COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

LOUISVILLE GAS & ELECTRIC COMPANY	)	
	)	CASE NO. 2011-00097
ALLEGED FAILURE TO COMPLY WITH KRS 278.042	)	

ORDER

Louisville Gas & Electric ("LG&E"), a Kentucky corporation which engages in the distribution of electricity to the public for compensation for lights, heat, power, and other uses, is a utility subject to Commission jurisdiction.[1]

KRS 278.042 requires the Commission to ensure that each electric utility constructs and maintains its plant and facilities in accordance with accepted engineering practices as set forth in the Commission's administrative regulations and orders and in the most recent addition of the National Electrical Safety Code ("NESC").

KRS 278.030 requires every utility to furnish adequate, efficient and reasonable service. KRS 278.260 permits the Commission, upon its own motion, to investigate any act or practice of a utility that affects or is related to the service of a utility. KRS 278.280(1) further permits the Commission, after conducting such investigation and finding that a practice is unreasonable, unsafe, improper, or inadequate, to determine the reasonable, safe, proper, or adequate practice or methods to be observed and to fix same by Order.

[1] KRS 278.010(3)(a).

Pursuant to KRS 278.280(2), which directs the Commission to prescribe rules and regulations for the performance of services by utilities, the Commission has promulgated 807 KAR 5:006, Section 24, which requires all utilities to adopt and execute a safety program.

Commission Staff submitted to the Commission an Electric Utility Personal Injury Accident Report ("Report"), dated January 27, 2011, which is attached as an Appendix to this Order. The report alleges that, on November 9, 2010, at the Aiken Substation in Middletown, Kentucky, James Willis, an employee of LG&E, sustained burn injuries as a result of an accident while cleaning a breaker cubicle located inside the Aiken substation.

According to the Report, on the day of the accident, the victim was working under the supervision of Mark Stallard, an employee of Custom Engineering Power Solutions ("CEPS"), a contractor working for LG&E. Mr. Willis was cleaning the inside of the control building after a fire, a couple of days prior, caused heavy smoke damage in the control building. Mr. Willis had been cleaning the day prior to the accident as well. At the time of the accident, Mr. Willis was cleaning and wiping down the inside of a breaker cubicle and made contact with an energized part which caused the shock and burn accident. The report states that no job briefing was performed the morning of the accident.

The Report states that Mr. Willis had cleaned the first day with everything de-energized. Sometime after he quit working on the first day, a transformer was repaired and placed back into service, which energized the bus side of the breakers. Mr. Willis was attempting to clean the bus side of one of the breakers when he made contact with

an energized part. Mr. Willis was not wearing the proper rubber personal protective equipment or the proper flame-resistant protection for the job he was performing. Mr. Willis sustained burns to the third and fourth fingers on his left hand and to his right hip.

The victim was transported to University Hospital in Louisville, Kentucky, and was released the following day.

Based on Commission Staff's investigation of the accident and the information provided by LG&E in its seven-day summary report (Attachment A to the Report), Commission Staff alleges that LG&E has violated the following provisions of the NESC:

1. 2007 NESC Section 41, Rule 410—Supply and Communication systems—Rules for employees—General Requirements—Effective as of January 1, 2009, the employer shall ensure that an assessment is performed to determine potential exposure to an electric arc for employees who work on or near energized parts or equipment. If the assessment determines a potential employee exposure greater than 2cal/cm2 exists (see Neal, Bingham, and Doughty [B59]), the employer shall require employees to wear clothing or a clothing system that has an effective arc rating not less than the anticipated level of arc energy. When exposed to an electric arc or flame, clothing made from the following materials shall not be worn: acetate, nylon, polyester, or polypropylene. The effective arc rating of clothing or a clothing system to be worn at voltages 1000 V and above shall be determined using Tables 410-1 and 410-2 or performing an arc hazard analysis. When an arc hazard analysis is performed, it shall include a calculation of the estimated arc energy based on the available fault current, the duration of the arc (cycles), and the distance from the arc to the employee. (There are exceptions to this rule.)

2. 2007 NESC Section 41, Rule 411.A.3—Supply and Communication systems—Rules for employers—Protective methods and devices—Methods—Employees shall be instructed as to the character of the equipment or lines and methods to be used before any work is undertaken thereon.

3. 2007 NESC Section 42, Rule 420.C.4—General Rules for Employees—Personal General Precautions—Safeguarding Oneself and Others—Employees who work on or in the vicinity of energized lines shall consider all of the effects of their actions, taking into

account their own safety as well as the safety of other employees on the job site, or on some other part of the affected electric system, the property of others, and the public in general.

4. 2007 NESC Section 42, Rule 420.C.5—General Rules for Employees—Personal General Precautions—Safeguarding Oneself and Others—No employee shall approach or bring any conductive object, without a suitable insulating handle, closer to any exposed energized part than allowed by Rule 431 (communication) or Rule 441 (supply), as applicable.

5. 2007 NESC Section 42, Rule 420.H—Personal General Precautions—Tools and Protective Equipment—Employees shall use the personal protective equipment, the protective devices, and the special tools provided for their work. Before starting work, these devices and tools shall be carefully inspected to make sure that they are in good condition.

6. 2007 NESC Section 42, Rule 421.A—Duties of a first-level supervisor or person in charge—this individual shall: 1. Adopt such precautions as are within the individual's authority to prevent accidents. 2. See that safety rules and operating procedures are observed by the employee under the direction of this individual.

7. 2007 NESC Section 44, Rule 441.1—Additional Rules for supply employees—Energized Conductors or Parts—Minimum Approach Distance to Live Parts—General— Employees shall not approach, or knowingly permit others to approach any exposed ungrounded part normally energized except as permitted by this rule. Minimum Approach Distance to live parts. Employees shall not approach or bring any conductive objects within the minimum approach distance listed in Table 4411 or Table 441-4 to exposed parts unless one of the following is met: The line or part is de-energized and grounded per Rule 444D. The employee is insulated from the energized line or part. Electrical protective equipment insulated for the voltage involved, such as tools, gloves, rubber gloves or rubber gloves with rubber sleeves, shall be considered effective insulation for the employee from the energized part being worked. The energized line or part is insulated from the employee and from any other line or part at different voltages.

The Report also notes six probable violations of 807 KAR 5:006, Section 24(1), which requires each jurisdictional utility to adopt and execute a safety program, including the establishment of a safety manual with written guidelines for safe working

practices and procedures to be followed by utility workers. The alleged violations arise under LG&E's Safety Manuel. Commission Staff alleges that LG&E has violated the following provisions:

1. A.2.1: General Rules—Individual Responsibility—It is the responsibility of each employee to perform assigned duties to assure: a. Safety to himself or herself; b. Safety to fellow employees; c. Protect the public; d. Protection of company property.

2. A.3.1—General Rules—Supervisors' Responsibility for Safety—Supervisors shall be responsible for the safety of the employees working under their direction and for the safety of the general public in connection with their work. The authority and responsibility for the action necessary to prevent accidents is an integral part of the supervisors' job.

3. A.3.2—General Rules—Supervisors' Responsibility for Safety—A job briefing/tailgate discussion shall be held prior to starting each job. The job briefing shall include at least the following subjects: a. Hazards associated with the job; b. Work procedures involved; c. Special precautions; d. Energy source controls; e. Personal Protective Equipment requirements.

4. A.13.1—General Rules—Personal Protective and Lifesaving Equipment—Employees shall use the personal protective equipment, protective devices and special tools provided for their work. Before starting work, the employee shall inspect these items to be sure that they are in safe operating condition.

5. F.1.18—Substations—Working in Substations—No employee may approach, or take any conductive object without an insulating handle, closer to exposed energized parts than the clearances set forth in table D-1 unless; a. The employee is insulated from the energized part; b. The energized part is insulated from the employee and any other conductive object at a different potential; c. The employee is insulated from any other conductive object, as during live line work.

6. F.1.19—Substations—Working in Substations—Electric equipment, lines and circuits shall be considered energized until determined by testing to be de-energized and grounded.

Based on its review of the Report and being otherwise sufficiently advised, the Commission finds that prima facie evidence exists that LG&E has failed to comply with KRS 278.042 and 807 KAR 5:006, Section 24(1). We further find that a formal investigation into the incident that is the subject matter of the Report should be conducted and that this investigation should also examine the adequacy, safety, and reasonableness of LG&E's practices related to the construction, installation and repair of electric facilities.

The Commission, on its own motion, HEREBY ORDERS that:

1. LG&E shall submit to the Commission, within 20 days of the date of this Order, a written response to the allegations contained in the Report.

2. LG&E shall appear on August 16, 2011, at 10:00 a.m., Eastern Daylight Time, in Hearing Room 1 of the Commission's offices at 211 Sower Boulevard in Frankfort, Kentucky, for the purpose of presenting evidence concerning the alleged violations of KRS 278.042 and of showing cause why it should not be subject to the penalties prescribed in KRS 278.990(1) for these alleged violations.

3. At the scheduled hearing in this matter, LG&E shall also present evidence on the adequacy, safety, and reasonableness of its practices related to the construction, installation and repair of electric facilities and whether such practices require revision as related to this incident.

4. The August 16, 2011 hearing shall be recorded by videotape only.

5. The Report attached as an Appendix to this Order is made a part of the record in this case.

6. Any requests for an informal conference with Commission Staff shall be set forth in writing and filed with the Commission within 20 days of the date of this Order.

By the Commission

ENTERED

MAR 2 9 2011

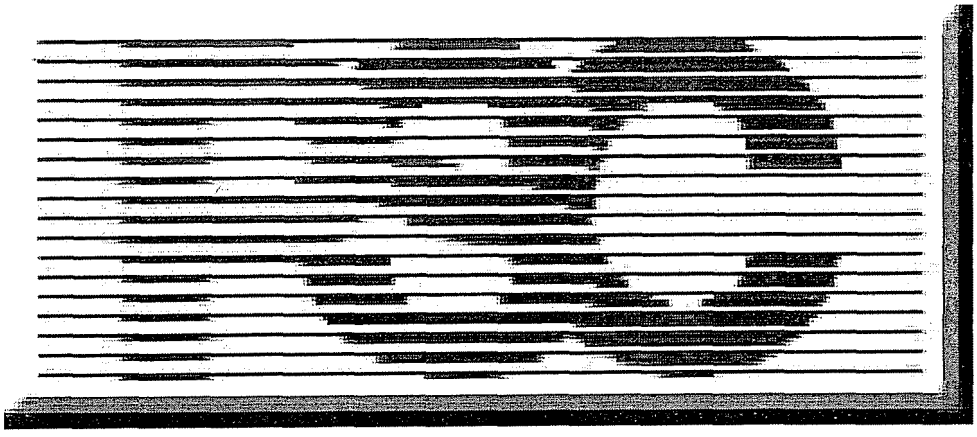
KENTUCKY PUBLIC SERVICE COMMISSION

ATTEST:

Executive Director

APPENDIX

APPENDIX TO AN ORDER OF THE KENTUCKY PUBLIC SERVICE COMMISSION IN CASE NO. 2011-00097 DATED MAR 29 2011



INCIDENT INVESTIGATION ~ Staff Report

Report Date ~ December 17, 2010

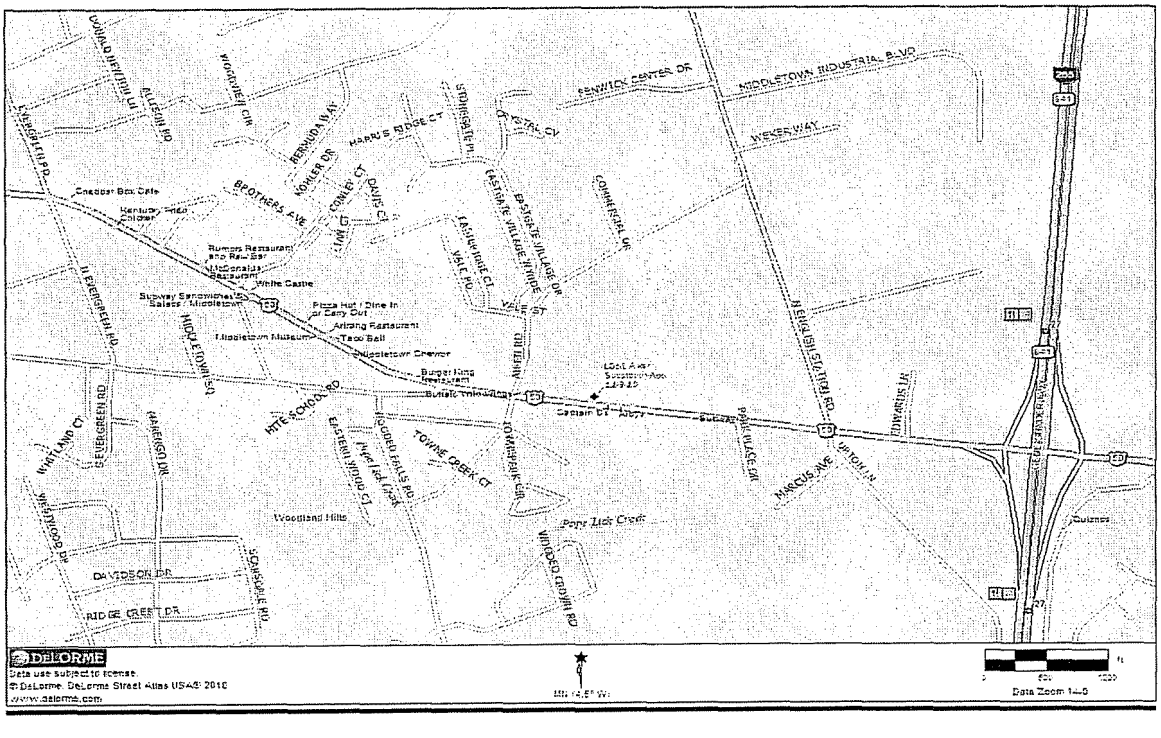
Incident Date ~ November 9, 2010

Serving Utility ~Louisville gas and Electric

Incident Location ~ Middletown, Kentucky

Victim ~ Mr. James Willis

PSC Investigator ~ Steve Kingsolver



Utility:

Louisville Gas and Electric (LG&E)

Reported By:

Ken Sheridan, LG&E Safety

Incident Occurred:

November 9, 2010, Approximately 9:15 AM

Utility Notified:

November 9, 2010, Approximately 9:15 AM

PSC Notified:

November 9, 2010, Approximately 10:30 AM

PSC Investigated:

November 10, 2010, Approximately 9:00 AM

Report Received:

November 16, 2010

Incident Location:

LG&E Aiken Substation
2909 Shelbyville Road
Middletown, Kentucky

KPSC Investigator:

Steve Kingsolver, Utility Regulatory and Safety Investigator IV

Incident Description:

This accident took place in the LG&E Aiken Substation in Middletown, Kentucky. The victim of this accident was James Willis, an LG&E employee. Mr. Willis' job classification at the time of the accident was Equipment Technician B and has held this classification since April 29, 2002. At the time of this accident Mr. Willis was working with a crew that was being supervised by Mark Stallard, an employee of Custom Engineering Power Solutions (CEPS), a contract company for LG&E. There were no witnesses to this accident. Mr. Willis was working alone in the control building at the time of this accident. On Sunday, November 7, 2010 there was a fire in the control building at the Aiken Substation as a result of an underground primary electric cable failure. The fire caused heavy smoke damage in the control building. It also caused the load on Transformer #1 to be transferred to other substations and this transformer was de-energized. Multiple crews from different departments worked in the substation cleaning, testing and placing back into service Transformer #1 and the breakers not directly affected by the fire. This work was completed by late Monday, November 8, 2010. This left two breakers off service that were directly affected by the fire, but the bus side of these breakers were energized from the transformer bus from Transformer #1. At the time of the accident, Tuesday, November 9, 2010, the victim, Mr. Willis, was cleaning and wiping down the inside of breaker # AK-1289 cubicle. Mr. Willis had cleaned the three line-side plugs on the breaker that was de-energized. Mr. Willis then proceeded to clean the right buss-side plug that was energized creating the shock and burn accident. Mr. Willis received burns to his third and fourth fingers on his left hand (Entry) and his right hip (Exit). Mr. Willis was taken to University Hospital and was released the following day. He is expected to make a full recovery. The equipment that Mr. Willis made contact with was energized at the primary voltage level of approximately 7200 volts. At the time of the accident, Mr. Willis was not wearing the proper rubber personal protective equipment and proper flame resistant protection for the job he was performing. From information provided by the utility and Mr. Willis, there was not a documented job briefing performed on the work on the day of this accident. An interview was conducted with the victim, James Willis, on December 14, 2010 and the notes of that interview are attached as Attachment D to this report.

Victim:	Name:	Address:	Employer:
	James Willis	4119 Boones Grove Louisville, Kentucky 40299	LG&E

Witnesses:	Name:	Address:	Employer:
	(NONE)		

Information From:	Name:	Position:	Employer:
	Keith McBride	Investigator	LG&E
	Doug Mullins	Safety Department	LG&E
	Ken Sheridan	Safety Director	LG&E
	James Willis	Equipment Technician B	LG&E

KAR 278.042 Service adequacy and safety standards for electric utilities-National Electric Safety Code

National Electric Safety Code:

Probable Violations:

#1:
Section 41: Supply and Communication systems-Rules for employers
410. General requirements
Effective as of January 1, 2009, the employer shall ensure that an assessment is performed to determine potential exposure to an electric arc for employees who work on or near energized parts or equipment. If the assessment determines a potential employee exposure greater than 2 cal/cm^2 exists (see Neal, Bingham, and Doughty [B59]), the employer shall require employees to wear clothing or a clothing system that has an effective arc rating not less than the anticipated level of arc energy.
When exposed to an electric arc or flame, clothing made from the following materials shall not be worn: acetate, nylon, polyester, or polypropylene.

The effective arc rating of clothing or a clothing system to be worn at voltages 1000 V and above shall be determined using Tables 410-1 and 410-2 or performing an arc hazard analysis.

When an arc hazard analysis is performed, it shall include a calculation of the estimated arc energy based on the available fault current, the duration of the arc (cycles), and the distance from the arc to the employee.

EXCEPTION 1: If the clothing required by this rule has the potential to create additional and greater hazards than the possible exposure to the heat energy of the electric arc, then clothing with an arc rating or arc thermal performance value (ATPV) less than that required by the rule can be worn.

EXCEPTION 2: For secondary systems below 1000 V, applicable work rules required by this part and engineering controls shall be utilized to limit exposure. In lieu of performing an arc hazard analysis, clothing or a clothing system with a minimum effective arc rating of 4 cal/cm^2 shall be required to limit the likelihood of ignition.

NOTE 1: A clothing system (multiple layers) that includes an outer layer of flame resistant material and an inner layer of non-flame resistant material has been shown to block more heat than a single layer. The effect of the combination of these multiple layers can be referred to as the effective arc rating.

NOTE 2: It is recognized that arc energy levels can be excessive with secondary systems. Applicable work rules required by this part and engineering controls should be utilized.

#2:
Section 41: Supply and Communication systems-Rules for employers
411. Protective methods and devices
A. Methods
3. Employees shall be instructed as to the character of the equipment or lines and methods to be used before any work is undertaken thereon.

#3:
Section 42: General Rules for Employees
420. Personal General Precautions
C. Safeguarding Oneself and Others
4. Employees who work on or in the vicinity of energized lines shall consider all of the effects of their actions, taking into account their own safety as well as the safety of other employees on the job site, or on some other part of the affected electric system, the property of others, and the public in general.

#4:
Section 42: General Rules for Employees
420. Personal General Precautions
C. Safeguarding Oneself and Others
5. No employee shall approach or bring any conductive object, without a suitable insulating handle, closer to any exposed energized part than allowed by Rule 431 (communication) or Rule 441 (supply), as applicable.

#5:
Section 42: General Rules for Employees
420. Personal General Precautions
H. Tools and Protective Equipment:
Employees shall use the personal protective equipment, the protective devices, and the special tools provided for their work. Before starting work, these devices and tools shall be carefully inspected to make sure that they are in good condition.

#6:
Section 42: General Rules for Employees
421. General Operating Routines
A. Duties of a First-Level Supervisor or Person in Charge
This individual shall:
1. Adopt such precautions as are within the individual's authority to prevent accidents.
2. See that the safety rules and operating procedures are observed by the employees under the direction of this individual.

#7:
Section 44: Additional Rules for supply employees
441. Energized Conductors or Parts
Employees shall not approach, or knowingly permit others to approach, any exposed ungrounded part normally energized except as permitted by this rule.
Minimum Approach Distance to Live Parts
1. General
Employees shall not approach or bring any conductive object within the minimum approach distance listed in Table 441-1 or Table 441-4 to exposed parts unless one of the following is met:
a. The line or part is de-energized and grounded per Rule 444D.
b. The employee is insulated from the energized line or part. Electrical protective equipment insulated for the voltage involved, such as tools, gloves, rubber gloves, or rubber gloves with sleeves, shall be considered effective insulation for the employee from the energized part being worked on.
c. The energized line or part is insulated from the employee and from any other line or part at a different voltage.

Table 441-1: AC Live Work Minimum Approach Distance[4]

(See Rule 441 in its entirety.)

(Page 266)

Voltage in kilovolts phase to phase[2]	Distance to employee			
	Phase-to-ground		Phase-to-phase	
	(m)	(ft-in)	(m)	(ft-in)
0 to 0.050[1]	not specified		not specified	
0.051 to 0.300[1]	avoid contact		avoid contact	
0.301 to 0.750[1]	0.31	1-0	0.31	1-0
0.751 to 15	0.65	2-2	0.67	2-3
15.1 to 36.0	0.77	2-7	0.86	2-10
36.1 to 46.0	0.84	2-9	0.96	3-2
46.1 to 72.5	1.00[3]	3-3[3]	1.20	3-11

1 For single-phase systems, use the highest voltage available.
2 For single-phase lines off three phase systems, use the phase-to-phase voltage of the system.
3 The 46.1 to 72.5 kV phase-to-ground 3-3 distance contains a 1-3 electrical component and a 2-0 inadvertent movement component .
4 Distances listed are for standard atmospheric conditions. The data used to formulate this table was obtained from test data taken with standard atmospheric conditions. Standard atmospheric conditions are defined as temperatures above freezing, wind less than 15 mi per hr or 24 km per hr, unsaturated air, normal barometer, uncontaminated air, and clean and dry insulators. If standard atmospheric conditions do not exist, extra care must be taken.

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807 KAR 5:006 General Rules

Section 24: Safety Program

LG&E Safety Manual

Probable Violations:

#1:
A. General Rules
A.2: Individual Responsibility
A.2.1: It is the responsibility of each employee to perform assigned duties to assure:
a. Safety to himself or herself.
b. Safety to fellow employees
c. Protect the public.
d. Protection of company property.

#2
A. General Rules
A.3 Supervisors' Responsibility for Safety
A.3.1 Supervisors shall be responsible for the safety of the employees working under their direction and for the safety of the general public in connection with their work. The authority and responsibility for the action necessary to prevent accidents is an integral part of the supervisors' job.

#3
A. General Rules
A.3 Supervisors' Responsibility for Safety
A.3.2 A job briefing/tailgate discussion shall be held prior to starting each job. The job briefing shall include at least the following subjects:
a. Hazards associated with the job.
b. Work procedures involved.
c. Special precautions.
d. Energy source controls.
e. Personal Protective Equipment requirements.

#4

A. General Rules
A.13 Personal Protective and Lifesaving Equipment
A.13.1 Employees shall use the personal protective equipment, protective devices and special tools provided for their work. Before starting work, the employee shall inspect these items to be sure that they are in safe operating condition.

#5:
F. Substations
F.1 Working in Substations
F.1.18: No employee may approach, or take any conductive object without an insulating handle, closer to exposed energized pasts than the clearances set forth in table D-1 unless;
a. The employee is insulated from the energized part.
b. The energized part is insulated from the employee and any other conductive object at a different potential.
c. The employee is insulated from any other conductive object, as during live line work.

Table D-1 (Page 119)

AC Live-Line Work Minimum Approach Distance and Clear Hot Stick Distance

Nominal Voltage in Kilovolts Phase-to-Phase	Phase-to-Ground Exposure Distance		Phase-to-Phase Exposure Distance	
	Feet–Inches	Meters	Feet–Inches	Meters
0 to 0.050	Not Specified		Not Specified	
0.051 to 0.300	Avoid Contact		Avoid Contact	
0.301 to 0.750	1–0	0.31	1–0	0.31
0.751 to 15	2–2	0.65	2–3	0.67
15.1 to 36.0	2–7	0.77	2–10	0.86
36.1 to 46.0	2–9	0.84	3–2	0.96
46.1 to 72.5	3–3	1.00	3–11	1.20
72.6 to 121	3–2	0.95	4–3	1.29
138 to 145	3–7	1.09	4–11	1.50
161 to 169	4–0	1.22	5–8	1.71
230 to 242	5–3	1.59	7–6	2.27
345 to 362	8–6	2.59	12–6	3.80

Minimum safe clearances as referenced in rules D.1.4, D.1.8, D.2.2, D.3.5, D.8.1, E.9.1, F.1.17, F.1.18 and I.7.21.

#6:
F. Substations
F.1 Working in Substations
F.1.19: Electric equipment, lines and circuits shall be considered energized until determined by testing to be de-energized and grounded.

Investigated By:	Name:	Company:
	Steve Kingsolver	KPSC
	Utility Regulatory and Safety Investigator IV	

Signed: Steve Kingsolver

Date: 1-27-11

Reviewed By:	Name:	Company:
	John Shupp	KPSC
	Manager, Electric Branch	

Signed: John V. Shupp

Date: 1/27/11

Approved By:	Name:	Company:
	Reggie Chaney	KPSC
	Director of Engineering	

Signed: Reginald Chaney

Date: 1/27/11

Attachments:

A. LG&E Summary Accident Report
B. KPSC Photographs of Accident Site
C. KPSC Map of Accident Site
D. Victim Interview Notes

Attachment A

LG&E Summary Accident Report

E.ON U.S.

November 15, 2010

RECEIVED
NOV 16 2010
PUBLIC SERVICE COMMISSION

Mr. John Shupp
Manager Electrical Branch
Division of Engineering
Kentucky Public Service Commission
211 Sower Blvd.
P.O. Box 615
Frankfort, KY 40602

LG&E and KU Energy LLC
Law Department
220 West Main Street
P.O. Box 32030
Louisville, Kentucky 402
www.lge-ku.com

Jim Dimas
Senior Corporate Attorney
T 502-627-3712
F 502-627-3367
jim.dimas@lge-ku.com

Re: Aiken Sub-Station
2909 Shelbyville Road
10-ED-E-022

Dear Mr. Shupp:

I am forwarding the attached Investigation Report prepared by Keith McBride regarding the above-referenced incident. This report is being submitted as required by Section 26 of 807 KAR 5:006. Please return in the enclosed self addressed stamped envelope a copy of the filed report.

If you need additional information concerning this incident, please contact me at (502) 627-3712 so I can direct your request to the appropriate person.

Sincerely,

Jim Dimas

JD/kmw

Enclosures

On November 1, 2010, E.ON U.S. LLC was renamed LG&E and KU Energy LLC.

20th
11-9-10

KPSC INVESTIGATION REPORT

LG&E Employee Injured
Type of Report

10-ED-E-022
Report Number

McBride / Cross
Investigator

November 9, 2010
Date of Incident

Utility: **Louisville Gas and Electric Company ("LG&E")**

Reference: **LG&E Employee Injured While Working in Sub-Station Control Building**

Location: **Aiken Sub-Station**
2909 Shelbyville Road
Louisville, Kentucky

Case Summary

On November 9, 2010 at approximately 9:15 a.m., LG&E's Distribution Control Center (DCC), was notified of a possible electrical contact by an LG&E employee inside of the Aiken Sub-Station.

Preliminary reports were James Willis, Equipment Technician B, had received burns to his left hand. Mr. Willis was treated and later admitted to the hospital.

Due to the nature and treatment of the injury suffered by Mr. Willis, resulting in admittance to the hospital, it was determined that this would be a reportable incident to the Kentucky Public Service Commission (KPSC). Ken Sheridan, Manager of Safety and Technical Training, Energy Delivery, notified the KPSC of the incident.

Investigation

On Sunday, November 7, 2010 circuit Aiken (AK) 1289 locked-out. Crews were dispatched to the circuit for patrol. After opening a set of switches midway into the circuit, DCC advised Load Dispatch to close the circuit. The circuit did not hold and shortly thereafter DCC received reports of a fire inside the Aiken Sub-Station.

Investigation found that the fire was the result of a cable failure on circuit AK-1289. The fire also damaged the cable on circuit AK-1293 and heavy smoke filled the control building. At that time, Transformer #1 was switched out affecting 5

separate circuits: AK-1289, 1293, 1294, 1296, 1296. After some extensive switching to tie circuits, all customers on the Aiken Sub-Station Transformer #1were restored. Several LG&E Sub-Station Construction and Maintenance employees responded to the incident, along with several contract crews from Custom Engineered Power Solutions (CEPS).

All crews worked into Monday, November 8 to clean, test, and place back into operation, three of the circuit breakers not directly involved in the fire damage. Late Monday night, the Aiken Transformer #1 was closed. The remaining Sub-Station crews on site, with the assistance of over-head line crews, operated the breakers and switched AK-1294, 1295 and 1296 back into normal service. AK-1289 and 1293 remained out due to the damaged cable.

On Tuesday, November 9, LG&E and CEPS Sub-Station crews along with LG&E Network and Pike Electric Network crews returned to the Aiken Sub-Station. The Sub-Station crew installed a grounding device on the AK-1293 breaker and was to complete the clean-up on the AK-1289 breaker cubicle. AK-1289 breaker was sitting on the floor. The Network crews were to pull out the damaged cable and install new cable.

With the Network crews primarily working on the outside of the station, the Sub-Station crew, consisting of Mr. Willis and Mack Stallard, Lead Electrician for CEPS, stayed inside the control building to clean.

Mr. Stallard stated during an interview, that he left the control building to retrieve a vacuum tester used to test the vacuum on the breaker. Mr. Stallard stated that as he left the building, he reminded Mr. Willis not to wash the wall because the DC current was on.

All workers on site were aware that the Aiken Sub-Station Transformer #1 was back in and AK-1294, 1295 and 1296 were energized. The investigation found that Mr. Willis had wiped and cleaned the top 3 line-side plugs in the AK-1289 cubicle. With the breaker out, these plugs were not energized. Forgetting that the transformer buss was energized, Mr. Willis attempted to wipe and clean the buss-side plug located on the lower right of the cubicle.

Mr. Stallard stated that as he got to the truck, he heard Mr. Willis yelling. Mr. Stallard stated that he ran back to the control building and found Mr. Willis standing on the floor and leaning on the breaker panel shaking his left hand. Mr. Stallard assisted Mr. Willis out of the building. The LG&E and Pike Network crews assisted Mr. Willis and performed first aid until EMS arrived.

EMS transported Mr. Willis to University of Louisville Hospital where he was treated for burns to his third and fourth fingers on his left hand, and for what was

initially described as a scrape to his right thigh. Mr. Willis was released from the hospital the next day, November 10, and is expected to make a full recovery.

James Willis – Injured LG&E employee
4119 Boones Grove Way
Louisville, Kentucky 40299
LG&E hire date – 01/21/1985
Sub-Station Dept. entry date – 04/23/2001 - Electrical Apprentice
Classification – Equipment Technician B
Classification date – 04/29/202

Mack Stallard – CEPS employee (crew member) – not a witness
4109 Lambert Ave.
Louisville, Kentucky 40218
LG&E Retiree
OPS – 6 years
CEPS – 3 years

Custom Engineered Power Solutions (CEPS) – not on job site
1803 Taylor Avenue
Louisville, Kentucky 40213
502.716.7281
Jim Molter – General Manager, CE Power, Kentucky

LG&E Network employees:

- John Book – Lead Network Technician – not a witness
- John Shirley – Network Tech A – not a witness
- Seneca Newton – Network Tech B – not a witness

Pike Electric Network employees:

- Ray Malloy – Foreman – not a witness
- Bobby Ford – Network Tech A – not a witness
- Brian Collett – Network tech B – not a witness
- Mike Coyle – Ground-man – not a witness

ATTACHMENTS:

- Utility scene photographs

DATE OF REPORT: NOVEMBER 12, 2010
END OF REPORT

Kingsolver, Steve (PSC)

From: Sheridan, Kenneth [Kenneth.Sheridan@lge-ku.com]
Sent: Wednesday, December 01, 2010 10:50 AM
To: Kingsolver, Steve (PSC)
Cc: Gardner, Sheri; McBride, Keith; Dimas, Jim
Subject: FW: James Willis Injury
Importance: High

From: Gardner, Sheri
Sent: Wednesday, December 01, 2010 10:33 AM
To: steve.kingsolver@kentucky.gov
Cc: Sheridan, Kenneth; McBride, Keith; Dimas, Jim
Subject: James Willis Injury
Importance: High

Mr. Kingsolver:

In follow-up to your conversation yesterday with Keith McBride, attached is a copy of the job briefing for the Aiken Substation job, and information as to the FR clothing Mr. Willis was wearing at the time of the incident. Please feel free to contact Keith or Ken Sheridan if you have any further questions.

<<20101129_152757_00261.pdf>>

- Mr. Willis was wearing an 8 cal/cm2 work uniform. Pants and shirt.

Sheri Gardner

Sr. Paralegal

LG&E and KU Energy LLC

220 W. Main St. - 11th Floor

Louisville, KY 40202

502-627-2195

502-217-2289 PC FAX

PROJECT #

WO #

Maintenance Work Order
Facility LVAK-

W.O. # 6156071
PROJECT # 112273
RES. CENTER # 003160
JOB PLAN #
P.M. #
TAG #

JOB CATEGORY: X

STATUS: INPRG TAG LOCATION:

PRIORITY: URGENT WORK TYPE: CORRECTIVE REPORT DATE: 11/7/2010

REPORTED BY: E003009 Fisher, Russell PHONE:

LOCATION: LVAK-CUB289 NAME: AK 1289 CUBICLE

EQUIPMENT: 102000238 1289 CUBICLE

DESCRIPTION: AK-1289 faulted causing fire in several cubicals repair/rewire for service

WORK PLANS OPERATIONS: PRE-JOB MEETING CONDUCTED: (✓) YES ( ) NO INITIALS RL
* CHECK CLEARANCE - WORK SAFELY - VERIFY EQUIPMENT DATA *

WHERE: AIKEN SUBSTATION

FAILURE CLASS: CUBICLE_REB PROBLEM CODE: OTHER

CREW: LVFLDMT MSL: E002383 Retail Electric - Substation Field Maintenance

SCHEDULE DATE: LABOR TYPE: FM CREW SIZE:

RESOURCE: LVFLDMT ACTUAL HRS: 0.00 EST. PERSON HRS: 0.00

REMARKS:

QUALITY AUDITS COMPLETED ☐

Name: _____ Date: ____/____/_____ Hrs: _____

Name: _____ Date: ____/____/_____ Hrs: _____

11/7/2010

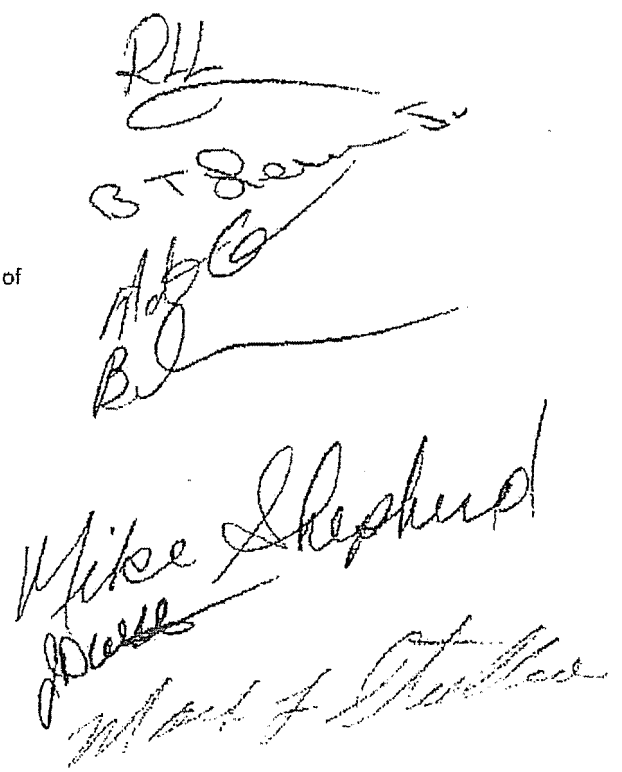
Work Order Safety Plan

Work Order: 6156071 AK-1289 faulted causing fire in several cubicals repair/rewire for service

Safety Plan: LVJOBRFG Louisville Job Briefing

1 HAZARD: LVJOBRFG Louisville Job Briefing HAZARD TYPE: JOB BRIEFING

Completed: Y/N	Precautions:	
☑	1	Review: Hazards of Job
☑	2	Review: Work Procedures
☑	3	Review: Special Precautions
☑	4	Check: Energy Source Control
☑	5	Review: PPE Requirements
☑	6	Review: Location of any energized equipment
☑	7	Review: Limits of any de-energized work area
☑	8	Review: Fall Arrest/Prevention Hazards - Method of Arrest/Prevention



PROJECT #

WO #

Maintenance Work Order
Facility LVAK-

W.O. # 6156072
PROJECT # 112273
RES. CENTER # 003160
JOB PLAN #
P.M. #
TAG #

JOB CATEGORY: X

STATUS: INPRG TAG LOCATION:

PRIORITY: URGENT WORK TYPE: CORRECTIVE REPORT DATE: 11/7/2010

REPORTED BY: E003009 Fisher, Russell PHONE:

LOCATION: LVAK-CUB293 NAME: AK 1293 CUBICLE

EQUIPMENT: 102000245 1293 CUBICLE

DESCRIPTION: AK-1293, 1289 faulted causing fire in several cubicals repair/rewire for service

WORK PLANS OPERATIONS: PRE-JOB MEETING CONDUCTED: (✓) YES ( ) NO INITIALS _____
* CHECK CLEARANCE - WORK SAFELY - VERIFY EQUIPMENT DATA *

WHERE: AIKEN SUBSTATION

FAILURE CLASS: CUBICLE_REB PROBLEM CODE: OTHER

CREW: LVFLDMT MSL: E002383 Retail Electric - Substation Field Maintenance

SCHEDULE DATE: LABOR TYPE: FM CREW SIZE:

RESOURCE: LVFLDMT ACTUAL HRS: 0.00 EST. PERSON HRS: 0.00

REMARKS:

QUALITY AUDITS COMPLETED ☐

Name: _____ Date: ____/____/_____ Hrs: _____

Name: _____ Date: ____/____/_____ Hrs: _____

WO2.rpt 02/04/2003

11/7/2010

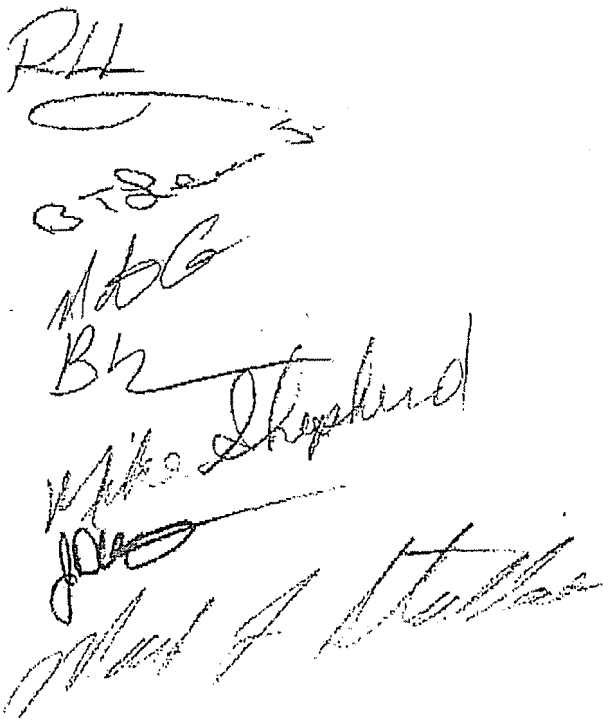
Work Order Safety Plan

Work Order: 6156072 AK-1293, 1289 faulted causing fire in several cubicals *repair/rewire for service*

Safety Plan: LVJOBRFG Louisville Job Briefing

1 HAZARD: LVJOBRFG Louisville Job Briefing HAZARD TYPE: JOB BRIEFING

Completed: Y/N		Precautions:
☑	1	Review: Hazards of Job
☑	2	Review: Work Procedures
☑	3	Review: Special Precautions
☑	4	Check: Energy Source Control
☑	5	Review: PPE Requirements
☑	6	Review: Location of any energized equipment
☑	7	Review: Limits of any de-energized work area
☑	8	Review: Fall Arrest/Prevention Hazards - Method of Arrest/Prevention



E.ON U.S.

LG&E and KU Energy LLC
Law Department
220 West Main Street
P.O. Box 32030
Louisville, Kentucky 402
www.lge-ku.com

Jim Dimas
Senior Corporate Attorney
T 502-627-3712
F 502-627-3367
Jim.dimas@lge-ku.com

November 24, 2010

Mr. Steve R. Kingsolver
Division of Engineering
Kentucky Public Service Commission
211 Sower Blvd.
P.O. Box 615
Frankfort, KY 40602

Re: James Willis, Employee Injury
Aiken Sub-Station
2909 Shelbyville Road
10-ED-E-022

Dear Mr. Kingsolver:

At your request, enclosed are the following Square D Instruction & Maintenance Manuals relative to this incident:

- SF(6) Circuit Breaker Type FG-2 Drawout
- 5-15 kV Metal-Clad Indoor Switchgear

If you need additional information concerning this incident, please contact me at (502) 627-3712 so I can direct your request to the appropriate person.

Sincerely,

Jim Dimas/kmw

Jim Dimas

JD/kmw

Enclosures

On November 1, 2010, E.ON U.S. LLC was renamed LG&E and KU Energy LLC.

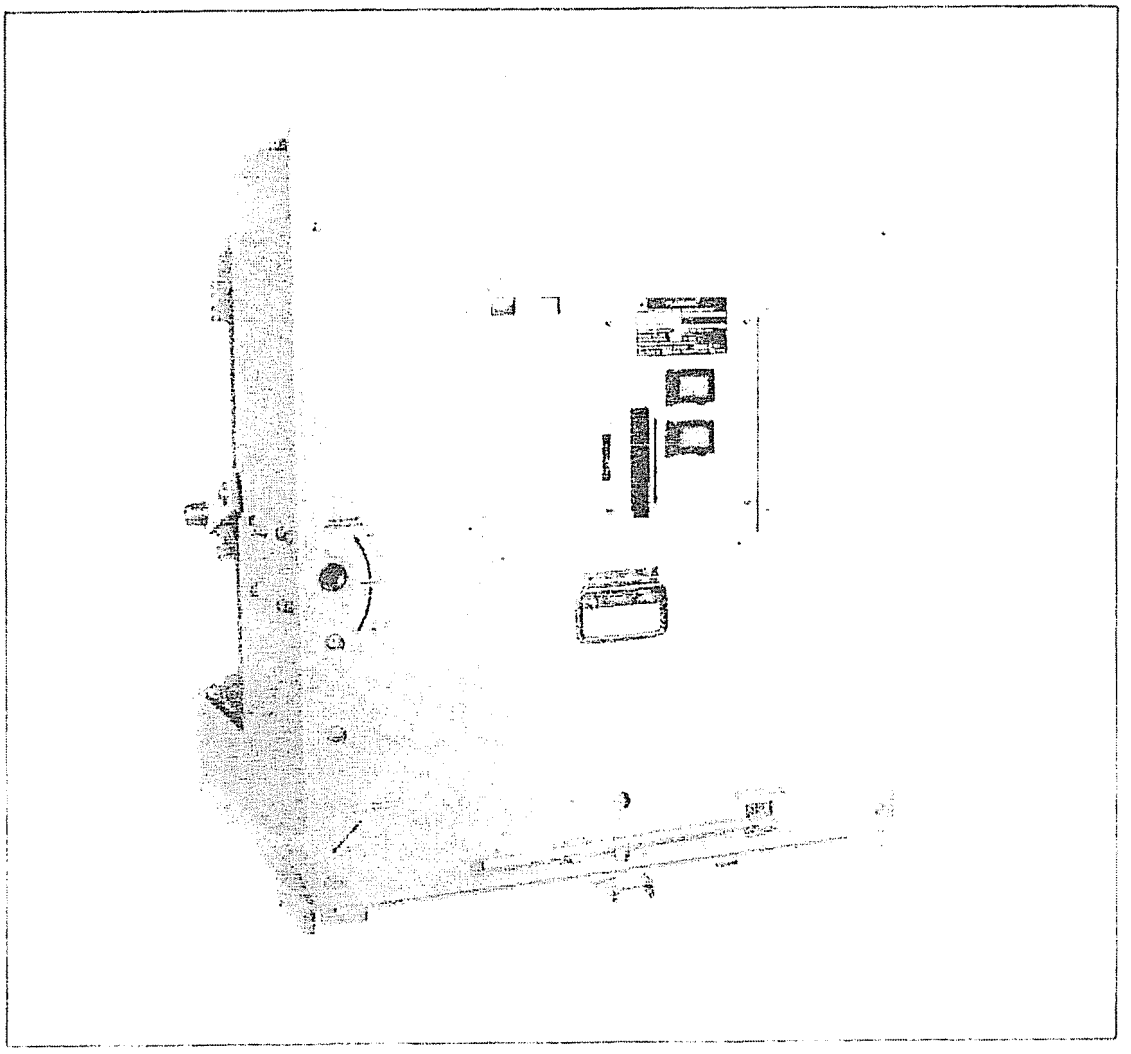
October, 1987

Manual 6055-2

Supersedes Manual 6055-2
Dated July, 1986

Instruction & Maintenance Manual

SF_6 Circuit Breaker
Type FG-2 Drawout
Series 2



SQUARE D COMPANY

SF_6 CIRCUIT BREAKER TYPE FG-2 DRAWOUT SERIES 2

TABLE OF CONTENTS

SF_6 CIRCUIT BREAKER
TYPE FG-2 DRAWOUT
SERIES 2

TABLE OF CONTENTS (Continued)

2.0 INTRODUCTION

The FG-2 SF$_6$ Circuit Breaker employs the latest in SF$_6$ technological advances, promising superior performance with low maintenance. This manual offers comprehensive information about the FG-2 circuit breaker to provide the user with sufficient information to support the style of maintenance program suited to the user's needs.

This manual contains information relating to receiving, handling, installation, operation, maintenance and spare parts. If you have further questions, contact your local Square D Company representative for comprehensive factory and/or specialized field service.

2.2 Theory of Operation

Type FG-2 Circuit Breaker pole units contain three contact structures:

1. Arcing Contacts
2. Tulip Contacts
3. Main Contacts

As the breaker closes, the first contacts to make are the tubular shaped arcing contacts which make an end-to-end configuration. After the arcing contacts meet, a set of tulip contacts, mounted on the moving arcing contact, slides over the moving and fixed stationary arcing contacts, providing a secondary contact structure to enable the arcing contacts to carry additional current, particularly needed under fault closing operation. After the arcing and tulip contact structures have been made, the main contacts close, enabling the pole unit to carry continuous current.

2.1 Breaker Ratings

Type of Breaker	Nominal Rating: Three Phase MVA	Nominal Rating: Voltage kV — RMS	Rated Cont. Current 60 Hertz Amps — RMS	Rated Voltages: Maximum Voltage kV — RMS	Rated Voltages: K Factor Max. kV / Min. kV	Rated Voltages: Minimum Voltage kV — RMS	Insulation Level Rated Withstand: Low Frequency kV — RMS	Insulation Level Rated Withstand: Impulse 1.2x50µs kV — CREST	Interrupting Ratings Amps — Symmetrical: Maximum kV Amps — RMS	Interrupting Ratings Amps — Symmetrical: Nominal kV Amps — RMS	Interrupting Ratings Amps — Symmetrical: Minimum kV Amps RMS	Asymmetrical Rating Factor	Short Time Rating 3 Sec Amps RMS	Close & Latch Rating Amps RMS	Interrupting Time Cycles
FG-2-05025-12	250	4.16	1200	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05025-20	250	4.16	2000	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05025-30	250	4.16	3000	4.76	1.24	3.85	19	60	29,000	33,200	36,000	1.1	36,000	58,000	5
FG-2-05035-12	350	4.16	1200	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-05035-20	350	4.16	2000	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-05035-30	350	4.16	3000	4.76	1.24	3.85	19	60	41,000	46,900	49,000	1.1	49,000	78,000	5
FG-2-08050-12	500	7.20	1200	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-20	500	7.20	2000	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-08050-30	500	7.20	3000	8.25	1.25	6.6	36	95	33,000	37,800	41,000	1.1	41,000	66,000	5
FG-2-15050-12	500	13.8	1200	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-20	500	13.8	2000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15050-30	500	13.8	3000	15.0	1.30	11.5	36	95	18,000	19,500	23,000	1.1	23,000	37,000	5
FG-2-15075-12	750	13.8	1200	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-20	750	13.8	2000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15075-30	750	13.8	3000	15.0	1.30	11.5	36	95	28,000	30,400	36,000	1.1	36,000	58,000	5
FG-2-15100-12	1000	13.8	1200	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5
FG-2-15100-20	1000	13.8	2000	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5
FG-2-15100-30	1000	13.8	3000	15.0	1.30	11.5	36	95	37,000	40,200	48,000	1.1	48,000	77,000	5

BREAKER IDENTIFICATION
FG-2 - 05 - 025 - 12

Continuous Current Rating
MVA Rating
Voltage Rating
Breaker Type

SF_6 CIRCUIT BREAKER
TYPE FG-2 DRAWOUT
SERIES 2

1 UPPER CURRENT TERMINAL
2 LOWER CURRENT TERMINAL
3 MAIN CIRCUIT
4 MAIN CONTACTS
5 FIXED ARCING CONTACT
6 MOVING ARCING CONTACT
7 INSULATING NOZZLE
8 MOVING PISTON
9 INSULATING ROD
10 OPERATING SHAFT
11 SHAFT SEAL
12 FILTER

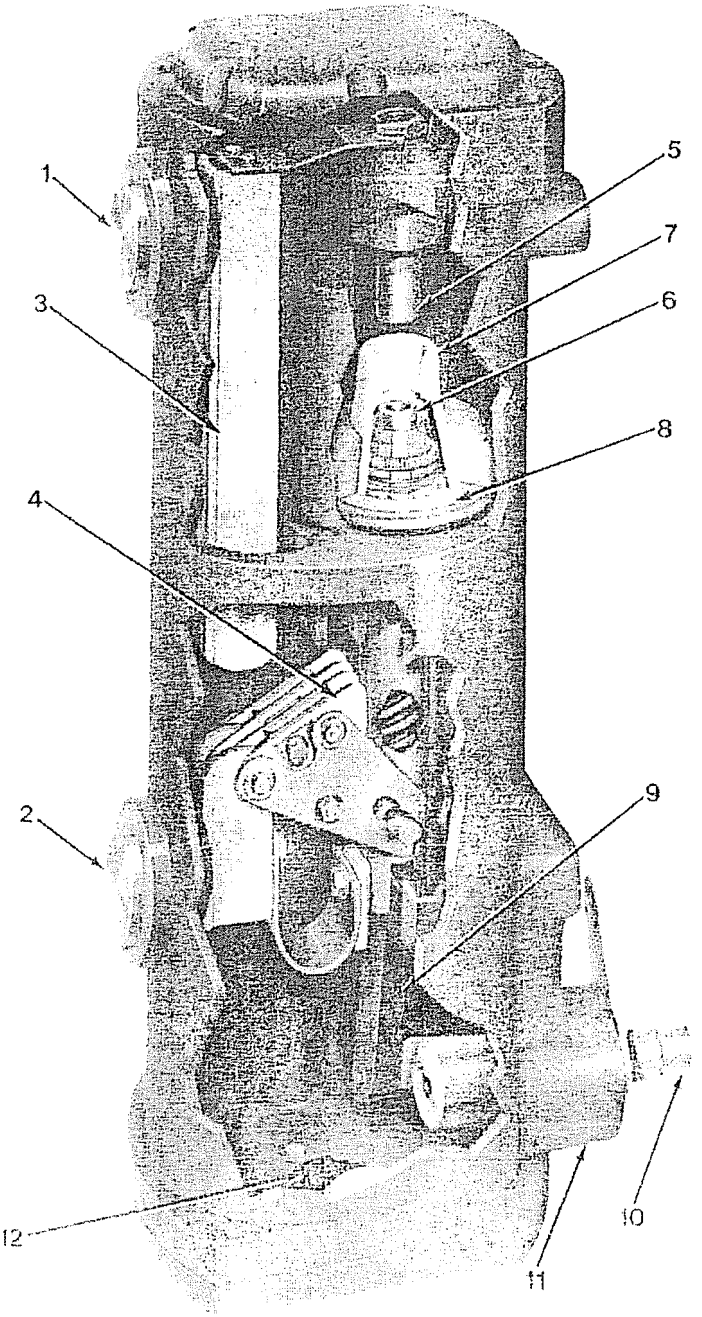


Figure 1
Bottle Cross Section

As the breaker opens, the sequence of contact opening is reversed. First the main contacts open, then the tulip contacts, and finally the arcing contacts separate, at which point the interrupting process begins.

The FG-2 Circuit Breaker utilizes the SF_6 (sulphur hexafluoride) puffer principle of arc interruption. During the period of time when the main and tulip contacts are in the process of being opened, a quantity of SF_6 gas is being compressed in a cylinder within the pole unit. The compressed gas is directed through a nozzle which directs a high velocity flow of gas across the arc as the contacts part. The flow of gas forces the arc into the tubular arcing contacts. The arc usually extinguishes at the first current zero. The properties of SF_6 gas, high electronegativity, high thermal conductivity, and insulating properties, work together to assure a restoration of the dielectric strength of the gas at the current zero. These properties are enhanced at elevated pressures. Thus, the pole units are charged with SF_6 gas to perform at their intended rating.

2.3 Safety

This equipment has been constructed and tested in accordance with the latest safety related requirements of ANSI C37.04, C37.06, and C37.09. This equipment has been judged to be safe in view of these present, industrial standards. The Square D Company cannot be responsible for special design requirements of local codes and ordinances which are not specified in the purchase documents. Due to the nature of electrical power and circuit breakers of this type, a margin of risk remains. Each user (including the maintenance authority) has a responsibility for implementing a safety program commensurate with the types of hazards involved and local codes or requirements. Known hazards with this type of equipment are electrocution, burning as a result of arcing equipment, and pinching as a result of discharge of stored mechanical energy.

Because of the various conditions which may exist at any given installation, the following suggestions are not intended to be complete and shall in no way diminish the user's responsibility for implementing an appropriate safety program covering installation, operation and servicing of the equipment.

1. All personnel associated with the installation, operation and maintenance of the equipment should be thoroughly trained and experienced with respect to high voltage equipment in general, with respect to the specific operation of this particular equipment, and with respect to the types and severity of personal injury.

2. Maintenance and operation of the equipment should be well planned and in accordance with safe practices. Adequate safety related tools and equipment appropriate for the tasks involved should be provided.

3. Do *not* work on or near electrically energized equipment. Contact with energized parts can result in severe shock or burn.

4. Do not work on or near electrically energized parts where there is a possibility of accidentally contacting an energized part.

5. Be sure the circuit breaker mechanism is discharged or blocked so that spring energy cannot be accidentally released. Careless release of stored energy can result in serious personal injury.

6. Use only test equipment rated for the service intended. **Do not use instruments or multimeters rated for low voltage service** on high voltage circuits. Incorrect use can result in explosion and serious personal injury to the operator.

FG-2 breaker interrupters contain sulphur hexafluoride (SF_6) gas at 22 psig. and 37 psig. pressure respectively, depending on their rating. SF_6 gas is a colorless, odorless, non-flammable, non-toxic and chemically inert gas. There are no known ill effects as result of exposure to the human body. As the gas is exposed to electric arcs inside the breaker interrupters, a portion of the gas decomposes into compounds which can be toxic. These toxic compounds exist in both gaseous and solid form. Should used pole units be opened or accidentally broken, the following precautions should be taken:

1. Avoid breathing the gases coming from the equipment.

2. Ventilate the area thoroughly.

3. Wear gloves to avoid direct skin contact with any internal component of the pole unit.

4. [illegible] personnel should not enter [illegible] damaged units, or should [illegible] breathing apparatus with self-contained oxygen should be used.

Some gases evolved from the decomposition of SF_6 [illegible] "rotten-egg" odor and may be smelled long before concentrations of the toxic gases are harmful. Halogen detectors may be used to determine the relative concentration of gases present in the atmosphere.

2.4 Receiving

Upon receipt, remove the shipping materials from the circuit breaker for visual inspection. This can be accomplished by carefully removing the staples located at the bottom of the box cover. The box cover may then be lifted from the shipping pallet.

This packaging has been arranged so that the breaker may be repackaged for temporary storage prior to placement into service.

2.5 Inspection

Inspect the breaker for physical handling damage and verify that the breaker specifications on the rating nameplate match the order specifications. A claim for damage should be filed at once with the transportation company if there is visual evidence of damage. Notify the Square D Company of the damage claim and/or any discrepancies noted. See paragraph 5 of the Square D Company Condition of Sale.

2.6 Handling

The breaker packaging is designed to be moved and handled primarily by a fork lift truck. The weight of the packaged breaker is approximately 570 pounds (260 kilograms). In addition, the packaged breaker may be lifted using lifting hooks. See Figure 3. In order to use lifting hooks, cut away the top of the carton in the areas marked. Loosen the bolts on the lifting plates located on the breaker. Rotate the lifting plates into an upright position and tighten the bolts securely. Insert hooks into the holes in the lifting plates. After lifting is complete, return lifting plates to the storage position.

2.7 Storage

Breaker packaging is designed for indoor storage at temperatures ranging from 50 degrees F thru 130 degrees F with relative humidity to 80% for a period not to exceed two years.

The breaker should be operated at least once a year to keep the SF_6 seals lubricated and to refresh bearing lubrication. Beyond two years, breakers should be completely inspected, tested, and lubricated prior to service. Packaging is designed to permit no more than two breakers in one vertical stack.

3.0 OPERATING INSTRUCTIONS

This circuit breaker has been designed and manufactured in accordance with ANSI C37.04. The stored energy, spring operating mechanism has two step operation and is trip-free.

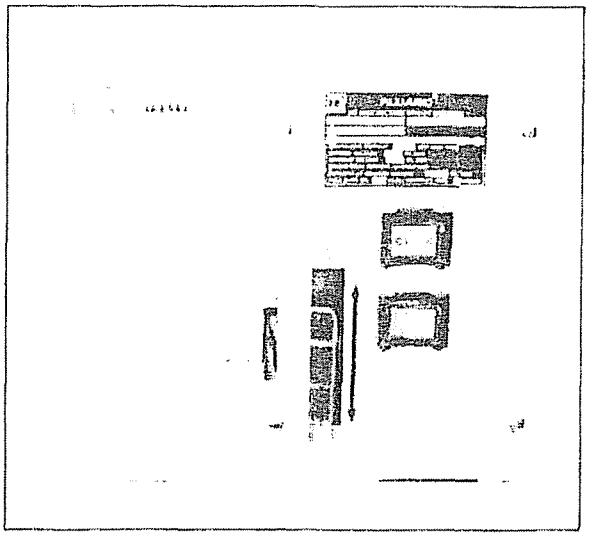


Figure 2
Breaker Operating Controls

Closing springs can be charged by either electrical or manual means. The breaker can be closed either electrically or manually by operation of the spring release latch, which releases the stored energy from the charged closing springs to close the breaker. During the closing operation, the opening springs are charged by a transfer of some of the energy from the closing springs. The breaker can be opened either electrically or manually by operation of the trip latch, which releases the opening spring energy.

The breaker may be used in reclosing sequence schemes where the breaker is opened, closed, and reopened in rapid sequence without momentary stops for recharging the springs.

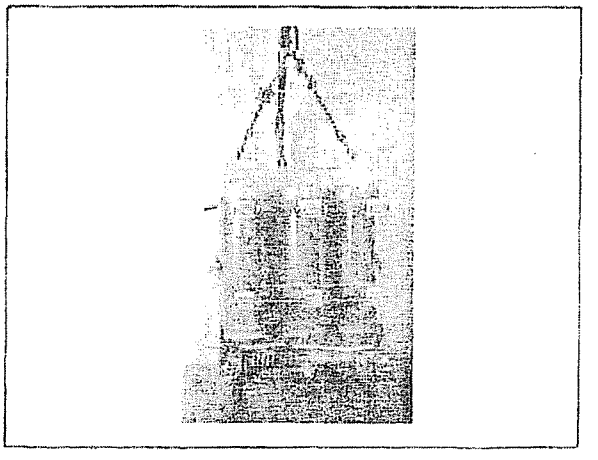


Figure 3
Breaker Lifting

3.1 Closing Spring Charging

3.1.1 ELECTRICAL MEANS - All breakers are equipped with a spring charging motor rated for the control system voltage. The control circuits are typically arranged to charge uncharged springs immediately after a breaker closes. On request, the control circuit may be arranged to charge the springs immediately after breaker opening.

The closing springs will automatically be charged upon connection of the secondary connector, if control power is available. The normal charging time at rated voltage is approximately 6 seconds. Interlocks are provided to prevent closing the breaker unless the breaker is fully connected or located in the test position. Springs are automatically discharged as the breaker is moved from the test position to a position out of the cell. Springs may be in the charged or discharged condition as the breaker is moved between the test and connected positions.

3.1.2 MANUAL MEANS - In the event of the loss of control power, or should the breaker be removed from the cell, the closing springs may be charged by manual means. The manual charging means is also used to accomplish contact wear checks and other maintenance functions.

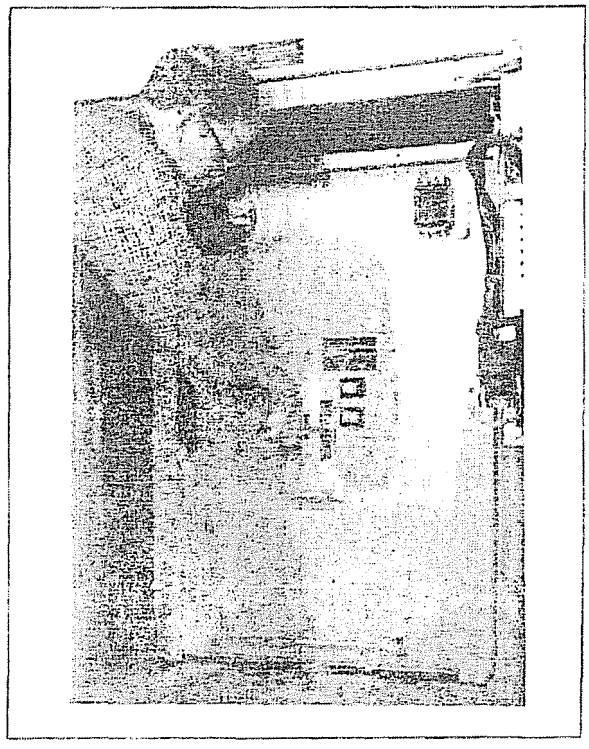


Figure 4
Manual Charging Means

Insert the charging handle into the manual charging slot as shown in Figure 4. Pump the handle up and down. Charging force is applied on the down stroke. There will be a noticeably lighter force near the end of the charging cycle and at the end, the mechanism will produce a loud snap. The charge indicator will suddenly move from the discharged position to the charged position. When the springs are fully charged, the charging handle cannot be, nor should it be, moved. The breaker cannot be closed until the springs are fully charged.

3.1.3 SPRING CHARGE STATUS INDICATOR - The springs charged indicator is located to the left of the manual charging handle slot. This indicator shows when the closing springs are fully charged or discharged. If springs are partially charged, the indicator will be in the discharged position.

3.2 Closing and Opening Pushbuttons

The breaker closing and opening pushbuttons provide the same operation as the closing and opening solenoids.

The closing pushbutton, through a series of mechanisms, releases the closing spring latch, causing the main contacts to close. The closing mechanism is equipped with an interlock which allows the pushbutton to move, however, it could be mechanically disconnected from the closing spring latch, preventing the breaker from closing. This interlock is interconnected with the trip mechanism so that the closing mechanism is disconnected prior to activation of the trip operation. A tripping signal always takes precedence over a closing signal. A closing signal and/or a tripping signal must be removed before the interlock can reset and the closing operation be activated.

If the breaker is in the open position and simultaneous closing and opening signals are received, the trip signal will disconnect the closing mechanism before the closing spring latch can release. The breaker will remain in the open position.

If the breaker is in the open position and a closing signal is received slightly ahead of an opening signal, the breaker will make a complete close-open cycle. During a portion of the closing stroke, the trip mechanism will be activated, but the breaker will continue to close, providing full close and latch capability. As soon as the breaker has fully closed, it will immediately trip with full interrupting capability.

If the breaker is in the closed position and the close button is pushed, nothing happens.

If the breaker is closed and the close and open pushbuttons are pushed simultaneously, the breaker will open. The breaker will remain open until both the trip and close buttons are released allowing the closing interlock to reset. Once the interlock has reset, the close button may be pushed to close the breaker.

3.3 Electrical Closing and Opening Functions

As indicated, the electrical closing and opening solenoids operate the same mechanisms as the panel mounted pushbuttons. The breaker functions the same as indicated for the pushbutton operation.

Closing solenoid circuits are provided with three electrical protective features.

A. END-OF-CHARGING SWITCH - Prevents a closing signal from being applied until the closing springs are fully charged.

B. BREAKER POSITION AUXILIARY CONTACT - A normally closed (b) auxiliary breaker contact is arranged to remove a closing signal from the closing solenoid to prevent overheating of the closing solenoid.

C. ANTI-PUMP RELAY - An anti-pump relay circuit is provided to prevent multiple close-open operations in the event that a continuous close signal is applied, followed by an opening signal. The breaker will not reclose until the closing signal is removed and then reapplied.

Opening solenoid circuits are provided with a normally open (a) auxiliary breaker contact. This contact prevents overheating of the opening solenoid in the event that a continuous trip signal is applied.

3.4 Contact Position Indicator

A window and flag arrangement is provided to indicate the position of the breaker main contacts. A red flag with the word "closed" indicates that the breaker main contacts are closed. A green flag with the word "open" indicates that the breaker main contacts are open. This indicator is not to be used as final authority to indicate the safety of the power circuit.

3.5 Operations Counter

An operations counter counts the number of close-open cycles. The counter advances by one on the opening stroke. The breaker mechanism is capable of at least 10,000 close-open cycles, however, the life of the interrupters can be considerably less depending upon the amount of current switched with each operation. See Figure 13 for specific life-load information.

3.6 Release-Free (Trip-Free) Operation

This breaker is equipped with an advanced design trip-free mechanism in accordance with the latest proposals for ANSI C37.04 and ANSI C37.100. The basic requirement is that an opening operation can prevail over a closing operation during specified parts of the closing operation. It is also necessary, for safe operation of circuit breakers, that a breaker close with full closing force in order to be capable of withstanding a full rated fault. In addition, to provide full interrupting capability, the main contacts must travel to their fully closed position in order to completely fill the SF_6 puffer cylinder with interrupting gas.

The mechanism of this breaker is arranged such that a trip signal always takes precedence over a closing signal. However, in instances where the closing signal leads the trip signal by a sufficient amount of time to release the closing spring latch, the breaker will respond with a full close-open cycle, assuring full breaker performance under all conditions.

3.7 Drawout Operation

The breaker removable element is equipped with a worm gear racking mechanism equipped with necessary interlocking to prevent racking a breaker with the main contacts closed. The secondary control circuit connections are provided with an automatic disconnect device arranged to permit manual coupling in the test position.

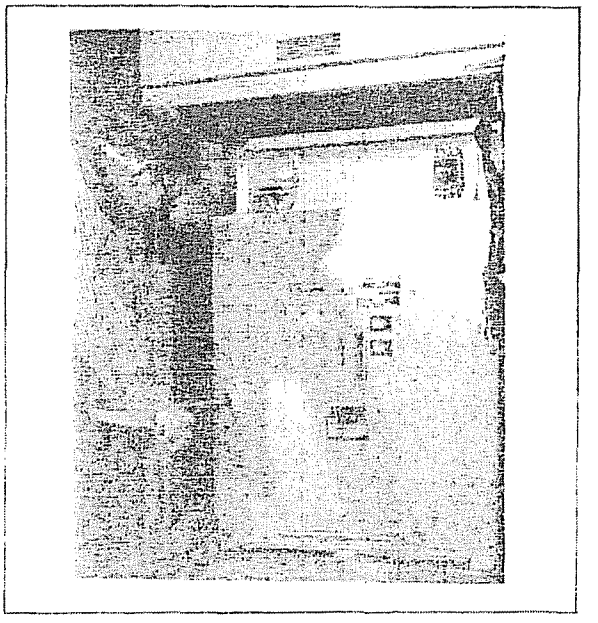


Figure 5
Drawout Operation

3.7.1 RACKING INTERLOCKS - A shutter is provided to block the entrance of the racking crank while the breaker is closed. The breaker must be tripped before the shutter opens.

3.7.2 RACKING MECHANISM - The breaker is moved between the test/disconnected position and connected position by means of levering arms on the sides of the breaker. The arms are driven by a worm gear.

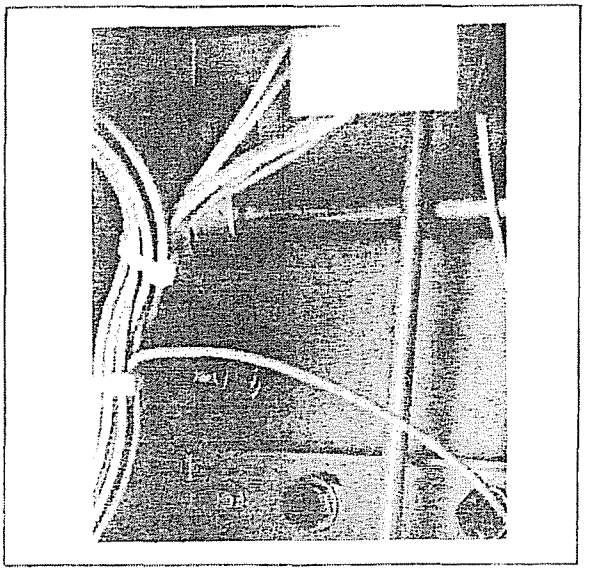


Figure 6
Racking Mechanism

3.7.3 RACKING IN PROCEDURE

1. Check to see if the breaker is open. If not, open the breaker. Move the levering arms to a position 15° below horizontal, pointing to the rear of the breaker.

2. Roll the breaker into the cell to the Test/Disconnected position. The arrow on the guide at the front of the breaker will be in alignment with the Test/Disconnect position label on the cell floor. As the breaker enters the cell, breaker trip rollers will contact cams mounted on the cell floor which will cause the breaker to cycle through a close-open operation to discharge stored energy should the closing springs be charged. If the springs are not charged, the breaker will not operate.

3. Turn the crank clockwise to rack the breaker to the Connected position until the racking mechanism comes to a firm stop. *Do not overtorque*. The arrow in the guide rail at the front of the breaker will be in alignment with the Connected position label on the cell floor.

3.7.4 RACKING OUT PROCEDURE

1. Check to see if the breaker is open. If not, open the breaker.

2. Insert the racking crank and rotate in the counterclockwise direction until the racking mechanism comes to a firm stop. *Do not overtorque.*

   Note: This position is a combination of the test and disconnected positions.

3. To remove the breaker from the cell, lift the latch on the lower left side of the breaker and roll the breaker out of the cell.

CAUTION

IF BREAKER BEING REMOVED IS LOCATED IN THE TOP CELL OF TWO HIGH METAL CLAD SWITCHGEAR, INSURE THAT A SQUARE D LIFT TRUCK HAS BEEN LOCKED INTO POSITION BEFORE WITHDRAWING THE BREAKER FROM THE CELL.

3.8 Secondary Control Disconnect

The breaker is equipped with a 19 pin control power plug for automatic connection and disconnection of control circuits to the breaker. The control power plug is mounted on the end of a retractable slide handle to permit connection in either the Test or Connected position. Test position operation is achieved by:

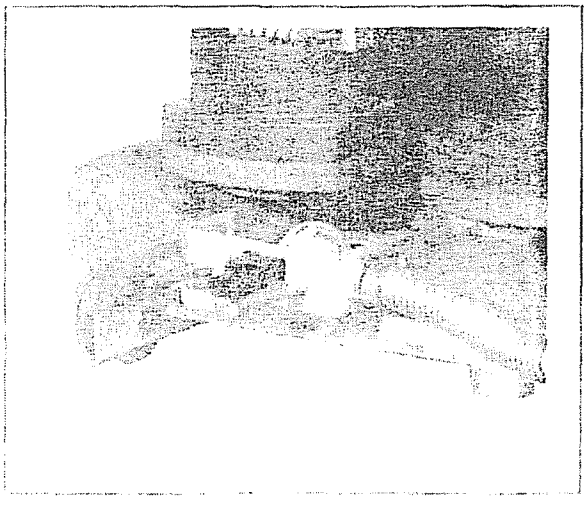


Figure 8
Secondary Disconnect Normal Retracted

1. Insert the breaker into the Test position of the cell by following steps 1 and 2 of racking in procedure 3.7.3 (do not rack the breaker into the cell).

2. Pull the secondary slide handle out of its retaining clip and rotate it out so that it is protruding straight out from the breaker.

3. Lift slightly on the secondary handle and push it into the breaker until the secondary handle has traveled to its fullest extent into the breaker.

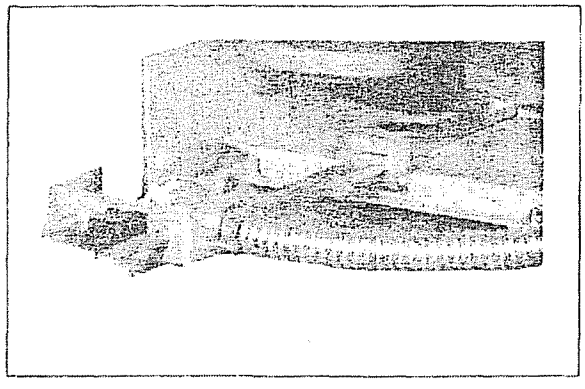


Figure 9
Secondary Disconnect Test-Extended

4. The control circuit of the breaker is now connected to the cell.

5. The secondary disconnect may be retracted by reversing the above procedure. The breaker may also be moved into the connected position with the control power plug in the extended position. The slide handle will automatically retract and latch in the retracted position.

3.9 TOC Assembly (Optional)

An optional TOC (Truck Operated Contact) assembly is available on the structure. TOC contacts are normally required on switchgear containing two mains and a tie, with an automatic transfer scheme. The TOC actuation pin, mounted on the upper left side of the breaker changes the state of the structure mounted contacts when the breaker is moved from the test to the connected position and vice versa. The contacts themselves indicate to the circuitry whether the breaker is in the disconnected or connected position.

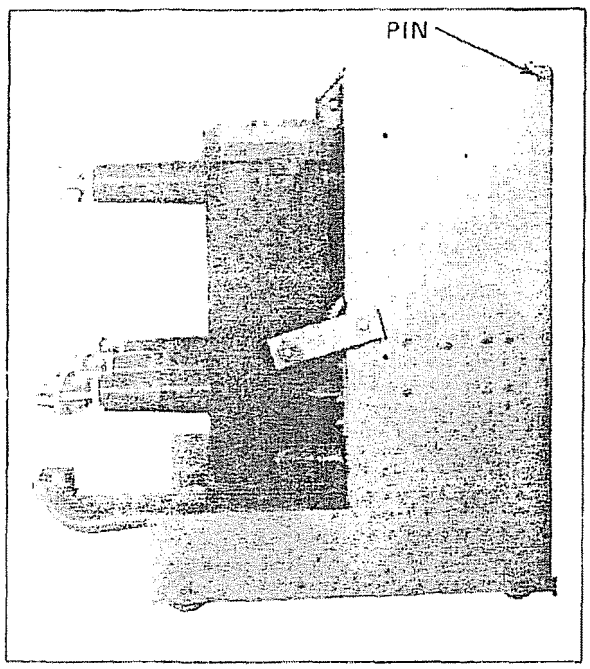


Figure 10
TOC Cam Plate

3.10 MOC Assembly (Optional)

An optional MOC (Mechanism Operated Contact) assembly is available on the structure. MOC contacts are normally required on switchgear containing two mains and a tie, with an automatic transfer scheme. The MOC roller, located on the right side of the breaker, is activated through a series of linkages on the breaker, connected to the right hand pole unit operating shaft arm. The structure mounted contacts, activated by movement of the roller, indicate whether the breaker is open or closed, the same as the breaker auxiliary switches.

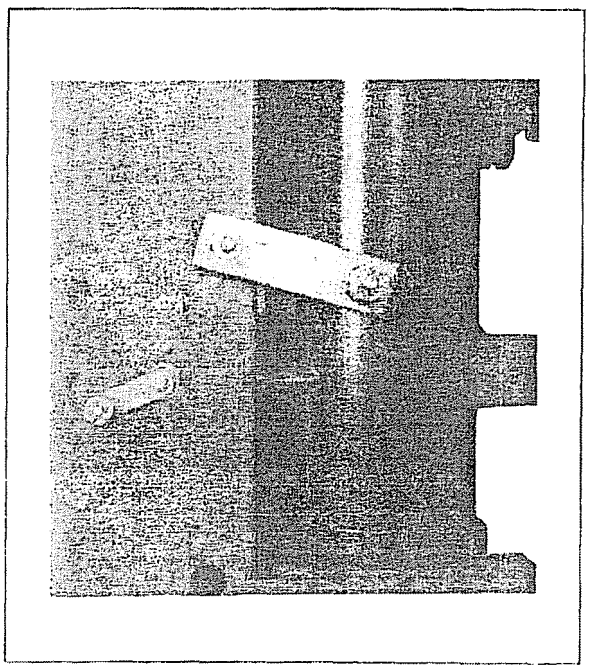


Figure 11
MOC Roller

4.0 BREAKER COMPONENTS

Each of the major components of the circuit breaker element will now be discussed in detail to provide information on function and servicing.

4.1 Breaker Pole Unit

Different SF_6 type FG-2 pole units are manufactured to provide the ratings covered in this manual and specified in ANSI standard C37.06, Table 2. Table 1 illustrates the breaker catalog number and the pole unit operating pressure.

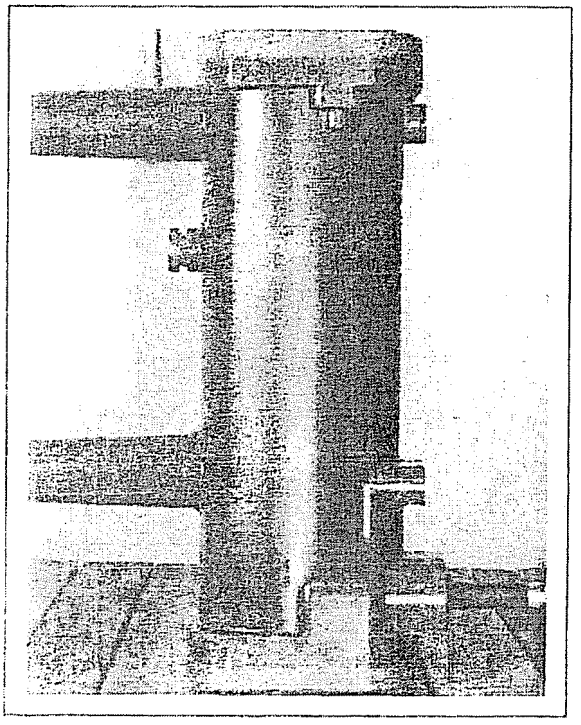


Figure 12
Pole Unit

BREAKER CATALOG NUMBER	CONTINUOUS CURRENT (A)	SF_6 GAS PRESSURE @ 20°C. (PSIG)
FG-2-05025-12	1200	36.25
FG-2-05025-20	2000	36.25
FG-2-05025-30	3000	36.25
FG-2-05035-12	1200	36.25
FG-2-05035-20	2000	36.25
FG-2-05035-30	3000	36.25
FG-2-08050-12	1200	36.25
FG-2-08050-20	2000	36.25
FG-2-08050-30	3000	36.25
FG-2-15050-12	1200	21.75
FG-2-15050-20	2000	21.75
FG-2-15050-30	3000	36.25
FG-2-15075-12	1200	36.25
FG-2-15075-20	2000	36.25
FG-2-15075-30	3000	36.25
FG-2-15100-12	1200	36.25
FG-2-15100-20	2000	36.25
FG-2-15100-30	3000	36.25

Table 1
Breaker Pole Units

4.1.1 GAS SERVICING - The pole units are designed to be sealed for life requiring no service. They are charged with sulphur hexafluoride gas (SF_6) at the factory to an initial pressure as indicated in Table 1. **They require no charging upon installation.**

Pole units are designed to remain in service for the life of the equipment without the user having to check the gas pressure or replenish the gas.

It is **not** recommended that the user check the gas pressure.

4.1.2 ARCING CONTACT WEAR - The breaker life is primarily limited by arcing contact wear. The rate of contact wear is affected by closing currents, interrupted currents, and other related factors. Applications such as capacitor switching tend to expend contact tip materials upon closing on the circuit whereas other applications might cause wear upon interruption of the current. To an extent, life-load performance is predictable. Figure 13 is provided to be used as a guide to predict arcing contact life, based only upon interruptions of symmetrical currents. Closing on high currents as well as asymmetrical interruptions will significantly shorten the life.

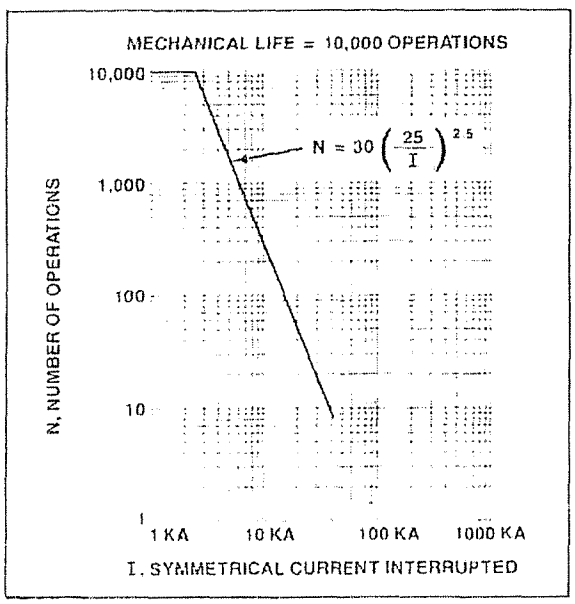


Figure 13
Life Load Performance

4.1.3 ARCING CONTACT WEAR MEASUREMENTS - The remaining life of a pole unit may be determined by a measurement of the arcing contact wear. This is accomplished by measuring the position of a reference mark, located on the opening spring link, with respect to the breaker frame. See Figure 14.

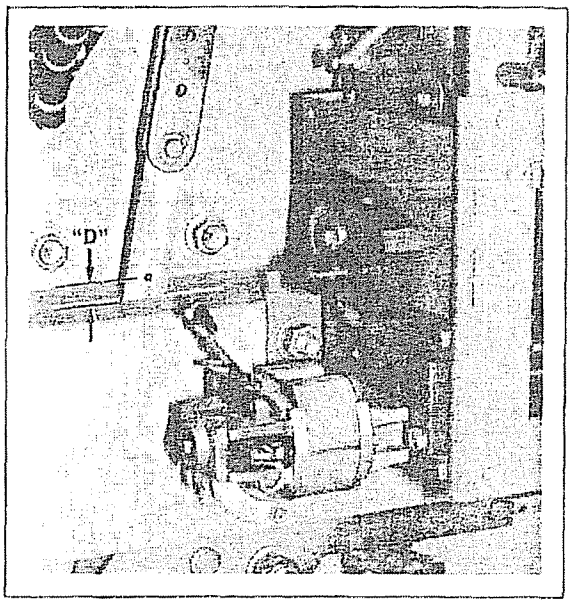


Figure 14
Contact Wear Measurement

In order to make the measurement, the following steps must be taken. It is recommended that the breaker be removed from the cell.

REMOVE CLOSING SPRINGS

1. Be sure that the closing springs are discharged and that the breaker is open. If the springs are charged, they can be discharged by closing and then opening the breaker.

2. Locate the holes in the lower end of the outer closing spring guide.

3. Using the manual charging handle, slowly charge the springs until the holes in the outer spring guide line up with the bottom end of the inner spring guide. See Figure 15.

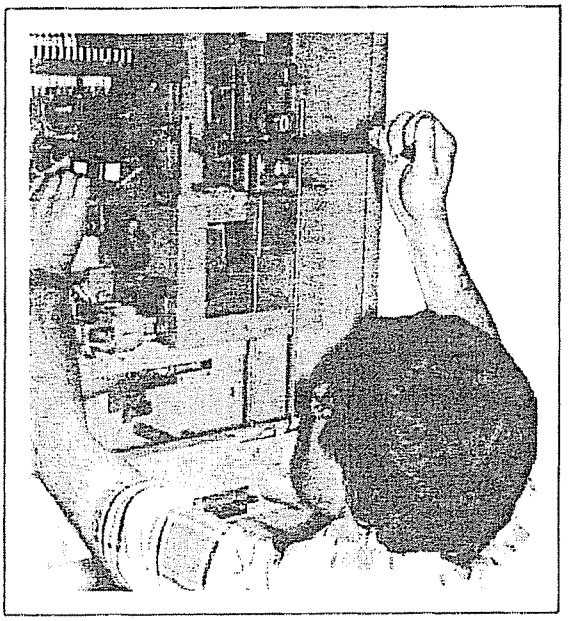


Figure 15
Manual Charging

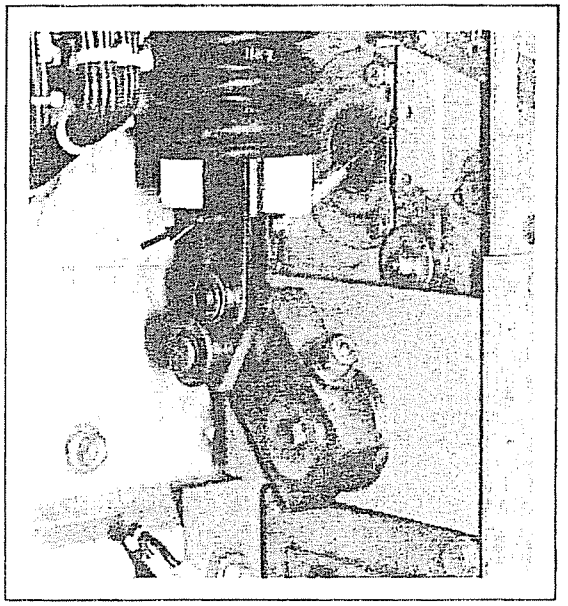


Figure 16
Inserted Pin

4. While applying force to the charging handle, insert a 7/32" diameter pin through the holes. When force is released from the handle, the pin should assume the spring pressure. This releases the pressure from the upper and lower mounting pins. If charging has gone too far, remove the pin, fully charge the springs, close and then open the breaker, and start over at step 3. Be sure to insert the pins into both sets of closing springs. See Figure 16.

5. Remove the retaining rings from the bottom mounting pins and remove the spring assemblies. Note the position of any washers and bushings which must be removed.

ATTACH A CONTINUITY TEST DEVICE

1. Attach a continuity test device (light, bell, or ohm meter) across each pole unit to indicate main contact closing.

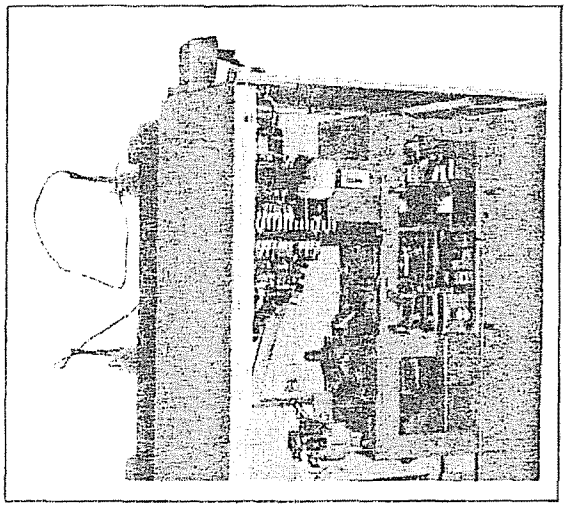


Figure 18
Continuity Test Device

SLOW CLOSE THE ARCING CONTACTS

1. Using the manual charging handle, charging the mechanism to the end of charge cycle. When the lower spring mounting pin rotates to the bottom of its travel, it will have to be pulled forward to complete the cycle.

2. Push and hold the close button in and begin slow closing the breaker by operating the charging handle.

3. Continue the slow closing operation until the continuity test device indicates that the arcing contacts have just kissed. Slow closing should be stopped at this point.

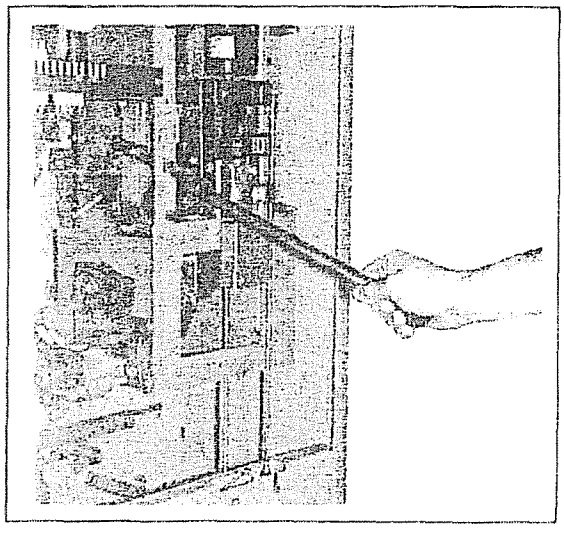


Figure 19
Slow Closing

4. This operation may be repeated to insure that the kiss position has been reached without overclosing. Uneven arcing contact wear may require additional measurements made at each of two or three positions where arcing contact kiss is determined.

MEASURING ARCING CONTACT WEAR

1. Measure and record the perpendicular distance from the top of the frame to the center of the red dot. See Figure 14.

2. A new breaker should measure 0.41 inch (10.5 mm).

3. If the bottom of the red dot is tangent to or below the top of the frame, the arcing contacts are completely worn out. All three pole units should be replaced per section 4.1.4.

MEASUREMENT "D"	REMAINING LIFE (%)
0.41 in. (10.5 mm)	100
0.33 in. (8.5 mm)	75
0.26 in. (6.5 mm)	50
0.18 in. (4.5 mm)	25
0.10 in. (2.5 mm)	0

Table 2
Arcing Contact Wear

REPLACE CLOSING SPRINGS

1. Using the manual charging handle, continue the slow closing sequence until the breaker is fully closed. An audible click will be heard indicating that the closing cycle is complete.

2. Push the open pushbutton to open the breaker.

3. Replace the closing springs on the mechanism. Be sure that all washers and bushings are located in the same position as noted in 4.1.3.

4. Replace the spring clips on the top mounting pins and the retaining rings on the bottom pins, insuring that each one is seated in its proper groove.

5. Manually charge the closing springs slightly so that the 7/32" diameter pins can be removed. Be sure to remove the pins from both closing spring assemblies.

4.1.4 REPLACEMENT OF POLE UNITS - It is recommended that all three pole units be replaced at one time. However in unusual circumstances it may be only necessary to replace one pole unit.

CAUTION

MAKE SUITABLE ARRANGEMENTS TO HOLD THE POLE UNIT IN POSITION WHILE REMOVING THE MOUNTING SCREWS. EACH POLE UNIT WEIGHS APPROXIMATELY 75 POUNDS. THE POLE UNIT CONTAINS PRESSURIZED GAS AND MUST BE PROTECTED FROM SHOCK. IT IS RECOMMENDED THAT THE POLE UNIT BE ATTACHED TO A HOIST BY MEANS OF A SLING SECURED IN POSITION.

4.1.4.1 Pole Unit Replacement Procedure

1. Be sure that the breaker is open and that all springs are discharged.

2. Remove and replace one pole unit at a time. The replacement pole unit must be aligned and positioned with respect to the remaining pole units before proceeding to the next one.

3. Remove the spring clips at the rear of the cross link pins and remove the cross link pins on the outer two pole units. On the left hand pole unit (viewed from the front of the breaker).

4. Remove the bolt which holds the auxiliary switch actuating plate to the operating shaft arm on the left hand pole unit. (If the breaker is equipped with MOC provisions, remove the bolt holding the MOC actuating plate to the right hand pole unit operating shaft arm.

If not replacing the left hand pole unit, skip to section 4.1.4.3. If replacing only the center pole unit, skip to section 4.1.4.4.

4.1.4.2 Left Hand Pole Unit Replacement

1. Be sure section 4.1.4.1 has been completed before proceeding.

2. Remove the four mounting screws holding the pole unit to the breaker frame. Use care when removing the pole unit so that the auxiliary switch actuating plate and linkage are not damaged.

3. Install a new pole unit, insuring that the auxiliary switch actuating plate is placed on the pole unit operating shaft and that the operating shaft arm is located between the cross links. See Figure 21.

4. Install the four mounting screws. Insure that the pole unit is in proper alignment and has proper spacing with the remaining two pole units before tightening the mounting screws. It may be necessary to adjust the finger runback to obtain proper alignment. See Figure 22.

If replacing only the left hand pole unit, skip to section 4.1.4.5. If not replacing the right hand pole unit, skip to Section 4.1.4.4.

4.1.4.3 Right Hand Pole Unit Replacement

1. Be sure section 4.1.4.1 has been completed before proceeding.

2. Remove the four mounting screws holding the pole unit to the breaker frame. Use care when removing the pole unit so that the MOC actuating plate and linkage are not damaged (if breaker is equipped with MOC provisions).

3. Install a new pole unit, insuring that the MOC actuating plate (if so equipped) is placed on the pole unit operating shaft and that the operating shaft arm is located between the cross links. See Figure 21.

4. Install the four mounting screws. Insure that the pole unit is in proper alignment and has proper spacing with the remaining two pole units before tightening the mounting screws. It may be necessary to adjust the finger runback to obtain proper alignment. See Figure 22.

If not replacing the center pole unit, skip to section 4.1.4.5.

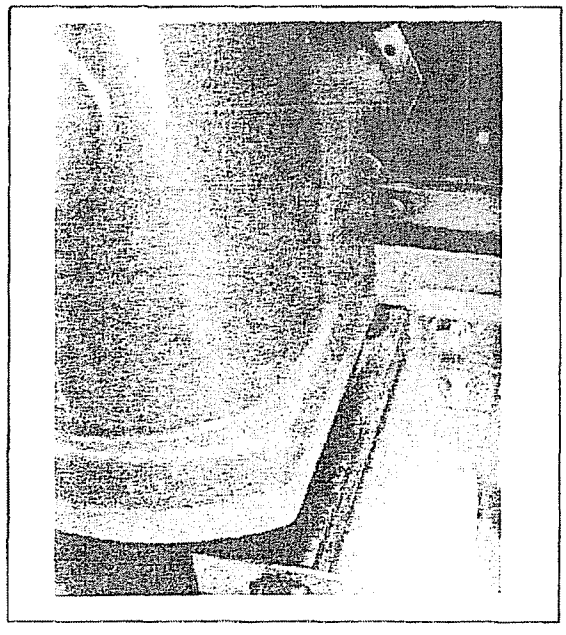


Figure 21
Operating Shaft Arm

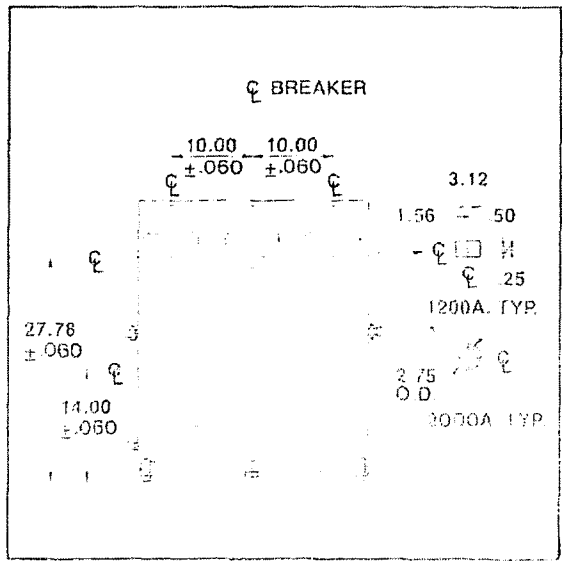


Figure 22
Alignment and Spacing

4.1.4.4 Center Pole Unit Replacement

1. Be sure section 4.1.4.1 has been completed before proceeding.

2. Remove the support channel below the pole units by removing the seven mounting screws. See Figure 23.

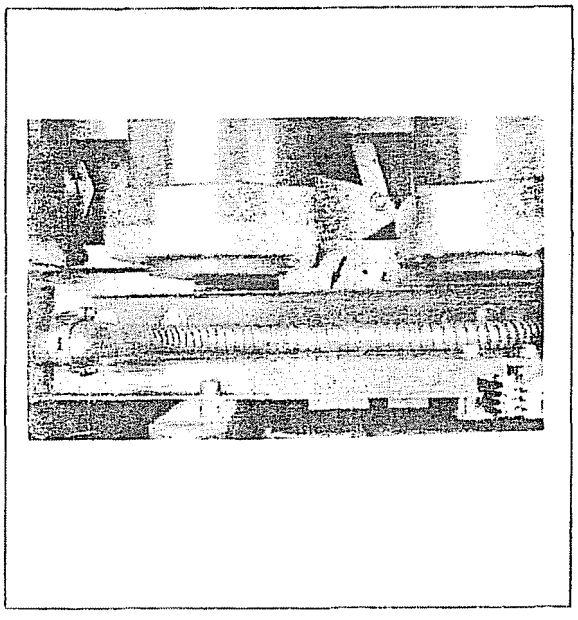


Figure 23
Support Channel

3. Remove the closing spring assemblies per section 4.1.3.A.

4. Using the manual charging handle, charge the mechanism to the end of the charge cycle. When the lower spring mounting pin rotates to the bottom of its travel, it will have to be pulled forward to complete the cycle.

5. Push and hold the close button in and begin slow closing the breaker by operating the charging handle.

6. Continue slow closing until the opening spring assembly begins to compress and the holes in the outer spring guide clear the bottom end of the inner spring guide. Install a 7/32" diameter pin through the holes on the opening spring guide. When force is released from the handle, the pin will assume the spring pressure. See Figure 24.

7. Remove the spring clip and pin to uncouple the opening spring assembly from the spring connecting link. See Figure 24.

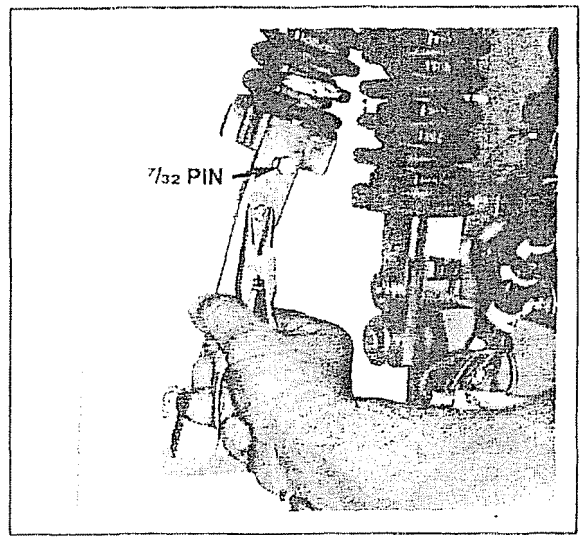


Figure 24
Disconnecting Opening Springs

8. Remove the cotter pin from the shock absorber axle, remove the axle from the rear, and drop the shock absorber down out of the way. Note the position of the spacers. See Figure 25.

9. Remove the retaining clip which holds the cross link to the pole unit and remove the cross link. See Figure 26.

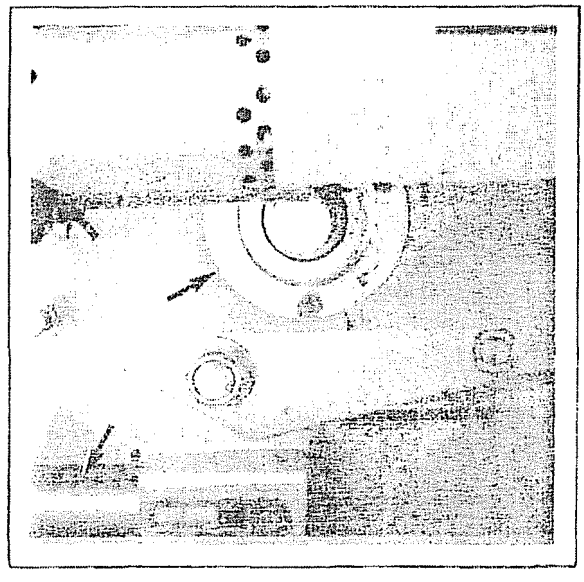


Figure 25
Shock Absorber and Bearing Cover

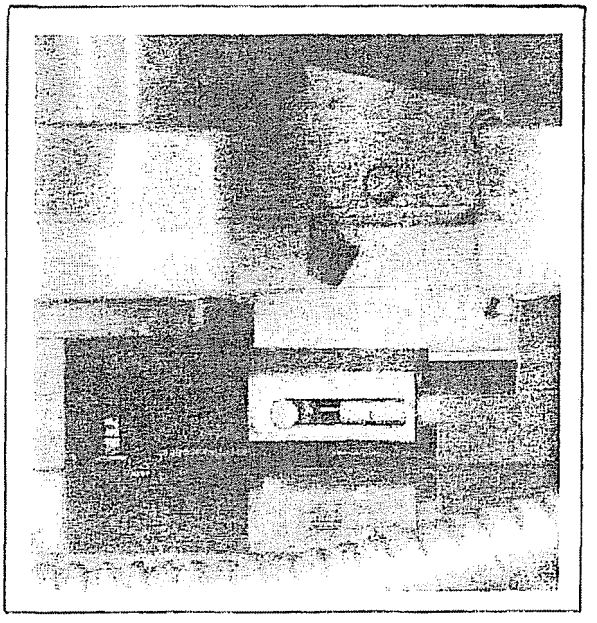


Figure 26
Cross Link Removal

10. Remove the bearing cover by removing the three mounting screws. Remove the bearing and spacers, noting the number and position of the spacers.

11. Remove the four mounting screws which hold the pole unit to the breaker frame. Remove the mechanism bell crank from the pole unit operating shaft.

12. Install a new pole unit, insuring that the mechanism bell crank is placed on the pole unit operating shaft.

13. Install the three mounting screws and finger tighten.

14. Replace the spacers in the position noted in step 4.1.4.4.10. and the bearing, centering the pole unit operating shaft in the bearing hole. Replace the bearing cover and secure with the four mounting screws.

15. Insure that the pole unit is in proper alignment and has proper spacing with the remaining two pole units. It may be necessary to adjust the contact finger runback to obtain proper alignment. See Figure 22. Tighten the mounting screws.

16. Reinstall the cross link and install the retaining clip onto the pin.

17. Position the shock absorber, installing the spacers as noted in section 4.1.4.4.8. Reinstall the shock absorber axle and install the cotter pin.

18. Reconnect the opening spring assembly to the connecting link, installing the pin from the rear, and reinstall the spring clip.

19. Using the manual charging handle, slow close the breaker slightly and remove the 7/32" pin on the opening spring assembly.

CAUTION

DO NOT PLACE A BREAKER INTO SERVICE WITHOUT REMOVING THE PIN.

4.1.4.5 Pole Unit Assembly Completion

1. Reconnect the auxiliary switch actuating plate to the operating shaft arm on the left hand pole unit. (If the breaker is equipped with MOC provisions, reconnect the MOC actuating plate to the operating shaft arm on the right hand pole unit.)

2. Install the pins which connect the cross links to the left and right pole unit operating shaft arms and install the circle clips. Be sure to pivot the stuck blade interlock so that it is on top of the auxiliary switch actuating plate.

If the center pole unit was replaced, complete section 4.1.4.6. If it was not replaced, reassembly of the breaker is complete. Check to see that all hardware, pins, clips, etc. were properly installed in the correct position. Before placing the breaker into service the opening stop must be readjusted per section 4.1.5.

4.1.4.6 Center Pole Unit Assembly Completion

1. Reinstall the support channel below the pole units and install the seven mounting screws.

2. Reinstall the closing spring assemblies per procedure 4.1.3.E.

Reassembly of the breaker is complete. Check to see that all hardware, pins, clips, etc. were properly installed in the correct position. Before placing the breaker into service, the opening stop must be readjusted per section 4.1.5.

4.1.5 OPENING STOP ADJUSTMENT

1. Remove the closing spring assemblies per section 4.1.3.A.

2. Disconnect the opening spring assembly per section 4.1.4.4, steps 4, 5, 6, and 7.

3. Disconnect the mechanism main link from the mechanism operating arm by removing the spring clip and pin located behind the main operating mechanism. See Figure 27.

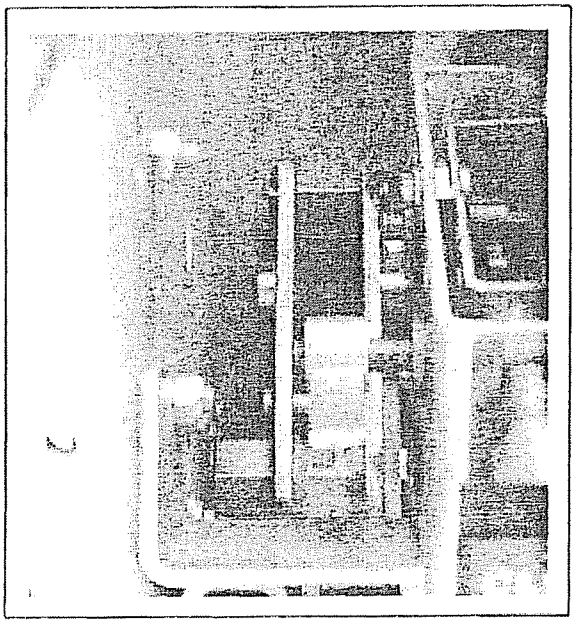


Figure 27
Mechanism Main Link

4. Loosen the locking nut and remove the stop screw and locking nut.

5. Move the cross links as far to the left as they will go. Measure the distance D_1 between the stop block surface and the surfaces of the cross links which come into contact with the stop screw. See Figure 28.

6. Coat the threads of the stop screw and locking nut with Loctite. Install the screw and locking nut so that the distance from the stop block surface to the top of the screw head is $D_2 = D_1 + 0.22"$ (5.5 mm). Secure the locking nut. See Figure 29.

7. Reconnect the mechanism main link to the mechanism operating arm with the pin and spring clip. See Figure 27.

8. Reconnect the opening spring assembly per section 4.1.4.4, steps 19 and 20.

9. Reinstall the closing spring assemblies per procedure 4.1.3.E.

The opening stop adjustment is complete.

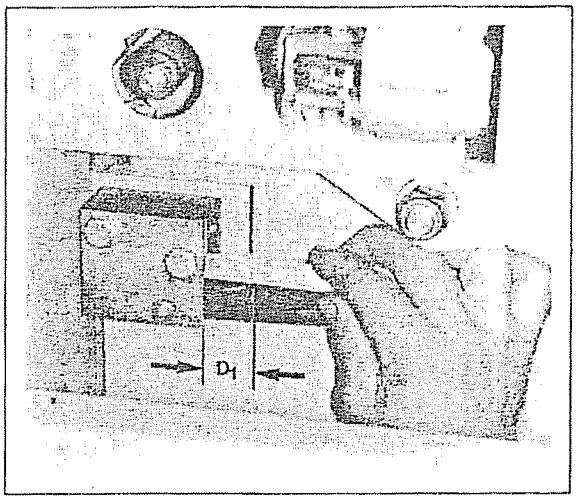


Figure 28
Stop Block Measurement

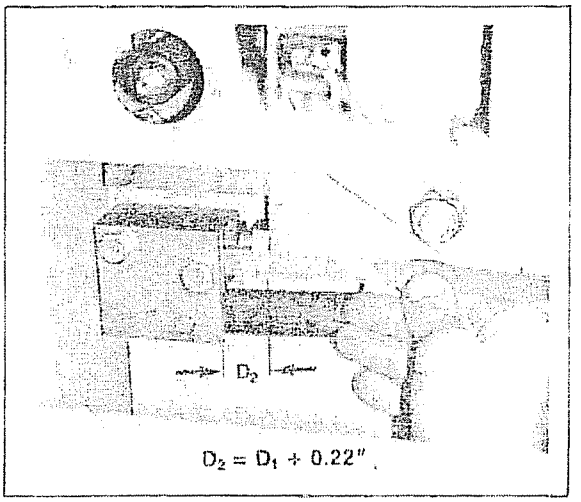


Figure 29
Stop Screw Installation

4.2 Primary Disconnecting Finger Assemblies

There are three ratings of primary disconnecting finger assemblies, 1200, 2000, and 3000 amp as shown below.

The fingers for each of the three ratings are the same. Force is applied by two leaf springs. The fingers are made of copper and have 0 0002 inch thick silver plating.

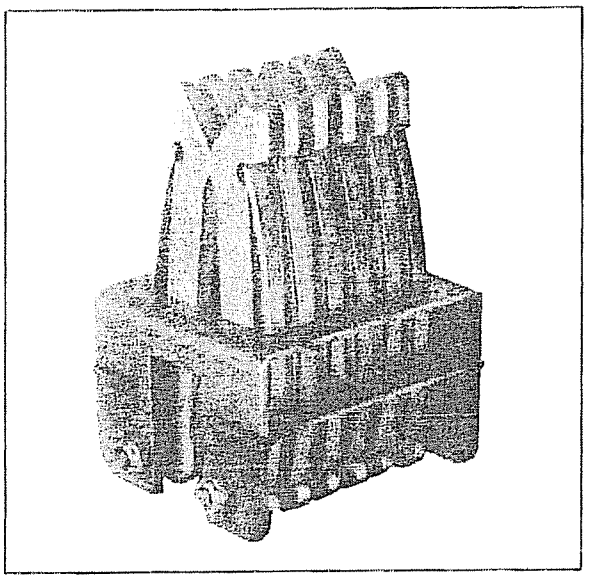


Figure 30
1200 Amp (12 Finger)
Part No. 46001-263-51

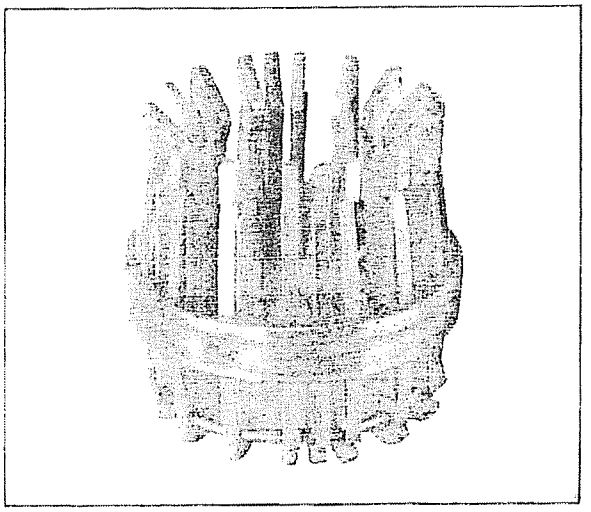


Figure 31
2000 Amp (20 Finger)
Part No. 46001-445-50

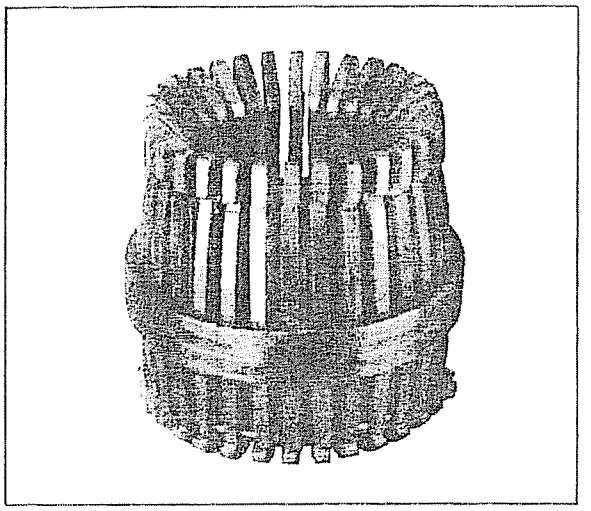


Figure 32
3000 Amp (32 Finger)
Part No. 46001-445-51

In cases of unusual service, it is possible that the silver plating may be worn off exposing the copper in some areas. This is not considered to be an unserviceable condition.

In the event the surfaces become pitted or otherwise contaminated to an unserviceable condition, the contact surfaces can be polished to a clean copper condition. Bare copper surfaces, in this case, should be replated using a portable process such as "Kool-Amp" to restore the silver surface.

Some ratings are coated at the factory using Square D Company electrical joining compound PJC-7201. It is recommended that this compound be used on all ratings should contact surface maintenance be necessary or adverse atmospheric conditions exist.

4.2.1 1200A CONNECTOR REPLACEMENT

To service the 1200A contact fingers, remove the assembly by removing the two #10-32 screws and sliding the finger assembly from the retainer. When reinstalling, be sure the screws are behind the pins in the connector block and that they secure each finger to the assembly.

4.2.2 2000A & 3000A CONNECTOR REPLACEMENT

To service the 2000A and 3000A contact finger assemblies, the clusters must be removed from the breaker runbacks. Remove the four #10-32 screws holding the retaining anchors. After removing the four screws and anchors, remove the plug from the center of the finger cluster. Slide the finger cluster off of the runback. Individual fingers are removed from the cluster by first removing the leaf springs.

Reassembly is accomplished by reversing this procedure.

4.2.3 PRIMARY DISCONNECT ALIGNMENT

The primary disconnect is designed to provide full ratings while being out of alignment with the fixed stab in the breaker cell by as much as 0.125 inch (3mm).

4.2.4 GROUND SHOE

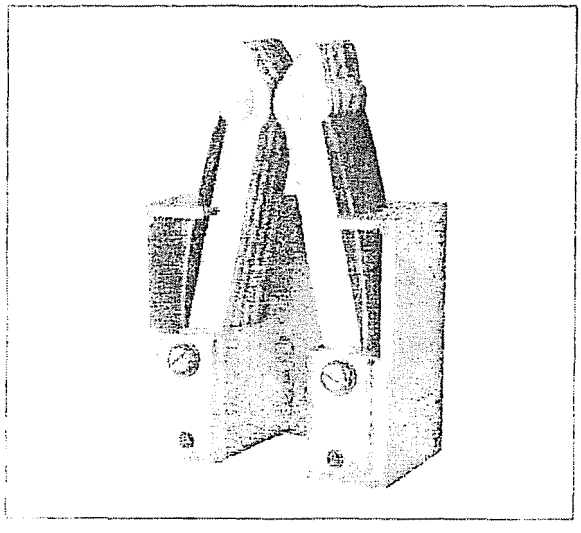


Figure 33
Ground Shoe
Part No. C1504

4.3 Control Circuits

Figure 34 illustrates a typical control circuit schematic with AC or DC closing and AC tripping. Figure 35 shows AC or DC closing and DC tripping.

In addition to the breaker mounted auxiliary switches, up to 12 additional breaker operated auxiliary contacts may be mounted on the breaker cell structure. As illustrated, breaker control circuits may operate at different control voltages. For example, a breaker may have closing circuit components rated for 120V AC and trip circuit components rated for 125V DC.

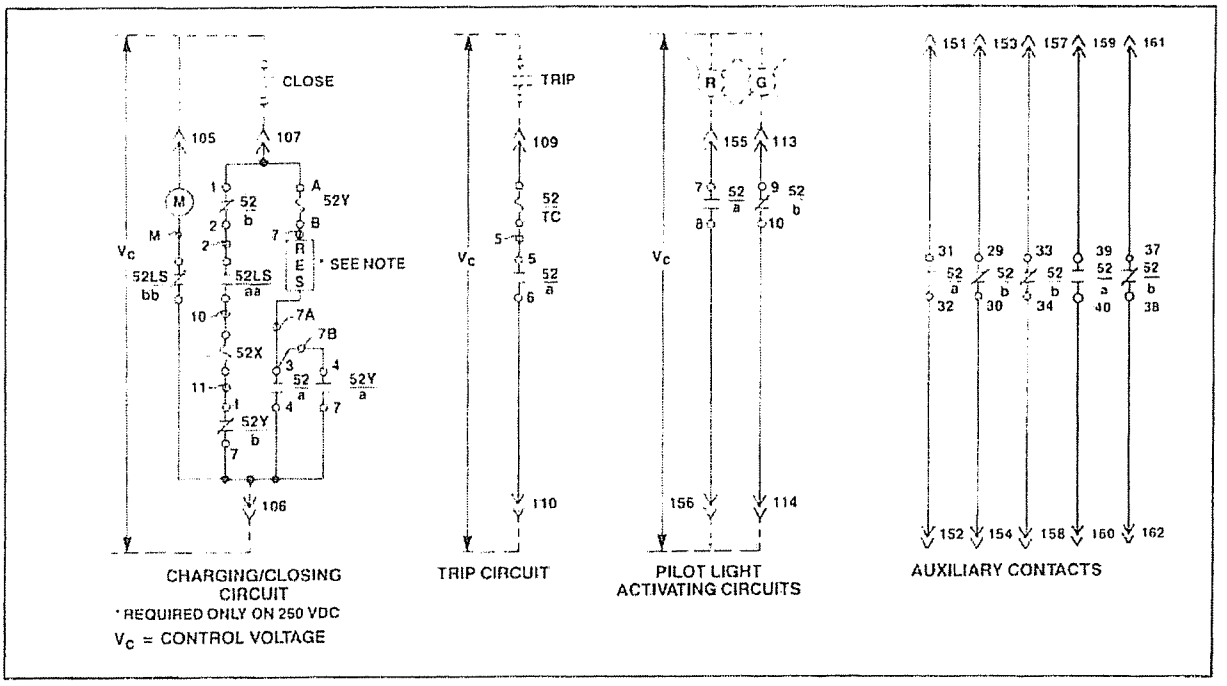


Figure 34
AC or DC Close, AC Trip

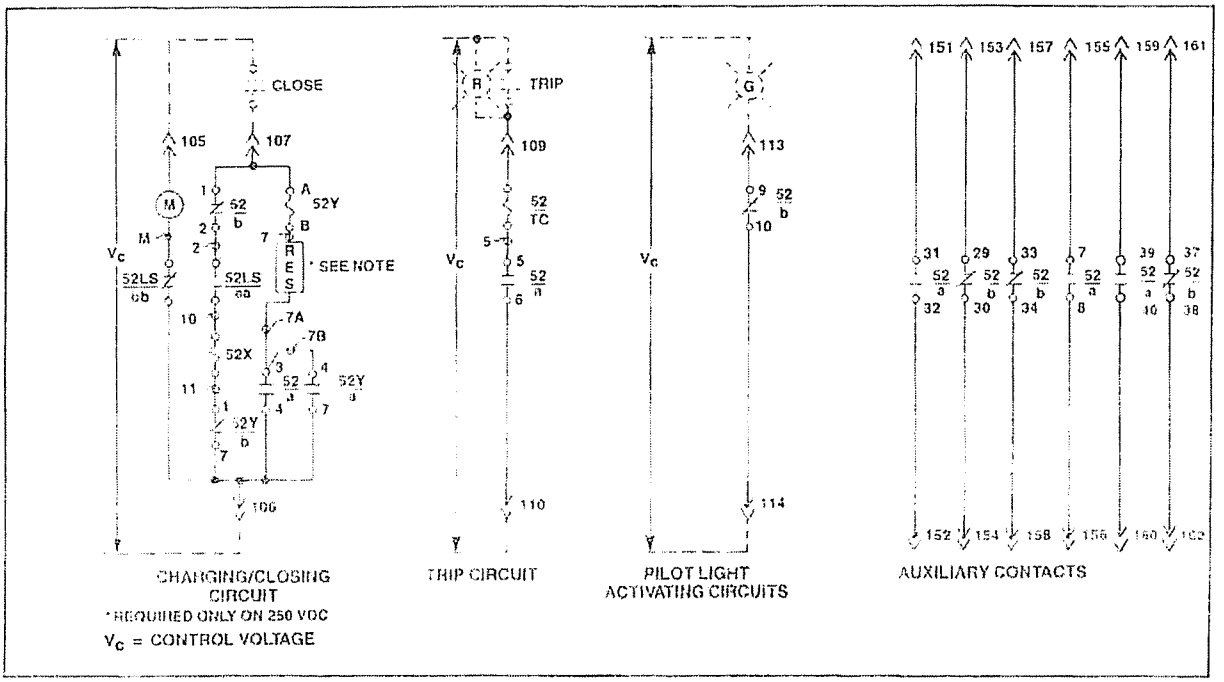


Figure 35
AC or DC Close, DC Trip

4.3.1 CHARGING MOTOR

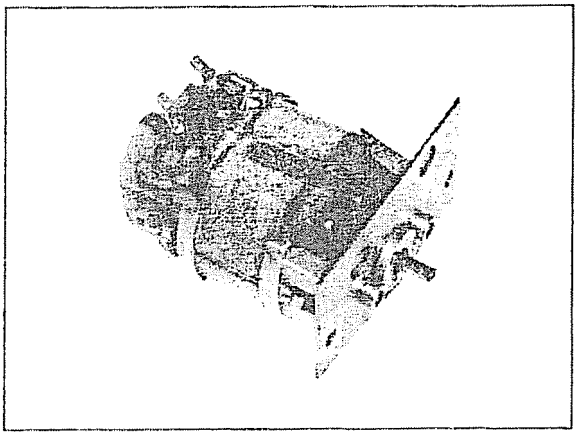


Figure 36
Charging Motor

CHARGING MOTORS		
RATED VOLTAGE	PART NUMBER	CURRENT AT RATED VOLTAGE
48VDC	886658	6A
125VDC	886672	3.2A
250VDC	886662	1.6A
120VAC	886672	3A
240VAC	886662	1.6A

4.3.2 CLOSING SOLENOID

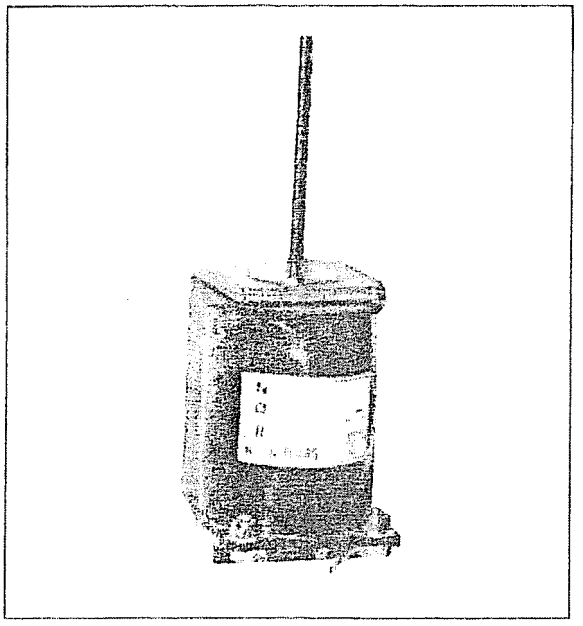


Figure 37
Closing Solenoid

CLOSING SOLENOIDS		
RATED VOLTAGE	PART NUMBER	DC RESISTANCE @20°C(Ω)
48VDC	887191 AH	68
125VDC	887191 AD	480
250VDC	887191 AA	1700
120VAC	887191 AK	26
240VAC	887191 AG	115

4.3.3 ANTI-PUMP RELAY

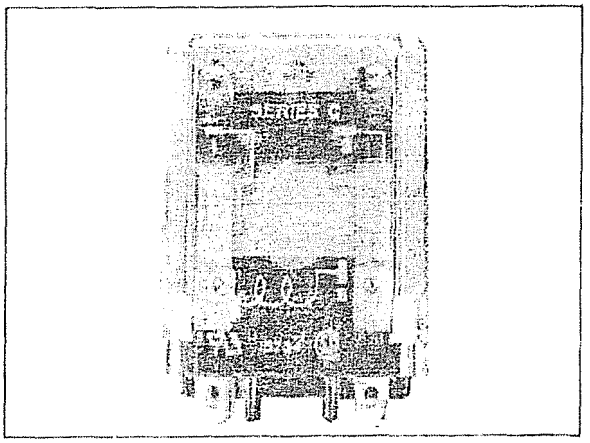


Figure 38
Anti-Pump Relay

ANTI-PUMP RELAYS		
RATED VOLTAGE	PART NUMBER	DC RESISTANCE @ 20 °C(Ω)
48 VDC	KUP 11D 55 48 VDC	1800
125 VDC	8501 KFD 12 125 VDC	6450
250 VAC	*8501 KFD-12 125 VDC	**12450
120 VAC	8501 KF-12 120/60	2250
240 VAC	44050-266-01	7200

*Resistor Part Number 26160-21660 Required
**Includes Resistor of 6000Ω

4.3.4 OPENING SOLENOID

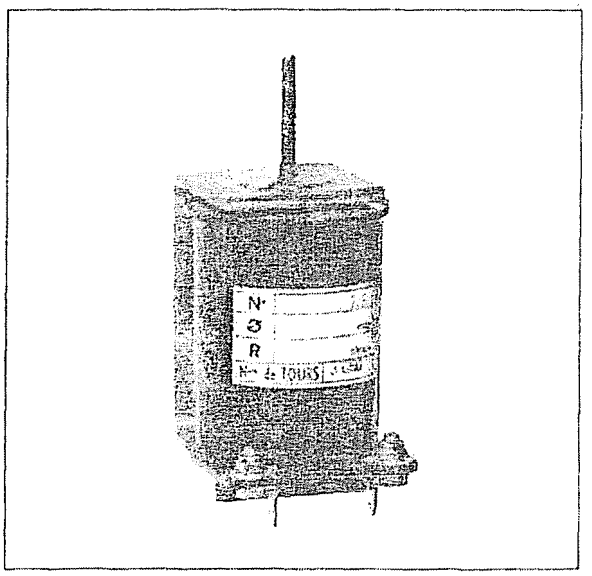


Figure 39
Opening Solenoid

OPENING SOLENOIDS		
RATED VOLTAGE	PART NUMBER	DC RESISTANCE @ 20 °C(Ω)
24VDC	887191 BN	6.75
48VDC	887191 BJ	44.5
125VDC	887191 BF	184
250VDC	887191 BB	1100
120VAC	887191 BJ	44.5
240VAC	887191 BF	184

4.3.5 END-OF-CHARGING SWITCH

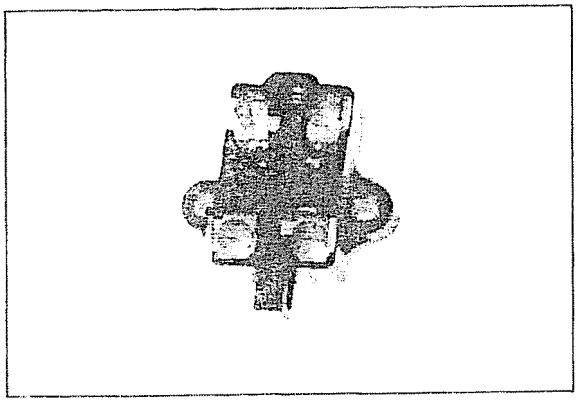


Figure 40
Part Number 25710904

4.3.6 SECONDARY CONTROL POWER PLUG

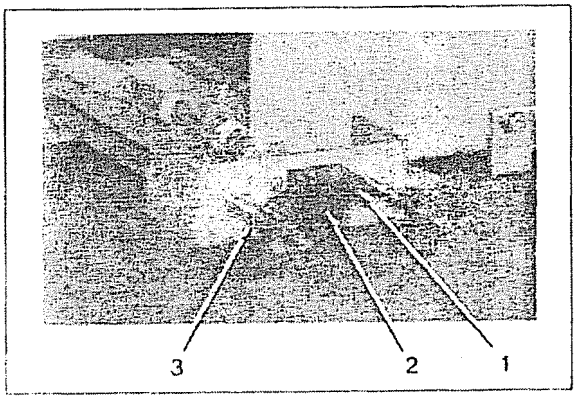


Figure 41
Secondary Control Power Plug

1	CONTROL PLUG RECEPTACLE	46049-25901
2	PIN	46049-25903
3	SLEEVE PIN	46003-219451

4.3.7 BREAKER CONTROL SWITCH BLOCK - (UPPER SWITCH BLOCK)

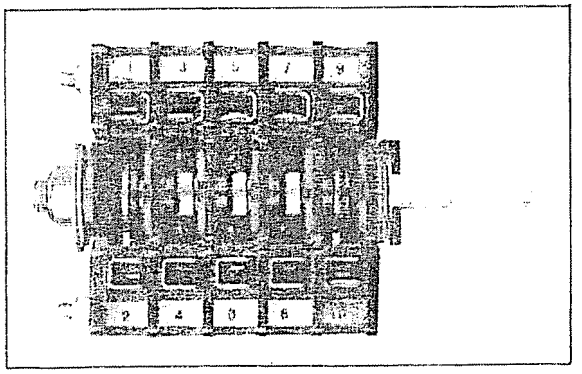


Figure 42
Five Circuit Control Switch Block
Part Number 877942K

The breaker control circuit switch block contains two normally closed (b) contacts and three normally open (a) contacts. Each contact is a standard contact using short contact cams. The timing of these contacts is factory set and should not require adjustment. The type of contacts as well as the contact numbering is different than on the 877942C Auxiliary Switch Block. Note these differences to ensure the proper switch block is used if it is to be replaced.

4.3.8 AUXILIARY SWITCH BLOCK - (LOWER SWITCH BLOCK)

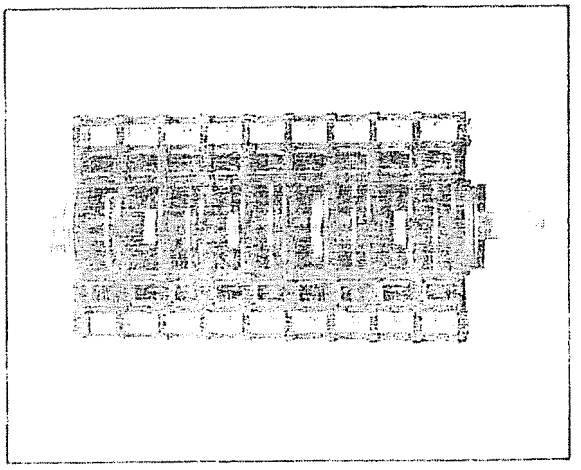


Figure 43
Nine Circuit Auxiliary Switch Block
Part Number 877942C

FG-2 breakers are equipped with nine circuit auxiliary switch blocks as standard. Only three of these circuits may be wired out through the control power plug. Additional circuits are available through the use of the cell mounted mechanism operated contacts. Nine circuit switch blocks have five normally closed (b) contacts and four normally open (a) contacts. One of the (b) contacts is equipped with a wide cam to provide a late break contact. One of the (a) contacts is equipped with a wide cam to provide an early make contact. Standard wiring provides two standard normally closed (b) contacts and one standard normally open (a) contact. The mix of contacts may be changed by rewiring the switch block. As an example, move the wires from the terminals of a (b) contact to the terminals of an (a) contact to change the mix to two standard normally open contacts and one standard normally closed contact.

In addition, the contact cams are provided with indentations which permit up to 34 different timing positions. For critically timed circuits, the cams can be adjusted to provide the specific timing necessary to satisfy the requirement.

4.3.8.1 Auxiliary Switch Cam Timing

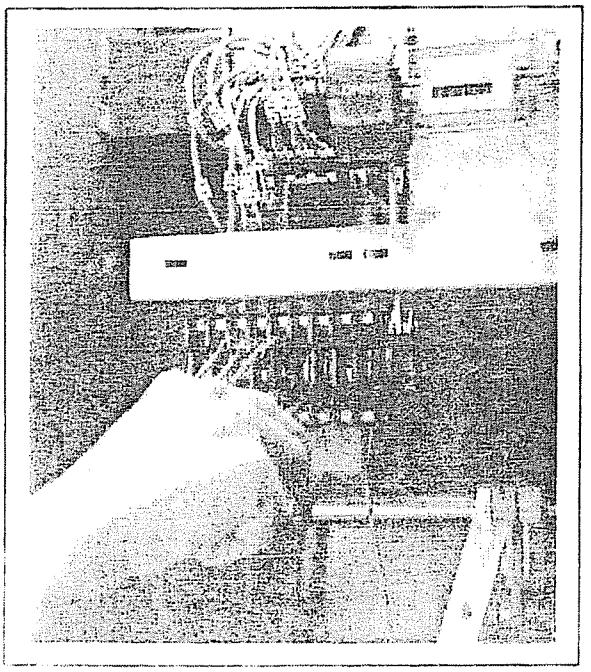


Figure 44
Auxiliary Switch Cam Timing

Cam timing is accomplished as follows:

1. Note the position of each cam with the breaker closed and open. A pencil sketch is recommended.
2. Open or close the breaker to position the cam to be changed in the open position.
3. Hold the square end of the shaft using an eight millimeter open end wrench.
4. Using a 13mm wrench, loosen the lock nut on the opposite end of the shaft 1 or 2 turns.
5. Insert a thin bladed screwdriver between the metal cam and the notched ring of the contact to be adjusted to separate and release the indentation in the metal cam from the notched ring. See Figure 44.
6. The cam is now free to turn. Rotate the cam to the new position.
7. Insert the screwdriver between the nut and washer at the end of the block to reclose the gap between the metal cam and the notched ring. The cam may need to be moved slightly to align the indentation and the notch. See Figure 45.

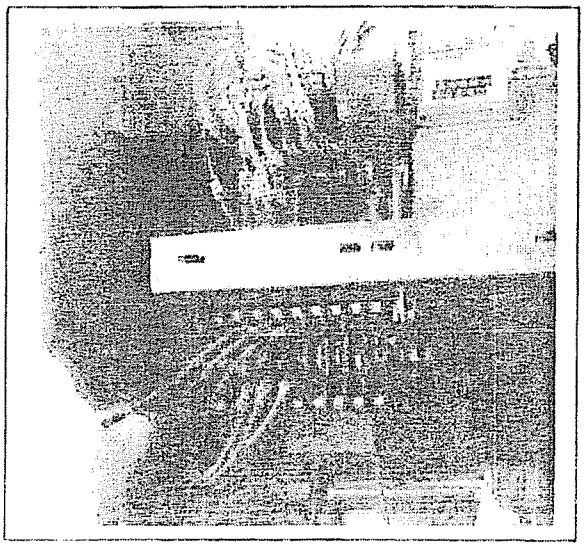


Figure 45
Auxiliary Switch Reassembly

8. Retighten the 13mm lock nut, taking care that all of the other cams are in their original position and all of the cam indentations are properly seated in their respective notches.
9. Operate the breaker to assure that the adjustment accomplished the purpose intended, and that all other cams operate as before.

CAUTION

IT IS POSSIBLE THAT SPECIAL CAM SETTINGS MAY PRODUCE UNINTENDED OPERATION BY OVERTRAVEL AT THE END OF EITHER THE OPEN OR CLOSE OPERATION. USING AN 8MM OPEN END WRENCH, APPLY A TORQUE TO THE SWITCH OPERATING SHAFT IN BOTH DIRECTIONS, WITH THE BREAKER IN BOTH THE OPEN AND CLOSED POSITIONS, TO INSURE THAT THE CONTACTS DO NOT CHANGE STATE AT THE ENDS OF TRAVEL.

4.4 Charging Mechanism

The mechanism provides the mechanical energy to open and close the breaker under all conditions. Energy is required to perform the following operational functions:

1. Closing the breaker into short circuit currents.
2. Operating the auxiliary switches.
3. Charging the opening springs.
4. Operating the MOC switches (if so equipped).

With the breaker open and the closing springs uncharged, the stored energy level is essentially zero and no functions can be performed. With the breaker open and the closing springs charged, the stored energy level is such that the breaker can perform one complete close-open cycle. The stored energy is at its highest level when the breaker is closed and the closing springs are charged. In this case, both the opening and closing springs are charged. Thus, the breaker is capable of opening, closing, and reopening without recharging the springs.

All of the energy for one close-open cycle is supplied by a single charging of the closing springs. The closing springs may be recharged immediately following a closing operation.

A close-open cycle is accomplished by the following basic steps:

1. Charging the closing springs.
2. Releasing the closing spring latch.
3. Releasing the opening latch.

During the closing operation, a portion of the closing energy is used to charge the opening springs.

4.4.1 CLOSING SPRINGS & CHARGING MECHANISM The closing springs are attached to cranks at both ends of a hexagonal shaft. The shaft and mechanism are designed to rotate in only one direction a total of 360 degrees. A notched wheel and pawl assembly is arranged such that as the pawl assembly is oscillated, the hexagonal shaft is rotated from the rest position to a position just past 180 degrees from the uncharged position. The pawl assembly is oscillated by manual means or by an electric motor. An electric motor and gear box is equipped with an eccentric cam which oscillates the pawl assembly.

The notched wheel has a missing tooth which is at the location of the motor driven pawl when the springs are fully charged. This prevents damage to the mechanism and gear box due to the kinetic energy remaining in the motor after being switched off.

The hexagonal shaft also connects to a cam which is used in closing the breaker. A roller in this cam is designed to come in contact with the closing spring latch just as the charged springs go over center. This stops the shaft from rotating and the breaker from closing until the closing spring latch is released.

4.4.2 CLOSING SPRING LATCH - The closing spring latch is a compound latch assembly. The primary latch consists of a roller, mounted to the closing cam, and the main closing latch arm. The latch arm is subsequently held by a secondary closing latch shaft which has a machined cut in the side. As the closing latch shaft is rotated, it releases the latch arm which in turn slips by the roller in the closing cam permitting the hexagonal shaft to rotate discharging the spring energy into the closing cam.

The closing latch shaft (with the machined cut) is equipped with a disconnecting link interlock. This interlock is interconnected with the opening shaft in such a way that whenever the opening shaft is operated, the interlock is activated. When the interlock is activated, the input to the closing latch is disconnected and the closing springs cannot be released to close the breaker. This interlock is arranged such that a closing signal must first be removed before the interlock will reset and allow the application of a closing signal to the closing spring latch.

The closing signal from the pushbutton or closing solenoid is applied as input to the closing latch.

There are no adjustments to any of these mechanical systems. To insure proper operation, the sequence of the closing latch interlock should be observed. The interlock linkage should disconnect the closing latch with an initial motion of the opening latch shaft and before the opening latch releases. The linkage should be reconnected when the opening latch is in the rest position. Should the interlock function as indicated and the breaker closes within published closing times, the closing mechanism should be judged adequate.

4.4.3 OPENING LATCH - The opening latch is a compound latch assembly. The primary latch operates in conjunction with the closing cam follower. As the breaker closes, the cam follower latches in the closed position with the primary opening latch prop. The latch prop is carried by a bell crank which toggles with an opening arm which finally is latched by the opening shaft having a machined flat on one side.

The primary opening prop is positioned such that with the opening latch system in the latched position, the prop is pushed by the cam follower to a stop mounted on the bell crank. As the latch system is released, the bell crank moves in such a way that the forces on the prop permit the prop to rotate away from the stop permitting the cam follower to open freely. Although not adjustable, the condition of the prop is critical and should malfunctions be encountered, this should be checked per procedure 4.4.4.

The bell crank is normally held from turning by the opening latch arm which is in turn latched by the opening shaft. Any mechanical signal applied to the opening shaft at any time will release the opening latch system permitting the breaker to open (or reopen if in the process of closing). Should an opening signal be applied while the breaker is in the process of closing, the breaker will close completely and then open.

A tapered screw forms a stop for the rotational motion of the opening shaft. The position of the stop controls the amount of overlap of the opening shaft with the opening arm. Insufficient overlap can cause excessive wear and nuisance tripping. Excessive overlap can cause longer trip times and higher trip currents to be applied to the solenoids.

4.4.4 OPENING PROP CHECK - It is possible through wear or contamination that a breaker could trip open for no reason or not stay closed. Should this condition exist, the condition of the opening prop should be checked. This is accomplished in the following manner:

1. Close the breaker.

2. Force a 0.080 inch (2mm) thick wedge between the opening prop and bell crank mounted stop.

3. If this forces the prop over center and the breaker opens, the breakers will require servicing.

4. If forcing the wedge into the stop does not cause the breaker to open, the mechanism is considered usable.

Should this test show that servicing is required, contact your local field office for service.

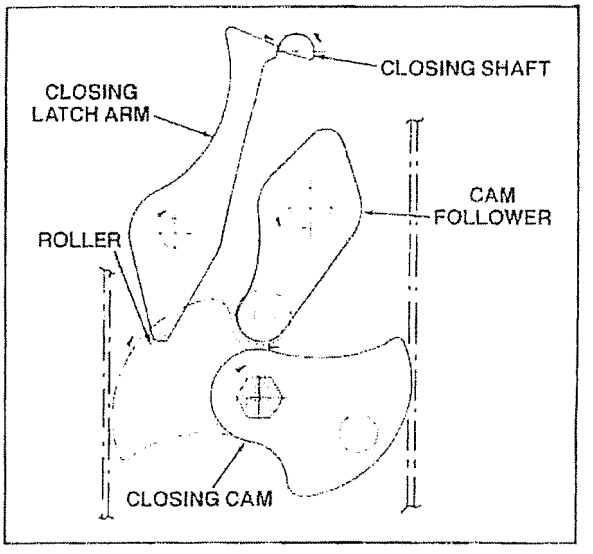


Figure 46
Closing Mechanism

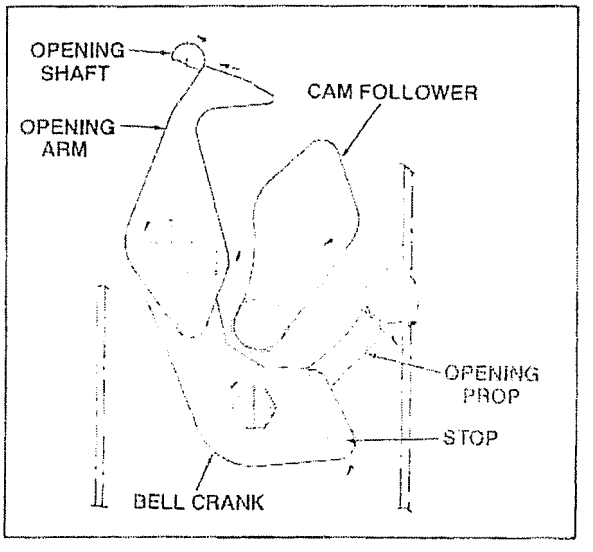


Figure 47
Opening Mechanism

4.4.5 CLOSING SPRING ASSEMBLY

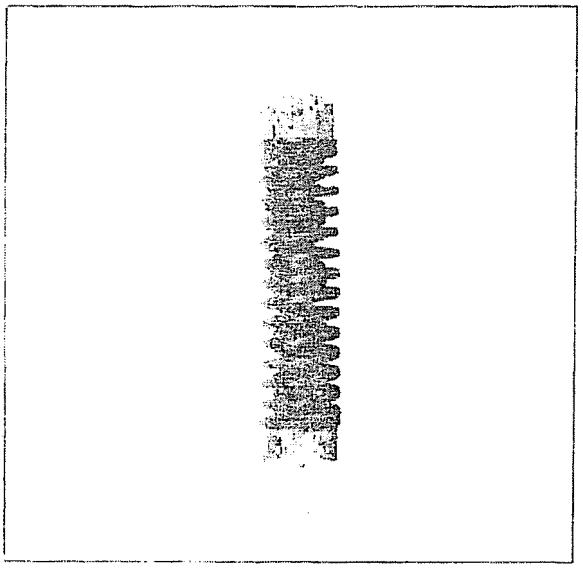


Figure 48
Closing Spring Assembly

4.4.6 OPENING SPRING ASSEMBLY

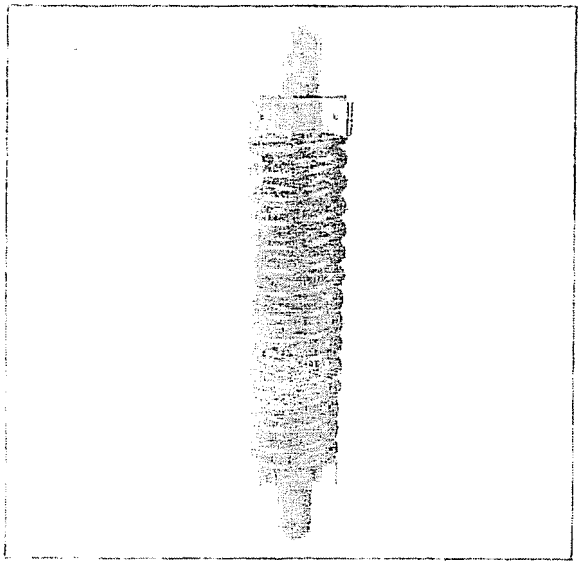


Figure 49
Opening Spring Assembly

5.0 RECOMMENDED SPARE PARTS

PART CONSIDERED FOR STOCK	NUMBER OF BREAKERS IN SERVICE			
	1	2-3	4-10	11-30
CHARGING MOTOR			1	2
AUXILIARY SWITCH BLOCK			1	2
END-OF CHARGING SWITCH	1	1	1	2
ANTI-PUMP RELAY		1	1	2
CLOSING SOLENOID	1	1	1	2
OPENING SOLENOID	1	1	1	2
POLE UNIT			1	3
PRIMARY DISCONNECT FINGER ASSEMBLY		1	3	6
SECONDARY CONTROL POWER PLUG		1	1	2

Table 3
Recommended Spare Parts

6.0 MAINTENANCE

6.1 Lubrication Materials

1. Multi-Grade Fluid Oil (SAE 10W40)
2. Molybdenum Disulfide Grease (Dow Corning, Molykote BR-2 Plus)
3. PJC 7201 Joint Compound

CAUTION

INCORRECT USE OF LUBRICANTS MAY CAUSE IMPROPER OPERATIONS. FOR EXAMPLE, EXCESSIVE USE OF GREASE NOT INTENDED FOR COLD WEATHER OPERATION MAY CAUSE THE MECHANISM NOT TO OPERATE OR TO OPERATE WITH A LONGER TIME SPECIFIED FOR

6.2 Frequency Of Maintenance

Maintenance should be scheduled every three years or every 2000 operations, whichever comes sooner. Due to specific environmental conditions, maintenance may be scheduled more, or less, frequently. Consideration for more frequent maintenance should be given to applications in environments with high temperatures or contaminated atmospheres.

6.3 Mechanism Cleaning

Of prime importance is the cleanliness and proper lubrication of bearing surfaces. Dirt on the exterior surface of parts does not necessarily indicate the condition of bearing surfaces. In many instances it is better to lubricate without cleaning, as long as dirt is not forced into bearing surface areas. Should cleaning be attempted, consideration should be given to the part and bearing surface being cleaned such that dirt is not introduced into the bearing areas of the parts of interest. Should cleaning be necessary, the parts to be cleaned should be disassembled and cleaned thoroughly before new lubricants are applied. Except for isolated cases, it is recommended that cleaning be limited to portions of the mechanism that can be disassembled, cleaned, inspected, lubricated and reassembled.

6.4 Field Lubrication

Field lubrication would consist of adding lubricants without cleaning in most instances.

1. Locate all mechanical bearing surfaces such as rotating shafts in bearings, or parts sliding in relation to each other. This would include ball bearings. Apply sufficient quantities of a multi-grade fluid oil in the most direct fashion available to assure that the oil has been applied to the surfaces to be lubricated. See Figures 50, 51 and 52. Operate the mechanism a few times and relubricate to enhance the flow of lubricant. Wipe off excessive lubricant taking care not to force dirt into lubricated areas.

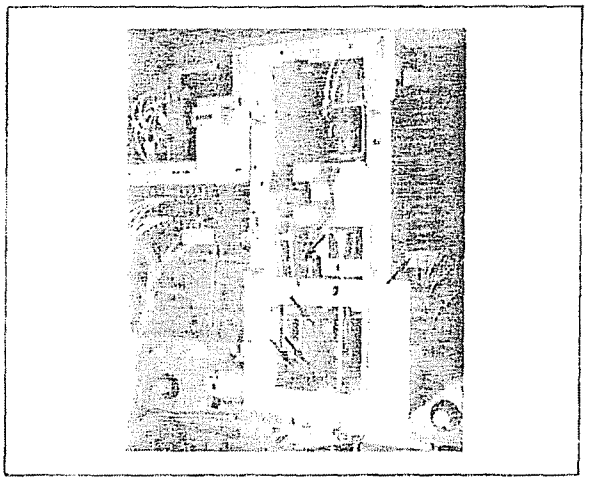


Figure 50
Mechanism Lubrication

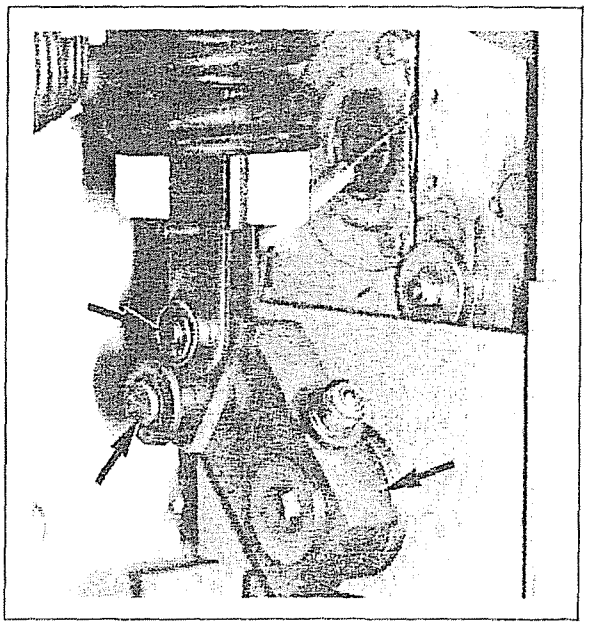


Figure 51
Mechanism Lubrication

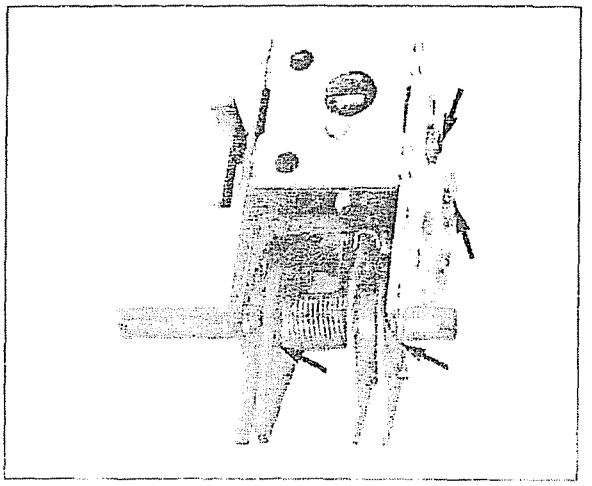


Figure 52
Latching Mechanism Lubrication

2. Lubricate the opening and closing spring guide slides using a low temperature grease. See Figure 53.

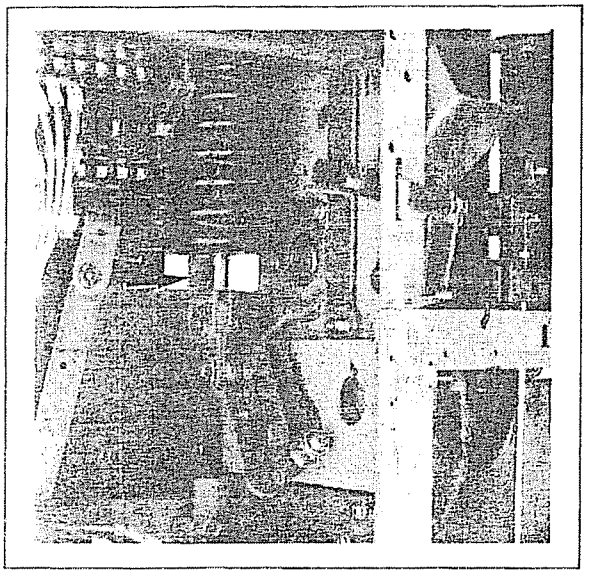


Figure 53
Spring Guide Lubrication

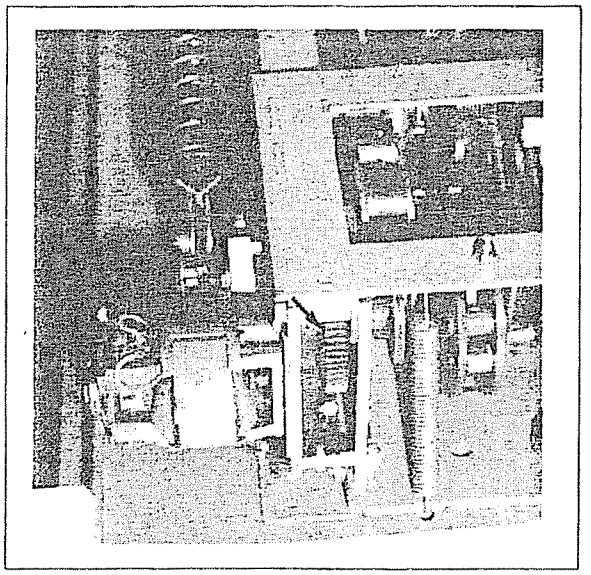


Figure 55
Gear Lubrication

3. Lubricate trip latch surfaces and gears using molybdenum disulfide grease. See Figures 54 and 55

4. Clean, and lubricate primary disconnect fingers using PJC-7201 joint compound

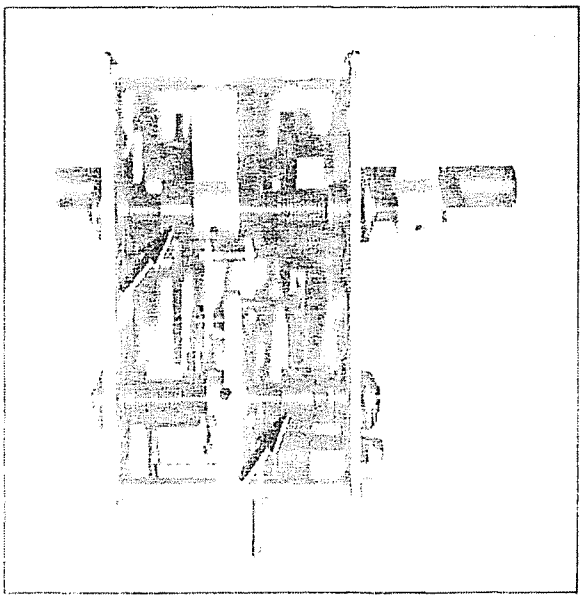


Figure 54
Latch Lubrication

6.5 Testing

6.5.1 Pole Unit Resistance Check

POLE UNIT RESISTANCE CHECK - Low resistance measurements are usually made by a four terminal resistance bridge. With the breaker closed, high current (about 100 A. DC) is passed through the pole unit using two current probes. The two potential probes should be placed just behind the primary disconnect finger assemblies to read the resistance.

It is possible that the measured resistance can vary up to 100%. Variations above 100% should be considered questionable and the pole unit should be considered for replacement.

CURRENT RATING	RESISTANCE in OHMS
1200A	[illegible]
2000A	[illegible]
3000A	[illegible]

Table 4
Pole Unit Resistance

6.5.2 DIELECTRIC TEST

With the breaker open, apply 27kV 60 Hz or 38kV DC potential from each terminal to ground, and between each set of terminals, including across each open pole unit.

With the breaker closed, apply 27kV 60 Hz or 38kV DC potential from each pole to ground and between the poles.

The breaker should carry this test voltage for one minute without failure.

6.5.3 ARCING CONTACT WEAR CHECK

Measure the arcing contact wear per section 4.1.3.

6.5.4 GAS PRESSURE CHECK

Gas pressure checks are not recommended as a normal routine test. The pole units are sealed for life, requiring no service.

SQUARE D COMPANY
330 Weakley Road, Smyrna, Tenn. 37167

Manual 6055-2 2.5M 10-87 PS Printed in U.S.A.

October, 1987

Manual 6055-1

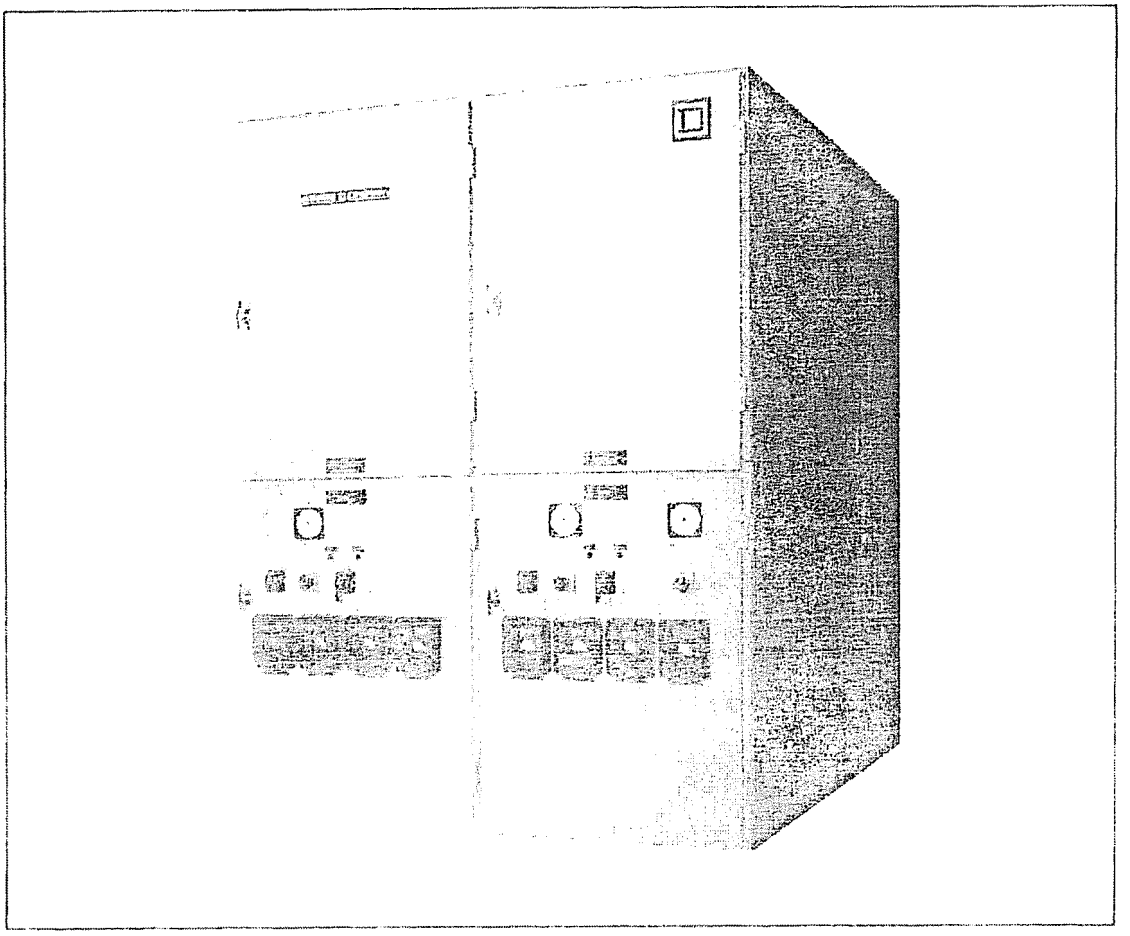
Supersedes Manual 6055-1
Dated September, 1984

Instruction & Maintenance Manual

5-15kV Metal-Clad Indoor Switchgear

Series 2

WITH TYPE FG-2 (SF_6) OR TYPE VAD-2 (VACUUM) AC HIGH VOLTAGE CIRCUIT BREAKERS



SQUARE D COMPANY

CLASS 6055

5-15kV METAL-CLAD INDOOR SWITCHGEAR SERIES 2

CAUTION

SQUARE D TWO-HIGH, 5-15kV, Draw-Out, Metal-Clad Switchgear is heavy duty electrical equipment designed and thoroughly tested to provide high voltage distribution. The assembly consists of sophisticated mechanical and electrical devices that when properly installed, operated and maintained will provide a safe, efficient and durable coordinated electrical system.

1. All personnel involved in the Handling, Site Preparation, Installation, Testing, Operation and Maintenance should be thoroughly familiar with the information in this Instruction Manual and shown on the Customer Drawings provided BEFORE working on this equipment.

2. Do not drop or roughly handle the assembly or the circuit breakers. The shipping skids and crates are more than adequate for normal handling, but the assembly structure, insulation, relays, meters and the circuit breakers could be damaged by abusive handling and could result in costly start-up delays.

3. The Site Preparation should be completed with floor channels, station grounds and conduit stubs in place and the concrete cured and finished before setting the assembly in place.

4. The assembly is mechanically arranged so that all high voltage parts are covered by metal or insulated panels or barriers. All panels and barriers removed for inspection and installation MUST be put back in place before energizing this equipment.

5. "THINK SAFETY"
   a) Always assume all high voltage parts are energized until you yourself have proven them to be de-energized.
   b) Check interconnection circuit diagrams to be sure there is no chance of back feed.
   c) Never disconnect the main trip source of energized equipment.
   d) Do not open a circuit breaker door unless the circuit breaker is tripped.
   e) Remove circuit breakers to the disconnect position before removing rear access panels.
   f) Use OUT of SERVICE tags and padlocks when working on equipment and leave in place when leaving area or until work is completed and equipment is ready to be put back in service.
   g) WHEN IN DOUBT, STOP! Re-read this Instruction Manual or refer to the Customer Drawings before proceeding. Eliminate dangerous and costly human errors!
   h) The complete assembly arrangement determines if the top or bottom contacts are the line side, and both can be energized when the circuit breaker is removed from the compartment.
   i) Disconnect all high voltage to the switchgear before accessing the horizontal bus compartment.

6. Do not use water or liquid fire extinguishers on electrical fires! Be absolutely sure the main source of power is disconnected and the main and all feeder circuit breakers are tripped before trying to extinguish fires within the assembly.

7. Provide adequate ventilation for station battery systems and avoid the use of open flames near the batteries.

This Instruction Manual does not cover all the details or possible combinations of equipment available, or field conditions that may exist, or that may arise during handling, site-preparation, installation, testing, operation or maintenance. If additional information is necessary or unforseen site conditions or problems exist, contact the local Square D field office.

The standard product covered by this Instruction Manual meets all the requirements of the applicable ANSI, IEEE and NEMA standards; but due to the wide variances possible it is not implied that it will be in accordance with all local codes and ordinances.

5-15kV METAL-CLAD INDOOR SWITCHGEAR SERIES 2

CONTENTS

CONTENTS (Continued)

5-15kV METAL-CLAD INDOOR SWITCHGEAR SERIES 2

INTRODUCTION

TWO-HIGH, 5-15kV, Draw Out Metal-Clad Switchgear provides a unique design that allows the individual use or combined use of Type FG-2 (SF_6) or Type VAD-2 (Vacuum) circuit breakers to give the speed and type of interrupting medium desired to control each high voltage distribution circuit.

The assembly consists of individually grounded steel cells, each compartmentalized and built with doors, barriers and removable access panels to isolate the separate working functions and provide maximum personnel safety. All of the circuit breakers, instrument and control power transformers, relays, meters and other components are factory assembled, wired and tested as an assembly. The user is normally only required to make the external control, ground and power connections at the terminals provided and reconnect the wiring and bus bars at the shipping splits.

Each assembly is custom designed to meet the users specifications using standard cells and bus configurations. These standards are then arranged and combined with the type of circuit breaker and other components necessary to allow the required number of feeders, metering and protective scheme required.

Complete customer drawings are furnished for each assembly including floor plan and elevations, one line diagram, control schematics and wiring diagrams.

DESCRIPTION

Assembly

An assembly consists of one or more basic cells, each with its own complement of compartments. Each cell is a separate, rigid, self-contained structure, fabricated of heavy gauge steel and welded to insure accuracy and interchangeability. Additional bolted-in support members, panels and mechanisms are then added to complete the cell structure.

There are two basic standard cell designs:

a) Auxiliary or combination Auxiliary and Circuit Breaker cell with Main Bus and Cable Compartments.
b) Two-High Circuit Breaker cell with Main Bus and Cable Compartments.

Auxiliary Section (Figure 1)

An auxiliary section may be assembled using a maximum of four auxiliary drawout drawers or two auxiliary drawout drawers and a circuit breaker compartment to provide the circuit arrangement required.

The individual auxiliary drawers may be used for:

a) Control Power Transformer with primary fuses and interlocked secondary breaker (up to 15kVA, single phase).
b) Fused Voltage Transformers.
c) Fuses for fixed mounted Control Power Transformer (above 15kVA or three phase).

Drawout Control Power Transformer Compartment (Figure 2)

A control power transformer is provided to supply A.C. voltage for circuit breaker closing and capacitor trip charging as well as the many miscellaneous station auxiliary power functions. The transformer is sized for the specific order requirements and should not have arbitrary nonspecified loads added after installation.

The control power transformer as well as its primary current limiting fuses and secondary molded case circuit breaker are mounted in the drawer and are withdrawn as an assembly. No tilting or levering is required. The drawer rides on two extension rails. A positive stop limits the travel in the fully withdrawn position.

The drawer front panel is recessed behind the front door in the connected position and is held in place by an interlock-latch and two thumb screws.

An interlock-latch prevents withdrawing or inserting the drawer while the secondary breaker is in the closed position. To release the latch, push the secondary breaker handle to the left (off position). To engage the latch, push the secondary breaker handle to the right (on position) after returning the assembly to the operate position.

An insulating barrier with openings for the moving primary contacts divides the compartment. The stationary primary contacts and associated high voltage parts are mounted safely behind the barrier. Floating, self aligning, stationary contacts engage the moving contacts as the drawer is inserted into the connected position.

The moving secondary contacts are mounted on the drawer on the front left, and they engage floating, self aligning, stationary secondary contacts mounted on the compartment side sheet.

A static shield contact is mounted on top of the compartment and grounds the transformer as the drawer is withdrawn.

Drawout Voltage Transformer Compartment (Figure 3)

Voltage transformers are provided to supply voltage indication for metering and relaying purposes. Primary current limiting fuses are mounted on each voltage transformer. No secondary fusing is furnished in the auxiliary compartment or on the drawout drawer.

The front panel, drawout drawer and voltage transformers are withdrawn as an assembly. No tilting or levering is required. The drawer rides on two extension rails. A positive stop limits the travel in the fully withdrawn position. The drawer is recessed behind the front door.

An insulated barrier with openings for the moving primary contacts divides the compartment. The stationary contacts and associated high voltage parts are mounted safely behind the barrier. Floating, self aligning, stationary contacts engage the moving contacts as the drawer is inserted into the connected position.

Secondary sliding finger type contacts are mounted on the front left side of the drawer and engage fixed compartment mounted contacts in the connected position.

Static ground contacts are mounted on a compartment cross bar and engage the load side of the fuses as the drawer is withdrawn.

Drawout Fuse Compartment

Drawout fuses are provided for fixed mounted control power transformers. Fixed mounted CPT's are supplied when three phase control power is required or control power requirements exceed 15 KVA. The front panel, support insulators, current limiting fuses, and secondary molded case circuit breaker are mounted in the drawer and withdrawn as an assembly. No tilting or levering is required. The drawer rides on two extension rails. A positive stop limits the travel in the fully withdrawn position. The drawer front panel is recessed behind the front door in the connected position and is held in place by an interlock latch and two thumb screws.

An interlock-latch prevents withdrawing or inserting the drawer while the secondary breaker is in the closed position. Push the secondary breaker handle to the left (off position) and slide the latch handle upward to release latch. To engage the latch, push the secondary breaker handle to the right (on position) after returning the assembly to the operate position.

An insulating barrier divides the compartment. The stationary contacts and associated high voltage parts are mounted safely behind the barrier. Floating, self aligning, line and load contacts engage the moving contacts as the drawer is inserted into the connected position.

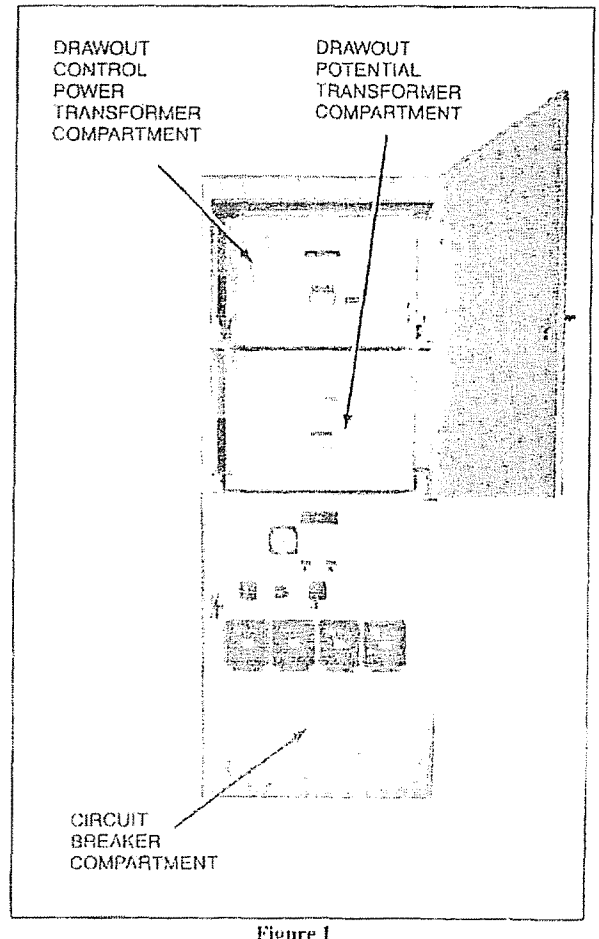


Figure 1
Front View—Breaker/Auxiliary Vertical Section

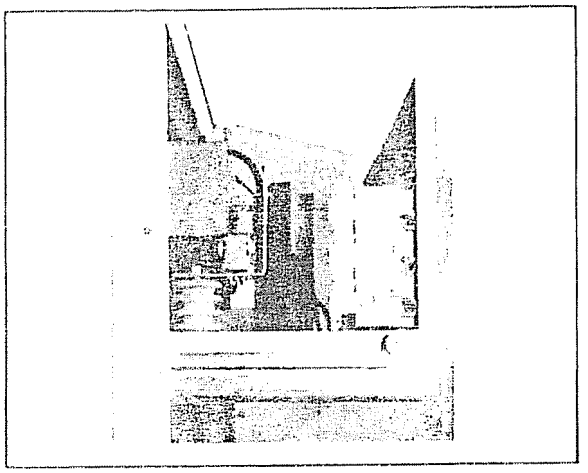


Figure 2
Drawout Control Power Transformer.

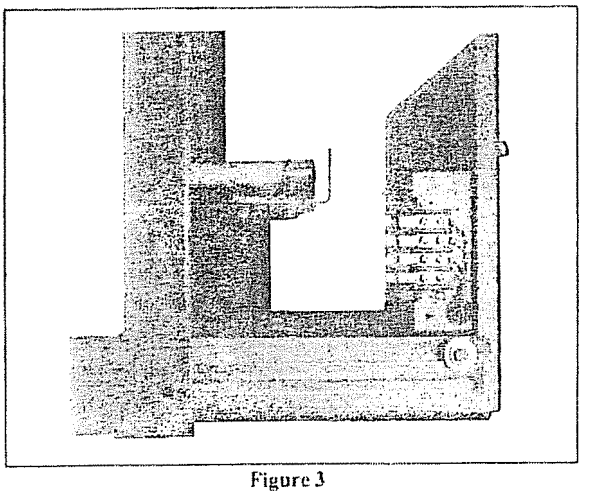


Figure 3
Drawout Voltage Transformers.

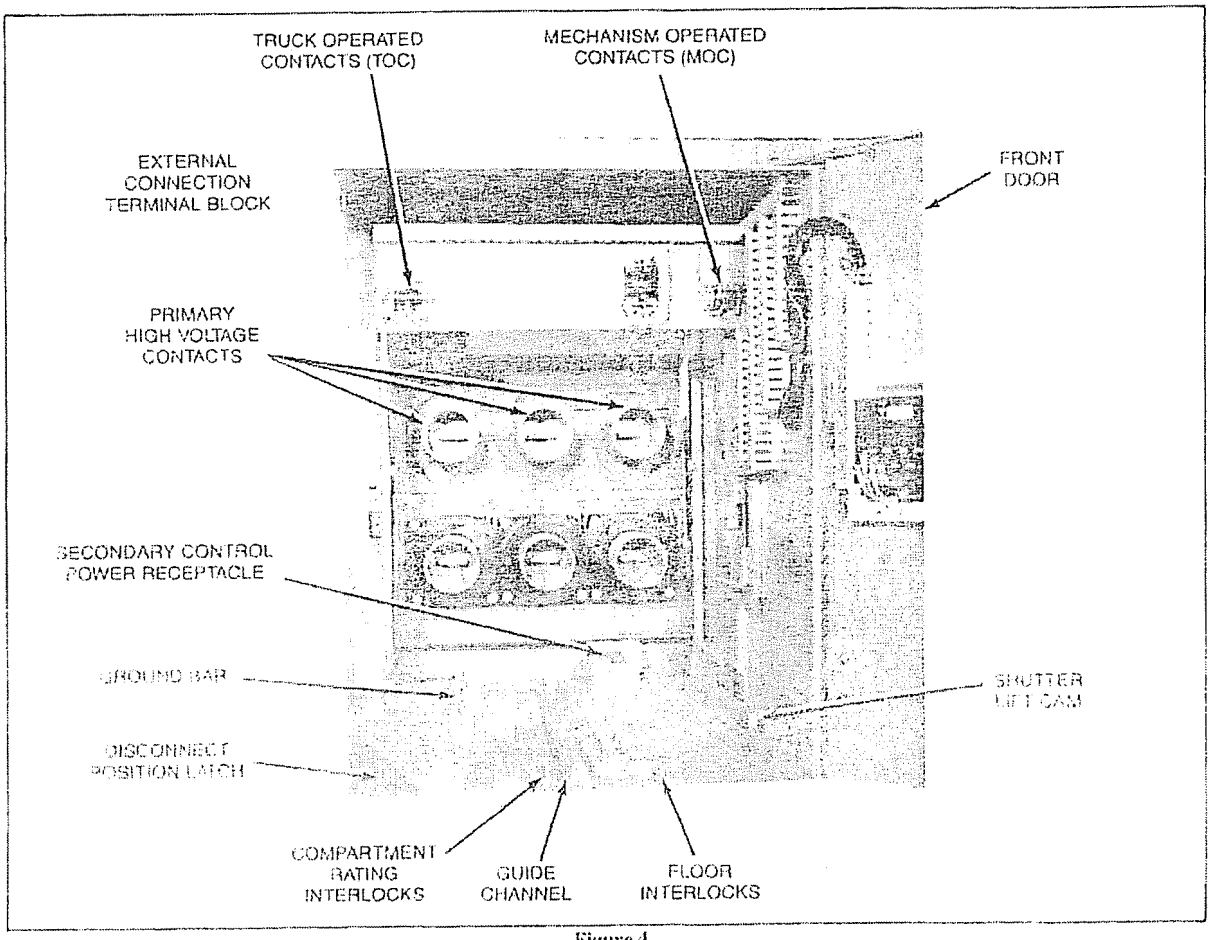


Figure 4
Breaker Compartment—Interior View.

Circuit Breaker Compartment (Figure 4)

Drawout circuit breakers are provided for all main, tie and feeder circuits. Each circuit breaker is a complete device that can be removed from the compartment for inspection and maintenance while the compartment maintains its own electrical, mechanical and safety function integrity.

The circuit breaker compartment contains fifteen separate but coordinated features each necessary for the safe operation of the circuit breaker.

1 Front door
2 Guide channel
3 Floor interlocks
4 Circuit breaker ground bar
5 Racking guide brackets
6 Shutters
7 Primary high voltage contacts
8 Current transformers
9 Secondary control power receptacle
10 Control Wiring
11 Disconnect position latch
12 Compartment rating interlocks
13 Mechanism operated contacts (MOC) (Option)
14 Truck operated contacts (TOC) (Option)
15 Cell interlock

Front Door

The front door is used to mount the normal complement of meters, relays, indicating lights and switches, and to complete the Metal-Clad assembly. A convenient door stay connects between the door and the compartment frame. The door stay allows the door to open to its maximum open position to remove the circuit breaker without interference with the door mounted components. It automatically locks in place when the door is completely open and is released by lifting up on the door stay bar near the compartment.

Guide Channel

The guide channel is a compartment floor mounted channel running from front to back in the center of the compartment. It is used to align the circuit breaker in the compartment. Mating guides are located on the underside of the circuit breaker. The circuit breaker guides slide inside the compartment guide bar when the circuit breaker is properly inserted into the compartment.

Floor Interlocks

Two compartment floor mounted interlock cam systems are provided as safety features.

A COMPARTMENT POSITION INTERLOCK is used to prevent the circuit breaker from being accidentally closed between the test/disconnect and connected positions. The interlock cam mechanically operates the circuit breaker trip mechanism between these two positions so the circuit breaker cannot be closed.

The CHARGED SPRING DISCHARGE INTERLOCK is used to discharge all the springs. If the closing springs are charged and the circuit breaker is inserted into or withdrawn from the compartment, the springs will be automatically discharged approximately one inch from the disconnect position.

Circuit Breaker Ground Contact Bar

A compartment floor mounted circuit breaker ground contact bar is mounted in the back left section of the compartment. It is directly connected to the assembly ground to provide a solidly grounded system. A mating set of sliding contacts are located on the underside of the circuit breaker and engage the circuit breaker ground contact bar in the connected position, all positions between, and in the test/disconnect position.

Racking Guide Brackets

Each circuit breaker has its own internal gear driven mechanism which operates a racking arm with roller on the left and right sides of the circuit breaker. The breaker mechanism is operated by a removable racking crank inserted into the front of the circuit breaker. The racking arms should be down approximately 15° below horizontal with the rollers toward the back of the circuit breaker in the normal withdrawn position.

Compartment mounted racking guide brackets are located on the left and right sides of the compartment: Two guide bracket slots are used on each side. The upper slot is used by the VAD-2 (Vacuum) circuit breaker while the lower slot is used by the FG-2 (SF_6) circuit breaker.

Position indicators are mounted on the floor of the compartment and the front of the circuit breaker. Proper position is obtained by visually aligning the arrow points on the stationary and moving indicators. The circuit breaker is mechanically held in position by the racking mechanism in the connected position. A positive stop is felt when the breaker reaches the connected position.

Shutters

Two grounded steel shutters are mounted directly in front of the primary high voltage contacts. They are appropriately marked DANGER HIGH VOLTAGE. Shutters are used to prevent accidental contact with the primary high voltage contacts if it is necessary to be in an energized compartment for any reason. The shutters move in a rotary motion, and they are stored above the top and below the bottom primary high voltage contact tubes when the circuit breaker is in the connected position. In normal operation the shutters are only open in the connected position and for the short distance required to move the circuit breaker separable contacts into or out of the primary high voltage contact tubes.

Shutter position is controlled by a pivoting lever mechanism on the lower right side of the compartment. A roller on the right side of the circuit breaker rides over the lever mechanism forcing it to pivot and the shutters to open and remain open while the circuit breaker is being racked into the connected position.

The shutters have provisions for locking closed with the breaker withdrawn from the cell or in the test/disconnect position. These provisions are part of the "Cell Interlock" discussed on page 11.

Primary High Voltage Stabs

Each circuit breaker compartment has six primary high voltage stabs. These stabs are used to make the connection between the circuit breaker separable contacts and the main bus in the bus compartment or load terminals.

CAUTION

THE COMPLETE ASSEMBLY ARRANGEMENT DETERMINES IF THE TOP OR BOTTOM CONTACTS ARE THE LINE SIDE, AND BOTH CAN BE ENERGIZED WHEN THE CIRCUIT BREAKER IS REMOVED FROM THE COMPARTMENT!

Two contact designs are used. The 1200 AMP circuit breaker compartment uses flat bus bar type contacts while the 2000 AMP and 3000 AMP use round stud type contacts.

Each contact is mounted in and is partially enclosed by an insulated primary high voltage contact tube. This insulating tube extends well past the front end of the contact, and the open end of the tube is covered by the shutter when the circuit breaker is removed from the operate position.

Current Transformers

Bushing type single or multi ratio current transformers can be mounted around either the top or bottom insulating tubes. A maximum of four model 190 CT's can be mounted per phase, 2 on line, 2 on load.

Secondary Control Power Receptacle

The breaker secondary control power receptacle is located in the lower right floor of the compartment. The molded insulating receptacle contains nineteen contacts and two tapered guide pin holes. A moving mating contact plug is mounted on the circuit breaker and allows the circuit breaker to be used in both the test and connected positions. Engagement is automatic in the connected position.

The stationary secondary receptacle is mounted on two bolts so that it may float approximately 1/8" in each direction. Control wiring is connected to the terminals on the back of the receptacle and is brought forward to the terminal blocks.

Control Wiring

Two terminal block locations are used. A compartment mounted, external connection terminal block is vertically mounted on the left front of the compartment directly above the cut-out in the floor designated for control conduit. All connections necessary for external control are conveniently brought to this terminal block. The second terminal block is vertically mounted on the right front side of the compartment. This terminal block is used for the hinge wiring to door mounted components. Pull-out type control power fuses are mounted in the top sections of this terminal block.

Both terminal block locations are accessible with the circuit breaker in the connected and test/disconnect positions. All interconnecting wiring is enclosed in isolating wire trough to prevent mechanical damage.

Disconnect Position Latch

There are two physical positions of the circuit breaker in the compartment, connected and test/disconnect. There are three functional positions, connected, test, and disconnect.

In the connected position the circuit breaker is racked into the compartment until both the primary high voltage contacts and the secondary control power contacts are made. The circuit breaker is fully operational in this position and it is locked securely in place by the racking mechanism.

In the test position the secondary control power contacts are made and the circuit breaker can be opened and closed electrically. The shutters are closed and cover the primary high voltage contacts isolating the circuit breaker separable high voltage contacts from the main bus and the terminals. The circuit breakers are prevented from accidently moving into the compartment by the racking arms and from moving out toward the door by the disconnect position latch.

In the disconnect position both the circuit breaker secondary control power contacts and separable high voltage contacts are disconnected and the circuit breaker is not operable electrically. The circuit breaker is held in position the same as in the test position.

The disconnecting position latching cam is located on the left front of the compartment floor. A latching lever is located on the left front on the circuit breaker. When the circuit breaker is inserted into the compartment the latching lever rides over the latching cam. Manually raising the latching lever handle allows the circuit breaker to be removed from the compartment.

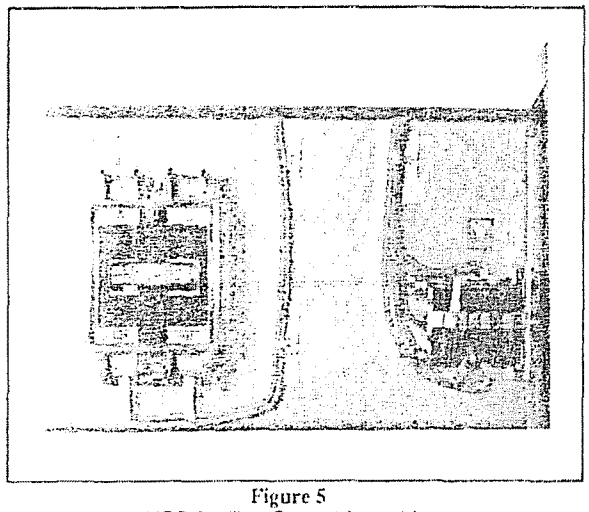


Figure 5
MOC Auxiliary Contact Assembly.

CAUTION

DO NOT ATTEMPT TO REMOVE A CIRCUIT BREAKER FROM THE TOP CELL WITHOUT A SQUARE D BREAKER LIFT TRUCK HAVING BEEN PUT IN PLACE.

Compartment Rating Interlocks

Each compartment and circuit breaker is provided with a set of fixed mechanical interference compartment rating interlocks. These "go-no go" interlocks prevent accidental insertion of circuit breakers of the incorrect current, voltage, or interrupting rating into the compartment.

The stationary interference pins are mounted on the floor of the compartment and the moving part of the interlock system is mounted on the underside of each circuit breaker.

DO NOT FORCE OR PRY CIRCUIT BREAKERS INTO COMPARTMENTS. DO NOT REMOVE RATING INTERLOCKS.

Mechanism Operated Contacts (Option) (Figure 5)

Mechanism operated contacts (MOC) are compartment mounted auxiliary contacts operated by the circuit breaker mechanism. They indicate the open or closed position of the circuit breaker the same as breaker mounted auxiliary contacts. They are operated in both the connected and test/disconnected positions.

MOC contacts are used if more than five auxiliary contacts are needed on one breaker. A maximum of five auxiliary contacts can be mounted on both the FG-2 and VAD-2 breakers.

The MOC is mounted on the right side of the horizontal steel barrier that is located in the top center of the compartment. It is operated by a mechanism in the lower right side of the compartment that is driven vertically by a roller on the right side of the circuit breaker. Gravity and an extension spring hold the mechanism in the open position when the circuit breaker is withdrawn from the compartment.

Truck Operated Contacts (Option) (Figure 6)

Truck operated contacts (TOC) are used to indicate the physical position of the circuit breaker in the compartment. They indicate the breaker is in the connected or test/disconnect position. The TOC contact does not distinguish between the circuit breaker being in the test/disconnect position or withdrawn completely from the compartment.

The TOC is mounted on the left side of the horizontal steel barrier that is located in the top of the compartment. It is operated by a spring loaded lever which in turn is activated by a pin located on the upper left side of the breaker just before the breaker reaches the operating position.

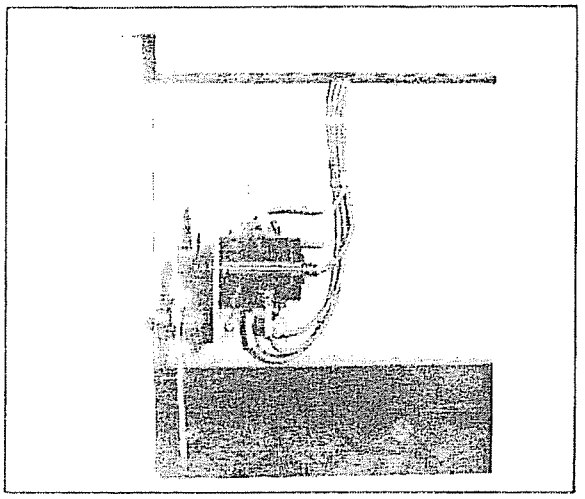


Figure 6
TOC Contact Assembly

Cell Interlock

An interlock known as "Cell Interlock" is provided in each breaker compartment for locking a breaker out of the connected position.

The cell interlock is located on the lower right side of the compartment and has padlock provisions as standard. It can be equipped with a key interlock when specified by the customer.

The cell interlock works by locking the shutters closed. It prevents racking the breaker into the connected position. A breaker can be stored in the test/disconnect position with the cell interlock locked.

Main Bus Compartment (Figure 7)

The main bus compartment is located in the center of the switchgear. It is isolated from other compartments by removable metal access plates. These removable plates and the main bus compartment are accessible from the back of the cell through the cable compartment.

1200A and 2000A main buses are available in aluminum or copper. The 3000A is always copper.

The vertical riser bus in each vertical section will be sized according to the breakers installed in that section.

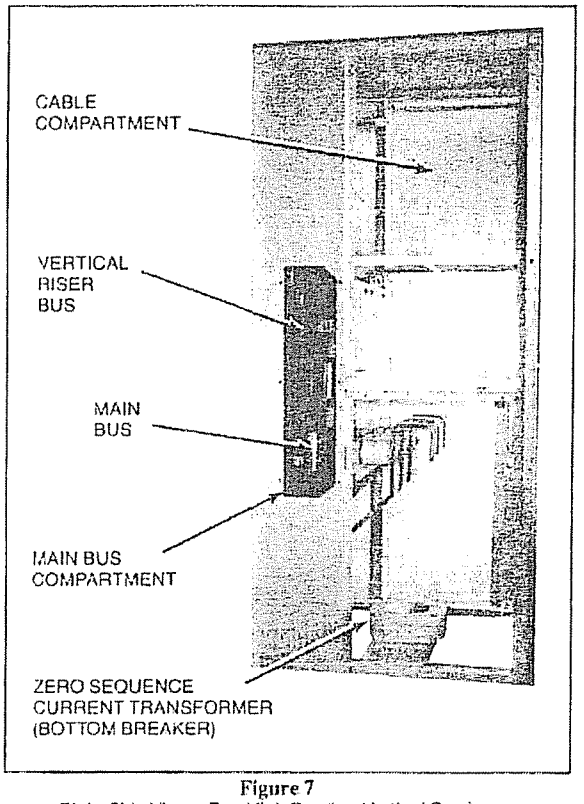


Figure 7
Right Side View—Two-High Breaker Vertical Section.

Each bus bar has fluidized bed epoxy insulation rated for 105°C operation. Flame and track resistant glass polyester barriers are used to separate the bus compartments between adjacent cells. Porcelain inserts are available as an option.

Polyvinyl chloride boots are used to insulate the connection in the main bus compartment. These boots overlap the epoxy insulation on the bus bars.

IT IS NOT GOOD SAFETY PRACTICE AND UNDER NO CIRCUMSTANCES SHOULD THE COVERS OF THE MAIN BUS COMPARTMENT BE REMOVED OR THE EPOXY BUS INSULATION OR THE INSULATING BOOTS BE TOUCHED WHILE THE MAIN BUS IS ENERGIZED.

Cable Compartments (Figure 8)

A separate cable compartment is provided for each breaker in a vertical section. It is accessible by removing a steel cover

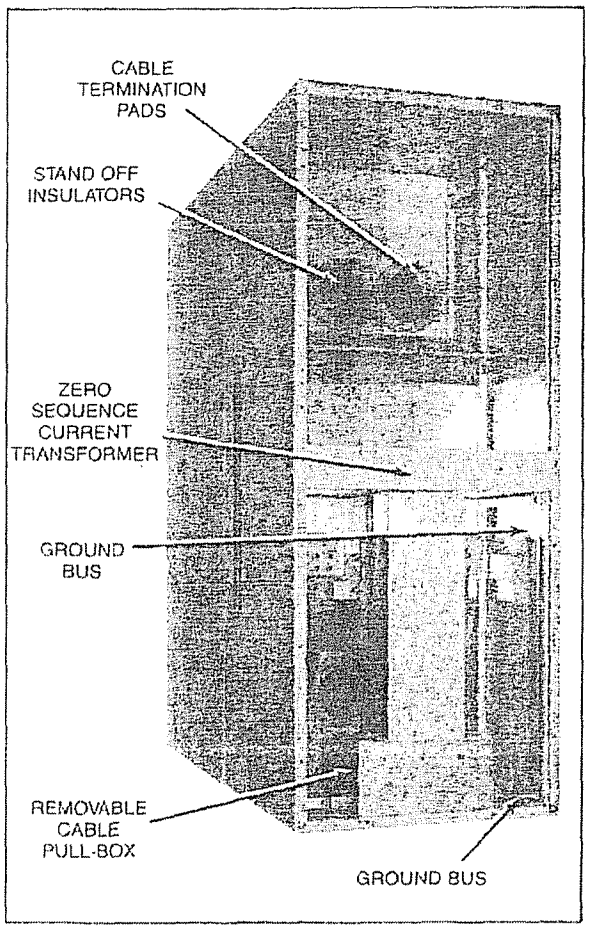


Figure 8
Rear View—Cable Compartments, Two-High Breaker Vertical Section.

on the back. Insulated load connectors are provided for terminating cables. As standard, the load connectors are punched with NEMA 2-hole pattern for terminating two cables per phase. Lugs can be provided by Square D if requested.

Tape and associated material is not supplied as standard for insulating cable terminations.

An assembly ground bus is provided in the cable compartment with lugs on each end for the assembly ground. This ground bus connects to each circuit breaker compartment ground bar, and to the individual ground bar in each cable compartment, and provides a common ground for the assembly. All instrument transformer, metering and relaying grounds are also connected to this common ground system.

Conduit must enter the cable compartments in the areas shown on the customer drawings from either the top or bottom of the cable compartment. NOTE: Conduit should be stubbed in the concrete as part of the site preparation before the assembly is installed, BUT top entrance conduit must be installed after the assembly is put in place. The top covers can be removed, punched to fit the conduit and put back in place.

A removable steel metal cable pull-box is provided to isolate cables when two breakers are installed in one vertical section and cables for both breakers must enter from the same direction, above or below. The front conduit area is for the bottom breaker when all cables enter from below, and for the top breaker when all cables enter from above. This cable pull-box may be removed to permit the rear cables to be installed first.

Zero sequence current transformers are conveniently located in each cable compartment when required.

Various cable termination systems are used and they are specified on the plans and specifications. Solderless or compression lugs can be supplied on the load connectors. Potheads are mounted on grounded support brackets. The compound and tape for their internal connections are shipped in a container with the other miscellaneous parts. Tape and insulating material necessary for completing the field connection at the bus pad is not normally supplied with the assembly.

IT IS NOT GOOD SAFETY PRACTICE TO REMOVE THE BACK ACCESS COVERS OF THE CABLE COMPARTMENT WHILE THE CIRCUIT BREAKERS ARE IN THE CONNECTED POSITION OR ENERGIZED.

Surge Protectors (Option)

Surge protectors are provided as standard on all circuits using Type VAD-2 (Vacuum) circuit breakers. They are mounted in the incoming and outgoing cable compartments. Their primary cable connection may be made to the bus pad and the connection is not taped or otherwise insulated when the assembly leaves the factory. Complete the insulation of the surge protector primary cable when installing the power cables (see "INSTALLATION," pages 19-24).

Lightning Arresters (Option)

Lightning arresters are only furnished when specified in the user's specifications. The vulnerability of the incoming and outgoing lines to lightning strikes or other high voltage transient conditions determines their type and justification. They are mounted in the incoming and outgoing cable compartments when furnished. Their primary cable connection may be made to the bus pad and the connection is not taped or

otherwise insulated when the assembly leaves the factory. Complete the insulation of the lightning arrester primary cable when installing the power cables (See "INSTALLATION," pages 19-24.)

SURGE PROTECTERS AND LIGHTNING ARRESTERS (if provided) ARE NOT PERMANENTLY CONNECTED AT THE FACTORY AND MUST BE DISCONNECTED FOR HI-POT OR RESISTANCE TESTING.

SURGE PROTECTORS AND LIGHTNING ARRESTERS (if provided) MUST BE RECONNECTED AFTER HI-POT OR RESISTANCE TESTING BEFORE THE POWER CABLE CONNECTIONS ARE COMPLETED.

Circuit Breakers (Figures 9, 10, 11, 12, 13, & 14)

Two different types of circuit breakers are available for use in Two-High, 5-15kV, Metal-Clad, Drawout Switchgear.

Type FG-2 (SF_6) circuit breakers use sulphur hexafluoride gas at a low pressure as the insulating and arc extinguishing medium. They give a quiet, dependable arc interruption of five cycles or less, and have sealed, minimal maintenance, interrupters.

Type VAD-2 (Vacuum) circuit breakers use a high vacuum as the insulating and arc extinguishing medium. They give a high speed, quiet, dependable arc interruption of three cycles or less, and have hermetically sealed, minimal maintenance, interrupters.

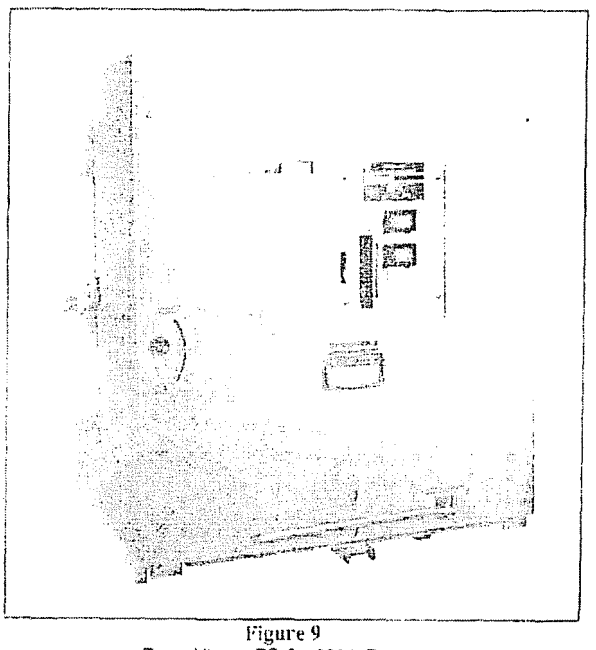


Figure 9
Front View—FG-2 1200A Breaker

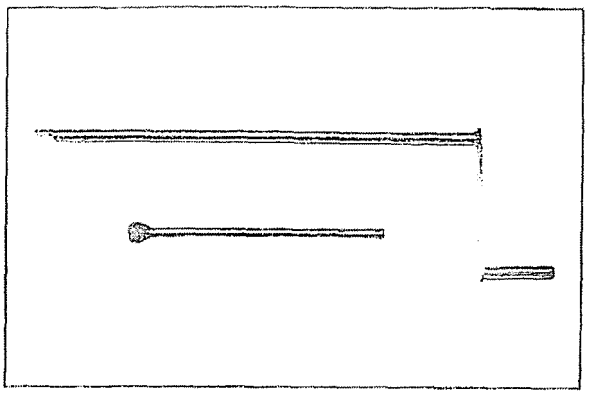
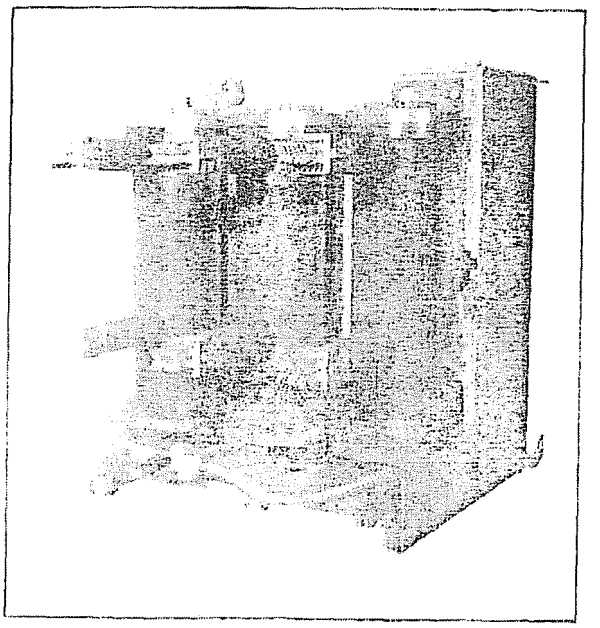


Figure 10
Breaker Racking and Charging Handles.

The two types of circuit breakers are easily distinguishable:

Type FG-2 (SF_6) circuit breakers have a steel, grounded front panel with a distinctive racking shaft cover box on the left side, and a window insert with the nameplate, open/closed indicator, operation counter, springs charged/discharged indicator, manual close and trip buttons and manual springs charge handle slot on the front. The interrupters are enclosed in large cast epoxy envelopes in back of the operating mechanism. These envelopes serve as their own insulating support structure.



Type VAD-2 (Vacuum) circuit breakers have a steel, grounded front panel with the racking shaft located on the upper right part of the panel. All of the indicators, etc., are visible through openings in the front panel. The interrupters are vacuum bottles which contain the stationary and moving contacts and are located in back of the operating mechanism. Large red insulated interphase and side barriers isolate the interrupters. Two nameplates with complete rating information are provided; one on the front panel and one on the upper right side of the operating mechanism. CAUTION: If Type VAD-2 (Vacuum) circuit breakers of different ratings are used in the same assembly, match the nameplates on the circuit breaker and panel when reassembling after an inspection or maintenance program.

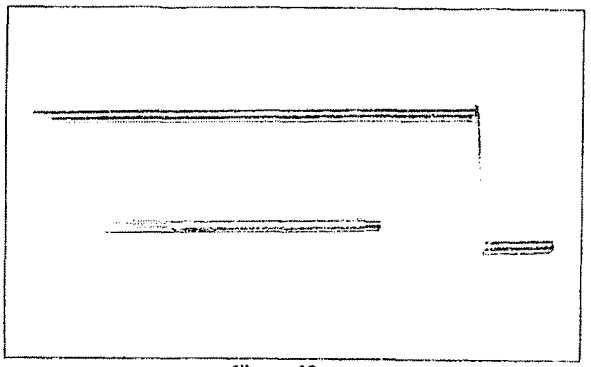


Figure 13
Breaker Racking and Charging Handles.

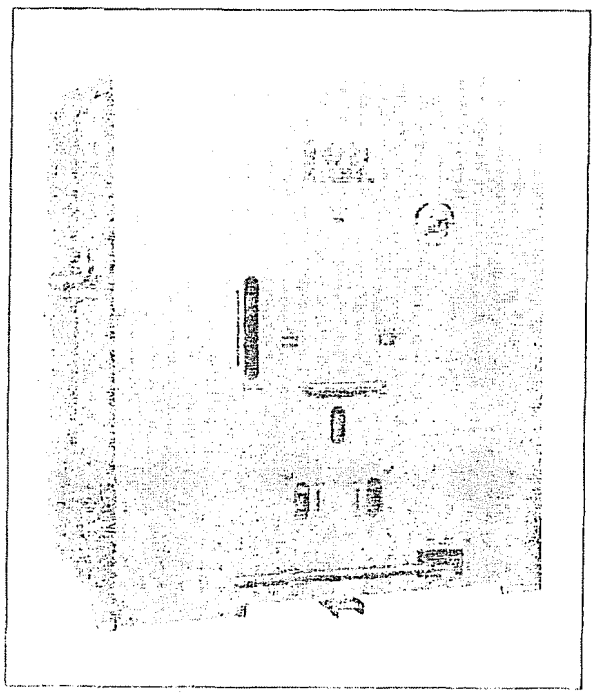


Figure 12
Front View—VAD-2 1200A Breaker

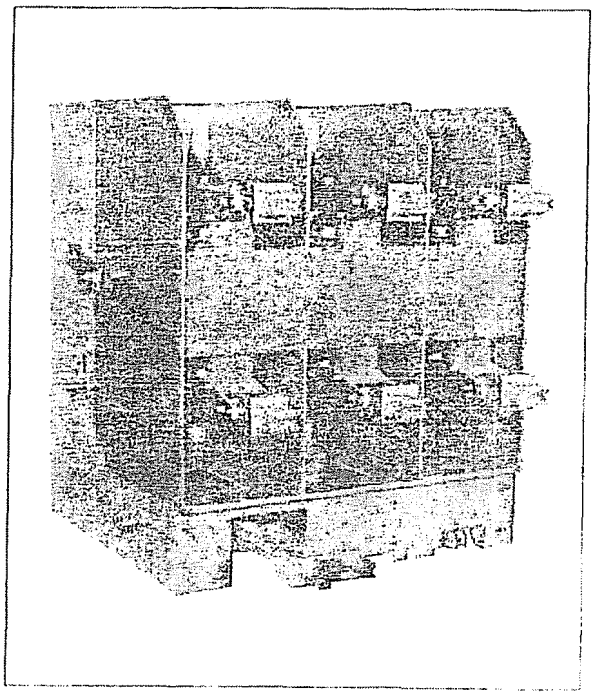


Figure 14
Rear View—VAD-2 1200A Breaker

OPERATION

FG-2 Circuit Breaker (Figure 15)

Type FG-2(SF_6) circuit breakers have six mechanisms that are manually operated but are coordinated with safety controls built into the circuit breakers and compartments.

(1) Racking mechanism
(2) Secondary control power plug
(3) Disconnect position latch
(4) Manual spring charge mechanism
(5) Manual close pushbutton
(6) Manual open pushbutton

Racking Mechanism

The racking mechanism is only used to move the circuit breaker from the test/disconnect position to the connected position and back to the test/disconnect position.

Push the circuit breaker into the compartment to the test/disconnect position and the disconnect position latch engages. The racking mechanism arm rollers should be aimed to the back of the circuit breaker and they should be down approximately 15° below horizontal.

The racking handle cannot be inserted into a circuit breaker that is in the closed position. Insert the racking handle and rotate clockwise to rack the circuit breaker into the connected position. When the circuit breaker is in the connected position, it will stop its forward motion, the compartment and circuit breaker position indicators will be aligned and a positive stop will be felt when the breaker is in the connected position. The breaker position interlock prevents closing the circuit breaker between the test/disconnect and connected positions or racking a closed circuit breaker onto or off of the primary high voltage contacts.

IT IS GOOD SAFETY PRACTICE TO ONLY OPERATE CIRCUIT BREAKERS IN THE CONNECTED POSITION ELECTRICALLY WITH THE COMPARTMENT FRONT DOOR CLOSED.

IT IS NOT GOOD SAFETY PRACTICE TO OPERATE CIRCUIT BREAKERS IN THE CONNECTED POSITION MANUALLY WITH THE COMPARTMENT FRONT DOOR OPEN.

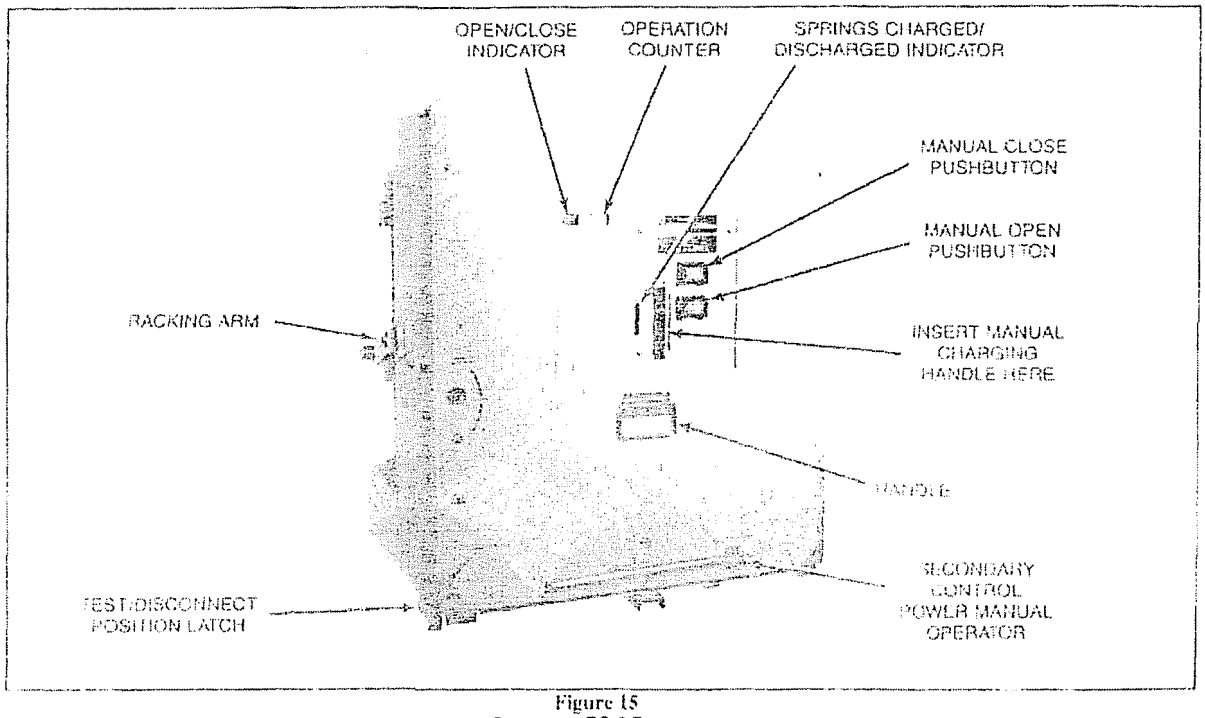


Figure 15
Features—FG-2 Breaker

To remove a circuit breaker from the connected position to the test/operate position, open the circuit breaker electrically with the compartment door closed. Then open the door and insert the racking handle and rotate counterclockwise until the compartment and circuit breaker position indicators line up.

Through the door racking to move the breaker between the test and operating positions is available as an option.

Secondary Control Power Plug

The secondary control power plug automatically engages the compartment receptacle in the connected position and disengages as the circuit breaker is racked out to the test/disconnect position.

A manual operator is provided to engage the control power plug in the test/disconnect position.

It is possible, if it is left in the manually extended test position, to engage or disengage the secondary control power plug when inserting the circuit breaker into or withdrawing from the test/disconnect position.

Disconnect Position Latch

The disconnect position latch is provided to prevent the circuit breaker from rolling out of the compartment in the test/disconnect position. Simply lift and hold the latch handle up while pulling the circuit breaker out of the compartment.

Manual Spring Charging Mechanism

The circuit breaker closing springs may be charged automatically, by the charging motor, or manually. In normal operation the motor charges the springs.

A manual spring charging mechanism is provided for testing and maintenance purposes and extreme emergency operating conditions. NEVER CLOSE A CIRCUIT BREAKER MANUALLY IN THE CONNECTED POSITION UNLESS THE OPENING SOURCE OF POWER AND PROTECTIVE RELAYS ARE CONNECTED AND OPERABLE. Insert the manual charging handle into the manual spring charging mechanism and pump the handle up and down until a loud "CLICK" is heard and the pumping force is prohibitive. REMOVE THE HANDLE. The closing springs are now charged and the circuit breaker can be closed and opened electrically or manually.

Manual Close Pushbutton

A manual close pushbutton is provided on the circuit breaker for test and maintenance purposes, and extreme emergency operating conditions. NEVER CLOSE A CIRCUIT BREAKER MANUALLY IN THE CONNECTED POSITION UNLESS THE OPENING SOURCE OF POWER AND PROTECTIVE RELAYS ARE CONNECTED AND OPERABLE.

Manual Open Pushbutton

A manual open pushbutton is provided on the circuit breaker for test and maintenance purposes, and extreme emergency operating conditions.

IT IS GOOD SAFETY PRACTICE TO ONLY OPEN CIRCUIT BREAKERS ELECTRICALLY IN THE CONNECTED POSITION WITH THE DOOR CLOSED AND NEVER MANUALLY IN THE CONNECTED POSITION.

Type VAD-2 (Vacuum) Circuit Breaker Operation (Figure 16)

Type VAD-2 (Vacuum) circuit breakers have six mechanisms that are manually operated but are coordinated with safety controls built into the circuit breakers and compartments.

(1) Racking mechanism
(2) Secondary control power plug
(3) Disconnect position latch
(4) Manual spring charge mechanism
(5) Manual close
(6) Manual open

Racking Mechanism

The racking mechanism is only used to move the circuit breaker from the test/disconnect position to the connected position and back to the test/disconnect position.

Push the circuit breaker into the compartment to the test/disconnect position and the disconnect position latch engages. The racking mechanism arm rollers should be aimed to the back of the circuit breaker and they should be down approximately 15° below horizontal.

Insert the racking handle and rotate clockwise to rack the circuit breaker into the connected position. If the circuit breaker is in the closed position it will automatically open as it moves from the test/disconnect position. When the circuit breaker is in the connected position it will engage latches and the compartment and circuit breaker position indicators will be aligned.

The compartment door mounted interlock prevents accidentally closing the circuit breaker between the test/disconnect and connected positions or racking a closed circuit breaker onto or off of the primary high voltage contacts.

IT IS GOOD SAFETY PRACTICE TO ONLY OPERATE CIRCUIT BREAKERS IN THE CONNECTED POSITION ELECTRICALLY WITH THE COMPARTMENT FRONT DOOR CLOSED.

To remove the circuit breaker from the connected position to the test/disconnect position, open the circuit breaker electrically with the compartment door closed. Then open the door and insert the racking handle and rotate counterclockwise until the compartment and circuit breaker position indicators line up. Through the door racking is available as an option.

Secondary Control Power Plug

The secondary control power plug automatically engages the compartment receptacle in the connected position and disengages as the circuit breaker is racked out to the test/disconnect position.

A manual operator is provided to engage the control power plug in the test/disconnect position for electrical operation.

It is possible, if it is left in the manually extended test position, to engage or disengage the secondary control power plug when inserting the circuit breaker into or withdrawing from the test/disconnect position.

Disconnect Position Latch

The disconnect position latch is provided to prevent the circuit breaker from rolling out of the compartment in the test/disconnect position. Simply lift and hold the latch handle up while pulling the circuit breaker out of the compartment.

Manual Spring Charging Mechanism

The circuit breaker closing springs may be charged automatically by the charging motor or manually. In the normal operation the motor charges the springs.

A manual spring charging mechanism is provided for testing and maintenance purposes and extreme emergency operating conditions. NEVER CLOSE A CIRCUIT BREAKER MANUALLY IN THE CONNECTED POSITION UNLESS THE OPENING SOURCE OF POWER AND PROTECTIVE RELAYS ARE CONNECTED AND OPERABLE. Insert the manual charging handle into the manual spring charging mechanism and pump the handle up and down until a loud "CLICK" is heard and the pumping force is prohibitive. REMOVE THE HANDLE. The closing springs are now charged and the circuit breaker can be closed and opened electrically or manually.

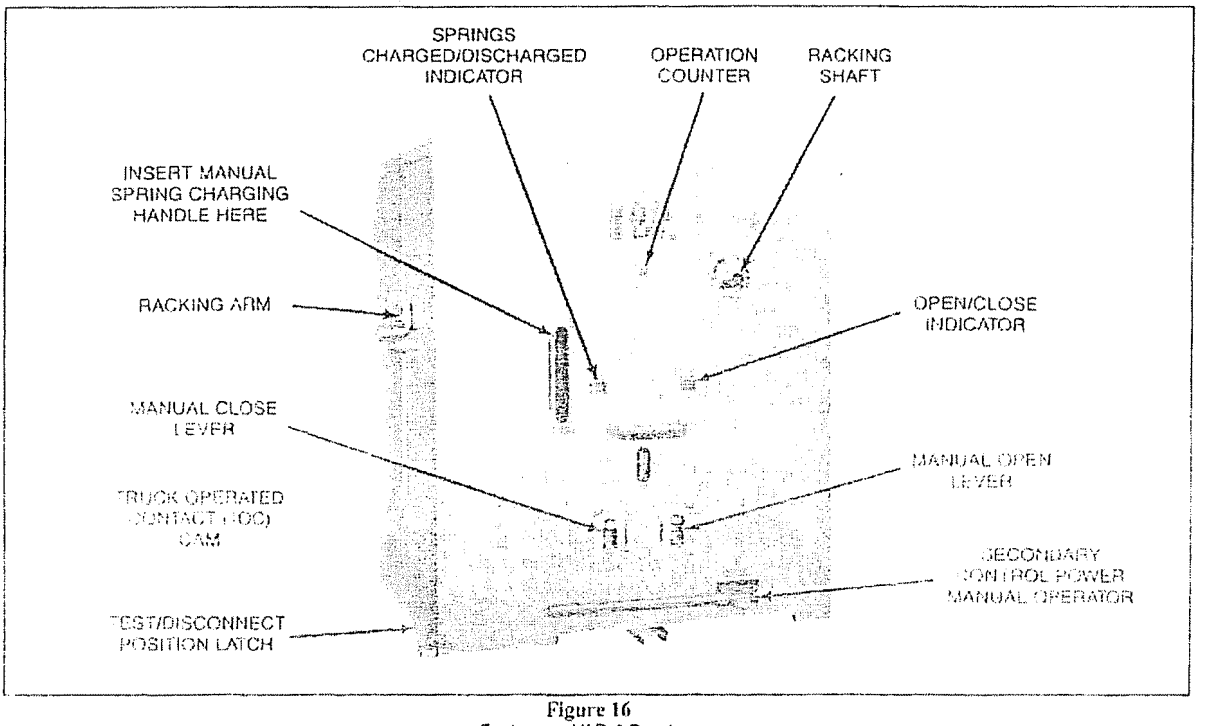


Figure 16
Features—VAD-2 Breaker

Manual Close Lever

A manual close lever is provided on the circuit breaker for test and maintenance purposes, and extreme emergency operating conditions. NEVER CLOSE A CIRCUIT BREAKER MANUALLY IN THE CONNECTED POSITION UNLESS THE OPENING SOURCE OF POWER AND PROTECTIVE RELAYS ARE CONNECTED AND OPERABLE.

Manual Open Lever

A manual open lever is provided on the circuit breaker for test and maintenance purposes, and extreme emergency operating conditions.

IT IS GOOD SAFETY PRACTICE TO ONLY OPEN CIRCUIT BREAKERS ELECTRICALLY IN THE CONNECTED POSITION WITH THE DOOR CLOSED AND NEVER MANUALLY IN THE CONNECTED POSITION.

RECEIVING, HANDLING, STORAGE

Receiving

Two-high 5-15kV metal-clad indoor switchgear is shipped on skids with appropriate protective crating to prevent damage during normal transit. The drawout control power transformer drawer, voltage transformer drawer and drawout fuse drawer (if supplied) are shipped in place. Circuit breakers are individually skid mounted and crated.

Each crate is individually marked and the packing list will indicate the number of crates and what is in each. The packing list will be in an envelope on the outside of the number one crate.

Inspect each crate for external damage or indication of rough handling before accepting the shipment. If there is any indication of external damage or mistreatment or the correct number of crates have not been received it should be so noted on the shipping papers when signed for. A formal damage claim should be filed immediately with the carrier. Notify the local Square D Field Office of the extent of damage or shortages and attach a copy of the formal damage claim.

The shipping crates should be opened as soon as possible after receipt and the contents inspected and checked in detail against the shipping papers to reduce the possibility of hidden damage.

Notify the local Square D Field Office of any discrepancies, as last minute field improvisions may cause serious operational problems.

If the equipment is going to be stored until being installed it may be practical to leave it on the shipping skids to facilitate moving.

Handling As Received

The individual crates may be lifted by a crane with slings thru the skids or by fork truck. If lifted by slings, be sure there are adequate spreaders used to prevent distortion of the assembly structure or damage to the doors or door mounted components.

The assembly may not have equal weight distribution so the position of the sling lifting point may be important to prevent shifting or swinging. Lifting jacks and rollers under the skids may be used on relatively flat surfaces if other equipment is not available or space prohibits use of other means of moving.

Handling Uncrated Assemblies

Assemblies consisting of more than two cells wide are divided into shipping sections for ease of lifting and handling. Each shipping section is structurally strong enough to be lifted as a unit if properly handled. Four lifting lugs are provided on top of each section. They are located so that the shipping section is approximately in balance if the lift point is midway between the lugs. Use adequate spreaders so the assembly does not tilt or swing. If at all possible, limit the lift height so the assembly just clears the conduit stubs.

Remove the cable compartment cable pull-boxes so that it will be easier to see the conduit stubs and prevent bending the zero sequence current transformer mountings of the bottom circuit breakers.

If rollers are used, remove the back covers and pry the assembly from the skid directly onto the rollers. Place a 2x6 across the back of the assembly and pry against it to apply the force evenly across the frame. Use two pry points at the same time if at all possible.

Circuit breakers should be removed from their skids with a crane. Two lifting plates are suplied on each breaker. DO NOT USE THE PRIMARY SEPARABLE CONTACTS OR BUSHINGS AS HANDLES.

If a fork truck is used to lift the circuit breakers from their skids, space the fork truck lifting arms to match the circuit breaker wheels and carefully roll the circuit breaker directly into the lifting arms. DO NOT FORCE THE LIFTING ARMS UNDER THE CIRCUIT BREAKER FRAME as the interlocks and secondary control power plug will be damaged.

Lifting eyes are provided on each circuit breaker and should be the only place used for lifting. DO NOT LIFT WITH HOOKS ATTACHED TO THE RACKING MECHANISM ARMS as the circuit breaker weight distribution is not suited for this method and it will tilt and swing and be difficult to maneuver.

TABLE 1—CUBICLE WEIGHTS*		
TWO HIGH VERTICAL SECTIONS		
TYPE OF CELL	MAIN BUS RATINGS	WEIGHT
Auxiliary/Breaker or	1200	2600
Auxiliary/Auxiliary	2000	2700
	3000	2800
Breaker/Breaker	1200	2500
	2000	2600
	3000	2700

* Weights are in pounds and do not include skids or crates.

TABLE 2—CIRCUIT BREAKER WEIGHTS*		
CURRENT RATING	FG-2 (SF_6)	VAD-2 (VACUUM)
1200A	500	530
2000A	550	580
3000A	550	N/A

* Weights are in pounds and do not include skids or crates.
N/A Not Available

Storage Of Indoor Equipment

It is often impossible to install indoor switchgear immediately after being received. If the assembly is to be stored for any length of time it should be kept in a clean dry, well ventilated area with a mean temperature of approximately 70°F. Loose shipping items should be kept neatly together to prevent being misplaced. The storage area should be closed off to unauthorized personnel to eliminate nuisance tampering or pilfering. Circuit breakers should be loosely covered with dust covers. The assembly doors should be kept closed and all the removable covers kept in place. If space heaters are furnished in the assembly they should be energized from a separate source. Consult the schematic diagrams and wiring diagrams for a logical connection point and the voltage and power requirements.

IF THE SPACE HEATERS ARE NORMALLY ENERGIZED FROM THE ASSEMBLY CONTROL POWER TRANSFORMER OPEN THE CONTROL POWER TRANSFORMER SECONDARY CIRCUIT BREAKER, REMOVE THE PRIMARY CURRENT LIMITING FUSES AND INSTALL AN OUT OF SERVICE TAG BEFORE ENERGIZING THE SPACE HEATERS TO PREVENT BACK FEED TO THE MAIN BUS THROUGH THE CONTROL POWER TRANSFORMER.

If no space heaters are installed in the assembly and the area is cold and damp temporary heating should be used. Avoid greasy smoke type of heaters as the high carbon content smoke can result in carbon deposits on insulation that can cause tracking and eventual insulation failure.

Batteries and battery chargers, when furnished with the assembly, should be put on trickle charge upon receipt.

INSTALLATION

Site Preparation

Good site preparation is absolutely necessary to eliminate costly and time consuming installation problems and insure proper and reliable operation of the assembly. Carefully compare the plans and specifications with the customer drawings provided to be sure there are no discrepancies:

Floor channel sill mounting holes and method of anchoring are important so the assembly can be properly welded or bolted in place.

Conduit runs and size, power and control cable type and size, and assembly ground locations should agree.

Continuous loops of reinforcing rod or structural steel around any single conductor of a three phase power circuit should be eliminated.

Aisle space should be allowed for in the front, back and on the ends of the assembly to open doors, remove and turn circuit breakers, remove access covers, walk and work.

A minimum of 7 feet is required in the front and 3 feet for the back and ends is normally acceptable.

NOTE: A MINIMUM OF THREE FEET IS ABSOLUTELY NECESSARY ON THE RIGHT END FACING THE FRONT OF THE LINE-UP FOR DOOR CLEARANCE TO REMOVE THE CIRCUIT BREAKERS. DO NOT INSTALL BATTERIES IN THIS AREA.

Local building codes may require more space.

Ventilation should be provided at all times so the ambient temperature around the assembly does not exceed 90 °F. Clean, dry filtered air should be supplied.

Adequate lighting and convenience outlets for hand tools should be furnished for both the front and back aisle space.

If control power batteries and charger are used, clear space for the battery rack and charger must be allowed. Typically the charger and battery rack are mounted near the end of the assembly that has the main circuit breaker.

Consult the customer drawings for source of power for the battery charger and inter-connection to the assembly.

Floor drains should be provided to prevent water build up from broken or leaking pipes.

Sewer, water and steam lines should be routed so they do not pass over or near the assembly. Dripping liquids may damage the insulation and cause the switchgear to fail.

Ample head room must be allowed for top entrance or exit conduit and cable bends.

NOTE: BUS PADS AND CABLE TERMINATIONS ARE FOR CONNECTIONS AND ARE NOT INTENDED TO SUPPORT THE DEAD WEIGHT OF LONG VERTICAL CABLE DROPS.

Foundation (Figures 17 & 18)

The switchgear must be installed on a flat and level surface to prevent distortion and assure that the circuit breakers will be interchangeable in all compartments. It is recommended the switchgear be installed on a concrete pad leveled to ±1/16 inch in any square yard and that steel channels be installed in the pad for anchoring the switchgear. See figures 17 and 18.

A seven foot long aisle space should be poured in front of the mounting pad flush with and finished to the same tolerance as the mounting pad. This level surface is necessary for the circuit breaker lift truck and inserting the circuit breakers into the bottom compartment.

The weight of a complete assembly with its breakers in place will depend on the number of cells and circuit breakers. Approximate weights of the individual Two-High cells and the circuit breakers are given in Tables 1 and 2, page 19, RECEIVING, HANDLING AND STORAGE. The circuit breaker does not transmitt impact-load to the foundation on closing or interrupting and need not be considered. The combined assembly and circuit breaker dead weight is all that need be considered.

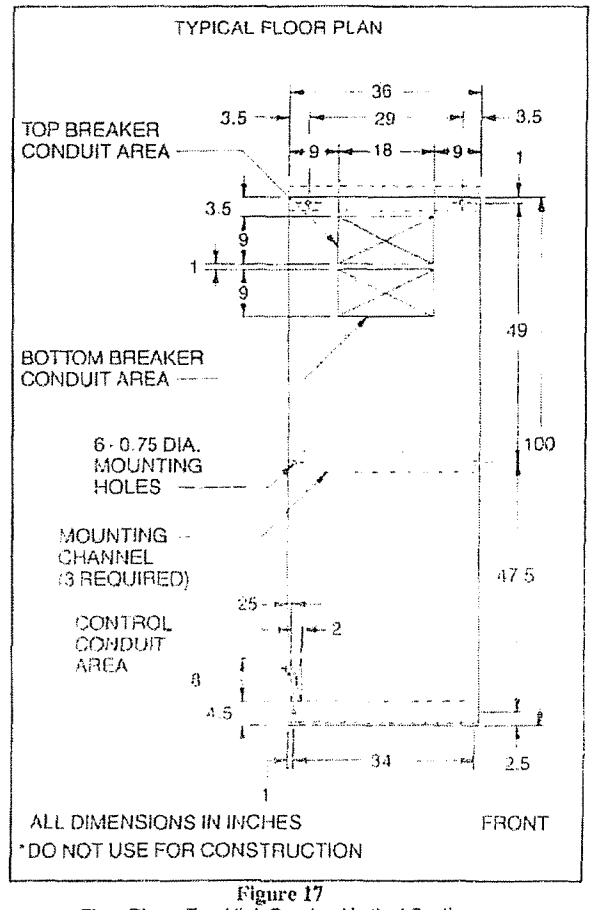


Figure 17
Floor Plan—Two-High Breaker Vertical Section.

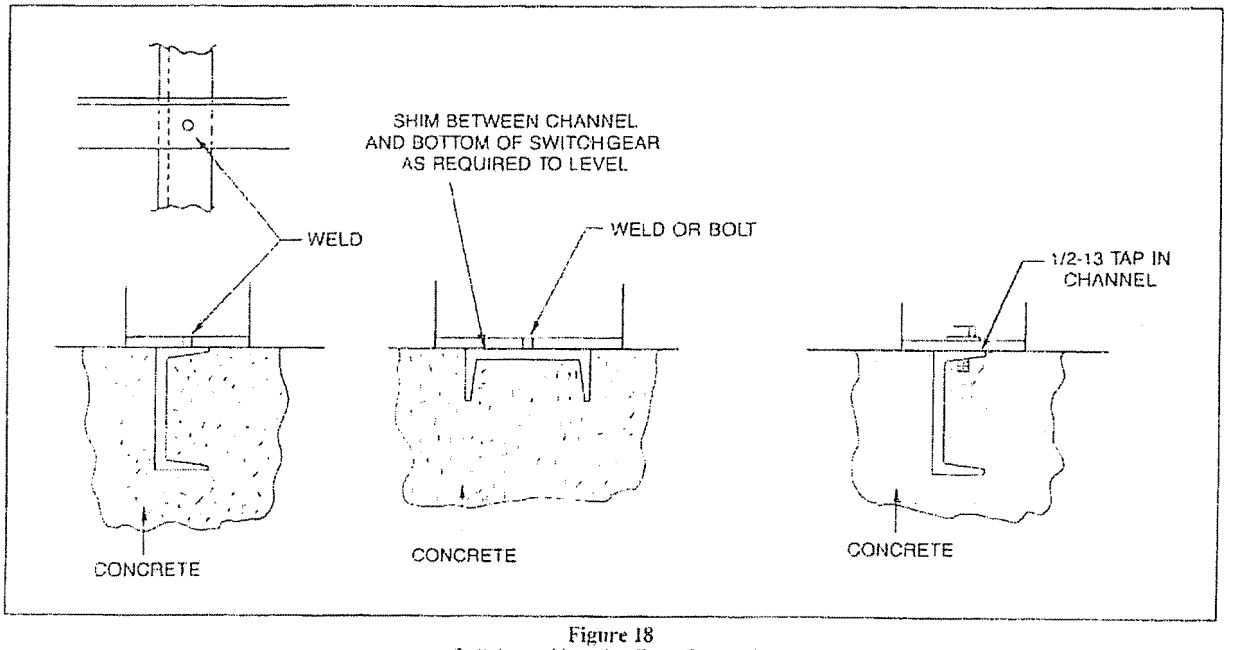


Figure 18
Switchgear Mounting Floor Channels.

If the installation is to be made on an existing concrete floor it is suggested that a new floor with mounting channels be installed over the existing floor. The new floor must not extend in front of the switchgear more than 3" or it will prevent docking of the Square D breaker lift truck. An alternate would be to cut the existing floor to install the mounting channels and then fill in the low spots with one of the many epoxy surfacing materials available and grind the complete mounting pad to the required tolerance.

Conduits should be stubbed a maximum of 2 inches above floor level so that they do not extend into the Zero Sequenced Current Transformers. The conduit location should be very accurate so that there is no mechanical interference with the assembly frame.

Installation of Assembly

Two High 5-15kV Metal Clad Indoor Switchgear may be shipped in one or more shipping sections depending on the number of cells in the assembly.

CONSULT THE CUSTOMER DRAWINGS AND SECTION MARKINGS TO INSURE PROPER LINE UP BEFORE INSTALLING EACH SECTION.

If two shipping sections are furnished, install the section first that allows the most maneuverability for the second section.

When more than two shipping sections are involved carefully measure the conduit spacings and compare with the customer drawings. Cumulative error in conduit locations may require starting with the center shipping section and working toward either end. If the conduits are properly located install the end shipping section first that allows the greatest maneuverability for installing the additional sections.

Sweep the pad area before installing sections.

Move the section(s) in place by crane or rollers. When the first section is approximately in the proper position lower onto the pad. Place a 2x6 across the assembly and pry into place. DO NOT PRY DIRECTLY ON THE STRUCTURE, DOORS OR COVERS. The conduits should be in the center of the cut outs, the back of the unit parallel with the pad and with proper clearance, and the mounting holes lined up with the holes in the mounting channels before proceeding.

Level each section before installing the next. Install steel shims, if necessary, between channels and switchgear. After leveling a section, bolt it to the previously installed section(s) before proceeding. If the sections do not fit snugly together, pry together. DO NOT ATTEMPT TO PULL SECTIONS TOGETHER WITH THE HARDWARE.

Move all the shipping sections into place and bolt together before attempting to bolt or weld to the channel sills or installing the horizontal main bus.

After all the sections are level and bolted together, again check that all shipping sections are in their correct position per the job drawings. If they are, weld or bolt the switchgear to the pad. If bolted, 1/2-13 bolts should be used.

THE MAIN BUS AT THE SHIPPING BREAKS SHOULD ONLY BE INSTALLED AFTER THE SHIPPING SECTIONS ARE SECURELY ANCHORED IN PLACE AND NO ADDITIONAL MOVEMENT WILL BE MADE TO THE ASSEMBLY.

The bus bar extensions for the shipping breaks are shipped with the miscellaneous items.

Remove the main bus covers and the removable insulating boots. Install one phase at a time by sliding through the bus barriers and loosely bolting the horizontal bus to the vertical bus. DO NOT BEND OR FORCE THE BUS TO MAKE THIS CONNECTION. The through bushings and the divided insulating barrier may be loosened if necessary. They have sufficient clearance and adjustment to make up for minor field mis-alignment of shipping sections. Tighten the bolts holding the bus bar joints only after all three bus bars are in place and fit properly. Use a torque wrench to insure bolts are tightened in accordance with Table 5, page 24, Installation of Assembly.

Connect the ground bus splice at each shipping section. Remove the hardware and position the splice plate and tighten hardware on both ends.

THE GROUND BUS MUST BE CONNECTED FOR PROPER OPERATION OF RELAYING, INSTRUMENTATION AND PERSONNEL SAFETY.

Consult the customer wiring diagram for reconnection of wiring at the shipping break. Each wire will be identified, and it was been previously connected during assembly and testing at the factory. If the identification is missing or clarified, ring out before connecting to avoid start up control circuit and instrument panel problems.

With all primary and control power circuits de-energized, insert each circuit breaker into the connected position of its respective breaker compartment and observe the operation of the ground contacts, shutters, secondary control power plug and disconnect position latch operation.

Remove each circuit breaker from its compartment. Open the shutters and check that impressions from main disconnects extend back a minimum of 1/2" from front edge on each bar. Check that ground shoe leaves tracks on breaker ground bus.

DO NOT FORCE CIRCUIT BREAKERS INTO CIRCUIT BREAKER COMPARTMENTS. COMPARTMENT RATING INTERLOCKS PREVENT INSERTING CIRCUIT BREAKERS INTO INCORRECT CELL.

Withdraw the drawout control power fuse drawer and the drawout voltage transformer drawer and observe their operation. Check that the static ground operates properly and that the primary and secondary contacts are making properly.

The bus and circuit breakers should be Hi Pot tested or Resistance tested as an assembly before the external power connections are made.

LIGHTNING ARRESTERS (if provided) ARE NOT CONNECTED AT THE FACTORY.

WITHDRAW THE CONTROL POWER TRANSFORMER DRAWER, THE VOLTAGE TRANSFORMER DRAWER AND DRAWOUT FUSE DRAWER (if provided) BEFORE HI-POT OR RESISTANCE TESTING.

Disconnect the external source (if used) from the space heaters and reconnect the space heaters to their original connection.

Place all of the circuit breakers in their proper circuit breaker compartments in the operate position, charge their springs manually and close by means of the manual pushbutton on each circuit breaker.

CAUTION

VACUUM CIRCUIT BREAKERS MUST BE CLOSED WHILE PERFORMING HI-POTENTIAL TESTS TO ELIMINATE POSSIBLE RADIATION OF X-RAYS. SEE VACUUM CIRCUIT BREAKER MANUAL FOR DETAILS.

Hi Pot testing should only be done with a reliable transformer type tester with a built in voltmeter and milliammeter. Capacitor loaded bench type testers with neon bulb indicators do not have sufficient capacity to give reliable results.

Resistance measurements should be made with a motor driven 1000 or 2500 volt megger with sufficient scale range to read at least 250 megohms on the scale before it indicates infinity.

See Tables 3 & 4 for normal test values for dry, clean, new assemblies. Field high-potential tests are made at 75% of factory test voltages in accordance with ANSI standards.

If satisfactory results are not obtained the trouble should be located, corrected and the test rerun, before proceeding.
The assembly should now be ready for connecting the power cables, ground wires, external wiring and battery (if supplied).

Field Test Levels

Table 3

ONE MINUTE HIGH-POTENTIAL TEST*			
ASSEMBLY RATED MAXIMUM VOLTAGE	FACTORY TEST VOLTAGE	FIELD TEST VOLTAGE	
		AC	DC
4.76kV	19kV	14kV	20kV
8.2kV	36kV	27kV	38kV
15kV	36kV	27kV	38kV

*All Voltages Are 60Hz RMS Symmetrical.

Table 4

PRIMARY INSULATION RESISTANCE MEASUREMENTS*		
ASSEMBLY RATED MAXIMUM VOLTAGE	NUMBER OF CONNECTED CIRCUIT BREAKERS	MINIMUM ACCEPTABLE ASSEMBLY RESISTANCE
4.76kV	1-3	30 Megohms
	4+	25 Megohms
8.2kV	1-3	55 Megohms
	4+	50 Megohms
15kV	1-3	80 Megohms
	4+	75 Megohms

* All measurements are made phase to phase AND phase to ground.

Phasing

All bus within the switchgear is phased A-B-C left to right, top to bottom and front to back when viewing the assembly from the front (the circuit breaker compartment side) per NEMA standards. If for any reason bus must be phased different than noted above, the phase will be identified on the bus with a label.

If the incoming main power source cables are connected to provide the proper phase rotation it eliminates feeder phase rotation problems and reconnecting of metering or relaying that depends on proper phase rotation for operation.

Individual feeder cables can be rung out and tagged before connecting to the bus pads which will assist in keeping the complete system in the proper phase rotation.

ASSEMBLIES THAT HAVE TWO SOURCES OF MAIN POWER AND THAT CAN BE SUPPLIED FROM EITHER SOURCE OR FROM BOTH SOURCES IN PARALLEL THRU A TIE BREAKER MUST HAVE BOTH SOURCES COMPARED AND HAVE NOT ONLY THE PROPER PHASE ROTATION BUT THE SAME ABSOLUTE PHASE (ZERO VOLTAGE DIFFERENCE) ON THE SAME PHASE.

Cable Connections

Extreme care should be taken when making up all types of cable terminations as the successful operation of the electrical distribution system will depend on successful terminations. Avoid sharp turns, edges or corners in order to prevent damage to the cable installation. Follow the cable manufacturer's recommendations for minimum bending radius. These instructions will vary from manufacturer to manufacturer.

The most common method for connecting power cables to metal-clad switchgear is by use of solderless or compression type cable lugs. Follow the cable manufacturer's instructions for making the terminations for each type of power cable. After the cable connections have been made they should be insulated as described below. Place SCOTCHFIL putty (3M Company) around the lugs and bolts to reduce the concentrated field created by their irregular shapes. (See Figure 19.) A layer of #13 semi-conducting tape should be used over the SCOTCHFIL. This tape is to be half-lapped and touch the conductor. It should not extend up over the bus epoxy insulation. Apply Scotch Brand #130C tape over the #13 tape. This tape is to be half-lapped for two layers on 5kV installations and four layers for 8.2kV and 15kV installations. The tape is to extend 1½ inches for 5kV and 2 inches for 15kV up over the bus insulation and cable insulation.

Two layers of Scotch Brand #22 tape are to be applied next and extended up over the #130C tape in all directions. The tape and other insulating materials for completing these field connections are not normally supplied with the switchgear.

Table 5

TORQUE—FOOT POUNDS		
BOLT SIZE	SAE #2 STEEL BOLTS①	SAE #5 STEEL BOLTS②
1/4-20	7	10
5/16-18	14	20
3/8-16	21	35
1/2-13	42	70

① For sheet-metal joints and TLD brass lugs.
② For electrical connections, copper or aluminum.

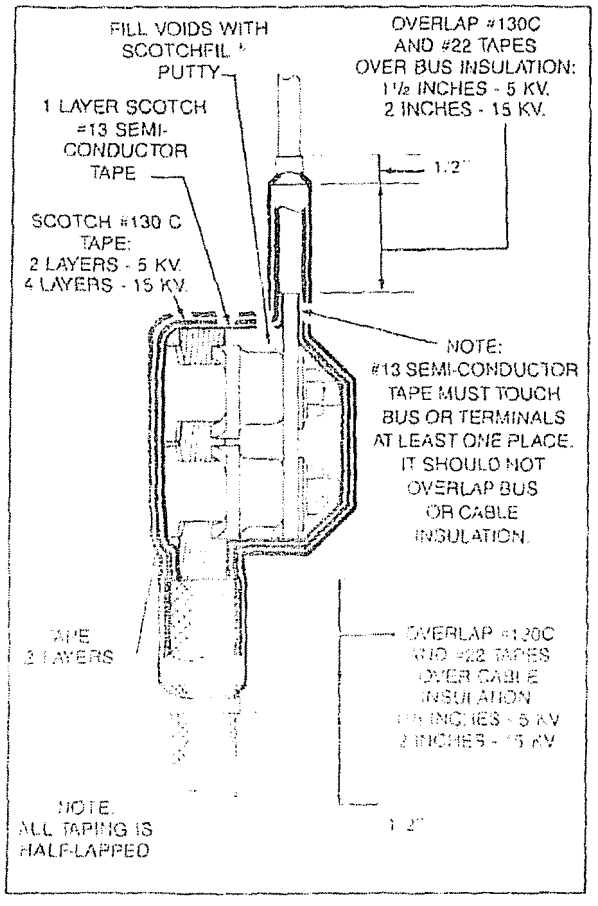


Figure 19
Terminal Insulation, High Voltage Cables

Potheads

When potheads or terminators are supplied for terminating power cables, the customer should follow the pothead manufacturer's instructions for terminating the cables in these devices. The bus side is not taped to facilitate installation of the power cables. After the cables have been made up, insulate the pothead to bus connections per the instructions previously described for insulating cable lugs.

Flexible Connectors

Occasionally, flexible connectors are provided for relieving the strain on insulators when the switchgear is connected to a transformer. These connectors also facilitate the connections between equipment supplied from various facilities. Flexible connectors used for these applications must be taped to provide adequate insulation. The taping instructions discussed under cable connections should be followed.

START UP

BEFORE THE MAIN SOURCE OF POWER IS CONNECTED TO THE ASSEMBLY, A THOROUGH PRE-START UP NO VOLTAGE CHECK SHOULD BE MADE.

Every compartment should be vacuumed out, all loose parts, tools and miscellaneous construction items and litter should be removed.

All the main bus covers and any other barriers or covers which were removed during installation should be put in place.

The cable compartment back covers should be installed.

The battery charger and batteries (if used) should be connected to the switchgear control bus per the order drawings.

All of the protective relays should be unblocked and set to the relay schedule. A relay test set should be used to verify the settings and electrical operation of each relay.

The Drawout Control Power Transformer (or Drawout Fuse Drawer) should have the current limiting fuses in place. Be sure the drawer should be in the withdrawn position.

The Drawout Voltage Transformers should have their current limiting fuses in place, BUT the drawer should be in the withdrawn position.

All the circuit breakers should be in their compartments and in the test/disconnect position.

CONNECT A TEMPORARY SOURCE OF LOW VOLTAGE POWER TO THE STATIONARY SECONDARY CONTACT OF THE CONTROL POWER TRANSFORMER OR ANY LOGICAL POINT. (CONSULT THE CUSTOMER SCHEMATIC AND WIRING DIAGRAM.) OPEN THE SECONDARY BREAKER AND REMOVE THE PRIMARY FUSES.

Rack one circuit breaker at a time into the connected position and electrically close and open with the door mounted circuit breaker control switch. Open the circuit breaker by "bumping" the contacts of each protective relay. Reset the targets after each operation.

Electrically operate from remote control locations, check remote indicating lights etc.

Operate all electrical interlocking, transfer schemes, lock out relays and other control functions to insure proper operation.

REMOVE THE TEMPORARY SOURCE OF LOW VOLTAGE POWER AND MAKE THE PERMANENT CONNECTION OF LOW VOLTAGE POWER. RACK ALL CIRCUIT BREAKERS INTO THEIR CONNECTED POSITION. INSERT THE DRAWOUT CONTROL POWER TRANSFORMER, DRAWOUT FUSES, AND DRAWOUT VOLTAGE TRANSFORMERS INTO THE OPERATE POSITION.

Test (again) trip voltage is available at breaker terminals in each compartment.

Energize incoming high voltage circuit(s).

Close breakers to initiate service.

INSPECTION AND MAINTENANCE

Inspection and maintenance should be performed on the basis of operating conditions and experience. Abnormal operation or

conditions may require immediate action while regularly scheduled inspection and maintenance will depend on when "down-time" can be tolerated and qualified personnel are available. Unfortunately "down-time" is usually only available at night, weekends or holidays so maintenance must be properly planned and scheduled well in advance.

Read the entries in the inspection and maintenance log book to help determine the work to be done, replacement parts available and to estimate the "down-time" and personnel required. Do not rush and take unnecessary short cuts or by-pass good safety practices because of poor planning.

INSPECTION AND MAINTENANCE SHOULD ONLY BE DONE WITH THE MAIN SOURCE/SOURCES OF POWER DISCONNECTED AND LOCKED OPEN WITH A WORK LOCK. BE ABSOLUTELY SURE THERE IS NO BACK FEED THRU ANY FEEDER CIRCUIT. GROUND THE MAIN AND FEEDER CIRCUITS BEFORE TOUCHING THE MAIN BUS, BUS PADS OR PRIMARY CONTACTS.

Main Bus Compartment

Remove the covers from each main bus compartment and inspect the bus bars, primary contact supports and the insulating barriers and thru bushings. All insulation should be clean with no indication of carbon deposits.

Track paths or "treeing" indicate areas of high voltage stress and insulation deterioration. All aged insulation should be replaced immediately or scheduled for replacement during the next scheduled maintenance depending on the severity of the deterioration.

Remove the insulating boots from the primary contacts and check the bolts for proper tightness. See Table 5, page 24 for proper torque. Slight discoloration or tarnish of the silver plate is normal and of no concern. Severe discoloration of the silver plate is an indication of an improper or loose contact and overheating. Clean the discoloration from the contact surfaces of the bus bar and primary contact.

Use a commercial silver polish or denatured alcohol to clean the silver plated contact surfaces. CAUTION: Keep away from sparks or flame. Avoid breathing large quantities of vapor and excessive contact with skin. Do not use sandpaper or other abrasive materials that will scar or remove the silver plate.

Vacuum each compartment to remove dust, spiderwebs, etc. Wipe off the insulation with a clean cloth. Replace the insulating boots and the removable covers.

Cable Compartment

Inspect the load connectors, stand-off insulators, primary contact supports and all accessible cable terminations for indication of insulation deterioration.

Remove the insulating boots from the primary contacts and check for discoloration and bolt tightness. Clean the silver plated contact surfaces if necessary and tighten in accordance with Table 5, page 24.

Vacuum each compartment and wipe off all insulation. Replace the insulating boots and the removable back covers.

Drawout Control Power Transformer Compartment

Withdraw the drawer to the fully withdraw position. Inspect the moving and stationary primary and secondary contacts and the static ground contacts. All contacts should be free of burning or pitting marks and of any build up of grease or dirt, and should have bright shiny areas where the contacts have been made. Clean the contact surfaces and remove any burning or pitting marks. Both the stationary primary and secondary contacts have adjustable compression springs that can be adjusted if necessary to increase contact pressure.

Remove the current limiting fuses and inspect the fuse clip and fuse contact surfaces. Clean if necessary. Inspect the control power transformer for indication of insulation deterioration. Tighten all hardware including the secondary contact wiring terminals.

Vacuum the compartment and drawer and wipe off the insulation and control power transformer with a clean dry cloth.

Lightly lubricate the moving primary and secondary contacts with Square D contact grease #PJC-7201. DO NOT USE NO-OXIDE, METALLIC PARTICLE OR LOW TEMPERATURE GREASES. DO NOT GET GREASE ON INSULATION OR ON THE CONTROL POWER TRANSFORMER.

Inspect the molded case circuit breaker and interlock mechanism for proper operation. Replace the current limiting fuses BUT leave the drawer in the withdrawn position until all the inspection and maintenance is completed.

Drawout Voltage Transformer Compartment

Withdraw the drawer to the fully withdrawn position. Inspect the moving and stationary primary and secondary contacts and

the static ground contacts. All contacts should be free of burning or pitting marks and of any build up of grease or dirt, and should have bright shiny areas where the contacts have been made. Clean the contact surfaces and remove any burning or pitting marks. The stationary primary contacts have adjustable compression springs that can be adjusted if necessary to increase contact pressure.

Remove the current limiting fuses and inspect the fuse clip and fuse contact surfaces. Clean if necessary. Inspect the voltage transformer for indication of insulation deterioration. Clean all hardware including the secondary contact wiring terminals.

Vacuum the compartment and drawer and wipe off the insulation and voltage transformer with a clean dry cloth.

Lightly lubricate the moving primary and secondary contacts with Square D contact grease #PJC-7201 or equal. DO NOT USE NO-OXIDE, METALLIC PARTICLE, OR LOW TEMPERATURE GREASES. DO NOT GET GREASE ON INSULATION OR ON THE VOLTAGE TRANSFORMER.

Replace the current limiting fuses, BUT leave the drawer in the withdrawn position until all inspection and maintenance is completed.

Drawout Fuse Compartment (If Supplied)

Withdraw the drawer to the fully withdrawn position. Inspect the moving and stationary line and load contacts and the static ground contacts. All contacts should be free of burning or pitting and any buildup of grease or dirt, and should have bright shiny areas where the contacts have been made. Clean the contact surfaces and remove any burning or pitting marks. The stationary line and load contacts have adjustable compression springs that can be adjusted if absolutely necessary.

Remove the current limiting fuses and inspect the fuse clip and fuse contact surfaces. Clean if necessary. Tighten all hardware including the secondary contact wire terminals.

The control power transformer will be located in the cable compartment of the same cell and should be inspected for insulation deterioration. Clean and have the connections tightened.

Vacuum the compartment and drawer and wipe off stand-off insulators with a clean, dry cloth.

Lightly lubricate the moving primary and secondary contacts with Square D contact grease #PJC-7201, or equal. DO NOT USE NO-OXIDE, METALLIC PARTICLE, OR LOW TEMPERATURE GREASE. DO NOT GET GREASE ON STAND-OFF INSULATORS.

Replace the current limiting fuses, BUT leave the drawer in the withdrawn position until all inspection and maintenance is completed.

Circuit Breaker Compartment

Withdraw each circuit breaker from its compartment and thoroughly inspect each of the moving mechanisms in the compartment.

The shutters, mechanism operated cell switch and truck operated cell switch should raise and lower smoothly with no indication of binding, twisting, hesitation or hang-up. Inspect and tighten their hardware if necessary.

Primary contacts should be free of burning or pitting marks and should have bright shiny surfaces indicating good contact with the circuit breaker separable contacts. Slight discoloration or tarnish of the silver plate on the primary contact is normal and of no concern. Severe discoloration of the silver plate is an indication of excessive heating and should be corrected. Typical causes are: poor contact between the circuit breaker separable contacts and the primary contacts, loose hardware or otherwise improper contact at the bus connection, severe overcurrent operating condition for an extended period of time or internal heating problems in the circuit breaker. Each possible source of trouble should be investigated and corrected. Rated contact force is 5.5 lbs. on each end of each finger of the main separable contact.

Consult the "Installation and Maintenance Log Book" for the condition of the primary contacts in the main bus and cable compartments and for operating history for that particular circuit breaker. If the problem is in the circuit breaker, it should be tagged and given a thorough inspection and maintenance before returning to service. Clean the discoloration and tighten the contact mounting bolts to the proper torque. Inspect the primary contact high voltage mounting tubes and support insulation. All insulation should be clean with no indication of track paths or "treeing", cracks or other mechanical damage. Damaged insulation should be replaced immediately or scheduled for replacement during the next scheduled inspection and maintenance depending on the severity of the deterioration.

The ground contact should be free of burning or pitting marks and should have bright shiny marks indicating good contact with the circuit breaker sliding contacts. Clean the contact surfaces to remove grease and dirt build up and inspect and tighten the hardware. Relubricate with grease #PJC-7201, or equal.

Inspect the stationary control power receptacle. The molding should be free of cracks, the female contacts clean, and the assembly free to move the mounting bolts. DO NOT TIGHTEN THE MOUNTING BOLTS AND PREVENT THE ASSEMBLY FROM FLOATING. Clean the front and back surfaces of the receptacle to prevent contamination build up

Vacuum the compartment and wipe off the primary contact high voltage insulating tubes and support insulation with a clean dry cloth.

Lightly lubricate the primary stab and the ground contacts with Square D grease #PJC-7201. DO NOT ALLOW GREASE TO GET DIRECTLY ON THE PRIMARY HIGH VOLTAGE INSULATING TUBES, SUPPORT INSULATION OR ON THE FRONT AND BACK OF THE CONTROL POWER RECEPTACLE.

Check all terminal block connections for loose hardware and crimp-on terminal condition. The hinge wiring to the door should not be frayed nor have insulation damage, and all wires should be contained in the hinge loop.

Compare the individual protective relay setting with the relay schedule and test each relay with a test set to verify the settings and proper operation. Consult the manufacturers literature for detailed inspection and maintenance procedure for each type of relay.

The batteries and battery charger (if provided) should be given a thorough inspection in accordance with the manufacturer's recommendations. Refer to the manufacturer's instruction manual in the Job Instruction Manual for cleaning, tightening of terminals, water level, etc.

Circuit Breakers

Type FG-2 (SF_6) and Type VAD-2 (Vacuum) circuit breakers are minimal maintenance devices. The interrupters are sealed mechanisms and do not require internal inspection or maintenance.

Consult the individual circuit breaker instruction and maintenance manual for cleaning, adjustments and lubrication.

Preparation For Return To Service

It should not be necessary to Hi Pot the assembly after a normal inspection and maintenance, but a resistance measurement comparison is advisable. Consult the "Installation and Maintenance Log Book" for previous readings.

Place all circuit breakers, except the main circuit breaker, in the connected position; but do not close. Make phase to phase and phase to ground resistance measurements on the main bus side primary high voltage stabs in the main circuit breaker compartment.

Resistance measurements should be made with the same or similar type megger that was used on previous testing if at all possible. The resistance readings should be no lower than when originally installed and will probably be higher because of the way the testing is being done. Lower resistance readings are an indication of possible insulation deterioration that was missed during the inspection and maintenance. Localize the problem, correct and retest before putting the assembly into service.

If proper previous resistance measurement records are not kept refer to Table 4, page 23, for MINIMUM ACCEPTABLE READINGS.

Rack all of the circuit breakers to the TEST/DISCONNECT position with their secondary control power plugs engaged and close the compartment doors. Insert the control power transformer and voltage transformer drawers in the operate position.

Close the main source/sources of power and operate each circuit breaker electrically in the TEST/DISCONNECT position. CAUTION: THE MAIN BUS AND ALL HIGH VOLTAGE PARTS MUST BE CONSIDERED HOT AND IN OPERATION AT THIS TIME.

ACCESSORIES

Circuit Breaker Lift Truck (Figure 20)

One circuit breaker lift truck is required for each two-high assembly. It is intended to be used for the circuit breakers in the top compartments of the two high cells, but it may also be used for the lower compartments.

The cradle is raised and lowered by self-braking worm and pinion drive system with a winch and wire cable. No ratchet release or locking is required due to the automatic load retaining clutch feature. A clockwise rotation of the handle raises the cradle and counterclockwise lowers it.

Push the lift truck toward the circuit breaker compartment so that the cradle is square with the front of the circuit breaker compartment. Raise the cradle until the two holes in the cradle clear the two pins in the front of the circuit breaker compartment door. Lower the cradle until the pins lock in the holes and the cradle bottom rests on the compartment floor locking the lift truck to compartment. Release the disconnect position latch and roll the circuit breaker directly from the compartment onto the cradle and pull forward until the circuit breaker/lift truck latch is engaged.

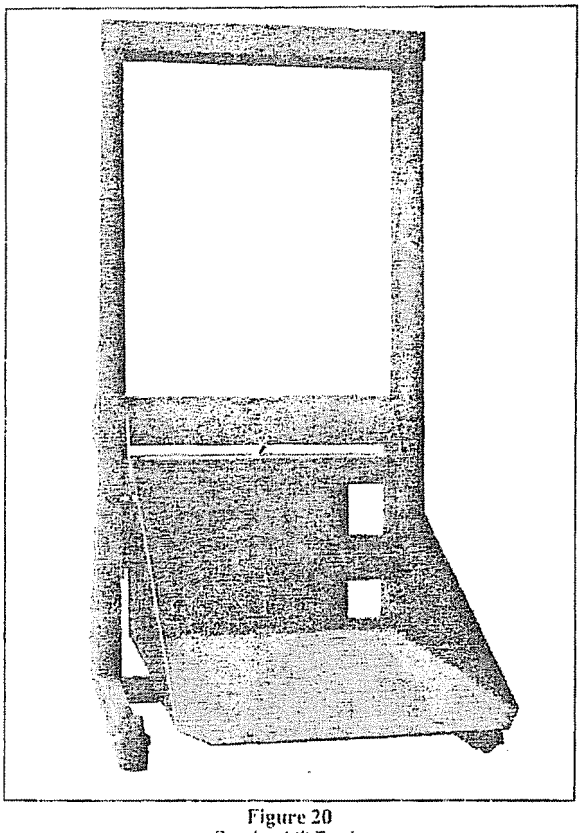


Figure 20
Breaker Lift Truck

DO NOT RAISE THE CRADLE AND MOVE THE LIFT TRUCK UNLESS THE CIRCUIT BREAKER/LIFT TRUCK LATCH IS ENGAGED AND IS HOLDING THE CIRCUIT BREAKER SECURELY AGAINST THE FRONT OF THE LIFT TRUCK AND THE BACK-UP SAFETY CABLE IS HOOKED TO THE BREAKER FRONT HANDLE.

The circuit breaker/lift truck latch may be released when the circuit breaker is lowered to the floor level. An access hole is provided in the cradle front panel to easily reach the circuit breaker/lift truck latch.

Two fixed wheels on the compartment side and two swivel wheels on the operator side of the circuit breaker lift truck provide for maneuverability in limited aisle space.

CAUTION

LUBRICATION OF ANY KIND MUST NOT COME IN CONTACT WITH THE LOAD RETAINING CLUTCH.

Test Cabinet (Option) (Figure 21)

An optional wall mounted test cabinet may be furnished if specified in the users specification.

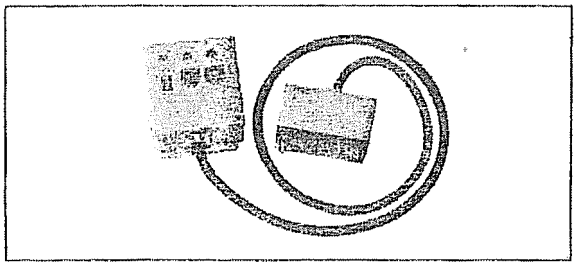


Figure 21
Breaker Test Cabinet

The test cabinet consists of a small enclosure with a Power ON-OFF toggle switch, White Power-On indicating light, Red Circuit Breaker Closed indicating, Green Circuit Breaker Open indicating light, Close and Open pushbuttons and an 8 foot cable with a Secondary Control Power Receptacle.

Mount the test cabinet on a wall approximately 4 feet above the floor. The location must allow for sufficient working space to move a circuit breaker in and out, to be able to easily get around the circuit breaker, and to be able to manually insert the cable mounted secondary control power receptacle on to the circuit breaker mounted secondary control power plug. Consult the customer drawings for the external power connections and requirements necessary for the cabinet. A convenient terminal block is provided inside the test cabinet for these connections.

Ground And Test Device (Option)

Two types of ground and test devices are available:

(1) Manual
(2) Automatic

Manual ground and test devices are designed to mechanically and electrically withstand their rated short circuit current for two seconds.

Automatic ground and test devices are designed to close into and mechanically and electrically withstand their rated short circuit current for two seconds.

Ground and test devices are safety devices, typically used for:

a) Grounding of circuits during maintenance periods.

b) Connection points for applying voltage for hi-pot testing and cable testing.

c) Access to both line and load side circuits for phase sequence testing.

d) Connection points for emergency connection of an alternate power source during a prolonged unscheduled or scheduled main power source outage.

Complete description, operating instructions and maintenance information is included in separate Ground and Test Devices Instruction Manual.

INSTALLATION AND MAINTENANCE LOG BOOK

An installation and maintenance log book should be started and kept current for reference. The log book may be only a loose leaf note book, but if good entries are made it becomes a reliable source of information when maintenance is performed as well as a guide to when immediate or normally scheduled maintenance is required.

Typical installation and start up entries are:

Date of installation and contractor or workman names.

List of problems (if any) during installation, and any parts damaged and replaced or modification made.

Date of pre-start up check, checks made, resistance or Hi Pot results and contractor or workman's names.

Date of start up and acceptance and names of personnel involved.

Circuit breaker serial numbers with operation counter reading for each, and circuit identification.

Typical operational entries are:

Dates of unscheduled outages due to main source of power failure.

Dates of severe thunder and lightning storms in area.

Dates of individual circuit breaker operation due to protective relay opening, with relay operated and circuit identification.

Dates and description of abnormal sounds, vibrations, etc. within the assembly, and action taken.

Dates of variations in meter readings and possible reasons.

Typical maintenance entries are:

Date of maintenance and workman's names.

Circuit breaker serial numbers with operation reading for each, operations since start up/ last maintenance and circuit identification.

Specific list of all maintenance work done.

Specific list of any parts to be replaced or work to be done immediately or at next maintenance period.

List parts ordered, when received, where stored, etc.

The log book, complete instruction manual and a complete set of as-installed customer drawings should be kept together in one safe place (preferably in the metal-clad switchgear assembly area) and available for use and reference by authorized personnel.

5-15kV METAL-CLAD
INDOOR SWITCHGEAR
SERIES 2

INSTALLATION AND MAINTENANCE LOG

Installation & Start Up Record

Date Received _____ Carrier _____
Condition Received _____
Shipping Damage _____

Damage Claim Filed _____
Shortages _____

Square D Field Office Notified _____ Salesman _____
Rigging Contractor _____
Riggers Names _____
Date Installed _____
Installation Contractor _____
Electricians Names _____

Installation Problems _____

Parts Damaged or Replaced _____

Field Modifications _____
Date Pre-Start Up Check _____
Electricians Names _____

Checks Made _____

Resistance Measurement Equipment Used _____

Resistance Measurements _____

Hi Pot Equipment Used _____

Hi Pot Results _____ kV

INSTALLATION AND MAINTENANCE LOG

Installation & Start Up Record

Circuit Breakers	Serial Numbers	Operation Counter	Circuit

Date Relays Set _____
Relay Test Equipment Used _____
Relay Technician _____
Date of Start Up _____
Start Up Engineer _____
Approved By _____
Accepted By _____
Notes _____

5-15kV METAL-CLAD
INDOOR SWITCHGEAR
SERIES 2

CLASS 6055

INSTALLATION AND MAINTENANCE LOG

Maintenance Record

Date _____

Electricians Names _____

Circuit Breakers	Serial Number	Operation Counter	Circuit

Maintenance Done

Drawout Fuse Drawer _____

Drawout P.T. Drawer _____

Drawout Fuse Drawer _____

Main Bus Compartments _____

Cable Compartments _____

Circuit Breaker Compartments _____

Circuit Breakers

Serial Number	Work Done

Relays Set _____

Notes _____

Parts Ordered _____

Date Ordered _____

Purchase Order Number _____

Date Received _____

Stored At _____

Work to be done at _____

Next Maintenance _____

INSTALLATION AND MAINTENANCE LOG

Operational Record

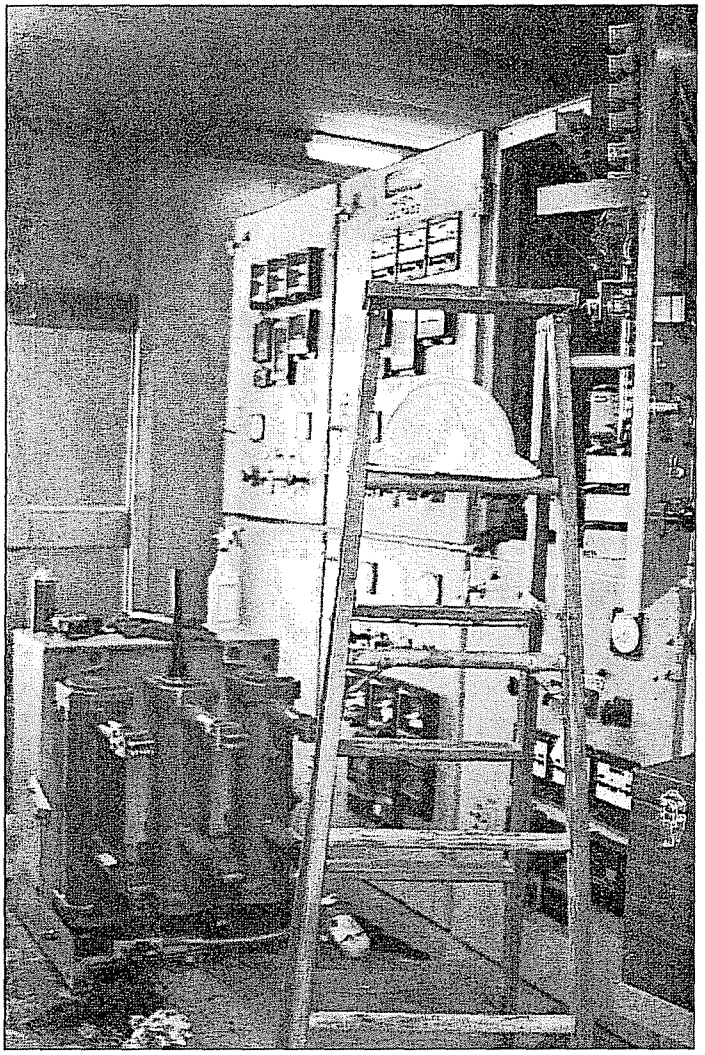
Date	Notes

SQUARE D COMPANY
330 Weakley Road, Smyrna, Tenn. 37167

Manual 6055-1

LBM 9 69 PS

Printed in U.S.A.



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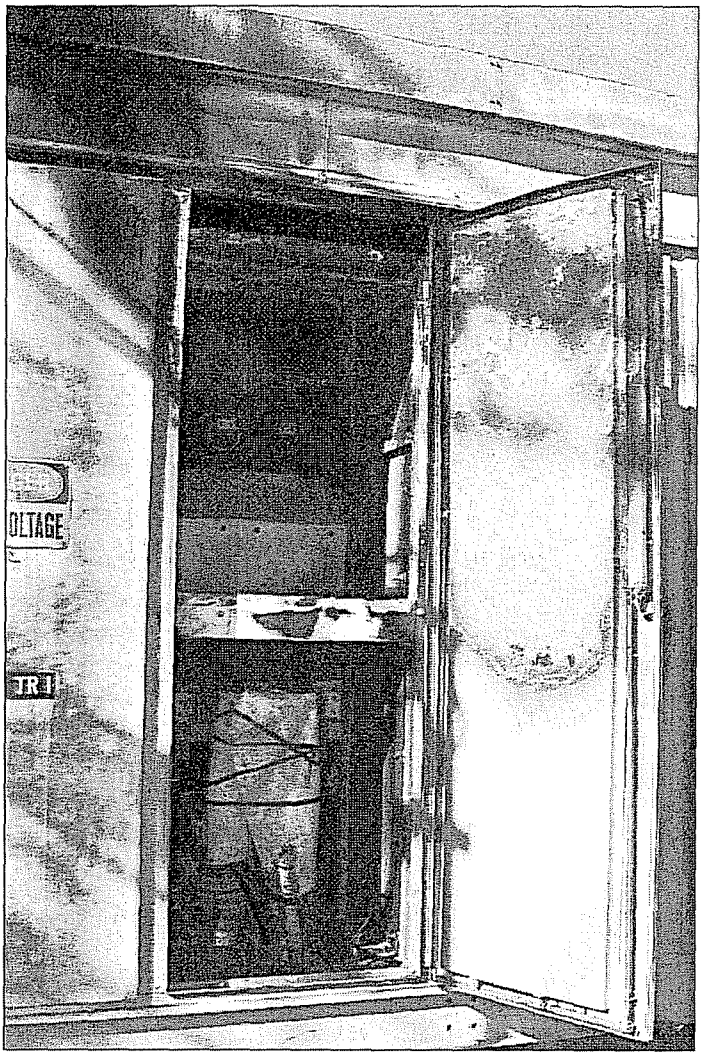

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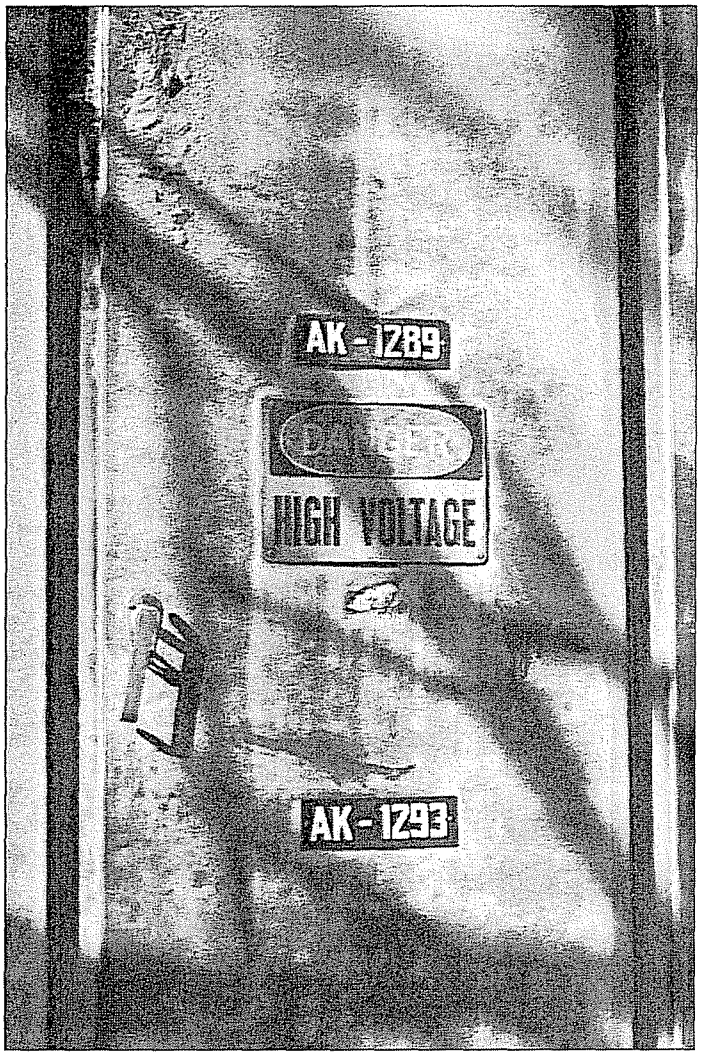

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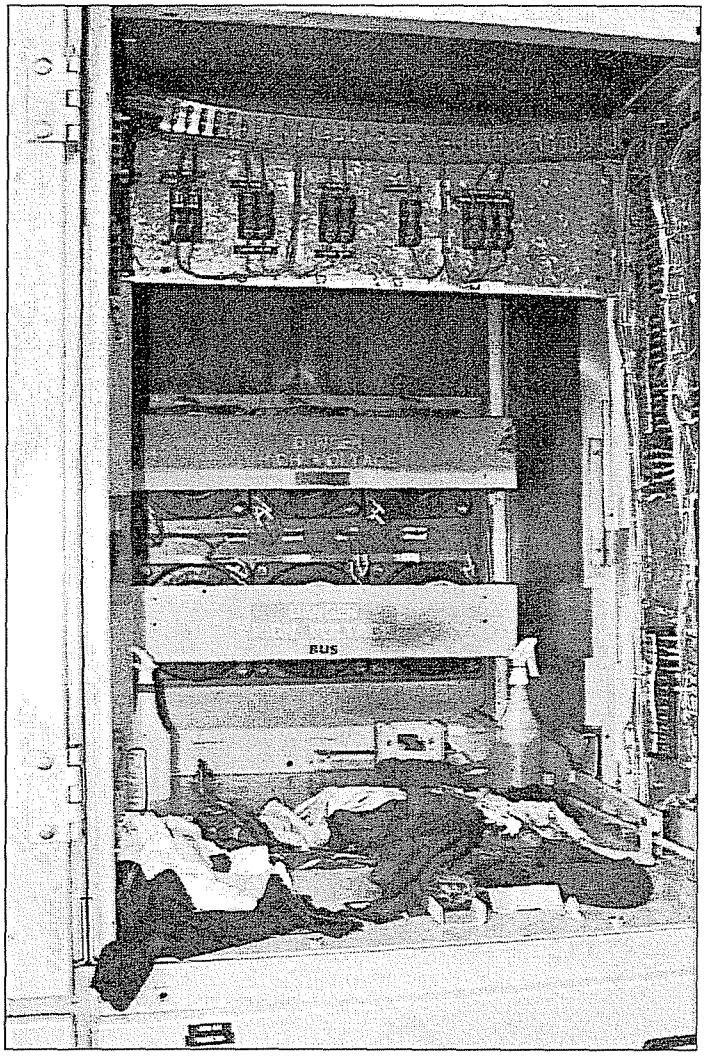

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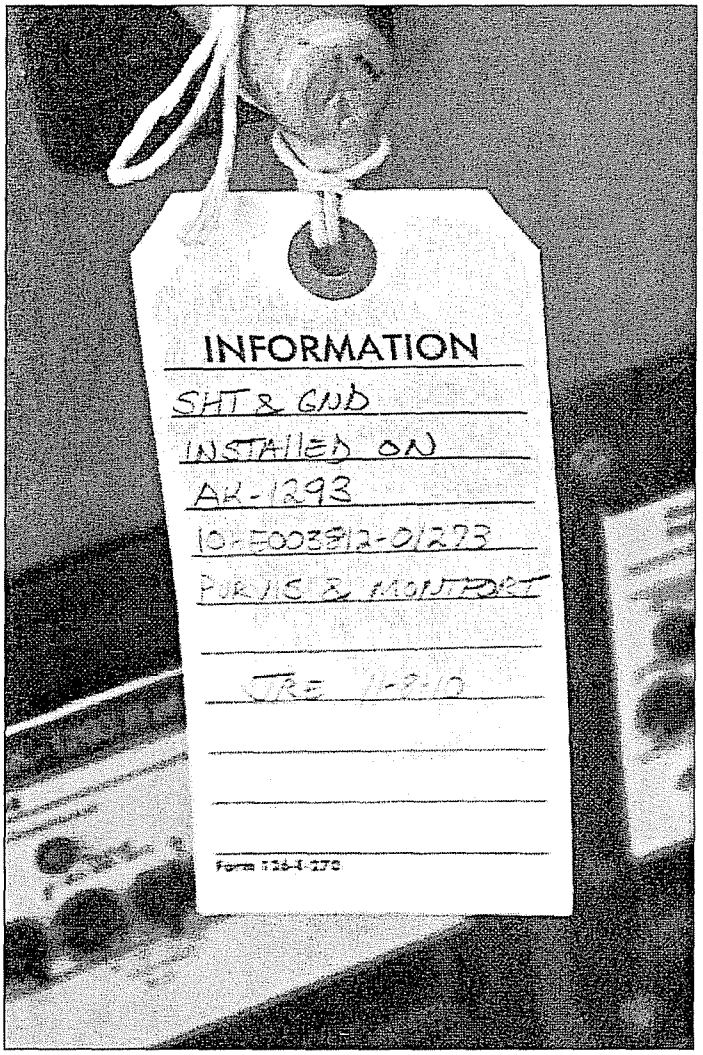
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AK-1293
10-E003812-01273
PARTS & MONTART
Form 726-4-270

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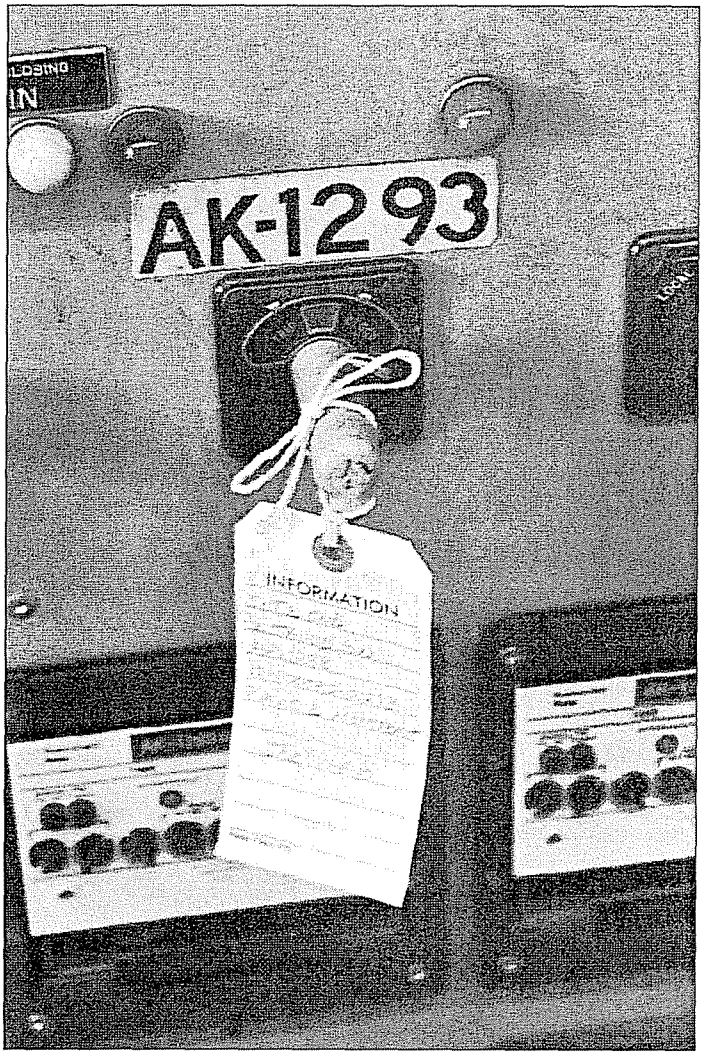
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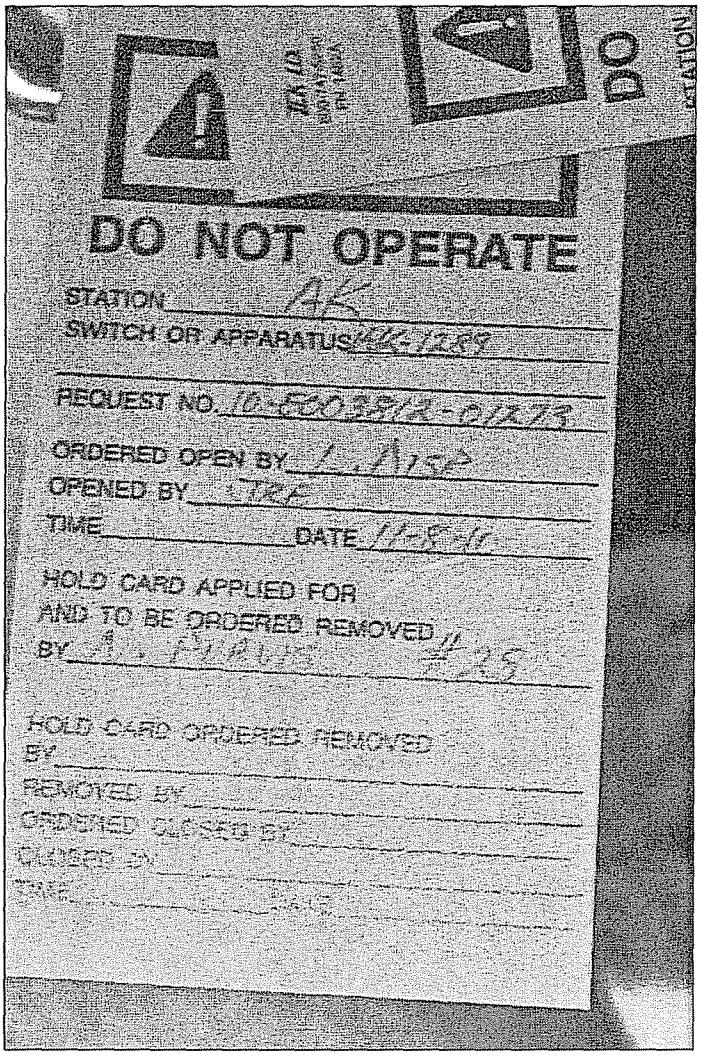
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STATION
SWITCH OR APPARATUS
REQUEST NO.
ORDERED OPEN BY
OPENED BY
TIME
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HOLD CARD APPLIED FOR
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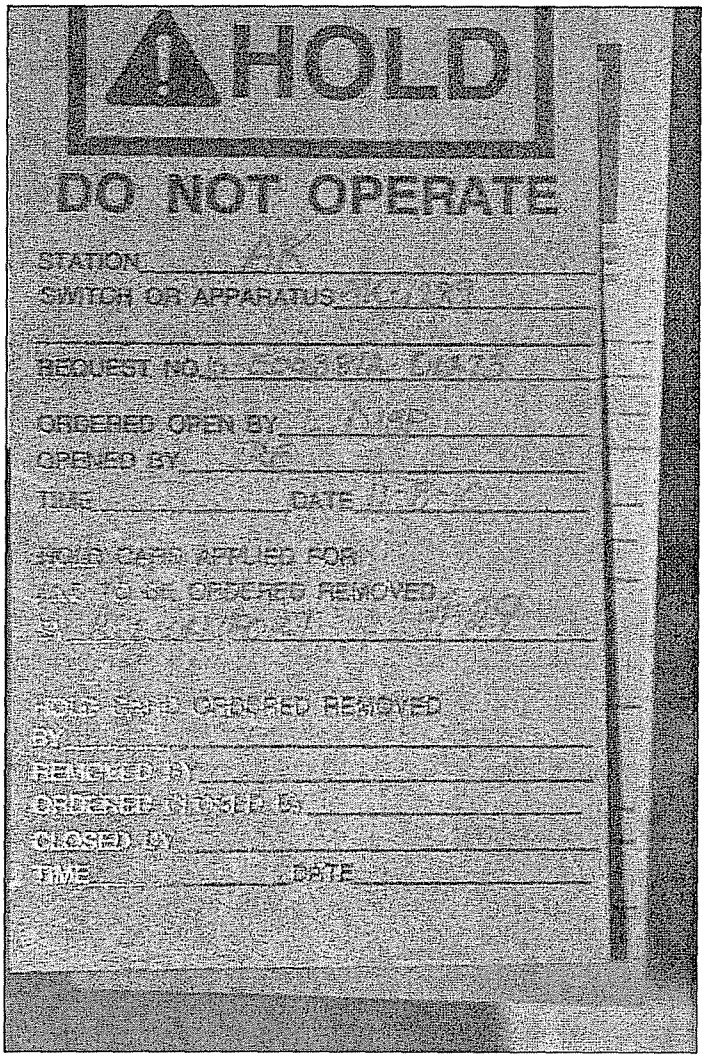
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DO NOT OPERATE
STATION
SWITCH OR APPARATUS
REQUEST NO.
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HOLD CARD APPLIED FOR
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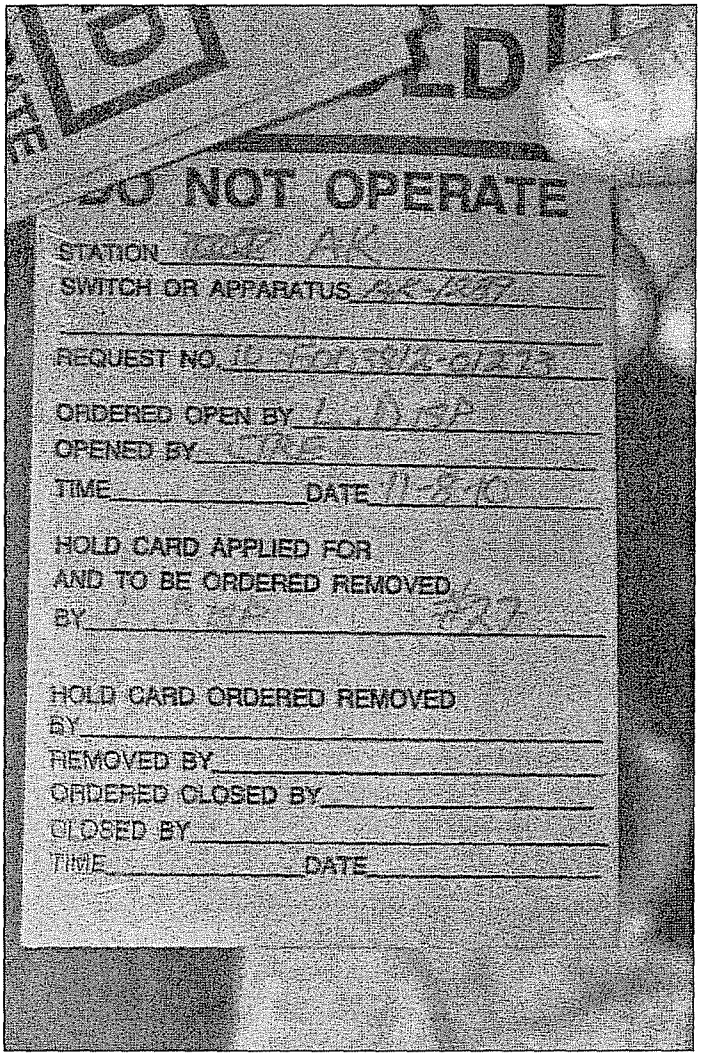
DO NOT OPERATE
STATION
SWITCH OR APPARATUS
REQUEST NO.
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OPENED BY
TIME
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HOLD CARD APPLIED FOR
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TIME
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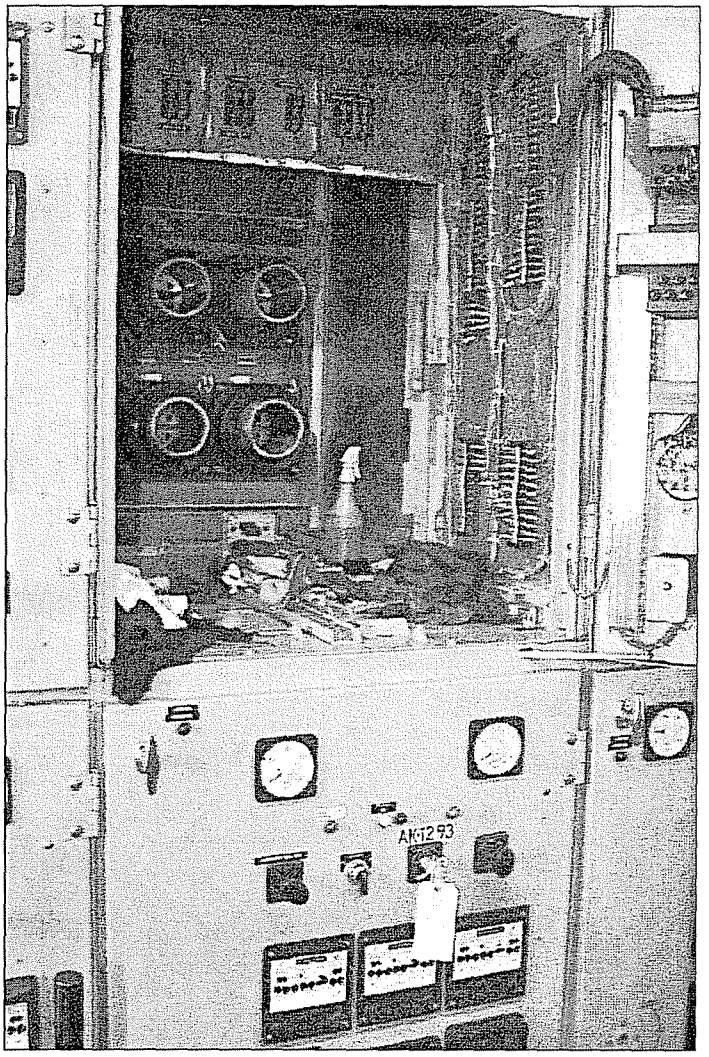
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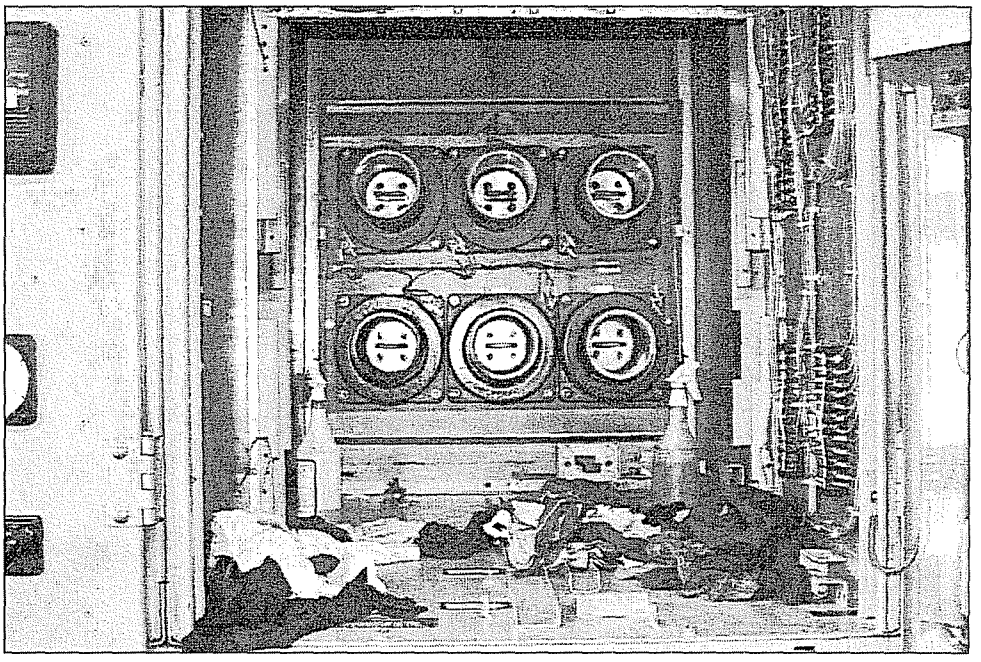

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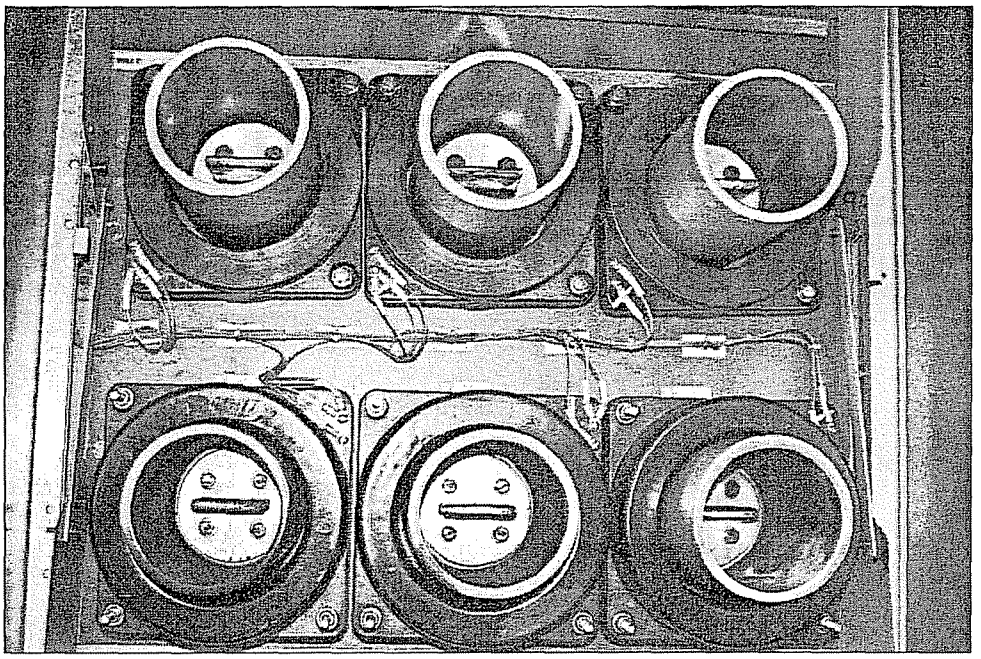

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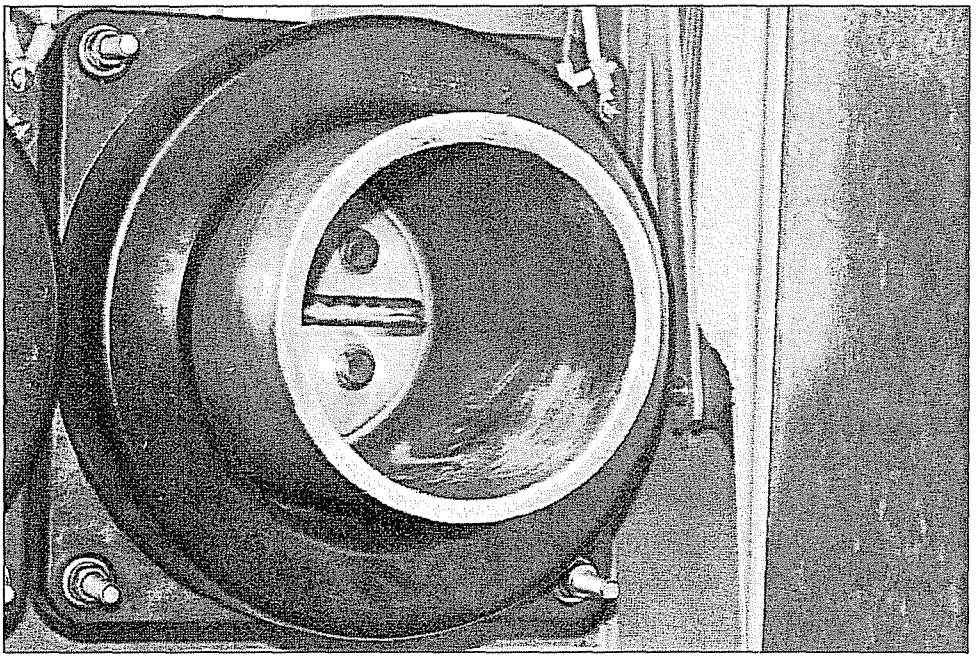

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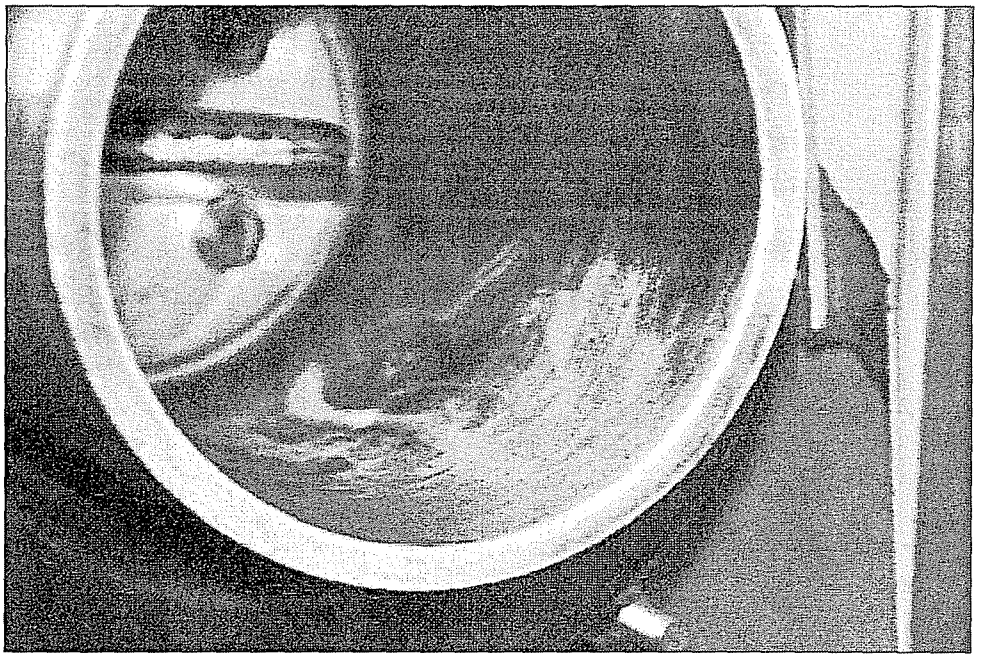

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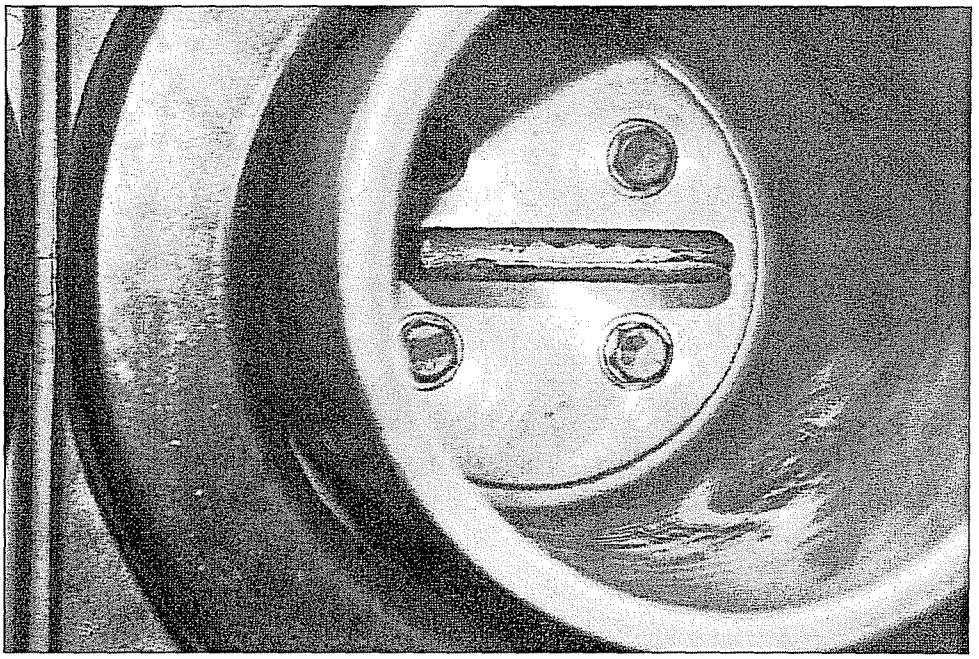

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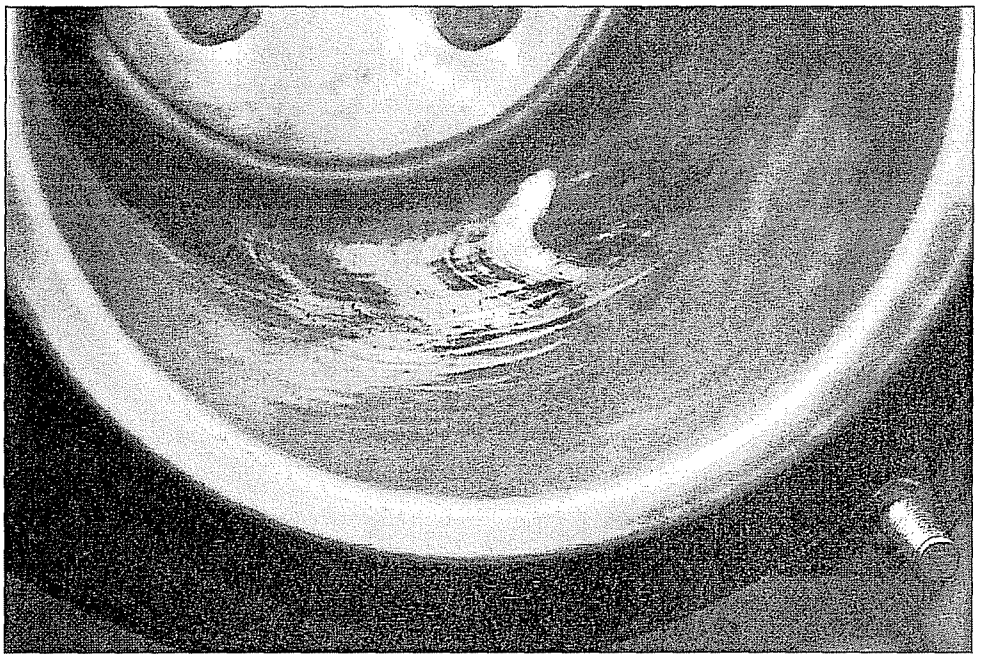

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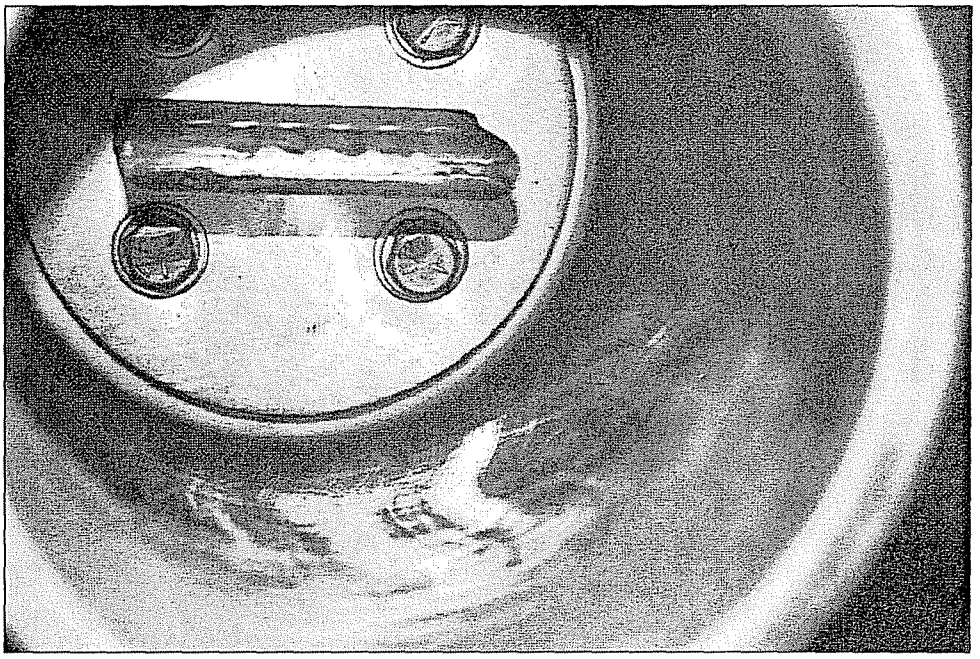

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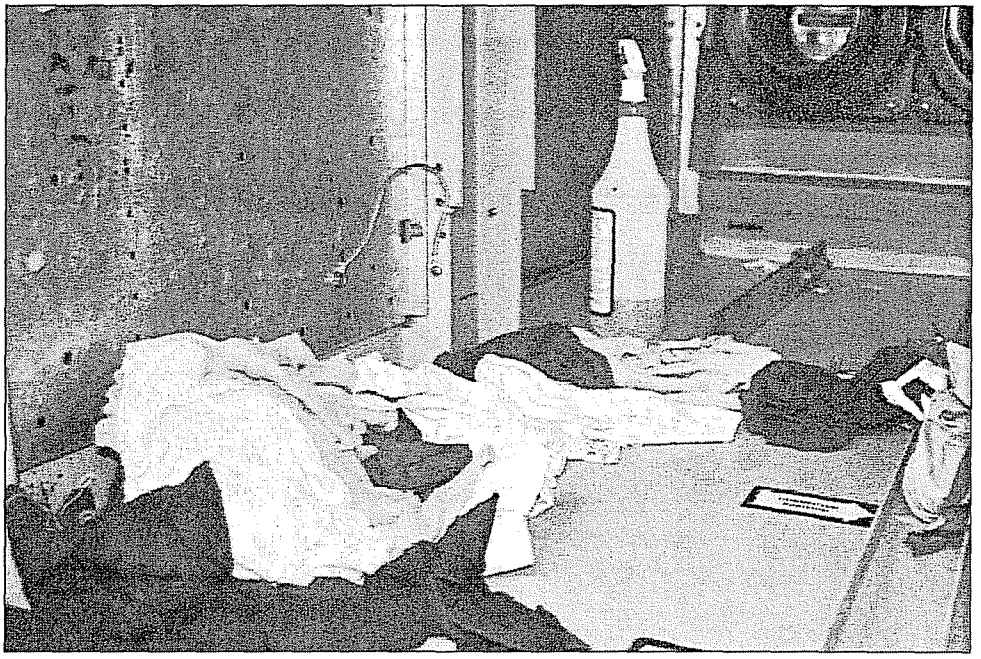

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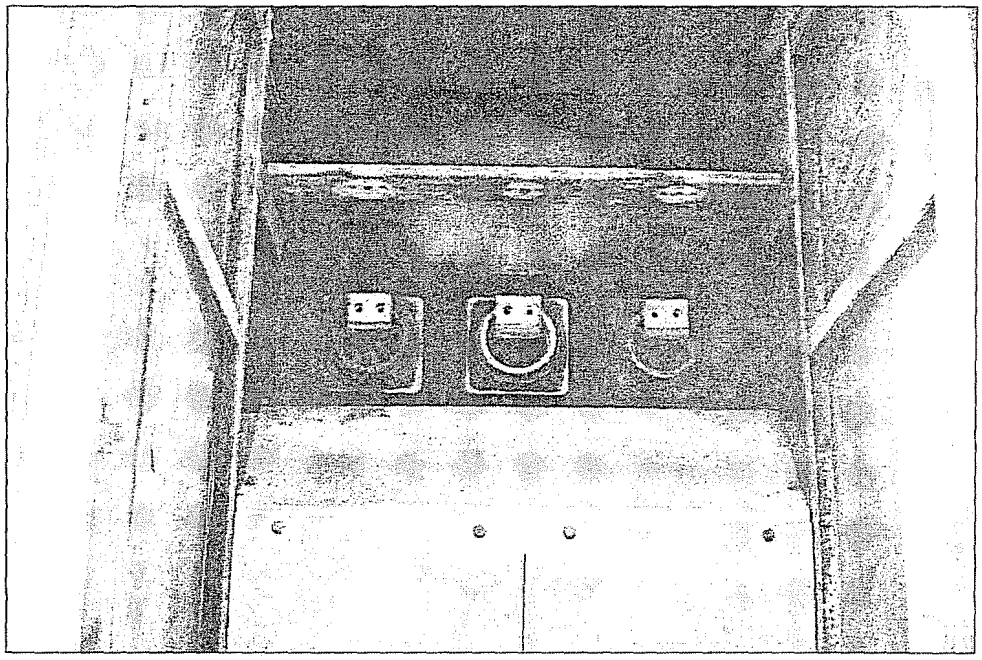

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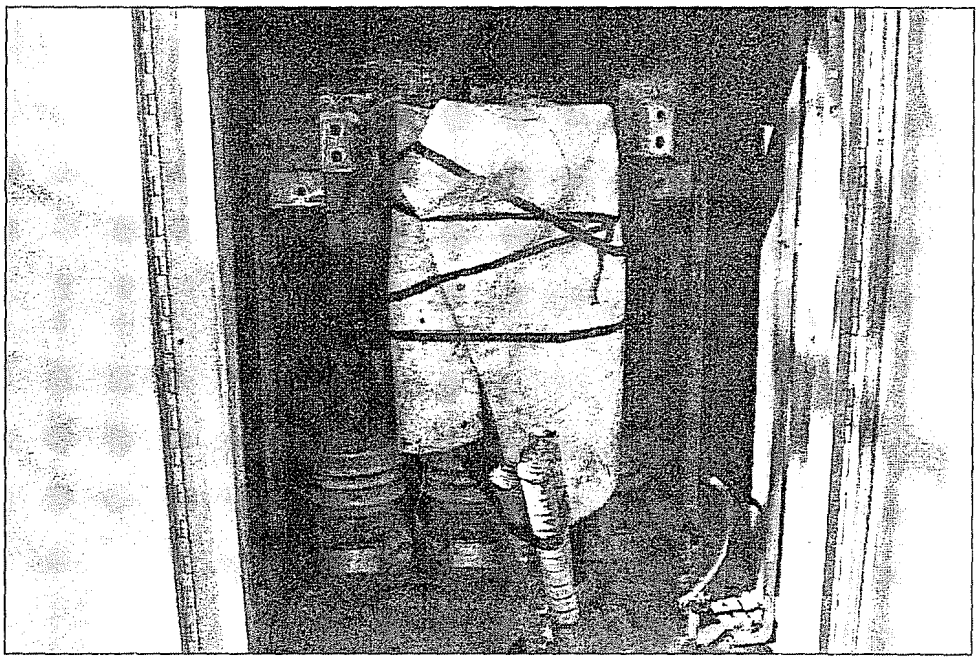

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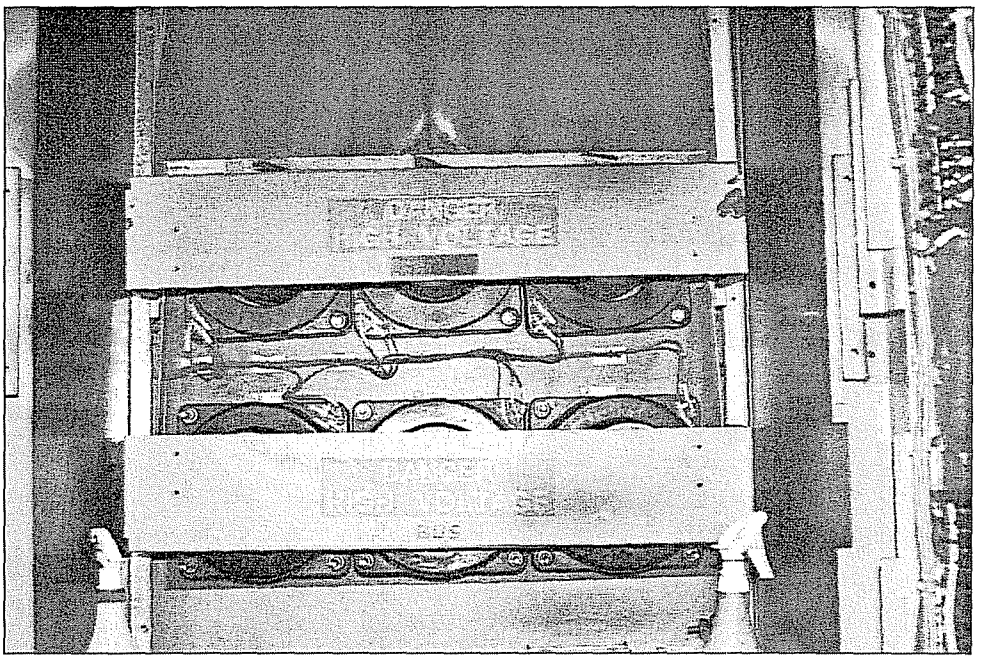

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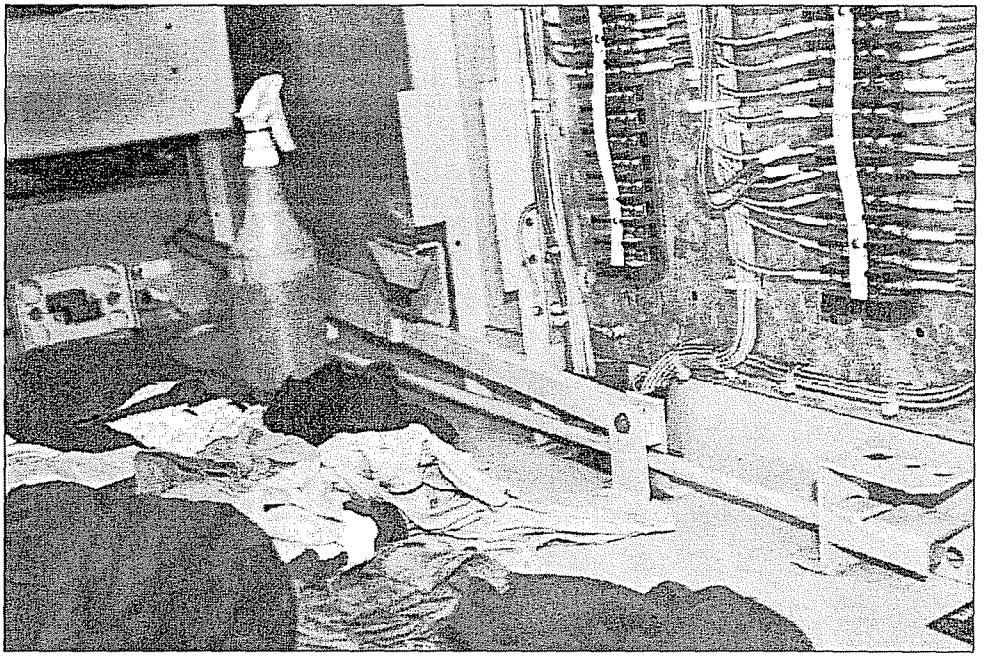
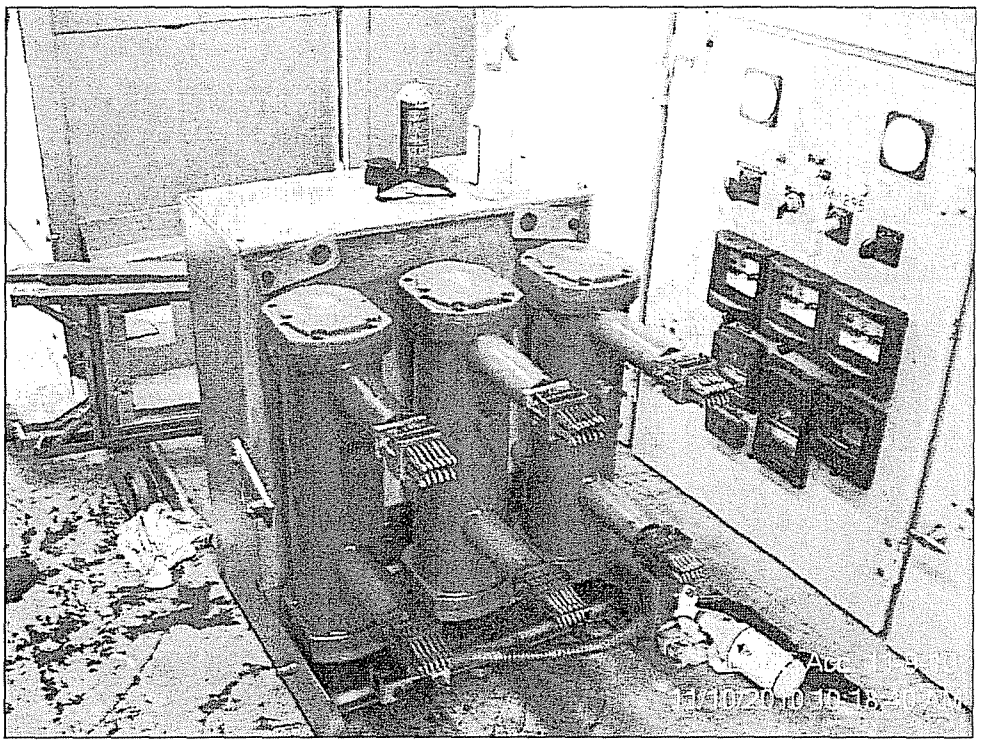


#25

Attachment B

KPSC Photographs of Accident Site



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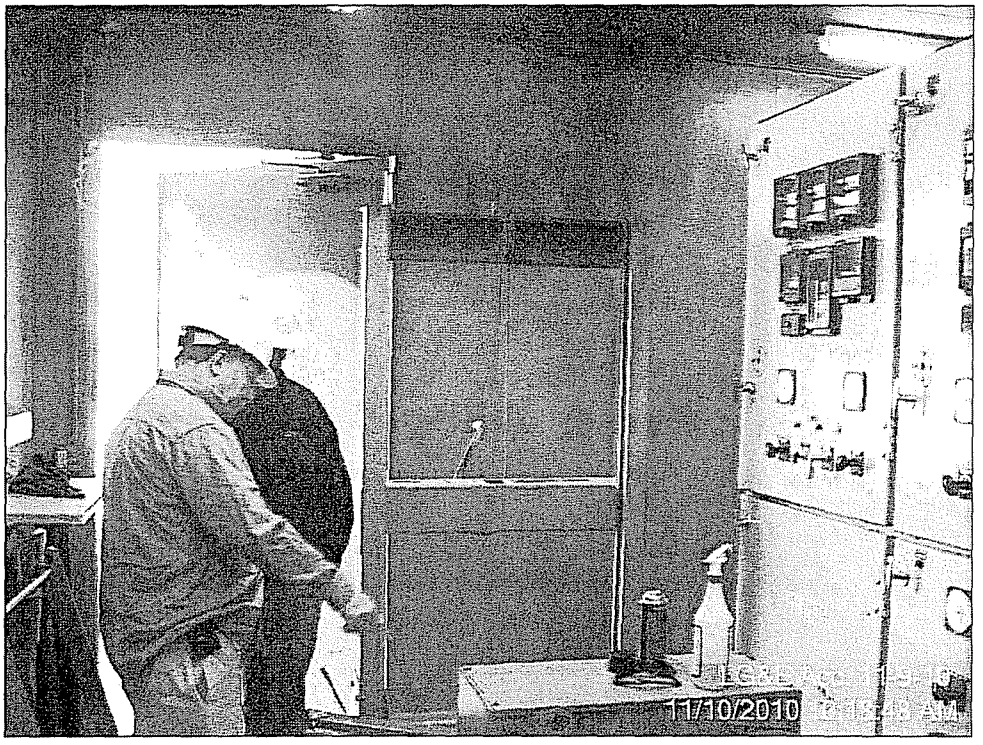

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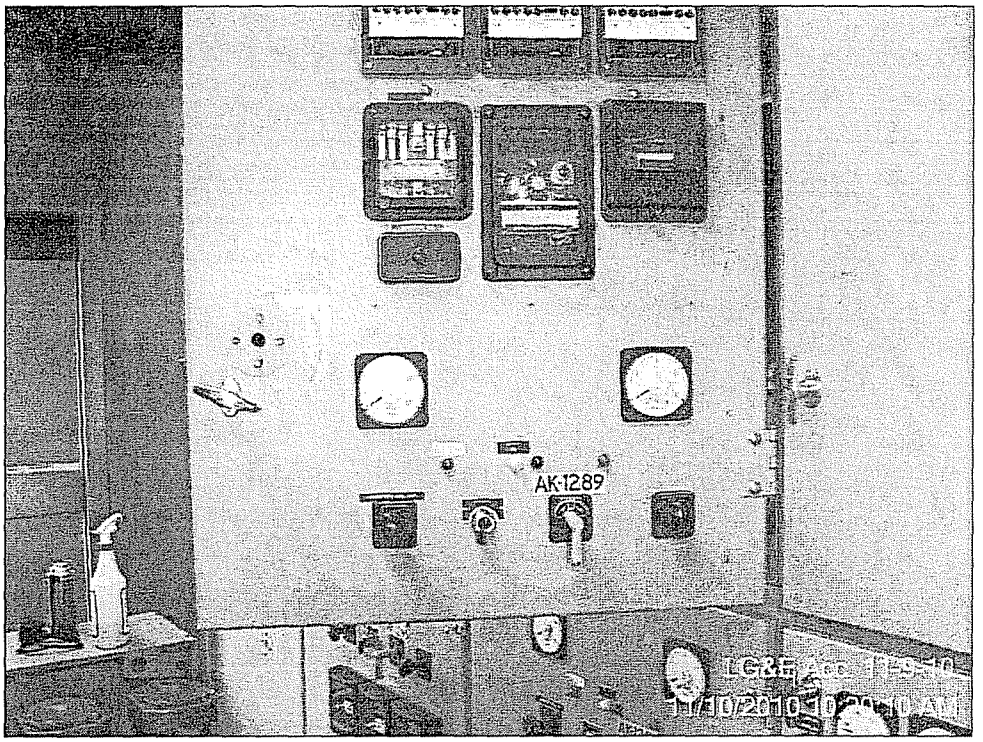

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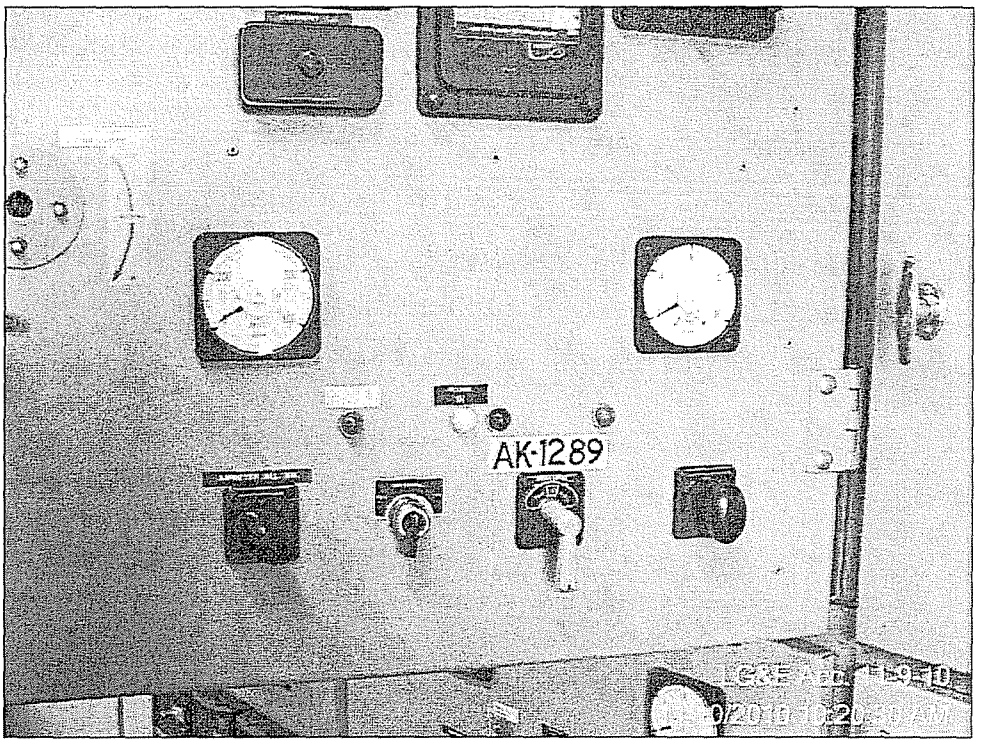

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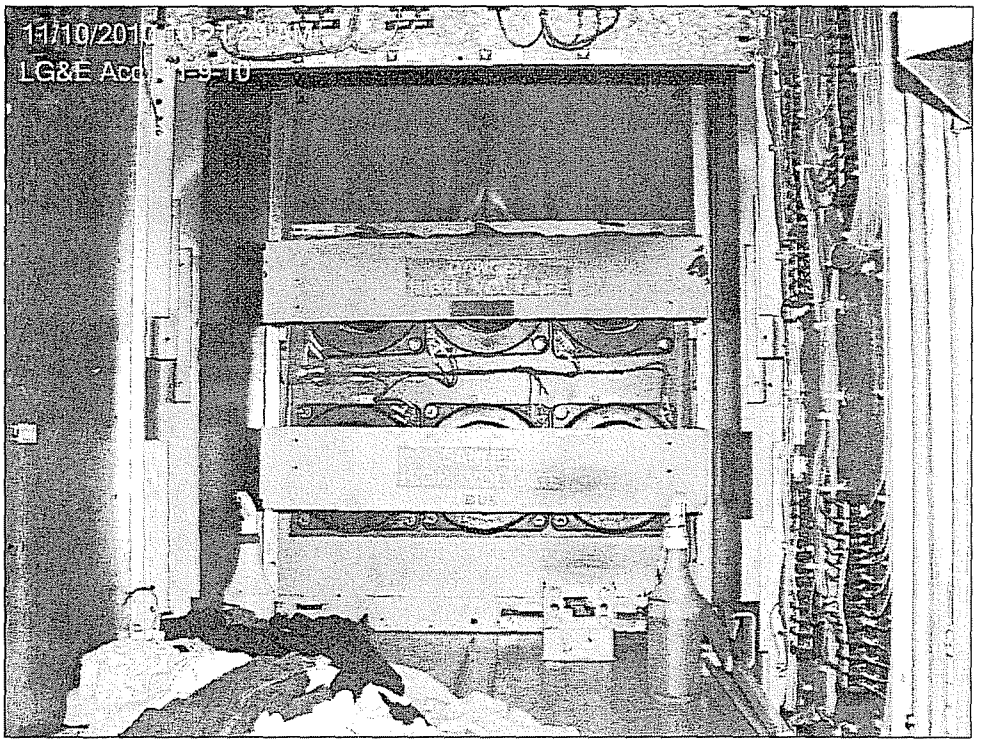

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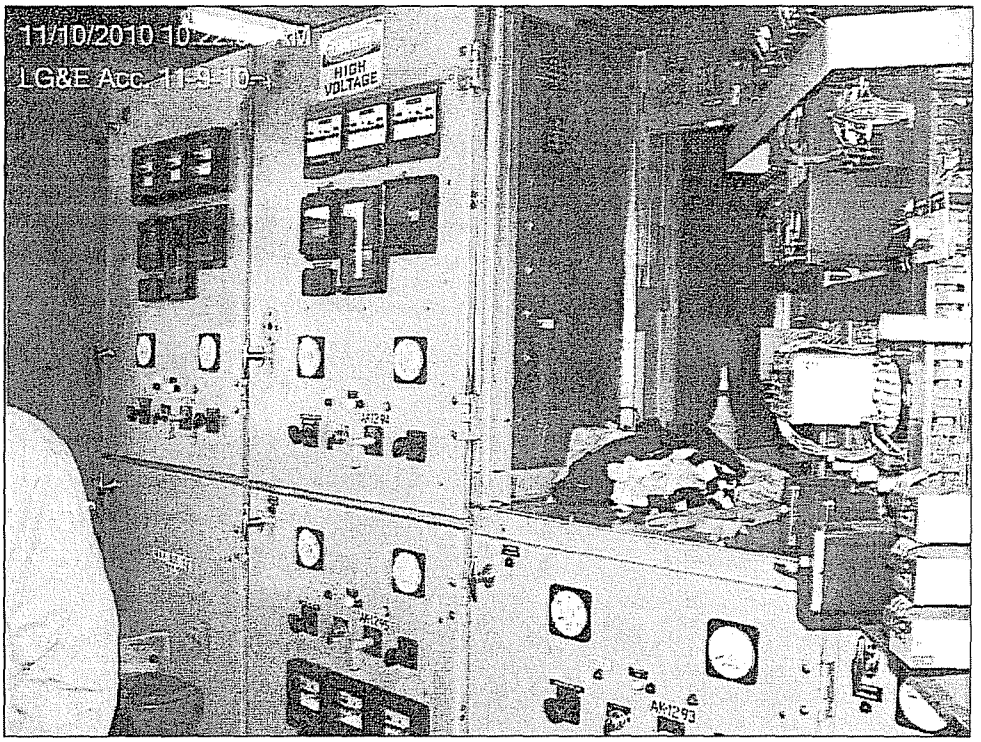

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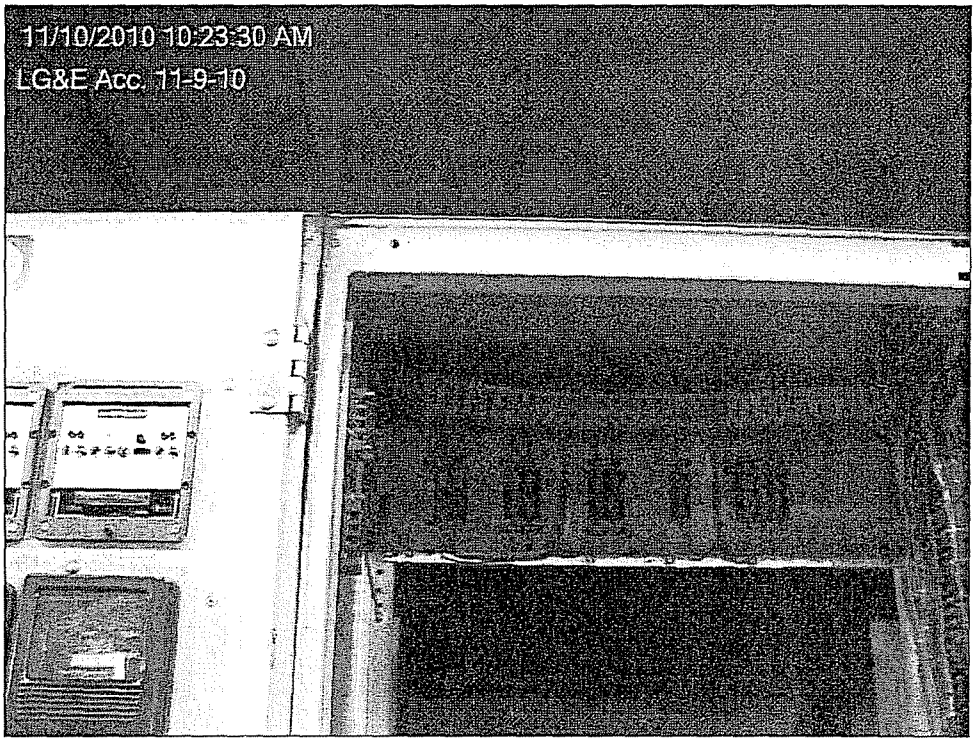

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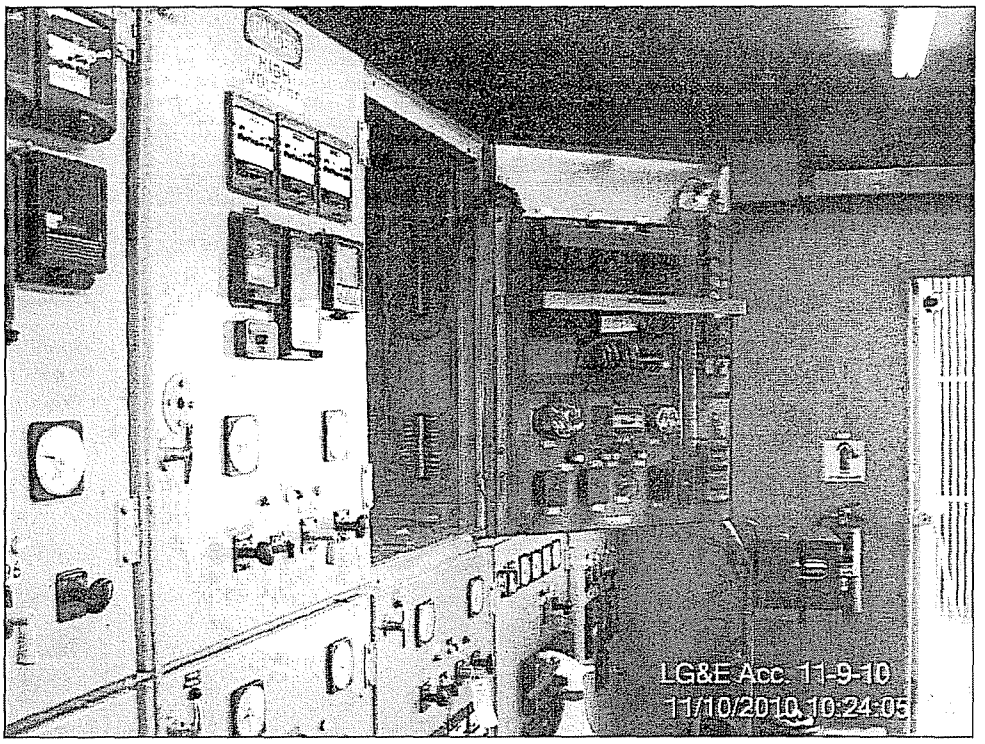
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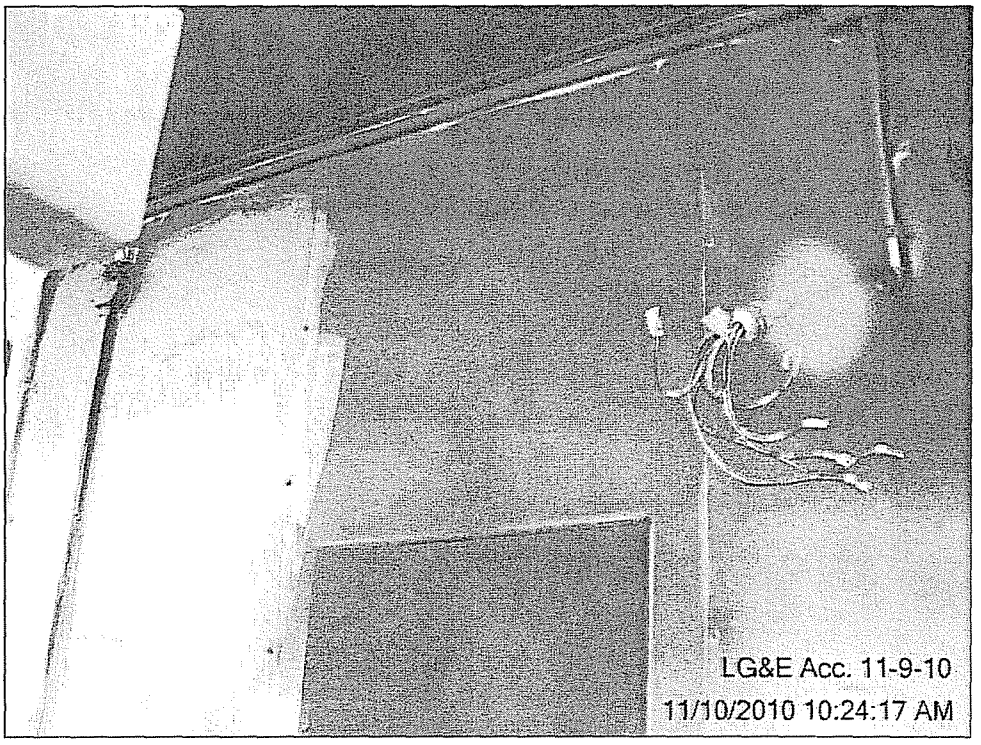
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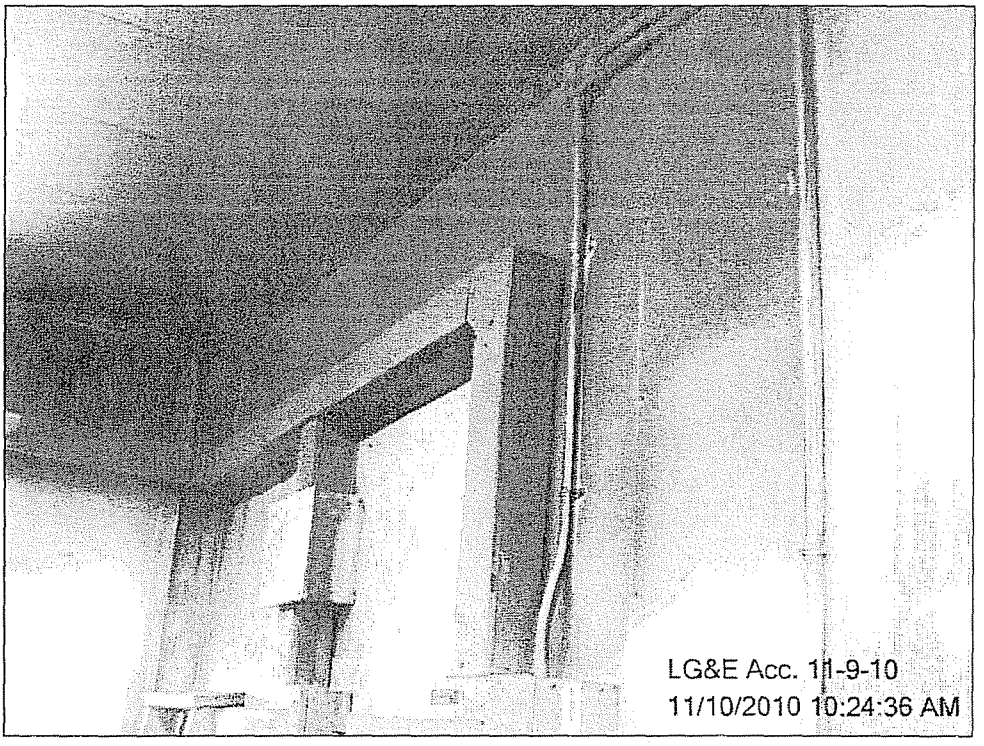
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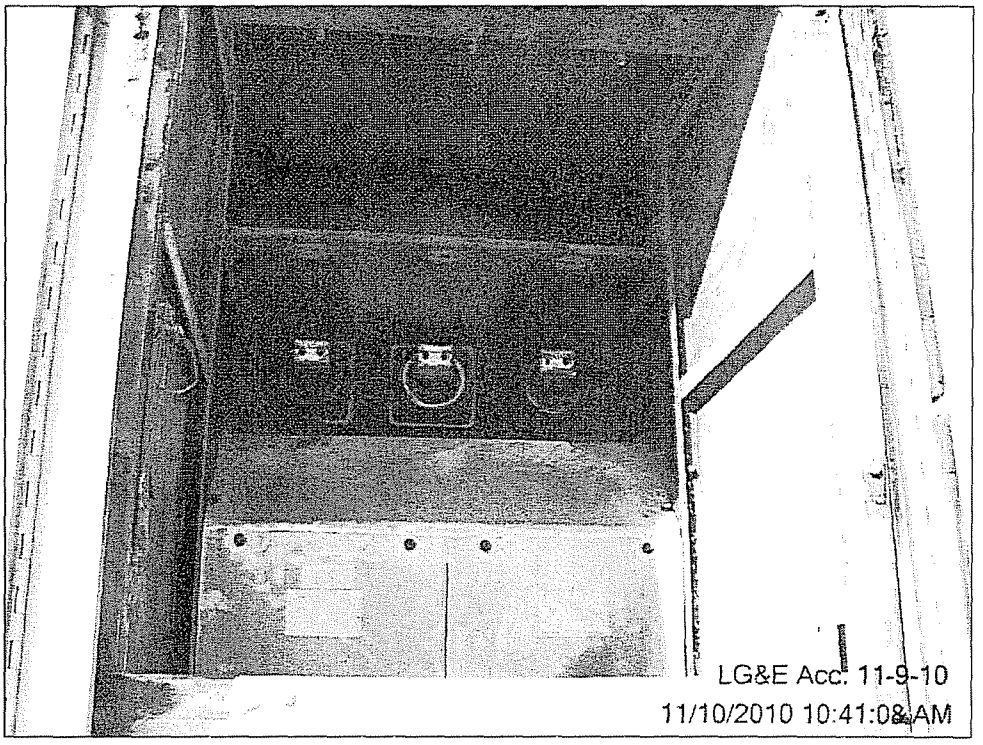
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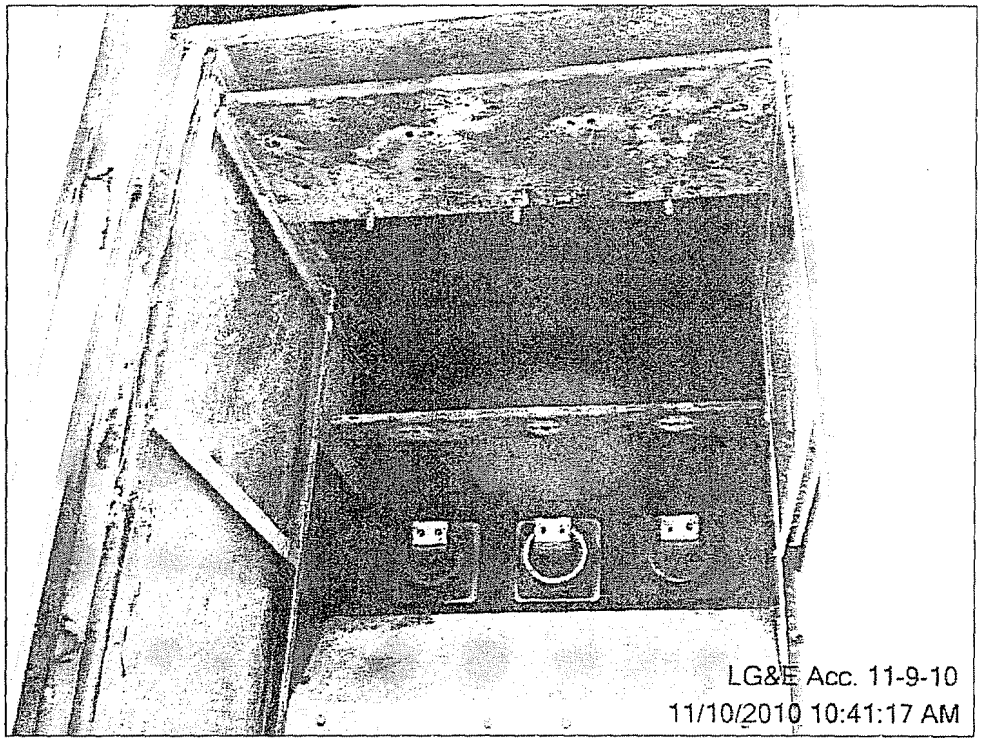

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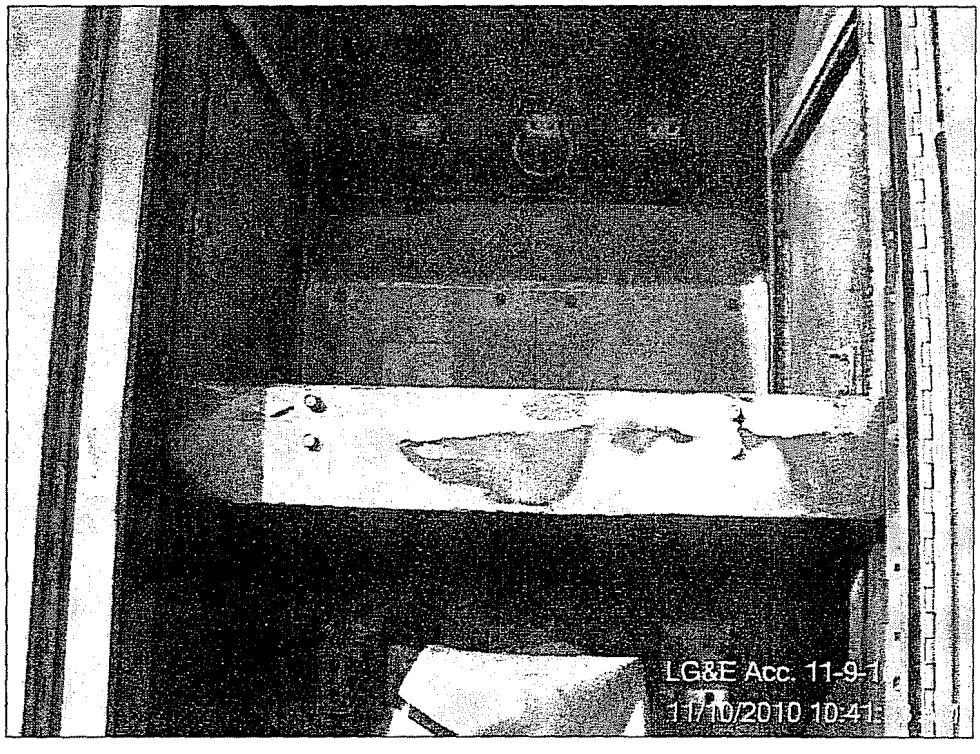

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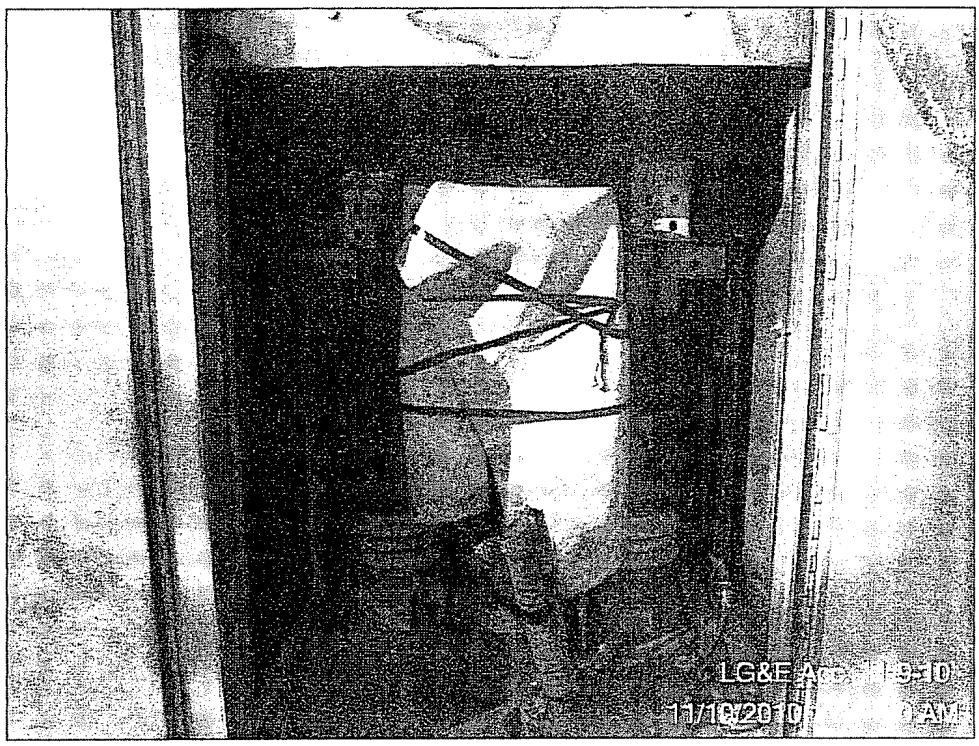

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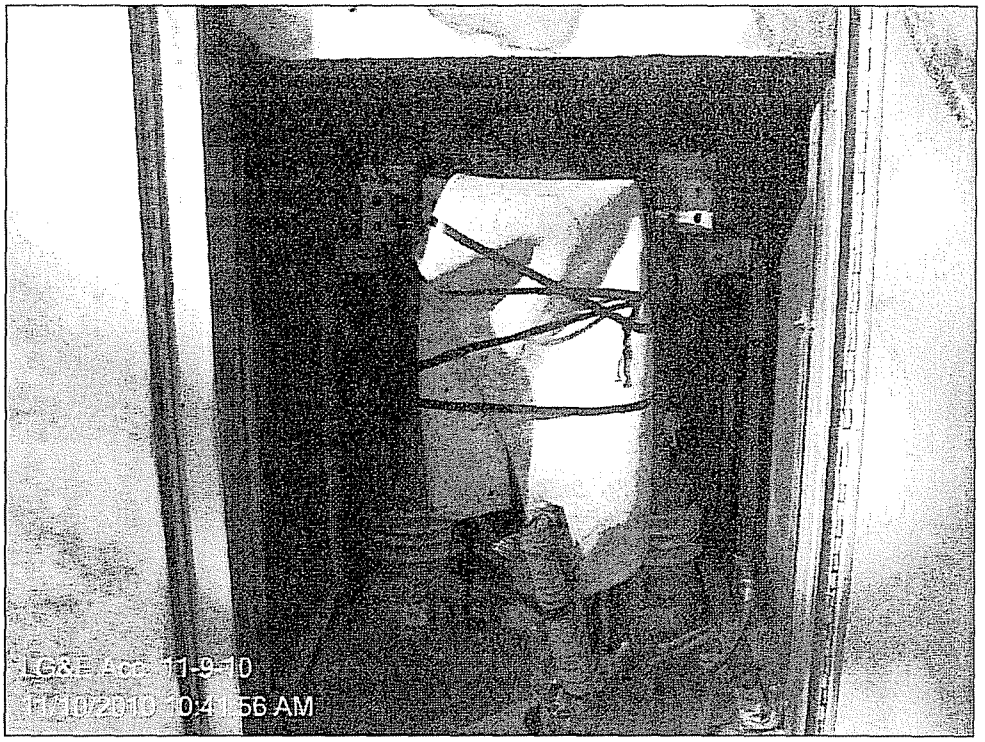
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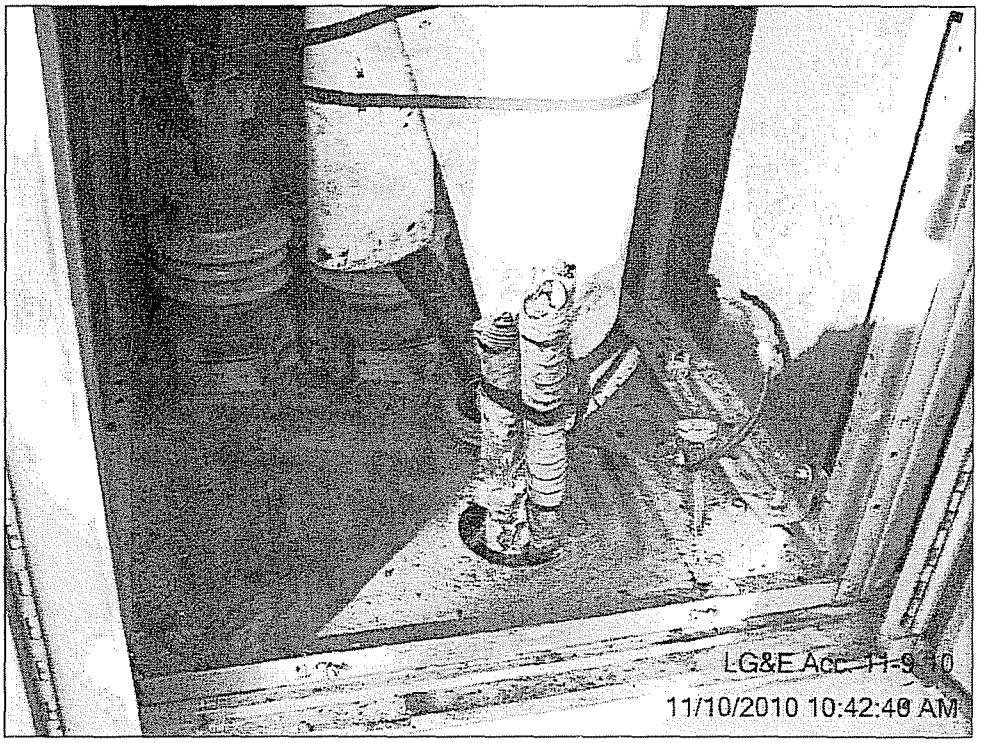
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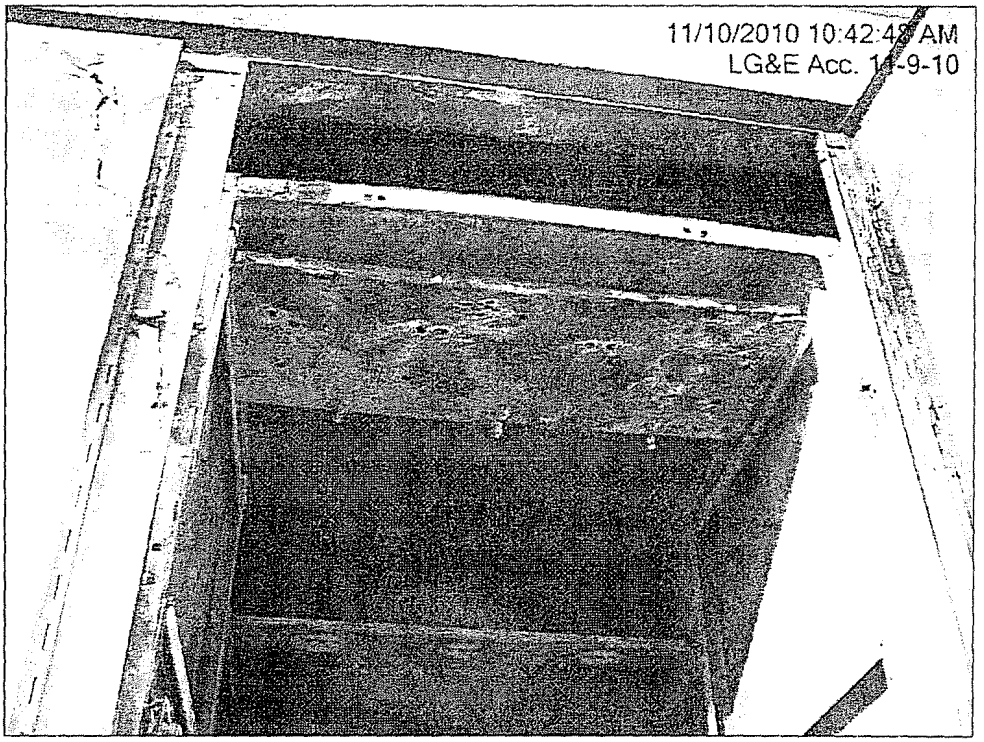
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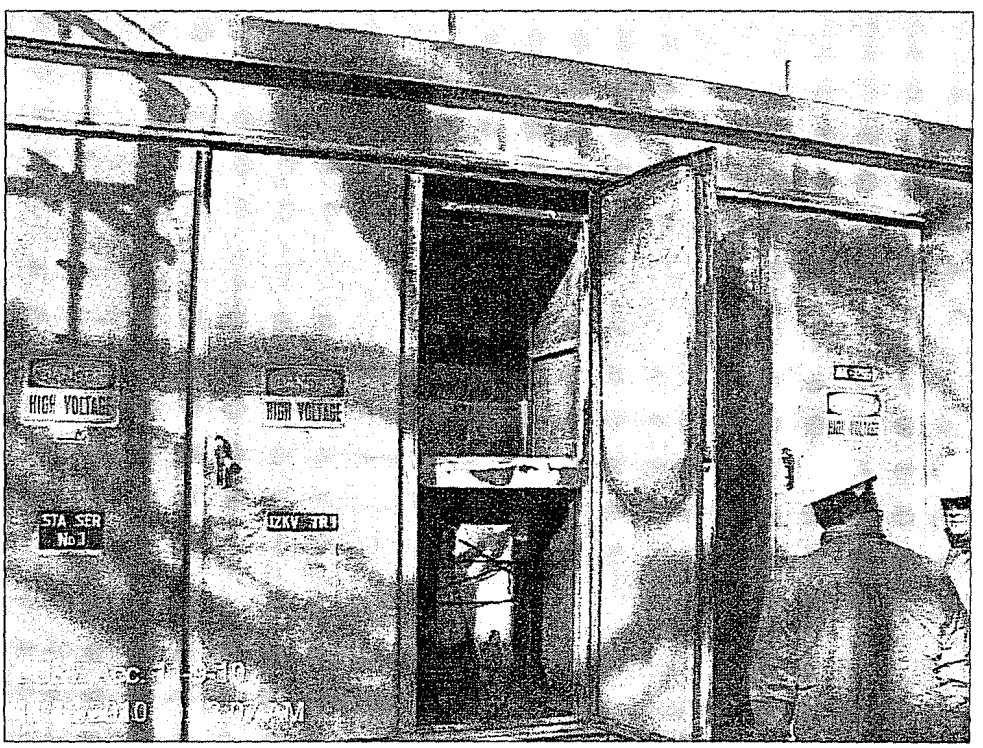
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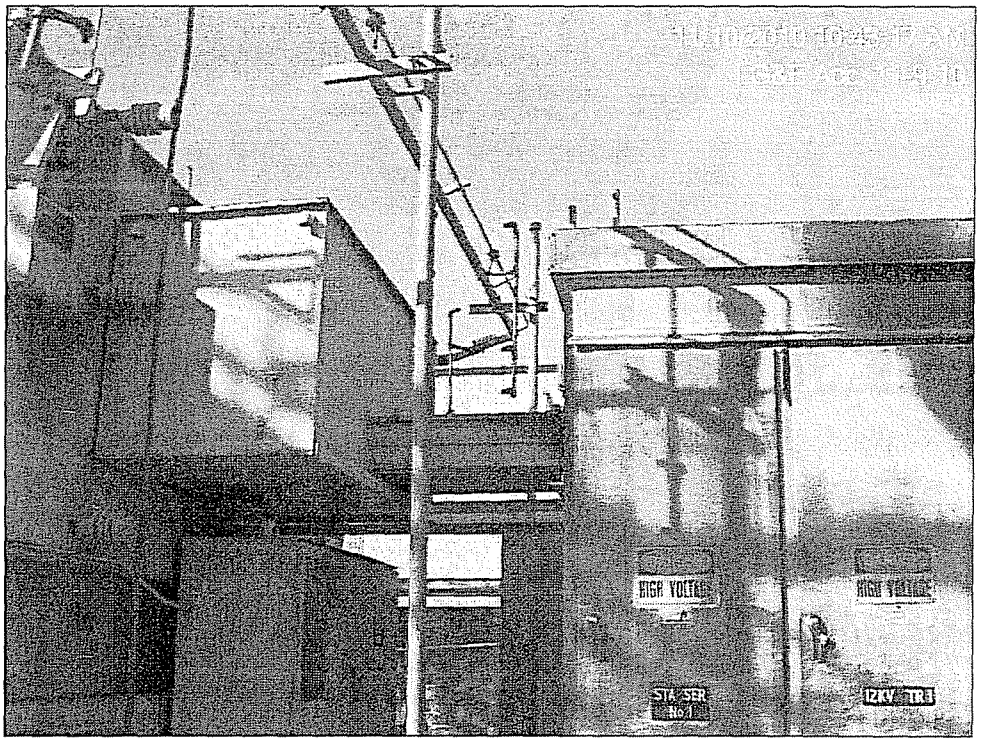
HIGH VOLTAGE
STA SER
No.1
12KV TRL

#24



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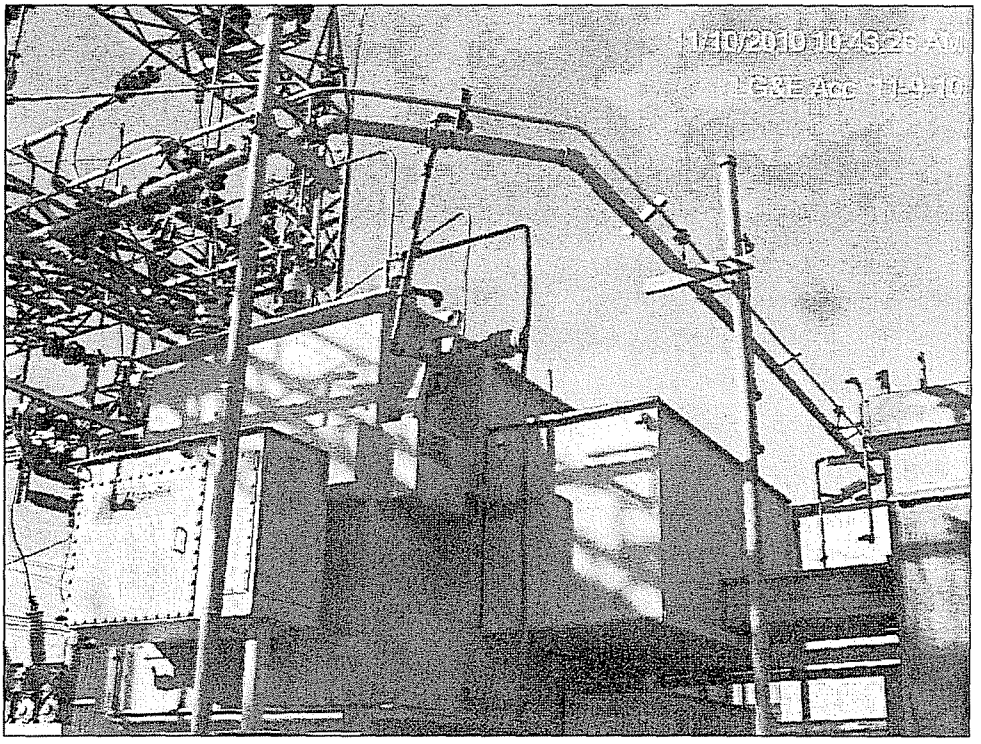

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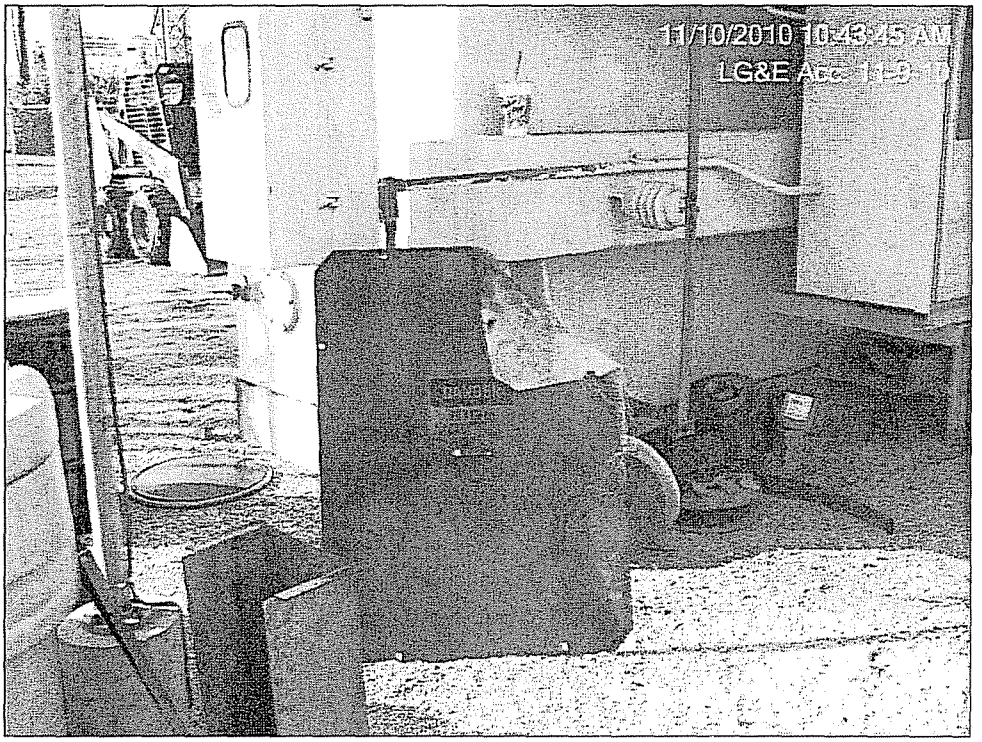

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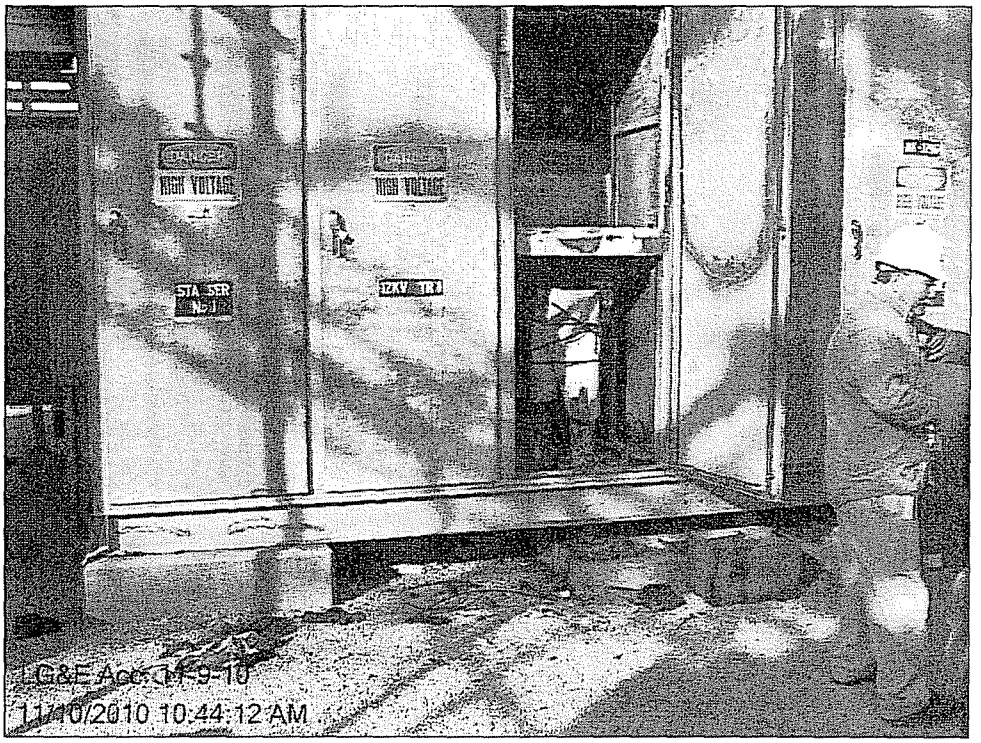
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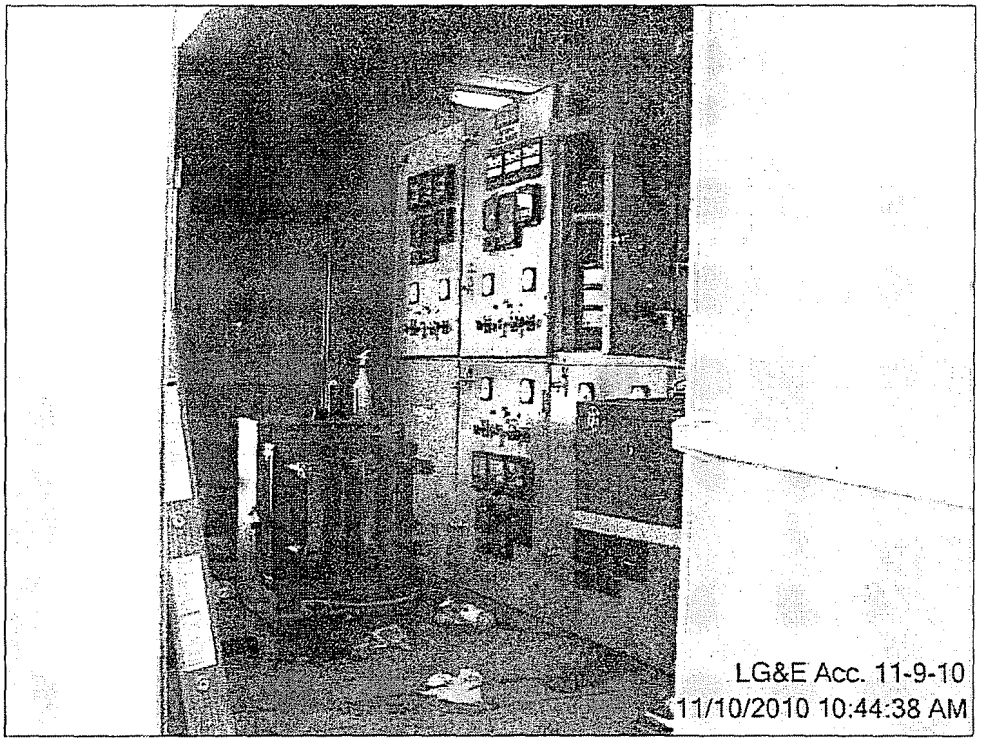
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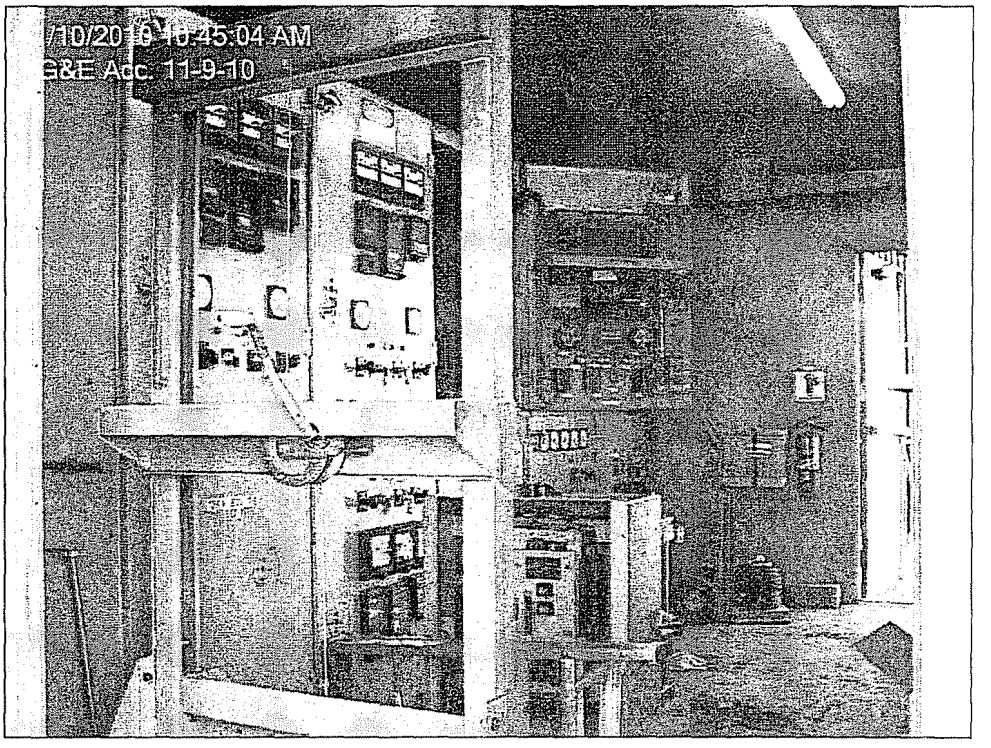
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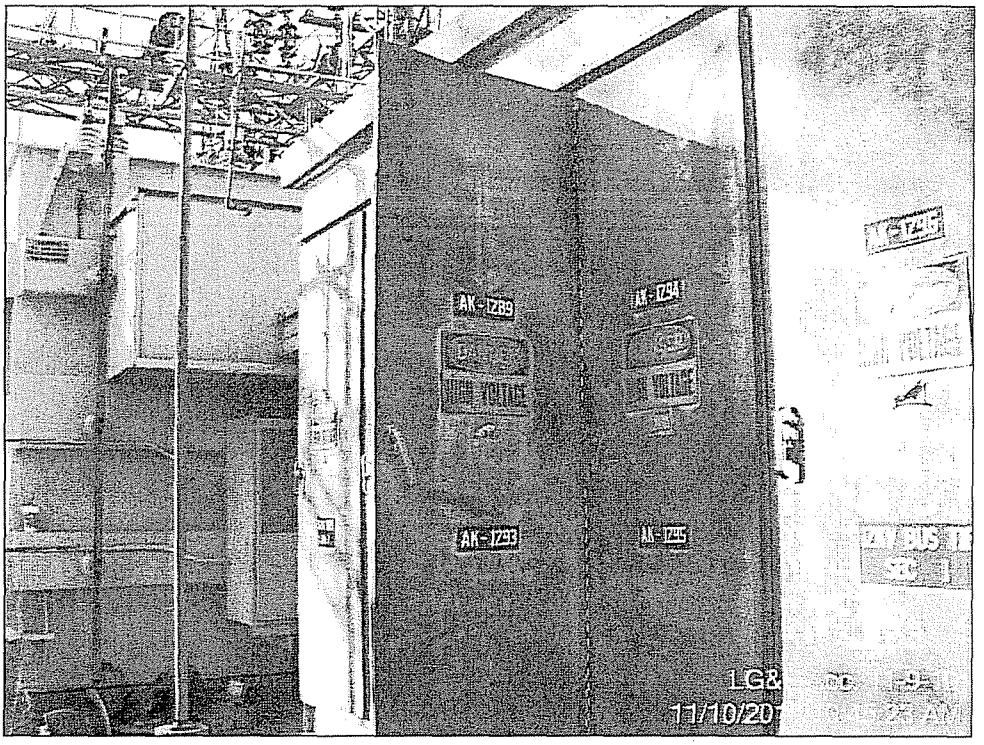
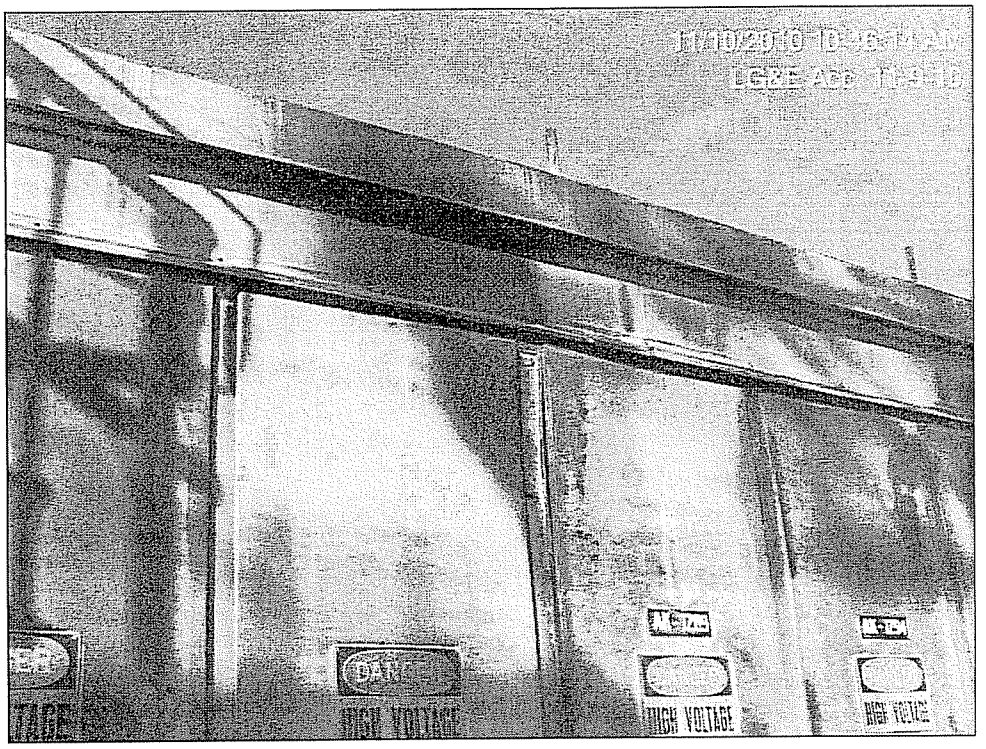

AK-1289
AK-1294
AK-1293
AK-1295
HIGH VOLTAGE
LG&
11/10/20

#33


AK-1289
DANGER
HIGH VOLTAGE
AK-1294
HIGH VOLTAGE
LG&E Acc. 11-9-10
11/10/2010 10:45:31 AM

#34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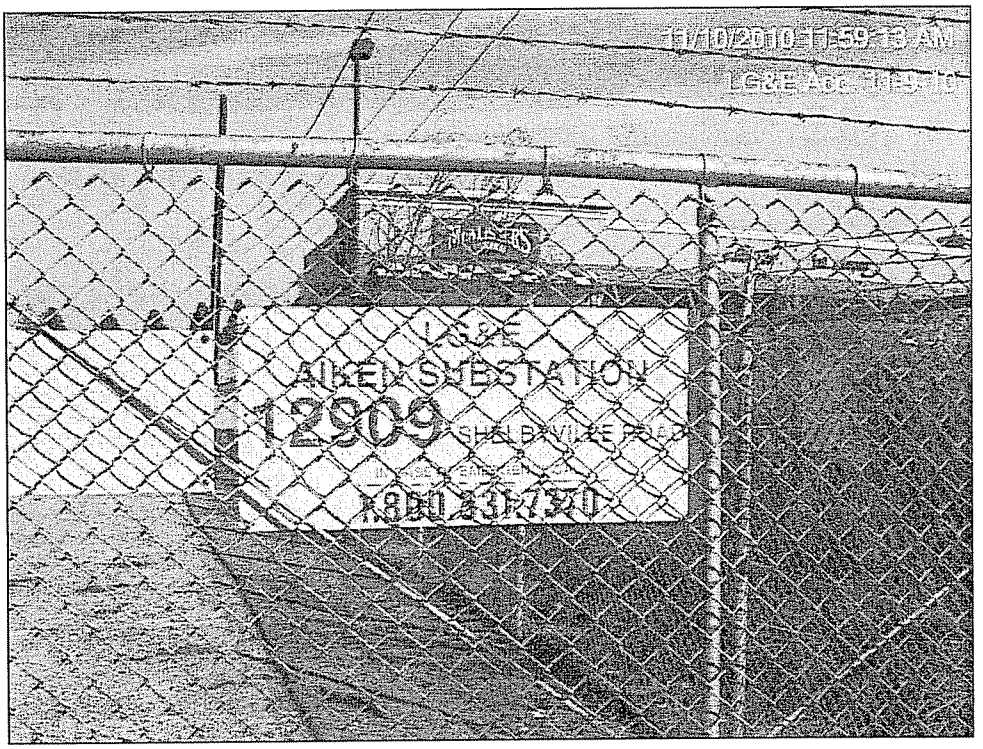

L G&E
AIKEN SUBSTATION
12909 SHELBYVILLE ROAD

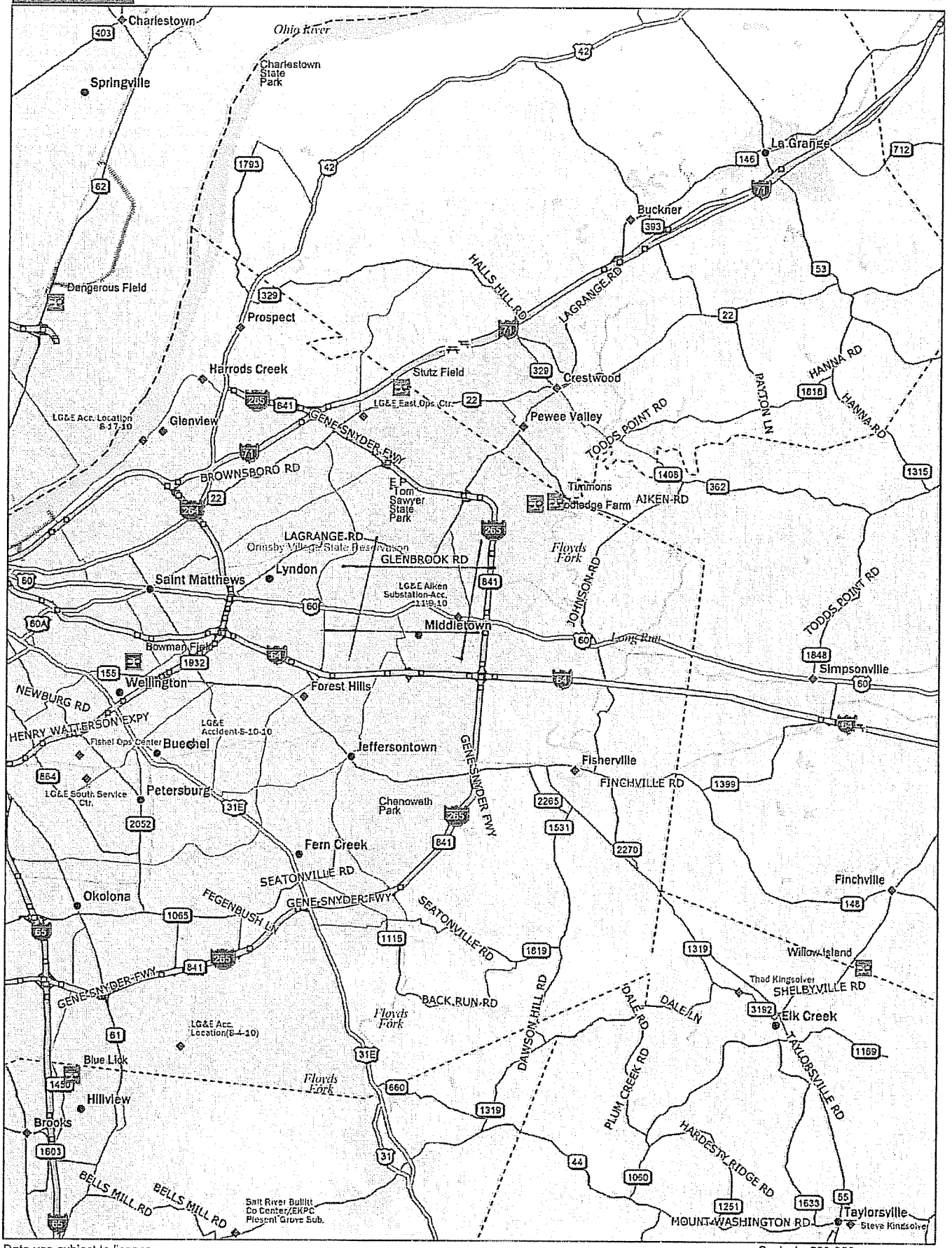
#36

Attachment C

KPSC Map of Accident Site

DeLorme

DeLorme Street Atlas USA® 2010



TN

MN (4.6°W)

Scale 1 : 200,000

1" = 3.16 mi

Data Zoom 10-0

Attachment D

Victim Interview Notes

James Willis, Victim of November 9, 2010 Accident, Interview

December 14, 2010

Persons involved in interview:

James Willis, Victim of Accident, LG&E
Curtis Stratton, Union Representative, LG&E
Beth McFarland, Manager, Substations, LG&E
Keith McBride, Investigator, LG&E
Steve Kingsolver, Investigator, KPSC

Mr. Willis was cleaning the cubicle on Breaker 1289 in the Aikens Substation. Mr. Willis stated that he worked Monday, November 8, 2010, until approximately 8-9 PM cleaning other cubicles that were de-energized at that time. Another crew energized the transformer buss sometime after Mr. Willis left work on Monday night. Mr. Willis stated that when he returned to work on the morning of the accident, November 9, 2010, he did not know that the transformer buss had been energized the night before the accident. Mr. Willis also stated that Monday night, November 8, 2010, he was aware that the other crews working in the substation were working to get the transformer buss re-energized.

Mr. Willis stated that there was not a job briefing performed on Tuesday, November 9, 2010, the morning of this accident.

Mr. Willis stated that he had worked 16 days straight with little time off and this may have played a part in this accident.

Mr. Willis stated that on Tuesday morning, November 9, 2010, that a few Pike employees stated that they had it dead and grounded. They were referring to the underground circuit that they were going to replace from the breaker to the pole outside of the substation. Mr. Willis stated that may have misled him and after the accident he realized that they were talking about their work and that had nothing to do with the transformer buss being de-energized.

Steve Kingsolver

Lonnie E Bellar
VP - State Regulation an
Louisville Gas and Electric Company
220 W. Main Street
P. O. Box 32010
Louisville, KY 40202