

ELECTRICITY GENERATING AUTHORITY OF THAILAND

**Supplemental Notice No. 1**

**Invitation to Bid No. RTS3-S-02**

**Supply and Construction of 115 kV Chaiyaphum Substation (GIS) and  
Improvement of 230 kV Chaiyaphum Substation**

**Transmission System Expansion and Renovation Project Phase 3**

**(Two-Envelope)**

The attached Supplemental Notice shall be considered as part of the bidding documents No. RTS3-S-02.

As acknowledgement of receipt that all additions, deletions and revisions contained in this Supplemental Notice are incorporated into the above bidding documents, Bidder is requested to sign and return this acknowledgement via email address : [thana.kir@egat.co.th](mailto:thana.kir@egat.co.th) within three (3) days from the date of the announcement of this Supplemental Notice on <http://www4.egat.co.th/fprocurement/biddingeng/>.

The original acknowledgement which is manually signed in ink by a person or persons duly authorized shall be included in the proposal to be submitted on the bid opening date.

ELECTRICITY GENERATING AUTHORITY OF THAILAND

April 25, 2025

ACKNOWLEDGEMENT

This undersigned Bidder hereby certifies that the additions, deletions and revisions set forth in this Supplemental Notice to Invitation to Bid No. RTS3-S-02 are incorporated as part of the above bidding documents and will be fully included in any bids which he may submit.

Signed \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Date \_\_\_\_\_

## ELECTRICITY GENERATING AUTHORITY OF THAILAND

## SUPPLEMENTAL NOTICE NO. 1

## INVITATION TO BID NO. RTS3-S-02

SUPPLY AND CONSTRUCTION OF 115 kV CHAIYAPHUM SUBSTATION (GIS)  
AND IMPROVEMENT OF 230 kV CHAIYAPHUM SUBSTATION

## TRANSMISSION SYSTEM EXPANSION AND RENOVATION PROJECT PHASE 3

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The following supplemental information is hereby given for the above described Invitation:

**Volume I of IV**

1. Section A : Invitation to Bid  
Postpone the price and technical proposals submission date from April 30, 2025 to **May 30, 2025**.
2. Section H : Scope of Work  
Replace pages H1-1 thru H1-2 and H1A-1 thru H1A-8 of Scope of Work with the revised pages with (Rev. 1) attached.

**Volume II of IV**

3. Section I : Ratings and Features  
Replace pages I5 thru I10 of Ratings and Features with the revised pages with (Rev.1) attached.

**Volume III of IV**

4. Section K : Specifications  
Replace Specification No. 170 (Sep. 2021) with the revised one with (Dec. 2024) attached.

Bid submitted must be in accordance with this Notice. Receipt of this Notice shall be acknowledged by the Bidder on the proposal included in the Bidding Documents in the space provided on page Part 3 - C16, Article C-5 Supplemental Notices.

ELECTRICITY GENERATING  
AUTHORITY OF THAILAND

April 25, 2025

## **1. 115 kV CHAIYAPHUM SUBSTATION (GIS)**

### **GENERAL**

The renovation of Chaiyaphum Substation project to construct new 115kV Gas Insulated Switchgear (GIS) substation is initiated in order to replace the existing 115kV conventional substation, which have been utilized for many years shall no longer be in operation after the completion of new GIS substation.

The Chaiyaphum Substation is located at Phon Thong sub-district, Mueang Chaiyaphum District, Chaiyaphum province. The renovation of Chaiyaphum Substation consists of the 115kV GIS substation with Breaker & A Half scheme. During the new 115 kV Gas Insulated switchgear (GIS) construction, the renovation will be operated beside the existing 115 kV conventional substation due to the limited area.

Twelve (12) Feeders Six (6) Diameters of Breaker & A Half scheme at the new 115 kV GIS shall be provided for transmissions lines and autotransformers as follows :

- Three (3) feeders for 115 kV Lines No. 1 & 2 & 3 to PEA
- One (1) feeders for 115 kV Lines to Phon
- Two (2) feeders for 115 kV Lines No. 1, 2 to BAMNET NARONG
- Two (2) feeders for 200MVA, 230-121-22kV power transformer “KT2A & KT4A”
- One (1) feeder for 115kV Capacitor bank No.1 (24Mvar)
- Three (3) feeders for 115 kV Lines (Future)

The contractor shall supply equipment, perform construction and installation work necessary for completion of operation substation in accordance with the contract documents. The design work shall include, but not limited to, technical calculation, preparation of drawings, bill of materials for installation and construction work. For accomplishment of complete operational substation, Scope of contractor's work shall include connection to all public utilities i.e. electrical power, water and drainage. Testing and commissioning of all equipment required to make the substation function properly.

Besides, all detailed engineering design work, calculations, drawing preparation, submission of backup data, test reports instruction books (and), etc. shall be included.

- 1) As stated elsewhere in these bidding documents, the drawings included in the bidding documents except drawing mark "For Construction" are for bidding purposes only and shall not be used for execution of the work.
- 2) The submitted drawings which are incomplete/unacceptable, or are the bidding document copies with minor modifications shall be returned unmarked to the Contractor.
- 3) The drawings shall be furnished which provide all details required for thoroughly described equipment as well as installation methods and requirements. However, EGAT retains the right to request additional details if those furnished are perceived inadequate.

- 4) Calculations, backup data and documentation are required for all parts of the design. The furnished data shall verify completely that design is adequate for application purpose.

## **ELECTRICAL PART**

### **Schedule 1 : 115 kV CHAIYAPHUM SUBSTATION (GIS)**

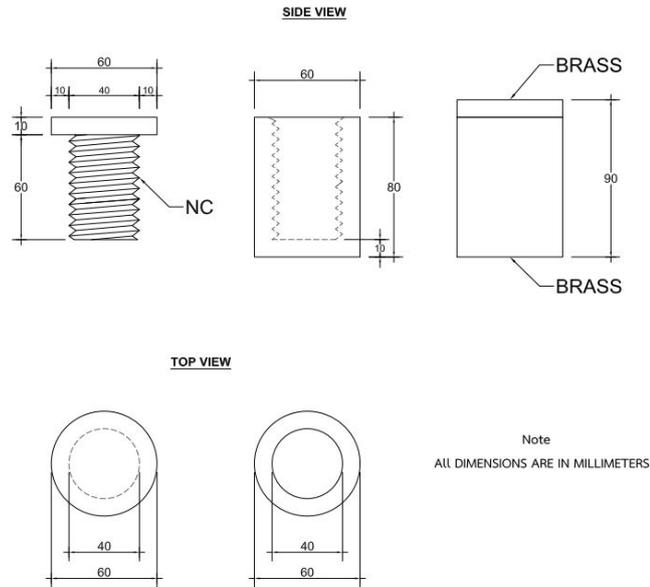
#### **Work included in this contract.**

The work included in this contract to be performed by the contractor shall be as specified in the contract documents and as follows:

#### **For Electrical work**

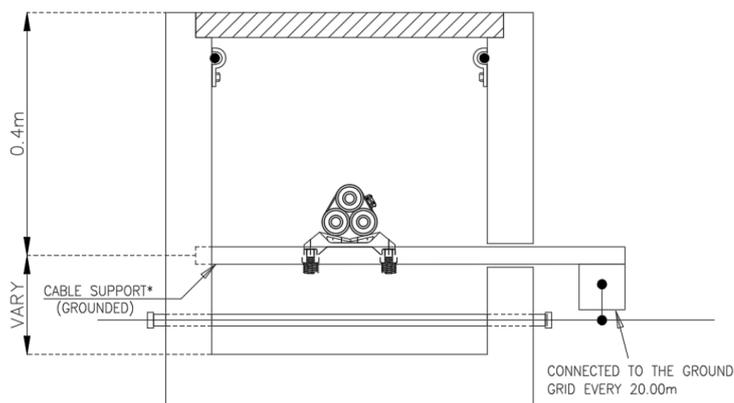
##### **1. GIS Substation**

- 1.1. Design, supply and installation of equipment required for a complete new 115kV GIS digital substation and 22kV-400/230V power supply system.
- 1.2. Design, supply and installation of miscellaneous hardware required for the following:
  - 1.2.1. The connection between the 230kV and 115kV substations.
  - 1.2.2. The connection of the 115kV GIS air bushings to the 200MVA, 230/115-22kV auto-transformers (KT2A, KT4A)
  - 1.2.3. The connection of the 115kV GIS air bushings to the 24MVAR, 115kV shunt capacitor bank No.1
  - 1.2.4. The connection of the 200MVA, 230/115-22kV power transformers (KT2A, KT4A) to the 22kV Load break switch for station service system.
  - 1.2.5. The connection of 115kV GIS air bushings to 115kV overhead lines.
  - 1.2.6. The grounding equipment and miscellaneous hardware for 24MVAR, 115kV shunt capacitor bank No.1
- 1.3. To meet EGAT's service continuity requirements, the GIS gas compartment can be designed as indicated in the single line diagram or can be designed differently under a condition that the design of the gas compartment shall fulfill the requirements as specified in the specification
- 1.4. Supply and installation of the marking pins for the referenced positions from the main bus shall be provided in the GIS buildings. The positions of the marking pins shall be shown on the drawings for future GIS extension and the quantity shall not be less than 4 sets. The making pins shall be made of brass or stainless steel that have the formation as follows:



- 1.5. The GIB shall not be installed in multiple stacks for the purpose of convenient maintenance.
- 1.6. The detachable walk way ( cat walk) for visual inspection shall be properly installed on each GIS module and removable service platform, removable ladder shall be provided for GIS inspection.
- 1.7. The contractor shall supply the cart for transporting the equipment from the loading area to the 115kV GIS room for construction and maintenance.
- 1.8. The feeder nameplates as well as phasing, device and switching numbers shown on the GIS module shall be painted or mounted (detachable type) on the enclosure of GIS whichever is appropriate according to the instruction from EGAT GIS installation team.
- 1.9. The contractor shall supply identification plates for the both indoor and outdoor substation. The material, size and color shall be as shown on attached drawings except size of GIS identification plates shall be proposed by the contractor and approved by EGAT.
- 1.10. The sag and tension of phase wires and overhead ground wires shall be calculated and designed according to internationally-accepted standards by the contractor and the said calculation shall be submitted to EGAT for approval.
- 1.11. Design, supply and installation of 22kV XLPE cable system which comprises at least the following:
  - 1.11.1. The design and calculation of the 22kV cable system shall conform to IEC and/or IEEE standards.
  - 1.11.2. The 22kV XLPE cable shall be single-core with copper conductor.
  - 1.11.3. Design, supply and installation of the 22kV XLPE cables in a 22kV system complete from one end at the 22kV bus to the 22kV load break switch, the station service transformers KW2A and KW4A, including cable trench, cable supporting structures, cable spacers, cable cleats, cable termination supporting structures, cable terminations, miscellaneous hardware, link box, Sheath Voltage Limiter (SVL) (if applicable) and all related equipment, structures and hardware.

- 1.11.4. The 22kV XLPE cable shall be installed in trefoil formation.



\* : DESIGNED BY CONTRACTOR

- The cable support structure shall be made of stainless steel, aluminum alloy or galvanized steel. The contractor shall design, supply and install the cable supporting structures that are suitable for cable cleats and cable system installation and their grounding.
- 1.11.5. The minimum bending radius of the 22kV XLPE cable shall be checked by contractor for cable installation and cable trench design.
- 1.11.6. The contractor shall design the 22kV cable system such that one (1) 1/C-35 Sq.mm. XLPE cable shall be able to carry the continuous current not less than **50A** respectively given that the ambient temperature is no less than 45°C. The effect of solar radiation shall be considered if deemed technically necessary. The other parameters used in the design shall be practical, reasonable, operational and conform to IEC standard. The design report shall be submitted to EGAT for approval. The calculated continuous current rating shall be shown in the single-line diagram.
- 1.11.7. The contractor shall calculate the sheath induced voltage in accordance with IEEE standard. The sheath standing voltage at every point on the metallic sheath of 22kV XLPE cable system shall be less than 60V under the rated continuous current. The cable jacket shall be properly designed to be protected from overvoltage. Determine the specification for a surge voltage limiter (SVL) and PGCC cable if deemed technically necessary. The design report shall be submitted to EGAT for approval.
- 1.11.8. Calculate the mechanical force due to short-circuit current as per IEC standard. Determine the specification for cable cleats. For the calculation of forces caused by short-circuit currents, the peak short circuit current of **62.5kA** shall be used. The design report shall be submitted to EGAT for approval.
- 1.11.9. Design, supply and installation the equipment to protect the power cable from the surge and over-voltage.
- 1.11.10. The abnormal condition which occurs from the design and installation of the 22kV XLPE cable system for example the Ferro resonance etc, shall be responsible for the contractor.
- 1.11.11. Based on the design of 22kV XLPE cable system aforementioned, the contractor shall provide detailed drawings for the installation of this cable system including all related components.
- 1.11.12. The position and number of the cable cleats shall be calculated and determined by the contractor to withstand the electromechanical force

from short circuit according to IEC standard. The cable cleats shall be metallic hot dip galvanized.

## 2. Station service system

2.1. Design, supply and installation of station service system complete with integral accessories to provide a complete system operation. The station service system mainly consists of as follows:

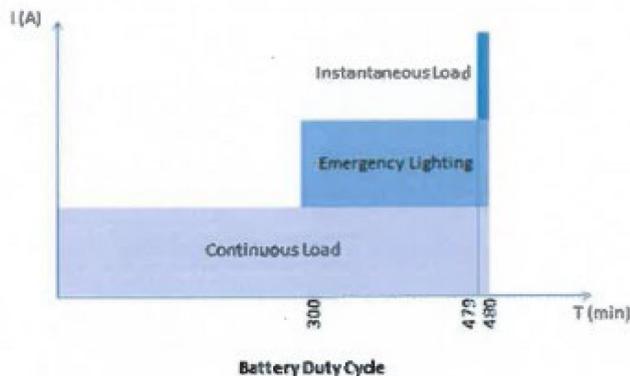
- 500kVA, 22,000-400/230V distribution transformer (KW2A)
- 500kVA, 22,000-400/230V distribution transformer (KW4A)
- Load Center Unit Substation (LCUS)
- 22kV drop-out fuses
- 22kV Load break switches
- 600V, 800A safety switches
- 22kV equipment, and AC&DC distribution boards, stationary batteries, battery chargers, power cables and all related equipment for the complete operation.

2.2. Design, supply and installation of equipment required for a complete 400/230V power supply system.

2.3. Design, supply and installation of the stationary battery, in which the battery is capable of delivering power to the control and protection for tripping all circuit breakers and emergency essential load for at least **8** hours if normal station service fails. The capacity of the battery shall be designed by the contractor which the considered factor the influence the capacity of battery shall be as follows:

- The temperature correction factor is 1.0
- The design margin factor is 1.15
- The aging factor is 1.25

2.4. In case of bus faults occurring on the last hour of battery power, the battery shall generate sufficient power for tripping all circuit breakers as shown in figure below. The stationary battery shall be designed and calculated in accordance with IEEE or other acceptable international standards. In addition, the size of the stationary battery shall be designed to support the operation of the existing 230kV AIS and new 115kV GIS as shown on the attached bidding document drawings. The calculation shall be submitted to EGAT for approval. The size of battery shall not be less than 2,600Ah.



2.5. Emergency lighting system shall be installed at the new control building, 230/115kV GIS building in case of normal station service fails. The said emergency lighting system is activated and capable of generating illumination level of at least **150 LUX** for at least 3 hours.

### 3. Grounding system

- 3.1. Design, supply and installation the grounding system of New 115kV GIS substation grounding system including the grounding system of 230/115kV control building , 115kV GIS building and 22kV system
- 3.2. The grounding conductor of the substation grounding system shall be 4/0 AWG bare copper wire type.
- 3.3. The ground grid conductor spacing under the building area shall be 10 meters.
- 3.4. Design, supply and installation of the grounding equipment and miscellaneous hardware for 115/22kV system including the 22kV power supply system and 22kV XLPE cable system.
- 3.5. The contractor shall evaluate the price of ground grid for the additional area based on the specified design for price reference as below:
  - 3.5.1. The maximum ground grid conductor spacing (D0) shall be **10** meters.
  - 3.5.2. The number of ground rod shall be **24** pieces.
- 3.6. The contractor shall conduct the soil resistivity measurement. The result shall be submitted to EGAT for approval.
- 3.7. The contractor shall design a grounding grid based on the measured soil resistivity by hand calculation using the equations in IEEE-80 standard and submitted to EGAT for approval. The parameters for grounding system calculation shall be used as follows;
  - Fault current division factor (sf) value = **1**
  - Fault current (rms) = **50 kA**
  - Time duration of fault = **1 second**These parameters shall be used for determine the size of grounding conductor for the substation grounding system. If the ground conductor spacing calculated by hand (D1) is less than the grounding conductor spacing for reference (D0), the contractor shall design a grounding grid by using the software. The certification of software shall be acceptable for commercial use.

### 4. Lightning protection system

- 4.1. Design, supply and installation of the substation lightning protection system complete with all related equipment. The contractor shall design the lightning protection system for the protection of all substation equipment which is under the protective zone. To meet EGAT's design criteria for the lightning protection system and to enhance the stability of lightning protection system, the Basic Insulation Level voltage (BIL) of:
  - a) 900kV for 230kV substation.
  - b) 550kV for 115kV substation.shall be used in calculation instead of Critical Flashover voltage (CFO). For 22kV substation, the stroke current of **2kA** shall be used for the calculation.
- 4.2. For the design of lightning protection system for the control building and GIS buildings, the lightning protection level (LPL) shall be used level 1 for calculation and the overhead ground wire is not permitted. Air terminal rods installed at the roof shall be used instead.
- 4.3. Lightning protection system shall be designed to meet IEC, NEMA and E.I.T. standards or internationally-accepted standards.

## **5. Facility system**

### **5.1. Outdoor facility system**

- 5.1.1. Design, supply and installation of a substation lighting system complete with all integral accessories to provide a complete system operation. The lighting system shall mainly consist of equipment lighting, fence lighting, access road lighting, power box (PRB), sign board lighting, raceways and wiring cables for lighting circuits.
- 5.1.2. The lamps for outdoor facility lighting system shall be LED type with all integral accessories, e.g. lamp holders, fixtures, reflectors, and etc. The contractor shall provide drawings that show details for installation.

### **5.2. Indoor facility system**

- 5.2.1. Design, supply and installation of the facility system which mainly consists of power supply, lighting system, lightning protection system, grounding system, power supply, fire alarm and protection system, air conditioning system, ventilation system and telephone & LAN system in the 230/115kV Control building and 115kV GIS buildings. All cable wiring systems shall conform NEC and IEC standards or accepted international standards.
  - 5.2.2. The lamps for indoor facility lighting system shall be LED type with all integral accessories, e.g. lamp holders, fixtures, reflectors, and etc. The contractor shall provide drawings that show details for installation and specify the LED lamp and LED luminaire circuit identified that the LED lamp circuit shall be supplied by 2 - 3 manufacturers. The power factor of the LED lamps shall be more than 0.9.
  - 5.2.3. All steel accessories e.g. lip-channel, conduit, conduit fittings, conduit accessories, box and cover shall be hot dip galvanized.
- 5.3. The size of low voltage cable shall be sufficient to keep the voltage drop at the load point less than 5% at rated current.
  - 5.4. The voltage drops from the safety switch to the AC boards and from the AC boards to the load shall not exceed 3% and 2% respectively.
  - 5.5. The voltage drop shall conform to EGAT's requirement and the calculation shall be submitted for approval.

## **6. Telecommunication system**

- 6.1. Design, supply and installation of the telecommunication tower installed on the roof deck of the 230/115 kV control building. The telecommunication tower shall be constructed and divided into appropriate portions which are painted white and orange alternately with the top and bottom portions being painted orange. The obstruction lighting system shall be controlled by automatic flash box (AFB) that gives 30 - 60 flashes per minute. The AFB shall be turned on and turned off by a photo-light switch. The lightning protection system for the telecommunication tower shall be calculated and designed by the Contractor and the said calculation shall be submitted to EGAT for approval.

## **7. Other Work**

- 7.1 Supply and Installation of miscellaneous hardware required for suspension and post insulators assembly
- 7.2 Modification of junction box supporting structure (JB001) for the installation of safety switches.
- 7.3 Modification of junction box supporting structure (JB003) for the installation of outdoor receptacle box (ORB3).

- 7.4 Modification of BS202 and BS203 for installation of 22kV XLPE cables, 22kV power fuses, 22kV voltage transformer and junction box (PT6)
- 7.5 Removal of equipment. Details of removal are shown on the bidding document drawings. All removed equipment shall be carefully packed by the Contractor and delivered to EGAT at Nakhon Ratchasima 2 Substation. Nakhon Ratchasima 2 Substation is located at Tumbon Ban Mai, Amphoe Mueang, Nakhon Ratchasima Province
- 7.6 The Contractor shall Design, supply and installation cable with equipment required for connect cable to new operator house, foam house, fire pump house, warehouse and underground water tank for living area.

## **8. Grid-Connected Solar Photovoltaics (PV) Rooftop System**

The Contractor shall design, supply, deliver, install, construct, test, commission and maintain the Grid-Connected Solar PV rooftop system, which shall be completed with all necessary accessories and minor items to facilitate the correct completion of the work. All requirements of relevant standards over these works shall be applied.

The 60 kWp Solar on Grid system with string inverters shall be installed at the rooftop of GIS with control building or control building. All the Solar PV rooftop system should be metered and the energy generated from the PV rooftop system shall be recorded.

### **General Requirement**

- 8.1 The grid-connected rooftop solar power system shall consist of the following equipment/components but not limited to:
  - Photovoltaic modules (PV modules) with grid-connected rooftop solar power support structure
  - Grid-connected inverter
  - DC combiner panel
  - AC panel
  - DC fuse or DC circuit breaker & AC circuit breaker
  - DC & AC surge arrester
  - DC & AC cable
  - Conduit & Cable tray
  - DC & AC connector
  - Identification plate
  - Monitor equipment
  - Tools required for operation and maintenance
  - Any other item(s) that may be required to successfully commission, operation and maintain the grid-connected solar PV rooftop system.
- 8.2 All equipment/components parts used in the grid-connected solar PV rooftop system shall conform to the single line diagram and Technical Specifications of systems as shown in Dwg.No. SE-PV-0-01-01/01 & SE-PV-0-02-01/02 – 02/02 or internationally-accepted standards.
- 8.3 Submittals for documents, drawings, catalogs and manuals of equipment, warranty cards and spare parts shall conform to Technical Specifications of systems as shown in Dwg.No. SE-PV-0-02-01/02 – 02/02.
- 8.4 All documents and drawings shall be certified and signed by the Contractor's authorized senior professional engineers certified by Thailand's Council of Engineers.
- 8.5 The contractor or subcontractor shall have experience in executing at least two (2) contracts as the contractor for design and installation of Solar PV rooftop system in Thailand which has the capacity of PV system more than 60kW<sub>p</sub>, with successful operation of at least two (2) consecutive years.

- 8.6 Testing and commissioning of the grid-connected solar PV rooftop system shall conform to the internationally-accepted standards.
- 8.7 Mentoring and training to EGAT's operating staff for operation and maintenance
- 8.8 The insurance period for workmanship and Materials shall conform to Technical Specifications of systems as shown in SE-PV-0-02-01/02 – 02/02.

**9. Testing and commissioning**

- 9.1 Testing and commissioning of all equipment required to make the substation function properly.

**Work not included in this contract**

The Work not included in this contract shall be as shown on the drawings and as follows:

1. Supply and installation of 115kV shunt capacitor bank No.1
2. Supply station post and suspension insulators.
3. The stringing work for the connection between the 115 kV substation take-off structures and the dead-end towers of the transmission lines.



<b>Ratings and Features</b>	<b>Designed : via ECM system</b>	<b>Validated : via ECM system</b>	<b>Revision 3</b>	<b>Page 1/4</b>
<b>RF No. IS7541(IEC)</b>	<b>Verified : via ECM system</b>	<b>Approved : via ECM system</b>	<b>Dated : via ECM system</b>	

a.	Type	SF <sub>6</sub> gas	
b.	Service condition	Indoor for GIS and Outdoor for GIB/GIL	
c.	Enclosure	Single phase or three phase enclosure	
d.	Rated voltage	123	kV
e.	Number of phases	3	
f.	Rated frequency	50	Hz
g.	Maximum permissible partial discharge intensity at 120% rated voltage	5	pC
h.	Rated Insulation level		
	- Rated short-duration power-frequency withstand voltage, r.m.s.		
	- Phase-to-earth, across open switching device and between phases	230	kV
	- Across the isolating distance	265	kV
	- Rated lightning impulse withstand voltage, peak.		
	- Phase-to-earth, across open switching device and between phases	550	kV
	- Across the isolating distance	630	kV
i.	Current rating		
	- Rated normal current		
	- Busbars	2,000	A
	- Coupling Bay	2,000	A
	- Feeders	2,000	A
	- Rated short-time (1 s) withstand current for main and earthing circuit	40	kA
	- Rated peak withstand current for main and earthing circuit	100	kA
j.	Circuit Breaker		
	- Type of mechanism	Spring, Hydraulic-Spring Operating mechanism	
	- Rated Insulation level		
	- Rated short-duration power-frequency withstand voltage, r.m.s.		
	- Phase-to-earth, across open switching device and between phases	230	kV
	- Rated lightning impulse withstand voltage, peak.		
	- Phase-to-earth, across open switching device and between phases	550	kV
	- Rated normal current		
	- Feeders and transformers	2,000	A
	- Coupling bay	2,000	A
	- Rated short-time (1 s) withstand current	40	kA
	- Rated short circuit breaking current	40	kA
	- Rated interrupting time	3	Cycles
	- Rated short circuit making current	100	kA
	- Rated permissible tripping delay	1	Sec
	- Rated reclosing time	20	Cycles
	- Type of tripping	Three poles	
	- Rated operating sequence	O - 0.3s - CO - 3 min - CO	
	- Control circuit voltage	125	V <sub>dc</sub>



<b>Ratings and Features</b>	<b>Designed : via ECM system</b>	<b>Validated : via ECM system</b>	<b>Revision 3</b>	<b>Page 2/4</b>
<b>RF No. IS7541(IEC)</b>	<b>Verified : via ECM system</b>	<b>Approved : via ECM system</b>	<b>Dated : via ECM system</b>	

- Max/Min control voltage
  - Opening coil 137.5/87.5 V<sub>dc</sub>/V<sub>dc</sub>
  - Closing coil 137.5/106.25 V<sub>dc</sub>/V<sub>dc</sub>
  - External AC power source 400/230 V<sub>ac</sub>, 50 Hz
- k. Disconnecting Switch Combined with Standard Earthing Switch
- Type Triple pole, Triple throw and Single break
  - Rated Insulation level
    - Rated short-duration power-frequency withstand voltage, r.m.s.
      - Phase-to-earth and between phases 230 kV
      - Across the isolating distance 265 kV
    - Rated lightning impulse withstand voltage, peak.
      - Phase-to-earth and between phases 550 kV
      - Across the isolating distance 630 kV
  - Rated normal current
    - for feeders and transformers 2,000 A
    - for coupling bay 2,000 A
  - Rated short-time (1 s) withstand current 40 kA
  - Rated peak withstand current 100 kA
  - Operating mechanism Motor and emergency manual operation
  - Operating and control voltage 125 V<sub>dc</sub>
  - The ground connection shall be brought out through minimum 2 kV insulated bushing.
- l. Bus Section Disconnecting Switch (if any, see Single Line Diagram Drawing)
- Type Triple pole, Single throw and Single break
  - Rated continuous current 2,000 A
  - Rated short time (1s) withstand current 40 kA
  - Rated peak withstand current 100 kA
  - Operating mechanism Motor and emergency manual operation
  - Operating and control voltage 125 V<sub>dc</sub>
- m. Fast-acting earthing Switch
- Type Triple pole, Single throw and Single break
  - Rated short time (1 s) withstand current 40 kA
  - Rated short circuit making current 100 kA
  - Induced-current switching Classification B
  - Operating mechanism Motor and emergency manual operation
  - Operating and control voltage 125 V<sub>dc</sub>
  - The ground connection shall be brought out through minimum 2 kV insulated bushing.
- n. Voltage Transformer and Current Transformer as specified in Rating and Features of VT and CT for GIS Sheets
- o. Terminations
- Entrance Bushing (if any, see Single Line Diagram Drawing)
    - Number per feeder 3
    - Type SF<sub>6</sub> to Air
    - Rated current 2,000 A
    - Rated thermal short-time current 40 kA
    - Rated dynamic current 100 kA
    - Cantilever withstand load 4,000 N
    - Creepage distance ≥ 3,075 mm



<b>Ratings and Features</b>	<b>Designed : via ECM system</b>	<b>Validated : via ECM system</b>	<b>Revision 3</b>	<b>Page 3/4</b>
<b>RF No. IS7541(IEC)</b>	<b>Verified : via ECM system</b>	<b>Approved : via ECM system</b>	<b>Dated : via ECM system</b>	

- Insulation level
  - Power-frequency withstand voltage, rms 230 kV
  - Lightning impulse withstand voltage, peak 550 kV
  - Porcelain insulator colour Chocolate brown
  - Terminal Terminal and Terminal connector suitable for 2x1272 MCM ACSR (supplied by contractor)
- EMC at  $1.1U_r/\sqrt{3}$  RIV  $\leq 2500 \mu\text{V}$  or partial discharge free
- Cable Connection (if any, see Single Line Diagram Drawing)
  - Number per feeder as specified in Single Line Diagram Drawing
  - Type Plug-in Cable
  - Insulation level
    - Power frequency withstand voltage, rms 230 kV
    - Lightning impulse withstand voltage, peak 550 kV
  - Rated normal current 2,000 A
  - Rated short time (1 s) withstanding current 40 kA
  - Rated peak withstand current 100 kA
- p. Rated control circuit voltage 125 V<sub>dc</sub>
- q. Sync. Check relay (2S), located in local control cubicle (x) Required ( ) Not required
- r. Enclosure and gas Compartment length
  - Enclosure GIS  $\leq 10$  m
  - Enclosure GIL  $\leq 10$  m
  - Gas compartment  $\leq 50$  m
 (Weight of SF<sub>6</sub> gas filling for each gas compartment shall not exceed 150 kg.)
- s. Gas buffer compartments which are intentionally designed for maintenance, repair and extension (MRE) propose as specified in Single Line Diagram Drawing
- t. SF<sub>6</sub> gas service and storage unit (complete with hoses, coupling, connectors DN20 that suitable for operate 3 phases in the same time and weighing scale for SF<sub>6</sub> liquid storage tank) (if any, see Price Schedule)
  - Type Oil free compressor
  - Compression pressure  $\geq 50$  bar
  - Suction rate  $\geq 35.0$  m<sup>3</sup>/hr.
  - SF<sub>6</sub> gas recovery down to  $\leq 50$  mbar
  - Vacuum pump rate  $\geq 40$  m<sup>3</sup>/hr.
  - Final vacuum down to  $\leq 1$  mbar
- u. SF<sub>6</sub> gas filling cart (complete with 6 m. hoses, primary and secondary gauge show the value of pressure with the Matric Unit of Bar) (if any, see Price Schedule)
  - Vacuum pump rate  $\geq 16$  m<sup>3</sup>/hr.
  - Evacuate rate down to  $\leq 1$  mbar
  - The weighting scale 0 – 120 kg, accuracy  $\pm 20$  g
  - Pressure reducer for SF<sub>6</sub> 0 to 10 bar
- v. Portable SF<sub>6</sub> gas leak detector (with digit display) (if any, see Price Schedule)
  - Sensitivity  $\leq 3$  ppmv or  $\leq 3$  g/year
  - Accuracy  $\pm 5$  % of full scale

**SF<sub>6</sub> Gas Insulated Switchgear (GIS)  
Specification No. 170**



**Substation Electrical  
Equipment Engineering Department**

<b>Ratings and Features</b>	<b>Designed : via ECM system</b>	<b>Validated : via ECM system</b>	<b>Revision 3</b>	<b>Page 4/4</b>
<b>RF No. IS7541(IEC)</b>	<b>Verified : via ECM system</b>	<b>Approved : via ECM system</b>	<b>Dated : via ECM system</b>	

- w. SF<sub>6</sub> gas quality measuring device (automatic return system with pumping back measuring gas to equipment)  
(if any, see Price Schedule)
  - Moisture content : Range of Dew point -50 to 0 °C, accuracy ± 2 °C
  - SF<sub>6</sub> content : Range 0-100 % by volume, accuracy ± 1 % volume
- x. Gas decomposition tester  
(if any, see Price Schedule)
  - SO<sub>2</sub> : Range 1-25 ppmv, accuracy ± 15 %

**Voltage Transformer**

- for VY1A, VY2B, VY4A, VY4B, VY5A, VY5B, VY5C, VY5D and VY6B As specified in DWG. NO. CYP-S-1 Sheet 02/05, 03/05

- Type	Electromagnetic	
- Voltage Factor	1.5 for 30s	
- Connection	Line-to-ground	
- Quantity	As specified in Single Line Diagram Drawing	
- Highest voltage for equipment ( $U_m$ )	123	kV
- Rated primary voltage ( $U_{Pr}$ )	$115/\sqrt{3}$	kV
- Withstand test voltage (H1)		
- Lightning impulse withstand voltage, peak	550	kV
- Power frequency withstand voltage, rms		
- Primary to ground	230	kV
- Withstand test voltage (H2)		
- Power frequency withstand voltage, rms		
- Neutral end of the primary to ground	10	kV
- Voltage ratio	577/1,000 & 577/1,000 : 1	
- Secondary voltage rating		
- No 1 secondary winding	115/66.4	V
- No 2 secondary winding	115/66.4	V
- Burden		
- No 1 secondary winding	30	VA
- No 2 secondary winding	30	VA
- Simultaneous	30	VA
- Accuracy class		
- No 1 secondary winding	3P	
- No 2 secondary winding	3P	
- Polarity	Subtractive	

- for VY1B, VY2A, VY3A and VY6A As specified in DWG. NO. CYP-S-1 Sheet 02/05, 03/05

- Type	Electromagnetic	
- Voltage Factor	1.5 for 30s	
- Connection	Line-to-ground	
- Quantity	As specified in Single Line Diagram Drawing	
- Highest voltage for equipment ( $U_m$ )	123	kV
- Rated primary voltage ( $U_{Pr}$ )	$115/\sqrt{3}$	kV
- Withstand test voltage (H1)		
- Lightning impulse withstand voltage, peak	550	kV
- Power frequency withstand voltage, rms		
- Primary to ground	230	kV
- Withstand test voltage (H2)		
- Power frequency withstand voltage, rms		
- Neutral end of the primary to ground	10	kV
- Voltage ratio	577/1,000 & 577/1,000 : 1	
- Secondary voltage rating		
- No 1 secondary winding	115/66.4	V
- No 2 secondary winding	115/66.4	V
- Burden		
- No 1 secondary winding	0 - 15	VA
- No 2 secondary winding	0 - 15	VA
- Simultaneous	30	VA

- Accuracy class
- No 1 secondary winding 0.2 & 3P
- No 2 secondary winding 0.2 & 3P
- Polarity Subtractive

Note: 1) Test for accuracy at 0 VA burden shall be performed in Routine test in addition to 25% and 100% of the rated burden (15 VA).

- 2) Test for accuracy for both 0.2&3P classes shall be subjected simultaneously for each winding in Routine test.

### Current Transformer

- for QY1A, QY1B, QY1C, QY2A, QY2B, QY2C, QY3A, QY3B, QY3C, QY4A, QY4B, QY4C, QY5A, QY5B, QY5C, QY6A, QY6B and QY6C As specified in DWG. NO. CYP-S-1 Sheet 02/05, 03/05
  - Quantity per phase 1 Set
  - No of core 4
  - Current ratio 300/400/500/800/1,100/1,200/1,500/1,600/2,000 : 1//1//1//1
  - Accuracy class & burden 5P20, 20 VA
  - Continuous thermal current rating factor 1.0
  - Polarity Subtractive
  - Thermal short time current rating for 1 s 40 kA
  - Mechanical short time current rating, peak 100 kA
- for QY1D, QY2D, QY3D and QY6D As specified in DWG. NO. CYP-S-1 Sheet 02/05, 03/05
  - Quantity per phase 1 Set
  - No of core 2
  - Current ratio 600 × 1,200 : 1//1 \*
  - Accuracy class & burden 0.2S, 20 VA
  - Continuous thermal current rating factor 1.0
  - Polarity Subtractive
  - Thermal short time current rating for 1 s 40 kA
  - Mechanical short time current rating, peak 100 kA

Note : \* In case of double ratio with taps in secondary winding is proposed, the accuracy class shall be in accordance with the specified accuracy class and burden at all ratios.

## Specification No 170

### SF<sub>6</sub> Gas Insulated Switchgear (GIS)

**170-1 General.** This specification cover the general technical requirements for the design, manufacture, testing at works, supply, supervision of erection and testing at site of the SF<sub>6</sub> gas insulated switchgear.

Specific ratings, characteristics, features and performance characteristics of equipment not cover herein are shown on the accompanying Ratings and Features sheets.

For indoor GIS the building will be equipped with an overhead crane suitable for lifting the heaviest part for installation unless otherwise specified.

**170-2 Material, Workmanship and Design.** All materials used in the manufacture of the specified equipment shall be unused, of recent manufacture and of the kind, composition and physical properties be suited to their various purposes and in accordance with the best engineering practices.

Workmanship shall be of the highest grade and conform to the best modern practice for the manufacture of high grade machinery and electrical equipment.

All work shall be performed by mechanics and electricians skilled in their various trades.

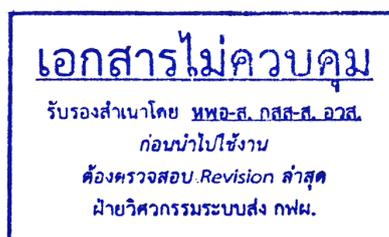
The factory welders shall be qualified personnel. Materials and process specifications needed for weldings shall meet the applicable requirements. Field weldings of the switchgear are to be avoided to achieve high quality of welding.

Maximum reliability is to be achieved by a minimum amount of erection on site. Sub-assemblies are to be erected and tested in the factory to a maximum extent. The size of the sub-assemblies should only be limited by the transport conditions.

The modular design of the switchgear shall offer maximum flexibility from the point of view of design, operation, maintenance and possible repairs. Similar modules are to be easily interchangeable.

The GIS shall be designed to provide enough space between each bay which accessible to maintenance and test so that any component of the GIS can be easily removed for testing and maintenance without requiring the removal of an adjacent component. If necessary it is permissible that one adjacent component may be removed. Removal of more than one component shall not be accepted.

The enclosure must be designed as pressure vessels for the highest pressure that can occur during service.



4 เมษายน 2568

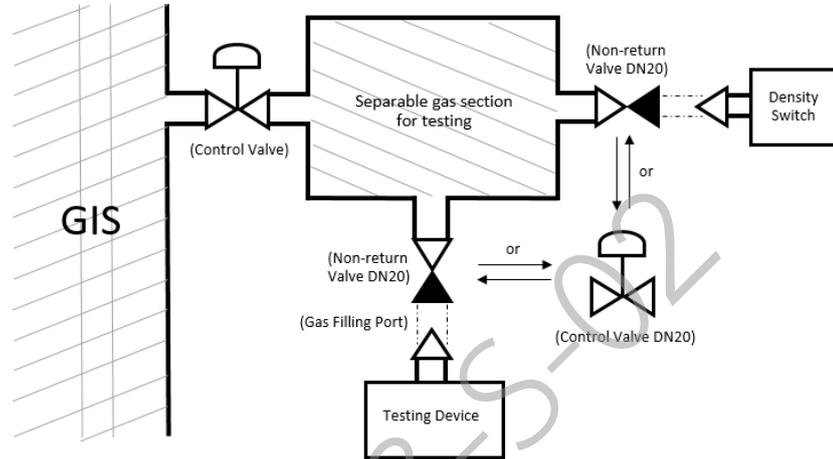
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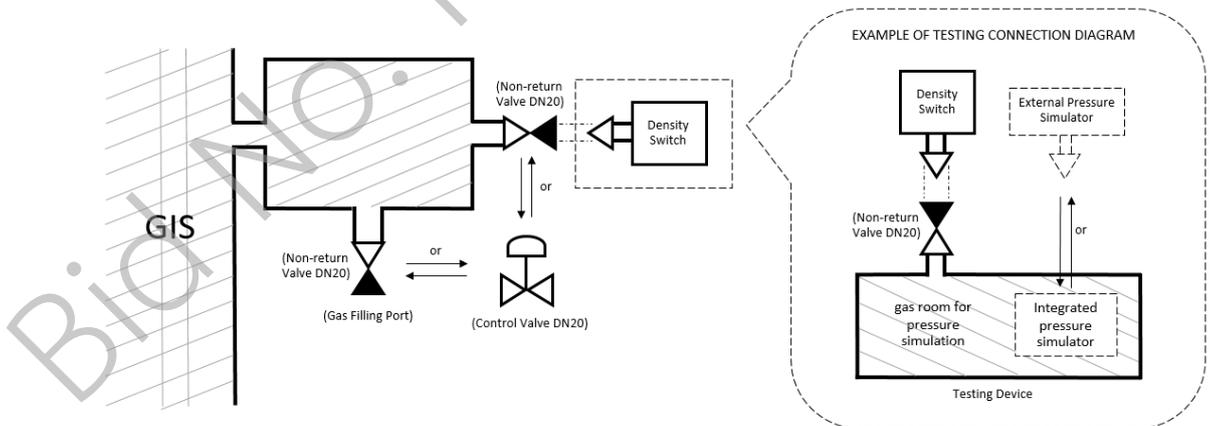
*has the greater portion of gas (to provide the same temperature reference as much as possible).*

To test the density switch, one of the following conditions shall be provided.

- The gas compartment shall be provided separable gas section by the control valve completed with the other 2 valves of DN20 (either non-return or control valve type) ; one for connecting with density switch and the other one for connecting with the testing device (gas filling device).



- In case no separable gas section provided, the density switch is required to be dismantled from the GIS via non-return or control valve and connected to the testing device which an integrated gas room is required to simulate the gas pressure at each operating point for density switch testing.



The device to verify the operation of density switch contacts shall be included in the testing device set (sub-article g. Test Unit for Checking Gas Density Monitor in clause no. 170-5.13) for both said cases.

- Connecting means shall be provided for connecting of pressure gauge to measure the SF<sub>6</sub> pressure of each compartment.
- Loose pressure gauges, *as spare parts for the installed pressure gauges*, completed with necessary fitting suitable for connecting to the connecting means mentioned above shall be provided in the quantity shown in the Price Schedule.

- For the last gas compartment at the end of Main Busbar where the extension bay will be connected with, the common uses of density switch, gas filling port and absorbent with the adjacent gas compartment are allowed.

The manufacturer shall guarantee that the pressure loss within each individual gas compartment will not be more than 0.5% per year.

All supplied gauges used for both gas and hydraulic pressure supervisions, including the gauge(s) supplied for sub-article h. Precision gauge and Vacuum gauge in clause no. 170-5.13, shall be shown in either Gauge pressure only or Absolute pressure only for whole GIS.

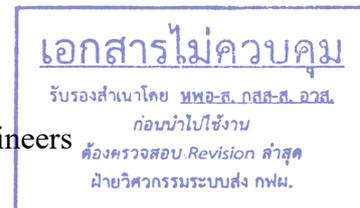
To ensure safety during maintenance work, all part of the main circuits shall be capable of being grounded before opening the enclosure. In addition, it shall be possible, after opening of the enclosure, to connect ground electrodes for the duration of maintenance.

The intervals between the necessary inspections shall keep the maintenance cost to a minimum. The inspection schedule is to be established by the Contractor.

**170-3 Service Conditions.** All materials shall be suitable for installation and use at an altitude of 1000 m or less in a tropical climate with a maximum ambient temperature of 45°C and 100% relative humidity for outdoor equipment (or a maximum ambient temperature of 40°C and 90% relative humidity for indoor equipment) without corrosion, deterioration or degradation of performance characteristics.

**170-4 Codes and Standards.** All equipment, materials, devices, fabrication and testing shall conform to the codes, specifications and standards listed below and all applicable codes, specifications and standard referred therein.

IEC	International Electrotechnical Commission
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
IEEE	The Institute of Electrical and Electronics Engineers
ICEA	Insulated Power Cable Engineer Association
NEMA	National Electrical Manufacturers Association



4 เมษายน 2568

All threaded parts requiring external connection shall have UNC screw and pipe threads. All internal parts may have threads in accordance with the established specification in the country of manufacturer.

It is the intent that all equipment, materials, devices, fabrication and testing shall conform to the application codes, specifications and standards even though they are not

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specifically noted herein. Equivalent codes, specifications and standards established and approved in the country of equipment or material manufacture may be used subject to EGAT's approval. If this election is made, the Bidder shall so state and include in his bid the governing codes, specifications, and standards proposed together with an itemized list of specific deviations from the requirements of codes, specifications and standards referred herein.

The latest issue of all codes, specifications and standards shall govern.

The most stringent requirement, in the event of code, specification or standard conflict, shall govern. This specification shall govern in the event of discrepancies between it and applicable codes, specifications and standards.

## 170-5 Equipment Requirements

**170-5.1 Composition of Switchgear.** The switchgear shall be installed and associated with circuit breakers, disconnecting switches, earthing switches, potential transformers, current transformers, buses, joint boxes, terminations, control cubicles and necessary support structures.

**170-5.2 Component of GIS Equipment.** The assembly shall consist of completely separate pressurized sections designed to minimize the risk of damage to personnel or adjacent sections in the event of a failure occurring within the equipment. In addition, the gas separation section shall be designed to meet with the service continuity as EGAT's service continuity requirements. Rupture diaphragms shall be provided in each gas compartment to prevent the enclosures from uncontrolled bursting and suitable deflectors shall provide protection for the operating personnel. In order to achieve maximum operation reliability, it is not desirable to install internal relief devices because adjacent compartments will be affected.

Maximum rated SF<sub>6</sub> gas pressure at 20°C shall not be more than 7.5 bar (gauge) for each gas compartment.

Modular design, complete pressure segregation, arc-proof and gas tight partition insulators and plug-in connection pieces shall allow ready removal of any section and replacement with minimum disturbance of the remaining pressurized switchgear. Circuit breaker compartment and disconnecting switch compartment shall be completely pressure segregation from each other. In the busbars partition insulators are required bay by bay. All the partition insulators shall withstand the different pressure that occurs in one compartment while the adjacent compartment is fully vacuum. The switchgear manufacturer shall prove this feature, which permit the erection and testing of extension along side the equipment already in service.

In the design of the enclosure, heat absorption due to solar radiation shall be considered in accordance with IEC 62271-203.

The temperature rise of the GIS bus and any other part at ambient temperature shall not exceed the temperature-rise limits specified in IEC 62271-203 or approved equivalent standards.



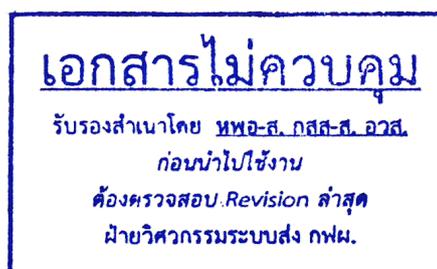
Additional new switchgear components required for the extension can be completely installed, gas-filled and tested with minimum disturbance to operation of the existing switchgear.

Dismantling and reassembly of each module can be taken place at any time completely independent of the other.

For system voltages of 230 kV and above. A GIS shall have internal couplers, which are usually of similar design to capacitive couplers, installed in the GIS. The internal couplers are used for detecting the partial discharge occurred in the GIS during the test after installation on site and the test after maintenance of the GIS. The number of couplers shall be sufficient to detect the partial discharge in the whole GIS, to be proven by the sensitivity verification. The partial discharge detection on-site by using VHF/UHF method and the sensitivity verification of VHF/UHF method shall be performed according to the latest IEC standard 62271-203.

### 170-5.3 Local Control Equipment

- a. The SF<sub>6</sub> gas insulated switchgear shall be provided with local control equipment mounted in firmly/stably-assembled cabinets on at least 2.0 mm thick panels positioned in the immediate vicinity of the switchgear to perform the following function.
  - (a) Control, interlock and indicate the position of switching devices in the switchgear.
  - (b) Monitor the density of the gas in the various gas sections.
  - (c) Monitor the drive mechanisms of the circuit breakers, disconnecting switches and earthing switches.
  - (d) Provide a connection point to central control equipment such as protective relays, measuring instruments, remote control interfacing, etc.
- b. The circuit breakers and their associated disconnecting switches and earthing switches in each bay, shall be equipped with control cubicles. The cubicles shall be equipped with circuitry and auxiliaries to show, perform or control the following functions :



4 เมษายน 2568

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- (a) A mimic diagram showing the arrangement of all electrical equipment in the bay, including Current Transformer, Voltage Transformer, Gas barrier, Gas compartment name and Line Lamp (B phase) as well as associated bus sections and circuits to the transformer banks and transmission lines. The Mimic diagram colour shall be in accordance with the following representative colour of each nominal system voltage rating.

Nominal System Voltage	Specific Colour Name	Colour Code	
		RAL No.	Munsell No.
500 kV	Deep Black	9005	N-1.0
230 kV	Fire Red	3000	5R4/13
115 kV	Orange	2003	2.5YR6/13
69 kV	Lemon Yellow	1018	7.5Y9/12

- (b) Indicators for showing the position of all circuit breakers, disconnecting switches and earthing switches. They shall be of LED type indicators.
- (c) Control switches for operating the circuit breakers, disconnecting switches and earthing switches. The colour of their operating handles shall be as follows;

- Circuit Breakers : Red
- Disconnecting Switches : Black
- Earthing Switches : Green

Unless the control switch is push button type, the above requirement shall be fully followed for the operating handle of control switch (spring-return selector switch).

For 3-position Switch (DS/ES combined mechanism), the Control switches of Disconnecter and Earthing Switch shall be completely separated from each other as well.

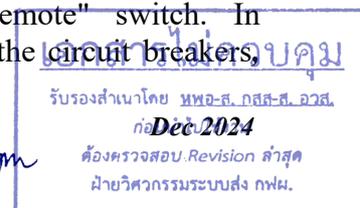
Nameplate of each Control switch shall be provided which showing only EGAT Switching Device Number of the corresponding equipment.

Note : Combination of Position Indicator(b) and Control switch(c), such as Discrepancy switch, is not acceptable.

- (d) Normal-Maintenance and Local-Remote switches for selecting control mode of circuit breakers and disconnecting switches according to the functional control requirement as shown on the " TYPICAL DRAWING No. TP-E-6.11 and TP-E-6.12 for 230 kV and above and 115 kV respectively "attached.

Normal-Maintenance switch normally is in the "Normal" position while Local-Remote switch is normally in the "Remote" position and both of them shall be operated by key for selecting the required mode. The key shall be able to be removed from operation only in "Normal" and "Remote" positions respectively. In "Normal" position the control mode shall be selected to operate either at Local or Remote by "Local-Remote" switch. In "Maintenance" position, the interlocking for the circuit breakers,

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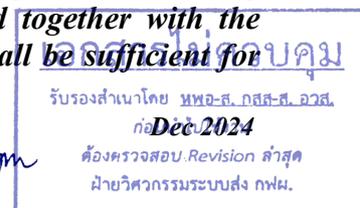


disconnecting switches and earthing switches shall be by-passed and tripping signals from protection system shall be blocked.

When "Local-Remote" switch is in the "Local" position, the circuit breakers, disconnecting switches and earthing switches shall be operated from control switch on the local control cabinet. In "Remote" position the circuit breakers and disconnecting switches shall be operated either from computer control system or control switch in the remote control room.

- (e) Interlocking between the circuit breakers, disconnecting switches and earthing switches shall be provided.
- (f) For line earthing switch, Undervoltage relay, with minimum adjustable voltage setting of 70% of measured voltage or lower, shall be provided for No Voltage on Line check function of line earthing switch interlocking circuit. The undervoltage relay can be either self-source or external supply source type. If the external supply source type is chosen, the measured voltage shall be used as its supply voltage as well in order to make one undervoltage relay works under the condition of its measured voltage only. In addition, since the measured voltage can be brought from either full tap or half tap of VT secondary side, so this measured voltage or input voltage shall be finalized and considered as one of the factors used for the undervoltage relay type selection; both measuring and supply voltage range shall be suitable for the input voltage. The operating principle of undervoltage relay shall be closed-circuit type, in other words, its contacts shall be energized in normal voltage condition and de-energized in no voltage condition.
- (g) Metering as shown on the Metering and Relaying diagram. ABB (Westinghouse) Flexi test type FT-1 test plugs or approval equal shall be provided for testing and calibrating the ammeters and voltmeters. ***The number of pole shall be sufficient for the connection with the supply source (125VDC) and input signals (current signals from CT for ammeter or voltage signals from VT for voltmeter or both for digital meter).*** Any necessary/special male test plug required for the said approved equivalent type shall be provided altogether.
- (h) Synchronizing relay shall be provided for each circuit breaker. The Synchronizing relay shall be energized in Local mode, Local-Remote switch in "Local" position, only. Bypass-Synchronous switch for bypassing the output contact of Synchronizing relay shall be provided as well. The Bypass-Synchronous switch normally is in "Synchronous" position and shall be operated by key for selecting the required mode. The key shall be able to be removed from operation only in "Synchronous" position. Besides, the switch shall be spring-return type which shall normally return back to "Synchronous" position. ***For testing and calibrating purposes, Test plugs shall also be provided together with the Synchronizing relay. The number of pole shall be sufficient for***

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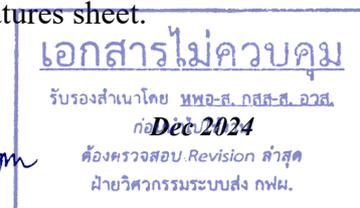
*the connection with the supply source (125VDC), input signals (voltage signals of the voltage supplies to be synchronized) and output contacts of Synchronizing relay (to be used in CB control circuit). Any necessary/special male test plug required for the supplied type shall be provided altogether.*

- (i) Annunciation of all alarms of the equipment in the bay. The annunciation shall be both visual and audible which shall be able to be reset by manual only. The visual annunciation shall flash and the audible annunciation sound until acknowledged. This audible annunciation shall be able to sound in Local mode only and shall be provided for each LCC panel individually. The typical annunciator for each GIS bay and annunciator operational sequence are as shown on " TYPICAL DRAWING No. TP-E-6.11 and TP-E-6.12 for 230 kV and above and 115 kV respectively " attached.
- c. All Local Control Cubicles shall be equipped with automatic lighting (door switch), duplex universal socket-outlet and thermostatically controlled heating element for control of condensation; by operating the heater when the surrounding temperature falls below specific temperature setting value. The mechanism boxes of all switching devices (CB, DS, ES and HSES) shall be equipped with heater as well, either thermostatically controlled or continuous type. In addition, Ground bar shall be provided inside all LCCs, mechanism boxes and secondary boxes of CT and VT for Earthing connection purpose.
- d. The terminal blocks for external wiring shall have the size suitable for the termination of the following cables :
  - For AC supply and DC supply : 6-35 mm<sup>2</sup>
  - For others and spares : 2x4 mm<sup>2</sup>
- e. The outer jacket **and insulation** of all cables inside LCC panel shall be polyvinyl chloride (PVC) compound to provide flame retardant characteristic. Polyethylene (PE) jacket **and insulation** shall be avoided.

#### 170-5.4 Circuit Breaker

- a. The circuit breakers shall be designed, rated, tested and manufactured in accordance with applicable portions of IEC 62271-100 or approved equivalent standards, unless otherwise specified. Each power circuit breaker shall be of the 3-pole, trip free, suitable for remote electrical closing and tripping, as well as for single pole and/or three pole tripping and reclosing (as specified in the Ratings and Features sheets) and furnished complete with operating mechanism and other accessories. The circuit breaker control system shall be completed with the anti-pumping circuit.
- b. **Interrupting Performance.** The circuit breakers shall be suitable for reclosing duty cycle, as specified in Ratings and Features sheet.

*Sotradil Hinthorn*



- c. **Control Circuit.** The functional control requirement shall be according to the functional control requirement as shown on the " TYPICAL DRAWING No. TP-E-6.11 and TP-E-6.12 for 230 kV and above and 115 kV respectively " attached.

The tripping circuit shall be directly connected to the power supply and two (2) sets of separating current and magnetic circuit tripping coils for primary and back-up tripping shall be provided for the following circuit breakers :

- (a) Single pole and three poles operated circuit breaker.  
(b) 230 kV and above three poles operated circuit breaker.

For single pole and three poles operated circuit breaker, pole disagreement shall be provided.

A pole disagreement sensing circuit for single-pole operated circuit breaker shall be provided that will trip the breaker after a time delay if, after an attempt has been made to close the breaker, one or two of the poles fail to close. The time delay shall be adjustable over a range of approximately 0.1s to 2s. A contact shall also be provided for the station alarm.

An auxiliary switch to be supplied shall not less than the contacts shown on the "TYPICAL DRAWING No. TP-E-6.11, sheet no.4 and TP-E-6.12, sheet no.3", in addition to those regularly connected in the control circuits by the manufacturer, any one of which may be used as an "a" switch or as a "b" switch. All unused contacts will be wired to the terminal board for external connection. The contact ratings shall be 125 Vdc to 10 A minimum continuous.

#### d. **Operating Mechanism**

The operating mechanism shall have supply records with successful manufacturing and operation/use of at least three (3) consecutive years.

Each mechanism shall have one (1) operation counter, non-resettable type with, at least, 4 digit display. The counting number shall be increased only after Close operation finished. In case Electrical counter type is chosen, the counter can be installed in LCC which shall be designed with the pulse input type where the direct parallel connection to the Close coil shall be avoided. The counting number on all counters shall be visible with the mechanism housing closed or LCC door closed. The operating mechanism shall be mounted and enclosed in a weather-proof housing whose doors are so arranged as to make accessible parts of the mechanism usually requiring inspection or maintenance.

A mechanical position indicator shall be provided to show the open and closed positions of each pole of the circuit breaker. It shall be positively, solidly and mechanically connected to the drive shaft. The indicator shall be of white letter "I" on red background and white letter

"O" on green background for closed and open position respectively and shall be located in such a way that visible from the far distance is possible with the mechanism housing closed.

Provision shall be made on each interrupter and its operating mechanism for the attachment of a device to record the operation of valves, contacts, etc., so that timing test can be made to verify the fact that the sequence of operation is as prescribed. Terminals for timing test shall be provided for both following conditions, direct to the coil (Close and Trip coils) and through auxiliary relay (see "TYPICAL DRAWING No. TP-E-6.11 and TP-E-6.12"). To confirm satisfactory performance of site timing test, the same terminals used during routine timing test at manufacturer factory shall be used for site timing test as well so that test result and record can be compared with the reference obtained during the said routine test.

For purposes of inspection and adjustment, means shall be provided for safe manual closing of the breaker at a conveniently accessible place. The maintenance closing device shall be designed that the contacts can be operated slowly by one man to adjust the breaker when it is not in service. The maintenance closing device shall be provided in the quantity shown in the Price Schedule.

In order to prevent the over charge of the operating mechanism from both manual and electrical operations, some self-protection device shall be provided to prevent damage to the operating mechanism or to slow down the degradation of the equipment. Overrun detection can be considered as the over-charge protection for electrical operation as well if the automatic charging-block function is integrated.

**(a) Hydraulic Operating Mechanism.** The hydraulic mechanism usually has one operating cylinder with a differential piston. The oil is pressurizes by a gas cushion in an accumulator, and the operating cylinder is controlled by a main valve. A complete and separate hydraulic system shall be furnished and installed with each breaker.

Each operating mechanism shall be provided with its own hydraulic equipment consisting of a pump, hand pump devices (in the quantity shown in the Price Schedule), accumulator, necessary control, piping and valves, and shall be provided for:

1. With CB inoperative duration of 8 hours, the number of hydraulic pump operation shall not be more than 1 time (This is internal leakage acceptance criteria).
2. Depend on the recharging time after a CO(Close-Open) operation of the circuit breaker, the number of close-open operations from normal hydraulic pump cut-on to minimum operating pressure shall not be less than the requirements specified in Section 6.8 "Stored energy requirements for operating mechanisms" of IEEE Std C37.04-1999.

3. The time required to charge the accumulator from the minimum hydraulic operating pressure to normal hydraulic cut-off pressure shall not exceed 30 min.
4. Undervoltage alarm relay, slow dropout type with contacts suitable for operation on DC circuit to permit remote indication of loss of potential on the AC supply to hydraulic pump motor and controls.
5. Oil indicator to indicate the oil level inside the oil tank shall be provided in order to check the abnormality in oil quantity. The indicator shall be visible with the mechanism housing closed or opened, dismantlement of any part is not allowed.
6. Time-meter driven by a self-starting synchronous motor with a register for 10,000 h without repetition, graduated in units not larger than one hour for indicating the total accumulated time that each hydraulic pump has operated. Each compressor shall have an operation counter.

The hydraulic pump shall be equipped with an automatic control to maintain normal hydraulic operating pressure. An alarm pressure switch which will close when the hydraulic pressure drops to a value approximately 10% above the minimum operating pressure of the mechanism shall be provided. A lockout pressure switches shall be provided to prevent a closing operation and opening(tripping) operation when the hydraulic pressure is too low to complete the operation. Contacts for remote indication of low hydraulic pressure shall also be provided. The interrupter of CB shall be designed to prevent the undesired movement by any factor that may be related with, such as, low hydraulic pressure against the constant value of gravitation, in order to avoid any damage on the main contact of CB itself.

The hydraulic system shall comprise of, at least, the following items.

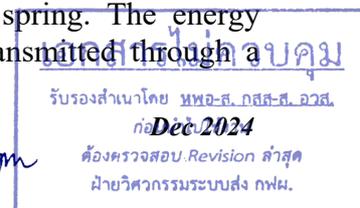
- Safety valve or Pressure release valve: to **automatically** release the overpressure from high pressure side to low pressure side.
- Bleeding valve or Air release valve: to **manually** release the air bubble inside the hydraulic to the outside air.

The hydraulic piping shall be readily connected from the factory or, if necessary, shall be prefabricated from the factory which ready for direct connection at site.

A manually operated valve shall be provided for closing and tripping hydraulically.

- (b) **Spring Operating Mechanism.** A mechanical spring mechanism usually consists of two springs, one for open and one for close operation. The closing spring generates the required force to close the circuit breaker and charge the opening spring. The energy stored in the spring will be released and transmitted through a

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system of levers and links and the contacts will move to the open or closed position. A complete and separate spring operating system shall be furnished and installed on each pole of circuit breaker.

Each operating mechanism shall be provided with its own motor spring charge equipment with a common control cabinet and shall be provided for:

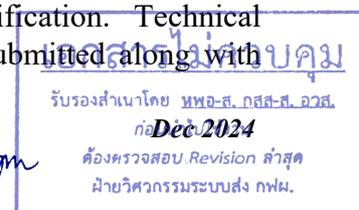
1. The time required to charge the closing spring after the closing operation shall be less than 15 s.
2. Undervoltage alarm relay with contact suitable for operation on DC circuit to permit remote indication of loss of potential on the supply to the spring charged motor and its controls. Moreover Over-charged and Over-load relay for motor protection are required.
3. Spring charged indicator to indicate the state of energy stored in the spring which shall be able to be seen easily while performing manual operation.
4. Means shall be provided to prevent the operation of the mechanism when maintenance work is being done. The mechanism shall be so arranged that emergency manual charging and release of the spring is possible without electrical means. Hand crank shall be provided for each circuit breaker (1 ea per each 3-pole CB). It shall be properly stored inside the mechanism box. If it is impossible to store inside, an additional stable support shall be designed for the crank storage in such a way that to attach the crank to the mechanism box. The electrical charging of the spring shall be prevented when the hand crank is engaged. On the other hand, for safety purpose, the hand crank shall not be able to be engaged when the electrical charging of the spring is being operated.

- (c) **Hydraulic spring-operated mechanism.** The hydraulic spring-operated mechanism is an operating mechanism combining hydraulics and springs. Energy is stored in a spring set, that is the tensioned hydraulically. A differential piston, powered by oil that is pressurized by the spring package, is used to operate the circuit breaker during opening and closing.

Each operating mechanism shall be provided with its own hydraulic equipment consisting of a pump, hand pump devices (in the quantity shown in the Price Schedule), accumulator, necessary control, piping and valves, and shall be provided for:

1. With CB inoperative duration of 8 hours, the number of hydraulic pump operation shall not be more than 1 time (This is internal leakage acceptance criteria), unless otherwise specified in Manufacturer manual/specification. Technical supporting reason/clarification shall be submitted along with

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the said document for EGAT consideration on the number of pump operating time which exceed above said requirement.

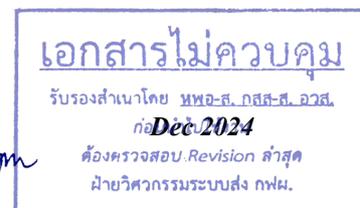
2. Depend on the recharging time after a CO(Close-Open) operation of the circuit breaker, the number of close-open operations from normal hydraulic pump cut-on to minimum operating pressure shall not be less than the requirements specified in Section 6.8 “Stored energy requirements for operating mechanisms” of IEEE Std C37.04-1999.
3. The time required to charge the accumulator from the minimum hydraulic operating pressure to normal hydraulic cut-off pressure shall not exceed 30 min.
4. Undervoltage alarm relay, slow dropout type with contacts suitable for operation on DC circuit to permit remote indication of loss of potential on the AC supply to hydraulic pump motor and controls.
5. Time-meter driven by a self-starting synchronous motor with a register for 10,000 h without repetition, graduated in units not larger than one hour for indicating the total accumulated time that each hydraulic pump has operated. Each compressor shall have an operation counter.
6. Spring charged indicator to indicate the state of energy stored in the spring.
7. Oil indicator to indicate the oil level inside the oil tank shall be provided in order to check the abnormality in oil quantity. The indicator shall be visible with the mechanism housing closed or opened, dismantlement of any part is not allowed.

The hydraulic pump shall be equipped with an automatic control to maintain normal hydraulic operating pressure. An alarm pressure switch which will close when the hydraulic pressure drops to a value approximately 10% above the minimum operating pressure of the mechanism shall be provided. A lockout pressure switches shall be provided to prevent a closing operation and opening (tripping) operation when the hydraulic pressure is too low to complete the operation. Contacts for remote indication of low hydraulic pressure shall also be provided. The interrupter of CB shall be designed to prevent the undesired movement by any factor that may be related with, such as, low hydraulic pressure against the constant value of gravitation, in order to avoid any damage on the main contact of CB itself.

The hydraulic system shall comprise of, at least, the following items.

- Safety valve or Pressure release valve: to **automatically** release the overpressure from high pressure side to low pressure side.
- Bleeding valve or Air release valve: to **manually** release the air bubble inside the hydraulic to the outside air.

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The hydraulic piping shall be readily connected from the factory or, if necessary, shall be prefabricated from the factory which ready for direct connection at site.

A manually operated valve shall be provided for closing and tripping hydraulically.

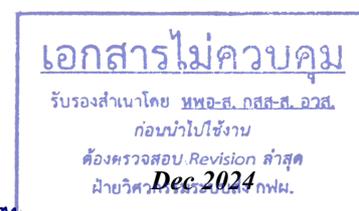
**170-5.5 Disconnecting Switch and Earthing Switch.** The switches shall conform to the applicable requirements of IEC 62271-102 or approved equivalent standards. All switches shall be triple pole single throw and single break type and must have the provision to inspect the contact position through a window (view port). The disconnecting switches and earthing switches shall be operated with 125 VDC motor, suitable for remote operation and a manual emergency drive mechanism shall be provided with manual operating tool (hand crank) for 2 sets per each type. The manual operating device shall be able to be engaged only when the interlocking condition is fulfilled and when it is engaged, Electrical motor operation shall be prevented. On the other hand, for safety purpose, the manual operating device shall not be able to be engaged when the electrical motor operation is being performed. The lockout condition with Padlock shall be provided along with each mechanism to block all possible operations, both Electrical and Manual. The mechanism shall open and close all three poles simultaneously (*except for High Speed Earthing Switch which may be designed with separated mechanism and position indicator for each pole*). Each motor drive shall be self contained and equipped with auxiliary switches. Life lubrication of the bearings shall guarantee the maintenance free.

All switches with electrical control for closing and opening operation shall be 2-pole controls.

The mechanical position indicator shall be equipped with each disconnecting switch and earthing switch. The indicator shall be of white letter "I" on red background and white letter "O" on green background for closed and open position respectively. In case DS/ES combined mechanism type is chosen, combined position indicator is acceptable which shall be of white letter "I" on red background for DS closed position, white letter "O" on green background for DS/ES open position and white letter "E" on blue background for ES closed(earthed) position. The position indicator shall be located in such a way that visible from the far distance is possible with the mechanism housing closed. These indicators shall be positively, solidly and mechanically connected to the drive shaft.

**a. Disconnecting Switch.** The disconnecting switches shall be capable of switching the capacitive charging currents of the buses, and also loop currents when bus bar transfer takes place in the multiple bus bar plants.

The disconnecting switch SF<sub>6</sub> gas compartment can be extended to cover adjoining passive plants items, such as connecting and extension pieces.



*Sorathide Hirinman*

The disconnecting switches shall be mechanical locking in both open and close position and pad locked. Interlocking against circuit breaker, earthing switches and other disconnecting switches shall be by electrical means.

All auxiliary contacts including the spare ones shall be wired up to terminal block in the local control cubicle for indication, control and interlock connection. Spare normally-open and normally-closed contacts shall be provided in the quantity shown on the " TYPICAL DRAWING No. TP-E-6.11 and TP-E-6.12 for 230 kV and above and 115 kV respectively " attached.

- b. Earthing Switch.** All bus bar earthing switches and earthing switches connected to the line or transformer in each outgoing bay shall be of the high-speed closing type, motor spring operated completed with emergency manual operated. These switches and their mechanism shall be suitable for fault-making operation. Such operation shall not endanger adjacent components or cause contamination or damage to the extent that immediate removal from service for overhaul is necessary.

All other maintenance earthing switches for grounding the current carrying part of the equipment, shall be of electrical motor operated completed with emergency manual operated which shall be withstand the short-circuit fault currents in fully closed position.

The earthing switches shall be fully interlocked with the disconnecting switches to avoid closing of earthing switch on to energized conductor and to prevent circuit breakers or disconnecting switches from closing to energize grounded conductors.

The ground connection of each earthing switches shall be brought out through bushings in a manner such that the ground connection can be removed and the earthing switch can be used to inject test voltages for site testing the adjacent equipment. The test shall be able to be performed without any linkage (between three phases) dismantling, in other words, the insulated bushing shall be provided for each phase earthing switch separately and individually. The bushing shall be insulated for minimum 2 kV and must withstand overvoltage when discharging the main circuit.



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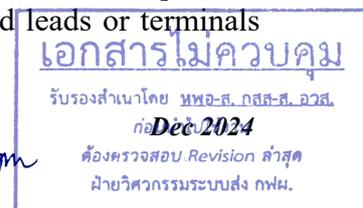
## 170-5.6 Current Transformers

- a. The current transformers associated with the circuit breaker, and elsewhere in the GIS assembly (if any), shall be ring core type, having ratio in accordance with the Ratings and Features sheets.
- b. The current transformers shall be of the number and location shown on EGAT drawings and shall be designed for mounting as an integral part of the bus system.
- c. The position of each primary terminal in the current transformer SF<sub>6</sub> gas section shall be clearly marked by two plates permanently fitted to the metal-clad at each end of the current transformer section.
- d. The current transformers shall be compatible with the station ratings and shall be in accordance with IEC 61869-2, where applicable.
- e. The current transformers shall have an accuracy classification in accordance with the Ratings and Features sheets.
- f. The current transformer secondary leads shall be stranded copper conductors with suitable size but not smaller than 4 mm<sup>2</sup>, sealed to prevent escape of insulation gas, if CT's are internal.
- g. All leads of each current transformer secondary shall be terminated on a separate short-circuiting type terminal block. The terminal blocks may be located in the local control cabinet or in a separate box in an easily accessible location.
- h. Current transformer nameplates shall be mounted on the equipment adjacent to the associated transformer, or at the terminal board where secondary leads are terminated and shall be in accordance with applicable requirements of IEC 61869-2. The details of terminal marking, both secondary box and LCC sides, shall be according to IEEE C57.13 which has details following:

When the polarity is indicated by letters, the letter “H” shall be used to distinguish the leads or terminals connected to the primary winding and the letter “X” (also “Y” and “Z,” etc., if multiple secondary windings are provided) shall be used to distinguish the leads or terminals connected to the secondary winding. In addition, each lead shall be numbered, for example, H1, H2, X1, and X2. If more than three secondary windings are provided, they shall be identified as X, Y, Z, and W for four secondary windings; X, Y, Z, W and V for five secondary windings; X, Y, Z, W, V, and U for six secondary windings, and so on. H1 and X1 (also Y1 and Z1, etc., if provided) shall be of the same polarity.

When multiple primary windings are provided, the leads or terminals shall be designated by the letter “H” together with consecutive pairs of numbers (H1, H2, H3, H4, etc.). The odd-numbered leads or terminals shall be of the same polarity.

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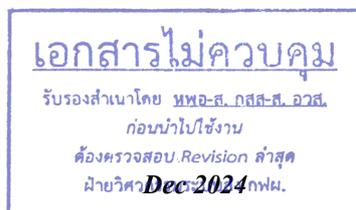


When taps or leads are provided on the secondary winding(s), the leads or terminals shall be lettered as required above and numbered X1, X2, X3, etc., or Y1, Y2, Y3, etc., with the lowest and highest numbers indicating the full winding and the intermediate numbers indicating the taps in their relative order. When X1 is not in use, the lower number of the two leads in use shall be the polarity lead. In the case of dual primary ratios that are obtained by secondary taps, the X3 or Y3 terminal shall be common to both taps.

- i. For the multiple core of current transformer, the multiple core conductor of power cable connecting between all core of current transformer and local control cabinet is not permitted. However, multiple core conductor of power cable is allowed for connecting between each core of current transformer and local control cabinet.
- j. Ammeter shall be provided to monitor the current from each CT GIS. It shall be installed inside the LCC which shall be visible with LCC door closed. The common use of digital meter monitoring both voltage and current is also acceptable.

#### 170-5.7 Voltage Transformers

- a. The voltage transformers shall be gas insulated for use as a voltage source for instruments and relays in a gas insulated substation. The transformers shall be designed as an integral part of the GIS system with specific requirements as described in the Ratings and Features sheets and as specified.
- b. The voltage transformers shall be single phase, SF<sub>6</sub> gas insulated type and shall comply with the requirement of IEC 61869-3. Ratios and accuracy classes shall be as specified in Ratings and Features sheets.
- c. The secondary leads of the transformers shall be brought out to a terminal box. All connections shall be made with solderless connectors. Cartridge type fuses or Miniature Circuit Breaker (MCB) for short circuit protection in the secondary circuits shall be furnished and installed in the terminal box. The fuses shall be non-renewable type and the interrupting rating shall be suitable for this installation.
- d. The transformers shall have a single primary and double secondary and may be either cascade or single core and coil type.
- e. The neutral end of the primary shall be brought out through a **10kV insulated** bushing.
- f. Compressed connection shall be securely made by applying copper ferrules compressed with a high pressure tool. The temperature rise of compressed connections shall be no greater than that of the associated conductor.
- g. Winding and core shall be contained in a metal tank.



- h. The windings shall be designed to eliminate, as far as practical, capacitive coupling between the primary and secondary.
- i. The transformer neutral bushing shall be adequately grounded to the enclosure by means of a removable copper strap.
- j. For the multiple winding of voltage transformer, the multiple core conductor of power cable connecting between all windings of voltage transformer and local control cabinet is not permitted. However, multiple core conductor of power cable is allowed for connecting between each winding of voltage transformer and local control cabinet.
- k. Voltmeter shall be provided to monitor the voltage from each VT GIS. It shall be installed inside the LCC which shall be visible with LCC door closed. The voltage values shown on the voltmeter display shall be of line to line voltage. The common use of digital meter monitoring both voltage and current is also acceptable.
- l. The voltage transformer shall withstand all GIS test items without saturation so that the test can be performed on the whole GIS with no VT dismantlement required. The integrated VT isolator is also acceptable as an alternative option.

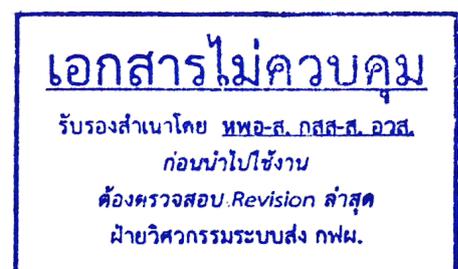
#### 170-5.8 Surge Arresters

- a. **General.** The surge arresters shall be station class, metal oxide surge arrester. Each arrester shall be new and a current standard production model with modifications as may be required to satisfy the requirements stated herein.

The arresters shall conform to the applicable requirements of IEC 60099-4, except as stated herein or as shown on the accompanying Ratings and Features sheets.

The arrester shall be insulated from ground with the ground end insulated.

Each arrester shall be furnished completely with a cyclometer type discharge counter with integral continuous AC leakage internal current indicator.



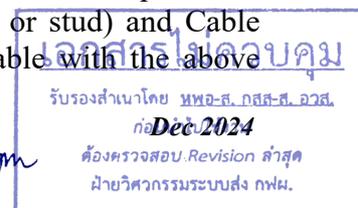
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## 170-5.9 Terminations

### a. Line Terminations

- (a) Termination of the overhead lines into the GIS shall be conventional SF<sub>6</sub> to air bushings.
- (b) All bushings shall be of approved manufacture and shall be capable of meeting the applicable requirements of IEEE C57.19 and IEC 60137 made by composite material (silicone rubber over a fibreglass core) or porcelain.
- (c) The rating of all bushings shall meet or exceed the requirements of the Ratings and Features sheets.
- (d) All porcelain used in bushings shall be wet process, homogeneous, nonporous, and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burns, and other defects. The porcelain colour shall be chocolate brown.
- (e) For composite bushings, the tracking and erosion type test has to be passed according to IEC 61462 and 62217.
- (f) The bushings shall be suitable for the use intended. The bushings may be either condenser type or non-condenser type but regardless of the type, they shall have proper voltage stress control. Condenser type bushings shall have an ANSI Standard potential tap in accordance with IEEE C57.19.
- (g) The puncture strength of all SF<sub>6</sub> to air bushings shall be greater than the dry flash over value.
- (h) The SF<sub>6</sub> to air bushings mounted on the bus extension of the GIS shall have the exterior terminals on centerlines sufficiently far from the GIS building to meet all phase-to-ground clearance requirements. These bushings shall be supported by structural members designed and supplied by the GIS manufacturer as an integral part of the GIS assembly.
- (i) The SF<sub>6</sub> to air bushings mounted on the wall of building shall have the metal shield inside in order to mitigate of transient ground potential rise.
- (j) Bushing terminals can be equipped with either terminal pad or stud. In case of the terminal pad, it shall be provided with 14.3 mm (9/16 in) diameter holes with 44.5 mm (1 3/4 in) spacing between the centers of each hole in accordance with the NEMA Standards CC1, 4 holes arrangement for rated primary current that less than 3000 A and 6 holes arrangement for rated primary current that more than or equivalent to 3000 A. For the terminal connector which required for the connection between Bushing terminal (pad or stud) and Cable terminal (pad), it shall have the interface suitable with the above

*Sotradis Hirinon*



said requirement as well because this requirement is applied for the whole substation including the terminal pad of the cable where the connector has to be connected with.

**b. Cable Terminations**

The Cable termination shall be designed properly for connecting with the Gas Insulated metal-enclosed Switchgear (GIS). The Cable termination's manufacturer shall thoroughly coordinate for the interface between Cable termination and GIS with GIS manufacturer. The Cable termination shall be designed to conform following standards and conditions;

**(a) For Dry type or fluid filled type**

- IEC 62271-203
- IEC 62271-209
- IEC 60840 or IEC 62067

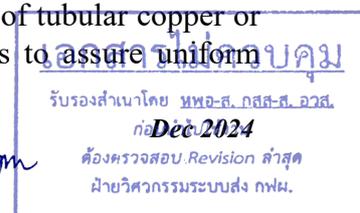
**(b) For Dry type plug-in type**

- IEC 62271-203
- IEC 62271-209
- IEC 60840 or IEC 62067
- JWG B1-B3.33 Cigre
- Female cable termination shall be assembled with GIS at GIS factory.
- Male cable termination shall be designed for plugging-in and plugging-out easily from female cable termination without gas handling work.

**170-5.10 Busbars, Insulators and Barriers**

- a.** The busbar shall be positioned and supported by epoxy-resin insulators acting also as sectional barriers between adjacent bays, called as partition, and as supports, called as support insulator. The insulator which changeable between partition and support insulator is also acceptable only if it can fulfill EGAT's service continuity requirements in clause no.170-14. The partition type insulator shall be painted with orange colour while the changeable type insulator shall be painted with blue colour. The indicator shall be provided for each changeable type insulator to indicate its current function, either as the partition or as support insulator.
- b.** Provisions to compensate for expansion and contraction of busbar and enclosure due to temperature fluctuation shall be included. No mechanical stress shall be imposed on insulating parts.
- c.** Insulators shall be given thermal cycle design tests and shall demonstrate dielectric and mechanical integrity after thermal cycling.
- d.** Bus conductors and the various connectors shall be of tubular copper or aluminum and have finger type plug-in connectors to assure uniform

*Sotradis Hirinon*



contact pressure. The movable and fixed contact surfaces of the connectors shall be silver plated or inlaid.

- e. The conductor surface shall be smoothly finished to prevent any electrical discharges. A homogeneous uniform electric field shall be maintained within the enclosure.

**170-5.11 Foundation, Support Structure and Grounding System.** All equipment shall be furnished with base frame, anchor bolts, hardwares, supporting steel structures as required for complete installation.

Support structures shall be freestanding nonguyed type and designed to withstand the 40 m/sec winds (applied to portions located outside building).

All metal parts other than those forming part of any electrical circuit shall be grounded to the grounding system. For EGAT application, 4/0 AWG cable is generally selected for earthing riser. If GIS manufacturer suggests that larger conductor of earthing riser is required to be capable with the rated short-circuit withstand current of GIS, multiple in number of 4/0 AWG cable is also acceptable. Any necessary terminals on any part of the equipment required for this purpose shall be provided.

**170-5.12 Cable and Other Necessary Materials.** The control cables and power cables connect between the GIS component devices such as circuit breaker, disconnecting switch, earthing switch, instrument transformer, etc. and the local control cubicle shall be supplied by the contractor. The outer jacket of all cables and wirings shall be polyvinyl chloride (PVC) compound to provide flame retardant characteristic. Control and auxiliary devices shall be segregated by grounded metallic partitions from the power supply circuit. GIS manufacturer or LCC supplier shall suggest that either grounding on one or both sides of the cable is required together with the technical supporting reason.

The wiring of auxiliary and control circuits shall also be segregated from the power supply circuit.

For control cable, the nominal cross-sectional area of conductor shall not be less than 1.5 mm<sup>2</sup>.

**170-5.13 Accessories.** The following accessories shall be provided if specified in Price Schedule or elsewhere:

- a. **SF<sub>6</sub> Gas Service and Storage Unit.** A gas service unit truck, if required and specified elsewhere, shall consist of all equipment necessary for filling and evacuating the SF<sub>6</sub> gas in the switchgear equipment and to enable any service and maintenance that may be required. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF<sub>6</sub> gas as well as any other gases which may be used in the process. The capacity of the storage facilities shall be sufficient for storing the maximum quantity of gas that must be removed from the most voluminous parts of the switchgear and associated equipment. The unit shall be capable of filtering, replenishing, and analyzing the

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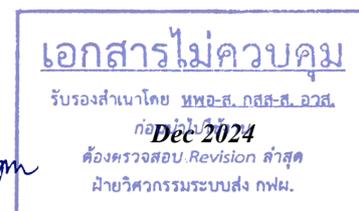


insulating gas while the equipment is in service. It shall have adequate facilities to remove moisture and decomposition products from the gas and to replenish lost gas from its own self-contained storage system and shall be designed so as to be protected from over-pressure such that a malfunction will not cause loss of gas from the GIS.

The unit shall be provided with all the necessary pipes, hoses, couplings, flexible tubes and valves for coupling up to the switchgear equipment for filling or evacuating all the gases to be used. A pressure relief valve shall be fitted to the filling pipe to prevent the gas pressure from rising to more than 10% above the design pressure during the filling of the enclosure. The design of the equipment, valves, couplings, connections, etc. must be of such quality standard that leakage of any SF<sub>6</sub> gas during the filling and evacuating processes is kept to an absolute minimum. By necessity, the equipment shall have facilities for dry air or any other gases which may be temporarily filled during the process of filling SF<sub>6</sub> gas.

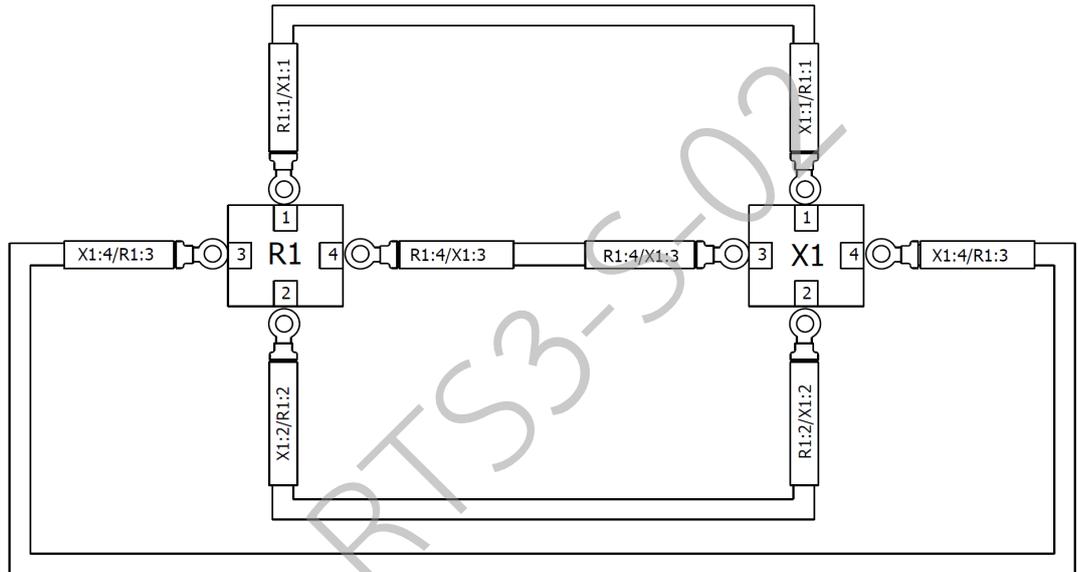
- b. **SF<sub>6</sub> Gas Filling Cart.** A gas filling cart for carrying one SF<sub>6</sub> gas cylinder together with regulator, hose, pressure gauge, valves and couplings shall be provided.
- c. **Portable SF<sub>6</sub> Gas Leakage Detector.** A highly sensitive and reliable leakage detector device capable of reliably detecting SF<sub>6</sub> gas leakage shall be supplied for checking the integrity of sealed joints.
- d. **Moisture Content Measuring Device-Dew Point Meter (SF<sub>6</sub> Gas quality measuring device).** An electronic hygrometer capable of reading both moisture and SF<sub>6</sub> concentrations shall be provided as specified in Ratings and Features sheets.
- e. **Gas Decomposition Tester.** A device for measuring the amount of gas decomposition shall be provided complete with all necessary fittings.
- f. **Test Unit for Checking Gas Density Monitors.** A highly accurate device for checking and calibrating the gas density switch shall be supplied complete with fittings.
- g. **Precision Pressure Gauge and Vacuum Gauge.** Two sets of portable digital pressure gauges complete with necessary fittings for checking pressure and vacuum respectively or only one set of the gauge capable of checking both pressure and vacuum range shall be supplied. Pressure gauge(s) shall precisely show the value of pressure with the Metric Unit of Bar. *These portable digital pressure gauges are GIS accessories which intended for facilitating the measurement of SF<sub>6</sub> gas pressure in any gas compartment as well as calibrating any installed pressure gauge.*
- h. **Operating Analyzer Fitting Means.** Provision shall be made for fitting an operating analyzer to perform speed test after installation of the circuit breaker.

*Sotradit Himmam*



**170-5.14 Terminal Block, Wire and Device Designations.** Every point of terminal block and wire shall be assigned a designation, with identical designation on each corresponding terminal block and wire as *one of* following formats:

***Format#1 (One-line pattern):*** The designation on each wiring end shall consist of both origin and destination designations which separated by ‘/’ symbol. The origin designation shall always be indicated on the side adjacent to where the wiring is terminated while the far side shall always indicate the destination designation of the wiring. Depending on the arrangement of Terminal Block, Device and Wiring, Wire designation on both ends of the same wiring may be different.

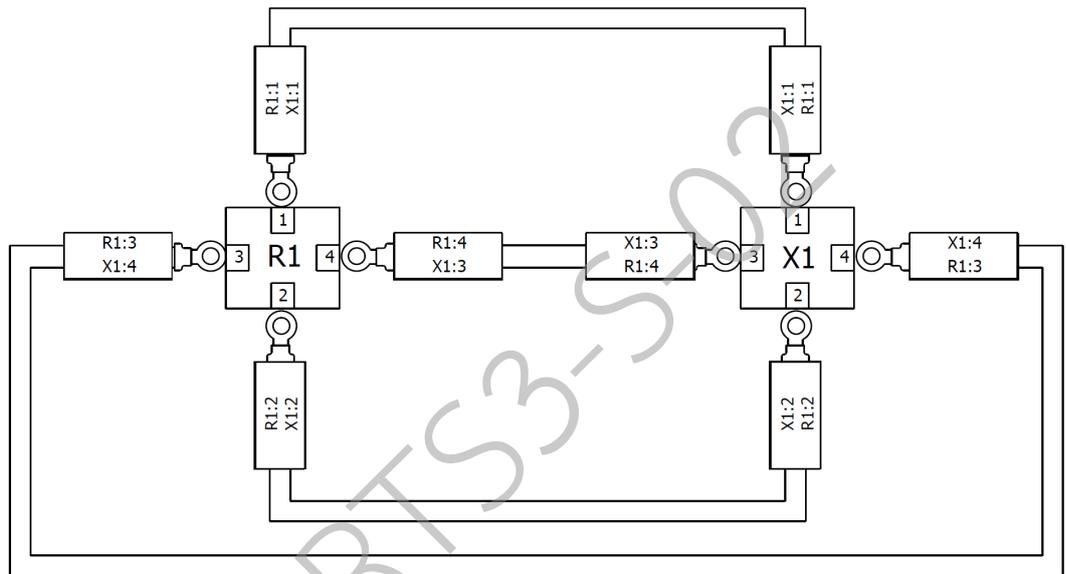


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ก่อนนำไปใช้งาน  
ต้องตรวจสอบ.Revision ล่าสุด  
ฝ่ายวิศวกรรมระบบส่ง กฟผ.

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***Format#2 (Two-line pattern):*** The designation on each wiring end shall consist of both origin and destination designations. The origin designation shall be indicated on the first line while the second line shall indicate the destination designation of the wiring. Thus, Wire designation on both ends of the same wiring shall always be different (alternately between first line and second line). Most importantly, the first line and the second line shall be distinguished by appropriate solutions. For general wire marking sleeves with a full-circle design, the spacing below the first line to the second line shall be minimal and significantly less than the spacing below second line to first line; to make it clear which line is the first and which is the second.



- The letters direction of wire mark shall be read from left to right (*for horizontal wiring*) and bottom to top (*for vertical wiring*)
- The terminal number of terminal block shall be arranged from top to bottom and left to right
- ***Only a single format shall be used. The use of both one-line and two-line formats is not permitted***

This same designation shall also be indicated in the schematic and wiring diagrams. As a rule, a designation will not change until the wire is terminated or connected to other equipment. All wiring shall be designated at both ends by printing on wire designation sleeves. Wire designation shall be by permanent method unaffected by heat, solvents, or steam, and not easily dislodged. Each designation on the terminal blocks shall be machine-lettered, stamped, engraved or neatly marked with permanent ink on the removable marking strips provided for every terminal block. Approximately 20% of spare wire designation sleeve shall be furnished. Adhesive labels shall not be acceptable.

The terminal blocks for AC circuit and the terminal blocks for DC circuit shall be separately grouped as well as the AC terminal blocks shall be covered with transparent plastic box.

All wirings shall always be arranged inside the wire way.

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 รับรองสำเนาโดย นพอ.ส.กสส-ส.อวส.  
 ก่อนนำไปใช้งาน  
 ต้องตรวจสอบ Revision ล่าสุด  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.

*Sorachit Hinmanom*

**170-6 Cleaning and Painting.** All equipment, accessories, piping and wiring shall be provided with tropical finish to prevent corrosion and fungus growth.

Surface to be painted shall be cleaned to base metal and shall be thoroughly dry before application of any paint. After cleaning, the surface shall be given a priming or sealing coat of paint. The primary coat shall be of the kind matching the finish paint mentioned above and shall have a rust preventive effect which followed by two coat of final paint.

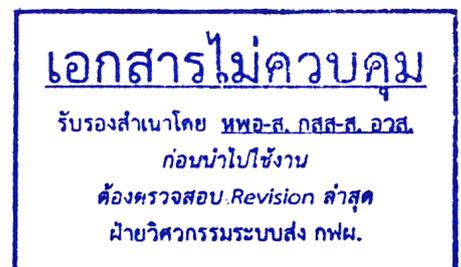
The exposed portion of all equipment to be erected at the site shall be shop-coated with primary paint and finish paint. After the equipment has been installed at the site, the Contractor shall carry out touch up painting. Control cubicles and control boxes for auxiliary equipment, motors, pumps, tanks and other shop-finished products by manufacturer's standard shall be shop-finished with spray painting and shall not undergo painting at site.

The color of all external of the GIS including correlated accessories and control cubicle shall be of light gray Munsell Notation No. 7.5 BG 6/1.5 or RAL 7035/7036/7038.

**170-7 Nameplate.** Nameplates shall be furnished and mounted at least the following :

**170-7.1 Nameplate of GIS.** A nameplate of anodized *aluminum* or stainless steel shall be attached in the front of GIS to show the general information of GIS at least the following :

- (a) Manufacturer/Country
- (b) Type
- (c) Voltage Rating (kV)
- (d) Current Rating
- (e) Continuous Current
  - Main bus (A)
  - Feeder bus (A)
- (f) Interrupting Current (kA)
- (g) BIL (kV)
- (h) Rated Frequency (Hz)
- (i) SF<sub>6</sub> Gas Pressure at 20 °C
  - Circuit Breaker Compartment
  - Other Compartment



4 เมษายน 2568

- (j) EGAT Contract Number  
(will be issued after signing of the LOA; Letter Of Award)
- (k) EGAT Serial Number  
(will be issued after signing of the Contract)

**170-7.2 Rating Plate of Equipment.** A nameplate of anodized aluminum or stainless steel shall be attached to each equipment in a conspicuous position near the equipment to show the necessary information of the equipment.

**170-7.3 Switching Device Number Plate.** Switching device number of each equipment as specified on single line drawing shall be indicating on nameplate made of anodized aluminum or stainless steel. The colours of background and lettering shall be as follows:

<u>Nominal System Voltage</u>	<u>Background</u>			<u>Lettering</u>		
	<u>Colour</u>	<u>RAL No.</u>	<u>Munsell No.</u>	<u>Colour</u>	<u>RAL No.</u>	<u>Munsell No.</u>
500 kV	Deep Black	9005	N-1.0	Pure White	9010	N-9.5
230 kV	Fire Red	3000	5R4/13	Pure White	9010	N-9.5
115 kV	Orange	2003	2.5YR6/13	Pure White	9010	N-9.5
69 kV	Lemon	1018	7.5Y9/12	Deep Black	9005	N-1.0
	Yellow					
GROUND	White Gray	-	N-7.0	Deep Black	9005	N-1.0

**170-7.4 Phase Indicator Plate.** The indicator plate shall be made by one of the following materials; stainless steel, anodized **aluminum**, sticker or paint. If the sticker or paint is chosen, the indicator shall be durable against surroundings and shall not be faded away after the time passed. Mounting location of the phase indicator plate shall be specified by manufacturer which shall be visible in the position of normal service and installation. Colour of the phase indicator shall be as follows:

- A phase : White letter "A" against Red background
- B phase : Black letter "B" against Yellow background
- C phase : White letter "C" against Blue background

**170-7.5 PD sensor nameplate.** A nameplate of anodized **aluminum** or stainless steel shall be attached with each PD sensor to indicate the location where the partial discharge is detected, if any. This PD sensor name shall be shown on one or all of your General Arrangement drawings, such as, Single Line Diagram, Gas Scheme, etc., for the above said location tracking purpose.

**170-7.6 Nameplates on front of LCC panel and Mimic Diagram.** All nameplates shall be made either by engraving on specific material (stainless steel, anodized aluminum or high-quality laminated plastic) or by permanent printing on the LCC sheet/plate (with high resolution). Both options shall have non-reflecting surface and the colour of the nameplates shall be of White letters against Black background (EGAT's preference) or Black letters against White background. Lettering shall be properly arranged with a clear and legible font, not too thick or too thin, where the space between letters shall not be too wide which could make it difficult to read full inscription of the nameplate.

*Sotradich Hinman*



**170-7.7** *Nameplates or Labels of all equipment/devices inside LCC panel. All nameplates or labels shall be made either by engraving on specific material (stainless steel, anodized aluminum or high-quality laminated plastic) or by permanent printing on sticker (best quality with strong durability against surrounding and shall not fall off easily). Both options shall have non-reflecting surface and the colour of the nameplates shall be of White letters against Black background (EGAT's preference) or Black letters against White background (or approved equivalent). Lettering shall be properly arranged with a clear and legible font, not too thick or too thin, where the space between letters shall not be too wide which could make it difficult to read full inscription of the nameplate.*

**170-8 Test.** Test of equipments shall be performed according to the requirements specified in each referred test item. The costs of all tests and reports shall be borne by the Contractor.

**170-8.1 Type Test.** The proposed equipment shall already have the type test record of the same type and same rating as EGAT called for, in accordance with the tests specified in their relevant standards and each equipment test items, which is subject to EGAT's approval (unless otherwise specified in each equipment test item). The type test record shall be required and submitted together with the tender document during the bidding.

**170-8.2 Routine Test.** Each equipment subjected to all tests specified in their relevant standards.

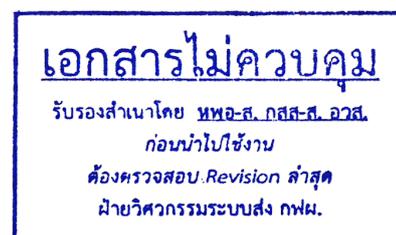
The purpose of these tests is to detect possible material or manufacturing defects. The routine test shall be performed on all components. For each equipment test items specified in this specification, the tests shall be made at the manufacture's works while all other unspecified tests may be performed at site.

**170-8.3 Quality Conformance Test.** The quality conformance test shall be performed by selecting the sample from each lot of equipment. The numbers of samples for the test shall be as specified in the Standard.

**170-8.4 Additional Test.** Additional test required as specified shall be performed on the one unit of equipment being supplied.

**170-8.5 Test Report.** The report of all tests, curves and standard application data shall be furnished to EGAT immediately after the completion of the tests.

**170-8.6 Test Procedure.** The Contractor shall submit the test procedure of specified tests and actual design tests to EGAT for approval. The test procedure shall consist of procedures, applied voltage, current and criteria to justify the result of the tests.



4 เมษายน 2568

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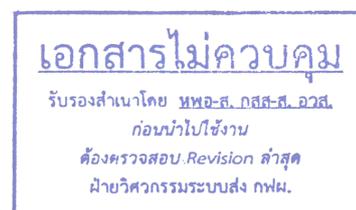
**170-8.7 Test Items for Gas Insulated Switchgear.** The tests shall be performed in accordance with the latest IEC 62271-203 and the following test items.

**a. Type Tests.** The purpose of design tests is to verify the design characteristics of the GIS, the design tests shall be carried out on a complete single-phase or three-phase assembly of one typical switchgear bay. Because of the variety of types, ratings and possible combinations of components, the performance of any particular arrangement may be substantiated by test data of comparable arrangements.

- (a) Tests to verify the insulation level of the equipment and dielectric tests on auxiliary circuits
- (b) Partial discharge tests
- (c) Tests to prove the radio interference voltage (RIV) level (This test applies only to bushing)
- (d) Tests to prove the temperature rise of any part of the equipment and measurement of resistance of the main circuit.
- (e) Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
- (f) Tests to verify the making and breaking capacity of included switching devices.
- (g) Test under conditions of arcing due to an internal fault.
- (h) Tests to prove the satisfactory operation at limit temperature.
- (i) Gas tightness tests
- (j) Proof tests for enclosures
- (k) Pressure test on partitions
- (l) Insulator tests (partitions and support insulators)
- (m) Verification of the degree of protection of auxiliary and control circuits.

**b. Routine Test.**

- (a) Dielectric test on the main circuit
- (b) Tests on auxiliary and control circuits
- (c) Measurement of the resistance of the main circuit
- (d) Tightness test
- (e) Design and visual checks



4 เมษายน 2568

*Sorathide Hirinon*

- (f) Pressure test on enclosures
- (g) Mechanical operation tests
- (h) Tests on auxiliary circuits, equipment and interlocks in the control mechanism
- (i) Pressure test on partitions

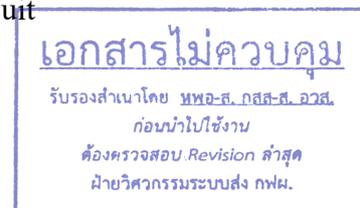
**170-8.8 Test Items for Power Circuit Breaker.** The tests shall be performed in accordance with the latest IEC 62271-100 and the following test items.

**a. Type Tests**

- (a) Dielectric test on the main circuit
- (b) Measurement of the resistance of the main circuit
- (c) Temperature rise tests
- (d) Short time withstand current and peak withstand current tests
- (e) Additional tests on auxiliary and control circuits
- (f) Mechanical operation test at ambient temperature
- (g) Short circuit current making and breaking tests
- (h) Tightness tests
- (i) EMC test (Electronic equipment or component are included in the secondary system)
- (j) Short line fault test
- (k) Out of phase making and breaking tests (out of phase rating assigned)
- (l) Capacitive current switching tests
- (m) Switching of shunt reactors (*if this application is assigned in Ratings and Features (RF) document*)

**b. Routine Tests**

- (a) Dielectric test on the main circuit
- (b) Tests on auxiliary and control circuits
- (c) Measurement of the resistance of the main circuit
- (d) Tightness test
- (e) Design and visual checks
- (f) Mechanical operating tests
- (g) Timing and motion tests, oscillograph shall be provided.



4 เมษายน 2568

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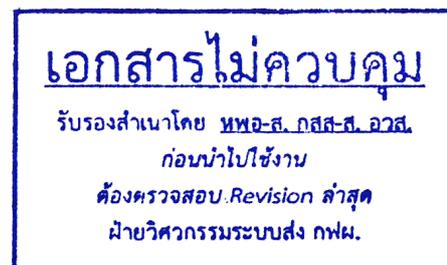
**170-8.9 Test Items for Disconnecting Switches and Earthing Switches.** The tests shall be performed in accordance with the latest IEC 62271-102 and the following test items.

**a. Type Tests**

- (a) Dielectric test on the main circuit
- (b) Temperature rise tests
- (c) Measurement of the resistance of the main circuit
- (d) Tightness test
- (e) Short time withstand current and peak withstand current tests
- (f) Test to prove the short circuit making performance of earthing switches
- (g) Electromagnetic compatibility tests (EMC)
- (h) Operating and mechanical endurance tests
- (i) Tests to verify the proper functioning of the position indicating device
- (j) Bus transfer current switching tests
- (k) Bus charging switching tests
- (l) Induced current switching tests

**b. Routine Tests**

- (a) Dielectric test on the main circuit
- (b) Dielectric tests on auxiliary and control circuits
- (c) Measurement of the resistance of the main circuit
- (d) Tightness tests
- (e) Mechanical operation tests
- (f) Design and visual checks



4 เมษายน 2568

**170-8.10 Test Items for Voltage Transformer.** The tests shall be performed in accordance with the latest IEC 61869-3 and the following test items.

**a. Type Tests**

- (a) Temperature rise test at thermal burden rating and at rated voltage factor.
- (b) Impulse voltage withstand test on primary terminals.
- (c) Electromagnetic compatibility tests.
- (d) Test for accuracy.
- (e) Verification of degree of protection by enclosures.
- (f) Enclosure tightness test at ambient temperature.
- (g) Pressure test for enclosure.
- (h) Short-circuit withstand capability test.

**Note: For Voltage Transformer which both Protective and Measuring classes are assigned on the same winding;**

**- If the type test of both specified or better classes have already been performed on the same winding, the type test report(s) shall be submitted with the tender documents during bidding stage.**

**- If not, the type test report(s) for each specified or better class on separated windings shall instead be submitted with the tender documents during bidding stage, along with manufacturer's letter to confirm the capability of manufacturing both classes on the same winding.**

**b. Routine Tests**

- (a) Power-frequency voltage withstand test.
- (b) Partial discharge measurement. The permissible partial discharge level shall not be more than 10 pC at  $U_m$  and 5 pC at  $1.2 U_m/\sqrt{3}$  ( $U_m$  : Maximum Service Voltage).
- (c) Test for accuracy.
- (d) Verification of marking.
- (e) Enclosure tightness test at ambient temperature.
- (f) Pressure test for enclosure.
- (g) Winding resistance measurement of primary and secondary winding for each ratio of all windings.
- (h) Insulation resistance measurement.

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ต้องตรวจสอบ.Revision ล่าสุด  
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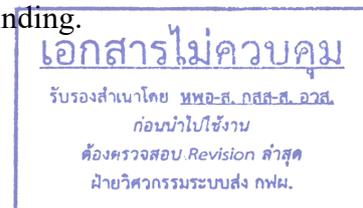
**170-8.11 Test Items for Current Transformer.** The tests shall be performed in accordance with the latest IEC 61869-2 and the following test items.

**a. Type Tests**

- (a) Temperature rise test at maximum rated current (of continuous thermal current rating factor).
- (b) Impulse voltage withstand test on primary terminals.
- (c) Electromagnetic compatibility tests.
- (d) Test for accuracy.
- (e) Verification of degree of protection by enclosures.
- (f) Enclosure tightness test at ambient temperature.
- (g) Pressure test for enclosure.
- (h) Short-circuit current test.

**b. Routine Tests**

- (a) Power-frequency voltage withstand test.
- (b) Partial discharge measurement. The permissible partial discharge level shall not be more than 5 pC at  $1.2 U_m/\sqrt{3}$  ( $U_m$  : Maximum Service Voltage).
- (c) Test for accuracy for each ratio of all winding (including excitation curve of one unit of each item for relaying class).
- (d) Verification of marking.
- (e) Enclosure tightness test at ambient temperature.
- (f) Pressure test for enclosure.
- (g) Determination of the secondary loop time constant.
- (h) Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.
- (i) Winding resistance measurement of primary and secondary winding for maximum ratio of all winding but one unit of each item shall be performed for each ratio of all winding.
- (j) Inter-turn overvoltage test.
- (k) Insulation resistance measurement.



4 เมษายน 2568

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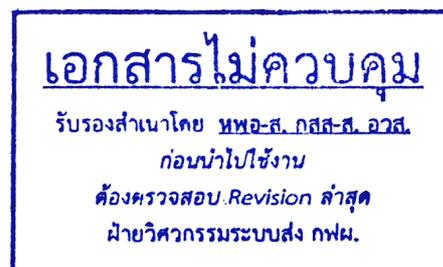
**170-8.12 Test Items for Metal Oxide Surge Arrester.** The tests shall be performed in accordance with the latest IEC 60099-4 and the following test items.

**a. Type Tests**

- (a) Insulation withstand tests on the arrester housing.
- (b) Residual voltage test.
- (c) Test to verify long term stability under continuous operating voltage.
- (d) Test to verify the repetitive charge transfer rating..
- (e) Heat dissipation behaviour verification of test sample.
- (f) Operating duty test.
- (g) Power-frequency voltage-versus-time test.
- (h) Short circuit tests.
- (i) Radio interference voltage (RIV) test.
- (j) Test to verify the dielectric withstand of internal components.
- (k) Test of internal grading components. (if, any)

**b. Routine Tests**

- (a) Measurement of reference voltage.
- (b) Residual voltage test at nominal discharge current.
- (c) Internal partial discharge test.
- (d) Power-frequency voltage test.
- (e) Seal leak rate test.
- (f) Current distribution test for multi-column arrester.



4 เมษายน 2568

*Sotradis Hirinon*

**170-8.13 Test Items for Metal Enclosed Bus and GIB.** The tests shall be performed in accordance with IEC 62271-203.

**a. Type Tests**

- (a) Tests to verify the insulation level of the equipment and dielectric tests on auxiliary circuits
- (b) Partial discharge tests
- (c) Tests to prove the temperature rise of any part of the equipment and measurement of resistance of the main circuit.
- (d) Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
- (e) Test under conditions of arcing due to an internal fault.
- (f) Gas tightness tests
- (g) Proof tests for enclosures
- (h) Pressure test on partitions
- (i) Insulator tests (partitions and support insulators)
- (j) Verification of the degree of protection of auxiliary and control circuits.

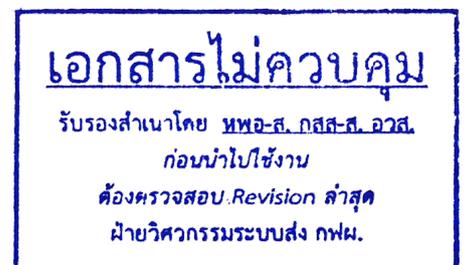
**b. Routine Tests.** The routine test shall be performed on all components. For each equipment test items specified in this specification, the tests shall be made at the manufacture's works while all other unspecified tests may be performed at site. Depending on the nature of transport unit, whether the Metal Enclosed Bus/GIB is assembled before transportation or not, if it is not assembled, the following test items shall be performed separately between Enclosure and Support Insulator/Partition or if it is assembled, all test items specified under Enclosure and Support Insulator/Partition shall be performed on their assembly unit.

- For Enclosure

- (a) Design and visual checks
- (b) Pressure test on enclosures
- (c) Gas tightness tests

- For Support Insulator/Partition

- (a) Design and visual checks
- (b) Pressure test on partitions
- (c) Dielectric test (Power Frequency and Partial Discharge)



4 เมษายน 2568

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## 170-8.14 Test Items for Terminations

### For Line Termination

- a. **Type Tests.** One unit of bushing of each type shall be performed to fully demonstrate the ratings required by this specification. The bidder shall furnish with his bid the tests he proposes as evidence of design adequacy, both electrical and mechanical.
- (a) Wet power- frequency voltage withstand test
  - (b) Dry lightning impulse voltage withstand test
  - (c) *Wet switching impulse voltage withstand test (SIL) (for  $U_m$  equal to or greater than 300 kV)*
  - (d) *Electromagnetic Compatibility test (EMC)*
  - (e) Temperature rise test
  - (f) Verification of thermal short-time current withstands
  - (g) Cantilever load withstand test
  - (h) Internal pressure test
  - (i) Verification of dimensions

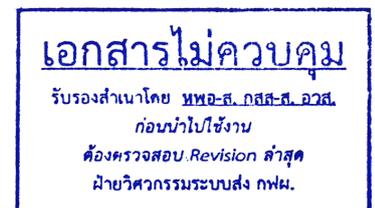
### For Cable Termination

- a. **Type Tests.** These tests may be omitted if a design test record can be submitted. The tests shall be performed in accordance with the conditions and standards mentioned in 170-5.9f.
- b. **Routine Test.** The tests shall be performed in accordance with the conditions and standards mentioned in 170-5.9f and the manufacturer standard.

## 170-8.15 Test and Verification after Erection

After erection, the equipment shall be tested to check its correct operating, possible defects resulting from incorrect erection and/or assembly, damage to components or the presence of a foreign body in the switchgear, which could give rise to a fault during operation. The tests shall be performed in accordance with IEC 62271-203. The following tests shall be made:

- a. General construction check
- b. Inspection of all pressure switch operation
- c. Mechanical operation of the CB, DS and GS



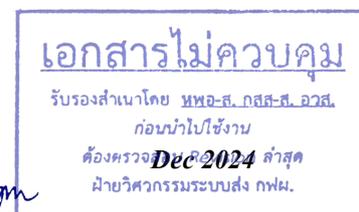
4 เมษายน 2568

- d. Operation of all valves
- e. Check of correct gas pressure in all sections
- f. Air or hydraulic pressure check before and after specified co-operation of circuit breakers
- g. Check for gas leakage in all sections and fluid leakages in all mechanisms
- h. Insulating gas characteristics test
- i. Measurement of Characteristic time quantities (timing) and Record of Mechanical travel characteristics (Motion) of Circuit Breakers : Test result and record shall confirm satisfactory performance by comparison with the reference obtained during the routine test at manufacturer factory as well as Manufacturer criteria
- j. Insulation resistance tests
- k. Dielectric test on main circuit,  
The following tests shall be performed :
  - Test procedure A ( below 230 kV)
    - Power- frequency voltage test.
  - Test procedure B (230 kV and above)
    - Power-frequency voltage test.
    - Partial discharge measurements completed with Sensitivity verification check
- l. Voltage tests of auxiliary and control circuits
- m. Main circuit resistance measurement
- n. Test all instrument transformers
- o. Check all porcelain
- p. Operational tests of all components, control, alarm and protection circuits
- q. Moisture content of SF6 gas in all sections

## 170-9 Spare Parts

The Bidder shall include in his bid a list of recommended spare parts, together with unit prices effective for a period of two years from the date of contract award.

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## 170-10 Appliances & Tools

The Contractor shall furnish all special appliances and tools including alignment templates that the equipment manufacturer deems necessary for satisfactory installation, operation, testing and maintenance of the equipment, including assembly and disassembly. Special tools and appliances shall be construed as those not readily available from appliance and tool suppliers in Thailand and those the equipment manufacturer has procured or fabricated for use with this or similar equipment. The Contractor shall submit to EGAT for approval a list of all appliances and tools required for the above stated purposes to furnish.

All required SF<sub>6</sub> gas, hydraulic fluid and oil, as applicable, including that needed to replace quantities lost as a result of leakage or waste during field assembly and testing, shall be furnished by the Contractor. The Contractor shall also furnish excess SF<sub>6</sub> gas, hydraulic fluid and oil in a quantity equivalent to 15% of the total equipment actual requirements. Gas required for field filling and excess gas shall be supplied in non-returnable American Standard Compressed Gas cylinders, with gas capacity of, at least, 40 kg up to 60 kg per cylinder. The SF<sub>6</sub> gas shall not contain oil or other contaminants. Hydraulic fluid and oil shall be furnished in non-returnable steel drums.

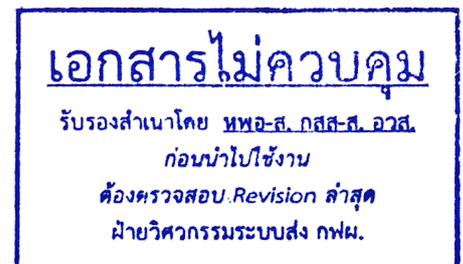
The Contractor shall furnish a hose or hoses, as required, complete with necessary fittings for transferring SF<sub>6</sub> gas from the gas cylinders to the GIS equipment.

The Contractor shall use his own all special appliances and tools including alignment templates that the equipment manufacturer deems necessary for satisfactory installation, operation and testing of the equipment, including assembly and disassembly. Therefore all spare appliances and tools shall not be used by Contractor. The Contractor shall submit to EGAT for approval a list of all appliances and tools required for the above state purposes.

## 170-11 Data, Description Materials and Drawings

The following drawings and information materials shall be furnished with the proposal data.

- General arrangement drawings of the GIS with different sections and module showing constructional features and disposition of various equipment.
- Technical leaflets of major equipment as stipulated in Sub-clause 170-5.1 of this specification.
- Type test data and certificate.



4 เมษายน 2568

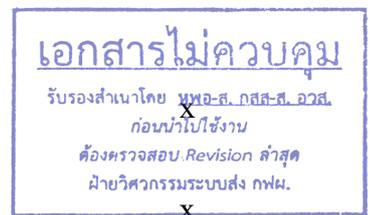
*Contractor's Signature*

## 170-12 Drawings and Documents

### 170-12.1 For GIS

Drawings and documents shall at least comprise of the followings :

Item	Drawings Title	Approval and Final Dwgs	CD-ROM
1	Drawing list of all drawings submitted for approval ( <i>use 'DDSR' form as attached at the end of this Specification</i> )	x	x
2	General arrangement drawing, outline dimension drawings of the equipment showing general arrangement, and location of fittings	x	x
3	<b>Single Line Diagram and Gas Compartment Diagram (including the length and estimated gas mass (in kg) for each gas compartment)</b>	x	x
4	Steel Supporting Structure drawings and calculation	x	x
5	<b>Removable Service Platform and Removable Ladder (including detachable walkways (catwalks)) drawings</b>	x	x
6	Earthing layout including Earthing connection details completed with Circulating current calculation	x	x
7	Foundation and anchor bolt details including dead load and impact load with direction	x	x
8	Electrical schematic and wiring diagram (internal wiring)	x	x
9	Interlocking logic diagram	x	x
10	Outline, schematic diagram and wiring diagram (internal wiring) for drive mechanism of various equipment	x	x
11	Local control cubicle outline including component layout completed with legend and mimic diagram	x	x
12	Assembly drawing for erection at site with part numbers and schedule of materials	x	x
13	Any other relevant drawings and data necessary for erection, operation and maintenance	x	x
14	Transport/shipping dimensions and weights	x	x
15	Drawing and list of GIS accessories and spare parts	x	x



4 เมษายน 2568

## 170-12.2 For Metal Oxide Surge Arrester

Drawings and documents shall at least comprise of the followings :

Item	Drawings Title	Approval and Final Dwgs	CD-ROM
1	Outline drawing including electrical and protective characteristics	X	X
2	Discharge counter with or without leakage current detector(if any) outline	X	X
3	Connection between arrester discharge counter and leakage current detector (if any)	X	X

**170-13 Instruction Manual for GIS.** Instruction manual shall consist of all necessary information and shall comprise of at least the following parts.

**Part A** : GIS instruction including installation, operation and maintenance manuals.

a. GIS general technical information

b. Installation instruction including but not limited to

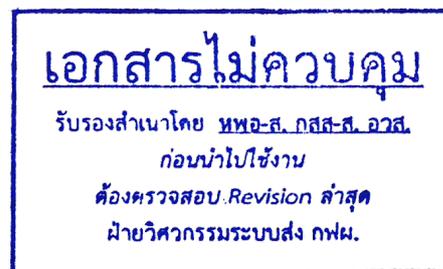
- Flow chart for installation
- Installation instruction
- SF6 gas filling

c. Maintenance and Operation instruction

- Routine inspection
- Maintenance
- Operation guide
- Assembly and disassembly instructions complete with component parts list including ordering part numbers, designation of part No. and part identification drawing.

**Part B** : Instructions and manual catalog including installation and maintenance manual of all accessories.

**Part C** : Complete set of all final drawings and/or documents arranged in order of each complete item.

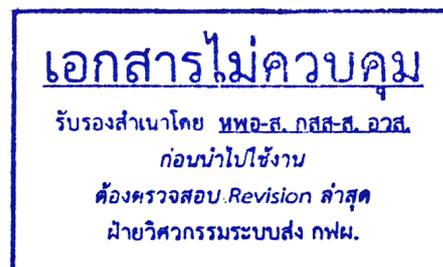


4 เมษายน 2568

**170-14 EGAT's service continuity requirements during maintenance (Repair & HV test) and extension.**

**Double-bus-single-breaker (DB-SB) GIS**

<b>Repair</b>	
- <b>Busbar disconnecter (Busbar DS)</b>	Only the affected feeder and the busbar to which the affected busbar DS is connected can be shutdown. The other bays (including those adjacent to the affected bay) shall still be energized.
- <b>Circuit breaker</b>	Only the affected feeder can be shutdown. Both busbars shall still be energized.
- <b>Current transformer</b>	Only the affected feeder can be shutdown. Both busbars shall still be energized.
- <b>Earthing switch next to the busbar DS</b>	Only the affected feeder and one bus-bar (in case of internal fault) can be shutdown.
- In case any other equipment in the bay fails, only the affected bay can be shutdown.	
<b>HV test</b>	
Both busbars in the section* where the affected equipment is connected can be shutdown. All feeders in the other sections shall still be energized.	
* The DB-SB GIS substation shall be sectionalized by DS as shown in the single-line diagram.	
<b>Extension</b>	
-	The gas buffer compartment shall be provided at the end of each bus in order to maintain the service continuity of the bays adjacent to the extension point during busbar connection. All the existing feeders shall still be energized.
-	The additional bays shall be tested separately before connecting to the existing GIS.
<b>Remarks</b>	
1	Only the partition (i.e. a gas tight insulator) shall be used to meet the requirements.
2	The compartment adjacent to affected compartment (stressed by internal fault) shall be de-gassed/depressurized during dismantling.
3	The gas separation diagram of the 115 kV (DB-SB) GIS shall be designed to meet the requirements or as specified in the single-line diagram.
4	Bus-bars shall be segregated bay width so that gas handling and mean time to repair in case of any repair work on bus-bars is reduced to minimum.



4 เมษายน 2568

*Sotradit Harnmorn*

**Breaker-and-a-half GIS**

<b>Equipment</b>	<b>Repair state</b>	<b>HV test</b>
<b>Busbar DS</b>	Only the busbar connected with the affected busbar DS can be shutdown. All feeders shall still be energized.	Only the busbar and the feeder connected with the affected busbar DS can be shutdown. The rest shall still be energized.
<b>Busbar CB</b>	Only the busbar and the feeder connected with the affected busbar CB can be shutdown. The rest shall still be energized.	Only the busbar and the feeder connected with the affected busbar CB can be shutdown. The rest shall still be energized.
<b>Middle row CB</b>	All feeders shall still be energized.	Only both feeders connected with the affected bay can be shutdown. The rest shall still be energized.
<b>Extension</b>		
-	The gas buffer compartment shall be provided at the end of each bus in order to maintain the service continuity of the bays adjacent to the extension point during busbar connection. All the existing feeders shall still be energized	
-	The additional bays shall be tested separately before connecting to the existing GIS.	
<b>Remarks</b>		
1	Only the partition (i.e. a gas tight insulator) shall be used to meet the requirements.	
2	The compartment adjacent to affected compartment (stressed by internal fault) shall be de-gassed/depressurized during dismantling.	
3	Bus-bars shall be segregated bay width so that gas handling and mean time to repair in case of any repair work on bus-bars is reduced to minimum.	

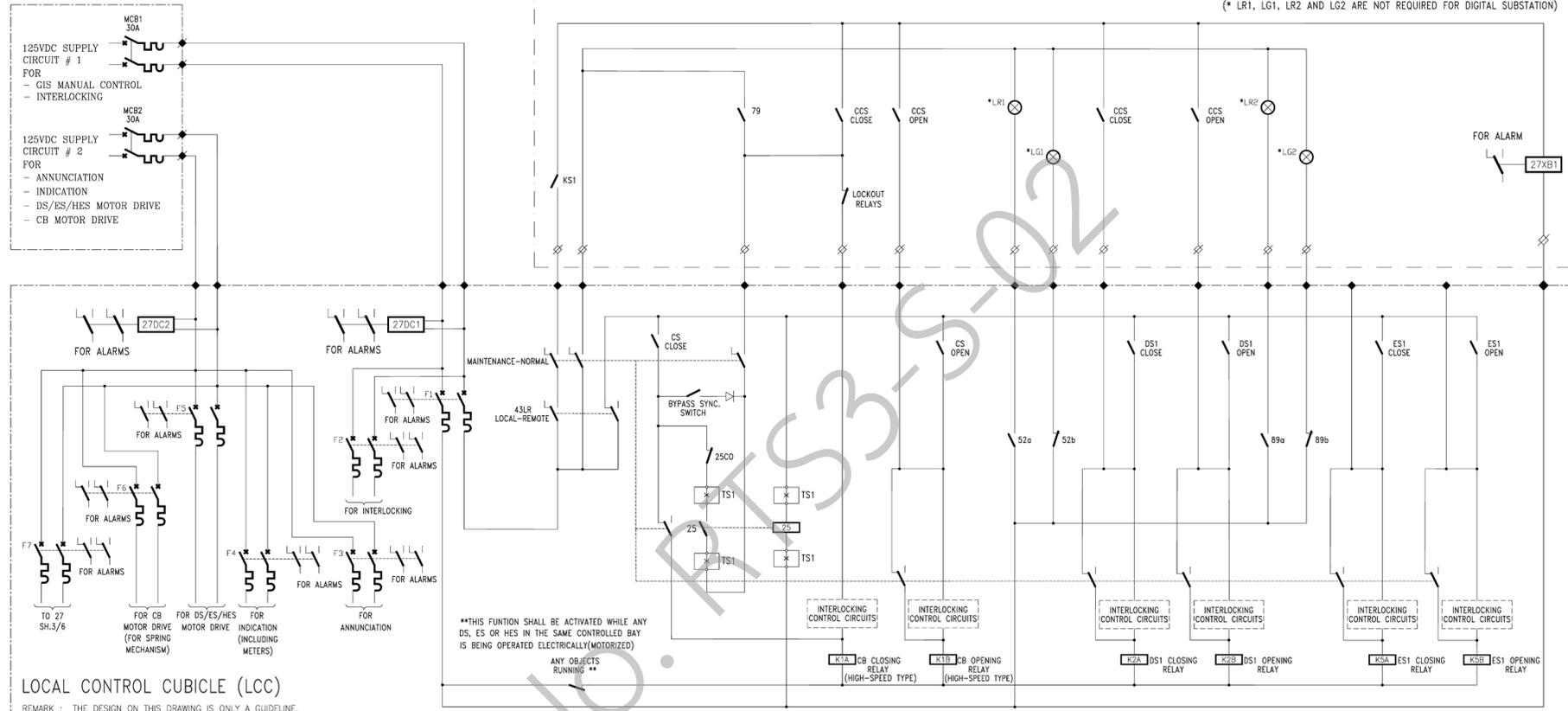
Bid No.

**เอกสารไม่ควบคุม**  
 รับรองสำเนาโดย **ทพอ-ส. กสส-ส. อวส.**  
 ก่อนนำไปใช้งาน  
 ต้องตรวจสอบ.Revision สำสุด  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.

4 เมษายน 2568

*Sotradis Hirinon*

FOR DIGITAL SUBSTATION, THE CONTROL AND PROTECTION SCHEME SHALL BE AS PER EGAT DWG. NO. TP-E-20.12.  
 (\* LR1, LG1, LR2 AND LG2 ARE NOT REQUIRED FOR DIGITAL SUBSTATION)



LOCAL CONTROL CUBICLE (LCC)

REMARK : THE DESIGN ON THIS DRAWING IS ONLY A GUIDELINE.

DEVICE	DESCRIPTION
CB-TRST	3A/4A/4B/4C Selector Switch
CCS	Computerized control system
LR	Local/Remote Selector Switch
CC	Closing coil
TC1	Primary tripping coil 1
TC2	Primary tripping coil 2
KT1***	Three pole tripping 1
KT2***	Three pole tripping 2
AP	Antipumping relay
GD	Gas density contacts
HP	Hydraulic pressure contacts
27AC	Under voltage alarm relay slow drop out The operating time shall be 2-10 seconds 125 Vdc external supply source type Setting range:70% of rated voltage or lower
KS	Knife switch
ZS	Synchronism Check Relay
TS1	Test Switch
Fx	Miniature Circuit Breaker

DEVICE	DESCRIPTION
LS	Limit Switch for Spring Charge Motor
AR	Auxiliary Relay for Reclosing
K1A***	Auxiliary Relay for Closing Breaker
K1B***	Auxiliary Relay for Tripping Breaker
K2A	Auxiliary Relay for Closing Disconnecter 1
K2B	Auxiliary Relay for Opening Disconnecter 1
K3A	Auxiliary Relay for Closing Earthing Switch 1
K3B	Auxiliary Relay for Opening Earthing Switch 1
27XBa	Auxiliary Relay for under voltage alarm Slow drop out type
27DCx	Under voltage alarm relay, Setting range:70% - 85% of rated voltage
62PD1	Timer Relays for Pole Disagreement (PD) Function (Setting range: 150 ms - 1 s)
62PD2-1***	Auxiliary Relays for Pole Disagreement (PD) Tripping and Alarm
62PD2-2***	Tripping and Alarm

\*\*\* These Auxiliary Relays shall be High Speed type and the operating time shall not exceed 10 ms.

NOTE : LINKAGE OR CONNECTION OF AC AND DC SUPPLY SOURCES BETWEEN LCCS IS NOT ALLOWED. AC AND DC SUPPLY SOURCES SHALL BE PROVIDED SEPARATELY AND INDIVIDUALLY FOR EACH LCC PANEL.

The Schematic Status

- CB, DS, ES at open position
- Gas at low density (Stage 2)
- Hydraulic at low pressure (Lockout)
- Hydraulic-Spring at low storage energy (Lockout)
- Spring at discharge
- Voltage at under voltage

- ◇ TERMINAL IN INTERPOSING PANEL
- ◇ TERMINAL IN RELAY PANEL
- ◆ TERMINAL IN LOCAL CONTROL CUBICLE



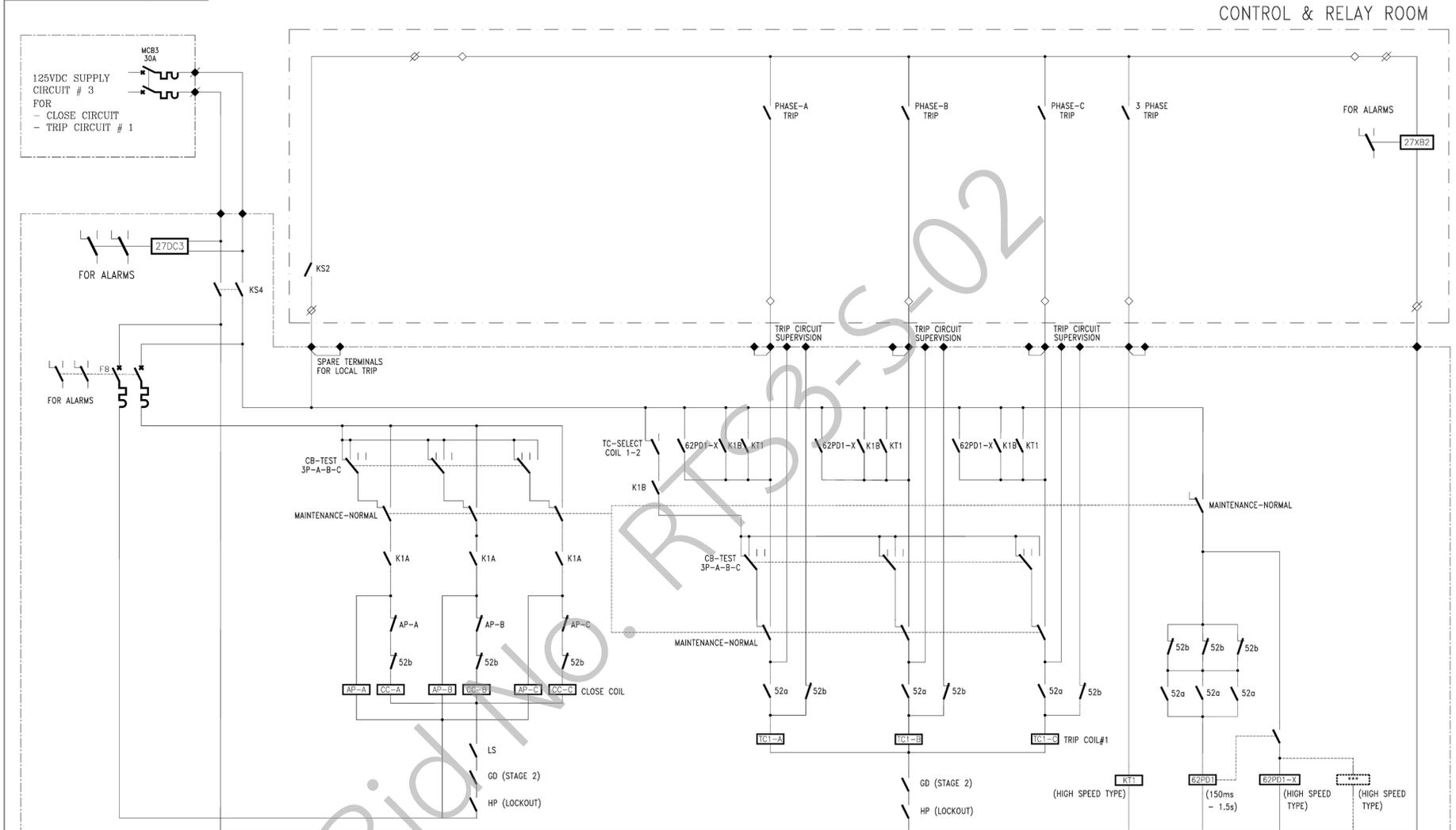
DO NOT AMEND MANUALLY

REV. NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE
1		TYPICAL DRAWING FOR 230KV AND ABOVE LOCAL CONTROL CUBICLE OF GIS.	H. CHINDARHA	H. CHINDARHA						

ELECTRICITY GENERATING AUTHORITY OF THAILAND			
DRAWN	RECOMMENDED AND VALIDATED	DRAWING NAME	
H. CHINDARHA	[Signature]	TYPICAL DRAWING	
DESIGNED	CHIEF, CONTROL AND PROTECTION SYSTEM ENGINEERING DEPARTMENT	DESCRIPTION OF DIGITAL DRAWING	
H. CHINDARHA	CONCURRED	230KV and Above GIS BREAKER & DISCONNECTORS MANUAL CONTROL SYSTEM AC/DC SCHEMATIC DIAGRAM	
VERIFIED	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION	JOB NO.	REPLACING DWG. NO.
60981	[Signature]		
APPROVED	DATE	30/09/2567	TP-E-6.11
[Signature]	DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		1 REV. 8 1

- 170.43 -  
 Sorasit Himmorn

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 ต้องตรวจสอบ Revision ล่าสุด  
 ฝ่ายวิศวกรรมระบบส่ง พทท.



LOCAL CONTROL CUBICLE (LCC)

REMARK : THE DESIGN ON THIS DRAWING IS ONLY A GUIDELINE.

Note : 62PD1-X shall be provided with minimum 6 contacts for TC-A, B, C, RTU, FRS and 50BF functions.  
 \*\*\* Multiple in number of relay is acceptable if 1 number of relay has less than 6 contacts.  
 However, only 1 relay with 6 contacts is still preferred.

NOTE : LINKAGE OR CONNECTION OF AC AND DC SUPPLY SOURCES BETWEEN LCCS IS NOT ALLOWED. AC AND DC SUPPLY SOURCES SHALL BE PROVIDED SEPARATELY AND INDIVIDUALLY FOR EACH LCC PANEL.



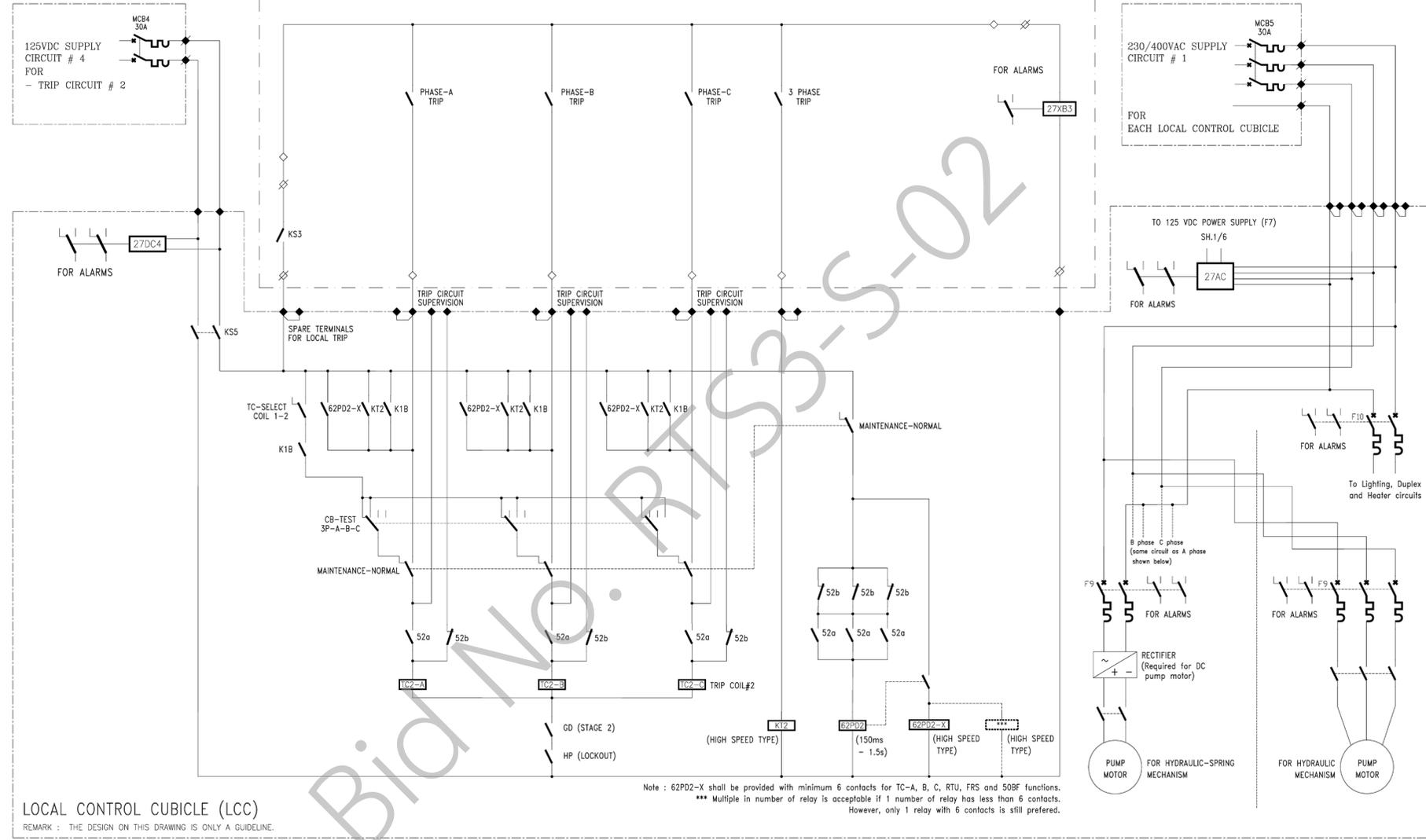
REV. NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE
1		TYPICAL DRAWING FOR 230kV AND ABOVE LOCAL CONTROL CUBICLE OF GIS.	H. CHINDARHA	H. CHINDARHA						

ELECTRICITY GENERATING AUTHORITY OF THAILAND			
DRAWN	H. CHINDARHA	RECOMMENDED AND VALIDATED	[Signature]
DESIGNED	H. CHINDARHA	CONCURRED	[Signature]
VERIFIED	60% 11	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION	[Signature]
APPROVED	[Signature]	DATE	30/09/2567
DRAWING NAME		TYPICAL DRAWING	
DESCRIPTION OF DETAIL DRAWING		DESCRIPTION OF DETAIL DRAWING	
230kV and Above GIS BREAKER CLOSING COIL & TRIPPING COIL I AC&DC SCHEMATIC DIAGRAM		230kV and Above GIS BREAKER CLOSING COIL & TRIPPING COIL I AC&DC SCHEMATIC DIAGRAM	
JOB NO.		REPLACING DRAWING	
DWG. NO.	TP-E-6.11		

- 170.44 -  
 Sorasit Hinmanom

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 รับรองสำเนาโดย หมอช.กตส.ช.อวส.  
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 ต้องตรวจสอบ Revision ล่าสุด  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.

CONTROL & RELAY ROOM



LOCAL CONTROL CUBICLE (LCC)

REMARK : THE DESIGN ON THIS DRAWING IS ONLY A GUIDELINE.

Note : 62PD2-X shall be provided with minimum 6 contacts for TC-A, B, C, RTU, FRS and 50BF functions.  
 \*\*\* Multiple in number of relay is acceptable if 1 number of relay has less than 6 contacts.  
 However, only 1 relay with 6 contacts is still preferred.

NOTE : LINKAGE OR CONNECTION OF AC AND DC SUPPLY SOURCES BETWEEN LCCS IS NOT ALLOWED. AC AND DC SUPPLY SOURCES SHALL BE PROVIDED SEPARATELY AND INDIVIDUALLY FOR EACH LCC PANEL.

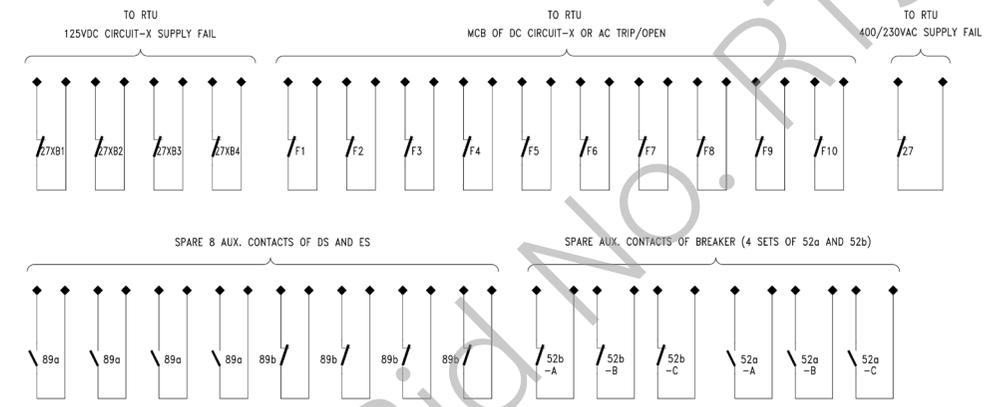
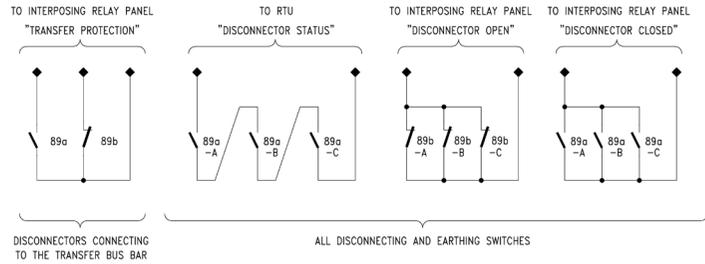
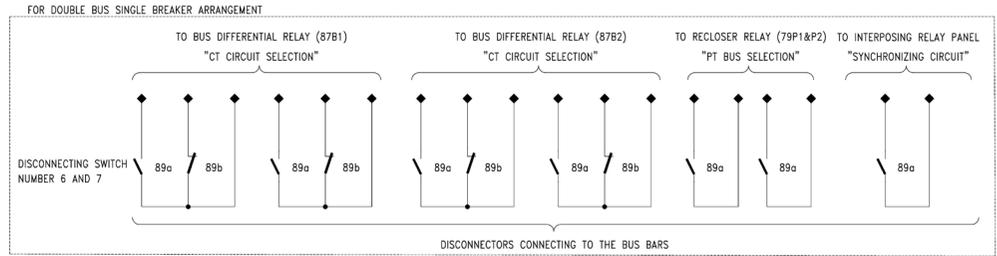


REV. NO.	JOB NO.	JOB DESCRIPTION	DRW. NO.	DESIGN NO.	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE
1	-	TYPICAL DRAWING FOR 230kV AND ABOVE LOCAL CONTROL CUBICLE OF GIS.	H. CHINDARHA	H. CHINDARHA	-	-	-	-	-	-

ELECTRICITY GENERATING AUTHORITY OF THAILAND			
DRAWN	H. CHINDARHA	RECOMMENDED AND VALIDATED	DRAWING NAME
DESIGNED	H. CHINDARHA	CONCURRED	TYPICAL DRAWING
VERIFIED	6/2/6/11	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION	DESCRIPTION OF DETAIL DRAWING
APPROVED		DATE	30/09/2567
JOB NO.			TP-E-6.11
REPLACING DRAWING			
DATE			30/09/2567
REVISION			3
REVISION			6
REVISION			1

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 รับรองสำเนาโดย มหอ.ศ. กศส.ช. อวส.  
 ก่อนนำไปใช้งาน  
 ต้องตรวจสอบ Revision ล่าสุด  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.





NOTE1 : ANY CONTACT OF 52a , 52b , 89a AND 89b USED FOR PROTECTION FUNCTION AND INTERNALLY IN LCC SHALL BE PURE CONTACT.

NOTE2 : EARLY BREAK CONTACT TYPE SHALL BE USED FOR PROTECTION FUNCTION AND FRs. LATE MAKE CONTACT TYPE SHALL BE USED FOR STATUS AND ALARM.

NOTE3 : FOR OTHER FUNCTIONS ASIDE FROM NOTE1, ANY AUXILIARY RELAYS FOR AMPLIFYING OF ANY 52a , 52b , 89a AND 89b CONTACTS SHALL BE OF LATCHING RELAY TYPE.

NOTE4 : IN ADDITION TO ABOVE SHOWN CONTACTS, 1 ADDITIONAL SET OF ALL ALARM CONTACTS USED FOR ANNUNCIATION SHALL BE PROVIDED FOR ALARM TO RTU. ALL OF THEM SHALL BE FULLY TERMINATED TO THE TERMINALS.



										ELECTRICITY GENERATING AUTHORITY OF THAILAND					
										DRAWN H. CHINDARHA		RECOMMENDED AND VALIDATED		DRAWING NAME	
										DESIGNED H. CHINDARHA		CONCURRED		TYPICAL DRAWING	
										VERIFIED 60967		ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		DESCRIPTION OF DETAIL DRAWING	
										APPROVED		DATE 30/09/2567		230kV and Above GIS AUXILIARY CONTACTS FOR REMOTE CONTROL CIRCUITS	
										DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		JOB NO.		REPLACING DWG. NO.	
														TP-E-6.11	
														5 REV. 6 -	

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 ฝ่ายวิศวกรรมระบบส่ง ทฟผ.

Typical Annunciator

DC Supply 1 Failure	DC Supply 2 Failure	DC Supply 3 Failure	DC Supply 4 Failure	AC Supply Failure	CB Failure
CB Pole Disagreement	DS/ES Intermediate Position	CB Compartment Low Gas Stage 1	CB Compartment Low Gas Stage 2 Lockout	* Compartment#1 Low Gas Stage 1	* Compartment#2 Low Gas Stage 1
* Compartment#3 Low Gas Stage 1	* Compartment#4 Low Gas Stage 1	* Compartment#5 Low Gas Stage 1	* Compartment#..X.. Low Gas Stage 1	Compartment#1 to Compartment#..X.. Low Gas Stage 2	** Compartment#....., ....., and .... Gas Over Pressure
*** Phase A Gas/Hydraulic Pressure Failure	*** Phase B Gas/Hydraulic Pressure Failure	*** Phase C Gas/Hydraulic Pressure Failure	MCB of DC Circuits Trip/Open	MCB of AC Circuits Trip/Open	MCB of VT Circuits Trip/Open
Mechanism Failure ...	Mechanism Failure ...	Mechanism Failure ...	DS/ES/HES Motor Overrun	Indicator for Annunciator supply Status	Acknowledge Push Button
Reset Push Button	Functional Test Push Button	Spare	Spare	Spare	Spare
		Active	Active	Active	Active
		Annunciator	Annunciator	Annunciator	Annunciator

Note.

- The annunciator windows shall at least comprise as shown on "Typical Annunciator for Each GIS Bay" however, the actual requirement for complete annunciation shall be the Contractor responsibility. For "Bus Coupling Bay" and/or "Transfer Bay", relevant windows shall be applied accordingly.
- The annunciator operation sequence shall be manual lamp reset type and shall conform to the indicated table.
- Low Gas Stage 1 = First alarm  
Low Gas Stage 2 = Second alarm for DS/ES = Lockout for CB  
Gas Over Pressure = Third alarm for any gas compartment which has the rated pressure lower than the adjacent compartment(s)
- No. of DS and ES for stage 1 shall be in accordance with the actual requirement.
- Mechanism Failure  
For Spring charging motor, the following alarms shall be provided separately on individual Annunciation window.  
- Spring motor overload \*\*\*\*  
- Spring motor overrun  
For Hydraulic or Hydraulic Spring system, the following alarms shall be provided separately on individual Annunciation window.  
- Pump/Compressor motor overload \*\*\*\*  
- Pump/Compressor motor overrun  
- Hydraulic Leakage (for Hydraulic system only)  
- Hydraulic low pressure (Alarm and Lockout) (if low pressure is not applicable for Hydraulic Spring system, the inscription of 'Hydraulic Spring Low Storage Energy' may be used instead.)  
\*\*\*\* Depending on the Manufacturer's Design, if the separated Overload Relay is not necessary, overcurrent signal from MCB is also acceptable for this alarm.
- Spare Active Annunciator shall be completed with annunciator circuit.
- Wrong operating of any push button shall not cause malfunction to the correct operation of the system.

Annunciator Operational Sequence

Designated Event	Visual Annunciator Lamps	Audible
Normal	Off	Off
Alert	Bright flashing	On
Acknowledge (Horn Reset)	Steady on	Off
Return to Normal	Steady on	Off
Return to Normal before Acknowledge	Bright flashing	On
Acknowledge (Horn Reset)	Steady on	Off
Reset	Off	Off
Functional Test	Bright flashing	On

\* To indicate the compartment where gas over pressure occurred, these alarm windows can be commonly used for Over Pressure alarm as well. The name of alarm windows may be changed to, e.g., "Compartment#3 Low Gas Stage 1/Gas Over Pressure". Meanwhile, the separated window of Gas Over Pressure alarm\*\*, where the over pressure alarm signals of all compartments are grouped, shall still exist.

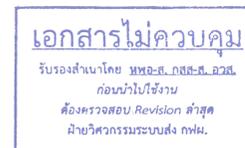
\*\*\* Phase Indicator alarm can be commonly used between Gas and Hydraulic system, if Hydraulic mechanism is chosen. For Gas system, both Low and Over pressure conditions shall be included in this alarm.



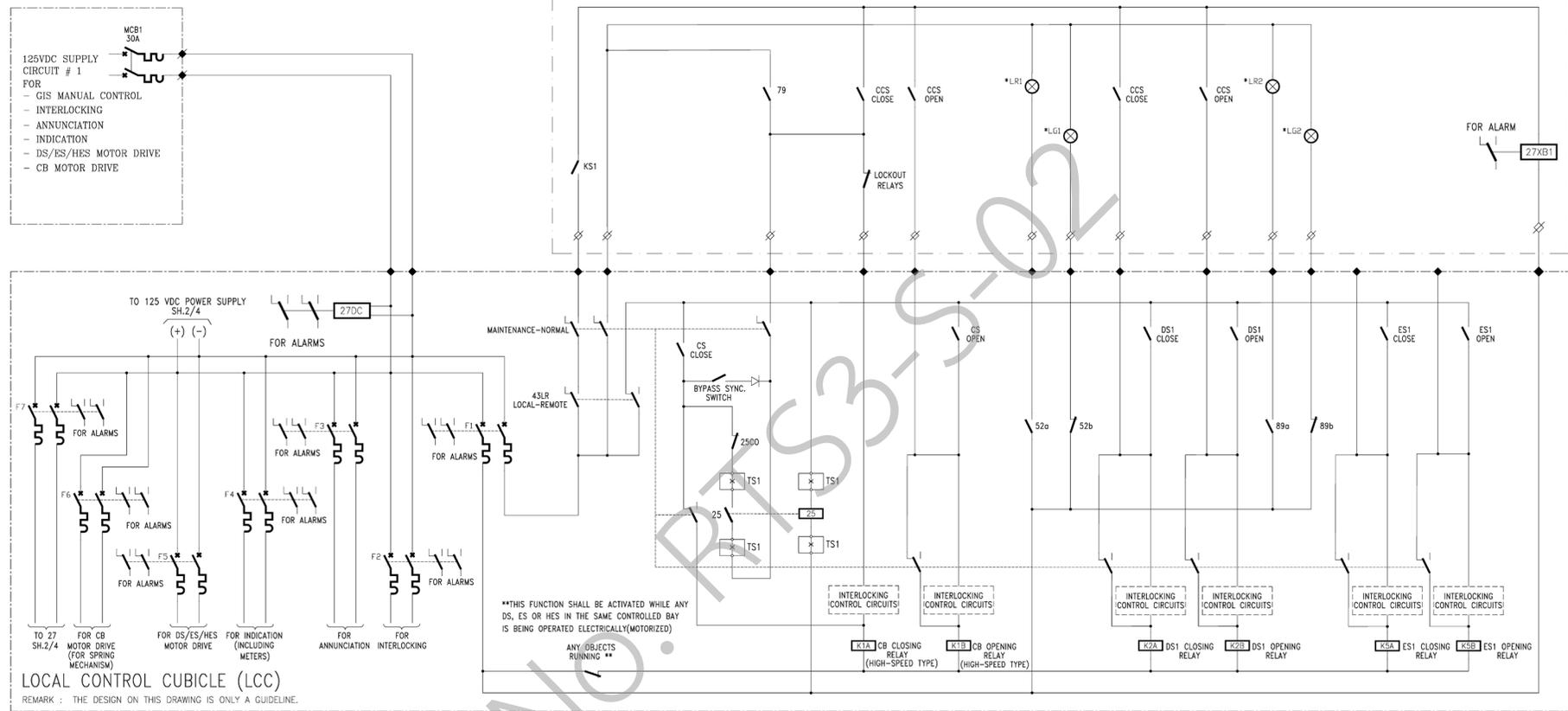
REV.	NO.	DESCRIPTION	DRWN	DESIGN	VERIFY	VALIDATE	RECOMMEND	CONCLUDE	APPROVE	DATE
-	-	TYPICAL DRAWING FOR 230KV AND ABOVE LOCAL CONTROL, OUTSIDE OF GIS.	H. CHINDARHA	H. CHINDARHA	-	-	-	-	-	-

ELECTRICITY GENERATING AUTHORITY OF THAILAND										
DRAWN	H. CHINDARHA	RECOMMENDED AND VALIDATED	DRAWING NAME							
DESIGNED	H. CHINDARHA	CONCLUDED	TYPICAL DRAWING							
VERIFIED	60% 11	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION	DESCRIPTION OF DETAIL DRAWING							
APPROVED	60% 11	DATE 30/09/2567	TYPICAL ANNUNCIATOR - GIS							
JOB NO.		REPLACING DWG. NO.	DWG. NO.	REV.						
-		-	TP-E-6.11	8 -						

- 170.48 -  
Sorasich Hinmanom



FOR DIGITAL SUBSTATION, THE CONTROL AND PROTECTION SCHEME SHALL BE AS PER EGAT DWG. NO. TP-E-20.12.  
 (\* LR1, LG1, LR2 AND LG2 ARE NOT REQUIRED FOR DIGITAL SUBSTATION)



LOCAL CONTROL CUBICLE (LCC)  
 REMARK : THE DESIGN ON THIS DRAWING IS ONLY A GUIDELINE.

DEVICE	DESCRIPTION
CCS	Computerized control system
LR	Local/Remote Selector Switch
CC	Closing coil
TC1	Primary tripping coil 1
TC2	Primary tripping coil 2
RT1**	Three pole tripping 1
RT2**	Three pole tripping 2
AP	Antipumping relay
GD	Gas density contacts
HP	Hydraulic pressure contacts
27AC	Under voltage alarm relay, slow drop out. The operating time shall be 2-10 seconds 125 Vdc external supply source type. Setting range: 70% of rated voltage or lower
KS	Knife switch
ZS	Synchronism Check Relay
TS1	Test Switch
Fx	Miniature Circuit Breaker

DEVICE	DESCRIPTION
LS	Limit Switch for Spring Charge Motor
AR	Auxiliary Relay for Reclosing
K1A**	Auxiliary Relay for Closing Breaker
K1B**	Auxiliary Relay for Tripping Breaker
K2A	Auxiliary Relay for Closing Disconnector 1
K2B	Auxiliary Relay for Opening Disconnector 1
K5A	Auxiliary Relay for Closing Earthing Switch 1
K5B	Auxiliary Relay for Opening Earthing Switch 1
27XBx	Auxiliary Relay for under voltage alarm, Slow drop out type
27DC	Under voltage alarm relay, Setting Range : 70% - 85% of rated voltage

\*\* These Auxiliary Relays shall be High Speed type and the operating time shall not exceed 10 ms.

CIRCUIT BREAKER CONTROL CIRCUIT      DISCONNECTING SWITCH CONTROL CIRCUIT      EARTHING SWITCH CONTROL CIRCUIT

- The Schematic Status
- CB at open position
  - Gas at low density (Stage 2)
  - Hydraulic at low pressure (Lockout)
  - Hydraulic-Spring at low storage energy (Lockout)
  - Spring at discharge
  - Voltage at under voltage
- ☒ TERMINAL IN INTERPOSING PANEL  
 ◇ TERMINAL IN RELAY PANEL  
 ◆ TERMINAL IN LOCAL CONTROL CUBICLE

NOTE : LINKAGE OR CONNECTION OF AC AND DC SUPPLY SOURCES BETWEEN LCCS IS NOT ALLOWED. AC AND DC SUPPLY SOURCES SHALL BE PROVIDED SEPARATELY AND INDIVIDUALLY FOR EACH LCC PANEL.



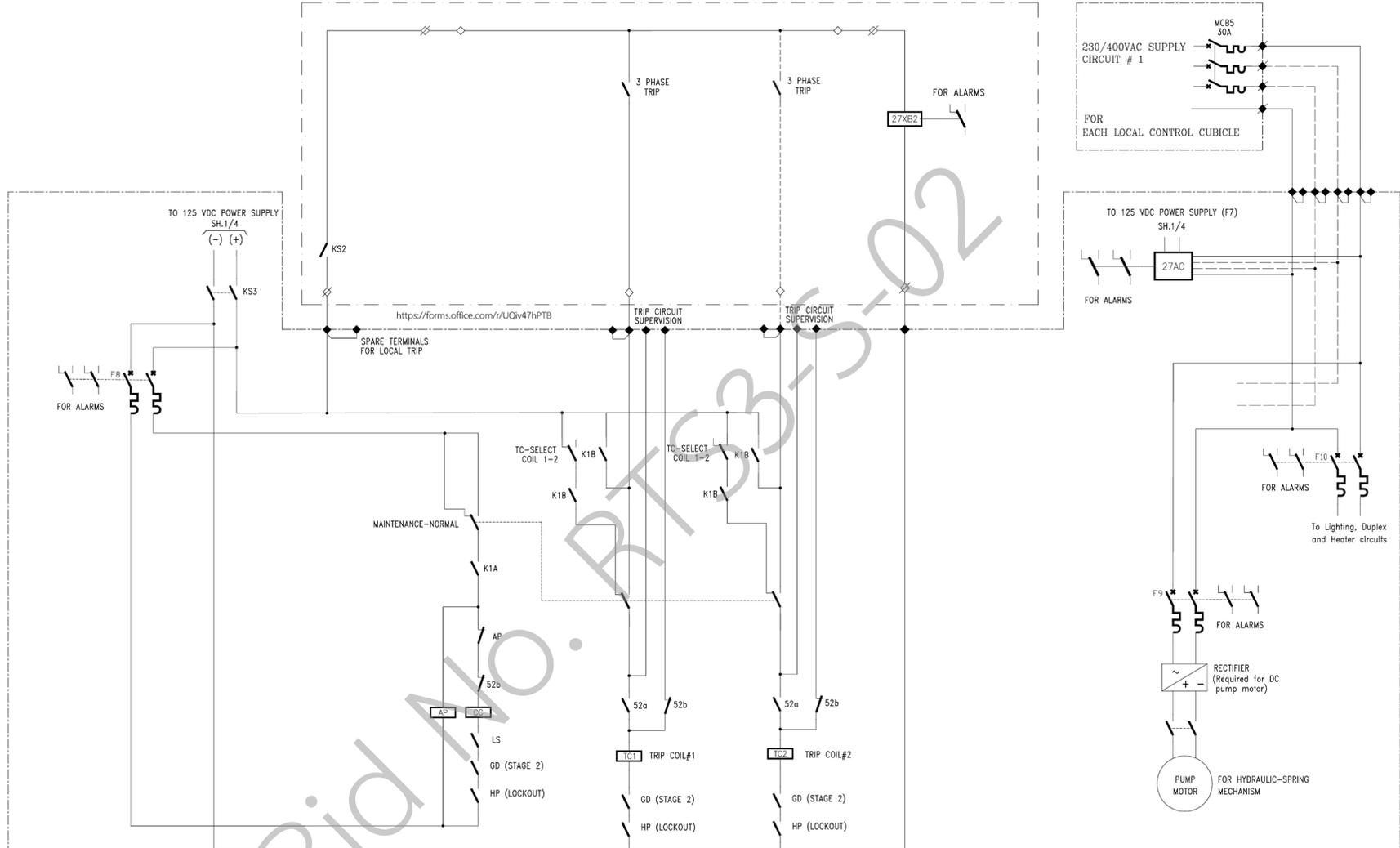
REV. NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE
-	-	TYPICAL DRAWING FOR 115kV LOCAL CONTROL CUBICLE OF GIS	H. CHINDARHA	H. CHINDARHA	-	-	-	-	-	-

ELECTRICITY GENERATING AUTHORITY OF THAILAND			
DRAWN	H. CHINDARHA	RECOMMENDED AND VALIDATED	[Signature]
DESIGNED	H. CHINDARHA	CHIEF, CONTROL AND PROTECTION SYSTEM ENGINEERING DEPARTMENT	[Signature]
VERIFIED	60% 11	CONCURRED	[Signature]
APPROVED	[Signature]	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION-1	[Signature]
DRAWING NAME		TYPICAL DRAWING	
DESCRIPTION OF DRAWING		115kV GIS BREAKER & DISCONNECTORS MANUAL CONTROL SYSTEM AC/DC SCHEMATIC DIAGRAM	
JOB NO.	-	REPLACING DRAWING	-
DATE	30/09/2567	DRAWING NO.	TP-E-6.12
DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		REV. 4	

- 170.49 -  
*Sorasilak Himmorn*

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 ก่อนนำไปใช้งาน  
 ต้องตรวจสอบ Revision ตัวสุดท้าย  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.

CONTROL & RELAY ROOM



LOCAL CONTROL CUBICLE (LCC)

REMARK : THE DESIGN ON THIS DRAWING IS ONLY A GUIDELINE.

NOTE : LINKAGE OR CONNECTION OF AC AND DC SUPPLY SOURCES BETWEEN LCCS IS NOT ALLOWED. AC AND DC SUPPLY SOURCES SHALL BE PROVIDED SEPARATELY AND INDIVIDUALLY FOR EACH LCC PANEL.



REV. NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE
-	-	TYPICAL DRAWING FOR 115kV LOCAL CONTROL CUBICLE OF GIS	H. CHINDARHA	H. CHINDARHA	-	-	-	-	-	-

ELECTRICITY GENERATING AUTHORITY OF THAILAND			
DRAWN	H. CHINDARHA	RECOMMENDED AND VALIDATED	[Signature]
DESIGNED	H. CHINDARHA	CONCURRED	[Signature]
VERIFIED	[Signature]	ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION	
APPROVED	[Signature]	DATE	30/09/2567
JOB NO.		REPLACING DRAWING	TP-E-6.12
JOB DESCRIPTION		TYPICAL DRAWING	
DESCRIPTION OF DIGITAL DRAWING		115kV GIS BREAKER CLOSING COIL & TRIPPING COIL 1&2 AC/DC SCHEMATIC DIAGRAM	
DATE		REV.	2
DATE		REV.	4

เอกสารไม่ควบคุม  
รับรองสำเนาโดย มหอ.ศ. กศ.ศ. อวส.  
ก่อนนำไปใช้งาน  
ต้องตรวจสอบ Revision ล่าสุด  
ฝ่ายวิศวกรรมระบบส่ง กฟผ.



Typical Annunciator for Each Bay

DC Supply Failure	AC Supply Failure	CB Failure	DS/ES Intermediate Position	CB Compartment Low Gas Stage 1
CB Compartment Low Gas Stage 2 Lockout	* Compartment#1 Low Gas Stage 1	* Compartment#2 Low Gas Stage 1	* Compartment#3 Low Gas Stage 1	* Compartment#4 Low Gas Stage 1
* Compartment#5 Low Gas Stage 1	* Compartment#...X.. Low Gas Stage 1	Compartment#1 to Compartment#...X.. Low Gas Stage 2	** Compartment#....., .... and .... Gas Over Pressure	DS/ES/HES Motor Overrun
MCB of DC Circuits Trip/Open	MCB of AC Circuits Trip/Open	MCB of VT Circuits Trip/Open	Mechanism Failure ...	Mechanism Failure ...
Mechanism Failure ...	Mechanism Failure ...	Indicator for Annunciator supply Status	Acknowledge Push Button	Reset Push Button
Functional Test Push Button	Spare Active Annunciator	Spare Active Annunciator	Spare Active Annunciator	Spare Active Annunciator

Note.

- The annunciator windows shall at least comprise as shown on "Typical Annunciator for Each GIS Bay" however, the actual requirement for complete annunciation shall be the Contractor responsibility. For "Bus Coupling Bay" and/or "Transfer Bay", relevant windows shall be applied accordingly.
- The annunciator operation sequence shall be manual lamp reset type and shall conform to the indicated table.
- Low Gas Stage 1 = First alarm  
Low Gas Stage 2 = Second alarm for DS/GS  
= Lockout for CB  
Gas Over Pressure = Third alarm for any gas compartment which has the rated pressure lower than the adjacent compartment(s)
- No. of DS and GS for stage 1 shall be in accordance with the actual requirement.
- Mechanism Failure  
For Spring charging motor, the following alarms shall be provided separately on individual Annunciation window.
  - Spring motor overload \*\*\*
  - Spring motor overrun
 For Hydraulic or Hydraulic Spring system, the following alarms shall be provided separately on individual Annunciation window.
  - Pump/Compressor motor overload \*\*\*
  - Pump/Compressor motor overrun
  - Hydraulic Leakage (for Hydraulic system only)
  - Hydraulic low pressure (Alarm and Lockout) (if low pressure is not applicable for Hydraulic Spring system, the inscription of 'Hydraulic Spring Low Storage Energy' may be used instead.)
 \*\*\* Depending on the Manufacturer's Design, if the separated Overload Relay is not necessary, overcurrent signal from MCB is also acceptable for this alarm.
- Spare Active Annunciator shall be completed with annunciator circuit.
- Wrong operating of any push button shall not cause malfunction to the correct operation of the system.

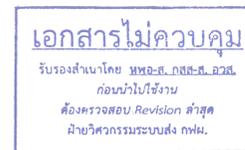
Annunciator Operational Sequence

DESIGNATED EVENT	VISUAL ANNUNCIATOR LAMPS	AUDIBLE
Normal	Off	Off
Alert	Bright flashing	On
Acknowledge (Horn Reset)	Steady on	Off
Return to Normal	Steady on	Off
Return to Normal before Acknowledge	Bright flashing	On
Acknowledge (Horn Reset)	Steady on	Off
Reset	Off	Off
Functional Test	Bright flashing	On

\* To indicate the compartment where gas over pressure occurred, these alarm windows can be commonly used for Over Pressure alarm as well. The name of alarm windows may be changed to, e.g., "Compartment#3 Low Gas Stage 1/Gas Over Pressure". Meanwhile, the separated window of Gas Over Pressure alarm\*\*, where the over pressure alarm signals of all compartments are grouped, shall still exist.



										ELECTRICITY GENERATING AUTHORITY OF THAILAND					
										DRAWN H. CHINDARHA		RECOMMENDED AND VALIDATED		DRAWING NAME	
										DESIGNED H. CHINDARHA		CHIEF, CONTROL AND PROTECTION SYSTEM ENGINEERING DEPARTMENT		TYPICAL DRAWING	
										VERIFIED 6/9/17		CONCURRED		DESCRIPTION OF DETAIL DRAWING	
										APPROVED		ASSISTANT DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		115kV GIS AUXILIARY CONTACTS FOR REMOTE CONTROL CIRCUITS	
										DIRECTOR, TRANSMISSION SYSTEM ENGINEERING DIVISION		DATE 30/09/2567		JOB NO. REPLACING DWG. NO. DWG. NO.	
														TP-E-6.12	
														4 REV. 4	



### Drawing and Document Status Report (DDSR)

Contract No. ....  
 Item No. ....  
 Job No. ....  
 Substation .....

Name of Company .....  
 Date .....

No.	Drawing Document No.	Sheet		Description	Submit/Return	1st Submission			2nd Submission			3rd Submission			Latest Submission			Completion Date for DWG	Number of Submissions	Remarks
		No.	Rev.			Ref.	Date	St./Act.	Ref.	Date	St./Act.	Ref.	Date	St./Act.	Ref.	Date	St./Act.			
					Submit													PLAN		
					Return													ACTUAL		
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Notes: Ref. = Referenced Letter No., St. = Status, Act. = Action  
 Status/Action: AD = Drawings/Documents for Approval, R-DWG = Drawings/Documents for Re-approval, FD = Final Drawings for Approval, RD = Reproducible Drawings for Approval,  
 CD = CD-ROM for Approval, A = Approved, AN = Approved except as Noted, AF = Approved and Regarded as Final Drawings/Documents, FC = For Construction,  
 NR = Not Reviewed, RC = Returned for Correction, ACPT = Accepted, ACK = Acknowledged

**เอกสารไม่ควบคุม**  
 รับรองสำเนาโดย พทอ-ส.กสส-ส.อวส.  
 ก่อนนำไปใช้งาน  
 ต้องตรวจสอบ.Revision ล่าสุด  
 ฝ่ายวิศวกรรมระบบส่ง กฟผ.