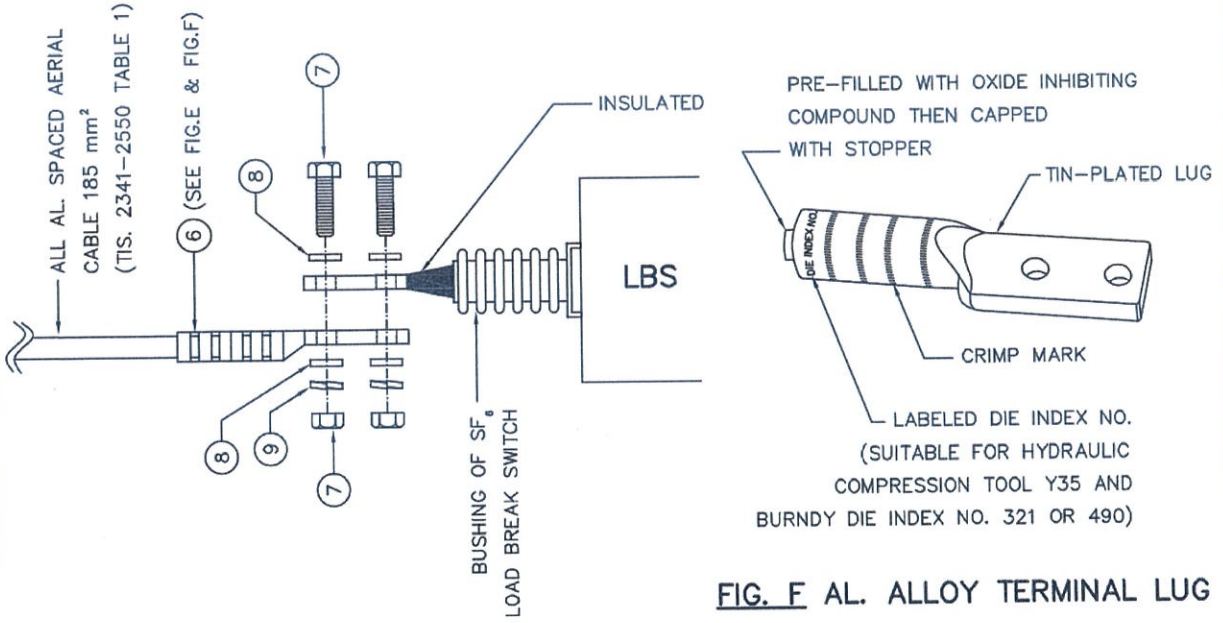
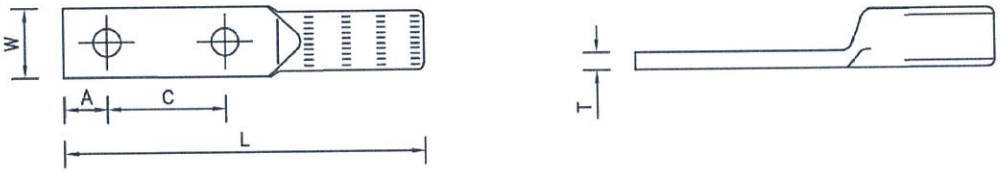


FIG. F AL. ALLOY TERMINAL LUG

FIG. D DETAIL OF TERMINATION CONNECTIONS



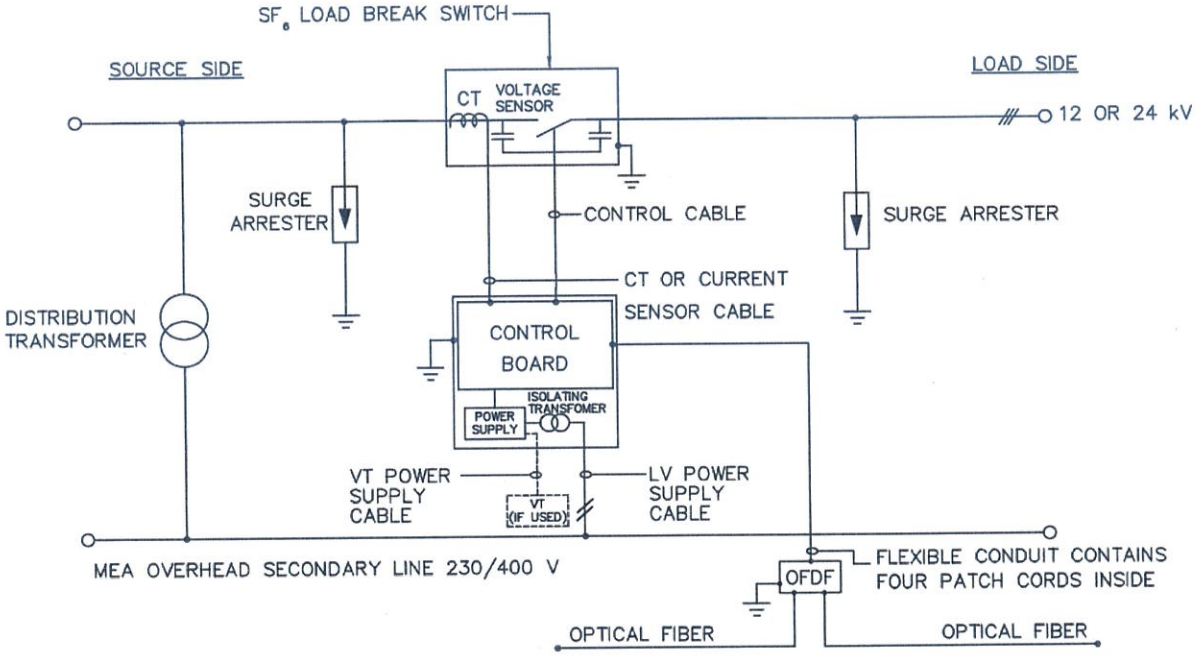
STUD HOLE SIZE	C	A	W	T	L
13–14.2	44.5–45	15.9–18	35–45	8.7–10.5	150–220

FIG. E DETAIL OF NEMA PAD. DIMENSION AND DRILLING

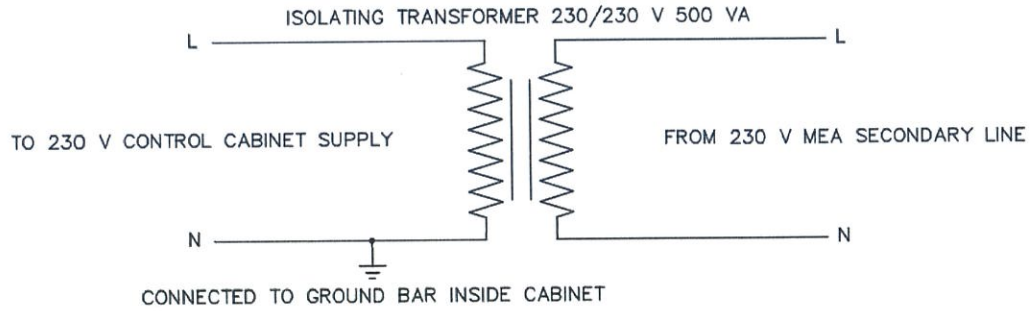
NOTE 1. DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. FOR ACCEPTANCE, THE TERMINAL LUG SHALL BE TEST THE DIMENSIONAL MEASUREMENT AND COMPRESSION TEST WITH MEA's DIE. (6201D5)

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn	TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SUPERSEDING DATE : 20/2/2564
CHK.		SH.NO. 3 OF 6
DIR.DIV.		DWG. NO. 631020
DATE 15/2/2566		



SINGLE LINE DIAGRAM



DETAIL A ISOLATING TRANSFORMER

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn	TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SUPERSEDING DATE : 20/2/2564
CHK.		SH.NO. 4 OF 6
DIR.DIV.		DWG. NO. 631020
DATE 15/2/2566		

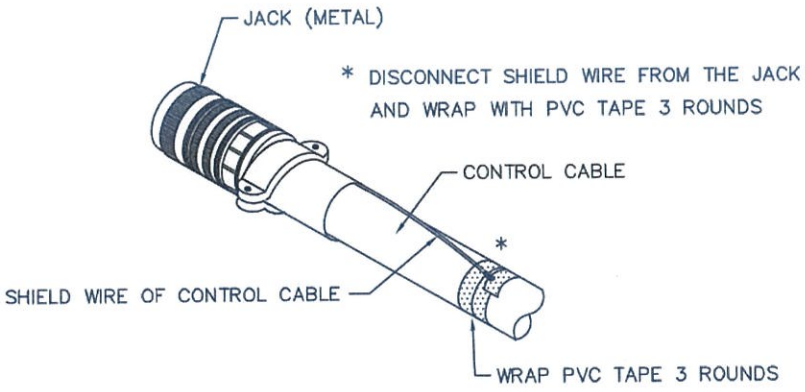
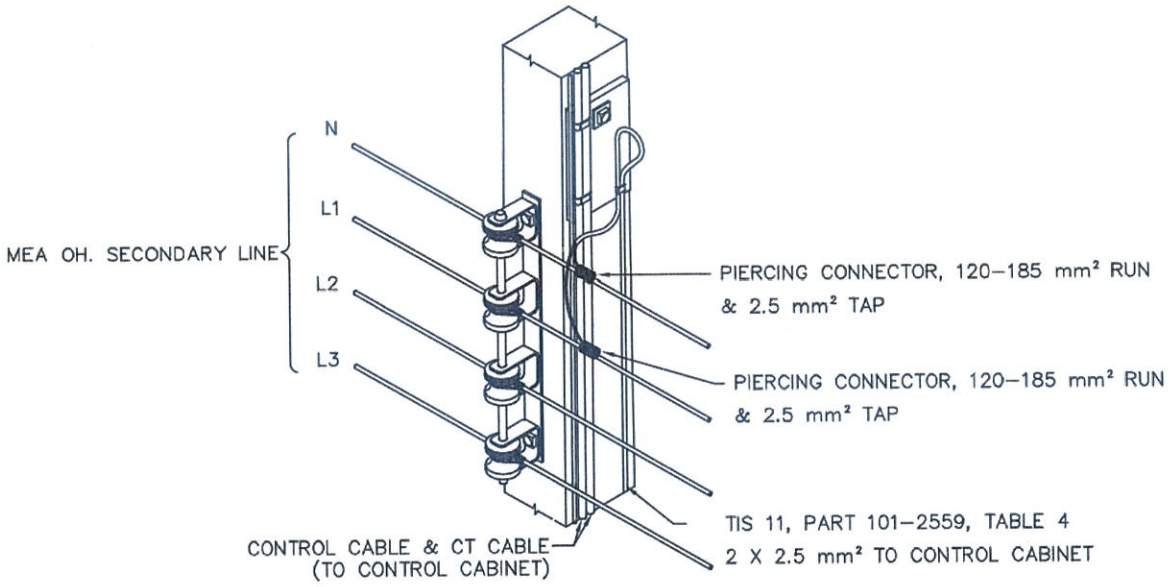


FIG. G DETAIL OF SHIELD CONNECTIONS

NOTES
- SHIELD WIRE OR CONTROL CABLE SHALL BE SEPARATED FROM JACK AT LOAD BREAK SWITCH.
- PVC TAPE COLOR SHALL BE DIFFERENT FROM CONTROL CABLE COLOR.

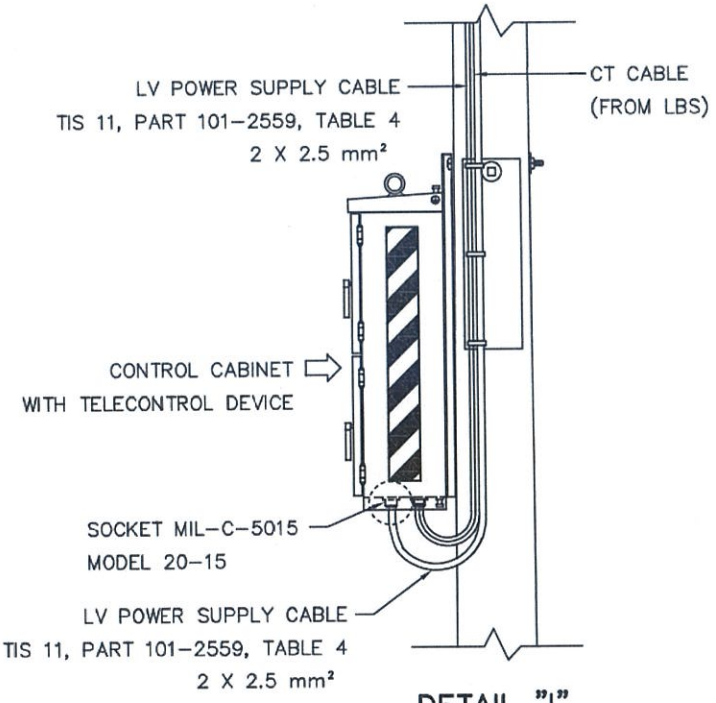
REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant	ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn		TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SUPERSEDING DATE : 20/2/2564
CHK.			SH.NO. 5 OF 6
DIR.DIV.			DWG. NO. 631020
DATE 15/2/2566			



DETAIL "H"

(CONNECTION OF AC POWER SUPPLY)



DETAIL "I"

หมายเหตุ

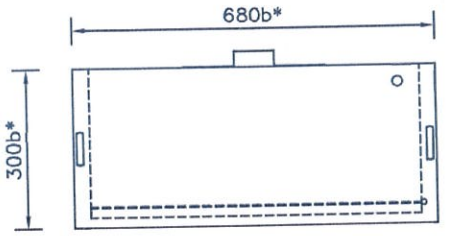
1. PIERCING CONNECTOR SUPPLY BY LOAD BREAK SWITCH CONTRACTOR

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

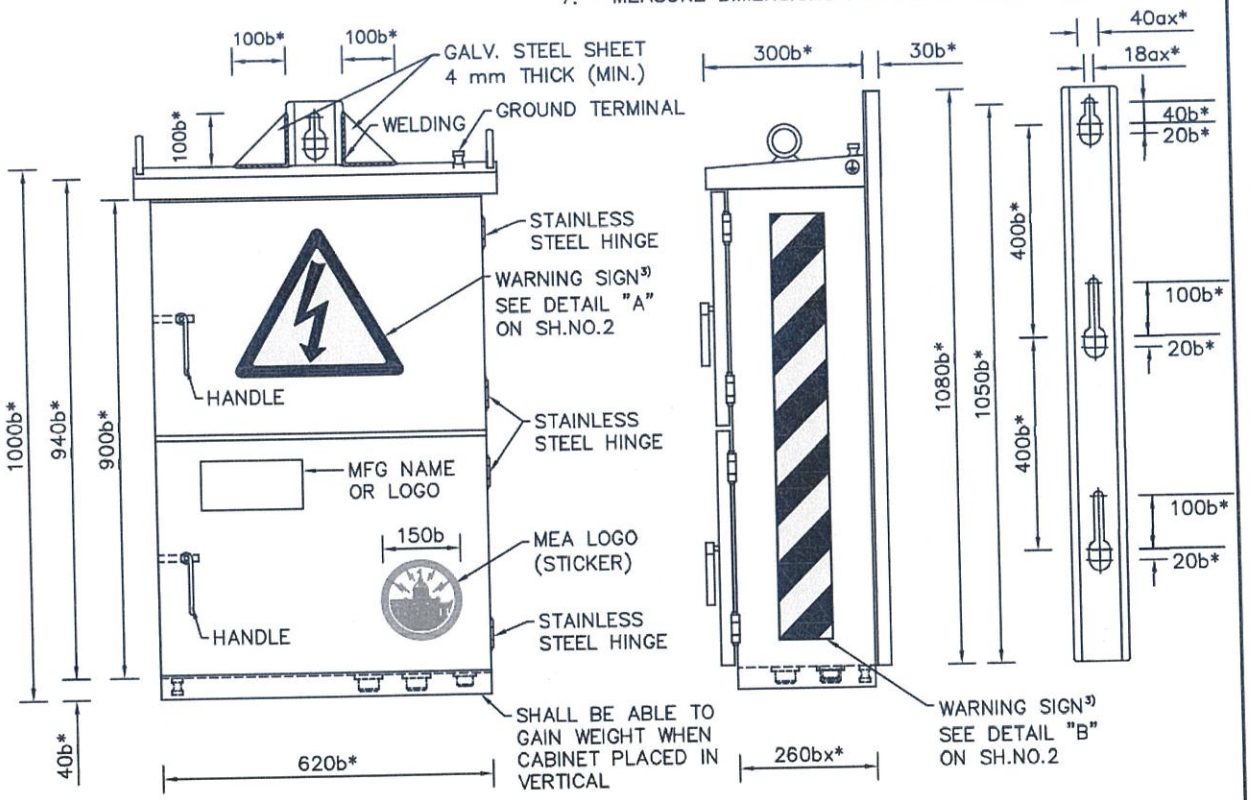
DR. Anant	ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn		TYPICAL 24 kV SF_6 LOAD BREAK SWITCH INSTALLATION	SUPERSEDING DATE : 20/2/2564
CHK.			SH.NO. 6 OF 6
DIR.DIV.			DWG. NO. 631020
DATE 15/2/2566			

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. SEE ALLOWABLE TOLERANCE ON SH.NO.2. OF 3.
3. INSTALL WARNING SIGNS (RETRO-REFLECTIVE STICKER) ON THE FRONT AND THE BOTH SIDES OF THE CABINET.
4. GROUND BAR/TERMINAL SHALL BE PROVIDED INSIDE THE CABINET SUITABLE FOR 2.5-6 mm² CU. INSULATED WIRE.
5. CONTROL BOARD AND TELECONTROL DEVICE BOARD SHALL HAVE GROUND TO GROUND BAR INSIDE THE CABINET. GROUND TERMINAL SHALL BE SUITABLE FOR GROUNDING CABLE SIZE 16-25 mm².
6. MEA'S SERIAL NUMBER SHALL BE PAINTED IN ORANGE ON THE TELECONTROL DEVICE. THE CODE NUMBER ON ALL TELECONTROL DEVICES SHALL BE EASILY VIEWABLE FROM GROUND LEVEL. THE CODE NUMBER WILL BE PROVIDED BY MEA AFTER THE CONTRACT.
7. * MEASURE DIMENSIONS FOR ACCEPTANCE TEST.

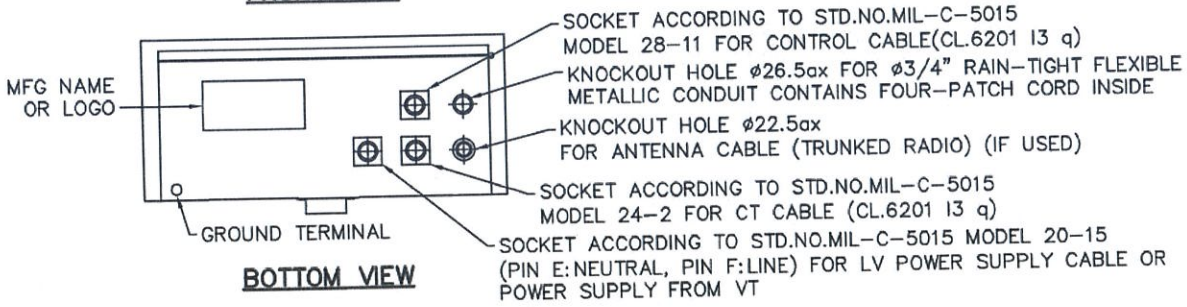


TOP VIEW



FRONT VIEW

SIDE VIEW

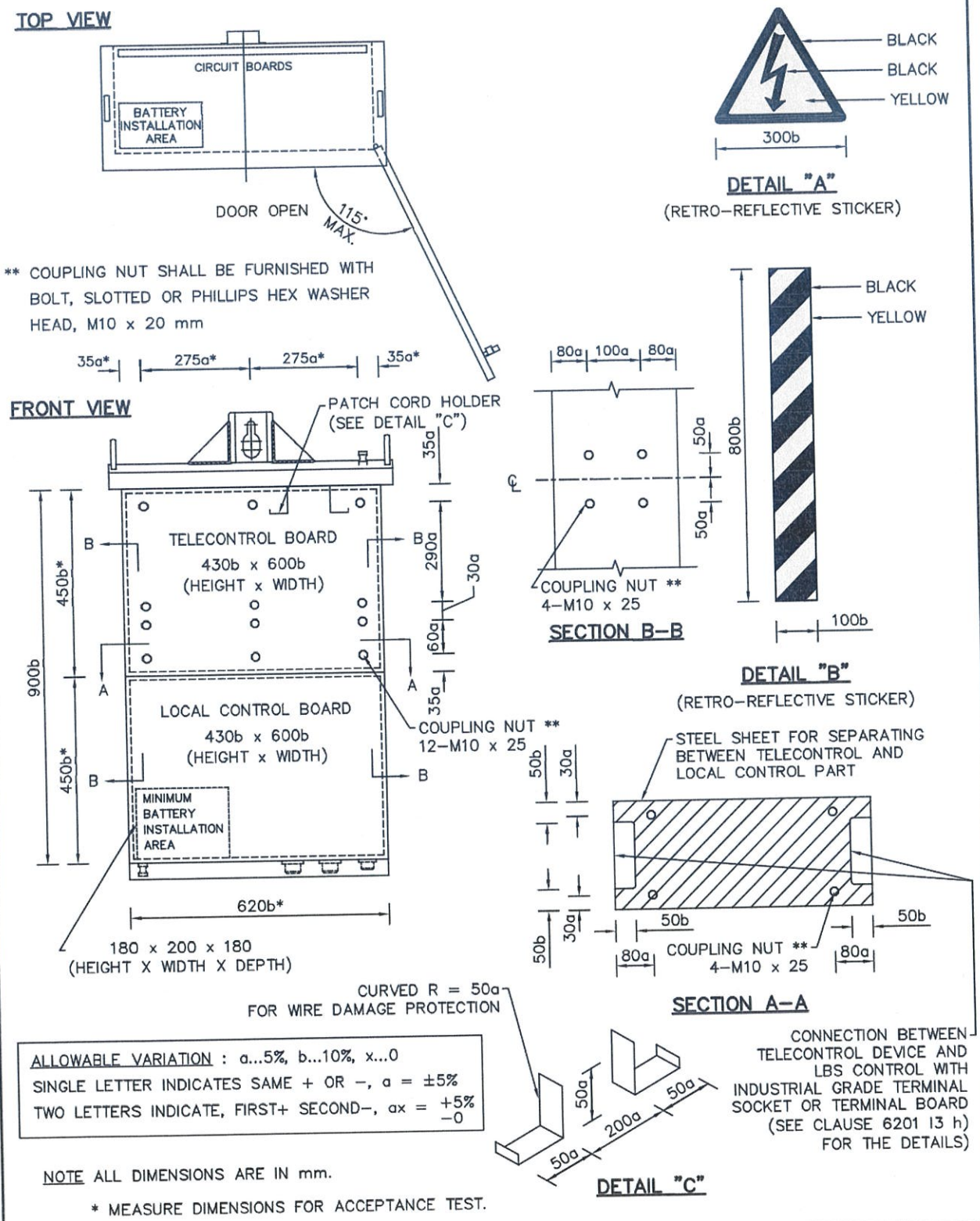


BOTTOM VIEW

FOR BOTTOM SIDE, GROUND TERMINAL AND ALL SOCKETS SHALL NOT BE REACHED MORE THAN EDGE OF CABINET.

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant	ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC.	Ratchakorn	TYPICAL CONTROL CABINET FOR DISTRIBUTION MANAGEMENT SYSTEM (DMS) PROJECT	SUPERSEDING DATE : 20/2/2564
CHK.			SH.NO. 1 OF 3
DIR.DIV.			DWG. NO. 631021
DATE	15/2/2566		



ALLOWABLE VARIATION : a...5%, b...10%, x...0
SINGLE LETTER INDICATES SAME + OR −, a = ±5%
TWO LETTERS INDICATE, FIRST+ SECOND−, ax = $^{+5\%}_{-0}$

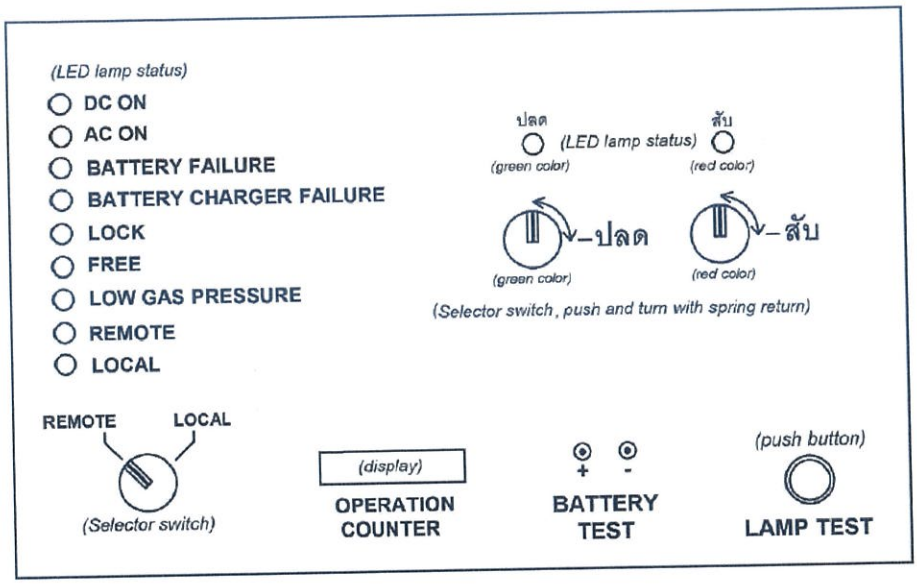
NOTE ALL DIMENSIONS ARE IN mm.

* MEASURE DIMENSIONS FOR ACCEPTANCE TEST.

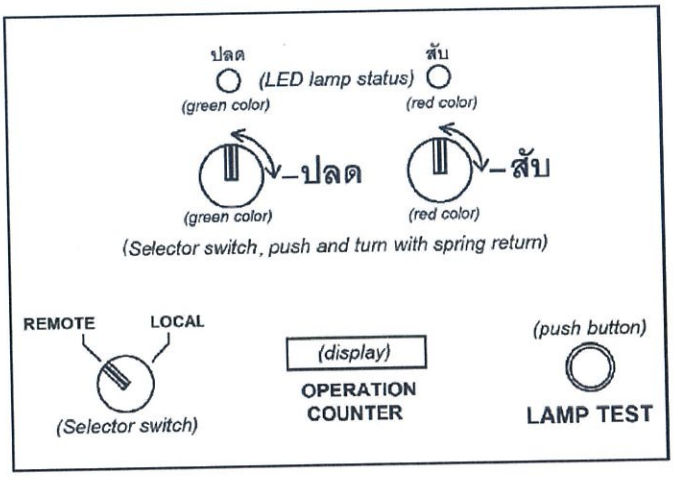
REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

DR. Anant	ENGR. Anant	METROPOLITAN ELECTRICITY AUTHORITY	SCALE NONE
CHF.SEC. Ratchakorn		TYPICAL CONTROL CABINET FOR DISTRIBUTION MANAGEMENT SYSTEM (DMS) PROJECT	SUPERSEDING DATE : 20/2/2564
CHK.			SH.NO. 2 OF 3
DIR.DIV.			DWG. NO. 631021
DATE 15/2/2566			

USER INTERFACE PANEL DESIGN
OPTION 1: FULL PANEL



OPTION 2: HALF PANEL (CONTROL ONLY) (SEE NOTE2)



NOTE 1. THE WORDS IN "()" ARE THE DESCRIPTION OF THE PANEL's COMPONENTS.
2. FOR OPTION 2, OTHER LED LAMP STATUS SHALL BE INSTALLED ON CONTROL CIRCUIT BOARD.
3. DIAMETER OF SELECTOR SWITCH SHALL BE NOT LESS THAN 2.5 cm.

REV.NO.	DESCRIPTION OF REVISIONS	BY	DATE

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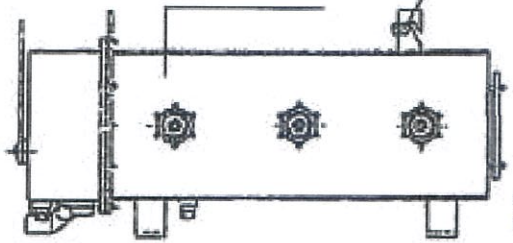
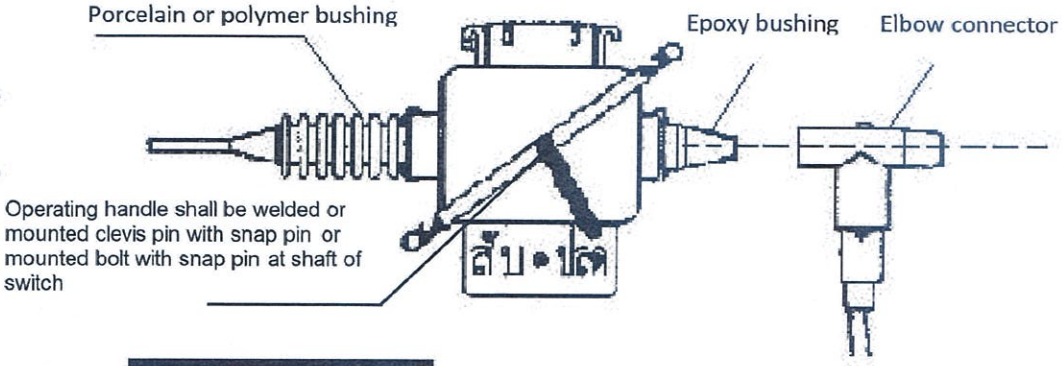
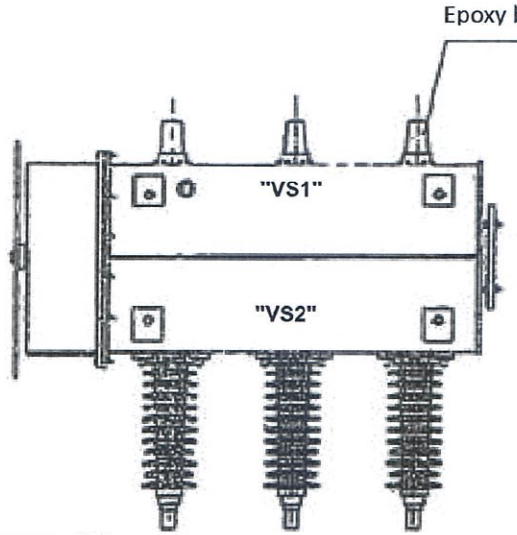
CHF.SEC. Ratchakorn		TYPICAL CONTROL CABINET FOR DISTRIBUTION MANAGEMENT SYSTEM (DMS) PROJECT	SUPERSEDING DATE : 20/2/2564
CHK.			SH.NO. 3 OF 3
DIR.DIV.			DWG. NO. 631021
DATE 15/2/2566			



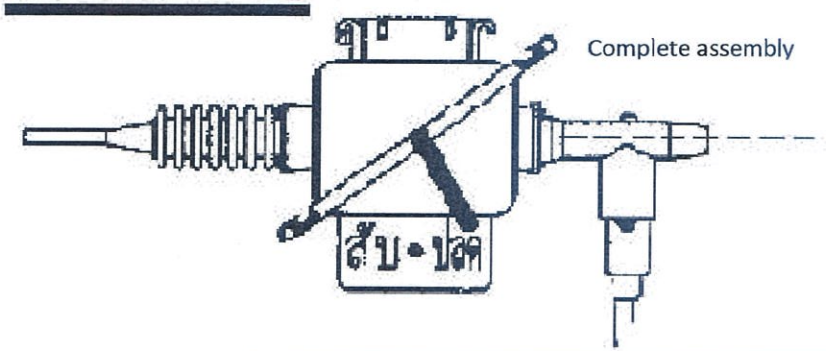
SIDE VIEW





BOTTOM VIEW

FRONT VIEW



Note. "VS1" stands for Voltage Sensor 1 and "VS2" stands for Voltage Sensor 2.

METROPOLITAN ELECTRICITY AUTHORITY POWER SYSTEM PLANNING DEPARTMENT	
TYPICAL 24 kV LOAD BREAK SWITCH FOR UG-OH SYSTEM	SCALE NONE SH.NO. 1 OF 1
DATE 6/1/2566	DWG. NO. 1