



**GUAM  
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AGANA, GUAM

**Specification No. 031**

Revision No. \_\_\_\_\_

Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

**GUAM POWER AUTHORITY**  
Post Office Box 2977  
Agana, Guam 96910

**TRANSMISSION & DISTRIBUTION SPECIFICATION**

**Specification No. E-031**

**FOR**

**MOBILE SUBSTATION**

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**GUAM  
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AGANA, GUAM

## Specification No. 031

Page 1 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### MOBILE SUBSTATION

### TABLE OF CONTENTS

SECTION		PAGE
1.0	Scope . . . . .	2
2.0	Contents . . . . .	2
3.0	General . . . . .	2
4.0	Service Conditions and Operation . . . . .	3
5.0	Conformance to Specification Requirements . . . . .	3
6.0	Submittals . . . . .	5
7.0	High Voltage Equipment . . . . .	10
8.0	Transformer Section . . . . .	13
9.0	Low Voltage Equipment . . . . .	24
10.0	Trailer . . . . .	29
11.0	Testing . . . . .	31
12.0	Shipping Requirements . . . . .	31

Effective date: 2/24/93

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 2 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### 1.0 SCOPE

This specification includes the requirements for one Mobile Substation, 18/24/30 MVA, three phase, 60 Hertz, 34500 Volts Delta to 13800 Volts Grounded Wye, mounted on a trailer, complete and ready for service in the electrical distribution system of the Island of Guam.

### 2.0 CONTENTS

The Mobile Substation will consist of the:

#### 2.1 Transformer section

#### 2.2 Incoming line section (high voltage) including:

- a. High Voltage Disconnect Switch
- b. High Voltage Lightning Arresters
- c. High Voltage Circuit Breaker
- d. Protective Relays

#### 2.3 Outgoing line section (low voltage) including auxiliary power transformers and:

- a. Low Voltage Vacuum Circuit Breaker
- b. Low Voltage Lightning Arresters
- c. Control and Metering Equipment
- d. Low Voltage Disconnect Switch

All mounted on a highway type semi-trailer.

### 3.0 GENERAL

The substation will be arranged with the incoming line section (high voltage equipment) on the front of the trailer and the outgoing feeder section on the rear. All electrical equipment will conform to the latest applicable ANSI, IEEE and NEMA standards. The complete unit will be an integral design conforming

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 3 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

wherever possible to the Guam Road Regulations, all ICC regulations and Federal Safety Standards with respect to operation and movement on Guam Paved Roads.

### 4.0 SERVICE CONDITIONS AND OPERATION

The power transformer is intended for use in tropical weather with corrosive salt air, sustained wind strengths of 155 MPH with gusts to 180 MPH, and subject to moderate to severe earthquakes.

### 5.0 CONFORMANCE TO SPECIFICATION REQUIREMENTS

Mobile Substation and its accessories shall meet the requirements of the following standards and specifications including latest revisions with respect to material, design and tests.

#### 5.1 Applicable Standards

##### FEDERAL SPECIFICATION

J-C-30A	Cable and wire, electrical (Power fixed installation)
W-T-631C(2)	Transformers, Power Distribution
WW-C-581d(3)	Conduit, metal, rigid, and coupling elbow, and nipple, electrical conduit zinc coated.

##### THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC., STANDARDS

48	Potheads
49	Roof, floor and wall bushings

##### AMERICAN NATIONAL STANDARDS INSTITUTE

C6.1	Terminal markings for electrical apparatus
C57.11	General requirements for transformers, regulators and reactors

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 4 of 34

Revision No. \_\_\_\_\_

Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- C57.12.00 Distribution, power and regulating transformers and shunt reactors, general requirements for
- C57.12.10 Transformers, 138,000 volts and below, 501 KVA through 10,000/13333/16667 single phase, 501 KVA through 30,000/40,000/50,000 KVA three-phase requirements for
- C57.12.80 Terminology including supplement
- C57.12.90 Distribution, power and regulating transformers, and shunt reactors, tests code for
- C62.1 Lightning arresters for alternating-current power circuits
- C76.1 Outdoor apparatus bushings, requirements and test code for

### NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION

LA-1 Lightning Arresters

TR-1 Transformers, regulators and reactors

#### **5.2 Deviation and Nonconformance Requirements**

**5.2.1** Deviations from this specification or changes in the material or design after the purchase order has been placed must be approved by the GPA Engineering Department and acknowledged by a Purchase Order Amendment.

**5.2.2** Units received with deviations or non-conformance which are not acknowledged as specified in subparagraph 5.2.1 are subject to rejection. The Supplier of units rejected in this paragraph is responsible for any corrective action including but not limited to materials, labor and transportation necessary to dispose of, or make the units conform to the specification.

**5.2.3** Notification of defective units discovered before or after installation that are believed to be inherent to manufacturing problems or workmanship shall be made and forwarded to the Supplier. The description of the item, documentation of the problem and the described information, disposition and/or follow-up (as appropriate) that GPA expects from the Supplier will be specified. The Supplier's

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 5 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

response shall be made within thirty (30) days unless an extension is acknowledged and approved in writing by the GPA Manager of Engineering.

### **6.0 SUBMITTALS**

#### **6.1 Bid Data**

**6.1.1** The Bidder shall provide with his bid the following data for the transformer:

- a. Transformer type
- b. High-voltage rating and type
- c. Low-voltage rating and type
- d. Kilovolt-ampere rating and class
- e. Guaranteed efficiency at 1-1/4 load
- f. Guaranteed efficiency at full load
- g. Guaranteed efficiency at 3/4 load
- h. Guaranteed efficiency at 1/2 load
- i. Guaranteed efficiency at 1/4 load
- j. Guaranteed regulation at 100% power factor
- k. Guaranteed regulation at 80% power factor
- l. Guaranteed total loss at 100% voltage and load
- m. Guaranteed no-load loss at rated voltage
- n. Guaranteed maximum auxiliary power loss

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 6 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

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- o. Guaranteed no-load loss at 110% voltage**
- p. Guaranteed exciting current at 100% voltage**
- q. Guaranteed exciting current at 110% voltage**
- r. Guaranteed percent impedance**
- s. Calculated zero-sequence percent impedance**
- t. Guaranteed maximum average audible sound level for each stage of cooling in decibels using the "A" weighing scale**
- u. Type of oil preservation system**
- v. Method of mounting radiators: that is, removable or integral with the tank**
- w. Shipping data:**
  - w.1 Shipping weight**
  - w.2 Shipping dimensions**
  - w.3 Oil or gas filled**
- x. Earliest possible shipping date**
- y. Type of transformer winding material used for all windings**

**6.1.2 An outline drawing shall be provided with each bid quotation. This drawing shall include the following information:**

- a. Projected dimensions of the mobile substation, including the trailer**
- b. Height of mobile substation from ground level to the top of transformer high-voltage bushing**
- c. Height of mobile substation from ground level to the top of transformer low-voltage bushing**

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**GUAM  
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AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 7 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- d. Height of mobile substation from ground level to the top of the highest mounted structure
- e. Weight of transformer core and windings
- f. Weight of transformer tank and radiators
- g. Weight of trailer
- h. Number of gallons of oil and total weight of the oil
- i. Total weight of the assembled mobile substation including oil
- j. Power requirements for all control and auxiliary equipment

### 6.2 Product Data and Shop Drawings

6.2.1 Within four weeks from the Notice to Proceed, the Contractor shall submit to the Owner a complete set of catalog cuts and manufacturer's information brochures, where applicable, for the equipment and devices to be installed.

6.2.2 Within four weeks from the Notice to Proceed, the Contractor shall submit for approval, such certified drawings as may be required, including those showing:

- a. Arrangement and dimensions of all fabricated equipment and assemblies, including outline of complete substation. Wiring diagrams of transformer.
- b. A complete set of ac and dc schematic diagrams, one for each piece of equipment, including, but not necessarily limited to the following:
  - (1) Protection and controls
  - (2) Breaker controls
  - (3) Auxiliary equipment controls

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*(Signature)*





**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 8 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- c. Current transformer data, including excitation and ratio correction factor curves and mechanical and thermal short-term ratings.
- d. Interconnection diagrams.
- e. Potential transformer data.
- f. Bill of Material.
- g. Three-line diagram.
- h. One-line diagram.
- i. Wiring diagram of mobile trailer showing tail lights, stop light, outline lights, coupler to tractor, and any other electric wiring.
- j. Piping diagram of mobile trailer showing power brakes, connecting hose, etc.

Also, contractor shall provide the names and addresses of the manufacturers of all the equipment furnished together with catalog information or other identifying description and estimated weights.

### 6.3 Drawing Approval

6.3.1 GPA shall be allowed two (2) weeks to review and approve drawings provided in section 6.2 without affecting the shipping date.

6.3.2 Drawings returned to the Supplier as approved shall be considered authorization to proceed with the work. The approval of GPA shall in no way abrogate the requirements of this specification.

### 6.4 Certified Reproduces

6.4.1 At least three (3) weeks prior to shipment of the equipment, the Supplier shall furnish GPA with one complete set of final certified reproducible vellum for each mobile substation purchased. Under no

Effective date: 7/24/93

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 9 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

circumstances will "Typical Drawings" be accepted. This includes both schematic and wiring diagrams.

**6.4.2** Final certified reproducibles shall be submitted on full size, right reading, photographic mylar. The following information shall be shown on each drawing submitted:

- a. GPA Purchase Order
- b. Supplier's Name
- c. Description of Drawing

### **6.5** Instruction Books

**6.5.1** At least three (3) weeks prior to delivery, the Supplier shall furnish GPA five sets of complete operating and instruction books for each mobile substation.

**6.5.2** One additional instruction book set shall be attached to each mobile substation.

**6.5.3** Each set of manuals or instruction books shall include the following:

- a. Both schematic and wiring diagrams. No typical drawings are acceptable.
- b. List of parts that were shipped loose from the mobile substation and are to be installed in the field.
- c. A replacement parts list that includes part number identification.
- d. A list of recommended spare parts and complete packing lists of accessory items.
- e. Instruction manuals covering step-by-step installation and assembly with illustrative drawings. An identification system shall be used to mark each separate part to aid in assembly.
- f. Manual recommending proper storage procedures.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 10 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- g. Operating and "troubleshooting" manual for the mobile substation.
- h. List of all special tools needed for installation and maintenance.

### **7.0 HIGH VOLTAGE EQUIPMENT**

#### **7.1 Disconnect Switch**

- 7.1.1 A three pole, single throw, gang operated 34.5 kV, 1200 Amperes, manually operated air disconnect switch suitable (with arc horns) for making and breaking transformer magnetizing current will be mounted on a high voltage supporting structure.
- 7.1.2 Operating Switch handle will be operable from ground level and will have provision for padlocking in either the closed or open position.
- 7.1.3 The phase spacing between center lines of the poles during operation will not be less than 42 inches.
- 7.1.4 Loops for attaching strain insulators will be supplied on the line insulators of the disconnecting switch for dead-ending the high voltage line leads.

#### **7.2 Lightning Arresters**

Three 30 kV lightning arresters, Station class, are to be supplied properly mounted and braced to withstand shocks and to avoid vibration during transit.

#### **7.3 High Voltage Circuit Breaker**

- 7.3.1 The 34.5 kV circuit breakers shall be oil-less type and be 3-pole, single throw, trip free, rated on the symmetrical current basis. Each shall have its characteristics based on a close open - 15 second - close open duty cycle, and shall be capable of interrupting its rating in 5 cycles or less from the time the trip coil is energized until the arc is extinguished.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 11 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

**7.3.2** The circuit breaker closing shall be operated by a stored energy mechanism, which is normally charged by an electric motor, but which can also be charged by a manual handle for emergency manual closing or test. The power supply for the stored energy mechanism shall be 125 Volts dc.

**7.3.3** The circuit breaker control voltage shall be 125 Volts dc. Supplier will provide the 125 VDC control power through a Nickel-Cadmium battery pack and recharger in a weatherproof enclosure.

**7.3.4** The breaker shall have the following features:

- a. Sturdy, self-aligning, silver-plated, primary disconnect contacts with high contact pressure. The circuit breaker element, primary disconnect shall be an integral part of the element.
- b. Auxiliary switch contacts connected to the mechanism of each breaker shall be provided. A minimum of 4 "a" and 4 "b" contacts for the Owner's use shall be supplied and shall be wired to terminal blocks. Contacts shall be field changeable from "a" to "b" and vice versa.
- c. An easy-to-read position indicator located on the front of the equipment.
- d. Manual means for tripping.
- e. Trip free and non-pumping operation.
- f. An operations counter.

**7.3.5** The circuit breaker shall meet ratings as listed in ANSI C 37.06. Circuit breaker ratings shall be as follows:

- |                              |     |
|------------------------------|-----|
| a. Rated maximum voltage, kV | 38  |
| Withstand test voltages -    |     |
| Low frequency RMS, kV        | 80  |
| Impulse crest, kV            | 150 |

Issued: 2/24/93

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GUAM  
POWER  
AUTHORITY  
AGANA, GUAM

## Specification No. 031

Page 12 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- |    |  |        |
|----|--|--------|
| b. | Rated continuous current, Amperes:   | 1,200  |
| c. | Rated short-circuit current at<br>rated maximum voltage, symmetrical<br>Amperes, RMS | 21,000 |
| d. | Maximum symmetrical interrupting<br>capability, Amperes RMS                          | 35,000 |
| e. | Rated Short Time Current:<br>Three second Amperes                                    | 35,000 |

### 7.4 Protective Relays

#### 7.4.1 General

Protective relays shall be the semi-flush mounted, back connected, dustproof switchboard type, with rectangular case for mounting on No. 11 United States Standard gage metal panel. Electro-mechanical relays shall have a removable transparent cover or a cover with a transparent window with provision for sealing. Relay trip functions shall be equipped with an operation indicating target with manual front-of-case reset device. Trip contacts shall be designed for operation on 125 Volts, dc. Loading resistors, where needed to secure reliable target operation, shall be furnished. Each relay shall operate with instrument transformer ratios and connections as shown on the proposed One-Line Diagram under both normal and short-circuit conditions. Each overcurrent and differential relay shall provide continuous operation at the current coil tap ratings. Protective relays shall be the type and model indicated below. Substitutions are not acceptable.

#### 7.4.2 Power Transformer Relays

##### a. Transformer Differential Relays - Device 87T

Transformer differential relays shall be a percentage differential type and shall have harmonic restraint. They shall be GE Type BDD or Westinghouse Type HU.

Effective date: 2/24/93

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GUAM  
POWER  
AUTHORITY  
AGANA, GUAM

## Specification No. 031

Page 13 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

b. Transformer Neutral Time Overcurrent Relays - Device 50/51N

Transformer neutral overcurrent relays shall be an inverse time type with a range which includes 1.5 to 12 Amperes and a 10 to 80 Amperes instantaneous element. The neutral overcurrent relay shall be GE Type IAC or Westinghouse CO-8.

c. Transformer Primary Instantaneous and Time Overcurrent Relay-Device 50/51

Time overcurrent relays shall have inverse characteristic and shall have a range of 1.5 to 12 Amperes. The instantaneous element shall have a range of 10 to 80 Amperes. The overcurrent relay shall be GE Type IAC or Westinghouse CO-8 with instantaneous element.

7.4.3 Lockout Relays - Device 86

Lockout relays shall be electrical trip, hand-reset, 125 Volt dc auxiliary lockout relay type. Relays shall be multi-contact and shall be GE Type HEA.

### 8.0 TRANSFORMER SECTION

- 8.1 The transformer will be oil filled, outdoor type, forced oil - forced air cooled, 65°C average rise over a 40°C maximum, 30°C ambient with the following rating:

Capacity :	<u>18/24/30</u>	MVA
Temperature rise:	<u>65</u>	°C
Frequency:	<u>60</u>	Hertz
Phase:	<u>3</u>	

High voltage 34500 V, Delta	200 kV BIL
Low Voltage 13800 V, Grounded Wye,	110 kV BIL
Low Voltage 7970 V, Grounded Wye,	95 kV BIL

Effective date: 2/24/93

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 14 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### 8.2 Impedance

Impedance at 18000 KVA, 34.5 kV to 13.8 kV connection will be 7.5% subject to ANSI standard tolerance.

### 8.3 Bushing Current Transformers

8.3.1 Standard multi-ratio current transformers for Authority's use are required as follows:

Each HV Bushing - Two (2) 1200/5 relay accuracy C400.

Each LV Phase Bushing - Two (2) 2000/5 relay accuracy C400.

LV Neutral Bushing - One (1) 600/5 relay accuracy C200.

8.3.2 All secondary tap leads (total of five for each CT) shall be brought out of the top or side wall of the transformer through a gas and oil-tight compartment and wired to identified circuit shorting terminal blocks in the transformer control cabinet. All connections between CT's and GPA connection points shall be bolted or crimped. No soldered split or disconnecting lugs shall be used.

8.3.3 All CT circuits shall be terminated into an eight-pole test switch as shown in Sketch 1.

8.3.4 The manufacturer shall provide accuracy curves for the current transformers furnished.

8.3.5 Bushing CT Nameplates shall be provided showing connection and ratio for each tap of each current transformer. These nameplates shall be mechanically fastened and located adjacent to GPA's connection terminals.

Effective date: 2/24/93

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**GUAM  
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AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 15 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### 8.4 Tap Changers

#### 8.4.1 High Voltage De-Energized Manual Taps

Externally operated, full KVA capacity, fixed taps shall be provided to regulate the high voltage  $+ 2 \frac{1}{2}\%$  and  $+ 5\%$  from the nominal voltage. The high voltage de-energized tap changer shall be operable by a wheel, crank, or lever accessible by an operator standing on the trailer. The operating device shall have provisions for padlocking. Each tap position and associated voltage for that tap shall be clearly identified on a tap position nameplate mounted on the transformer wall directly adjacent to the operating device. The nameplate shall state "For De-energized Operation Only".

#### 8.4.2 Load Tap Changer (LTC)

- a. The transformer shall be provided with ANSI Standard C57.12.30 Section 7 LTC equipment to provide plus 10% and minus 10% adjustment of the low voltage winding voltage. The 10% regulation shall be done in sixteen approximately  $5/8\%$  steps above and sixteen approximately  $5/8\%$  steps below rated low voltage.
- b. The LTC equipment shall be capable of delivering rated KVA at all positions from neutral to 10 percent regulation and reduced KVA output at a constant current equal to the current at the neutral position for all tap positions below neutral.

#### 8.4.3 Tap Changer Reliability

- a. Each no-load tap changer shall be capable of performing not less than 200,000 no-load operations without replacing or rebuilding any of its components.
- b. Each load tap changer shall be capable of performing not less than 20,000 load operations at 110% rated current and at rated step voltage without replacing any arcing contacts or other parts involved in the current interruption operation.

Effective date: 2/24/93

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 16 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- c. The oil which immerses the load tap changer operating mechanism shall be physically isolated from oil contained within the power transformer tank. Maintenance of the load tap changer components shall not require that the transformer tank oil level be lowered.

### 8.4.4 LTC Equipment

a. General

The load tap changing equipment shall consist of an arcing tap switch, or tap selector and arcing switch; a motor-drive mechanism; and control devices.

b. Arcing Tap Switch

- b.1 The arcing tap switch, or tap selector and arcing switch shall be located in one or more compartments mounted on the transformer. In the case of a liquid immersed arcing switch, provisions shall be made for the escape of gas produced by the arcing.
- b.2 Removable bolted covers shall be provided for access to the arcing switch compartment without opening the main tank or lowering the liquid in the main tank. Covers shall have handles.
- b.3 A one inch filling plug shall be located on the top of each oil filled compartment.
- b.4 A magnetic liquid level gauge with a vertical face shall be mounted on the side of each oil filled compartment.

c. Motor Drive Mechanism

- c.1 The motor-drive mechanism shall be suitable for operation from a single-phase 120/240 volt supply. It shall not incorporate a centrifugal switch. The motor circuit shall have dynamic braking.

Effective date: 7/24/83

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**GUAM  
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AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 17 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

c.2 A hand crank or handwheel for manual operation of the driving mechanism shall be provided. If a hand crank or spoke type handwheel is provided, it shall be mechanically and electrically interlocked to prevent operation by the motor while the crank or spoke type handwheel is engaged. If the hand crank or handwheel is detachable, a storage place shall be provided.

c.3 Mechanical stops to prevent over-travel shall be provided on the main drive shaft (not incorporated in gear drives). The mechanical stop must provide positive stop regardless of other devices used for normal control. Alarm contacts shall be provided to close when the LTC goes to the raise or lower limits.

c.4 Limit switches shall be provided, one to close at full raise and the other to close at full lower.

d. Position Indicator

A position indicator for the load tap changer with maximum and minimum indicating hands shall be provided. Provision for resetting the maximum and minimum indicator from a standing position on the trailer is required. The position indicator shall be readable while operating the LTC controls. The indicator shall be solidly tied to the operating mechanism. Remote indication of tap changer position shall be provided, using an Intelligent Controls, Inc. Model 1250A Programmable Position Monitor for telemetering each of the 32 positions of the tap changer. This indication shall be in discrete steps for each position. An Intelligent Controls, Inc. Model 1292 Synchro Transmitter shall also be provided to give a -1, 0, +1 mA output to indicate tap position.

e. Operation Counter

An operation counter shall be provided in order to register the accumulated number of tap changes performed.

Effective date: 2/24/93

Issued:

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 18 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### **f. Control Devices**

Automatic and other control devices shall be housed in a GPA approved weather-proof cabinet equipped with heater and hinged doors. All devices shall be mounted on the rear panel in the cabinet. The doors shall have provision for padlocking. The cabinet shall be readily accessible from a standing position on the trailer and be of adequate size to accommodate equipment supplied. The following devices and accessories shall be mounted in the cabinet:

- f.1** A device suitable for providing a time delay in the range from 0 to 120 seconds in both raise and lower directions. The time delay shall apply only to the first step of a tap change.
- f.2** A voltage-regulating relay to control automatically the operation of the load-tap changer. The device shall be equipped with facilities for setting any voltage from 110 to 130 volts, and adjusting facilities for bandwidth.
- f.3** Switching for automatic operation, and for non-automatic raise-lower operation with intermediate off positions.
- f.4** A line-drop compensator supplied with adjustable resistance and reactance elements to permit compensation for the line drop caused by load current fluctuations.
- f.5** A voltmeter (0-150 volts) for reading the voltage supplied to the automatic control equipment by the potential source.
- f.6** Protective devices shall consist of:
  - a.** Overcurrent automatic-trip, temperature-compensated, air circuit breaker with manual

Effective date: 2/24/93

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**GUAM  
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AGANA, GUAM

## Specification No. 031

Page 19 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

reset for control of the power circuit to the motor drive.

- b. Overcurrent automatic-trip, temperature-compensated, air circuit breaker with manual reset for control of the potential circuit to the control devices.

f.7 A screw-base lamp socket with switch and a convenience outlet for a 120 volt single-phase, 60 Hz supply. Outlet shall be duplex grounding type (for 3-prong plug). Screw-base lamp sockets with pull-chain switches are not acceptable.

f.8 A thermostatically controlled heater system having magnetic or thermo-magnetic overload protection in each control housing. If there is more than one control housing in a particular transformer arrangement, each housing shall have its own individual automatic control for the heaters. All heaters shall be 230 volt rated with connections for 115 volts. The heater supply voltage will be 115 volts 60 Hz single-phase.

f.9 Necessary control relays and equipment to operate alone or in parallel with one other transformer.

f.10 Necessary apparatus to limit circulating current when two (2) or more transformers are operated in parallel.

f.11 Necessary apparatus for remote operation of the Load Tap Changer.

g. Current and Potential Sources

g.1 GPA will furnish a potential transformer for the supply of power to the control circuit. The potential shall be from Phase 1 at 120 V line-to-neutral.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 20 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

**g.2** A current transformer shall be furnished to deliver to the line-drop compensator (LDC) a current which is in phase with line-drop compensator potential supply at unity power factor. LDC CT shall be wired through a two-pole shorting type switch.

### **8.5** Liquid Thermometer

The transformer shall have top oil gauges with alarm contacts and a 0-1 mA output shall be provided for top oil temperature.

### **8.6** Liquid Level Indicator

A magnetic liquid level indicator to indicate the level of the insulating liquid. Two electrically separate, normally open alarm contacts shall be provided to indicate both high and low liquid level.

A third contact shall be provided to trip for low liquid level. This contact shall be electrically isolated from the alarm contacts and shall be set so that the trip operation is at a lower liquid level than the low level alarm.

### **8.7** Hot Spot Thermometer

A three-stage hottest spot winding temperature indicator relay shall be provided in each winding. The second stage contacts shall be wired in parallel to an auxiliary relay to obtain two (2) normally open contacts in addition to fan control contacts. A 0-1 mA output shall be provided for winding temperature.

The loss of cooling and over temperature trip and alarm scheme shall contain the items listed below and shown in Schematic Drawing Sketch 2.

- a. Auxiliary contacts from second stage of winding temperature relay.
- b. Loss of voltage relay (Device 27-1).
- c. Timing relay to allow enough time for a source transfer before operation (Device 95)

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 21 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- d. Timing relay with instant transfer auxiliary switch self-resetting, 6-60 minutes, time delay pickup (Device 2-2). The equipment will be used to give an alarm with loss of voltage and high temperature and de-energize the transformer after a set period of time.
- e. Auxiliary time delay relay to give alarm upon loss of voltage to pumps and/or fans (Device 27-2).

### 8.8 Sudden Pressure Relay

A sudden pressure relay shall be provided. This relay shall be factory calibrated for the transformer on which the relay is to be used. The relay shall be provided with two electrically separated contacts for alarm and control. The sudden pressure relay shall be provided with an auxiliary lockout relay with hand reset. The auxiliary relay shall have a normally closed contact from the sudden pressure relay shunting the operating coil of the auxiliary lockout relay. The relay shall be suitable for 125 VDC operation. Relay assembly and location shall allow removal with the transformer energized.

### 8.9 Mechanical Pressure Relief Device

A self-sealing, mechanical pressure relief device shall be located on the cover. The relief device shall be furnished with alarm contacts and a visual operation indicator. The indicator shall be resettable with hot-sticks from ground level without the necessity of de-energizing the transformer.

### 8.10 Core Ground

It is preferred that the core ground connection be above the oil and accessible from a manhole to facilitate testing of the core to tank insulation without lowering the oil. The connector shall be the slotted type with a captive nut connection. The location of the core ground should be indicated on the transformer outline drawing.

### 8.11 Auxiliary Power Source

- 8.11.1 The auxiliary power will be single-phase 120/240 volt, 60 Hz AC. The Supplier shall design the transformer cooling system

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 22 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

including fans and pumps, LTC motor, controls and accessories to operate on both voltages. The Supplier shall inform GPA of the power requirements needed at the transformer. The terminals provided by the Supplier shall be adequate to receive GPA furnished AC service conductors.

**8.11.2** A 120 VAC, 15 ampere convenience outlet with ground fault protection shall be provided.

**8.11.3** Provisions shall be made for a Nickel-Cadmium battery pack and recharger to supply 125 VDC. All tripping, alarm, and associated devices shall be rated 125 VDC operation.

### **8.12** Centralized Termination and Control Devices Requirement

All equipment alarms, controls, protection and current transformers shall be brought to individual identified terminals centralized in a weather-proof control cabinet mounted on the equipment tank at a center of cabinet to base height of 5 feet 6 inches. Adequate hinged doors shall be provided with weatherproof latching facilities. The latching assemblies shall be operated by handles that can be reached by an operator standing on the trailer. Each handle shall have provisions for padlocking and be acceptable for weather-proofing the doors in the closed position.

All meters and instruments which require resetting shall be mounted less than six (6) feet above the base of the transformer.

Alarm contacts shall be electrically separate, open during normal conditions, self-resetting, suitable for closing 30 amperes, carrying 10 amperes continuously, and opening 3 amperes at 125 volts DC.

Control contacts shall be electrically separate, open during normal conditions, self-resetting, suitable for closing 30 amperes, carrying 10 amperes continuously, and opening 3 amperes at 125 volts DC.

Effective date: 2/24/93

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 23 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### 8.12 Forced Air Cooler

- 8.12.1 The fan and pump motors are to be designed for operation on a 230 volt, 3 phase, 60 cycle circuit. The pump motor will not require maintenance.
- 8.12.2 A vane-operated oil flow indicator is to be used with each forced oil pump on the transformer. It shall provide visual indication and confirmation by electrical alarm switches of the proper operation of the pump and adequate oil flow for cooling. The alarm switches are to be connected to trip the circuit breaker in the event the pump is not operating correctly.
- 8.12.3 A reversing switch for obtaining correct direction of rotation of pump and fan motors will be supplied.

### 8.13 Oil Preservation

Sealed-tank construction will be supplied to prevent exposure of transformer oil and insulation to oxygen and moisture.

### 8.14 Standard Accessories

- 8.14.1 The following minimum accessories are to be supplied as part of the transformer:
- a. A magnetic liquid level gauge, with low level alarm contacts, to continuously indicate the level of insulating oil.
  - b. Hot oil thermometer, complete with alarm contacts, to indicate the temperature of the hottest liquid.
  - c. Pressure vacuum gauge.
  - d. Two inch combination drain and lower filter press valve with 3/8 inch sampling valve at lowest point of tank.
  - e. One inch upper filter press valve.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 24 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- f. One inch filling plug on tank cover.
- g. Manhole or cover plates for access to core and coil assembly.
- h. Mechanical pressure relief device with automatic reclosing to prevent entrance of moisture, complete with alarm contacts and visual indicator.
- i. Sufficient oil for filling to normal level.

### **9.0 LOW VOLTAGE EQUIPMENT**

#### **9.1 Low Voltage Circuit Breaker**

- 9.1.1 The 15 kV circuit breaker shall have vacuum interrupters, and be 3-pole, single throw, trip free, rated on the symmetrical current basis. The breaker shall have its characteristics based on a close open - 15 second -close open duty cycle, and shall be capable of interrupting its rating in 5 cycles or less from the time the trip coil is energized until the arc is extinguished.
- 9.1.2 The circuit breaker closing shall be operated by a stored energy mechanism, which is normally charged by an electric motor, but which can also be charged by a manual handle for emergency manual closing or test. The power supply for the stored energy mechanism shall be 125 Volts dc.
- 9.1.3 The circuit breaker control voltage shall be 125 Volts dc. The supplier will provide the 125 VDC station control power through the Nickel-Cadmium battery pack and recharger specified in paragraph 7.3.3.
- 9.1.4 The breaker shall have the following features:
  - a. Sturdy, self-aligning, silver-plated, primary disconnect contacts with high contact pressure. The circuit breaker element, primary disconnect shall be an integral part of the element.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 25 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- b. Auxiliary switch contacts connected to the mechanism of each breaker shall be provided. A minimum of 4 "a" and 4 "b" contacts for the Owner's use shall be supplied and shall be wired to terminal blocks. Contacts shall be field changeable from "a" to "b" and vice versa.
- c. An easy-to-read position indicator located on the front of the equipment.
- d. Manual means for tripping.
- e. Trip free and non-pumping operation.
- f. An operations counter.

**9.1.5** The circuit breaker shall meet ratings as listed in ANSI C 37.06. Circuit breaker ratings shall be as follows:

a.	Rated maximum voltage, kV	15
	Withstand test voltages -	
	Low frequency RMS, kV	36
	Impulse crest, kV	95
b.	Rated continuous current, Amperes:	2,000
c.	Rated short-circuit current at rated maximum voltage, symmetrical Amperes, RMS	18,000
d.	Maximum symmetrical interrupting capability, Amperes RMS	23,000
e.	Rated Short Time Current: Three second Amperes	23,000

### **9.2** Meters and Instruments

For each of the feeder circuits, as well as for the transformer input circuits, Schweitzer SEL-DTA display as described under paragraph 9.4.1, units and

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 26 of 34  
Revision No. \_\_\_\_  
Date: \_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

the solid state meters described under paragraph 9.3, shall be used for metering of volts, amperes, watts, and vars.

### 9.3 Solid State Meter

9.3.1 The solid-state meter shall be multi-function, poly-phase, switchboard type (draw-out case) with electronic registers, displays, and pulse outputs. The meter shall be Schlumberger Industries Quantum Type Q220, with 2-1/2 element Watt and Var inputs. The display shall include digital kV, kA, kWh, kVarh, kW-demand, kW-demand, kVar-demand, and power factor. The meter shall provide kWh and kVarh pulse outputs for interface to a SCADA system.

9.3.2 The solid state meter shall be furnished with the following additional features:

- a. Mass memory/clock module to allow storage of up to 15 channels of internal register data in RAM. Minimum RAM size shall be capable of storing kW and kVar quantities of 15-minute intervals for 35 days.
- b. Digital interface module to enable remote interrogation via meter's RS-232C port by a SCADA system. Data to be provided shall include voltage, current, watts, vars, and power factor.
- c. Modem module to allow remote interrogation of stored data from an IBM-compatible personal computer.
- d. Connectors and cables for RS-232C interface.

### 9.4 Relays

#### 9.4.1 Protective Relays

- a. Protective relays shall be the semi-flush mounted, back connected, dustproof switchboard type, with rectangular case for mounting on No. 11 United States Standard gage metal panel. Relay trip functions shall be equipped with an

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 27 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

operation indicating target with manual front-of-case reset device. Trip contacts shall be designed for operation on 125 Volts, dc. Loading resistors, where needed to secure reliable target operation, shall be furnished. Each relay shall operate with instrument transformer ratios and connections as shown on the proposed One-Line Diagram under both normal and short-circuit conditions. Each overcurrent and differential relay shall provide continuous operation at the current coil tap ratings. Protective relays shall be the type and model indicated below. Substitutions are not acceptable.

**b. 13.8 kV Feeder Relays - Device 50/51/50G/51G**

- 1) Overcurrent relay shall be very inverse type with time overcurrent range of 1.5 to 12 Amperes and instantaneous range 10 to 80 Amperes.
- 2) Overcurrent ground relay shall be very inverse type with time overcurrent range of 1.5 to 12 Amperes and instantaneous range of 10 to 80 Amperes.
- 3) All of the above functions shall be provided by the Schweitzer solid-state relay type SEL-151C. Spare relay contacts shall be wired to terminal blocks.

**c. Display**

The SEL-151C relay shall be monitored by a display unit, SEL-DTA by Schweitzer. The SEL-DTA shall include the following features:

- 1) User interface to SEL-151C relay.
- 2) Access to target, meter, status and fault history.
- 3) Eight (8) programmable analog output channels, 0-5 VDC and 0-1 mA DC, for voltages, currents, kW, kVar, or fault location.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 28 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

- 4) Dry contact outputs for fault indication.
- 5) Metering and relay operation status provided via front panel LED display.
- 6) Adapter board for breaking the 25-pin "D" connector into screw terminals for transducer outputs.
- 7) Self-testing of memory modules.

### 9.5 Auxiliary transformers

Two single-phase auxiliary power transformers will be mounted on the trailer external the main transformer and permanently connected to the low voltage winding with the secondaries connected open delta to supply the pump and fan motors, the control, the station lights, and the metering potential.

### 9.6 Lightning arresters

Three 12 kV lightning arresters, station class, are to be supplied properly mounted and braced to withstand shocks and avoid vibration during transit.

### 9.7 Disconnect Switch

9.7.1 A three pole, single throw, gang operated 13.8 kV, 2000 Amperes, manually operated air disconnect switch suitable (with arc horns) for making and breaking transformer magnetizing current will be mounted on a high voltage supporting structure.

9.7.2 Operating Switch handle will be operable from ground level and will have provision for padlocking in either the closed or open position.

9.7.3 The phase spacing between center lines of the poles during operation will not be less than 42 inches.

9.7.4 Loops for attaching strain insulators will be supplied on the line insulators of the disconnecting switch for dead-ending the low voltage line leads.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 29 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### **10.0 TRAILER**

**10.1 The transformer and complete equipment listed above will be rigidly and securely mounted on a tandem (or triple) axle semi-trailer.**

**In addition, the trailer will include:**

- a. Dual wheels equipped with 12 ply pneumatic tires, 10.00 x 20.**
- b. Air brakes with emergency breakaway feature on all wheels.**
- c. Chock blocks for holding the trailer stationary when disconnected from the tractor.**
- d. Four heavy-duty screw jacks for leveling and removing the load from the tires.**
- e. Towing eyes at the rear of the trailer.**
- f. Fittings for connecting the brake system of the trailer to the tractor.**
- g. ATA receptacles (six and seven point) for connecting the lightning circuit of the trailer to the tractor.**
- h. Lighting circuits will be suitable for 12-volt supply.**
- i. Fifth wheel plate and kingpin suitable for 90 degree turning.**
- j. Front vertical supports with two-speed gears and two flat pads 12 x 18 inches.**
- k. Fenders or equivalent will be provided over the wheels.**
- l. Mud flaps will be provided to prevent throwing mud to the rear.**

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 30 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### 10.2 Operating and Safety features

- a. All high voltage parts less than seven feet above ground level and cooling fan blades will be shielded from accidental contact by permanently mounted metal shields.
- b. Ground pad will be supplied on each end of trailer.
- c. Outline lights for operation from a 12 volt battery on the tractor will be supplied.
- d. Two red lights indicating mobile substation is energized.
- e. The substation will be designed so that it can be energized and operated when out-of-level by not more than five (5) degrees.
- f. The design will be such that the substation can be tilted sideways up to an angle of twenty (20) degrees without overturning.
- g. The substation will withstand, without damage, a maximum speed in transit of fifty-five (55) miles per hour on paved roads.
- h. The substation is to be supplied with integral storage facilities for all equipment detached during transit and for auxiliary equipment such as special wrenches, removable manual maintenance closing device, a set of instruction manuals, and spare fuses.

### 10.3 I.C.C. Regulations

The complete substation will be provided with reflectors, red clearance lights, marker lights, stop lights, and turn indicating lights to comply with Guam and I.C.C. regulations.

### 10.4 Guam Road Regulations

The entire substation will be designed to meet Guam Road Regulations with respect to maximum width, height, length and weights.

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**GUAM  
POWER  
AUTHORITY**  
AGANA, GUAM

## Specification No. 031

Page 31 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

PREPARED BY ENGINEERING DEPARTMENT

### **11.0 TESTING**

The Supplier shall make his plant available to GPA Personnel to inspect the transformer during construction, testing, and/or packaging for shipment.

### **12.0 SHIPPING REQUIREMENTS**

- 12.1 Because of severe transportation conditions, the Supplier shall pay particular attention to the proper packaging and bracing of the apparatus to assure its safe arrival.
- 12.2 The Supplier shall prepare all materials and equipment for shipment in such a manner as to protect from damage in transit. All small parts and unit components shall be separately boxed or bundled to prevent galling due to rubbing of one part against another. Each item, box or bundle shall be plainly and individually identifiable for content according to item number, GPA P.O. Number, and Supplier's Identifying Number.
- 12.3 A complete itemized Bill of Lading, which clearly identifies and inventories each assembly, sub-assembly, carton, package, envelope, etc., shall be furnished and enclosed with each item or items at the time of shipment.
- 12.4 Openings in the transformer tank or radiators resulting from the removal of parts for shipment shall be identified and securely sealed against the entrance of moisture and foreign materials. Covers shall be of sufficient strength to resist puncture.

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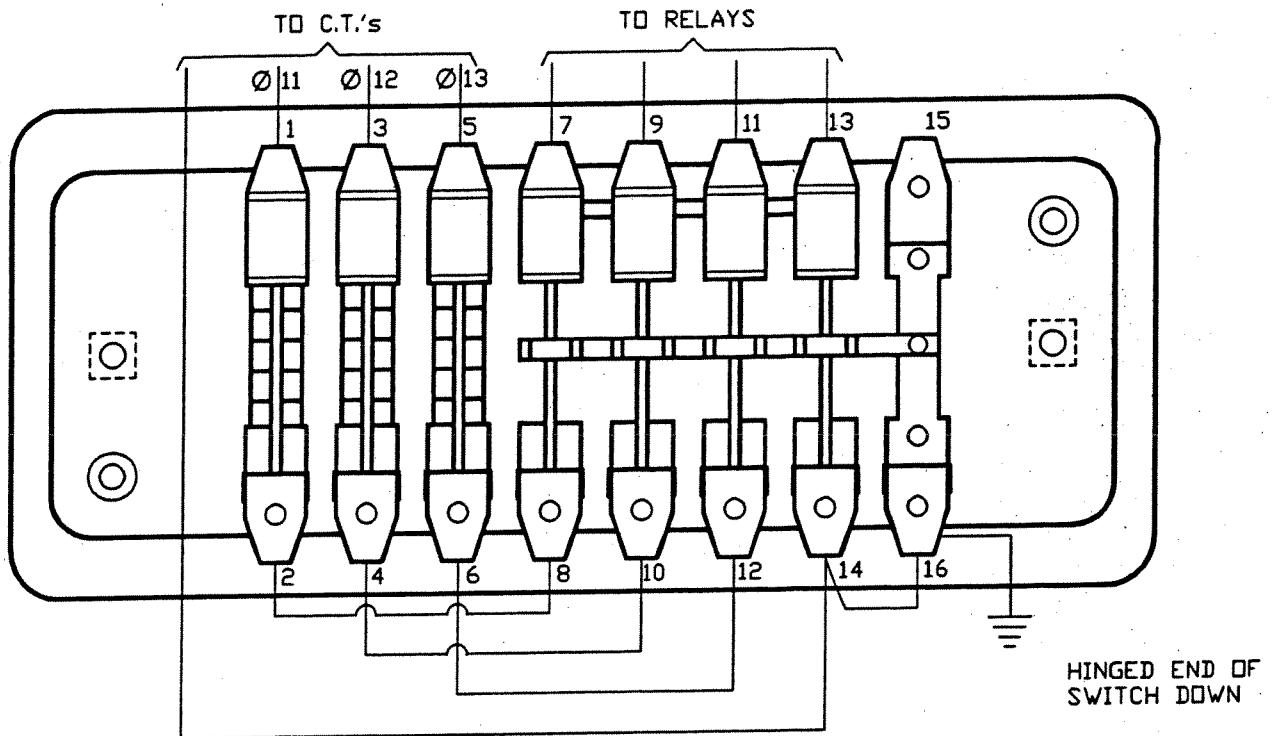


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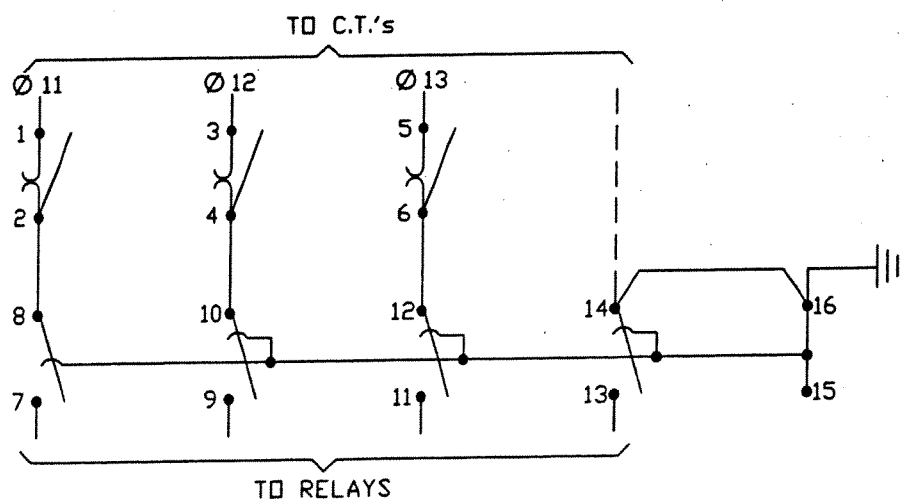
Specification No. 031

Page 32 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

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ENGINEERING TEST SWITCH LAYOUT-SUPERIOR T21835



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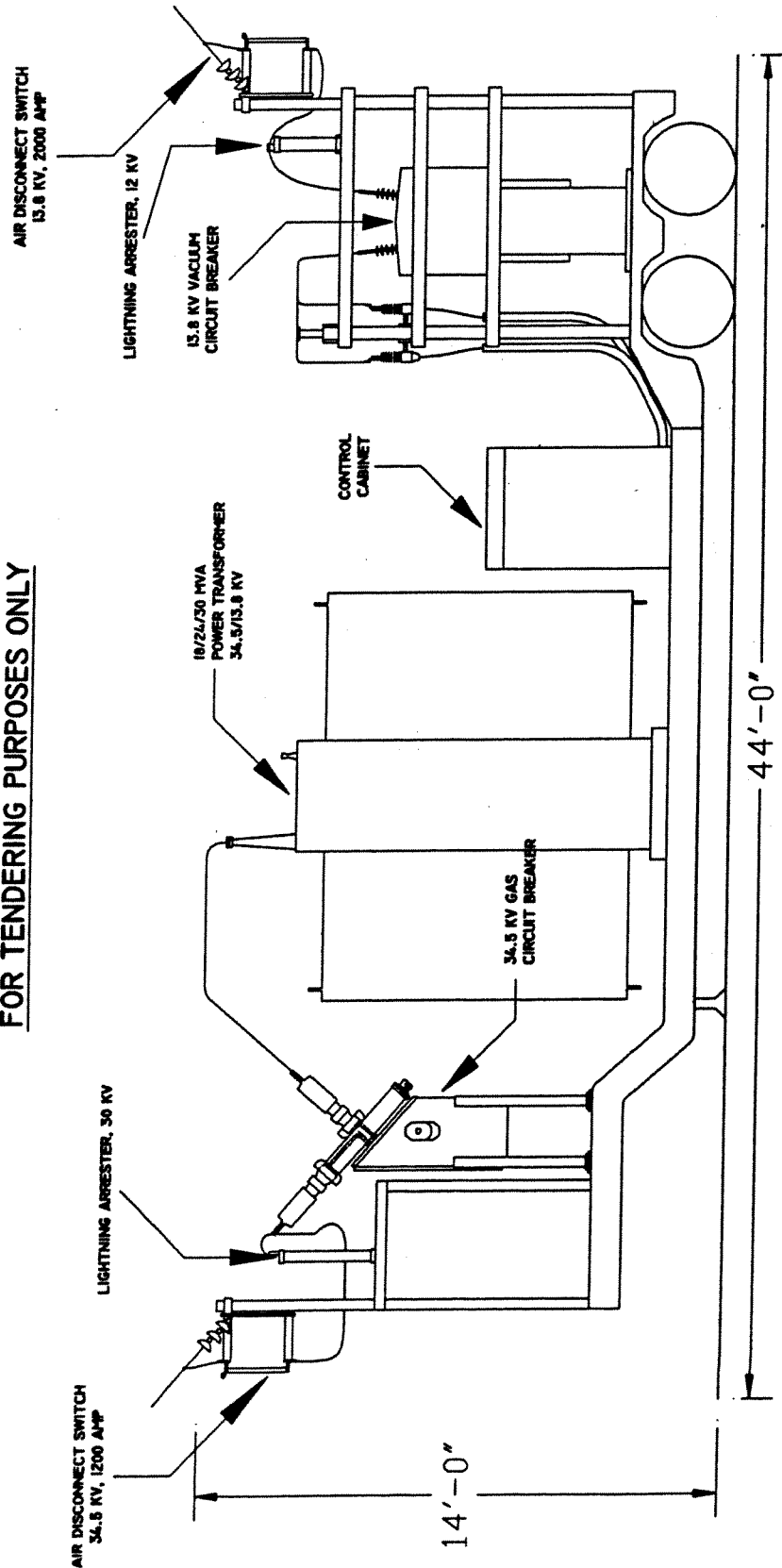
GUAM  
POWER  
AUTHORITY  
AGANA, GUAM

Specification No. 031

Page 34 of 34  
Revision No. \_\_\_\_\_  
Date: \_\_\_\_\_

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