BANGLADESH RURAL ELECTRIFICATION BOARD

PBS INSTRUCTION 100-29

SUBSTATION OPERATION, INSPECTION AND MAINTENANCE

BANGLADESH RURAL ELECTRIFICATION BOARD

PBS INSTRUCTION 100-29

Approval Date: 18/08/1983
Revision Date : 19/02/2020

SUBJECT: SUBSTATION OPERATION, INSPECTION AND MAINTENANCE

1.0 GENERAL

1.1 SCOPE

This part of the substation manual presents guidance in operation of PBS distribution substations on all PBS systems. It is intended to provide guidance to operating personnel for the continuous, reliable and safe operation of substations and their component parts.

1.2 OPERATING RESPONSIBILITIES

Responsibility for operation of the distribution substations will be assigned to the Senior General Manager/ General Manager of each PBS area. Some of this responsibility can be delegated to the Assistant General Manager (Operation and Maintenance) and his/ her subordinates provided these subordinates have adequate training before they are allowed to operate equipment in a substation. Responsibility for the inspection and maintenance of the substations will also be assigned to the Senior General Manager/ General Manager who will delegate some responsibility to the Assistant General Manager (Operation and Maintenance). But the overall responsibility must be maintained by the General Manager and the Deputy General Managers of the concerned zonal offices. The position of AGM(O&M) must be staffed by adequate manpower, vehicles, tools, and test equipment.

1.3 OPERATION PLANNING

All operations in a substation must be carefully planned to avoid accidents and equipment damage. If careful planning is not done, problems can develop which may cause increased outage time and equipment failure or damage. In switching operations in a substation, "think then switch". All non-emergency switching operations must have a written approved switching order.

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1.4 SUBSTATION LOGBOOK

A logbook shall be maintained at each substation. This logbook constitutes a record of all activities that take place at the substation. It should include entries regarding:

Any switching operation at the substation

Visits to the substation by personnel (give reason for the visit)

Inspection and maintenance activities

Other activities of note at the substation

The recommended column headings for the logbook are as follows:

Date	Time		Personnel Name, Designation & Office	Activity or Reason for Visit	Signature
	Arrived	Departed			

1.5 SUBSTATION RECORDS

Each PBS Headquarters shall maintain a file for each substation. This file shall contain all pertinent information regarding the substation and the equipment installed therein. See the Substation Equipment Forms and Substation Testing and Commissioning Forms in this section.

At each PBS Headquarters, a record system shall be established to properly maintain and permit analysis of the data obtained from the substation inspection reports.
Information from each inspection report shall be recorded to show pertinent data on:

Transformer Banks
Regulators
Three Phase ACR/ OCR/ Breaker
Single phase ACR/ OCR/ Breaker
Feeder Loads
Any additional data of note

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Records of substation inspections should include readings of all indicated and recorded electrical quantities, times and dates, ambient weather conditions and reference to work orders or job orders showing remedial work performed as a result of each inspection.

Files for each substation should include up-to-date drawings of substation wiring, structures, equipment, manufacturer's descriptive literature, instruction books, part lists and locations. Section 23 - "Reference Material" may be seen.

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-01(Version-1)

Name of PBS _____

METER RECORD CARD

METER DATA - (By Meter Department)

Manufacturer _____ Type _____ Serial No._____

Test Amps_____ Volts _____ Kh_____ Full Scale Demand - KW _____ Multiplier ____

INSTALLATION AND REMOVAL DATA - (By Finance Dept. - From Customer Meter Order)					
		INSTALLATION		REMOVAL	
CUSTOMER NAME	LOCATION/ ACCOUNTS NO.	Date	Reading	Date	Reading

Date Retired _____ Reason _____ Reference _____

BANGLADESH RURAL ELECTRIFICATION BOARD				
PBS Instruction 100-29: SUBSTATION OPERATION, INSPECTION AND MAINTENANCE				
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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-01(Version-1)

Master Test Data - (From Meter Dept.)

Test Date	Reason for Test	As Found				As Left				Type of Repairs	Tested By
		KWH Reading	FL	LL	50% PF	KWH Reading	FL	LL	50% PF		

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-02(Version-1)

Name of PBS _____

ACR/ OCR/ BREAKER RECORD CARD

MANUFACTURER _____ TYPE _____ YEAR _____ SERIAL NO. _____

PHASES _____ VOLTS _____ CAT NO. _____

CONTINUOUS RATING AMPS _____ INTER RATING AMPS _____

DELIVERY DATE _____

INITIAL INSTALLATION DATE _____

Date Installed	Location	ACR OCR/ Breaker Number	Date Removed	Reason

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-02(Version-1)

INSPECTION & MAINTENANCE DATA

Maintenance Schedule Date	Inspections Date	Counter Reading	Oil Test (KV)	All Check		Repair & Maintenance Work Performed
				OK	Not OK	

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-03(Version-1)

Name of PBS _____

VOLTAGE REGULATOR RECORD CARD

MANUFACTURER _____ TYPE _____ SERIAL NO. _____

RATING _____ VOLTS _____ DELIVERY DATE _____

DATE INSTALLED	LOCATION	REMOVED	
		DATE	REASON

VOLTAGE LEVEL	BANDWIDTH	TIME DELAY	RESISTANCE	REACTANCE	POLARITY SWITCH	COUNTER READING

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-03(Version-1)

INSPECTION AND MAINTENANCE DATA

DATE OF INSPECTION	COUNTER READING	OIL TEST (KV)	CHECK CONTACTS	REMARKS (TEST, REPAIRS, OBSERVATION)	SIGNATURE

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-04(Version-1)

Code No. _____

Name of PBS _____

POWER TRANSFORMER RECORD CARD

Manufacturer _____ Year _____ Serial No. _____

MVA _____ Type _____ Impedance _____

Primary Volts _____ Sec. Volts _____ Sub Station Capacity _____

On Load Tap Changer (OLTC): Yes ☐ No ☐ Condition: Functioning/ Not Functioning

DATE INSTALLED	LOCATION	REMOVED	
		DATE	REASON

* To be filled by Pencil

BANGLADESH RURAL ELECTRIFICATION BOARD				
PBS Instruction 100-29: SUBSTATION OPERATION, INSPECTION AND MAINTENANCE				
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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-04(Version-1)

INSPECTION AND MAINTENANCE DATA

Date & Time Inspected	Load (MW)		Remarks (Test, Repairs, Maintenance)	Signature
	Connected	Actual*		

*Load to be measured at Peak hours.

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-05(Version-1)

Code No. _____

Name of the PBS _____

DISTRIBUTION TRANSFORMER RECORD CARD

Manufacturer _____ Year _____ Serial no. _____

KVA _____ Type _____ %Impedance _____

No Load Loss _____ Full Load Loss _____

Cost of Transformer _____ Installation Cost _____ Total Cost _____

Date Installed	Location			* No of Customer		Remove	
	Station No.	Pole No.	Village	Staked	Served	Date	Reason

* To be updated and filled by pencil

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-05(Version-1)

INSPECTION AND MAINTENANCE DATA

Date and Time Inspected	Load (KW)		Remarks (Test, Repairs, Maintenance)	Signature
	Connected	Peak*		

* Load to be measured at Peak hours.

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BANGLADESH RURAL ELECTRIFICATION BOARD
BREB Form No. 100-29-06 (Version-1)

STATION TRANSFORMER INFORMATION SHEET

Name of PBS _____
Name of Substation _____ Date: _____
Complete the following using the nameplate information obtained from the installed transformer.
Refer to the example nameplate below for information location.

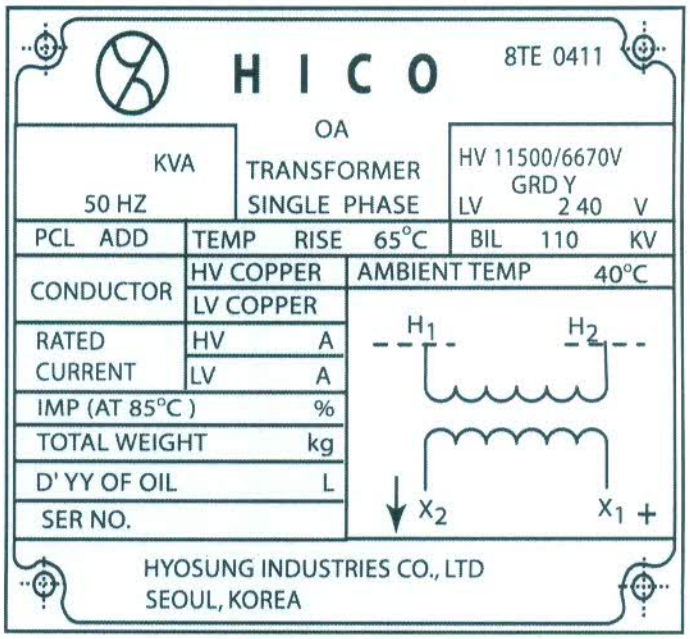
NAMEPLATE DATA

Manufacturer	:		Impedance at 85^0C(%)	:	
KVA Rating	:		Rated Voltage, HV(V)	:	
Serial No.	:		Rated Voltage, LV(V)	:	
Qty. of Oil (Gallon)	:		Rated Current, HV(A)	:	
Total Weight (Kg)	:		Rated Current, LV(A)	:	

OBSERVATIONS:

Insulation Test:
Result _____
Date _____

Oil Test:
Job No. _____
Result _____
Date _____



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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-07(Version-1)

POWER TRANSFORMER INFORMATION SHEET

Date _____

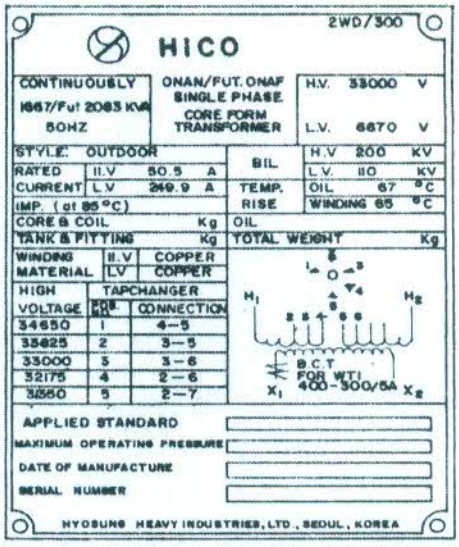
Name of PBS _____

Name of Substation _____

Complete the following using the nameplate information obtained from the installed transformer. Refer to the example nameplate below for information location.

NAMEPLATE DATA

Manufacturer	:		Applied Standard	:	
KVA Rating	:		Rated Voltage, HV(V)	:	
Serial No.	:		Rated Voltage, LV(V)	:	
Date of Manufacture	:		Rated Current, HV(A)	:	
Imp. at 85^0C (%)	:		Rated Current, LV(A)	:	
Qty. of Oil (Gal.)	:		Total Weight, Kg	:	
Tap Position No.	:		Core & Coil, Kg	:	
Max. Op. Pressure (PSI)	:		Type of Cooling	:	



OBSERVATIONS:

Insulation Test:

Result _____

Date _____

Oil Test

Job No. _____

Result _____

Date _____

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-08(Version-1)

PT AND CT INFORMATION SHEET

Name of PBS _____

Name of Substation _____ Date: _____

Complete the following using the nameplate information obtained from the installed CT/PT. Refer to the example nameplate below for information location.

NAMEPLATE DATA

Particulars	PT-1	PT-2	CT-1	CT-2
Serial No.				
Accuracy Class:				
Rated Burden (VA):				
Rated Primary:	V	V	A	A
Rated Secondary:	V	V	A	A
Total Weight (KG):				
Date of Manufacture:				
Qty. of Oil (Gal.):				

OBSERVATIONS:

Insulation Test:

Result _____

Date _____

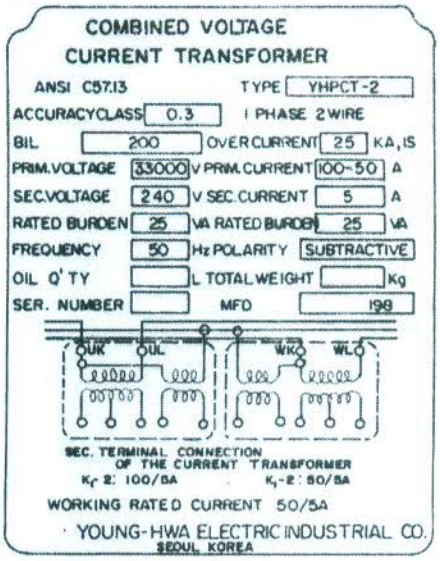
Oil Test:

Job No. _____

Result _____

Date _____

Connection:



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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-09(Version-1)

ACR/ OCR/ BREAKER INFORMATION SHEET

Name of PBS _____ Date _____

Name of Substation _____ Feeder _____

Complete the following using the nameplate control panel information obtained from the installed 3-phase ACR/ OCR/ Breaker

NAMEPLATE DATA			CONTROL PANEL DATA		
Manufacturer	:		Manufacturer	:	
Model	:		Model/ Part No.	:	
Serial No.	:		Serial No.	:	
Date of Manufacture	:		Date of Manufacture	:	
Rated Voltage, KV	:				
Rated Cont. Current, Amp	:		**PROTECTION SETTING DATA**		
Sh. Ckt. Making Curr., KA	:		Phase Trip Setting, Amp	:	
Sh. Ckt. Breaking Curr., KA	:		Ground Trip Setting, Amp	:	
Duration of Sh. Ckt., Sec.	:		Trip to Lockout, No.	:	
Basic Insulation Level, KV	:				

TRIP SETTING DATA

	Phase Protection Trip				Earth Protection Trip			
Trip No.	1	2	3	4	1	2	3	4
Inverse Curve Type:								
Instantaneous Multiplier:								
Minimum Time (sec.)								
Time Multiplier:								
Additional Time:								

OBSERVATIONS:

Insulation Test:

Result _____

Date _____

Oil Test

Job No. _____

Result _____

Date _____

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-10(Version-1)

VOLTAGE REGULATOR INFORMATION SHEET

Name of PBS :---------- Date: ----------

Name of Substation : ----------

Complete the following using the nameplate information obtained from the installed 1-phase Voltage Regulators. Refer to the example nameplate below for information location.

NAMEPLATE DATA

Particulars		Phase-R	Phase-Y	Phase-B
Manufacturer	:			
Model	:			
KVA Rating	:			
Load Amp	:			
Range of Regulation	:			
Rated Volts	:			
Man. CP Serial	:			
Manufacturing Date	:			
BIL, (KV)	:			
CT Ratio	:			
Un-tanking Wt. (Kg)	:			
Total Weight, (Kg)	:			
Qty. of Oil, (Gallon)	:			

OBSERVATIONS

INSULATING TEST:

Result _____

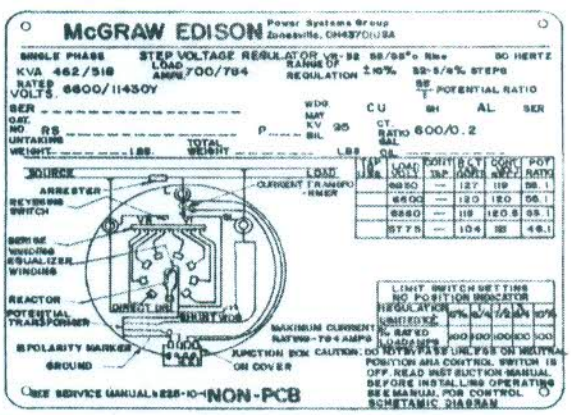
Date _____

Oil Test

Job No. _____

Result _____

Date _____



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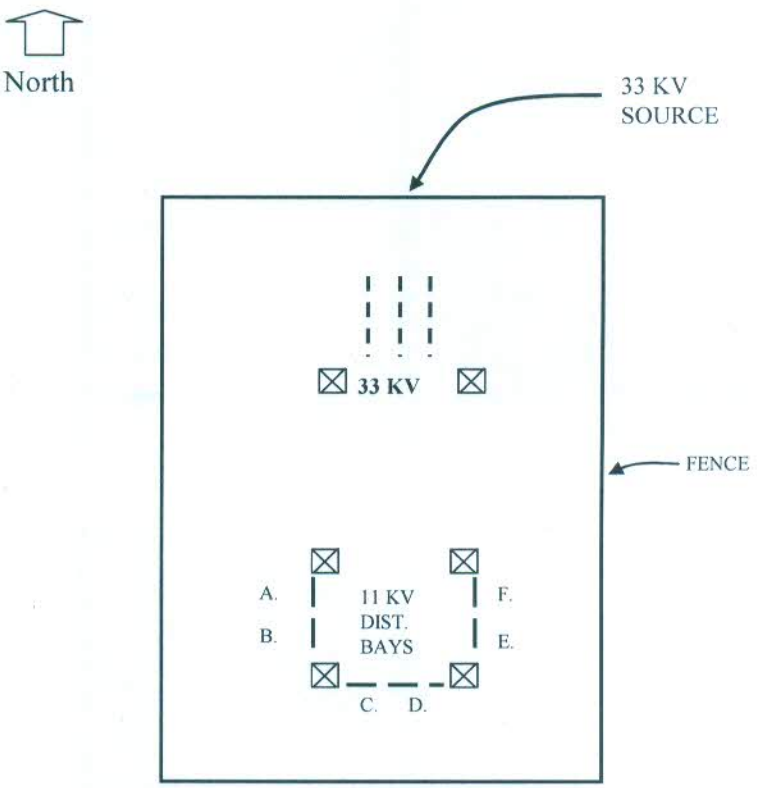
BREB Form No. 100-29-11(Version-1)

SUB-STATION LAYOUT DRAWING FORMAT

(SAMPLE)



Notes:

1. Indicate North Direction.
2. Indicate 33KV Phasing
3. Indicate Drive Thru Gate Location
4. Indicate 11KV Circuit to be used

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1.6 SUBSTATION TESTING & COMMISSIONING

A. A guideline and procedure on Sub-station testing, pre-commissioning and commissioning is given in PBS Instruction 100-20. For the purpose of testing, pre-commissioning and commissioning of a sub-station, PBS Instruction 100-20 should be followed.

B. For the purpose of electric Sub-station and line energization, renovation, up-gradation, modification, etc. outage may be required. As ready reference "REQUEST FOR OUTAGE" BREB Form No. 458, is enclosed below-

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 458

REQUEST FOR OUTAGE

Serial: Date:

1. To _____ AGM(O&M) of _____ PBS

2. Outage is requested for the following line section:
   a) Substation _____ b) Feeder: ----------
   c) From pole _____ to pole _____ including all laterals and taps in between these poles.
3. Outage requested on _____ From ____ Hrs to ____ Hrs.
4. Purpose:
5. Mr. _____ Having signature _____ is authorized to receive the outage and give clearance after completion of the work.

Requested by	Recommended by	Countersigned by
Contractor	SAE, BREB or AJE, PBS	AE/XEN, BREB or JE, PBS

6. Name & location of device by which the line section will be put out of service:

   Substation _____ Ckt. _____ Village ----------
   Name of equipment: ---------- Pole: ----------
7. Grounds required: 3φ / 1φ
8. No. of consumer affected (approximate)
   a) Domestic _____ b) Industrial ____ c) Agricultural ----------

   Approved by _____ AGM(O&M)

Clearance is hereby given for reenergization of the above line section with immediate effect.

Authorized signature _____ Date _____ Time

Copy to: JE, PBS/ AE of BREB(if applicable)/ Contractor or requesting person.

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2.0 SUBSTATION EQUIPMENT IDENTIFICATION

2.1 INTRODUCTION

To properly identify transformers and other equipment in each substation, a uniform numbering system shall be used. These numbers shall be installed in a conspicuous location on or near the transformer or equipment. This numbering system will help to assure correct switching in the substations. Single line diagrams of the substation showing these numbers shall be available at each substation. See Figures 2-1 to 2-3 and Table 2-1.

To properly identify transformer and other equipment phase designation, a uniform system of identification shall be used this identifying symbol shall be installed in a conspicuous location on the transformer or equipment. The phase identification system will help to assure correct transformer and equipment identification within the substation.

Some substations may not be equipped with an item of equipment listed in the procedures. If that be the case, proceed to the next line of the instructions.

2.1.1 Phase Identification of Single Phase Voltage Regulators

Each voltage regulator shall be identified by a color referenced phase-marking sign. The phase identification shall coincide with the transformer phase identification.

2.2 POWER TRANSFORMER IDENTIFICATION

Each single phase power transformer shall be identified by a color referenced phase-marking sign. Beginning from the 33 KV structure side the transformers will be numbered as follows:

No. 1, No. 2, No. 3, No. 4, No. 5 and No. 6

Each three-phase power transformer shall be assigned a number. The sign should, for example, read:

TRANSFORMER BANK NO. 1 and TRANSFORMER BANK NO. 2

For single phase Power Transformer, these numbers will be assigned only for presently on operation. That means no number will be assigned for spare. Assigned 1, 2 and 3 will represent virtually **TRANSFORMER BANK No. 1** and 4, 5, and 6 will represent **TRANSFORMER BANK No. 2.** When single phase power transformer is replaced by spare one, it will be designated by the number which was allocated for the replaced one.

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2.3 SWITCH NUMBERS

Disconnecting air break, and regulator bypass switches and reclosers shall be assigned a number and have a sign appropriately installed for identification.

2.3.1 An ACR/ OCR/ Breaker on the incoming 33KV circuit to the substation will be designated as Switch No. 99 (Figure 2-1 and Figure 2-2).

2.3.2 A numbering system utilizing three-digit numbers shall be assigned to switches associated with the transformer bank. The first digit in each case is the same as the transformer bank number subsequent digits identify the respective high voltage (99) and low voltage (66) circuit locations of the switches. (Figure 2-1)

TRANSFORMER BANK SWITCHES	SWITCH NUMBERS FOR BANK NO. 1	BANK NO. 2
First switchable device downstream of incoming feed	199	299
Second switchable device downstream of incoming feed	177	277
6.67/11.55 KV (low voltage) side switchable device	166	266

2.3.3 Two digit numbers shall be assigned to switches associated with three phase reclosers connected to the 11 KV **main bus**. (Figure 2-3)

RECLOSER SWITCHES	SWITCH NUMBERS	SWITCH NUMBERS for FEEDER ACR/OCR
SOURCE SIDE DISCONNECT SWITCHES	82	A2, B2, C2, etc.
LOAD SIDE DISCONNECT SWITCHES	84	A4, B4, C4, etc.
THREE PHASE ACR/ OCR/ Breaker	86	A6, B6, C6, etc.
BY-PASS DISCONNECT SWITCHES	88	A8, B8, C8, etc.

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2.3.4 Two digit numbers shall be assigned to switches associated with single phase Voltage Regulators connected to the 11 KV MAIN Bus. (Figure 2-1 and 2-3)

In the event that all three of the above switches are replaced with one sequenced Bypass/Disconnect switch, than it will be designated as switch no. 79. (see Figure 2-2)

VOLTAGE REGULATOR SWITCHES	**SWITCH NUMBERS**
SOURCE SIDE DISCONNECT SWITCHES	72
LOAD SIDE DISCONNECT SWITCHES	74
BY-PASS DISCONNECT SWITCHES	78
COMBINED DISCONNECT & BYPASS SWITCHES	79

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2.4 Single Line Schematic Diagrams

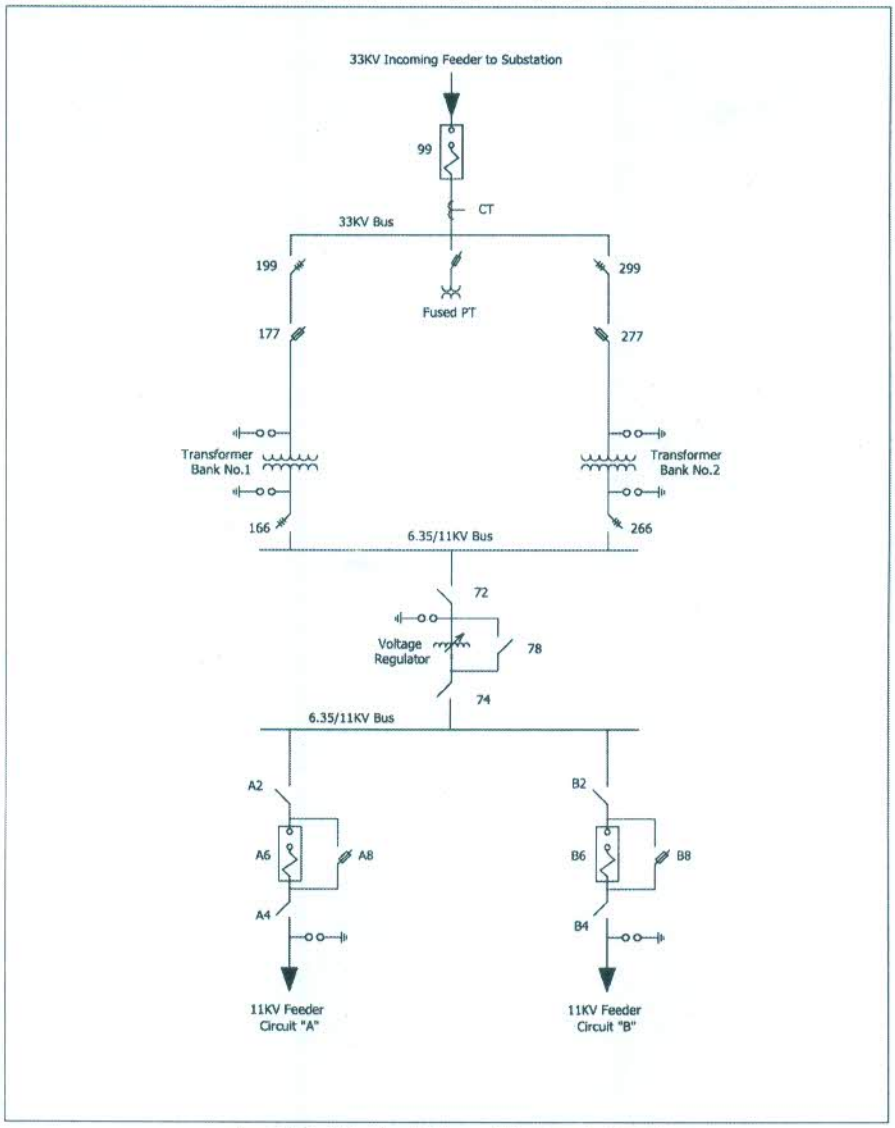

Figure 2-1: Single Line Schematic Diagram of 2 Transformer Bank Substation

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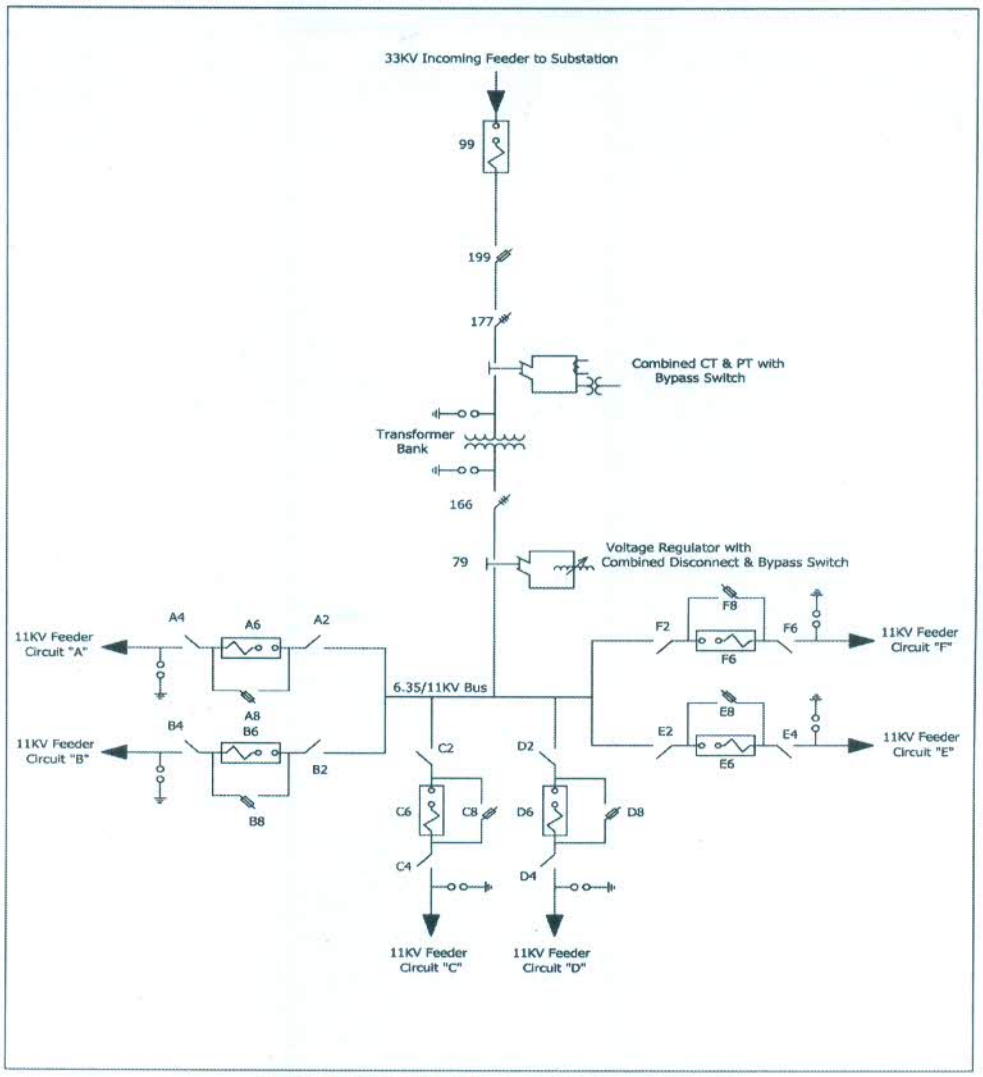

Figure 2-2: Single Line Schematic Diagram of 1 Transformer Bank Substation

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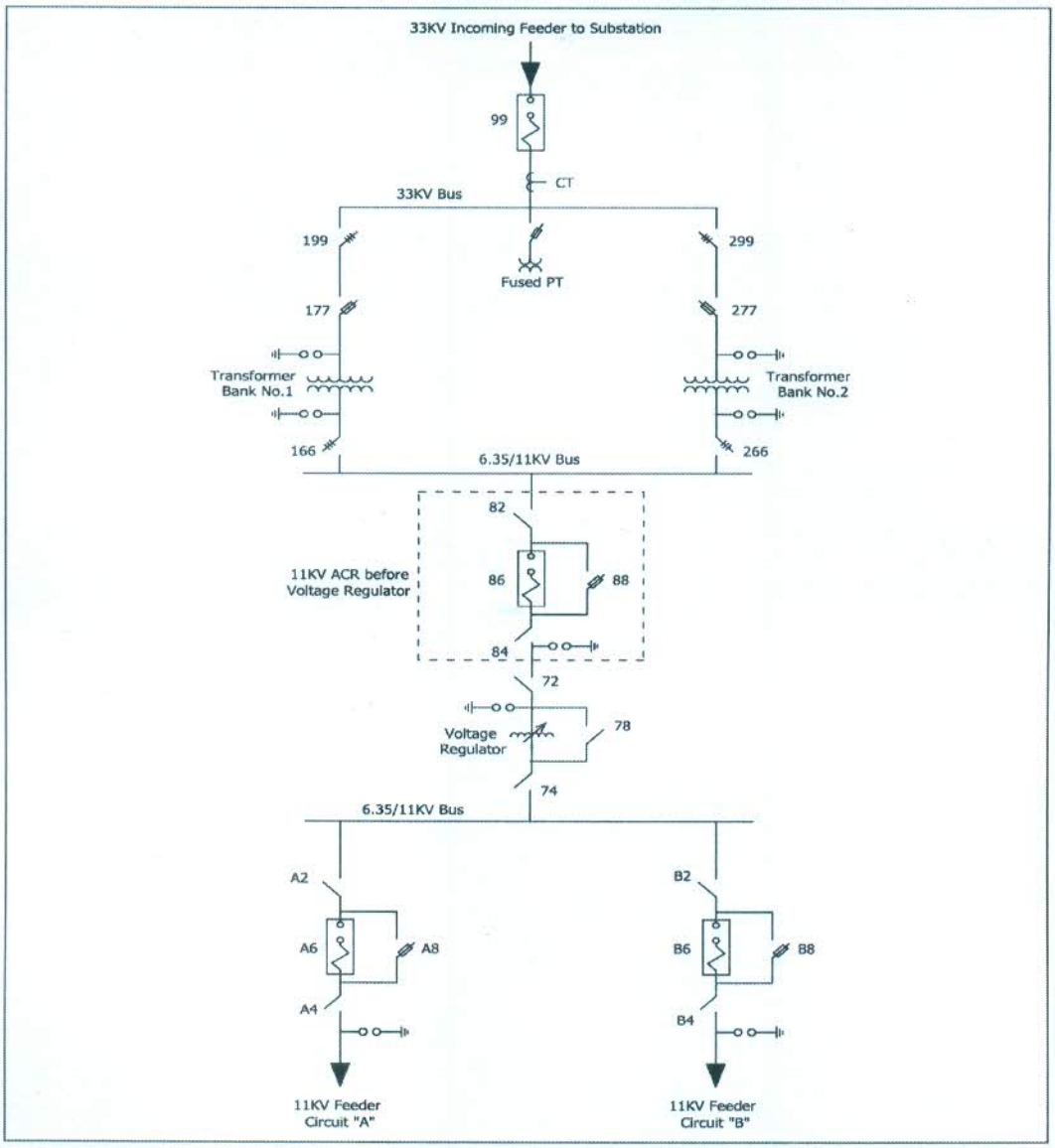

Figure 2-3: Single Line Schematic Diagram of 2 Transformer Bank Substation with 11KV ACR before Voltage Regulator

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2.5 Symbols for Single Line Diagram

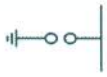
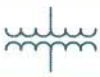
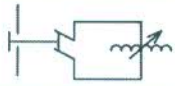
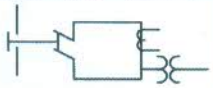
	HV Air Break Switch (3-pole)
	Fuse Switch (1-pole)
	Fused PT
	Surge (Lightning) Arrester
	Disconnect Switch (1-pole)
	Power Transformer
	Station Power Transformer
	Automatic Circuit Recloser
	Voltage Regulator with Combined Disconnect & Bypass Switch
	Current Transformer
	Shunt Capacitor
	Combined Current and Potential Transformer with Bypass Switch

Table 2-1: Symbols for Single Line Diagram

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3.0 CONNECTING EQUIPMENT INTO AND REMOVING EQUIPMENT FROM SERVICE

3.1 GENERAL

Before operating any equipment in a substation, all personnel involved in the installation, operation or maintenance should be thoroughly familiar with the equipment in the substation. The manufacturer catalogue data and maintenance and operation bulletins are excellent sources of information and description of the equipment. A list of reference material on the equipment used in substations is given in SECTION 23 - REFERENCE MATERIAL.

3.2 PRECAUTIONS

Only authorized personnel with wearing approved necessary safety tools, such as Safety Hat, Safety Boot, Rubber Gloves with Protectors, Switch Stick of proper voltage level etc. and assigned uniform are permitted to enter within the substation area.

When equipment is first energized or placed in service, pay particular attention to the following:

1. Be alert for equipment malfunction or failure. Only those personnel directly involved in energizing procedures shall be permitted to stay in the immediate area. All other personnel should go to a protected location at a safe distance from the equipment being energized.
2. If oil-filled equipment has been in storage for an extended length of time, a dielectric strength test shall be made on the oil. If the oil tests below 30 KV for 2.54mm gap, filter the oil. Reference ASTM D 877 may be consulted. See oil testing table for guidelines on acceptable levels.
3. Visually inspect the equipment for physical damage and oil leaks. Carefully check the bushings and other attachments to the equipment. Check all connections including the tank grounding connection. Check for proper oil level and correct position or settings of all adjustable components such as tap changers and control devices.
4. Operate power transformer and voltage regulator at no load initially and gradually raise load as recommended by manufacturer.

3.3 SWITCHING PROCEDURES

The following procedures are recommended for connecting or removing substation

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equipment to or from service. these procedures shall be performed only in accordance with approved switching orders and with proper switch tagging at each step of the procedure. Also refer to manufacture's instruction bulletins covering installation and operating instructions for the equipment.

Some substations may not be equipped with all the equipment listed in the switching procedures. If that is the case, proceed to the next line of instructions.

3.3.1 TRANSFORMER BANKS

The following procedures shall be used to connect or remove one or two transformer banks in substations.

(A) To Connect/ Energize-

1. To energize one transformer bank in a single transformer bank substation, proceed as follows: (Use Figure 2-2 for numbering references)
    1. Verify as open or switch open all of the distribution circuit ACR/ OCR/ Breakers A-6, B-6, etc.
    2. Verify as open or switch open the three phase ACR/ OCR/ Breaker No. 99. Set it for non-automatic operation.
    3. Verify as open or switch open the 199 high voltage air-break switch and No. 166 low voltage disconnect switch.
    4. Close the transformer fuses.
    5. Close the No. 79 CT/ PT by pass switch.
    6. Close the No. 199 high voltage air-break switch.
    7. Close the No. 166 low voltage disconnect switch to energize the low voltage bus.
    8. Close the 3-phase No. 99 ACR/ OCR/ Breaker. Set it for automatic operation.
    9. Close the feeder ACR/ OCR/ Breakers.
2. To energize two transformer banks in a two transformer bank substation, proceed as follow:

    (Use Figure 2-1 and 2-3 for numbering references. this assumes that transformer No. 1 bank will be energized first.

    1. Verify tap setting on high voltage no-load tap changers to be set alike on the two transformer banks

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2. Verify as open or switch open all of the distribution ACR/ OCR/ Breakers A-6, B-6, etc.,
3. Verify as open or switch open the three phase No. 99 ACR/ OCR/ Breakers and set it for non-automatic operation.
4. Verify as open the No. 199 and 299 high voltage air-break switches and the No. 166 and 266 low voltage disconnect switch.
5. Close the transformer fuses on transformer Bank No. 1 and transformer bank No. 2
6. Close the No. 199 high voltage air-break switch.
7. Close the No. 299 high voltage air-break switch.
8. Close the No. 166 low voltage horn gap disconnect switch to energize the low voltage bus.
9. To pick up load on the substation, proceed with closing the 3-phase No. 99 recloser. Set it for automatic operation.
10. Close the feeder ACR/ OCR/ Breaker.
11. Close the No. 266 low voltage disconnects switch. This will connect the two transformer banks in parallel.

(B) To Remove/ De-Energize

1. To remove a single transformer bank from service in a single transformer bank substation, proceed as follows: (Use Figure 2-2 for numbering references)
    1. Open all of the distribution circuit single phase oil circuit reclosers No. A-6, B-6, etc.
    2. Open the three phase No. 99 ACR/ OCR/ Breaker and set it for non-automatic operation.
    3. Open the No. 166 low voltage disconnect switch.
    4. Open the No. 199 high voltage air-break switch.
2. To remove one transformer bank in a two transformer bank substation, proceeds as follows (assume transformer No.1.Bank is to be taken out of service Use Figures 2-1 and 2-3 for numbering references.)
    1. Check load on substation to ensure that the remaining No. 2 transformer

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bank is adequate to supply the load.

2. Open the No. 166 low voltage disconnect switch.
3. Open the No. 199 high voltage air-break switch.

3.3.2 CIRCUIT RECLOSER/ BREAKERS (ACR/ OCR/ BREAKER)

Three single ACR/ OCR/ Breakers or one three phase ACR/ OCR/ Breaker per distribution circuit will be installed. These ACR/ OCR/ Breakers will be installed on the substation distribution feeder exits. One three phase oil or SF6 circuit recloser may be installed on the 33KV incoming source feeder positioned in or just outside of the substations. These three phase ACR/ OCR/ Breakers are installed to provide protection against faults (1) in the regulators and transformers,(2) on the 11 KV bus and (3) in other switches and equipment installed on the load side of the 11 KV portion in the substation.

CAUTION - BEFORE ATTEMPTING TO ENERGIZE AN ACR, CHECK TO BE SURE THAT ALL THREE SOURCE PHASES ARE ENERGIZED UP TO THE ACR.

Note: Some substations may not be equipped with all the equipment listed in the switching procedure. If that is the case, proceed to the next line of instructions.

A. To disconnect and connect a three phase No. 99 ACR/ OCR/ Breaker (for replacement), proceed as follows (Use Figure 2-1 or 2-2 for numbering references)

1. Verify as open or switch open all of the distribution circuit ACR/ OCR/ Breaker's No. A-6, B-6 etc.
2. Open, lock and tag open switch no. 166
3. Open lock and tag open switch No. 199
4. Verify that the ACR/ OCR/ Breaker source is de-energized on all three phases. This may be done by checking with phasing sticks or a high voltage detector. Tag and verify the source air break is locked and tagged open.
5. Remove and replace the ACR/ OCR/ Breaker as required
6. Remove lock and tags from source air break switch and close. (Note the line is now energized to the No. 99 ACR/ OCR/ Breaker) Verify with the ACR control or high voltage detector that all three phase's are energized.
7. Remove lock and tags from No. 199 and close
8. Remove lock and tags from switch no. 166 and close

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9. Close all of the distribution circuit ACR/ OCR/ Breakers (No. A-6, B-6 etc.)

10. Set ACR No. 99 for automatic operation.

B. To connect a feeder oil circuit recloser (assume "A" feeder is to be connected) proceed as follows (Use Figure 2-2 and Table 2-1 for numbering.)

1. Check each ACR/ OCR/ Breaker No. A - 6 operating handle in open (down) position.
2. Check source side isolating disconnect switches No. A-2 and load side isolating disconnect switches No. A-4 in the open position.
3. Check that bypass switch A-8 is in the open position.
4. Close the source side isolating disconnect switches No. A-2.
5. Close the load side isolating disconnect switches No. A-4.
6. Close each ACR/ OCR/ Breaker No. A-6 by closing from control cabinet or pushing the operating handle up when there is no electronic control.

C. To remove ACRs from service (assume "A" feeder recloser (s) are to be removed from service) proceed as follows: (Use Figure 2-2 and Table 2-1 for numbering references

1. Close fused bypass switch A-8.
2. Open ACR/ OCR/ Breaker No. A-6 by operating control handle.
3. Open the load side isolating disconnect switches No. A-4.
4. Open the source side isolating disconnect switches No. A-2.

3.3.3 SINGLE-PHASE STEP-TYPE VOLTAGE REGULATORS

A. To connect a single phase step-type voltage regulator into service, proceed as follows (Use Figures 2-1 and 2-3 for numbering references):

*** For substations with three bypass switches (No. 72, No. 74, and No. 78)

1. Check to see that the bypass switch No. 78 is closed and that the source and load side disconnects No. 72 and 74 are open.

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2. Make the required settings on the controls (voltage level, bandwidth, time delay, line drop compensation and range of tap-changer travel).

3. Close the source side isolating disconnect switches No. 72.

4. Place the power supply switch on INTERNAL.

5. Energize the control panel (i.e. Close the control power circuit breaker, close potential switch).

6. Manually operate the control switch to raise or lower to operate the tap changing mechanism to neutral position (position "0") as shown on the position indicator. When the neutral position lamp mounted on the control panel lights, return this control switch to the 'OFF' position.

7. De-energize the control panel. (i.e. open the circuit breaker, open the potential switch).

8. Close load side isolating disconnect switch No. 74.

9. Open bypass switch No. 78.

10. Visually check the voltage level, bandwidth, time-delay, and line drop compensation setting and reset if necessary.

11. Energize the control panel.

12. Place the control switch in the 'Auto' position. The above procedure is for the three disconnect switch type installation.

*** If a single combined operation disconnect and bypass switch unit is used, the above procedure must be altered accordingly by placing the tap changing mechanism on neutral with external control power and then operating the switch unit to accomplish energizing, load pickup and removing bypass combination switch No. 79 is installed. (Use Figures 2-2 for numbering references):

1. Check to see that switch No. 79 is open.

2. Make the required settings on the controls (Voltage level, bandwidth, time delay, line drop compensation and range of tap-changer travel).

3. Connect an external source to the control panel.

4. Place the power supply switch on EXTERNAL.

5. Energize the control panel (i.e. close the control power circuit breaker,

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close potential switch).

6. Manually operate the control switch to raise or lower to operate the tap - changing mechanism to neutral position (position "0") as show on the position indicator. When the neutral position lamp mounted on the control panel lights, return this control switch to the 'off' position.

7. De-energize the control panel. (i.e. open the circuit breaker, open the potential switch).

8. Close the No. 79 combination bypass switch.

9. Visually check the voltage level, bandwidth, time-delay, and line drop compensation setting and rest if necessary.

10. Energize the control panel.

11. Place the control switch in the 'Auto' position. The above procedure is for the combined disconnect and bypass switch type installation.

B. TO REMOVE SINGLE PHASE STEP-TYPE REGULATORS FROM SERVICE proceed as follows (Use Figure 2-1 and 2-3 for numbering references):

WARNING- AN ENERGIZED REGULATOR MUST BE IN THE NEUTRAL POSITION BEFORE BYPASSING IS ATTEMPTED. BYPASSING A REGULATOR OFF NEUTRAL WILL SHORT PART OF THE SERIES WINDING AND BE VERY HAZARDOUS BOTH TO THE LINEMAN AND THE REGULATOR.

1. Manually operate the control switch to run the regulator tap-changing mechanism to neutral position (Position "0"). This is accomplished by adjusting the control switch to raise or lower the regulator position. The neutral position lamp will light on the control panel. Return the control switch to the `off' position.

2. De-energize the control panel.

*** The below procedure is for <u>three</u> disconnect switches.

3a. Close bypass switch No. 78.

4a. Open source side isolating disconnect switch No.72.

CAUTION: IT IS PREFERRED TO USE A LOAD BUSTER TOOL ON THE DISCONNECT.

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5a. Open load side disconnect switch No. 74.

The above procedure is for three disconnect switch type installations.

*** If a single combined operation disconnect and by pass switch unit is used the above bypass and disconnect switch operations will be accomplished simultaneously in a single switching operation.

5b. Open the combination bypass switch No. 79.

CAUTION: Be sure the voltage regulator is in the Neutral Position and the Auto-Manual Switch on the control panel is in MANUAL before opening switch No. 79.

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4.0 SUBSTATION OPERATING PRACTICES

4.1 GENERAL

The prime responsibility for operating the substation and its installed equipment correctly and safely will be assigned/ delegated to the Assistant General Manager of Construction, Operation and Maintenance in each PBS area.

Many accidents occur in substations due to misinterpretation of instructions, carelessness or negligence on the part of someone. All personnel involved in any work assignment in a substation must be made aware of the potential hazards that exist and be thoroughly familiar with their work assignment by doing a "tail gate" walk around with everyone that is going to work in the substation. During this "tailgate" the responsible person who will act as foreman or supervisor will point out the visible opens, install all the personal protective grounds, indicate where the safe work area is located, and clearly describe the work to be done.

4.2 SAFE PRACTICE RULES

The following rules must be adhered to:

1. No equipment, bus or apparatus is to be considered safe to work on unless it is de-energized with a visible open and properly grounded. Temporary grounds shall be used to provide protection to workmen.
2. Do not touch any bus, wires or apparatus until you know it is safe to do so.
3. Each employee must accept responsibility to perform the job safely and to the best of his/ her ability to ensure that he/ she and his/ her fellow employees are not subjected to unnecessary risk.

4.3 SWITCHING AND TAGGING ORDERS AND PROCEDURES

Except in an emergency when life, property or the continuity of service is in jeopardy, any switching order received by an operator shall be written on the Switching and Tagging order Form (see Exhibit 4-1) before switching begins.

1. If it is necessary to give a switching order by wireless or telephone, the instructions must immediately be written (to confirm the oral instructions) on the form BREB Form No. 450. After completion of this confirming written instruction, it shall be read back to the person giving the instructions to minimize mistakes and misinterpretations.
2. Each operation to be performed will be shown on a separate line on the form. The person for whom equipment is to be tagged must be clearly noted on the form.
3. Should there be any questions regarding a switching order, the questions must be

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discussed and resolved with the person who gave the order. A complete understanding must be reached before the ordered switching is performed. If the person performing the switching realizes or believes that there is an error in the written switching and tagging order, it is his responsibility to discuss the apparent error with the person who gave the switching order for clarification and/or correction, prior to performing the switching.

4. The order or sequence of switching operations specified in the switching and tagging order shall be followed in the sequence given. When a switching sequence is interrupted and resumed later, each step must be reviewed from the beginning of the sequence to ensure that the complete and proper sequence is followed without omissions or deviations. (See Exhibit 4-2 which shows typical example of a switching and Tagging Order.)

5. The person performing switching should enter a statement in the substation logbook identifying the switching performed and the equipment out of service, if any, after tagging and switching is completed.

   In an emergency, when life, property, or the continuity of service is in jeopardy, the necessary switching can be permitted prior to writing a switching and tagging order. Immediately after performing this switching, a Switching and Tagging Order (S) must be written.

6. The nine basic steps to be followed in switching and tagging are:

   a. Receive order (written or verbal).

   b. Repeat verbal order for verification (if given on wireless or telephone or in person at the site.)

   c. Fill out switching and tagging order Form No. 100-29-13 according to the instructions under Section 4.4.

   d. Fill out tags (see following paragraph)

   e. Perform switching.

   f. Place tags (see following paragraph)

   g. Log equipment tagged.

   h. Notify person (s) of clearance limits.

   i. Notify person that ordered switching that switching and tagging is complete.

7. The Red Workman's Protective Tag, as described under Section 4.5 must be properly

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filled out and hung or placed on switches or other controls (as required) to:

(1) Warn against operation of tagged device and thus avoid accidents or harm to workmen due to erroneous switches.

(2) Avoid damage to substation equipment. The tag signifies that the equipment upon which the tag is placed is not to be moved in any way.

It means "Hands Off" as if there were a physical barrier around it. workmen shall not work on equipment unless the red workmen's protective Tags are in place at appropriate locations to prevent accidentally energizing the equipment being worked on.

This tag may be placed upon authorization of the AGM (O&M). After the tag has been placed, the person for whom the equipment is tagged must receive "Working Clearance" from the authority that ordered the protective tag placed.

When a workman's Protective tag is placed on switches or other devices, it defines the limits of "Working Clearance." The switches (or devices) where the tag is placed are not included in the working clearance limits and special permission must be obtained from the AGM(O&M) before, work can be permitted on the de-energized portion of any tagged switch.

An example of a workman's Protective tag form 451 that would be placed on the No. 82 Switch and tagged for A. RAHIM is shown on page 100-29-4-11. On single blade disconnect switches that are operated with a hot stick, the Workman's Protective tag is placed on the blade of the switch. On group-operated disconnect switches or air-break switches, place the workman's Protective tag on the operating handle.

On group operated switches, check to make sure all phases are open before tagging the switch.

Occasionally, Workman's Protective tags are missing from equipment after being properly placed. Do not operate a switch without first checking the logbook in the substation and obtaining proper switching authorization from the AGM(O&M). The Workman's protective Tag should not be removed unless:

(1) All men and equipment are in the clear of the equipment that was tagged out of service,

(2) All temporary grounds are removed, and

(3) The equipment is ready for service.

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The man for whom the equipment is tagged must release or give up his clearance and state that "all men and equipment are in the clear all temporary grounds have been removed, and the equipment is ready for service." Only then can the person that ordered the equipment out of the service initiate an order too restore the equipment to service. When work is completed and switches are again closed, visually check to ensure that all phases have closed properly.

8. **Caution Tags** are used for numerous applications on the electric system. The Caution Tag is described in section 4.6. It is not to be used in place of a Workman's Protective Tag but can be used to tag equipment or switches that are not to be operated for some reason.

   Again, these Caution Tags must be filled in, to properly communicate:

   (1) What equipment is being tagged,

   (2) The reason the tag is placed,

   (3) Special instructions,

   (4) Other data stating who placed and removed the tag, associated dates, etc.

This tag should be placed on the center switch of a single pole three phase switching point or on the operating handle of a group-operated switch. (Refer to Figures 2.-.1, 2-2 and 2-3 for switch identification numbers)

For Bus ACR/ OCR/ Breaker

99	-	Operating lever isolating disconnect switches.
88	-	Bypass disconnect switches
82	-	Source side isolating disconnect switches
84	-	Load side isolating disconnect switches

For Feeder ACR/ OCR/ Breaker

A-6 or B6	-	Operating handle of feeder ACR
A-2 or B2	-	Source side isolating disconnect switch
A4 or B4	-	Load side isolating disconnect switches

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A8 or B8 - Bypass disconnect switches.

For Voltage Regulator

72 - Source side switch

74 - Load side switch

78 - Bypass switch

79 - Bypass disconnect Combined switch.
(Combination Bypass switch)

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4.4 INSTRUCTIONS FOR COMPLETING THE SWITCHING AND TAGGING ORDER

4.4.1 GENERAL INSTRUCTIONS

1. Errors in writing switching and tagging orders must not be erased nor shall any inserts be made. Cross off the errors and make the necessary corrections or void the order and rewrite a superseding order completely.
2. PRINT (write with discrete, clear letters) all information on the switching and tagging order.
3. It is the responsibility of the person performing the switching and tagging to ensure correctness before starting to switch. Discuss any apparent or obvious errors with the person issuing the order.

4.4.2 Information to be Filled Out at Top of the Order

1. SUBSTATION: The correct and complete name of the substation
2. ORDER GIVEN: Name and title of person giving the order
3. DATE GIVEN: The day, month and year order was given
4. TIME GIVEN: The time order was given (use 24-hour clock time)
5. ORDER WRITTEN BY: The name of the person who receives or writes the order.
6. CARRIED OUT BY: The name of the person that performs the switching and tagging
7. APPROVED BY: This space should be initialed by the person responsible for the substation operation.
8. DATE STARTED: Day, month, and year order was started.
9. TIME STARTED: Time order was started (use 24-hour clock time)
10. DATE COMPLETED: Day, month and year order was completed
11. TIME COMPLETED: Time order was completed (use 24-hour clock time)
12. PURPOSE: Brief purpose of the order.

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BANGLADESH RURAL ELECTRIFICATION BOARD

BREB Form No. 100-29-12(Version-1) **Exhibit 4-1**

SWITCHING AND TAGGING ORDER

SUBSTATION .....DATA GIVEN .....

ORDER GIVEN BY .....TIME GIVEN.....

ORDER WRITTEN BY.....

CARRIED OUT BY .....APPROVED BY .....

DATA STARTED .....DATE COMPLETED.....

TIME STARTED .....TIME COMPLETED.....

PURPOSE

.....

Switch No.	

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BREB Form No. 100-29-12(Version-1) **Exhibit 4-2**

(EXAMPLE)

SWITCHING AND TAGGING ORDER

SUBSTATION KALIAKOIR **DATA GIVEN** 24-10-87

ORDER GIVEN BY A. RAHIM **TIME GIVEN** 13:30

ORDER WRITTEN BY K. RAHMAN

CARRIED OUT BY N. ISLAM **APPROVED BY** MD.R.S.

DATA STARTED 24-10-87 **DATE COMPLETED** 24-1087

TIME STARTED 14:00 **TIME COMPLETED** 15:00

PURPOSE Replace busing on regulator by-pass switch

SWITCH NO.	
A-6	Open ACR/ OCR/ Breaker 'A-Bay'
A-2	Open ACR/ OCR/ Breaker Disconnects
B-6	Open ACR/ OCR/ Breaker 'B-Bay
B-2	Open ACR/ OCR/ Breaker Disconnects
C-6	Open ACR/ OCR/ Breaker 'C-Bay'
C-2	Open ACR/ OCR/ Breaker Disconnects
D-6	Open ACR/ OCR/ Breaker 'D-Bay'
D-2	Open ACR/ OCR/ Breaker Disconnects
86	Open three Phase ACR/ OCR/ Breaker
166	Open 11 KV Air Break Switch
	Install Protective Grounds

Note: Refer to Figure 2-3 for switch identification numbers.

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4.5 INSTRUCTIONS FOR COMPLETING WORKMAN'S PROTECTIVE TAG

THIS TAG SHALL BE USED ONLY FOR WORKMAN'S PROTECTION (To Prohibit Erroneous Switching, etc.)

This **red colored** tag, properly filled out, is to be placed on each switch or its disconnects controlling a line or circuit.

A separate tag must be placed on each switch for each man who is to be in charge of work.

No tag shall be removed until orders to do so are received from the same authority that ordered the tag placed.

No switch or other device, on which a tag has been placed, shall be operated until all tags have been removed. When this tag has been removed and completely filled out, send it to the PBS Headquarters where it shall be preserved for three months, before destroying.

The following information must be printed in the spaces provided on the Workman's Protective Tag:

1. **Tagged for**: This must be the man in direct charge of the work to be done. PRINT the man's initials and fill last name on this line.
2. **Sub-station or Switching Point:** The correct name of the substation or the switching point must be printed here and if space permits, the location.
3. **Equipment Out of Service:** PRINT the name and number (or letter) by which the equipment taken out of service is designated and include any other description necessary to identify the equipment.
4. SWITCH OR DEVICE TAGGED: PRINT the switch or device tagged. Use the switch number and device name or other identification of the switch or device upon which this tag is placed. Use the appropriate number for the substation switches as described in Section 2.
5. **Tag Order Given by:** PRINT the title, initials and name of the person who ordered to place the tag. NOTE: If a person orders the tag to be placed, the same person must authorize the removal of the tag. EXCEPTION: A person of the same official capacity can order the tag removed.
6. **Tagged by:** On this line, print the initials and last name of the man who actually places the tag.
7. **Date and Time of Tag Placed:** On this line print the date and time when the tag is placed.
8. **Tag Removal Order by:** Print the initials, name and title of the person who ordered to remove the tag.

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9. **Tag Removed by:** PRINT the initials and last name of the man who actually removed the tag.

10. **Date and Time of Tag Removed:** Print the date and time when the tag was removed. Return this tag to the AGM(O&M) Office at PBS Headquarters for filing. This tag may be destroyed after three months.

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Exhibit 4-3

WORKMAN'S PROTECTIVE TAG (RED)

BANGLADESH RURAL ELECTRIFICATION BOARD **BREB Form No. 100-29-13(Version-1)** **WORKMAN'S PROTECTIVE TAG**
TAGGED FOR (INITIAL AND NAME):
SUBSTATION OR SWITCHING POINT:
EQUIPMENT OUT OF SERVICE:
SWITCH OR DEVICE TAGGED:
TAG ORDER GIVEN BY:
TAGGED BY:
DATE AND TIME TAG PLACED:
TAG REMOVAL ORDERED BY:
TAG REMOVED BY:
DATE AND TIME TAG REMOVED:

- USE -

1. Heavy String
2. Punched Hole
3. Bright Red Color
4. Strong & thick paper

NOTE:
Provide a transparent plastic protective cover or envelop for this tag to protect it from the weather.

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Exhibit 4-4 (Filled-out example)

WORKMAN'S PROTECTIVE TAG (RED)

O
BANGLADESH RURAL ELECTRIFICATION BOARD **BREB Form No. 100-29-13(Version-1)** **WORKMAN'S PROTECTIVE TAG**
TAGGED FOR (INITIAL AND NAME): A. RAHIM
SUBSTATION OR SWITCHING POINT: SAVAR SUBSTATION
EQUIPMENT OUT OF SERVICE: THREE PHASE RECLOSER
SWITCH OR DEVICE TAGGED: NO. 82 DISCONNECT SWITCH
TAG ORDER GIVEN BY: AGM (O&M), DHAKA PBS I
TAGGED BY: A. HAKIM, LINEMAN
DATE AND TIME TAG PLACED: 22/11/1979 16:10 Hrs
TAG REMOVAL ORDERED BY: AGM (O&M), DHAKA PBS I
TAG REMOVED BY: KAMAL UDDIN, LINEMAN
DATE AND TIME TAG REMOVED: 25/11/1979, 09:00 Hrs

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4.6 INSTRUCTIONS FOR COMPLETING WORKMAN'S CAUTION TAG

Errors in writing CAUTION TAGS must not be erased nor shall any inserts be made. Cross off the errors and make the necessary corrections or void the tag and rewrite superseding tag completely.

4.6.1 **PRINT ALL INFORMATION** on the tag.

It is the responsibility of the person performing the tagging to ensure correctness before tagging the switch. Discuss any apparent or obvious errors with the person issuing the tag.

The following information must be printed in the spaces provided on the CAUTION TAG.

1. EQUIPMENT TAGGED: Give the name of the equipment and identifying information like phase, serial no., or type.
2. REASON TAGGED PLACED: Give a brief description of the reason for the `hold' status of the equipment.
3. SPECIAL INSTRUCTIONS: If necessary indicate what precaution or task involves the caution status.
4. TAG ORDER GIVEN BY: PRINT the title, initials and name of the person who ordered to place the tag. NOTE: If a person orders to place the tag, the same person must authorize to remove the tag. EXCEPTION: A person of the same official capacity can order the tag removed.
5. TAG PLACED BY: On this line, print the initials and last name of the man who actually places the tag.
6. DATE TAG PLACED: On this line print the date when the tag is placed.
7. TIME TAG PLACE: on this line print the time when the tag is placed (use Military time).
8. TAG REMOVAL ORDERED BY: Print the initials, name and title of the person who ordered the tag removed.
9. TAG REMOVED BY: PRINT the initials and last name of the man who actually removed the tag.
10. DATE REMOVED: Print the date when the tag was removed.

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11. TIME REMOVED: Print the time when the tag was removed.

Return this tag to the Assistant General Manager (CO&M) office at PBS Headquarters for filing. This tag may be destroyed after three months.

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Exhibit 4-5

WORKMAN'S CAUTION TAG (YELLOW)

BANGLADESH RURAL ELECTRIFICATION BOARD **BREB Form No. 100-29-14(Version-1)** **WORKMAN'S CAUTION TAG**
EQUIPMENT TAGGED:
REASON TAG PLACED:
SPECIAL INSTRUCTIONS:
TAG ORDER GIVEN BY:
TAG PLACED BY:
DATE TAG PLACED:
TIME TAG PLACED:
TAG REMOVAL ORDERED BY:
TAG REMOVED BY:
DATE TAG REMOVED:
TIME TAG REMOVED:
LOCATION:

USE

1. Heavy String
2. Punched Hole
3. Bright Yellow Color
4. Strong & thick

NOTE:
Provide a transparent plastic protective cover or envelop for this tag

NOTE: This tag is used to freeze an existing status for equipment or lines that are not to be physically or electrically operated. It is not intended to be used for a "Workman's Protective Tag."

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Exhibit 4-6 (Filled-out example)
(YELLOW)

BREB Form No. 100-29-14(Version-1) **WORKMAN'S CAUTION TAG**
EQUIPMENT TAGGED: 'Y' PHASE REGULATOR
REASON TAG PLACED: REGULATOR OVERLOADED
SPECIAL INSTRUCTIONS: DO NOT CHANGE SETTINGS
TAG ORDER GIVEN BY: A. RAHIM. AGM (C O & M)
TAG PLACED BY: A. HAKIM, LINEMAN
DATE TAG PLACED: 06/06/1987
TIME TAG PLACED: 10:00 Hrs
TAG REMOVAL ORDERED BY: A. RAHIM, AGM (O & M)
TAG REMOVED BY: KAMAL UDDIN, LINEMAN
DATE TAG REMOVED: 08/06/1987
TIME TAG REMOVED: 15:00 Hrs
LOCATION: BAGERHAT SUBSTATION

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5.0 EMERGENCY PROCEDURES

5.1 GENERAL

Emergencies may arise occasionally requiring quick action to prevent undue equipment damage, or to protect the public or employees. Careful prior thought and contingency planning must be given in regard to the actions to be taken in order to prevent excessive damage. Again, "Think then Switch"

5.2 EMERGENCY PLANS

Emergency plans for a substation depend on the type and magnitude of expected problems. The following considerations should be made before attempting to correct an emergency.

1. Stay calm. Maintain a positive attitude.
2. If the person designated to perform switching or other operating functions is not familiar with the substation, he/ she should review the substation single line diagram before performing emergency switching.
3. Perform the necessary switching to clear (de-energize) the distressed equipment.

The substation's emergency plans must be an integral part of the overall system emergency plan when system emergencies exist. (This topic will be further discussed. in the Distribution Operation Manual).

5.3 ABNORMAL SUBSTATION CONDITIONS

Substations may experience abnormal conditions at various times for various causes.

1. Violent failures, faults or excessive overload conditions: These cause an emergency condition in the substation. These conditions may cause severe damage to substation equipment. Depending upon the severity of the condition, the condition may warrant disconnecting the device(s) that are being overloaded or otherwise over-stressed until the condition that caused the problem can be corrected. Emergency switching procedures should be followed.
2. Moderate overload conditions: In case of moderate overload, where approximately normal voltage is maintained, indications of distress may be difficult to detect and an interruption of the power supply may not occur for an extended period of time or perhaps not at all. Careful observation of the meters in the substation and temperature indicators on equipment is recommended to ensure that the equipment is not being harmed by this overload condition. Normal or emergency switching procedures may be followed as determined necessary and appropriate.
3. Transmission line abnormal conditions: The existence of transmission line trouble such as broken or faulted conductors or insulators will be evident in the various substations. An

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operator may be able to obtain some idea of the kind of trouble affecting the substation voltages and/or currents and it may be necessary to disconnect equipment temporarily until the abnormal transmission line condition is corrected. Switching by either normal or emergency procedure should be followed as determined necessary from analysis of the transmission line trouble.

4. Bulletins on Emergency Procedures: From time to time BREB System Operations will issue Substation Emergency Procedure Bulletins. These bulletins will provide detailed actions to take for specific recurring emergencies that have been shared by various PBS's. These bulletins should be maintained in a readily accessible file of fastened loose-leaf pages and copies amended to this instruction as they are issued. Emergency Procedure bulletins are described in Sections 5.1, 5.2 & 5.3.

5.4 GUIDELINE TO ISOLATE AND RE-ENERGIZE THE SUBSTATION AFTER TRIPPING THE 33 KV INCOMING LINE

When there is complaint from the Power Supplier that the 33 KV line trips due to the presence of faults in the distribution system of PBS, the PBS Engineer should isolate and re-energize the sub-station according to the following procedure:

1. Immediately open: a) Isolator Switch No. 199 or ACR/ OCR/ Breaker No. 99
   b) Bus and Feeder ACR/ OCR/ Breakers
2. Request Power Supplier to 'SWITCH ON' the 33 KV line.
3. If the 33 KV line trips again, the fault is in the 33 KV line, then -
   a) Keep Isolator Switch No. 199 or ACR/ OCR/ Breaker No. 99 'OPEN'
   b) Request Power Supplier to remove the fault from the 33 KV line.
4. If the 33 KV line does not trip after its energization, there may be a fault in the PBS substation.
   a) Observe the readings of the pressure gauge, the winding temperature gauge, the oil temperature gauge and the oil level gauge attached to the power transformer body.
   b) Check for the presence of any visible external fault of the HT and LT bushings, lightning arrester vents, pressure relief device flag, oil from around the pressure relief device or grounds.
5. If any unusual condition is observed as mentioned above, immediately inform the System Operation Directorate.
6. If everything is 'NORMAL' as checked in step 4, then close Isolator Switch No. 199 or ACR/ OCR/ Breaker No. 99.
7. If the 33 KV line or ACR/ OCR/ Breaker No. 99 trips then -

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a) Immediately open the Isolator Switch No. 199 or ACR/ OCR/ Breaker No. 99

b) Again request BPDB/ Power provider to switch 'on' the 33 KV line.

c) Perform the Insulation Resistance Test on the transformers and regulators Communicate to the BREB System Operation Directorate and zonal Superintending Engineer all the details about the Insulation Resistance Test result, the pressure gauge reading, temperature readings of transformer winding and transformer oil and evidence of oil on the top of the transformers or regulators.

8. If the power transformer operates normally after closing the Isolator Switch No. 199 or ACR/ OCR/ Breaker No. 99 then -

a) Close Isolator switch 166 if opened previously

9. If the ACR/ OCR/ Breaker does not trip, it means that the voltage regulators are okay. If ACR/ OCR/ Breaker No. 99 trips, then the voltage regulators, bus, arresters, or one of the feeder ACRs is most likely faulty.

a) Take the necessary steps to determine the faulty piece of equipment then remove it from service.

b) Set the good regulators to the 'NEUTRAL' position if possible. If there is no power to the station then it will not be possible to run the regulators to the neutral position until a separate power source is brought in. DO NOT BYPASS THE REGULATORS until they can be put to the neutral position or they can be re-energized with the switches in the normal in-service position.

c) Immediately inform the BREB System Operation Directorate and zonal Superintending Engineer of the problem giving all relative details.

10. If after closing the source ACR/ OCR/ Breaker 99, the system does not show any fault, then energize the 11 KV feeders one by one. Consider the 33 KV fault as temporary.

5.5.1 GUIDELINE TO RE-ENERGIZE THE SUBSTATION AFTER THE FAILURE OF A LIGHTNING ARRESTER

Before re-energizing a substation where either the 11KV LT or 33KV HT lightning arrester has failed, the following steps are to be strictly observed.

1. Determine the reasons of the lightning arrester failure and contact the BREB System Operation Directorate and zonal Superintending Engineer.

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2. Check the HT and LT bushing connections, the grounding connections and all transformer gauges and pressure relief device.

3. Perform an insulation resistance test of the power transformers and lightning arresters.

4. If after thorough checking everything is found satisfactory, the damaged lightning arrester should be replaced.

5. Having changed the lightning arrester, obtain clearance from the System Operation Directorate to re-energize the substation.

*** NOTE - If an LT lightning arrester is not readily available, one 9 KV distribution lightning arresters may be installed as per Figure 5-1. Within a maximum of 7 (seven) days, the proper size station class lightning arrester must be installed.

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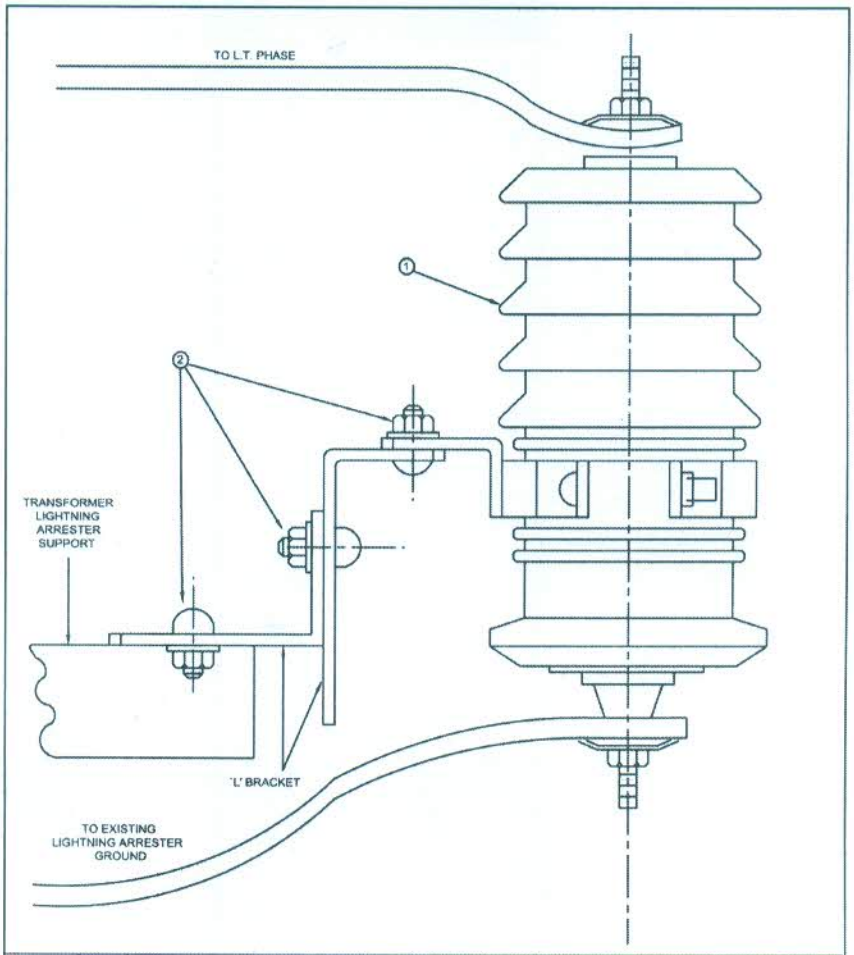

ITEM	NO.	MATERIAL	ITEM	NO.	MATERIAL
1	1	Lightning Arrester 9KV Distribution Class			
N/A	3	Parallel Groove Clamp (not shown)			
2	3	1/2" x 2" machine bolt			
		1/0 AWG Copper Conductor			

Figure 5-1

Emergency Lighting Arrester Substitution

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5.6 FAULT INDICATOR INSTRUCTIONS

5.6.1 General

Linam Type EHR automatic-reset fault indicators are magnetically tripped, electrostatically reset, and require no electrical connections. They are epoxy encapsulated and are completely waterproof and weatherproof. The trip level is factory calibrated and needs no further adjustment. The trip-current rating is printed on the indicator.

5.6.2 Operation

The trip circuit operates only when the line current exceeds the factory-set trip level of the indicator (within 10 percent). The indicator face shows all white in the un-tripped position; when tripped, the reflective red target rotates in view (Sub-figure 3 of Figure 5-3).

Resetting is automatically accomplished by the discharge of a capacitor through the reset coil. The capacitor is charged by the electrostatic voltage gradient between the line and a nearby ground plane. The indicator should be located near a ground plane to assure proper reset action. The indicator requires approximately a three-minute charging period after installation before it will operate correctly.

If current flow is interrupted (for example when an OCR opens due to a fault), the indicator target remains in the position it was in when current was interrupted. The target position cannot be mechanically changed due to a magnetic-balance principle.

Installation

1. Attach a shotgun-type switch stick to the indicator, using the installation eye on the indicator (Sub-figure 3 of Figure 5-3).
2. Position the indicator on the underside of the conductor (Sub-figure 1 of Figure 5-3).
3. Push the indicator onto the conductor with an upward - and slightly forward - motion. This causes the spring clamp to securely hold the cable against the indicator yoke(Sub-figure 2 of Figure 5-3).
4. Adjust the position of the indicator for maximum target visibility and remove the switch-stick (Figure 5-2).

5.6.3 Application

The automatic resetting fault indicators are to be used in substations where three-phase ACRs are the sectionalizing devices used for feeder protection. The use of the fault

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indicator will facilitate phase identification in the detection of single phase faults on the three phase feeders. The fault indicator should be placed on the horizontal bend or sweep of the load-side jumper between the ACR and load side disconnect switch (see Figure 5-2). This location will facilitate installation and reading of the indicator.

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Figure 5-2: Location of fixing Fault Indicator

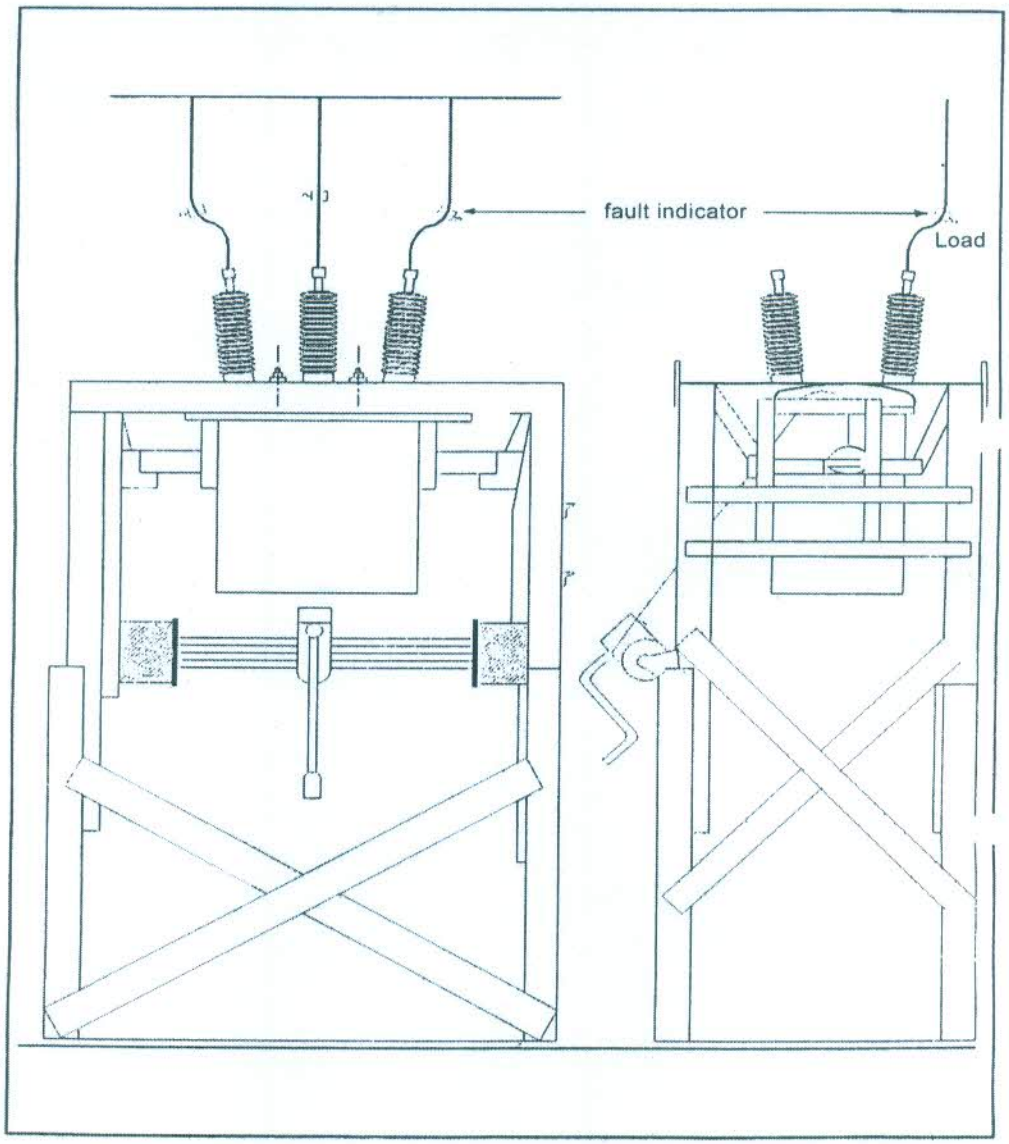

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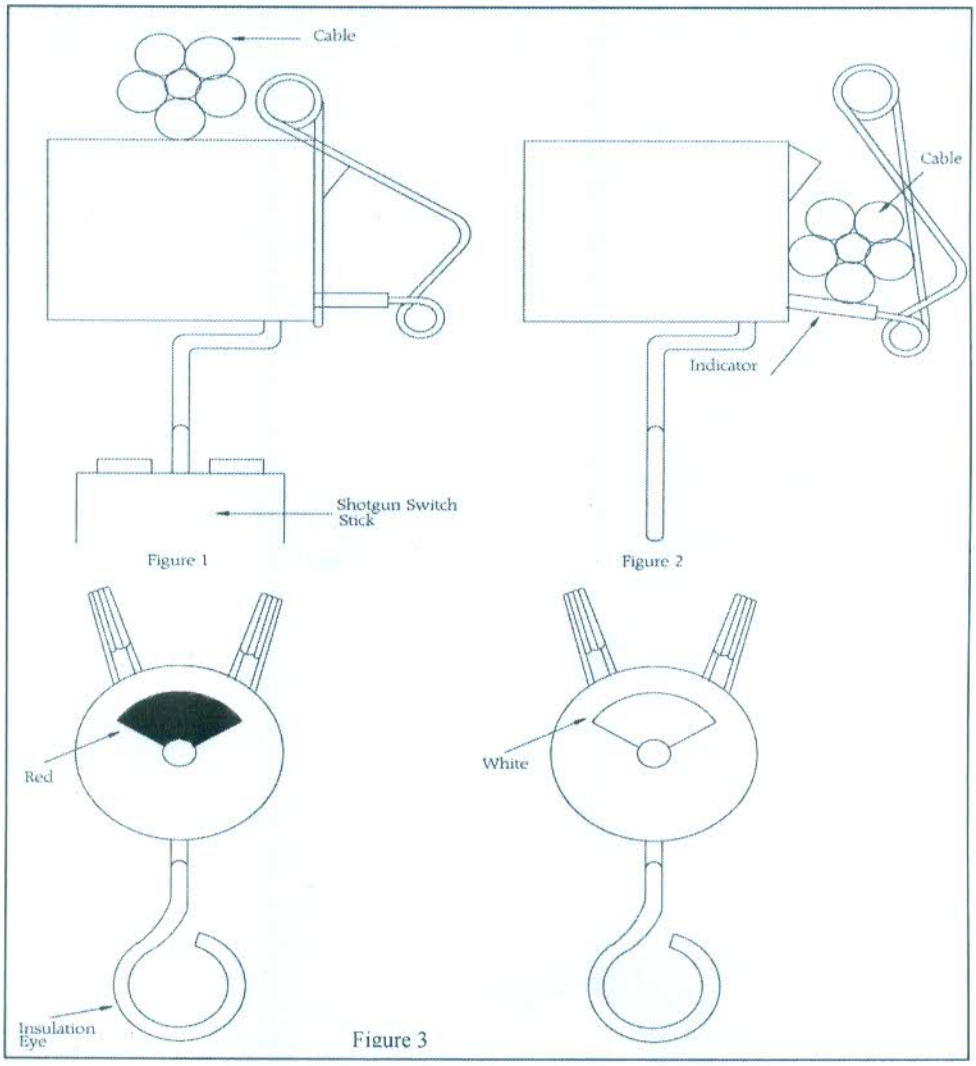
Figure 5-3: Fault Indicator Details



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6.0 GENERAL INFORMATION ON SUBSTATION INSPECTION & MAINTENANCE

6.1 SCOPE

This bulletin describes inspection and maintenance procedures for electric substations and the various items of equipment and apparatus installed in the substations.

A continuous program of preventive maintenance combined with periodic overhauling at regular intervals specified by the manufacturer and computerized maintenance management program, would prove to be the best for the various substations. This method consists of continually performing routine inspection, testing, adjustment and maintenance work to the important items of the equipment in a scheduled and organized manner so as to pay special attention to the equipment and to avoid outages caused by equipment failure. Maintenance is applied more specifically to the parts which are known to need repairs or replacement most often as determined from a computerized record system with inputs that are from routine maintenance, inspections and testing.

The underlying theory is that proper recording of inspections, testing, lubrication, adjustment and small repairs applied as required to the critical parts will make it less necessary to undertake complete periodic overhauls but will give the necessary alerts when major overhauls are needed to prevent a failure that leads to an outage.

Experience has shown that breakdowns are reduced, outages shortened or eliminated, and the necessity for periodic overhaul of equipment is lessened, when preventive maintenance is followed. The success of preventive maintenance will depend largely on an accurate recording system and operating personnel being alert for things which need attention, such as loose bolts, vibration, leaks, wear, unusual noise, odor, etc.

6.2 INSPECTIONS

Inspections should be performed systematically and at regular, scheduled intervals to ensure performance and completion of all necessary checks, observations and tests (see substation Inspection and Maintenance Schedule in Section 22: SUBSTATION INSPECTION AND MAINTENANCE FORMS). Records of inspections should be sufficiently detailed to adequately describe inspection, findings of the inspected equipment, work performed, test results and work to be performed at a later time as indicated to be necessary by inspection (see Substation Periodic Inspection Form 100-29-17 in Section-22 : SUBSTATION INSPECTION AND MAINTENANCE FORMS). All inspections should be made from

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ground level maintaining safety clearance as shown in Table 6-4. Binoculars should be used to view buses, isolators, insulators and other equipment.

6.3 OIL PHYSICAL TESTS

6.3.1 Introduction

Oil is used both as an electrical insulator and as a coolant. The ability of the oil to properly perform these two functions can be measured by the following set of physical and chemical tests. The tests are specified by the AS.T.M. (American Society of Testing and Materials) and are based on both field experience and technical understanding of those properties which are important to the insulating oil.

1. **Aniline Point**
   Method: ASTM D611
   New Oil Limit: 78°C max.
   Significance: This test relates to the solvency of the oil for materials which are in contact with it. The lower the aniline point, the more solvent the oil.

2. **Color**
   Method: ASTM D1500
   New Oil Limit: 0.5 max.
   Significance: The color generally indicates the degree of refinement for new oil and the amount of aging for old oil. Clear new oil is given a color index value of 0.0, while black oil has a color of 8.0. For in-service oils, an increasing or high color (3.0 or greater) indicates significant contamination or deterioration.

3. **Corrosive Sulfur**
   Method: ASTM D1275
   New Oil Limit: Non corrosive
   Significance: This test detects the presence of corrosive, sulfur-bearing compounds that can cause the corrosion of such metals as copper and silver.

4. **Dielectric Breakdown-DE Cell**
   Method: ASTM D877
   New Oil Limit: 30 KV min.
   Significance: The Dielectric Breakdown is the minimum voltage at which electrical flashover occurs between two flat electrodes 2.54mm apart. It is a measure of the ability of the oil to withstand electrical stress at power frequencies without breakdown. A low breakdown value is generally the result of contamination either by water, carbon or conducting particulates. The minimum breakdown voltage for in-service transformer oil is 26 KV.

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5. **Dielectric Breakdown-VDE Cell**

Method: ASTM D1816

New Oil Limit 28 KV min.

Significance: Similar to the above test, but uses spherical electrodes 0.04 inches (1mm) apart with the oil being stirred constantly during the test. This method is more sensitive in the detection of contamination products found in the oil. The minimum breakdown voltage for in-service transformer oils is 26 KV.

6. **Dissolved Gas Content**

Method: ASTM 831

New Oil Limit: 0.25% max.

Significance: The dissolved gas content is significant only for degassed oils. Oils not degassed and in contact with the air will have approximately a 10% by volume gas content. Dissolved gas results in a lowering of the dielectric strength of the oil which may be critical for high voltage conservator type transformers.

7. **Flash Point**

Method: ASTM D 92

New Oil Limit: 146°C min.

Significance: The flash point is the minimum temperature at which heated oil gives off a sufficient amount of vapor to form a flammable mixture with air. The test is a good detector of fuel oil contamination that may be encountered during shipping.

8. **Interfacial Tension**

Method: ASTM D971

New Oil Limit 40dynes/cm minimum

Significance: The interfacial tension is a measure of the surface tension of the oil at an oil-water interface. Contaminates like soap, paints, varnishes and oxidation products like sludge reduce the interfacial tension of the oil. For in-service oils, an interfacial tension value below 20 dynes/cm is an indication of sludge formation.

The interfacial tension can be improved through reclamation, a filtering process that removes the oxidation products of the oil

9. **Neutralization Number**

Method: ASTM D 974

New Oil Limit: 0.025 mg KOH/gram of oil

Significance: The neutralization number or acid number is a measure of the

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amount of acids in the oil. The number is found by measuring the amount of potassium hydroxide (KOH), a base, it takes to neutralize the acid in the oil. As oils age, the acidity and therefore the neutralization number increases as a result of oxidation. This acid acts on the cellulose insulation resulting in a reduction in its mechanical and dielectric strength.

For in-service oils, a neutralization number of greater than 0.25 mg KOH/gram of oil indicates that severe aging of the oil and insulation have taken place.

The neutralization number can be reduced by reclamation, a filtering process that removes the oxidation products of the oil.

10. Oxidation Inhibitor Content

Method: ASTM D1473 or D2668
New Oil Limit: 0.3% by weight Maximum
Significance: Oxidation inhibitor, normally D.B.P.C. (2, 6-ditertiary butyl-paracresol) is added to oil to help it resist oxidation. The oil is called "inhibited oil", and the test determines the amount of D.B.P.C. added to the oil.

Due to changes in the availability of certain types of crude oil stocks, the natural oxidation inhibitors found in much of today's insulating oils is not as effective as in previous types. The addition of D.B.P.C. is becoming a common option to make up for this deficiency

11. Oxidation Stability

Method: ASTM D2440

A. New uninhibited oil limit 72 hrs. max. sludge - 0.15% by mass
   Max. neutralization number 0.5
B. New inhibited oil limits,72 hrs. max. sludge - 0.1% by mass
   Max. neutralization number 0.3

Significance: This test assesses the oxidation resistance of the oil by measuring the amount of sludge and acid formed when the oil is subjected to a high temperature and exposed to large quantities of oxygen. Oils which meet or exceed the requirements tend to preserve the oil-cellulose insulation systems and exhibit good heat transfer characteristics.

12. Pour Point

Method: ASTM D97
New Oil Limit: (-40°C) max.
Significance: The pour point is the temperature at which the oil will just flow (like honey). A low pour point ensures that the oil will circulate and provide proper cooling and insulation in cold climates.

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13. Power Factor

Method: ASTM D924
New Oil Limit @25°C: 0.01% max.
@100 C: 2.99%.
Significance: A high power factor can indicate the presence of water, carbon, metallic soaps and other conducting materials in the oil.

14. Specific Gravity

Method: ASTM 01288
New Oil Limit: 0.910 max.
Significance: The specific gravity is the relative density of oil to water. In cold climates a high specific gravity (0.95 or more) can result in the floating of ice on the oil leading to possible flashover.

15. Viscosity at 40°C

Method: ASTM D445, D2161, D88 or D2161
New Oil Limit Max: 11 Centistokes
Significance: The viscosity is a measure of the oils resistance to flow and is an important factor in the transfer of heat

16. Water Content

Method: ASTM D1533
New Oil Limit: No free water
25 ppm after vacuum drying
Significance: Oil can absorb small amounts of water. This water reduces the dielectric strength of the oil. A low water content is necessary for good dielectric strength and may be obtained by vacuum treatment.

The test procedure requires a good deal of sampling care in order to prevent inadvertent water contamination. Sample retrieval during high humidity may also affect the integrity of your sample. Extreme care and cleanliness is a must.

6.4 FAULT GAS ANALYSIS

6.4.1 Introduction

Fault gas analysis has the ability to detect incipient faults in transformers, regulators and other oil filled devices in which electrical arcing is not normal. The analytical technique evaluates the amounts and types of gases dissolved in the insulating oil.

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6.4.2 Background

Water and gas can dissolve in insulating oil. In order to keep the insulation in good condition, water and oxygen must not be allowed into the transformer tanks to dissolve in the insulating oil.

Property filled transformers, regulators and etc. contain insulating oil that has practically no dissolved gas or water. In order to maintain this condition during operation, it is necessary to prevent the oil from contacting the atmosphere and absorbing gas and water. It is also necessary to allow the oil to expand and contract with changes in temperature.

One method of atmosphere isolation employs a flexible membrane that expands and contracts with the oil yet maintains a barrier between the oil and the atmosphere. Apparatus utilizing this type of oil preservation are generally called "Conservator Type" units. When working properly, the conservator maintains the insulating oil in a gas and water free condition.

A second method of atmosphere isolation employs a dry nitrogen blanket which acts as a cushion for the expansion and contraction of the oil. The nitrogen blanket is regulated at a positive pressure of approximately 0.5 to3PSIG and also provides a barrier between the oil and the atmosphere. Since the oil has the ability to absorb gas, it absorbs the nitrogen until saturated.

6.4.3 Gas Evolution

When working properly, the two preceding methods of oil preservation keep the oil in a contaminate-free condition. The appearance of undesirable gases is generally the result of one of the following:

1. Atmospheric leaks - Atmospheric leaks result in the oils absorption of primarily nitrogen and oxygen and smaller amounts of carbon dioxide ($C0_2$) and hydrogen. The long-term affects of these gases (primarily oxygen) is an acceleration of the aging process of both the paper and oil insulation systems.
2. Internal faults - Typically internal faults evolve slowly from a satisfactory operating condition to catastrophic failure. The time frame of this fault evolution can be from days to years. As a fault develops, various amounts of electrical energy is consumed by the fault This energy causes localized heating and a breakdown of the nearby oil or paper insulation systems. This breakdown results in an evolution of various gases which become dissolved in the oil. It is these gases which when properly identified indicate the presence of an incipient fault.

6.4.4 Gas Analysis

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