MAIN SWITCHYARD

(HADNOT POINT AREA)

D

SQUARE D COMPANY

FIELD SERVICE TRIP REPORT **FIELD SERVICE ORGANIZATION**

		JOB # C86-4-3707	
CUSTOMER	Square D Company	SERVICE SITE	Camp LeJeune Marine Corp Base
	Smyrna Plant		Lot #140 Holcomb Blvd.
	Smyrna, TN.		Camp LeJeune, NC. 28542
INDICATE TYPE OF ORDER	___CUSTOMER # X ___INTERPLANT ORDER #	17-69928	
SUBMITTED BY	Kenneth Chellevold	REPORTED TO	Dave Antiune
TITLE Field Service Rep	LOCATION Smyrna	TITLE	PHONE # 919/637-6185
DATE WRITTEN 5/26/86	REPORT # 1 INDICATE IF FINAL X	DATE REPORTED ON JOB 5/12/86	DATE COMPLETED JOB 5/16/86

REPORT ON FOLLOWING ITEMS IN SEQUENCE SHOWN

1. EQUIPMENT IDENTIFICATION (CLASS, TYPE FORM OR CAT #)	2. LENGTH OF TIME IN SERVICE & APPLICATION	3. PROBLEM	4. CONDITIONS AS FOUND	5. WORK DONE & STATUS OF JOB THIS REPORT	6. MATERIAL TO BE ORDERED & ANY FURTHER WORK TO BE DONE

1. 7-Class 6060-1 Type FB SF6 Circuit Breakers. FO 17-14272.

2. a. Not in service.
   b. Substation feeders.

3. a. Start-up Service.
   b. Set relays per customer information - Attachment A.
   c. Repair defective Brown Boveri reclosures.

4. One FB Breaker on pad. Other FB Breakers in substation yard.

5. a. Start-up Service was given to the seven SF6 type FB Circuit Breakers. The following procedure was used to test the Circuit Breakers (See Attachments B - D).
      1) Each breaker inspected for shipping damage.
      2) Bolted connections torqued and screw connections checked.
      3) Contact resistance checked.
      4) Hi-pot the bottles to check for presence of SF6 gas.
      5) Hi-pot circuit breaker poles phase-to-phase and phase-to-ground.
      6) Check circuit breaker contact erosion.
      7) Check mechanical and electrical operation of circuit breaker.
      8) Test operation of reclose relay.
      9) Test and set overcurrent relays per customer provided settings (Attachment A).
      10) Energized breaker and put on line.
   b. The 7-Circuit Breakers were given start-up service. One breaker was used as a by-pass breaker. Loads could be transferred to the bypass breaker from

5. b. continued

other circuit breakers to take them out of service. Six oil circuit breakers were being replaced with six FB feeder breakers. Initially one oil circuit breaker was replaced with an FB circuit breaker per day. This was done for the first two breakers. The last four breakers were done two per day.

c. The contractor positioned three of the FB breakers which caused the line and load to be reversed. The overcurrent relays and ammeters were wired to the line side current transformers.

d. The contractor was to reinstall an existing bus differential scheme. I instructed the contractor where to place his wires. The first feeder breaker was put on line and the bus differential relays operated which caused all of the circuit breakers to open and open the power company circuit breaker. The wiring connection was wrong. The direction of the current from the current transformers was in the wrong direction.

e. The circuit breakers were closed, except for the FB feeder breaker, after about one hour. The wiring was changed the next day and the FB circuit breaker was put on line. The differential trip signal was interrupted each time that an FB circuit breaker was put online to make sure that the wiring was correct and if not the breakers would not open up.

f. During the testing of the FB breakers I found one 240 volt charging motor that did not sound good and three solid state overcurrent relays that did not function correctly. A replacement motor was sent to the jobsite but I could not put it in because the FB breakers, the bypass breaker No. 12, could not be shutdown. The three overcurrent relays were returned to Smyrna.

g. An informal class was held with the substation operating personnel to familiarize them with the operation and maintenance of the FB circuit breaker. The following people attended the class:

Herman W Ireland
Gary L. Barrett
Gary Morton
John M. Horne
Tom Corbin
Andy Young

6. a. The 240 volt charging motor needs to be replaced on Breaker No 12 the bypass breaker.

b. Two phase overcurrent and one ground overcurrent relay need to be replaced tested and installed in breaker No. 1.

c. Smyrna Plant - Max Johns has been advised of 6 a and b.

PUBLIC WORKS DIVISION
BUILDING 1005, MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA 28542

In reply refer to:

85-C-6409
PWO
26 Feb 1986

MEMO TO FILE

From: Code 04
To: Code 02

Subj: CONSTRUCTION CONTRACT 85-C-6409, REPLACE MEDIUM VOLTAGE BREAKERS, CAMP LEJEUNE, NORTH CAROLINA

1. The settings for the protective relays and components of the medium voltage breakers that are provided by the subject contract are as follows:

Breaker No. 1

Phase Relays

TAP 5
TD 3
IT 20 *

Reclosing Relay: 0, ~~45~~ 30, ~~90~~ 60
Current Transformer Ratio (CTR): 600/5

Ground Relay

TAP 2
TD 5.5
IT 15

Breaker No. 2

Phase Relays

TAP 5
TD 6
IT 60

Reclosing Relay: 0, 30, ~~90~~ 60 *
CTR: 600/5

Ground Relay

TAP 2
TD 7
IT ~~50~~ *40 max

Breaker No. 3

Phase Relays

TAP 4
TD 3
IT 40

Reclosing Relay: 0, 30, 90 60 *
CTR: 600/5

Ground Relay

TAP 1.5
TD 8
IT 25

1.5 | 2.50 → 1.6

Breaker No. 6

Phase Relays

TAP 5
TD 4
IT 30

Reclosing Relay: 0, 20, 60
CTR: 600/5

Ground Relay

TAP 2
TD 5
IT 15

* Original values not possible to set, set values shown in ink. Ken Chelleveld

Subj: CONSTRUCTION CONTRACT 85-C-6409, REPLACE MEDIUM VOLTAGE BREAKERS, CAMP LEJEUNE, NORTH CAROLINA

Breaker No. 8

Phase Relays

TAP 5
TD 5
IT 40

Ground Relay

TAP 2
TD 8
IT 40

Reclosing Relay: 0, 30, 60
CTR: 600/5

Breaker No. 9

Phase Relays

TAP 5
TD 8
IT 40

Ground Relay

TAP 1
TD 8
IT 20

Reclosing Relay: 0, 30, 60
CTR: 600/5

Breaker No. 11 — Not supplied by Squared Co GHm 6/12/86

Phase Relays

TAP 4
TD 2
IT 40

Ground Relay

TAP 1.5
TD 8
IT 20

Reclosing Relay: 0, 30, 60
CTR: 600/5

2. The current transformer ratio for the differential protection scheme is 600/5; the current transformers on the load side of the medium voltage breakers are employed in the differential protection as indicated on NAVFAC Drawing No. 4126596.

3. The current transformer on the line side (source) are employed in the overcurrent protection for the feeder circuit.

4. If there are any questions, Point of Contact is Andy Young (Code 404), Public Works Division.

M. I. KIMBALL

Copy to:
404

SWITCHGEAR CHECK LIST

Sheet No. 1 of 1 Trip Report No. C86-4-3707

Customer _____ Date 5-16-86

Address _____ Air Temp. 80°F Rel. Humidity 30%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification _____

Mfgr. (Plant) SQD - SMYRNA Factory Order No. 17-14272

Dwgs. _____ Voltage Class 15 KV Type FBS

Customer's Identification _____

External Condition: CLEAN Good _____ Fair _____ Poor

Consisting of: 7 Total Breakers 28 Total Instruments 28 Total Relays — Molded Case Breakers

Other 7 RECLOSE RELAYS

1. General inspection of exterior of equipment — Good
2. Check panel lights for operation-burned out or missing bulbs and lamp covers. — O.K.
3. Check control knobs and switches for freedom of movement and contact condition. — O.K.
4. Inspect for damaged, bent, or twisted doors. — O.K.
5. Inspect door handles, locking bars, and mechanism. — O.K.
7. Inspect for broken instrument and relay cover glass — ~~and burned out phase indicator lights.~~ — O.K.
8. Inspect for proper grounding of equipment. — O.K.
9. Inspect bus support insulators. — O.K.
10. Torque test bolted bus. (Exposed connections only) — O.K.
11. Clean bus insulators — megger test for grounds. — O.K.
12. Inspect control and metering transformers. — O.K.
13. Ratio test transformers — — NA
14. Check resistors — grid assemblies and space heaters. — O.K.
15. Check condition of wiring & terminal connections. — O.K.
16. Report unsafe conditions. — NONE
17. Check control & instrument fusing for proper size & ratings — O.K.
18. Check bus for support & spacing. — O.K.
19. Remove draw out breakers. — NA
20. Check rails, guides, rollers, and shutter mechanism. — NA
21. Lubricate draw out assembly parts — NA
22. Check cell interlocks and auxiliary contact assemblies — O.K.
23. Inspect breaker and cell contacts. — O.K.
24. Vacuum and clean interior of cubicle. — NA
25. Test molded case breakers. — NA
26. Inspect and check instruments. — O.K.
27. Note and record as found relay settings. — O.K.
28. Determine correctness of settings — if improperly set — advise customer — O.K.
29. Restore control power to switchgear. — O.K.
30. Check relays for positive tripping. — O.K.
31. Test annunciator — alarm or target operation. — NA
32. Operate controls—close and trip breakers electrically. — O.K.
33. Check automatic transfer relay operation (if used). — NA
34. Recheck relays for positive tripping with breakers in test position. — O.K.
35. Make final visual inspection — remove leads — tools, etc. — O.K.

Insulation Test — HI-POT [redacted] READINGS AT 36,000 VOLTS IN MICROAMPS

	L1-G	L2-G	L3-G	L1-L2	L2-L3	L3-L1
Incomming A						
Incomming B						
Bus A						
Bus B						
Feeder 1						
BREAKER # 1	0.4	0.4	0.6	0.4	0.4	0.6
# 2	0.1	0.1	0.1	0.1	0.1	0.1
# 3	0.8	1.3	1.2	0.8	1.3	1.2
# 6	0.8	1.3	0.5	0.8	1.3	0.5
# 8	1.4	1.8	2.1	1.4	1.8	2.1
# 9	0.1	0.05	0.1	0.1	0.05	0.1
# 12	0	0	0	0	0	0

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-28-86

SQUARE D COMPANY

HIGH VOLTAGE

SFG [redacted] CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 1 of 7 Trip Report CBG-4-3707

Customer _____ Date 5-15-86

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 1

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1131 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. 3 kv. [redacted] MICROAMPS	0	0	0
Contact Res. Microhms	33	33	34
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE
SF6 CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 2 of 7 Trip Report C&G-4-3707

Customer _____ Date MAY 16 1986

Address _____ Air Temp. 80°F Rel. Humidity 30%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 2

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1126 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. 36kv. MICROAMPS	0	0	0
Contact Res. Microhms	31	32	32
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned / Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE

SF6 [redacted] CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 3 of 7 Trip Report C86-4-3707

Customer _____ Date 5-15-96

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 3

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1124 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. 36kv. [redacted] MICROAMPS	0	0	0
Contact Res. Microhms	34	37	36
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE

SF6 [redacted] CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 4 of 7 Trip Report CBC-4-3707

Customer _____ Date 5-14-86

Address _____ Air Temp. 75° F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 6

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1129 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. [redacted] kv. MICROAMPS	0.3	0.3	0.3
Contact Res. Microhms	31	29	30
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned / Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE

SF6 [redacted] CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 5 of 7 Trip Report C86-4-3707

Customer _____ Date 5-14-86

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # B

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1127 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. [redacted] kv. MICROAMPS	0.6	0.6	0.6
Contact Res. Microhms	36	35	32
Closing Sp. / Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned / Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol..		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE

SFG CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 6 of 7 Trip Report CBC-4-3707

Customer _____ Date 5-13-86

Address _____ Air Temp. 75°F Rel. Humidity 40%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 9

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1128 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. X kv. MICROAMPS	0	0	0
Contact Res. Microhms	34	35	37
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned / Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

HIGH VOLTAGE

SFG [redacted] CIRCUIT BREAKER TEST AND INSPECTION REPORT

Sheet No. 7 of 7 Trip Report C86-4-3707

Customer _____ Date 5-12-86

Address _____ Air Temp. 80°F Rel. Humidity 40%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LAJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 12 BYPASS BREAKER

Breaker Data:

Manufacturer SQ-D Voltage 15 KV Type FBS Amp. 1200 AMP Int. Rating 16,000

Serial No. 1125 Age _____ Other N.P. Data _____

Test Data:

	A	B	C
Ins. Res. [redacted] kv. MICROAMPS	0	0	0
Contact Res. Microhms	31	30	31
Closing Sp./Opening Sp.			

Adjustments:

	Mfr's. Rec.	As Found	As Left
Arcing Contact Tips			
Main Contact Gap			
Control Plug Interlock	—	—	—
Mechanical			
Electrical			

Inspection and Maintenance

	INS.	Dirty	Cleaned Lubed	See Remarks
Overall Cleanliness	CLEAN			
Insulating Members	Good			
Mech. Connections	TIGHT			
Structural Members	Good			
Cubicle	CLEAN			
Pri. Contact Fingers	NA			
Shutter Mech.	NA			
Relays	TESTED			
Auxiliary Devices	Good			
Racking Device	NA			
Arc Chutes	NA			
Puffers	NA			
Liner	NA			
Arc Runners	NA			
Main Contacts	Good			
Breaker Wiring	Good			
Heaters	Good			
Bearings	Good			
Anti Pump Ry.		240 VAC		
Close Sol.		240 VAC		
Trip Sol.		125 VDC		
Charging Motor		240 VAC		
Contact Sequence				
Ground Connection	Good			
Counter Reading				
Bkr. Cell Lock				

Remarks: _____

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 1 of 7

Trip Report No. C86-4-3707

Customer _____ Date _____

Address _____ Air Temp. _____ Rel. Humidity _____

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAINBASE SUBSTATION

Owner Identification BREAKER # 1

Circuit identification _____ C.T. Ratio 600:5A P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust —							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: RELAYS NOT AVAILABLE TO TEST

OVER CURRENT RELAY SETTINGS

	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type _____ Cat. _____								
B Ø Type _____ Cat. _____								
C Ø Type _____ Cat. _____								
G Type _____ Cat. _____								

OVER CURRENT RELAY SETTINGS

	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	—	As Found	As Left
A Ø							
B Ø							
C Ø							
G							

OVER/UNDER VOLTAGE RELAY SETTINGS

	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS

	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEVOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 2 of 7

Trip Report No. C86-4-3707

Customer _____ Date 5-16-86

Address _____ Air Temp. 80°F Rel. Humidity 30%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 2

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: MAXIMUM INSTANTANEOUS SETTING FOR GROUND RELAY IS 40 Amps WITH TAP SETTING OF 2

OVER CURRENT RELAY SETTINGS	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat. _____		12				5		6
B Ø Type ITE Cat. _____		12				5		6
C Ø Type ITE Cat. _____		12				5		6
G Type ITE Cat. _____		20				2		7

OVER CURRENT RELAY SETTINGS	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	——	As Found	As Left
A Ø		60			2X => 10 AMPS		12.74
B Ø		60			2X => 10 AMPS		12.58
C Ø		60			2X => 10 AMPS		12.38
G		40			2X => 4 AMPS		16.18

OVER/UNDER VOLTAGE RELAY SETTINGS	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 3 of 7

Trip Report No. CBG-4-3707

Customer _____ Date 5-15-86

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 3

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: _____

OVER CURRENT RELAY SETTINGS	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat. _____		10				4		3
B Ø Type ITE Cat. _____		10				4		3
C Ø Type ITE Cat. _____		10				4		3
G Type ITE Cat. _____		16.7				1.5		8

OVER CURRENT RELAY SETTINGS	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	—	As Found	As Left
A Ø		40			2X => 8 Amps		5.74
B Ø		40			2X => 8 Amps		5.82
C Ø		40			2X => 8 Amps		5.75
G		25			2X => 3 Amps		19.25

OVER/UNDER VOLTAGE RELAY SETTINGS	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 4 of 7

Trip Report No. CBG-4-3707

Customer _____ Date 5-14-86

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAINBASE SUBSTATION

Owner Identification BREAKER # 6

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: _____

OVER CURRENT RELAY SETTINGS	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat.		6				5		4
B Ø Type ITE Cat.		6				5		4
C Ø Type ITE Cat.		6				5		4
G Type ITE Cat.		7.5				2		5

OVER CURRENT RELAY SETTINGS	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	—	As Found	As Left
A Ø		30			2X ⇒ 10 Amps		8.07
B Ø		30			2X ⇒ 10 AMPS		8.15
C Ø		30			2X ⇒ 10 AMPS		8.10
G		15			2X ⇒ 4 AMPS		18.10

OVER/UNDER VOLTAGE RELAY SETTINGS	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 5 of 7

Trip Report No. C86-4-3707

Customer _____ Date 5-14-86

Address _____ Air Temp. 75°F Rel. Humidity 50%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 8

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: _____

OVER CURRENT RELAY SETTINGS

	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat. _____		8				5		5
B Ø Type ITE Cat. _____		8				5		5
C Ø Type ITE Cat. _____		8				5		5
G Type ITE Cat. _____		20				2		8

OVER CURRENT RELAY SETTINGS

	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	——	As Found	As Left
A Ø		40			2X ⇒ 10 Amps		10.31
B Ø		40			2X ⇒ 10 Amps		10.01
C Ø		40			2X ⇒ 10 Amps		10.34
G		40			2X ⇒ 2 Amps		18.89

OVER/UNDER VOLTAGE RELAY SETTINGS

	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS

	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 6 of 7

Trip Report No. C86-4-3707

Customer _____ Date 5-13-86

Address _____ Air Temp. 75°F Rel. Humidity 40%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 9

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: _____

OVER CURRENT RELAY SETTINGS

	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat. _____		8				5		8
B Ø Type ITE Cat. _____		8				5		8
C Ø Type ITE Cat. _____		8				5		8
G Type ITE Cat. _____		20				1		8

OVER CURRENT RELAY SETTINGS

	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	——	As Found	As Left
A Ø		40			2X => 10 Amps		16.91
B Ø		40			2X => 10 Amps		16.86
C Ø		40			2X => 10 Amps		16.43
G		20			2X => 2 Amps		24.67

OVER/UNDER VOLTAGE RELAY SETTINGS

	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS

	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

PROTECTIVE RELAY TEST REPORT

Sheet No. 7 of 7

Trip Report No. CBC-4-3707

Customer _____ Date 5-12-86

Address _____ Air Temp. 80°F Rel. Humidity 40%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER # 12

Circuit identification _____ C.T. Ratio 600:5 P.T. Ratio _____

VISUAL INSPECTION	V1	V2	V3	A	B	C	GRD
Cover Gasket							
Glass							
Foreign Material							
Moisture							
Spiral Spring							
Bearing Condition							
Bearing End-Play							
Disc Clearance							
Rust							

ROUTINE MAINTENANCE	V1	V2	V3	A	B	C	GRD
Glass Cleaned							
Case Cleaned							
Relay Cleaned							
Connection Tight							
Taps Tightened							
Contacts Cleaned							
Insulation Resistance							
Trip Circuit							

Remarks: RELAYS TESTED AT "AS FOUND" SETTINGS. RELAYS SET AT "AS LEFT" SETTINGS BY ANDY YOUNG.

OVER CURRENT RELAY SETTINGS	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat.	5	12			4	5	1	8
B Ø Type ITE Cat.	5	12			4	5	1	8
C Ø Type ITE Cat.	5	12			4	5	1	8
G Type ITE Cat.	5	20			1	2	1	8

OVER CURRENT RELAY SETTINGS	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	—	As Found	As Left
A Ø	20				2X => 8 Amps	1.57	
B Ø	20				2X => 8 Amps	1.44	
C Ø	20				2X => 8 Amps	1.48	
G	5				2X => 2 Amps.	2.00	

OVER/UNDER VOLTAGE RELAY SETTINGS	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEWOLD Date 5-26-86

SQUARE D COMPANY

SQUARE D COMPANY

FIELD SERVICE TRIP REPORT **FIELD SERVICE ORGANIZATION**

		JOB # C86-4-3707(A)	
CUSTOMER Square D Company		**SERVICE SITE** Camp LeJeune Marine Corps Base	
Smyrna Plant		Lot #140 Holcomb Blvd.	
Smyrna, TN.		Camp LeJeune, NC.	
INDICATE TYPE OF ORDER ___ **CUSTOMER #** X **INTERPLANT ORDER #** 17-70526			
SUBMITTED BY Kenneth Chellevold		**REPORTED TO** Dave Antiuane	
TITLE Field Service Rep	**LOCATION** Smyrna	**TITLE**	**PHONE #** 919/637-6185
DATE WRITTEN 6/27/86	**REPORT #** 1 **INDICATE IF FINAL** X	**DATE REPORTED ON JOB** 6/24/86	**DATE COMPLETED JOB** 6/24/86

REPORT ON FOLLOWING ITEMS IN SEQUENCE SHOWN

1. EQUIPMENT IDENTIFICATION (CLASS, TYPE FORM OR CAT #)	2. LENGTH OF TIME IN SERVICE & APPLICATION	3. PROBLEM	4. CONDITIONS AS FOUND	5. WORK DONE & STATUS OF JOB THIS REPORT	6. MATERIAL TO BE ORDERED & ANY FURTHER WORK TO BE DONE

1. Class 6060 Type FBS1121116 SF-6 Substation Circuit Breaker 1200 amp 15KV. FO 17-14272.

2. a. Energized two months.

   b. Substation feeder breakers.

3. a. Replace 3-bad overcurrent relays (2-phase O/C and 1-Gnd O/C) breaker #1 and perform field service testing on relays using attached customer provided protective relay settings.

   b. Replace charging motor in breaker #12.

4. Breaker #1 was Isolated from the power bus and breaker #12 was feeding a load.

5. a. The three phase overcurrent relays and one ground overcurrent relay were tested and set per the Attachment A settings from the contractor. The circuit breaker #1 trip circuit was tested by using the trip button on each overcurrent relay. The circuit breaker #1 was meggered and energized. The load was transferred from the bypass breaker #12, to circuit breaker #1. See Attachment B for Test Report.

   b. The bypass circuit breaker #12 was isolated from the power bus and the motor replaced. The by pass circuit breaker was closed and opened several times to test the operation of the charging motor.

6. None.

Subj: CONSTRUCTION CONTRACT 85-C-6409, REPLACE MEDIUM VOLTAGE BREAKERS, CAMP LEJEUNE, NORTH CAROLINA

Breaker No. 8

Phase Relays	Ground Relay
TAP 5	TAP 2
TD 5	TD 8
IT 40	IT 40

Reclosing Relay: 0, 30, 60
CTR: 600/5

Breaker No. 9

Phase Relays	Ground Relay
TAP 5	TAP 1
TD 8	TD 8
IT 40	IT 20

Reclosing Relay: 0, 30, 60
CTR: 600/5

Breaker No. 11

Phase Relays	Ground Relay
TAP 4	TAP 1.5
TD 2	TD 8
IT 40	IT 20

Reclosing Relay: 0, 30, 60
CTR: 600/5

2. The current transformer ratio for the differential protection scheme is 600/5; the current transformers on the load side of the medium voltage breakers are employed in the differential protection as indicated on NAVFAC Drawing No. 4126596.

3. The current transformer on the line side (source) are employed in the overcurrent protection for the feeder circuit.

4. If there are any questions, Point of Contact is Andy Young (Code 404), Public Works Division.

M. I. KIMBALL

Copy to:
404

PUBLIC WORKS DIVISION
BUILDING 1005, MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA 28542

In reply refer to:

85-C-6409
PWO
26 Feb 1986

MEMO TO FILE

From: Code 04
To: Code 02

Subj: CONSTRUCTION CONTRACT 85-C-6409, REPLACE MEDIUM VOLTAGE BREAKERS, CAMP LEJEUNE, NORTH CAROLINA

1. The settings for the protective relays and components of the medium voltage breakers that are provided by the subject contract are as follows:

Breaker No. 1

Phase Relays	Ground Relay
TAP 5	TAP 2
TD 3	TD 5.5
IT 20	IT 15

Reclosing Relay: 0, 45, 90
Current Transformer Ratio (CTR): 600/5

Breaker No. 2

Phase Relays	Ground Relay
TAP 5	TAP 2
TD 6	TD 7
IT 60	IT 50

Reclosing Relay: 0, 30, 90
CTR: 600/5

Breaker No. 3

Phase Relays	Ground Relay
TAP 4	TAP 1.5
TD 3	TD 8
IT 40	IT 25

Reclosing Relay: 0, 30, 90
CTR: 600/5

Breaker No. 6

Phase Relays	Ground Relay
TAP 5	TAP 2
TD 4	TD 5
IT 30	IT 15

Reclosing Relay: 0, 20, 60
CTR: 600/5

PROTECTIVE RELAY TEST REPORT

Sheet No. 1 of 7

Trip Report No. CB6-4-3707(A)

Customer _____ Date 6-24-86

Address _____ Air Temp. 85°F Rel. Humidity 40%

Owner/User MARINE CORPS BASE Date Last Inspection _____

Address CAMP LEJEUNE N.C. Last Inspection Report No. _____

Equipment Location MAIN BASE SUBSTATION

Owner Identification BREAKER #1

Circuit identification _____ C.T. Ratio 600:5A P.T. Ratio _____

VISUAL INSPECTION								ROUTINE MAINTENANCE							
	V1	V2	V3	A	B	C	GRD		V1	V2	V3	A	B	C	GRD
Cover Gasket								Glass Cleaned							
Glass								Case Cleaned							
Foreign Material								Relay Cleaned							
Moisture								Connection Tight							
Spiral Spring								Taps Tightened							
Bearing Condition								Contacts Cleaned							
Bearing End-Play								Insulation Resistance							
Disc Clearance								Trip Circuit							
Rust															

Remarks: _____

OVER CURRENT RELAY SETTINGS	INSTANTANEOUS				INVERSE TIME			
	TAP SETTING		SLUG SETTING		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
A Ø Type ITE Cat. _____		4				5		3
B Ø Type ITE Cat. _____		4				5		3
C Ø Type ITE Cat. _____		4				5		3
G Type ITE Cat. _____		7.5				2		5.5

OVER CURRENT RELAY SETTINGS	CURRENT MEASUREMENTS ARE SECONDARY CURRENT VALUES						
	INSTANTANEOUS				INVERSE TIME		
	PICK UP		NO PICK UP		TEST CURRENT	TIME IN SEC.	
	As Found	As Left	As Found	As Left	——	As Found	As Left
A Ø		20			2x ⇒ 10 Amps		5.68
B Ø		20			2x ⇒ 10 Amps		5.70
C Ø		20			2x ⇒ 10 Amps		5.75
G		15			2x ⇒ 4 Amps		10.70

OVER/UNDER VOLTAGE RELAY SETTINGS	UNDER VOLTAGE				OVER VOLTAGE			
	TAP SETTING		TIME DIAL		TAP SETTING		TIME DIAL	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1 Type _____ Cat. _____								
V2 Type _____ Cat. _____								
V3 Type _____ Cat. _____								

OVER/UNDER VOLTAGE RELAY TESTS	UNDER VOLTAGE				OVER VOLTAGE			
	Low Voltage Trip		Time To Trip		High Voltage Trip		Time To Trip	
	As Found	As Left	As Found	As Left	As Found	As Left	As Found	As Left
V1								
V2								
V3								

Submitted by KENNETH J. CHELLEVOLD Date 6-30-86

SQUARE D COMPANY

1986

INSTRUCTION MANUAL FOR SQUARE D

Job Title: Camp LeJeune

Location: Camp LeJeune Marine Corps Base, NC

Equipment Designation: 15KV, 1200A, 110Kv BIL Substation C/B

Architect:

Engineer: Design Branch, Public Works Div.

Electrical Contractor:

Customer: Graybar Electric

Customer Order No.: 325WP0916

Square D F.O. No.:17-14272A

Field Engineer: Lee Wilson

Application Engineer: H. Johns/R. Coil

Contract # 85-6409

NAVFAC Dwg Nos. 4126594
" 5
" 6

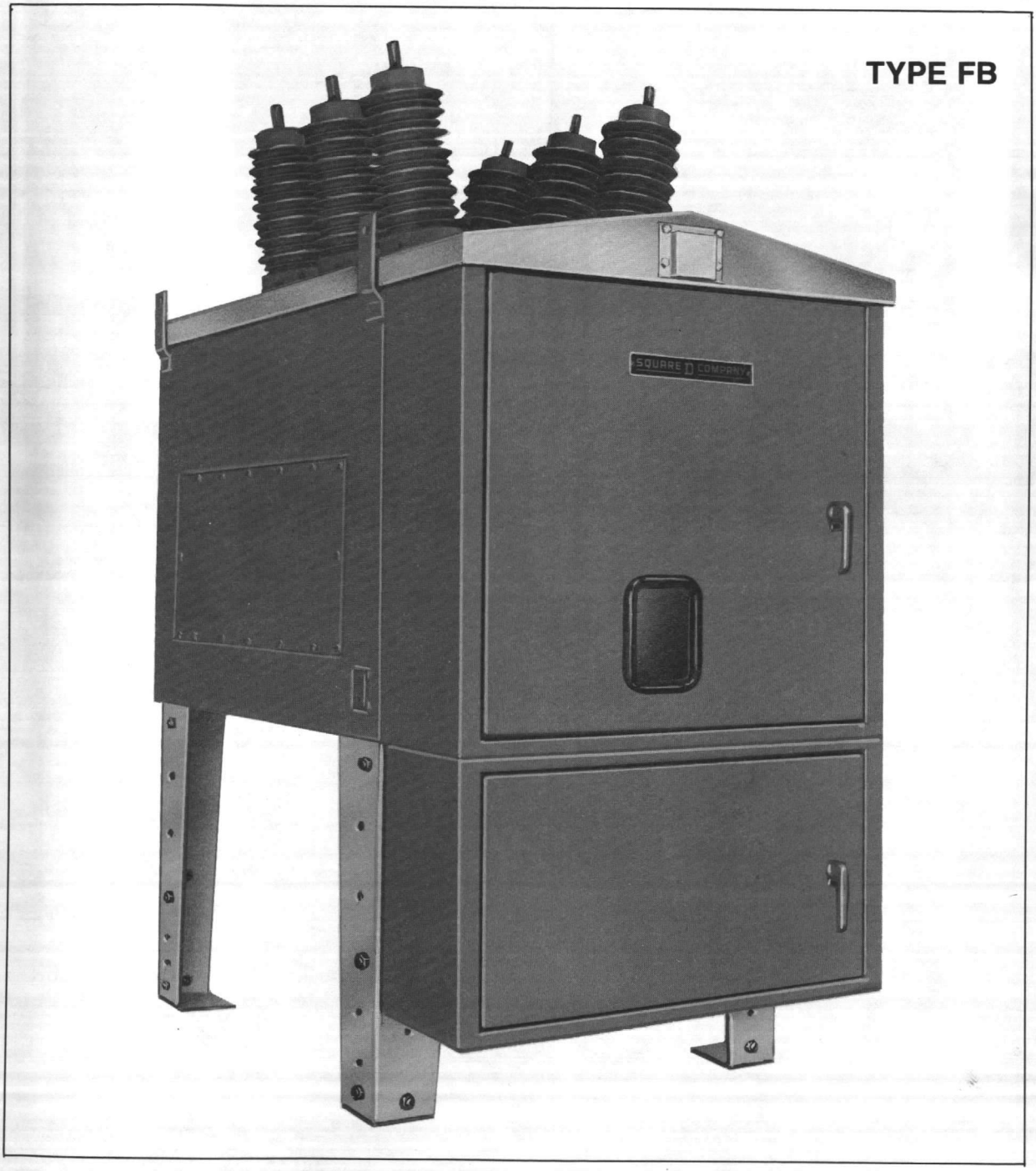
INDEX

SEPTEMBER, 1983
Supersedes 8/1981 Edition

MANUAL 6060-1

Installation & Maintenance Manual

SF_6 Substation Circuit Breakers



SQUARE D COMPANY

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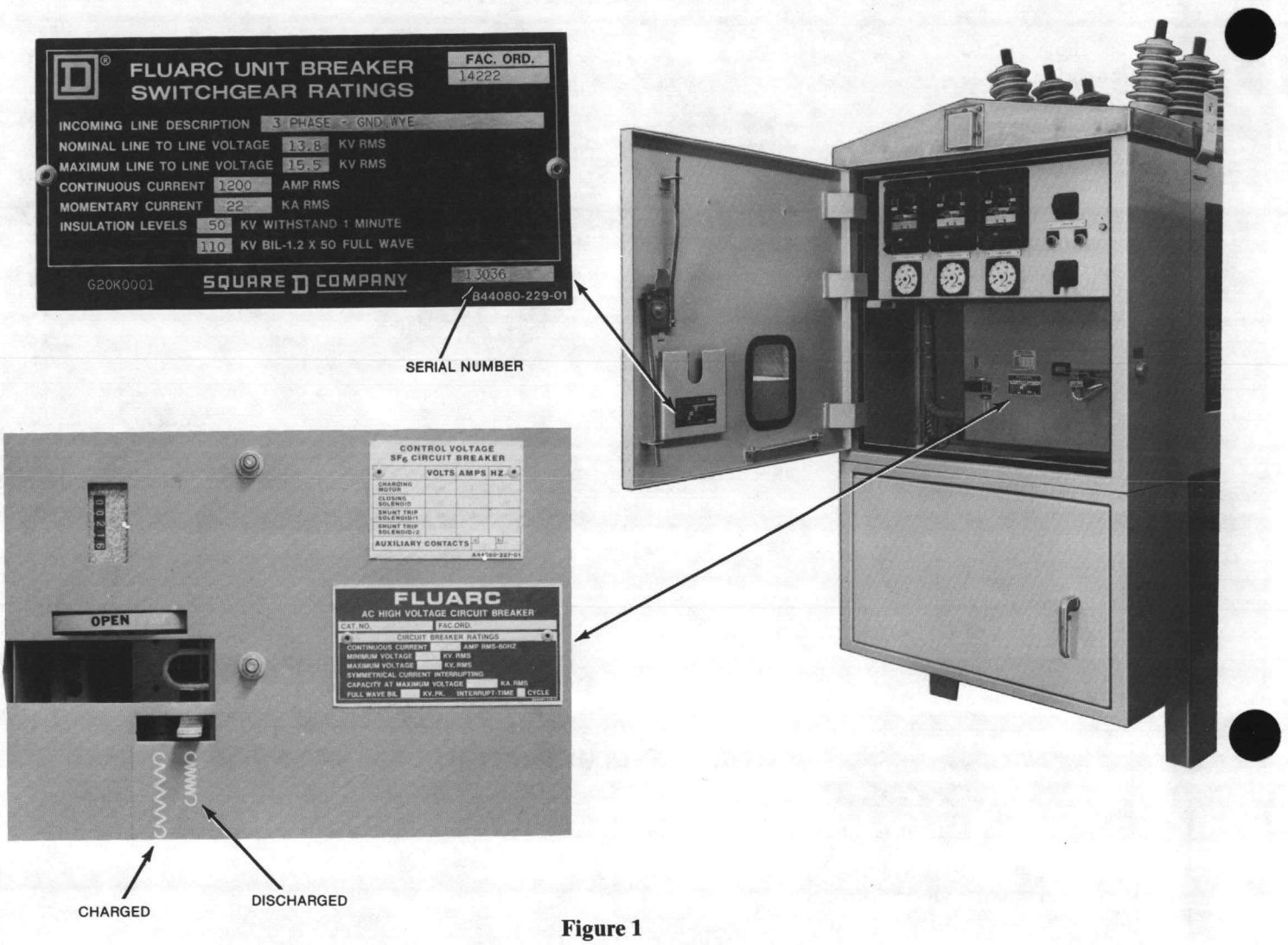


Figure 1

INTRODUCTION

The use of SF_6 gas (Sulfur Hexafluoride) equipment by utilities for high voltage and extra-high voltage application is relatively common. Square D Company's FLUARC® Circuit Breaker however, is a low pressure, sealed interrupter type, for applications at 2.4kV through 38kV.

The Type FB Substation FLUARC™ Circuit Breaker uses three (3) sealed interrupters. These interrupters are filled with SF_6 at the factory and sealed for life. FIELD CHARGING OF THE INTERRUPTERS IS NOT REQUIRED.

Designed for low maintenance techniques, the Type FB Circuit Breaker is housed in a painted steel enclosure protected by a stainless steel roof. Overall height is variable through the use of adjustable galvanized legs.

The breaker should be utilized within the design limitations described on the circuit breaker nameplate. See Table 1 for complete ratings.

*FLUARC is a trademark of Merlin Gerin.

STANDARD FB RATINGS

Breaker Type	FBS-1	FBS-2	FBS-3
Rated Frequency	60 Hz	60 Hz	60 Hz
Nominal Operating Voltage	14.4kV	23kV	34.5kV
Maximum Design Voltage	15.5kV	25.8kV	38kV
Basic Insulation Level	110kV	125kV	150kV
60 Hz Withstand: Voltage Dry Voltage Wet	 50kV 45kV	 60kV 50kV	 80kV 75kV
Minimum External Creep Distance	20.5 in.	25.75 in.	47 in.
Minimum External Strike Distance Terminal to Ground	14 in.	16 in.	22 in.
Minimum External Strike Distance Between Bushing Terminals Phase to Phase	10.12 in.	11.87 in.	13.46 in.
Interrupting Time (3 Cycles - Optional)	5 Cycles	5 Cycles	5 Cycles
Time Between Coil Energization And Contact Parting	45-65 msec.	45-65 msec.	45-65 msec.
Spring Charging Time	8-11 sec.	8-11 sec.	8-11 sec.
Closing Time	85 msec.	85 msec.	85 msec.
Reclosing Time	0.3 sec.	0.3 sec.	0.3 sec.
Continuous Current	400A-1200A	400A-1200A	400A-1200A
Interrupting Capacity (Max. Voltage)	20kA	18kA	16kA
Momentary Rating (Peak)	60kA	54kA	48kA

Table 1

HANDLING PRECAUTIONS

1. Only qualified and authorized personnel should be permitted to handle or operate the breaker.

2. Delicate instruments and relays may be damaged by rough handling. HANDLE WITH CARE DURING INSTALLATION.

3. Remove blocking on relay armatures and check control circuits (except current transformer circuits) for grounds and short circuits before applying control power.

4. Check proper phasing of all circuits and connect the switchgear to the station ground before applying high voltage power.

5. Do not work around "live" parts.

6. Any switch or breaker that has been opened to de-energize the equipment being serviced should be effectively locked, tagged, and even blocked open if possible to prevent accidental energization of the equipment.

7. Service current carrying parts only when these parts are disconnected from the system and grounded to the ground bus.

8. In case of fire do not use liquid fire extinguishers until all circuits have been made electrically "dead".

9. All personnel responsible for supervision and operation should be familiar with the breaker and its functions.

10. CAUTION: If breaker is to be stored prior to installation, provision must be made for energizing the space heaters to prevent condensation of moisture inside the enclosure.

11. If the circuit breaker is to be stored for an extended period of time prior to placing in service, periodic exercising is necessary to maintain the high integrity of the gas seal in the interrupters. Time between exercise periods should be no greater than one year.

PRE-SERVICE CHECK-OUT

Prior to placing the breaker in service, perform the following checks:

1. Open all panels and inspect for any shipping damage such as broken parts, loose hardware, etc.

2. Using a 1000 V. megohm tester, check insulation resistance at the bushings phase to phase and phase to ground. As a rule of thumb, readings should be no less than 1000 ohms/volt (system voltage).

3. With the circuit breaker isolated from High Voltage:
   a) Check the bushing clamp down nuts for tightness (recommended torque 15 ft-lbs)
   b) Check the interrupter power pole hardware for tightness (recommended torque 20 ft-lbs)
   These checks are part of normal factory quality procedures, however, it is suggested these items be re-checked prior to actual energization.
   c) Remove all dust and foreign particles from the bushings and interrupters by wiping with a soft dry cloth. For more extensive cleaning, a non-flammable solvent should be used.

4. Manually charge the closing springs and close and trip the breaker.

5. Apply control power and operate breaker electrically.

6. It would be advisable to perform the following:
   a) High potential dielectric test. (page 13)
   b) Bushing power factor test. (page 13)
   c) Contact resistance measurement. New breaker should read 150 or less micro ohms, using a DC test instrument.

7. If everything is found to be satisfactory, proceed to place breaker in service.

CIRCUIT BREAKER ENCLOSURE

The Type FB Substation Circuit Breaker consists of an isolated high voltage compartment and low voltage compartment.

The high voltage compartment includes cycloaliphatic cast epoxy bushings which protude through the stainless steel roof. Each roof penetration is extruded outward ¼" and gasketed to prevent water leakage due to gasket aging. Up to three current transformers can be mounted on each bushing. Provisions are included on each unit and therefore require no additional mounting parts.

Two large gasketed access panels (RHS and LHS - Figure 2) allow entry into the high voltage compartment. **CAUTION: DO NOT REMOVE PANELS WHILE BREAKER IS ENERGIZED.** The bushings, CTs, sealed interrupter poles, operating linkage, contact wear indicator and strip heater are readily accessible. Secondary CT wiring is extended to terminal strips in the isolated low voltage compartment.

A filtered ventilation grill and gasketed access panel is mounted on the bottom side of the high voltage compartment. Removal of this access panel exposes the opening springs and rotary shaft mechanisms. **CAUTION: DO NOT REMOVE WHILE ENERGIZED.** Access to "live" parts is shielded by the circuit breaker support channel, however the above safety precautions should always be observed.

The low voltage compartment is isolated by a steel barrier from the high voltage compartment. A hinged panel for relay mounting, terminal strips, strip heater, circuit breaker operating mechanism - all are accessible through a hinged and gasketed front door. (An optional compartment extension is supplied where the quantity of relaying dictates.) A padlockable vault type handle with three (3) point latch is provided. A wind stop and instruction manual pocket are provided on the rear of the door.

The large viewing window provides easy viewing of the circuit breaker operations counter, mechanical open/close indicator and closing spring charge indicator.

An emergency trip button is provided that includes lockout provisions and an electrical/mechanical hand reset interlock (ANSI 69 switch). This provision will preclude supervisory close and automatic reclose signals to the circuit breaker when an emergency manual trip and lockout situation exists.

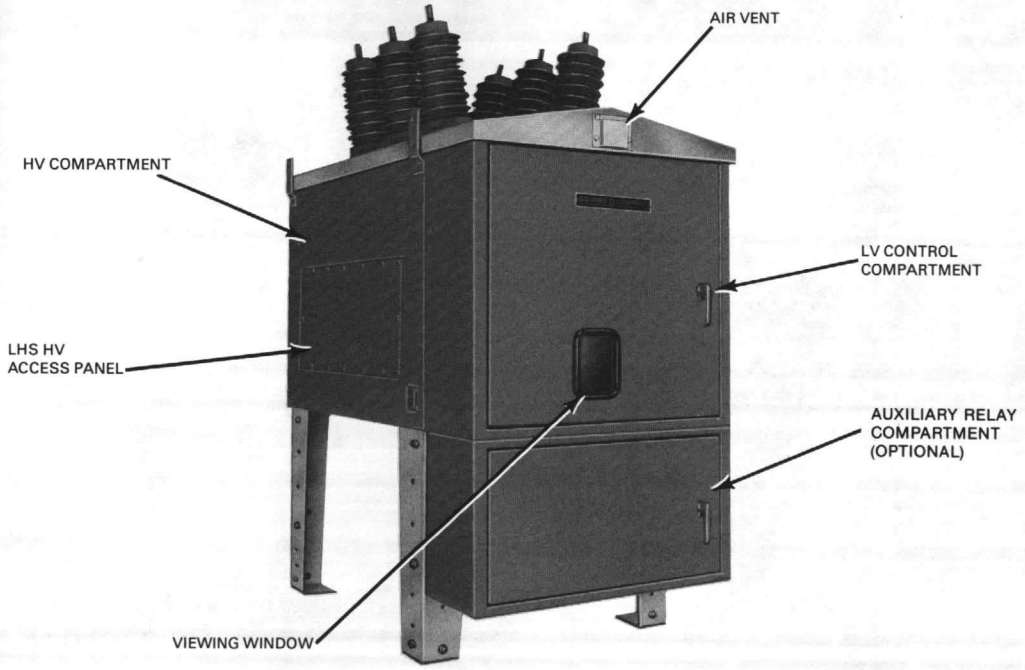


Figure 2

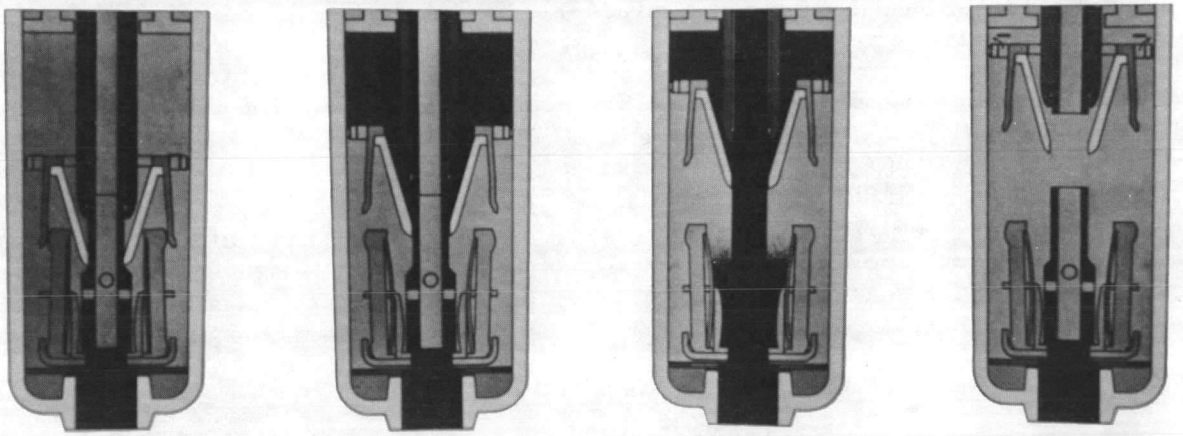
OPERATION THEORY OF SF_6

The FLUARC® system of arc interruption utilizes a puffer type interrupter. It moves the gas through a nozzle system across the arc.

As the arcing contacts part, the gas is compressed into the arc region. The action of the gas absorbs the arc energy and full interruption takes place at a current zero.

This system provides a soft high speed interruption, quiet operation, long interrupter life and reduced maintenance.

FB Circuit Breaker Operation



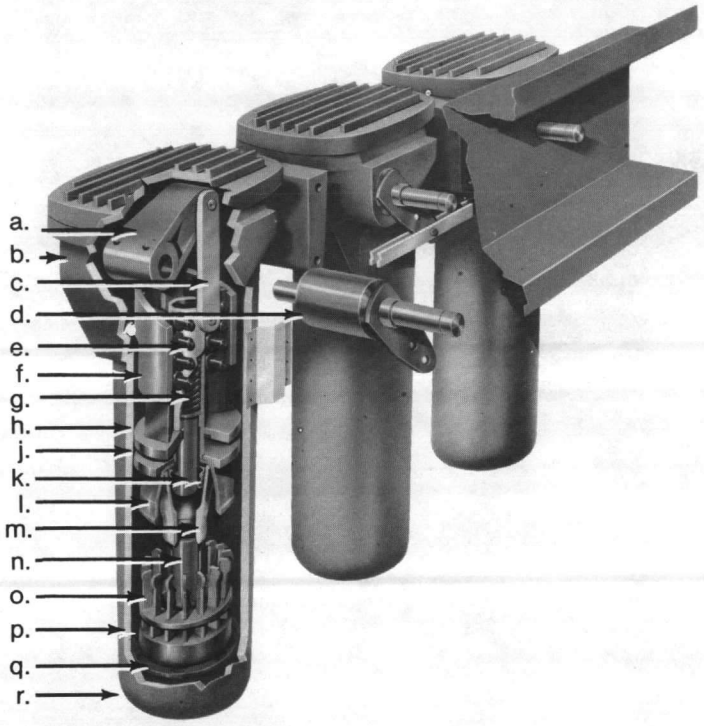
Cutaway of Fluarc SF_6 Circuit Breaker Bottle in Closed Position Prior to Interruption.

Separation of the Main Contacts Prior to Arc Inception and Compression of SF_6 Reservior.

Parting of Arcing Contacts. Puffing of the Arc Continues Until Interruption at a Current Zero.

Circuit Breaker in Open Position with Current Interrupted.

Figure 3



KEY:

a. Crank
b. Terminal
c. Operating Rod
d. Rotating Control Shaft
e. Conical Rollers
f. Cradle
g. Contact Stem
h. Cradle Base
j. Piston
k. Movable Arcing Contact
l. Movable Main Contact
m. Insulating Nozzle
n. Fixed Arcing Contact
o. Fixed Main Contact
p. Pole Enclosure
q. SF_6 Regenerating Material
r. Terminal

Figure 4

INSPECTION AND MAINTENANCE

GENERAL

The FB Breaker has been manufactured and tested with the concept of maintenance-free operation within the limits of predictable conditions. The mechanical life of the mechanism is 10,000 operations. The mechanical operations counter is incremented on CLOSE operations.

The life of the SF_6 interrupters can be predicted by use of the graph (Figure 24) showing the relationship of interrupting current vs. number of operations. The interrupter chambers are pressurized with SF_6, sealed and have no need of maintenance.

The need for inspections and possible interrupter replacement should be based upon the frequency of operation, types and levels of interruptions and environmental conditions. Specific inspections and/or maintenance would be as follows:

- Operating Mechanism
- Contact Erosion
- Ventilation Filter Condition
- Roof Bushing Dielectric Test
- Sequence of Operation
- Gas Servicing

WARNING: THROUGHOUT THESE PROCEDURES, THE OPENING AND CLOSING SPRINGS SHOULD BE DISCHARGED FOR SAFETY.

OPERATING MECHANISM DESCRIPTION

A stored energy mechanism is located in the control housing and consists of high energy closing springs and a ratcheting system for charging these springs. The breaker is prevented from being closed until the springs are fully compressed. Opening and closing speeds are independent of the method by which the springs are charged manual or electrical).

The springs can be charged either electrically through the gear motor or manually through the use of the manual charging handle. After the springs are fully charged, the breaker may be closed either electrically by energizing the closing solenoid or manually by pulling out the CLOSE/OPEN button. Depress the same button to trip the breaker.

The closed/open status of the breaker can be determined by a mechanical flag showing through the escutcheon plate of the mechanism. In the same general location is a flag that indicates whether the closing springs are CHARGED or DISCHARGED.

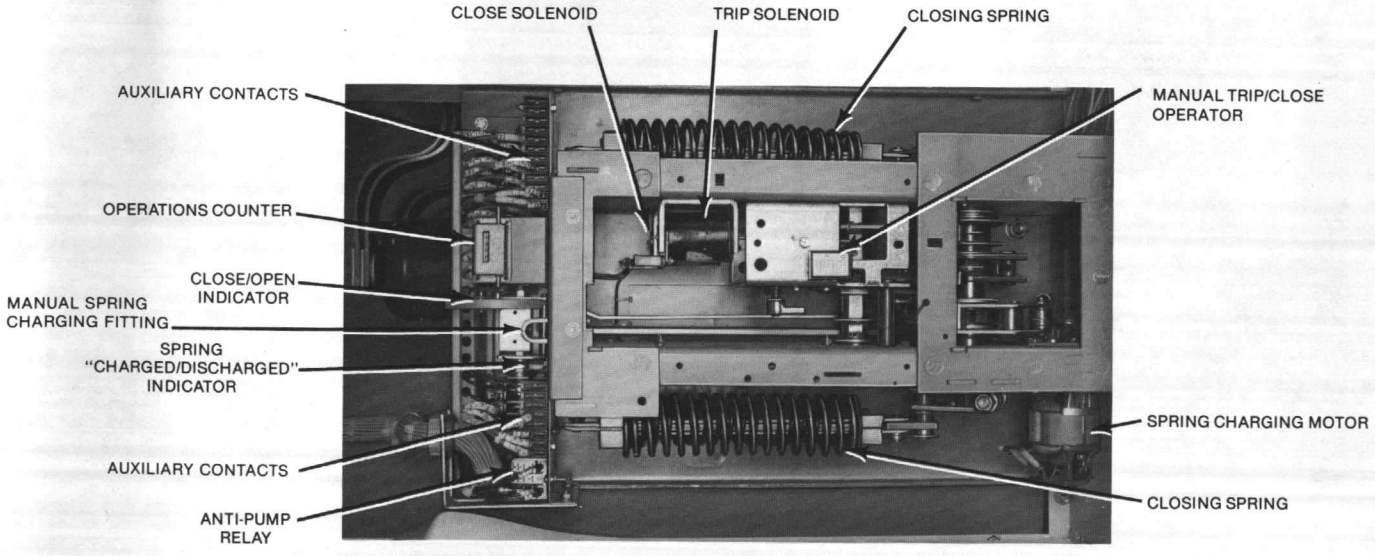


Figure 5

OPERATING MECHANISM LUBRICATION

An important part of normal preventive maintenance of this breaker would be to ensure that the mechanism is clean and properly lubricated. Cleaning and lubrication should be as follows:

1. Linkages designated should be cleaned with trichlorethylene and lubricated lightly with oil. (Figures 6, 7)
2. The spring guides and gears designated "G" should be greased lightly with a low temperature grease such as automotive molybdenum disulfide. (Figure 8)
3. The opening spring should be lubricated at point A with oil and point B with grease. (Figure 9)

Suggested maintenance frequency of the operating mechanism is every 3000 operations or 36 months, whichever comes first. Consideration must be given to a shorter cycle in the case of adverse environmental conditions.

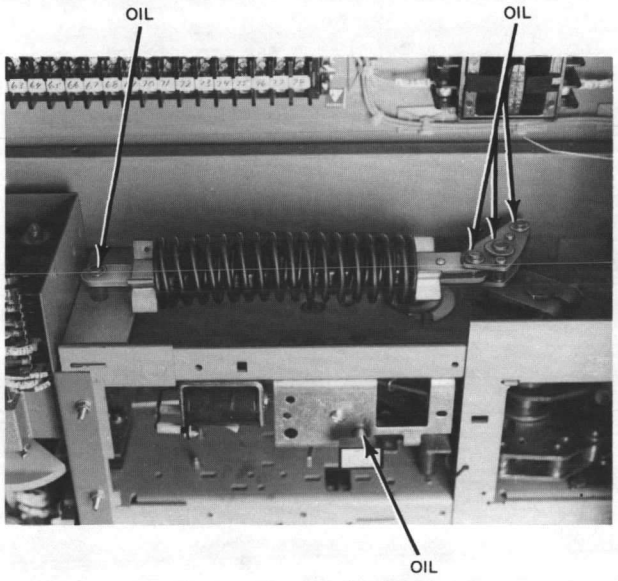


Figure 6

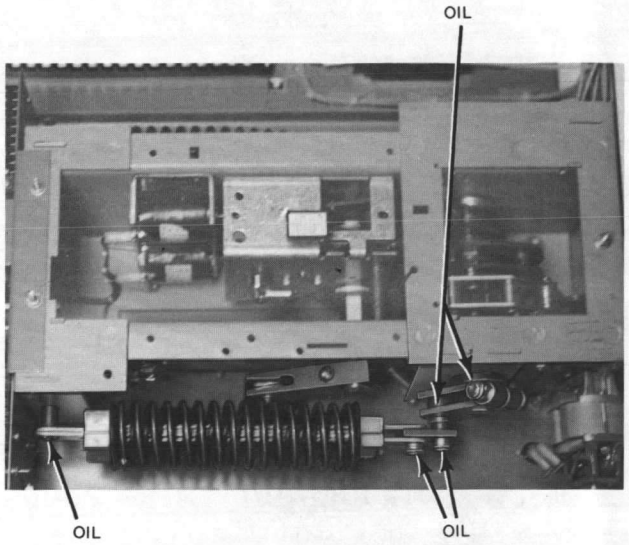


Figure 7

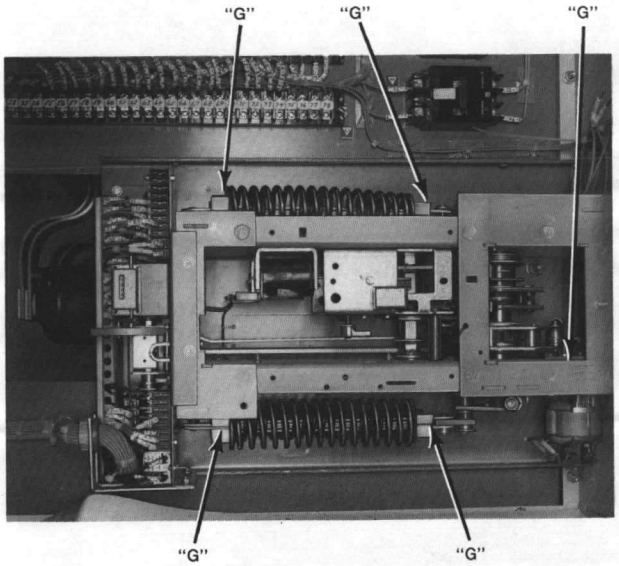


Figure 8

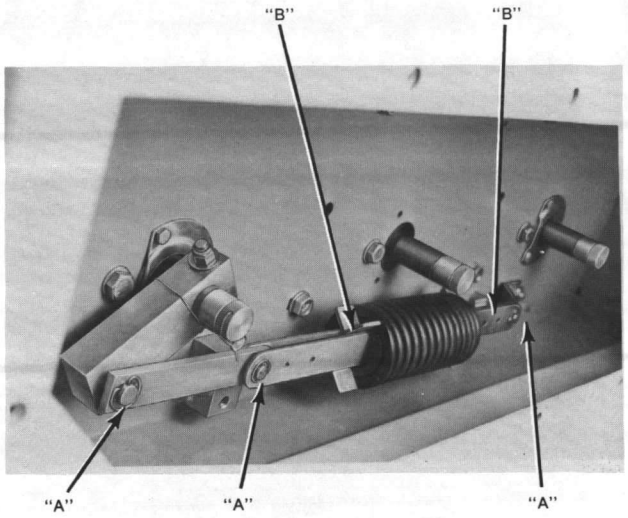


Figure 9

CONTACT EROSION

The total life of an interrupter is determined by a combination of interrupting current and number of operations, and can be measured through contact erosion. See (Figure 24) that depicts this phenomena graphically. Contact erosion becomes most significant after the breaker has reached 75% of its predicted life. This can be estimated by using the graph. A red and green indicator is provided in the high voltage compartment for determining whether or not the interrupters should be replaced. (See Figure 14)

To check contact erosion it is necessary to defeat and remove the closing springs and slow-close the breaker. Use the following procedure:

1. Totally remove the high voltage from the bushings and make sure the breaker is open and the springs are discharged.
2. As shown in (Figure 10), charge the mechanism manually so that the right-hand holes are just barely accessible. This should be such that a pin may be inserted.
3. Continuing to put a slight pressure on the charging handles, insert a 6mm or 10-32 diameter screw or pin through the hole as shown. Repeat for lower spring. (Figure 11)
4. Remove the snap rings on both springs (Figure 12). Be certain to note the position of the washers and the main pins so they may be replaced in the same manner when reassembling.
5. Detach and remove the springs. (Figure 13) shows top spring location after removal.

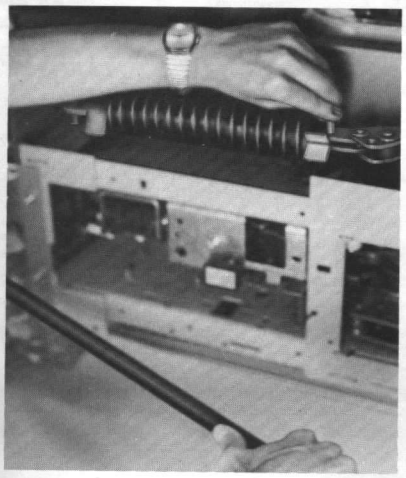


Figure 10

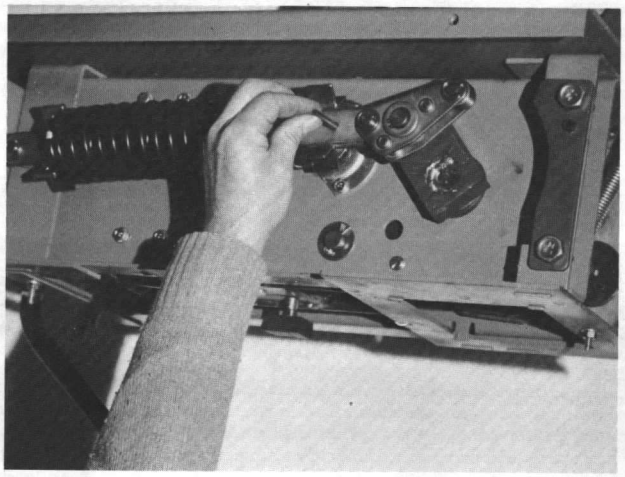


Figure 11

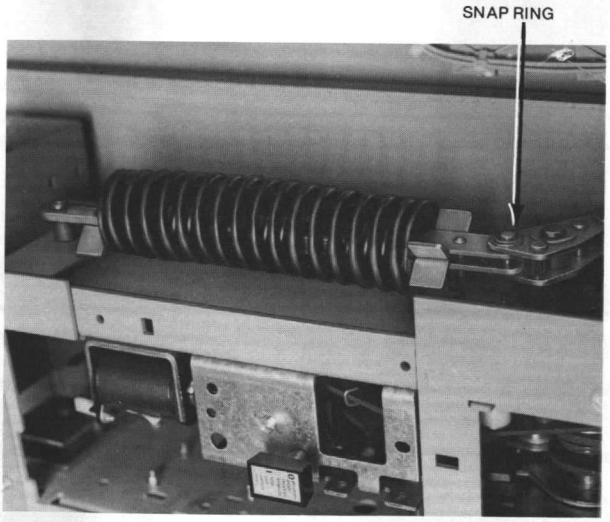


Figure 12

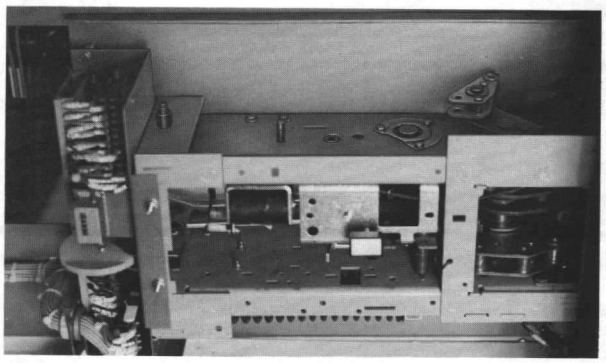


Figure 13

6. Charge the mechanism manually until a click is heard.
7. Pull the OPEN/CLOSE button.
8. Attach a bell-set, ohmmeter or 3-phase LED test set across each interrupter. Continue to slow close the breaker through the manual charging handle and check contact "make" point on each interrupter. As long as the end of the connecting link (index) is not in the red zone (Figure 14) the contact condition is considered good. When the index area (end of link) is at the red/green transition line, the bottle(s) should be replaced.

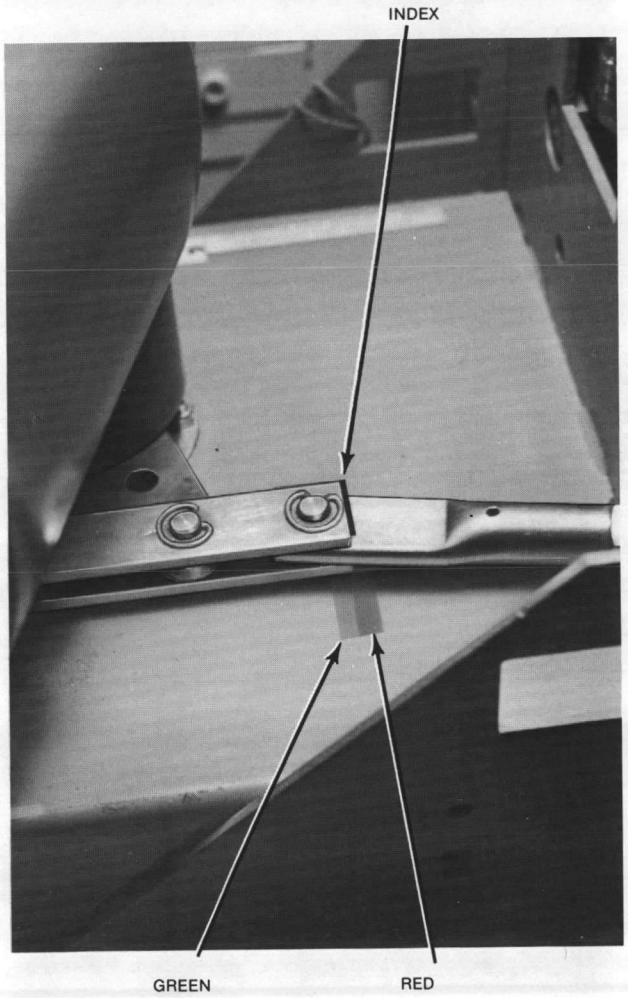


Figure 14

VENTILATION FILTER

The filter, located through the bottom access cover, (Figure 16) should be cleaned or replaced every 36 months, depending on environmental conditions.

To re-install the closing springs, use the following procedure:
1. Manually close the breaker fully, then trip it open, using the manual trip button.
2. Re-install both the top and bottom springs, recoupling them as shown in (Figure 15).
3. BE CERTAIN THE SPACERS, WASHERS AND PINS ARE INSTALLED IN THE SAME POSITION AS THEY WERE IN PRIOR TO REMOVAL.
4. After re-installation of the springs, charge the mechanism slightly to relieve the tension enough to be able to remove the pins that were inserted previously.
5. The mechanism should now be manually fully charged and the breaker tripped to ensure proper mechanical operation.

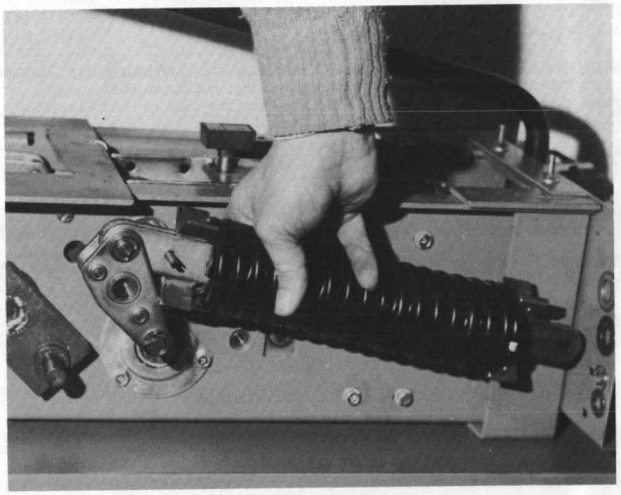


Figure 15

Figure 16

BUSHINGS

The bushings (Figure 17) are solid cycloaliphatic epoxy condensor type. They are mounted through a roof opening (Figure 18) that is extruded for protection from water "roll-off" entering the high voltage compartment. An "O" ring is added around the extrusion that completes the weather seal (Figure 19).

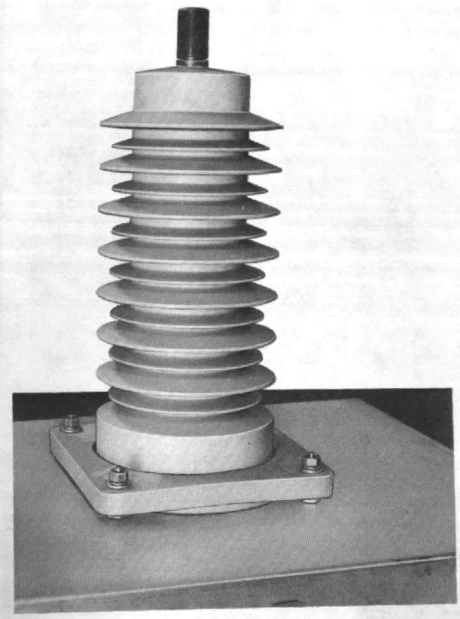


Figure 17

Depending upon environmental conditions, the user should establish the period between dielectric tests. If there is no previously established period for roof bushing tests, then a 5 year period is recommended. One or more of the following tests are suggested:

1. POWER FREQUENCY DIELECTRIC TEST

Apply a test voltage, (line to ground) in accordance with the values listed in the following table for a period of one minute:

Rated Maximum Voltage	Test Voltage at 60 Hz
15.5 kV	50 kV
25.8 kV	60 kV
38.0 kV	80 kV

The bushings are considered to have passed the test if no internal or external breakdowns occur.

2. POWER FACTOR TEST

(a) Disconnect ground from bushing.

(b) Using an appropriate test set and following test set instructions, connect test leads between top terminal of bushing and the bushing ground screen.

(c) OBSERVE GOOD SAFETY PRACTICES PER INSTRUCTIONS.

(d) Following test set instructions, record power factor reading to be used as a "bench mark" for subsequent readings.

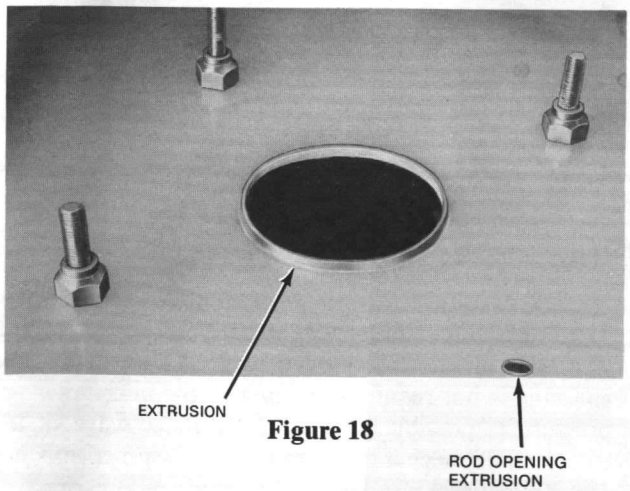


Figure 18

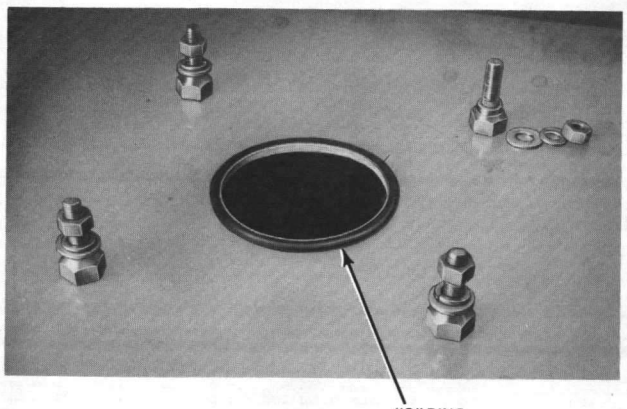


Figure 19

BREAKER EXERCISE AND SPEED OF OPERATION

At the time of normal relay maintenance it is also recommended that the breaker be totally exercised by closing and opening through all available means while checking the control functions.

The operating mechanism has been tested to 10,000 operations with a very slight (0.3 meters per second) variation over the entire range. Adjustments are not required over the life of the breaker in regard to speed of operation.

Opening Speed = 8.7-11.3 ft/sec.
Closing Speed = 6.9- 9.5 ft/sec.

CT REPLACEMENT

1. Disconnect flexible connector between bottom of the bushing and the entrance to the interrupter.
2. Disconnect CT wiring at CT.
3. Remove the two (2) retainer devices that hold the CT in place and remove CT.
4. BE CERTAIN TO OBSERVE POLARITY MARKS WHEN INSTALLING NEW CT.
5. Install replacement CT by following directions in reverse order.
6. Torque flex connector bolts to 18-22 ft-lbs.

ELECTRICAL OPERATION SEQUENCE

1. The breaker will close only after the closing springs are fully charged.
2. Charging of the springs is controlled by 52LS/bb. When the springs are discharged and power is available on terminals 61 and 62, the motor will charge the closing springs. When the springs are fully charged 52LS/bb opens, stopping the motor.
3. The breaker is electrically closed by operating the closing solenoid 52X. The closing signal is applied across terminals 69 and 70. With the closing springs fully charged, 52LS/aa is closed. As long as the breaker is open, 52/b and 52Y/b supply current to 52X. When the breaker closes 52/b opens the circuit. Contact 52/a energizes the anti-pump relay 52Y and 52Y/b opens, preventing the closing solenoid from being re-energized until 52Y is de-energized. At the same time, 52Y/a seals in the anti-pump relay until the close signal is removed from terminals 69 and 70. Contact 52LS/aa recloses as soon as the closing springs are recharged.
4. The breaker can be tripped by applying a signal across terminals 65 and 6. When the breaker is closed, 52/a is closed setting up the trip circuit. After the breaker opens, 52/a opens de-energizing the trip solenoid.

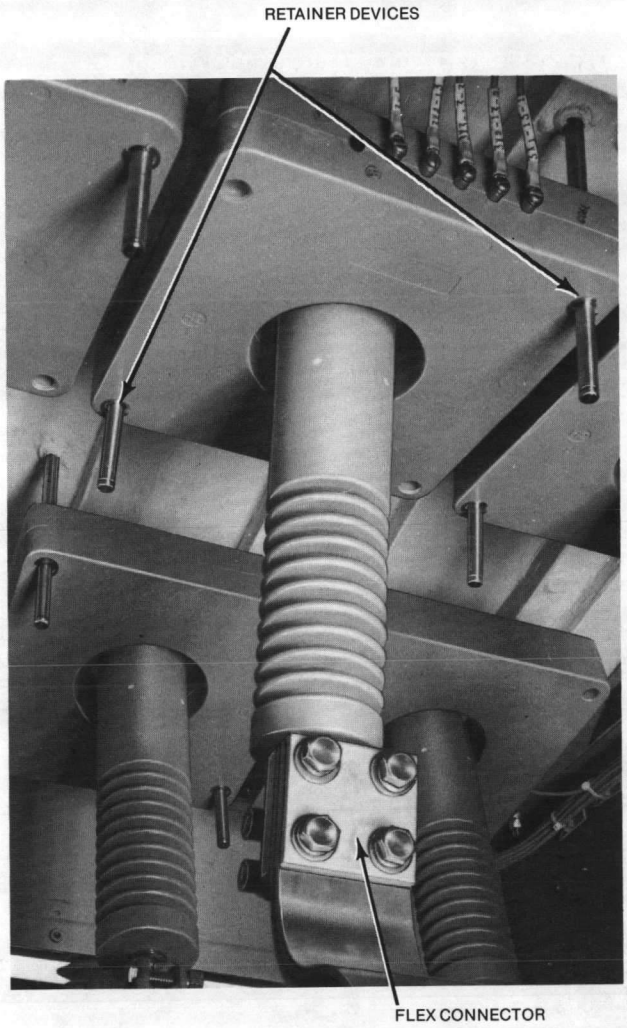


Figure 20

5. The open/closed status of the breaker may be determined remotely through the use of terminals 8, 10 and 73.
6. Some of the electrical options as shown include remote closing spring status indication, an additional trip coil, and an undervoltage trip coil.

GAS SERVICING

The Fluarc interrupters are designed and sealed for life. The interrupters are charged at the factory and field charging is not required. Testing of the interrupter gas pressure is possible through a Schrader valve in the rotary shaft mechanism. However, this practice is not recommended at installation. Execution of a gas pressure check will lead to more leakage (1 to 3 pounds of pressure) of SF_6 gas from the interrupter than would be expected over a number of years of service. For conservative maintenance and inspection procedures a 5 year gas pressure check should be adequate.

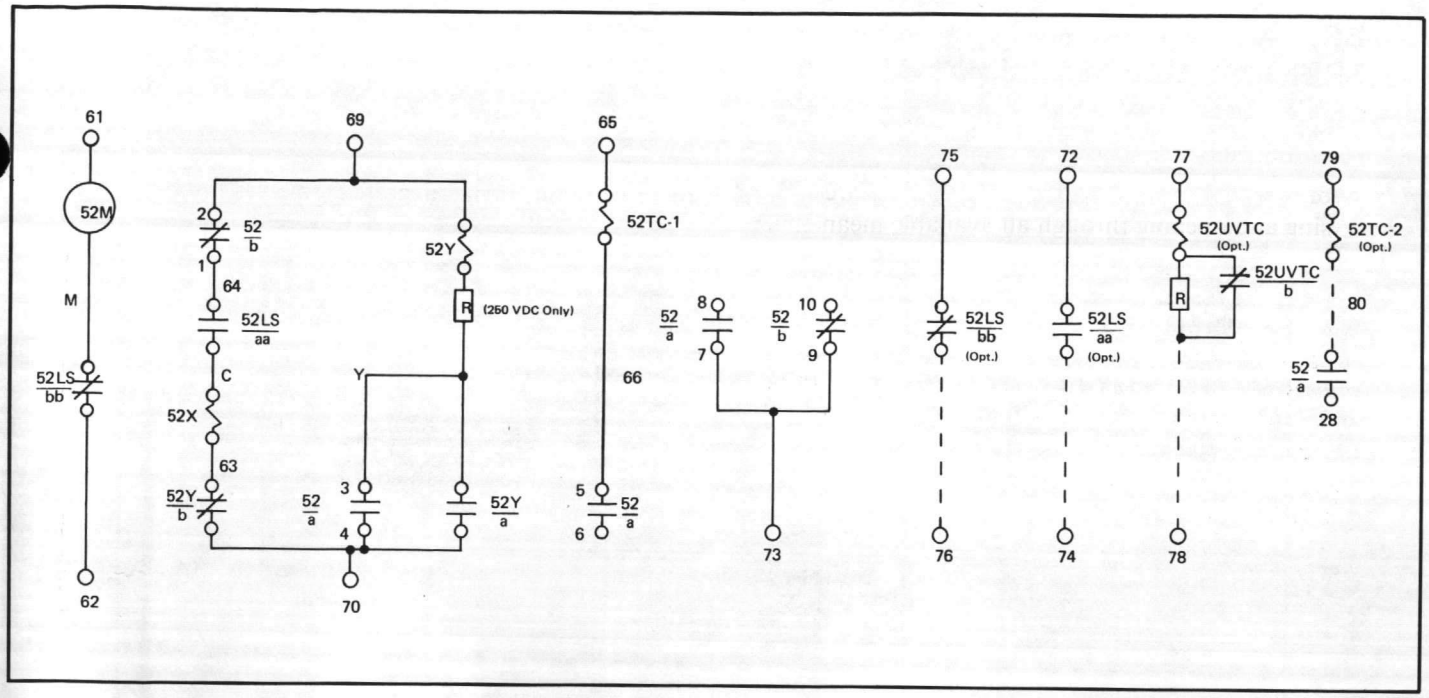


Figure 21

BREAKER INTERNAL WIRING

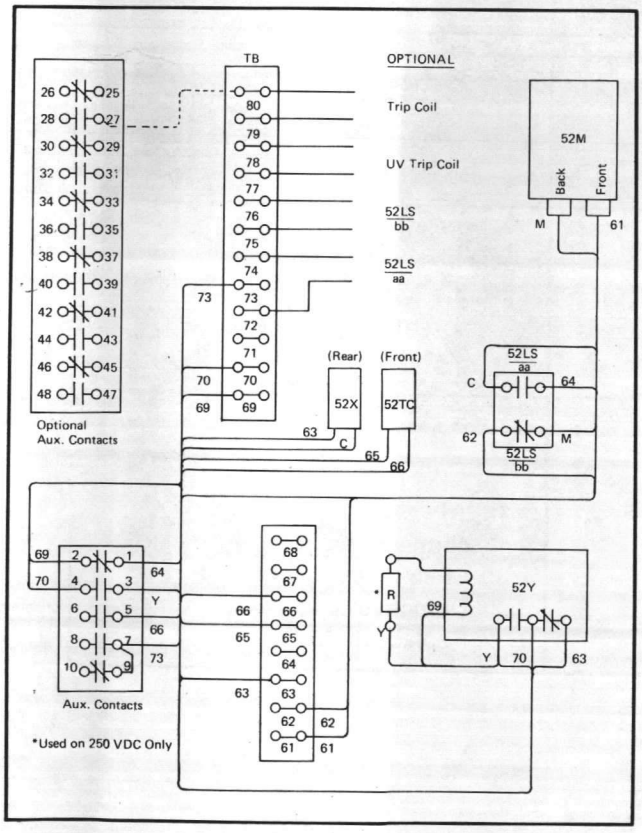


Figure 22

LEGEND:

52 UVTC	Undervoltage Trip Coil (Optional)
52TC-1,-2	Breaker Trip Solenoid (1 standard, 2 optional)
52X	Breaker Closing Solenoid
52Y	Anti-Pump Relay
52M	Closing Springs Charging Motor
52Y/a	Anti-Pump Relay Contact-Normally Open
52Y/b	Anti-Pump Relay Contact-Normally Closed
52LS/aa	Closing Springs Limit Switch-Open when springs are not charged. Closed when springs are charged.
52LS/bb	Closing Springs Limit Switch-Closed when springs are not charged. Open when springs are charged.
52/a	Auxiliary Switch Contacts-Open when breaker is in the tripped open position. Closed when breaker is in the closed position.
52/b	Auxiliary Switch Contacts-Closed when breaker is in the open position. Open when breaker is in the closed position.

NOTES:

Breaker shown in open position, closing springs discharged.

TROUBLESHOOTING GUIDE

These instructions allow shutdown periods to be kept to a minimum. If the suggested remedies fail to solve the problem, refer to the factory.

Problem	Possible Cause	Probable Reason & Remedy
MECHANISM DOES NOT CHARGE AUTOMATICALLY	Electrical Charging motor	Low voltage at the terminals of the motor. Correct the voltage. Replace the motor if necessary.
	End-of-charging switch	Check condition of switch. Replace it if necessary.
	Wiring	Check connections.
BREAKER WILL NOT CLOSE (The indicator stays green)	Closing solenoid	Bad connection. Check the circuit. Defective coil. Replace the coil.
	End of charging switch	Check condition of switch. Replace if necessary.
	Latch mechanism	Latch is in pivoted position clear of its holding pin. Clean and oil the hinge.
BREAKER CLOSES AND OPENS AT ONCE AND REMAINS OPENED WHILE THE CLOSING ACTION IS MAINTAINED	Any release (direct or indirect)	Fault in the HV main circuit or incorrect adjustment of protective circuits. Eliminate the fault. Adjust protective circuits.
BREAKER CANNOT BE OPENED ELECTRICALLY	Auxiliary switch	Check circuit.
	Trip solenoid	Trip control power connections. Check the circuit. Defective coil. Replace the coil.

Table 2

SUGGESTED MAINTENANCE TOOLS

The only tools necessary for "normal" maintenance such as checking contact erosion and simple cursory inspection are as follows:

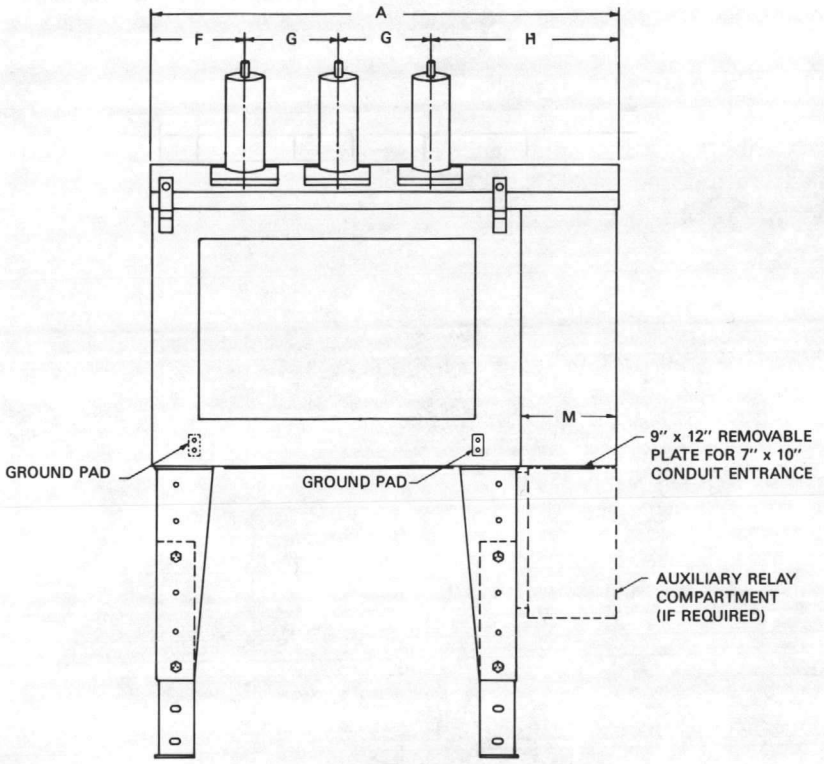
Long Nose Pliers
Continuity Tester
10mm Wrench or 6 in. Adjustable Wrench
13mm Socket or Box End Wrench
6mm-25mm or 10-32 × 1″ screw

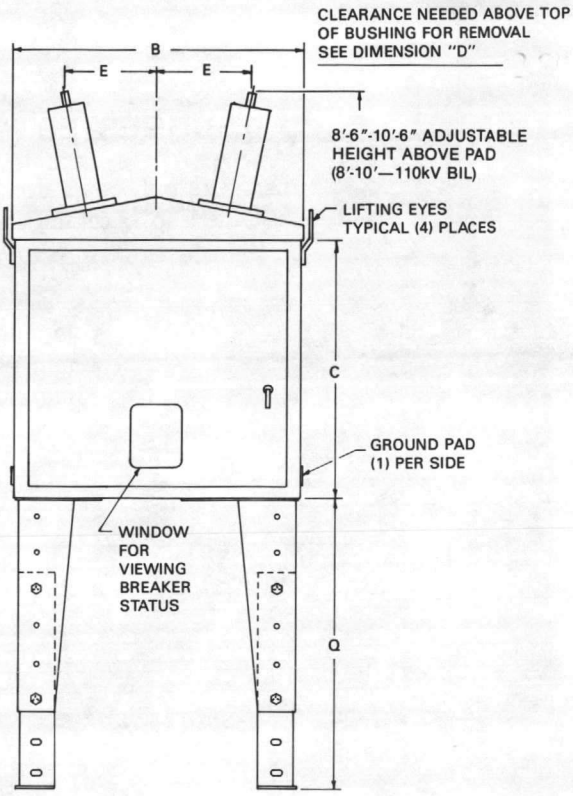
AVAILABLE REPLACEMENT PARTS

Device	Voltage	Part No.
Spring Charging Motor	24 VDC	B44065-357-01
	48 VDC	B44065-357-02
	125 VDC	B44065-357-03
	250 VDC	B44065-357-04
	120 VAC	B44065-357-05
	240 VAC	B44065-357-04
Closing Solenoid	24 VDC	C44065-033-01
	48 VDC	C44065-033-02
	125 VDC	C44065-033-03
	250 VDC	C44065-033-04
	120 VAC	C44065-033-05
	240 VAC	C44080-376-04
Trip Solenoid	24 VDC	C44080-384-01
	48 VDC	C44080-384-02
	125 VDC	C44065-034-07
	250 VDC	C44080-384-03
	120 VAC	C44065-034-08
	240 VAC	C44065-034-06
Anti-Pump Relay	(Class 8501 Type KF)	
Bushing	(Order by Breaker S/N + Description)	
Interrupter	(Order by Breaker S/N + Description)	

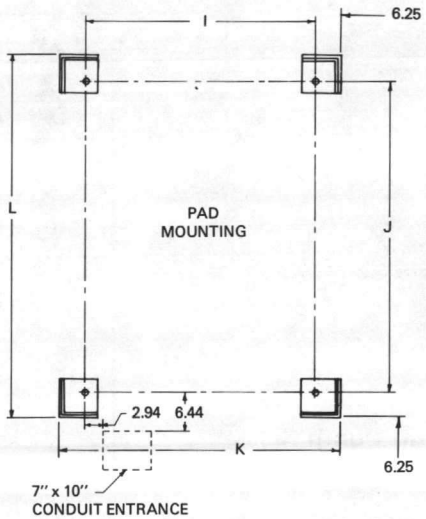
Table 3

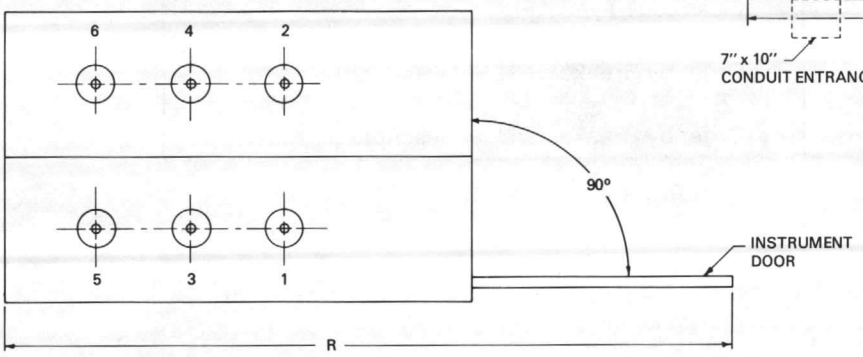
DIMENSIONS





DIMENSIONS	110kV BIL	125kV BIL	150kV BIL
A	58.07	63.60	75.28
B	41.66	46.78	46.78
C	37.00	39.62	41.00
D	20.00	22.00	24.00
E	18.81	14.01	15.26
F	10.02	11.13	15.30
G	11.25	13.00	14.96
H	25.56	26.46	30.07
I	33.25	38.37	38.37
J	33.87	39.37	51.13
K	39.50	44.62	44.62
L	40.12	45.62	57.38
M	15.25	15.25	15.25
Q (MIN)	40.23	41.50	34.43
Q (MAX)	64.23	65.50	58.43
R	93.31	103.93	115.66





Weight = 2500 lbs.
Uplift = 500 lbs/leg - 10 m sec.

Figure 23

INTERRUPTER LIFE EXPECTANCY CURVE
TYPE FB

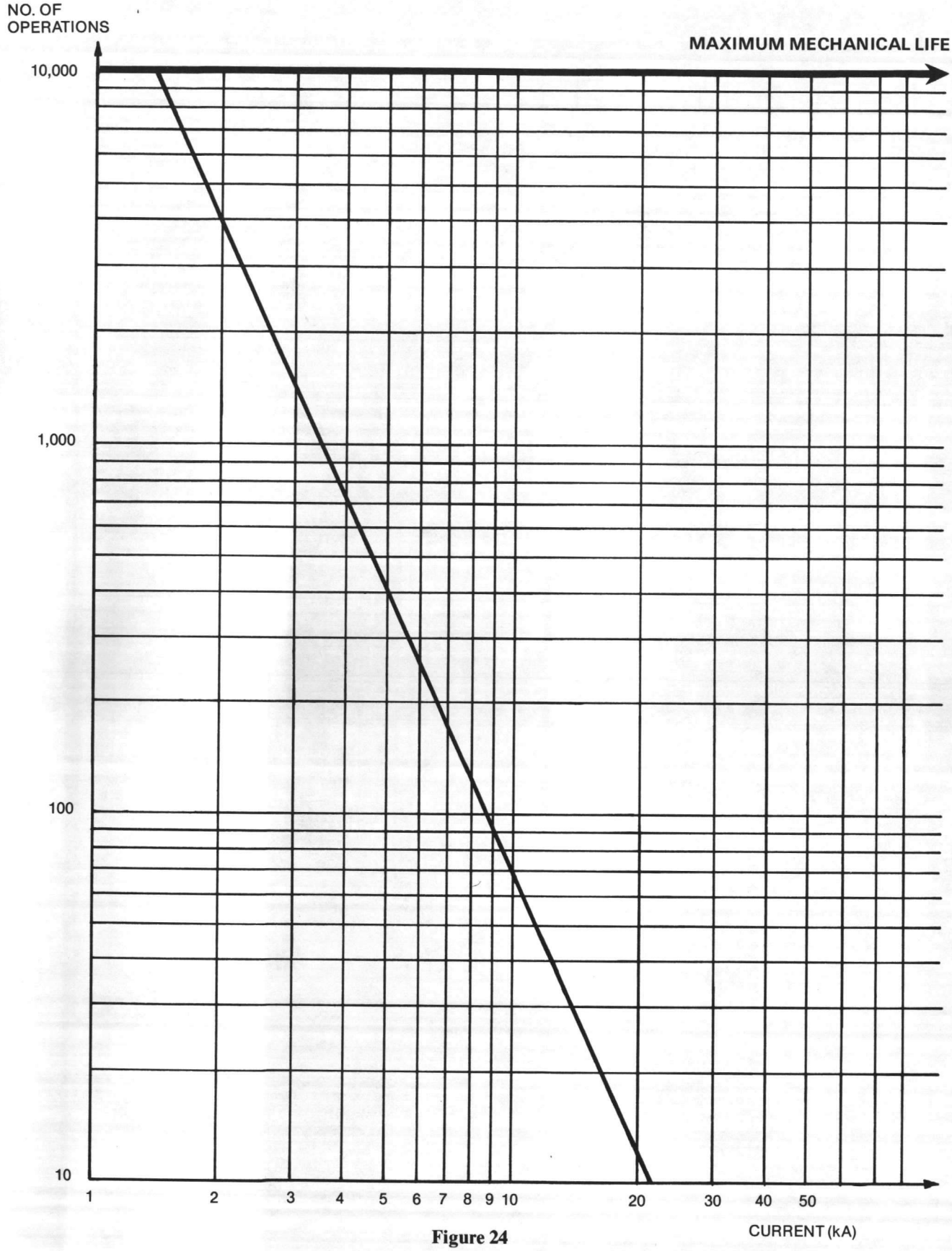
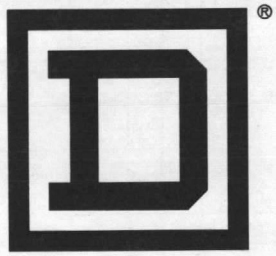


Figure 24



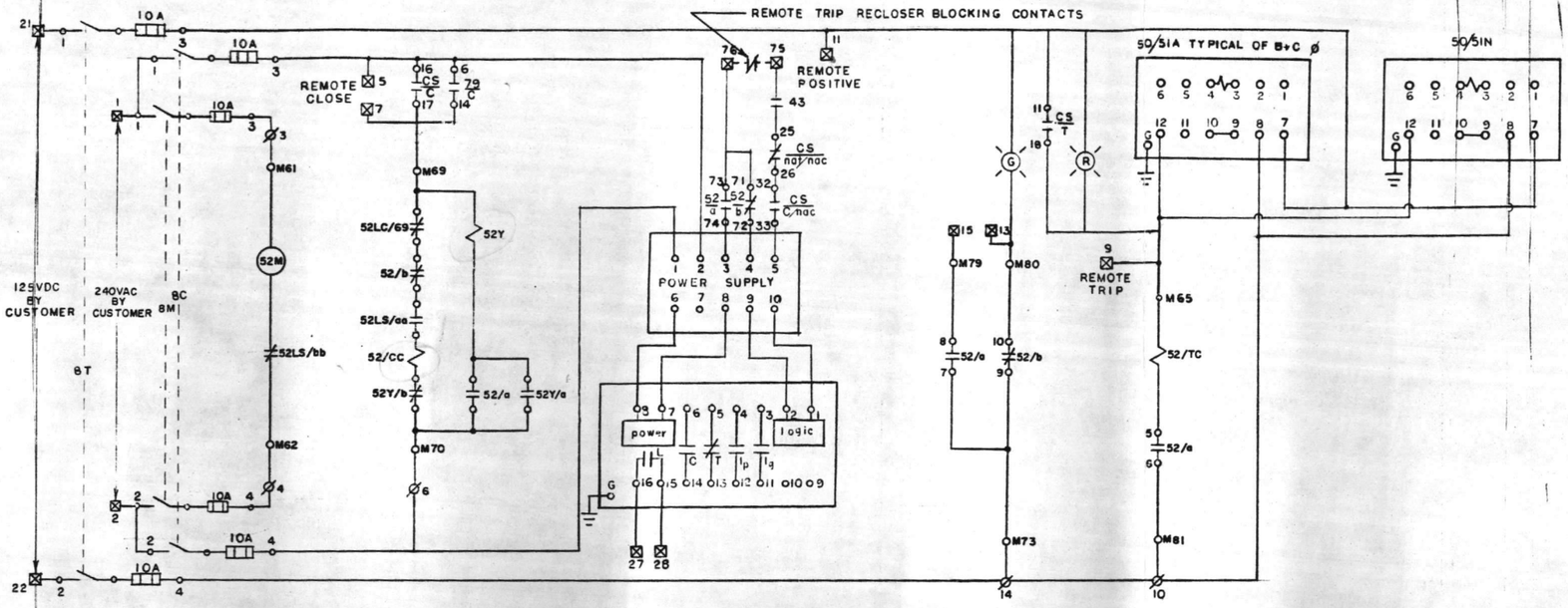
SQUARE D COMPANY

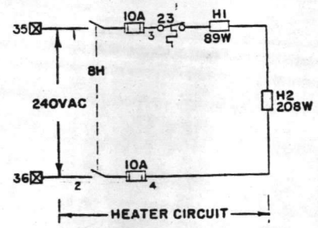
P.O. BOX 558, MIDDLETOWN, OHIO 45042

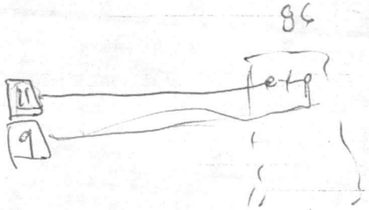
Manual 6060-1

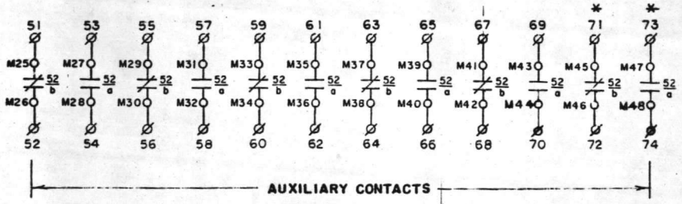
4.5M 9/83 PS

Printed in U.S.A.









* USED IN ABOVE CONTROL CIRCUIT

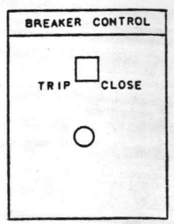
OPERATION OF BREAKER:

1. THE BREAKER WILL NOT CLOSE UNTIL THE SPRINGS ARE CHARGED.
2. CHARGING OF THE CLOSING SPRINGS IS CONTROLLED BY 52LS/bb. WHEN THE SPRINGS ARE DISCHARGED, POWER IS AVAILABLE ON TERMINALS 61 AND 62, THE CLOSING SPRINGS CHARGING MOTOR WILL RUN TO CHARGE THE CLOSING SPRINGS. WHEN THE SPRINGS ARE CHARGED, THE CONTACT 52LS/bb OPENS STOPPING THE MOTOR.
3. THE BREAKER IS ELECTRICALLY CLOSED BY OPERATING THE CLOSING SOLENOID 52CC. THE CLOSING SIGNAL IS APPLIED ACROSS TERMINALS 69 AND 70. THE CLOSING SPRINGS MUST BE CHARGED (CONTACT 52LS/aa CLOSED). CONTACTS 52/b AND 52Y/b PASS CURRENT TO THE CLOSING SOLENOID 52CC. WHEN THE BREAKER CLOSES, CONTACTS 52/b AND 52Y/b CHANGE STATE. CONTACT 52/a ENERGIZES THE ANTI-PUMP RELAY 52Y. CONTACT 52Y/b OPENS, PREVENTING THE CLOSING SOLENOID CIRCUIT. CONTACT 52/a ENERGIZES THE ANTI-PUMP RELAY 52Y. CONTACT 52Y/b OPENS, PREVENTING THE CLOSING SOLENOID FROM BEING RE-ENERGIZED UNTIL 52Y IS DEENERGIZED, AND CONTACT 52Y/a SEALS THE ANTI-PUMP RELAY UNTIL THE CLOSE SIGNAL IS REMOVED FROM TERMINALS 69 AND 70. CONTACT 52LS/aa ALSO OPENS BUT RECLOSES AS SOON AS THE CLOSING SPRINGS ARE RECHARGED. THE ANTI-PUMP RELAY 52Y LIMITS THE BREAKER TO ONE CLOSING OPERATION PER CLOSE SIGNAL APPLIED ACROSS TERMINALS 69 AND 70.
4. THE BREAKER IS ELECTRICALLY TRIPPED BY APPLYING A SIGNAL ACROSS TERMINALS 65 AND 81. IF THE BREAKER IS CLOSED (CONTACT 52/a CLOSED), THE TRIP SOLENOID WILL OPERATE, TRIPPING THE BREAKER. CONTACT 52/a OPENS, DE-ENERGIZING THE TRIP SOLENOID WHEN THE BREAKER IS OPEN.

LEGEND:

52TC	BREAKER TRIP SOLENOID
52/CC	BREAKER CLOSING SOLENOID
52Y	ANTI-PUMP RELAY
52M	CLOSING SPRINGS CHARGING MOTOR
52Y/a	ANTI-PUMP RELAY CONTACT-NORMALLY OPEN
52Y/b	ANTI-PUMP RELAY CONTACT-NORMALLY CLOSED
52LS/aa	CLOSING SPRINGS CHARGED LIMIT SWITCH-OPENS WHEN SPRINGS ARE NOT CHARGED. CLOSED WHEN SPRINGS ARE CHARGED.
52LS/bb	CLOSING SPRINGS CHARGED LIMIT SWITCH-CLOSED WHEN SPRINGS ARE NOT CHARGED. OPEN WHEN SPRINGS ARE CHARGED.
52/a	AUXILIARY SWITCH CONTACTS-OPEN WHEN BREAKER IS IN THE TRIPPED (OPEN) POSITION, CLOSED WHEN BREAKER IS IN THE CLOSED POSITION.
52/b	AUXILIARY SWITCH CONTACTS-CLOSED WHEN BREAKER IS IN THE TRIPPED (OPEN) POSITION, OPEN WHEN BREAKER IS IN THE CLOSED POSITION.
79	RECLOSING RELAY
43	RECLOSER CUT OFF SWITCH
69	MANUAL CLOSING DISCONNECT
52/LC	LATCH CHECKING SWITCH
8T	TRIP CIRCUIT DISCONNECT
8C	CLOSE CIRCUIT DISCONNECT
8M	CHARGING MOTOR CIRCUIT DISCONNET
8H	HEATER CIRCUIT DISCONNECT
M	TERMINAL BLOCK ON BREAKER MECHANISM
ø	ANSI TERMINAL BLOCK
⊠	CUSTOMER TERMINAL BLOCK

ELECTROSWITCH
CAT. NO. 2444D



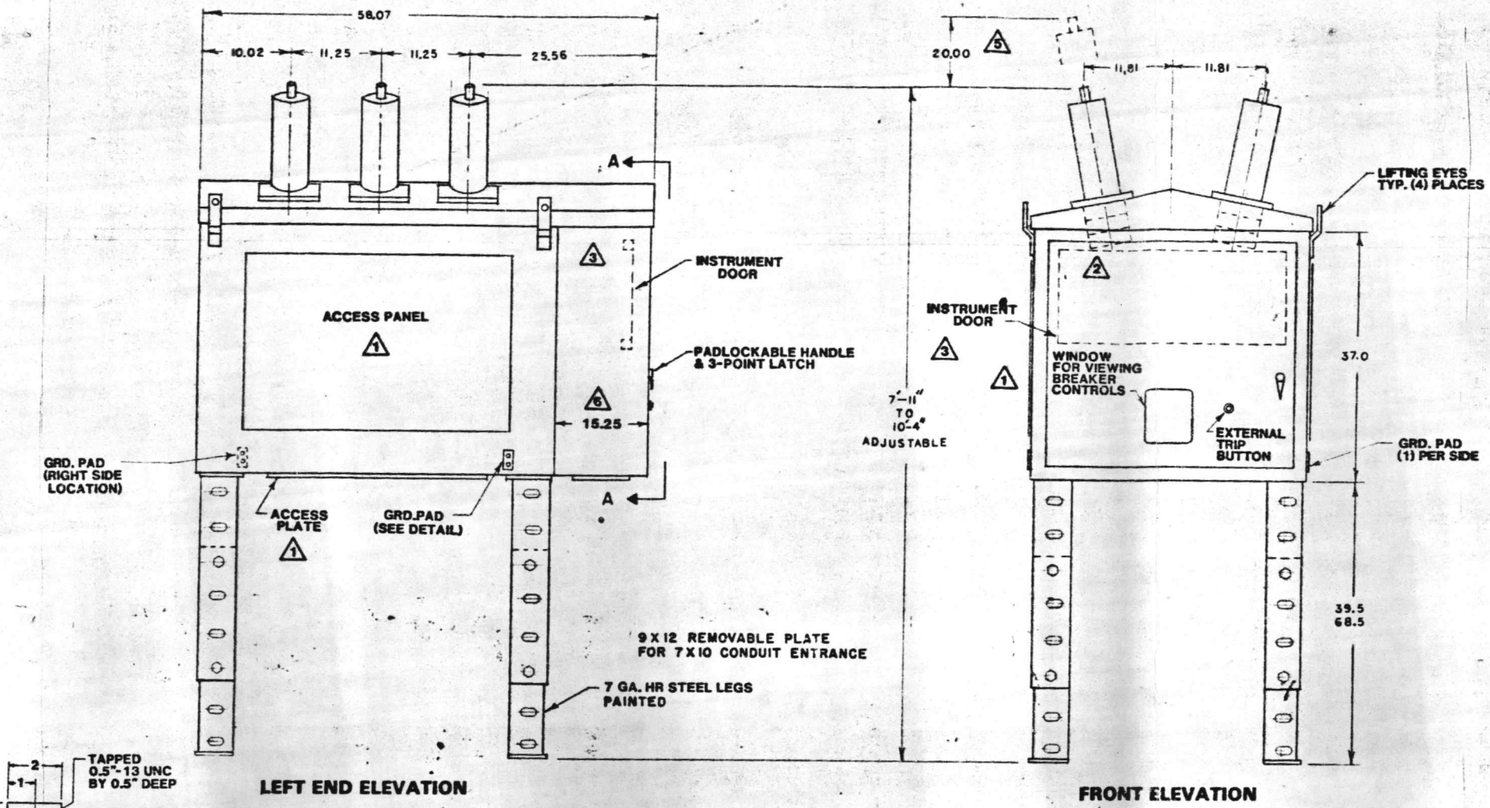
DECK	CONTACTS	TRIP	POSITIONS nor	nac	CLOSE
1	11 — 18	X			
	16 — 17				X
2	21 — 22		X	X	
	25 — 26		X	X	
3	32 — 33			X	X
	36 — 37			X	X

NOTES:

BREAKER SHOWN IN OPEN POSITION, CLOSING SPRINGS DISCHARGED.

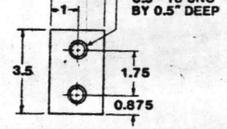
No.	KEY	REVISIONS	By	DATE
1		REVISED PER ENGINEERING	MF	10-18-85

JOB TITLE: CAMP LEJEUNE
LOCATION: CAMP LEJEUNE MARINE CORPS BASE, NC
ARCHITECT:
ENGINEER: DESIGN BRANCH, PUBLIC WORKS DIV.
ELEC. CONTRACTOR
FIELD OFFICE: WILMINGTON, NC
CUSTOMER: GRAYBAR ELECTRIC
CUST. ORDER No. 325WP0916
FACTORY ORDER No. 17-14272A
DRAWINGS FOR APPROVAL — FABRICATION WILL NOT BE STARTED UNTIL APPROVED DRAWINGS ARE RETURNED
DRAWINGS FOR RECORD — FABRICATION HAS BEEN STARTED. ANY CHANGES TO LAYOUT AS SHOWN MAY RESULT IN DELAY AND/OR ADDITIONAL CHARGES
DRAWN: MF
CHECKED: RC
SCALE: NTS
DATE: 10-3-85
SQUARE D COMPANY
POWER EQUIPMENT GROUP
SMYRNA, TENNESSEE
DWG. No. D-17-14272-SFBI-03
REV. 1

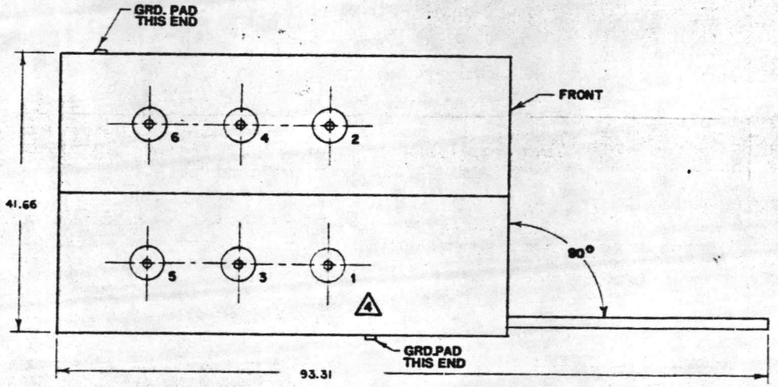


LEFT END ELEVATION

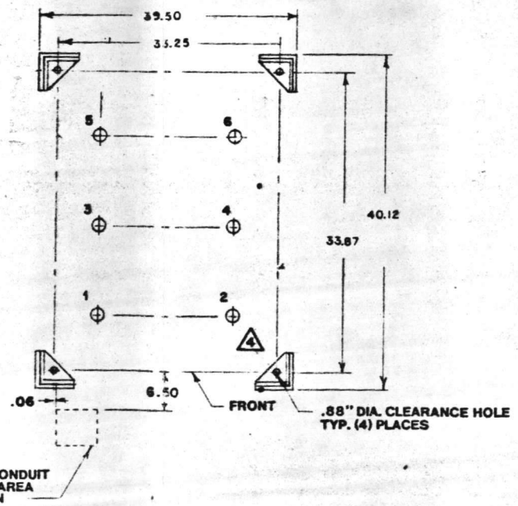
FRONT ELEVATION



GROUNDING PAD DETAIL



TOP VIEW



NOTES: △

1. REMOVABLE COVERS ON BOTH SIDES & BOTTOM Ⓑ
2. THERE ARE PROVISIONS FOR MOUNTING UP TO 3-CT'S PER BUSHING, 6 PER PHASE.
3. PROTECTIVE RELAYS MOUNTED ON THIS INTERIOR DOOR WHEN REQUIRED.
4. BUSHING LOCATION IDENTIFICATION NUMBERS, (SEE 3-LINE DIAGRAM).
5. CLEARANCE REQUIRED ABOVE UNIT TO REMOVE BUSHING.
6. INSTRUMENT COMPARTMENT IS 15.25 DEEP AND ISOLATED FROM HV COMPARTMENT WITH STEEL BARRIER.

BREAKER WEIGHT WITH ENCLOSURE - 1800 LBS.
UPLIFT PER LEG - 550 LBS.
CAT. # FBS 112116

NOTE: ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED.

SD6060-0009

ELEVATIONS

TYPE FB SF6 FLUARC SUBSTATION BREAKER RATED: 15.5 KV, 110 KV BIL, 1200 A,

No.	KEY	REVISIONS	By	DATE
2	B	REVISED AS NOTED	MF	12-12-85
1		REDRAWN	MF	10-18-85

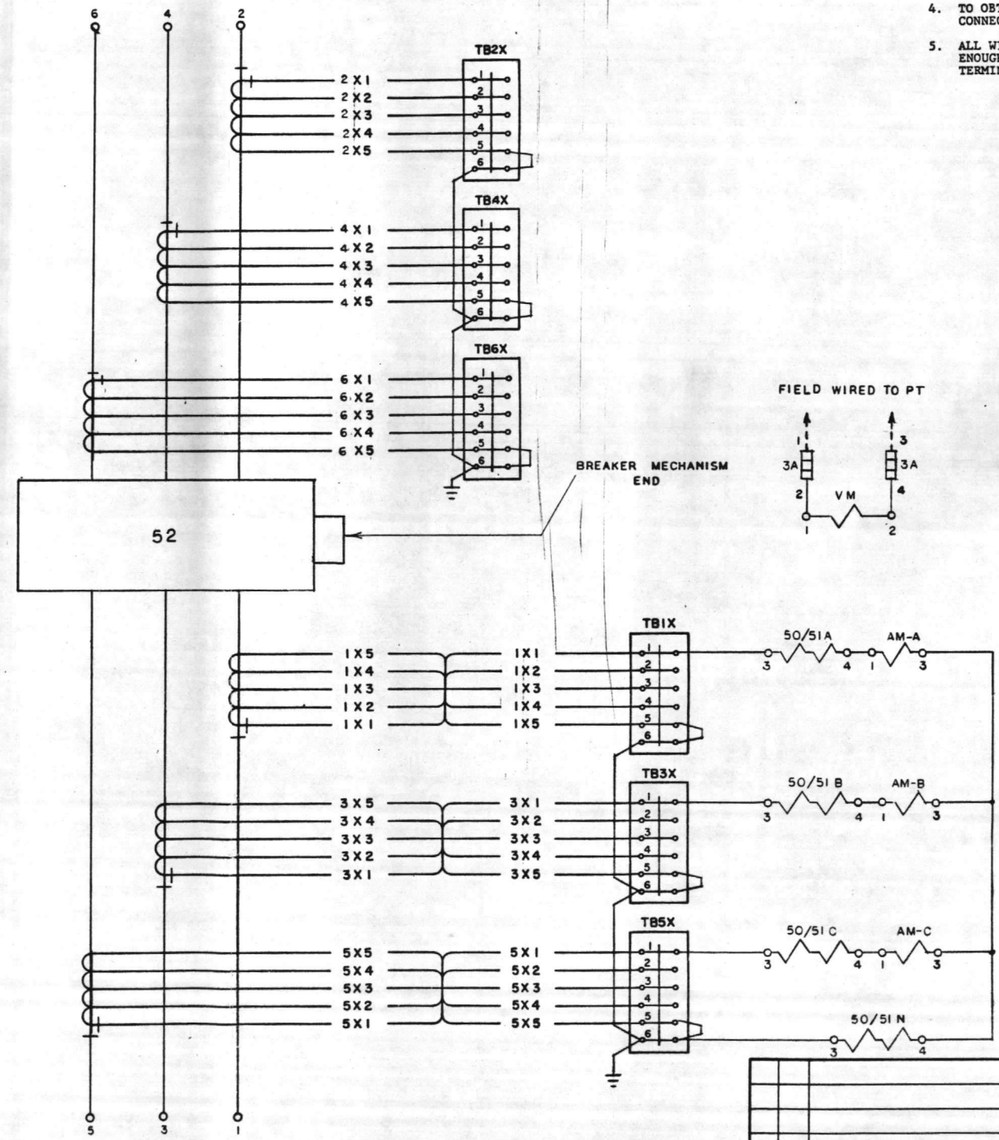
JOB TITLE: CAMP LEJEUNE
LOCATION: CAMP LEJEUNE MARINE CORPS BASE, N.C.
ARCHITECT:
ENGINEER: DESIGN BRANCH, PUBLIC WORKS DIV.
ELEC. CONTRACTOR
☒ FIELD OFFICE: WILMINGTON, N.C.
CUSTOMER: GRAYBAR ELECTRIC
CUST. ORDER No. 325WP0916
☒ FACTORY ORDER No. 17-14272A
DRAWN: MF
CHECKED:
SCALE: NTS
DATE: 10-4-85
☐ DRAWINGS FOR APPROVAL — FABRICATION WILL NOT BE STARTED UNTIL APPROVED DRAWINGS ARE RETURNED.
☐ DRAWINGS FOR RECORD — FABRICATION HAS BEEN STARTED. ANY CHANGES TO LAYOUT AS SHOWN MAY RESULT IN DELAY AND OR ADDITIONAL CHARGES.

SQUARE D COMPANY
POWER EQUIPMENT GROUP
SMYRNA, TENNESSEE

DWG. No. D-17-14272-SFBI-01 REV 2

NOTES:

1. ALL TERMINAL BLOCKS FOR M.R.C.T. HAVE SHORTING PROVISIONS.
2. TB1X, TB3X, TB5X, ETC. TO HAVE SHORTING SCREWS INSTALLED FOR SHIPMENT.
3. JUMPER WIRE SHOWN ON TERMINAL 6 OF EACH SHORTING TB FOR GROUND CONNECTION MUST BE LONG ENOUGH TO REACH ANY TERMINAL OF THAT BLOCK.
4. TO OBTAIN OTHER CT RATIOS, SEE TERMINAL CONNECTIONS ON CT NAMEPLATE DRAWING -05.
5. ALL WIRES C1, C2, C3, C01, ETC. TO BE CUT LONG ENOUGH TO REACH ANY TERMINAL ON THE ASSOCIATED TERMINAL BLOCK.



ALL CT's ARE 1200:5A MULTI RATIO
C200 RELAYING ACCURACY

No.	KEY	REVISIONS	By	DATE
1		REVISED PER ENGINEERING	mf	10/17/85

JOB TITLE: CAMP LEJEUNE
LOCATION: CAMP LEJEUNE MARINE CORPS BASE, NC
ARCHITECT:
ENGINEER: DESIGN BRANCH, PUBLIC WORKS DIV.
ELEC. CONTRACTOR
☒ FIELD OFFICE: WILMINGTON, NC
CUSTOMER: GRAYBAR ELECTRIC
CUST. ORDER No. 325WP0916
☒ FACTORY ORDER No. 17-14272A
☐ DRAWINGS FOR APPROVAL — FABRICATION WILL NOT BE STARTED UNTIL APPROVED DRAWINGS ARE RETURNED
DRAWINGS FOR RECORD ☐ — FABRICATION HAS BEEN STARTED. ANY CHANGES TO LAYOUT AS SHOWN MAY RESULT IN DELAY AND/OR ADDITIONAL CHARGES.
DRAWN: mf
CHECKED: RC
SCALE: NTS
DATE: 10-4-85
SQUARE D COMPANY
POWER EQUIPMENT GROUP
SMYRNA, TENNESSEE
DWG. No. D-17-14272-SFBI-02
REV. 1

I-T-E SOLID-STATE RECLOSING RELAYS
INSTRUCTIONS

Type ITE-79M, Multiple Shot Reclosing Relay

Type ITE-79M Reclosing Relay

BBC BROWN BOVERI
Brown Boveri Electric, Inc.
Manufacturer of I-T-E Electrical Power Equipment

INSTRUCTIONS FOR CIRCUIT-SHIELD SOLID-STATE RELAYS
DRAWOUT SEMI-FLUSH MOUNTED

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the CIRCUIT-SHIELD solid-state reclosing relay.

The CIRCUIT-SHIELD relay is housed in a semi-flush drawout relay case suitable for conventional panel mounting.

All connections to the relay are made at clearly numbered terminals located on the rear of the case.

The controls for the relay are located on the front panel behind a removable clear plexiglass cover.

A LOCKOUT indicator is also mounted on the front panel. This indicator uses a solid-state light emitting diode (LED) as its source of light. The Type ITE-79M three shot reclosing relay is designed for operation from 24Vdc control power. The relay is adapted to the system voltage by a power supply module which is housed in a small surface mounted case.

PRECAUTIONS

The following precautions should be taken when applying solid-state relays:

1. Incorrect wiring may result in damage to solid-state relays. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized. Be sure control power is applied in the correct polarity before applying control power.

2. Apply only the rated control voltage marked on the relay front panel or on the power supply nameplate.

3. Do not apply high voltage tests to solid-state relays. If a control wiring insulation test is required, bond all terminals together and disconnect ground wire before applying test voltage.

4. The entire circuit assembly of the CIRCUIT-SHIELD reclosing relay is removable. This board should insert smoothly. Do not use force.

5. Note that removal of the tap block pin is equivalent to setting the lowest tap.

Caution: Increasing the setting of the "No. of Reclosers" tap block is a command for additional automatic reclosers. Move the circuit breaker control switch to the trip position and then release before increasing this tap block setting; otherwise, the breaker will close.

6. Follow test instructions to verify that relay is in proper working order. If a relay is found to be defective, return to factory for repair. Immediate replacement of the removable element can be made available from the factory; identify by catalog number. We suggest that a complete spare relay be ordered as a replacement, and the damaged unit repaired and retained as a spare. By specifying the relay catalog number, a booklet describing the theory of operation and a schematic may be obtained from your local Sales engineer should you desire to repair or recalibrate the relay.

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the CIRCUIT-SHIELD relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify the nearest Brown Boveri Electric Sales Office. Use normal care in handling to avoid mechanical damage. The CIRCUIT-SHIELD system has no vital moving parts and if kept reasonably clean and dry, has no practical limit to its operating life.

2. INSTALLATION

Mounting

The outline dimensions and panel drilling for both the relay and the power supply module are shown in Figure 1.

Connections

Connection diagrams are shown on page 5.

All CIRCUIT-SHIELD relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G" and is located as shown in Fig. 1 below. In all applications this terminal should be wired to ground.

As shipped from the factory, the ITE-79M relay, catalog number 248C3_03, is wired so that the Instantaneous Cutout contacts OPEN when the proper number of trip operations (as set on front panel) occur and CLOSE when the relay RESETS or reaches LOCKOUT. However, the user may easily modify the relay so that the Instantaneous Cutout contact will remain OPEN on LOCKOUT, and CLOSE only on RESET. This modification is made by removing the relay from its case and clipping off the wire jumper which is in parallel with diode D37.

3. SETTINGS

NUMBER OF RECLOSURES

This tap pin is used to select 1, 2, or 3 reclosing operations.

Caution: Increasing the setting of the "No. of Reclosers" tap block is a command for additional automatic reclosers. Move the circuit breaker control switch to the trip position and then release before increasing this tap block setting; otherwise, the breaker will close.

OPEN INTERVAL TIME

These three dials are used to set individually the open interval time in seconds between the occurrence of a trip and the reclosing operation. The timing for each of these open intervals starts at zero seconds when its corresponding trip occurs. Note that the FIRST open interval selector dial includes an Instantaneous (I) position: to select (I), turn dial fully counterclockwise until switch clicks into place.

RESET TIME

This dial is used to set the time required for the breaker to remain closed to consider the reclosure as successful. The timing for this function starts from zero seconds each time the breaker is reclosed.

NUMBER OF INSTANTANEOUS TRIPS

This tap pin is used to select the number of trip operations which can occur before the reclosing relay opens the trip circuit of an external instantaneous overcurrent relay (by means of the Instantaneous Cutout contact).

APPLICATION DATA

The CIRCUIT-SHIELD Multi-Shot Reclosing Relay is used to automatically reclose a circuit breaker one or more times after it has been tripped by its protective relay. These relays are used to protect lines which are subject to temporary faults such as those caused by lightning, or tree branches which burn free leaving the line clear.

The reclosing relay provides for the selection of a desired number of reclosures. An adjustable time delay is also provided before each reclosure signal to allow line conditions to stabilize.

A successful reclose is determined by a preset time delay initiated by the reclosing relay each time the breaker recloses. If the breaker remains closed for this time period, the reclosing resets to reinstitute the desired number of reclosures.

If after the preset number of reclosures the breaker trips before the reset time elapses, the reclosing signal ceases and the relay indicates lockout.

The CIRCUIT-SHIELD reclosing relay uses latching reed relays to retain the reclosing program step during an interruption of control power. The relay's program continues when control power is restored.

The relay has a trip count circuit operated by a circuit breaker auxiliary contact (52/b) which closes when the breaker opens (trips). In addition, the relay has a close count circuit operated by a circuit breaker auxiliary contact (52/a) which closes when the breaker closes.

Furthermore, the trip count and close count circuits are interlocked so that a close must occur (indicated by the 52/a) contact) before a subsequent trip can be counted.

The relay also includes a reclose timing circuit operated by the trip count circuit and reset timing circuit operated by the close count circuit.

The CIRCUIT-SHIELD reclosing relay provides the following output contacts:

Close Contact (C) which closes on a trip count after a preset reclose delay.

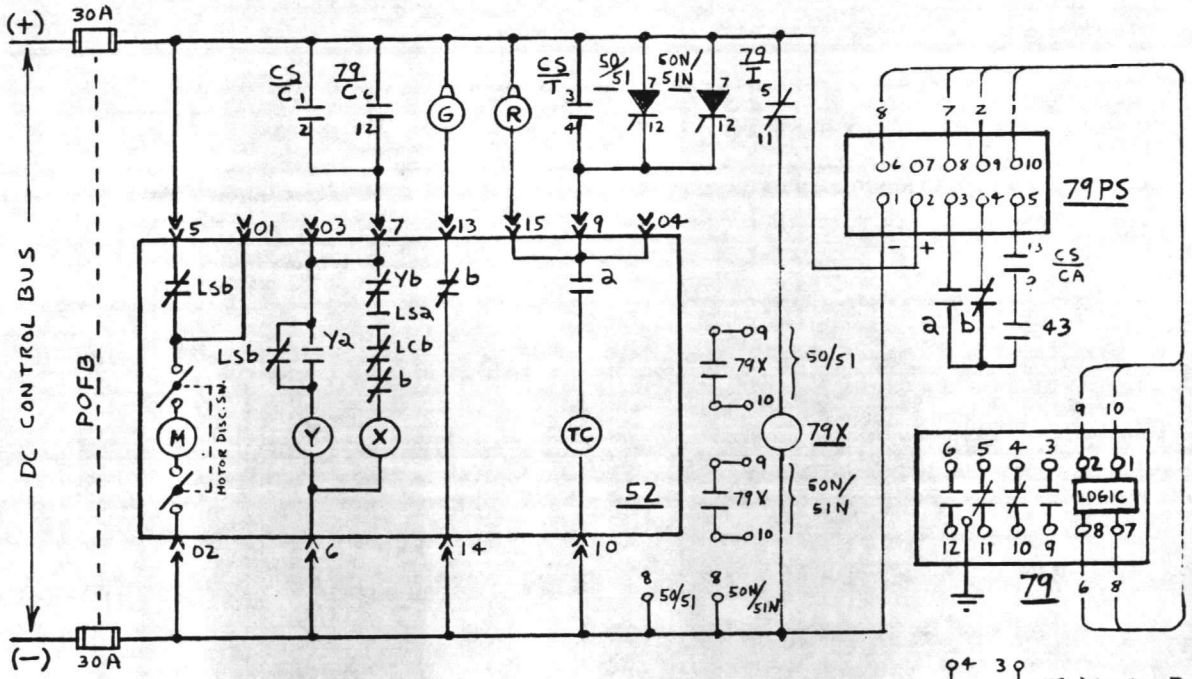
Instantaneous Cutout Contacts (I) which open on the selected trip count and close on reset or lockout. (A simple modification may be made to the relay circuitry so that the (I) contacts remain open on lockout. See Connections section, page 3.)

Tap Changer Cutout Contact (T) which opens on the first trip count and closes on reset or lockout.

Lockout Indication Contact (L) which closes on lockout and opens on reset or when (52/b) opens.

Relay Timing Ranges (seconds)

Catalog Number	Open Interval Times #1	#2	#3	Reset Time
208A3601	0-15	2-30	4-60	2-30
248C3603	0-15	2-30	4-60	2-30
248E3903	0-60	2-60	2-60	4-120



Notes:

1. CB charging motor is shown connected to DC control bus; alternate connection to AC control bus.

2. CIRCUIT SHIELD O.C. phase and ground relays with inst. cutout are shown. Where only phase inst. cutout is required, 79X is omitted and 79/I is connected directly across term 9 & 10 of device 50/51. When tap changer cutout is not used 79/T can be used for ground inst. cutout on the first trip by connecting the 79/T contact directly across terminals 9 and 10 of device 50N/51N.

3. Where type IAC or CO relays are used 79X is omitted. If inst. cutout is required, use 79/I in series with inst. O.C. contacts.

4. When inst. O.C. cutout is required, remove link across contacts 9 & 10 of CIRCUIT SHIELD O.C. relays.

5. The ITE-79M relay is available with 2 inst. cutout contacts to eliminate need for 79X relay. See page 5.

LEGEND

- 52 - Circuit Breaker
- 43 - Cutout Switch
- 50/51 - Ckt. Shield Phase O.C. Relay
- 50N/51N - Ckt. Shield Grd. O.C. Relay
- 79 - I-T-E Solid State Auto-Reclosing Relay
- 79/c - Close Contact
- 79/I - Inst. O.C. Cutout Contact
- 79/T - Tap Changer Cutout Contact
- 79/L - Lockout Contact, Closes on Lockout,
- 79PS - Power Supply For Dev. 79
- 79X - Aux. Relay, See Note 2 on Schematic Diagram
- CS - Control Switch

CS

PLAN VIEW HANDLE END SPRING RETURN	POSITIONS FRONT VIEW			
	NO TRIP	T-NORM-C		CLOSE
1-2				X
3-4	X			
5-6	X			X
7-8				X
9-10		X	X	
11-12				
13-14			X	X
15-16			X	X

CONTROL SWITCH
I-T-E TYPE C77
CAT. NO. C77-4000-1CC1-0002

826263-004

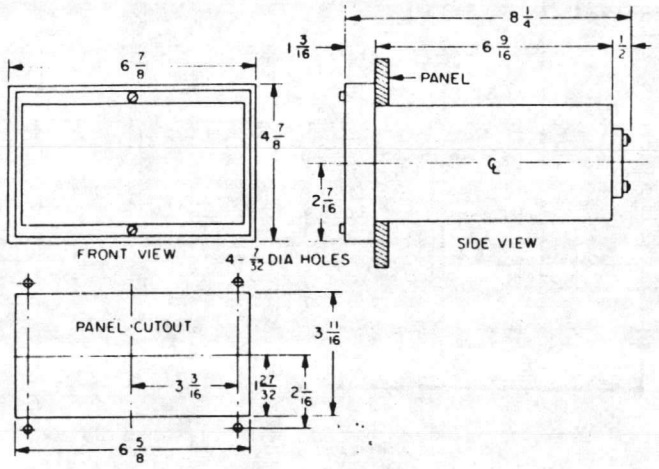
Figure 3: Typical Circuit Breaker Reclosing Scheme

Figure 1

CASE DIMENSIONS

Semi-Flush Mounted Case

DRAWOUT-MOUNTED RELAY—OUTLINE and DRILLING



Power Supply Module
Type ITE-79PS
Surface-Mounted Case

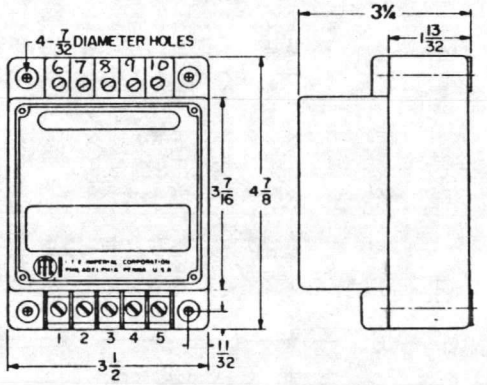
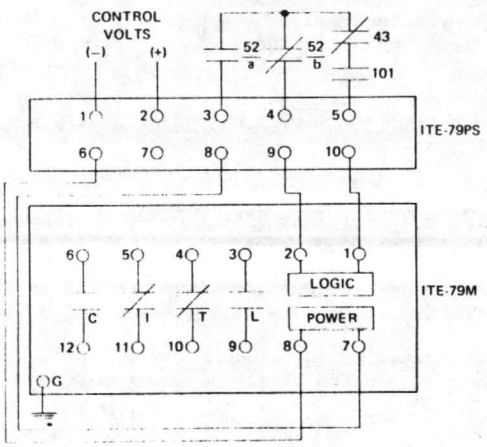


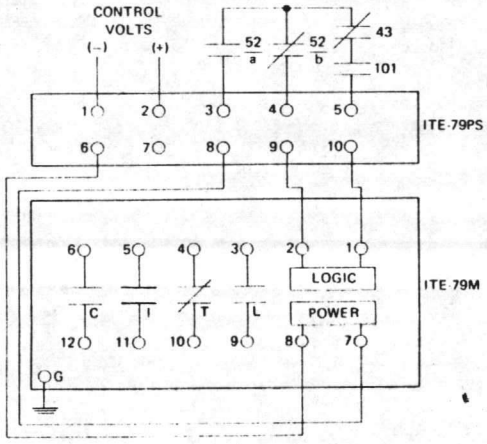
Figure 2

CONNECTION DIAGRAMS

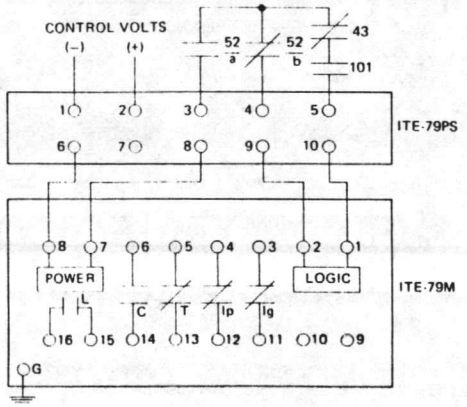
12D208B



12D208C



16D248B



Catalog Number	Applicable Diagram
208A3601	12D208B
208A3604	12D208C
248C3603	16D248B
248E3903	16D248B

LEGEND

43	– Recloser Cut-Out Switch
101	– Control Switch Contact, Closed Only After Close
I_g	– Instantaneous Cutout Contact, Ground
I_p	– Instantaneous Cutout Contact, Phase
T	– Tap Changer Cutout Contact
C	– Close Contact
L	– Lockout Indication Contact

RATINGS

Operating Temperature - -20^{o} to $+75^{o}C$

Output Circuits
Contact rating, each contact at 125Vdc
30 amperes, closing
5 amperes, continuous
1 ampere, opening resistive
0.3 ampere, opening inductive

Power Supply Module
Models available for:
48Vdc 120Vac 50/60 Hz.
125Vdc 240Vac 50/60 Hz.

Timing Tolerance
Open Interval Times
±10% or ±5 seconds whichever is greater.
Reset Time
±10% or ±10 seconds whichever is greater.

Tolerance is based on dial markings. If timing is set by test, repeatability will be excellent.

RELAY CONNECTIONS

The type ITE-79M reclosing relay is designed for operation from 24Vdc control power. The relay is adapted to the system voltage by a type 79PS Power Supply module which provides a regulated 24Vdc output.

The required power supply and control contacts wiring for the CIRCUIT-SHIELD relay are shown in Figure 2. As shown, the input control contacts should include the following:

A circuit breaker auxiliary contact (52/b) which closes when the breaker opens (trips).

A circuit breaker auxiliary contact (52/a) which closes when the breaker closes.

A circuit breaker control switch contact (101) which closes only in the after-close position of the switch.

A recloser cutout switch (43) for a separate manual cutout of the reclosing function.

Figure (3) shows typical connections of one of the CIRCUIT-SHIELD reclosing relays in a typical circuit breaker control scheme with phase and ground overcurrent relays. Note that the contacts 79/c (terminals 6 and 12) and 79/I (terminals 5 and 11) are the output contacts of the reclosing relay (79). Also note that the terminals (9) and (10) wired to the 79X contacts are the instantaneous cutout terminals of a CIRCUIT-SHIELD solid-state overcurrent phase and ground relays.

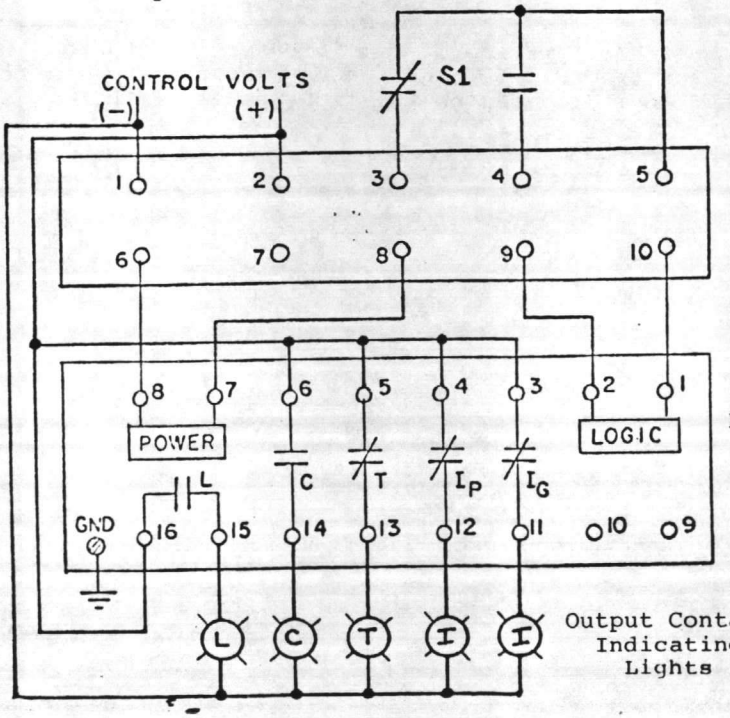


Figure 4: Typical Test Connections

Legend

L = lockout
C = reclose
T = tap changer cutout
I = instantaneous cutout

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the CIRCUIT-SHIELD relay.

Follow test instructions to verify that relay is in proper working order. If a relay is found to be defective, return to factory for repair. Immediate replacement of the removable element can be made available from the factory; identify by catalog number. We suggest that a complete spare relay be ordered as a replacement, and the damaged unit repaired and retained as a spare. By specifying the relay catalog number, a schematic may be obtained from your local sales engineer should you desire to repair or recalibrate the relay.

The output relays may be ordered from the factory. When ordering, state the type relay, catalog number, control voltage and serial number.

Also available from the factory are circuit card extenders. The 18 point extender, cat. 200X0018 is required for this relay.

Drawout circuit boards of the same catalog number are interchangeable. The board is removed by using the metal pull knobs on the front panel. The relay is identified by a catalog number on the front panel and a serial number on the under side of the circuit board.

2. HIGH POTENTIAL TESTS

Do not apply high voltage tests to solid-state relay circuits. If a control wiring insulation test is required, bond all terminals together and disconnect grounding wire before applying test voltage.

3. ACCEPTANCE TESTS

The operation of the reclosing relay may be checked by simulating breaker operation. Refer to the typical test connections shown in Figure 4. Manually operate toggle switch S1 to simulate a breaker trip. When the reclose lamp is lighted by the relay, return S1 to the "breaker closed" position. The relay may be stepped through its sequence to lockout, or allowed to reset, as desired by the tester.

NORM BUTTON

The NORMALIZE button, when depressed for a period of time greater than that set on the RESET TIME control, will reset the relay's counting program back to the reset (normal) condition. This button is located on the front panel of the relay.

BBC BROWN BOVERI Brown Boveri Electric, Inc.
Manufacturer of Electrical Power Equipment
Protective Relay Operation
207 Witmer Rd., Horsham, PA 19044, (215) 674-5900

IB 18.3.7-2 (2/77)
(replaces IB 18.3.7-2 for type ITE-79M)

CLNC MAIN
SWITCHING STATION

SQUARE D COMPANY

POWER EQUIPMENT DIVISION

JOB NAME:	CAMP LEJEUNE
LOCATION:	CAMP LEJEUNE MARINE CORPS BASE N.C.
EQUIPMENT:	15 KV, 1200A, 110 KV BIL SUBSTATION BREAKER QUANTITY OF BREAKERS : 7
CUSTOMER:	GRAYBAR ELECTRIC
CUSTOMER ORDER #	325WP0916
ENGINEER:	DESIGN BRANCH, PUBLIC WORKS DIV.
SQUARE D FIELD OFFICE:	WILMINGTON, N.C.
FACTORY ORDER:	17-14272 A
HQS. ENG.:	
DATE:	October 2, 1985

DRAWING INDEX

A17-14272-SFB1-00	TITLE PAGE
	DRAWING INDEX
	NOTES
	BILL OF MATERIALS
D17-14272-SFB1-01	ELEVATION VIEWS
D17-14272-SFB1-02	C. T. CONTROL SCHEMATIC
D17-14272SFB1-03	BREAKER CONTROL SCHEMATIC
A17-14272-SFB1-04	CIRCUIT BREAKER NAMEPLATE
A17-14272-SFB1-05	CURRENT TRANSFORMER NAMEPLATE
A17-14272-SFB1-06	BUSHING DRAWING
A17-14274-SFB1-07	C. T. EXCITATION CURVES
A17-14272-SFB1-08	O.C. TIME CURRENT CHARACTERISTIC CURVES

MANUFACTURING SPECIFICATIONS:

1.0 USER SYSTEM

1.1 Graybar Electric system nominally rated 12.47 kV, 60 Hz, 3 phase, four wire, wye connected

2.0 STANDARDS

2.1 The Fluarc SF6 unit circuit breaker supplied shall be manufactured in accordance with designated portions of American National Standard Institute (ANSI) and National Electrical Manufacturers Association (NEMA) Standards.

3.0 BREAKER RATINGS

3.1 Fluarc SF6 substation breaker catalog #FBS1121116 to be supplied on this order is rated as shown on the circuit breaker nameplate, drawing A17-14272-SFB1-04.

4.0 BUSHINGS

4.1 Bushings rated 1200 amperes continuous at 65 degree C. rise over 40 degree C. ambient.

4.2 Terminals to fit bushing top 1 1/8-12 threaded stud to be supplied by Square D

4.3 The enclosure bushings shall be in accordance with ANSI 21-1976/24-1977 and rated 110kV BIL full wave.

5.0 CURRENT TRANSFORMERS

5.1 Current transformers shall conform with ANSI C57.13-1978.

5.2 All CT wiring shall be with type SIS #12 AWG wire. Wires shall be terminated with ring terminals.

5.3 All taps on each multi ratio current transformer on each bushing shall be wired to a shorting terminal block located in the instrument compartment.

5.4 Stainless steel nameplate showing current transformer tap connections, ratings and ratios shall be supplied as shown on drawing A17-14272-SFB1-05

5.5 CT's rated C200 on 1200:5A full winding.

6.0 MOUNTING

6.1 Customer to install pad and 0.75 Dia. anchor bolts to match Square D standard base mounting dimensions.

7.0 CONTROLS

7.1 Circuit breaker controls to be rated as shown on circuit breaker nameplate as shown on drawing A17-14272-SFB1-04

7.2 Control voltage sources by Customer 240 VAC, 125 VDC

7.3 12 auxiliary switches to be wired out to terminal blocks.

7.4 The circuit breaker control wiring shall be in accordance with ANSI C37.11-1979.

7.5 Control Wiring to customer remote circuits to be terminated on individual terminal blocks, Square D type 9080-KCB-1 rated 600 volt, 30 amp. which accepts up to #10 control wire.

7.5.1 Terminal blocks to be identified.

7.6 Space heaters rated 240 VAC to be supplied. Heater shall be controlled by thermostat. Provided complete with safety gaurd.

7.7 All control wiring to be type SIS # 14AWG minimum except CT circuits, See paragraph 5.2

8.0 NAMEPLATES

8.1 Square D nameplates shall give the guaranteed ratings of the circuit breaker, including the interrupting rating and all information called for by ANSI C37.04-1982.

9.0 GROUNDING

9.1 All non-energized metal parts shall be bonded so that one ground connection to the frame will ground all normally dead parts.

10.0 PAINTING

10.1 The cubicle shall be cleaned, zinc phosphatized, non-chrome rinsed for corrosion resistance and sprayed with an enamel base coat, 1 mils thick. The finish coat shall be ANSI 70 2-part urethane paint, 1 mils thick. Total paint thickness is 2 mils.

10.2 The roof is stainless steel painted as above.

11.0 LIFTING

11.1 Cubicle shall have provisions for lifting.

11.2 Weight of total assembly is approximately 1800 lbs.

12.0 TOOLS

12.1 One handle for manually charging closing spring and slow closing main contact will be supplied.

12.2 Handle to be stored in instrument compartment. Instrument compartment to have Padlock provisions

13.0 DRAWINGS

13.1 Square D shall submit for record 11 complete sets of drawings.

14.0 INSTRUCTION BOOKS

14.1 Square D Company shall supply 11 (extra) instruction books. Reduced copies of drawings may be included in instruction manuals.

14.2 One additional instruction book shall be shipped with each circuit breaker.

15.0 STORAGE

15.1 Square D to make heater terminals available for electrical connection during storage to protect internal parts against moisture.

16.0 VENDORS

16.1
A. Square D Company
B. Electromagnetic Industries
C. Brown Boveri
D. Anderson
E. Electroswitch
F. General Electric
G. Superior

ITEM	QTY		SOURCE	
A	1	52	A	Fluarc SF6 substation circuit breaker, type FB rated 15 kV, 1200 amperes continuous, 16.5 KA interrupting, Cat. #FBS1121116.
B	6	BUSHING	B	Enclosure current transformer bushing (see notes 4.0), Cat. #44080-099-01.
C	4	8C,8H,8M,8T	G	Fusible control power disconnect, 2 pole type, Cat. #21330F.
D	1	CS	E	Breaker control switch, Cat. #2444D.
E	1	RIL	A	Indicating lamp, 125VDC, resistor type with red color cap and nameplate marked "CLOSED", Cat. #9001-KP38-R6.
F	1	GIL	A	Indicating lamp, 125 VDC, resistor type with green color cap and nameplate marked "OPEN" Cat. #9001-KP38G6.
G	6	CT	B	Bushing current transformer (see note 5.0) 1200:5 multi-ratio, C 200 relaying accuracy, rated 15 kV, 110 kV BIL as installed on bushings, Cat. #311-122.
H	6	TB	F	Six circuit shorting terminal block, cat. #EB27A06S.
I	3	50/51	C	Type ITE-51E overcurrent relay, extremely inverse time characteristic, 4-12 amp tap, with 8-240 instantaneous trip, cat. #223S3341.
J	1	50/51G	C	Type ITE-51E overcurrent relay, extremely inverse time characteristic, 5-2 amp tap, with 1-40 instantaneous trip, cat. #223S3141.
K	1	79	C	Type ITE-79M reclosing relay, 4-60 timing, 2-30 closing and reset, cat. #248C3603.
L	1	43	A	Recloser cut-off switch, DPST, Cat. #7402K4. With nameplate marked "ON-OFF".
M	3	AM	A	A C ammeter, 0-5 amp rating Cat. # EA1AF1200.

ITEM	QTY		SOURCE	
N	6	STUD CONNECTOR	D	Bushing stud connector, sized for 500 MCM stranded copper cable, Cat.# DSC-11050-12-TP.
O	1	VM	A	AC voltmeter rated 11% accuracy with 0-18 KV scale Cat.# 2830-1041-PZXE.
P	1	POWER SUPPLY	C	240 VAC Power supply module for reclosing relay, Cat.# 79PS240M.

Items Q thru S will be shipped as spare parts items. The quantities listed in column # 2 is the total number to be supplied.

Q	3		Bottle rated 1200 ampere, 15 KV, part # 758962B.
R	3		Enclosure current transformer bushing, Cat. # 44080-099-01.
S	3		Bushing current transformer, 1200:5A multi-ratio, C200 relaying accuracy, rated 15 KV, 110 KV BIL as installed on bushings, Cat # 311-122.

FLUARC SF_6 SUBSTATION CIRCUIT BREAKER

CAT. NO. FBS1121116 S/N [ ] F/O 17-14272A
CUST. P. O. NO. 325WP0916 CONTROL DIAG. NO. 17-14272-SFBI-03
INSTRUC. BOOK NO. 6060-1 YEAR OF MANUFACTURE 1985

MAX. VOLTAGE 15.5 KV RMS FULL WAVE BIL 110 KV PEAK
MIN. VOLTAGE 10 KV RMS ONE MIN. WITHSTAND 50 KV
CONTINUOUS CURRENT 1200 AMPS, RMS FREQUENCY 60 HZ.
MAX. INTERRUPTING CURRENT 16 KA RMS SYM. AT MAX. VOLTS
CLOSING AND LATCHING CAPABILITY 25.6 KA RMS ASYM.
2 SEC. MAX. PERMISSIBLE TRIPPING DELAY AT 16 KA RMS SYM.
CLOSING TIME 6 CYCLES RECLOSING TIME 15 CYCLES
INTERRUPTING TIME 5 CYCLES DUTY CYCLE O-ØSEC-CO-15S-CO

CHARGING MOTOR	240	VAC	254	v.max.	208	v.min.	1.0 AMPS @ NOM.V.
CLOSING COIL	240	VAC	254	v.max.	208	v.min.	1.0 AMPS @ NOM.V.
TRIPPING COIL 1	125	VDC	140	v.max.	70	v.min.	3.51 AMPS @ NOM.V.
TRIPPING COIL 2				v.max.		v.min.	AMPS @ NOM.V.

AUXILIARY CONTACTS 6 a 6 b

SF_6 PRESSURE 22 PSIG AT 20°C

6.5"

7.5"

REVISIONS			SF_6 BREAKER NAMEPLATE	DRAWN BY- MJ CHECKED BY- RC DATE- 10-2-85
				SA-6060-0002 5/83
1	10/11/85	MJ	SQUARE D COMPANY POWER EQUIPMENT GROUP SMYRNA, TENNESSEE	A- 17-14272-SFBI-04 REV.

ELECTROMAGNETIC INDUSTRIES
SQUARE D COMPANY
MADE IN U.S.A.
88

MODEL B [ ] CURRENT TRANSFORMER
BIL 10KV INS. CLASS 0.6KV [ ] 60 HZ

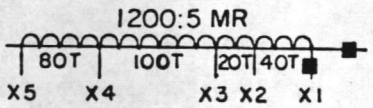
METER ACC. [ ] 1200:5 A

SHORT TIME THERMAL [60] X RATED CURRENT

PO. NO. [ ]

RELAY ACC. [C200] 1200:5 A

MFR. ORDER NO. [ ]



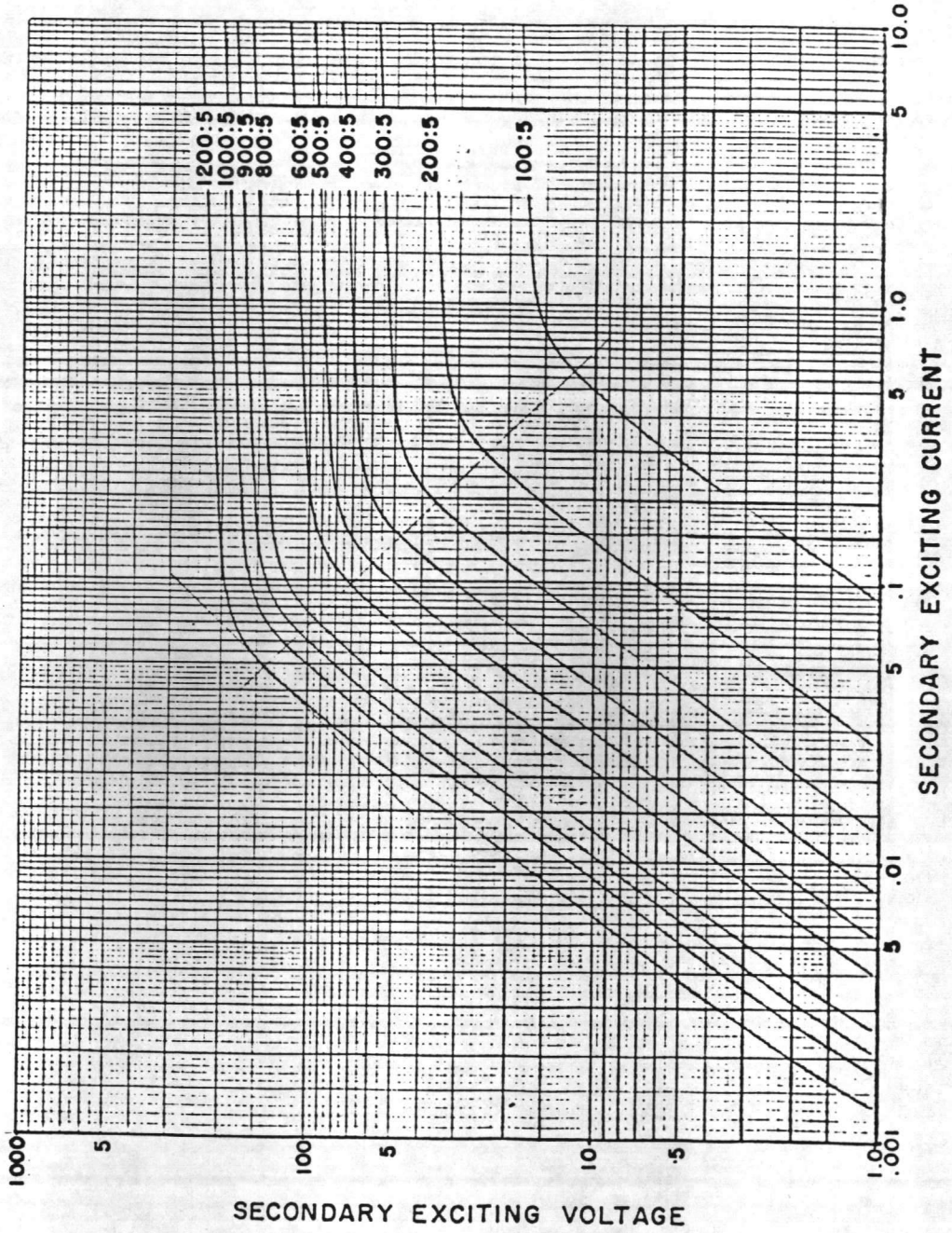
RES. PER TURN [.0016] OHM AT 25°C

RATING FACTOR [1.5] 30°C AMB DATE MFG. [ ]

CAT. NO. [311-122] SER. NO. [ ]

RATIO	100:5	200:5	300:5	400:5	500:5	600:5	800:5	900:5	1000:5	1200:5
TERMINALS	X2-X3	X1-X2	X1-X3	X4-X5	X3-X4	X2-X4	X1-X4	X3-X5	X2-X5	X1-X5

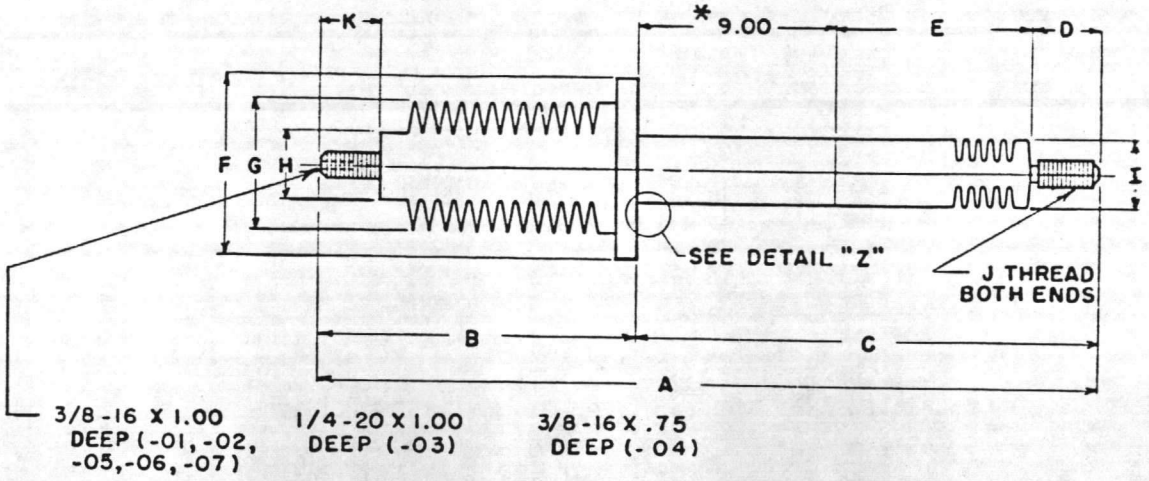
REVISIONS			CURRENT TRANSFORMER NAMEPLATE 1200:5 A	DRAWN BY- MJ CHECKED BY- RC DATE- 10-2-85 SA-6060/6080-0017	
			SQUARE D COMPANY POWER EQUIPMENT GROUP SMYRNA, TENNESSEE	17-14272- A- SFBI-05	REV.



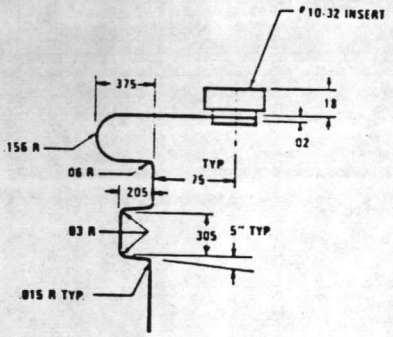
CUR. RTG. AMPS	SEC. RES. OHMS 20 C
100:5	0.0330
200:5	0.0659
300:5	0.0989
400:5	0.1319
500:5	0.1648
600:5	0.1978
800:5	0.2637
900:5	0.2967
1000:5	0.3297
1200:5	0.3956

REVISIONS			CT EXCITATION CURVES 1200:5A CAT. NO. 311-122	DRAWN BY-MJ CHECKED BY-RC DATE-10-2-85 SA-6060/6080-0031 8/84	
			SQUARE D COMPANY POWER EQUIPMENT GROUP SMYRNA, TENNESSEE	A- 17-14272-SFBI-06	REV.

* GROUND PROTECTION AREA

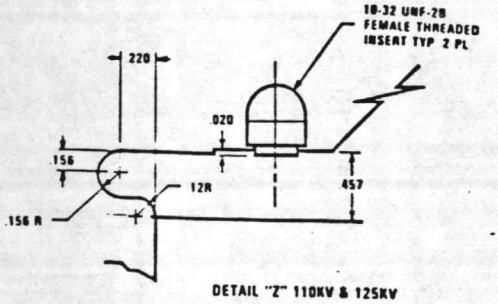


PART NO.	RATING (A)	EI CAT. NO.	DIM.	A	B	C	D	E	F	G	H	I	J	K
*D44080-099-01	600/1200	SD-15-110-1200	110KV	34.99	14.19	20.80	3.00	8.80	8.25	5.954	3.125	3.125	1 1/8-12	2.50
D44080-099-02	600/1200	SD-25-125-1200	125KV	37.57	16.19	21.38	3.00	9.38	8.25	5.954	3.125	3.125	1 1/8-12	2.50
D44080-099-03	1200	SD-38-150-1200	150KV	45.07	22.07	23.00	3.00	11.00	10.50	8.500	5.370	4.370	1 1/2-12	2.50
D44080-099-04	3000	SD-15-110-3000	110KV	37.49	15.70	21.80	4.00	8.80	9.88	7.710	4.880	5.500	2 7/8-12	4.00
D44080-099-05	2000	SD-38-150-2000	150KV	46.88	22.88	24.00	3.00	12.00	13.65	10.780	3.400	6.800	2 - 12	3.00
D44080-099-06	2000	SD-15-110-2000	110KV	35.50	14.70	20.80	3.00	8.80	9.00	6.830	4.000	4.000	2 - 12	3.00
D44080-099-07	600/1200	SD-38-200-1200B	200KV	50.44	22.07	28.37	3.00	16.37	10.50	8.50	5.380	4.380	1 1/8-12	2.50



* BUSHING USED ON THIS APPLICATION

Q.C. TEST CHART		PARTIAL DISCHARGE TEST VALUES		1 MIN. WITHSTAND
SYSTEM VOLTAGE (KV)	PART NUMBER	MAXIMUM TEST VOLTAGE (KV)	MINIMUM VOLTAGE AT WHICH EXTINCTION (SPICOC) MUST OCCUR (KV)	TEST VALUE TO BE APPLIED FOR ONE MINUTE WITH OUT BREAKDOWN (KV)
15.5	D44080-099-01	17.9	9.8	50.00
25.8	D44080-099-02	29.8	16.4	60.00
38	D44080-099-03	43.9	24.1	80.00
15.5	D44080-099-04	17.9	9.8	50.00
38	D44080-099-05	43.9	24.1	80.00
15.5	D44080-099-06	17.9	9.8	50.00
38	D44080-099-07	43.9	24.1	80.00



DETAIL "Z" 110KV & 125KV

REVISIONS				

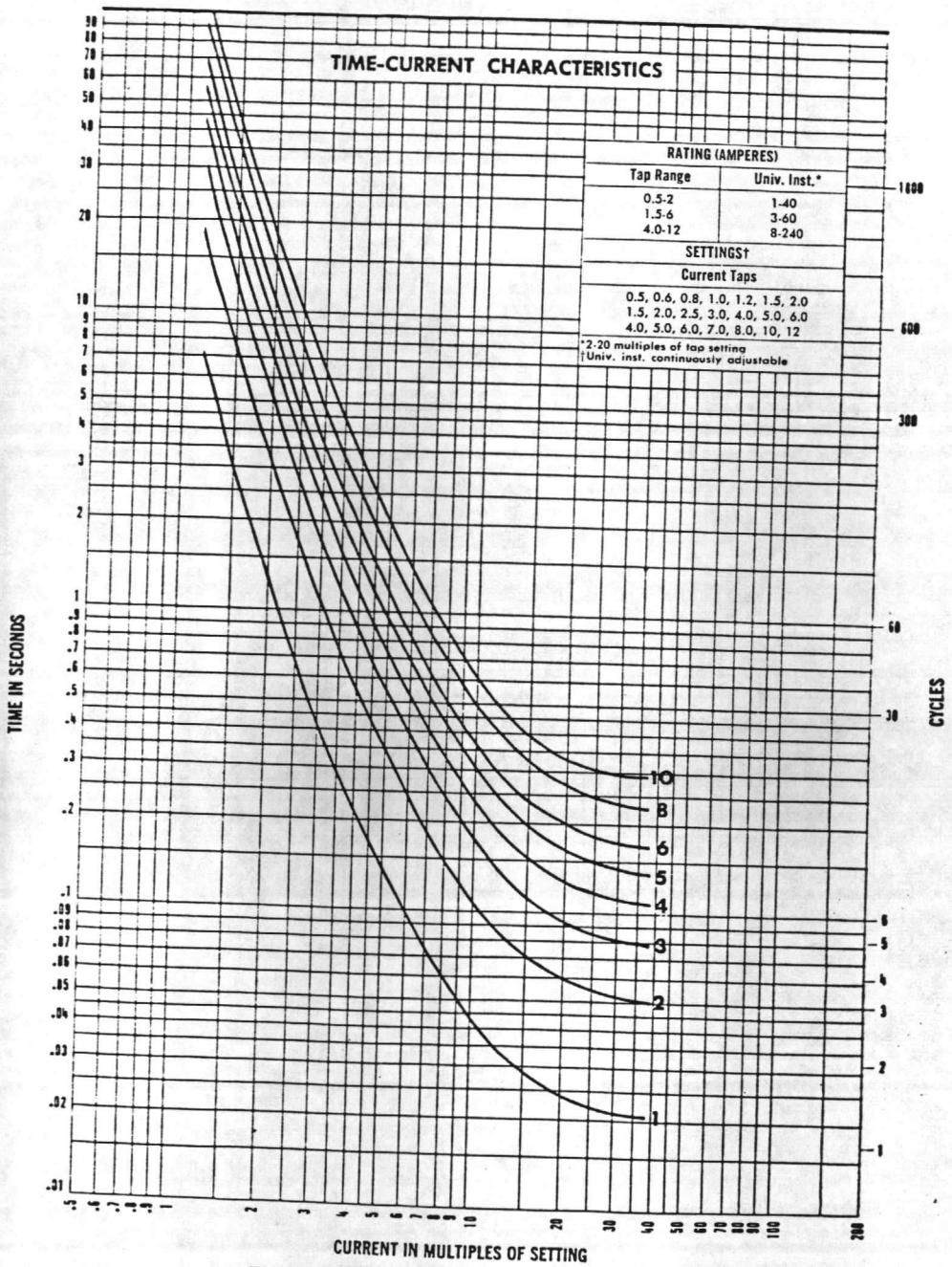
SF_6 CONDENSER BUSHING

DRAWN BY- MJ
CHECKED BY- RC
DATE- 10-2-85
SD44080-099 REV. F

SQUARE D COMPANY
POWER EQUIPMENT GROUP
SMYRNA, TENNESSEE

A-17-14272-SFBI-07

REV.



TYPE ITE 51E EXTREMELY INVERSE

REVISIONS				
			DRAWN BY- MJ CHECKED BY- RC DATE- 10-2-85	
			SQUARE D COMPANY POWER EQUIPMENT GROUP SMYRNA, TENNESSEE	A- 17-14272-SFBI-08	REV.

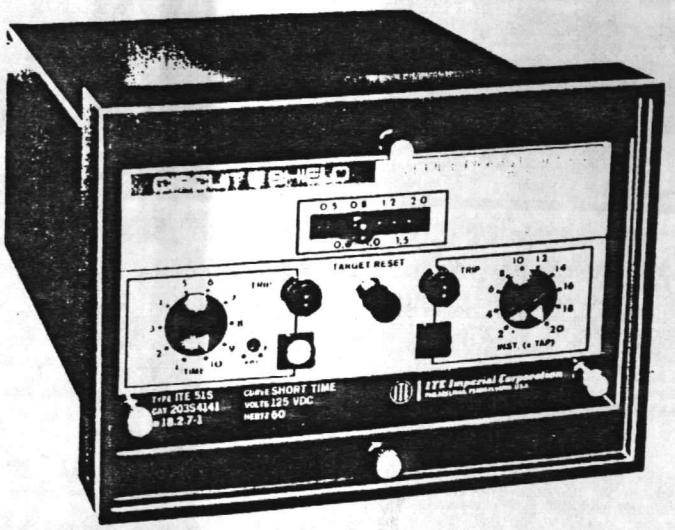
BBC
BROWN BOVERI

IB 18.2.7-1
Issue I
Instructions

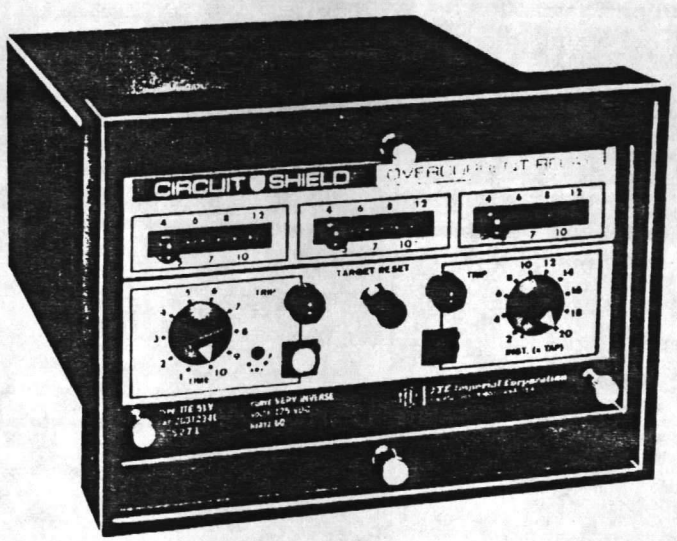
I-T-E Overcurrent Relays

DRAWOUT SEMI-FLUSH MOUNTED SINGLE-PHASE AND THREE-PHASE RELAYS

INVERSE	ITE-51I
VERY INVERSE	ITE-51Y
EXTREMELY INVERSE	ITE-51E
INSTANTANEOUS	ITE-50
INVERSE INSTANTANEOUS	ITE-50I
SHORT TIME	ITE-51S
LONG TIME	ITE-51L
DEFINITE TIME	ITE-51D
LONG TIME INVERSE	ITE-51IM:
LONG TIME VERY INVERSE	ITE-51YM



SINGLE PHASE
FOR RESIDUAL GROUND PROTECTION



THREE PHASE
FOR PHASE PROTECTION

Brown Boveri Electric

INSTRUCTIONS FOR CIRCUIT-SHIELD™ SOLID-STATE RELAYS
DRAWOUT SEMI-FLUSH MOUNTED
SINGLE-PHASE AND THREE-PHASE

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the complete CIRCUIT-SHIELD line of solid-state overcurrent relays.

The CIRCUIT-SHIELD overcurrent relay is housed in a semi-flush drawout relay case suitable for conventional panel mounting.

All connections to the relay are made at terminals located on the rear of the case and clearly numbered, one (1) through twelve (12).

CURRENT, TIME, and INST. pickup controls are located on the front panel behind a removable clear plexiglass cover.

TIME and INST. target indicators are also mounted on the front panel. Both targets are reset by means of a pushbutton extending through the relay cover.

PRECAUTIONS

The following precautions should be taken when applying solid-state relays:

1. Incorrect wiring may result in damage to solid-state relays. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized. Be sure control power is applied in the correct polarity before applying control power.

2. Apply only the rated control voltage marked on the relay front panel. Unlike conventional relay contacts, solid-state outputs are rated for a particular control voltage. If rectified AC voltage is used in place of a battery, proper filtering will be required to insure SCR "Holding Current".

3. Be sure the trip circuit is interrupted by an "a" contact to remove high currents from solid-state output circuits. Solid-state output circuits have inherently high momentary current ratings and low continuous current ratings. Never exceed the ratings.

4. When applying input current to protective relays, be sure to interrupt the input current immediately after the relay operates.

5. Load (trip coils or auxiliary relays) must draw at least 0.10 amps to insure operation. SCR's require a minimum current to remain conducting after triggering. Parallel a resistance with a low current coil to guarantee the holding current, if necessary.

6. Do not attempt to manually operate target vanes on CIRCUIT-SHIELD overcurrent relays. Although the targets return their indication under shock, they can be damaged by manual operation with a pencil or pointed object.

7. Do not apply high voltage tests to solid-state relays. If a control wiring insulation test is required, bond all terminals together and disconnect ground wire before applying test voltage.

8. Be sure to note the connections to terminals 9, 10, and 11 (described under CONNECTIONS on page 3) required for the proper operation of the TIME and INSTANTANEOUS elements. Jumper links are supplied with all relays.

9. Only the lower circuit board of the CIRCUIT-SHIELD overcurrent relay is removable. This board should insert smoothly. Do not use force.

10. Note that removal of the tap block pin is equivalent to setting the highest tap.

11. Follow test instructions to verify that relay is in proper working order. If a relay is found to be defective, return to factory for repair. Immediate replacement of the removable element or the fixed element can be made available from the factory; identify by catalog number. We suggest that a complete spare relay be ordered as a replacement, and the damaged unit repaired and retained as a spare. By specifying the relay catalog number a schematic may be obtained from your ITE sales engineer should you desire to repair or recaliabrate the relay.

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the CIRCUIT-SHIELD relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify the nearest Brown Boveri Electric Office. Use normal care in handling to avoid mechanical damage. The CIRCUIT-SHIELD system has no vital moving parts and if kept reasonably clean and dry, has no practical limit to its operating life.

2. INSTALLATION

Mounting

The outline dimensions and panel drilling and cutout information is given in Figure 2.

Connections

External connection diagram is shown in Figure 1.

For the instantaneous function to be operable Terminals 9 and 10 must be externally shorted. Instantaneous relay operation can be cancelled for reclosing applications by using an external supervisory contact connected to these terminals.

For the TIME function to be operable on relays supplied with torque control (CAT. 223 . _ . _ .) terminals 10 and 11 must be externally shorted. The TIME function can be cancelled for directional or voltage control by using an external supervisory contact connected to these terminals.

All CIRCUIT-SHIELD relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G" and is located as shown in Fig. 2 below. In all applications this terminal should be wired to ground.

Special care must be taken to connect control power in the proper polarity. Reversing plus (+) and minus (−) will cause SCR A and SCR B to block the flow of trip current and the relay will not function. For capacitor trip applications, the plus (+) output of the capacitor trip device must be connected to terminal 7 of the relay, the negative (−) to terminal 8.

3. SETTINGS

Current Pickup Taps

A tap block for each phase is located on the relay front panel. Each tap block provides for seven (7) pickup settings which are marked in CT secondary amperes. When a pin is pulled out, that phase switches to the maximum tap setting. The pin may be moved with the relay in service.

Time Dial

One of ten (10) time-current curves is selected by a two-element control labeled TIME on the left side of the relay front panel.

a) A ten position SWITCH giving discrete steps 1 through 10.

b) A screwdriver adjusted VERNIER providing continuous time adjustment between steps.

When the vernier, marked "ADJ", is turned to the extreme counterclockwise position, the time-current curve shown on the switch has been selected. The vernier provides a continuous time adjustment between the switch selected curve and the curve indicated by the next higher number. Intermediate positions can be verified by test.

Instantaneous

Instantaneous pickup is selected by the potentiometer dial on the right side of the relay front panel. The dial is labeled "INST." The markings indicate multiples of the pickup tap setting.

For example, if the phase one (1) tap is set at six (6) amperes and the INST. dial is set at eight (8), the INST. setting is:

6 amps X 8 = 48 amps

Consequently, an instantaneous trip will occur at 48 amps in phase one (1) of the relay.

TESTING IN SERVICE

In general, it is not necessary to schedule periodic maintenance and testing of this relay. However, if tests are desired to confirm the proper functioning of the system, the following procedure can be used.

Mounted in Switchgear

Tests should be made on a de-energized main circuit. If tests are to be made on an energized circuit, be sure to take all necessary precautions.

It is customary to test the trip circuit of electro-mechanical overcurrent relays by manually closing the trip contacts to trip their associated circuit breakers. If the contacts are allowed to part before the seal-in contact closes, the relay contacts are eroded by the arc. Also, high transient voltages will appear from trip bus to positive.

This problem is avoided in the CIRCUIT-SHIELD overcurrent relay by the operational test feature. Separate pushbuttons labeled "TRIP" are provided for the TIME and INST. functions. The pushbuttons, recessed to prevent accidental operations, will cause the breaker to trip.

A portion of the control voltage is applied to the time circuit when the TIME pushbutton is depressed. The time delay circuit then produces a trip signal, in a time corresponding to approximately two (2) multiples of current tap setting, (at nominal control voltage), and the TIME target operates. For this test the INST. pickup must be set above (2) multiples or the INST. element will trip first.

Similarly, a portion of the control voltage is applied to the INST. circuit when the INST. pushbutton is depressed, producing a trip signal and operating the INST. target.

On special three phase relays with individual phase targets, the tests described will cause the middle phase target to operate in addition to the TIME or INST. target.

Drawout Element

Lower drawout circuit boards of the same catalog number are interchangeable and will operate in either a single phase or a three phase relay case. The board is removed by using the metal pull knobs on its front panel. Removing the board will not cause an open C.T. secondary or a false trip, therefore, the board may be changed while the relay is in service.

Note that the relay is identified by a serial number on the under side of the circuit board and on a label on the inside of the case; under normal circumstances, case and board should be kept as a unit.

The relay time-current characteristic and control voltage rating is determined by the drawout element. This nameplate data will be found on the front panel of the drawout element.

Test Accessory

A test accessory which can be used to quickly check the primary C.T.'s, the upper non-drawout input section of the relay, control power, and the continuity of the trip circuit is available from the factory. This drawout test accessory is plugged into the relay in place of the drawout element to make the checks. See IB-18.2.7-4 for details.

APPLICATION DATA

CIRCUIT-SHIELD overcurrent relays provide overcurrent protection phase-to-phase or phase-to-ground. They are designed to be operated by standard five (5) ampere secondary current transformers. The output circuit (trip circuit) will operate conventional circuit breaker trip coils at the DC voltage specified on the relay nameplate.

These relays can be used for all applications where conventional electromechanical relays are used. They come in seven different time-current curve families, INVERSE (51I), VERY INVERSE (51Y), EXTREMELY INVERSE (51E), SHORT TIME (51S), LONG TIME (51L), DEFINITE TIME (51D), LONG TIME INVERSE (51IM), and LONG TIME VERY INVERSE (51YM). A standard INSTANTANEOUS function or a special INVERSE INSTANTANEOUS function can be furnished as an option with any of the time families or as a separate INST(50) relay.

These overcurrent relays are offered with the following pickup ranges:

Range	Taps‡
0.1 - 0.5	0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5
0.5 - 2.0	0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0
1.5 - 6.0	1.5, 2.0, 2.5, 3, 4, 5, 6
2 - 5	2.5, 2.8, 3.1, 3.5, 4.0, 4.5, 5.0
4 - 12	4, 5, 6, 7, 8, 10, 12

‡When tap plug is removed, affected phase reverts to the maximum pickup.

Any one of six control voltages can be obtained: 24Vdc, 48Vdc, 125Vdc, 250Vdc, 175Vdc (120Vac. capacitor trip), 350Vdc (240Vac capacitor trip).

TOLERANCES

TIME PICKUP ..... ±5% of tap setting

TIME DELAY

dial #10 (2-20 multiples) ..... ±5%
dial #1 (2-20 multiples) ..... 10 ms or ±10% (whichever is larger)

INST. PICKUP ..... ±10% of pickup amps (tap x dial setting)

RATINGS

TEMPERATURE

Nominal ..... 25°C ambient
Additional ±5% tolerance ..... −15°C to +55°C
Must operate ..... −30°C to +70°C

FREQUENCY

Nominal ..... 60 Hertz
Additional ±5% tolerance ..... +1 to −3 Hertz

INPUT CIRCUIT

Phase one (1) current — terminals 1 and 2.
Phase two (2) current — terminals 3 and 4.
Phase three (3) current — terminals 5 and 6.

The current input for single-phase relays is made at terminals 3 and 4.

Each input current is fed to a tapped transformer primary. The secondary winding produces a voltage across a burden resistor. This voltage is rectified and supplied to the static circuitry.

The pickup of the static circuit is adjusted to the desired pickup current by tap selection of the transformer primary turns.

INPUT CURRENT RATINGS

Time	Tap Range, A	Input Current, 1 Ø or 3 Ø (CT Secondary Amperes)
1 Second	0.1 - 0.5 0.5 - 2.0 1.5 - 6.0 2.5 - 5.0	300 multiples of pickup tap setting or 235 A rms, whichever is less.
	4 - 12	300 multiples of pickup tap setting or 390 A rms, whichever is less.
Continuous	All Ranges	1.5 multiples of pickup tap setting.

BURDEN

The burden of the Circuit Shield overcurrent relay is very low, allowing the use of current transformers which would give unsatisfactory performance if they were driving electro-mechanical relays.

Because the input characteristic of the Circuit Shield relay is nonlinear, an impedance cannot be specified, however, the burden voltage across the relay current input terminals can be readily calculated for any given value of current transformer secondary current:

TAP (AMPS)	R_{DC} OHMS
0.5	.092
0.6	.078
0.8	.065
1.0	.055
1.2	.048
1.5	.040
2.0	.032
1.5	.042
2.0	.034
2.5	.038
3.0	.026
4.0	.022
5.0	.020
6.0	.0185
4	.020
5	.020
6	.0185
7	.0175
8	.017
10	.0165
12	.0165

$$V = \frac{1.0}{I_T} + I_S \times R$$

V = burden voltage (volts)
I_S = current transformer secondary current (amperes)
I_T = relay pickup current tap setting (amperes)
R = D.C. resistance of relay input circuit (ohms) (select from table)

NOTES:

1. for units with 0.1 to 0.5A tap range, the Is x R term is negligible.
2. for units with 2 to 5A tap range, use values shown for 1.5 to 6A unit.

OUTPUT CIRCUIT

The CIRCUIT-SHIELD overcurrent relay energizes the breaker trip coil by means of an output SCR. Two SCR's are provided, one for the time delay and one for the instantaneous circuit as indicated in the wiring diagram shown in Figure 1.

As shown, relay terminal 7 is connected to the control power positive, with the trip coil connected to relay terminal 12 through a 52/a contact.

SCR A is gated by the time delay circuit, while SCR B is gated by the instantaneous circuit.

Note that once an SCR is gated (turned on), it will remain in conduction until its anode current falls below its holding current which typically is 5 to 20 milliamperes. Consequently, the trip coil current must be interrupted with the 52/a contact.

OUTPUT TRIP CIRCUIT RATINGS

Nominal Voltage	Range of Operation	Max. Current, Amps DC		
		6 Cycles	1 Second	Continuous
48 Vdc	28 - 60	30	15	1
125 Vdc	70 - 140			
250 Vdc	140 - 280			
• 175 Vdc	100 - 195			
• 350 Vdc	200 - 385			

*Capacitor Trip Applications

TARGET CIRCUITS

The target indicators for the TIME and INST. circuits are polarity sensitive devices which are set by current flow through the corresponding trip SCR.

Target reset is accomplished by the control power connection (terminals 7 and 8 of Figure 1) through the TARGET RESET pushbutton.

Standard 3 phase relays (CAT 2 _ 3T _ _ _) have two targets — TIME and INST. Special 3 phase relays (CAT 2 _ 3P _ _ _) have five targets — TIME, INST., and individual PHASE targets. These three additional targets will indicate which phase currents are in excess of tap setting when the relay trips the breaker.

50 Hz OPERATION

These relays are suitable for 50 Hz systems; however, the time current curves shown on pages 7 to 15 are for 60 Hz operation. Contact the factory for 50 Hz curves.

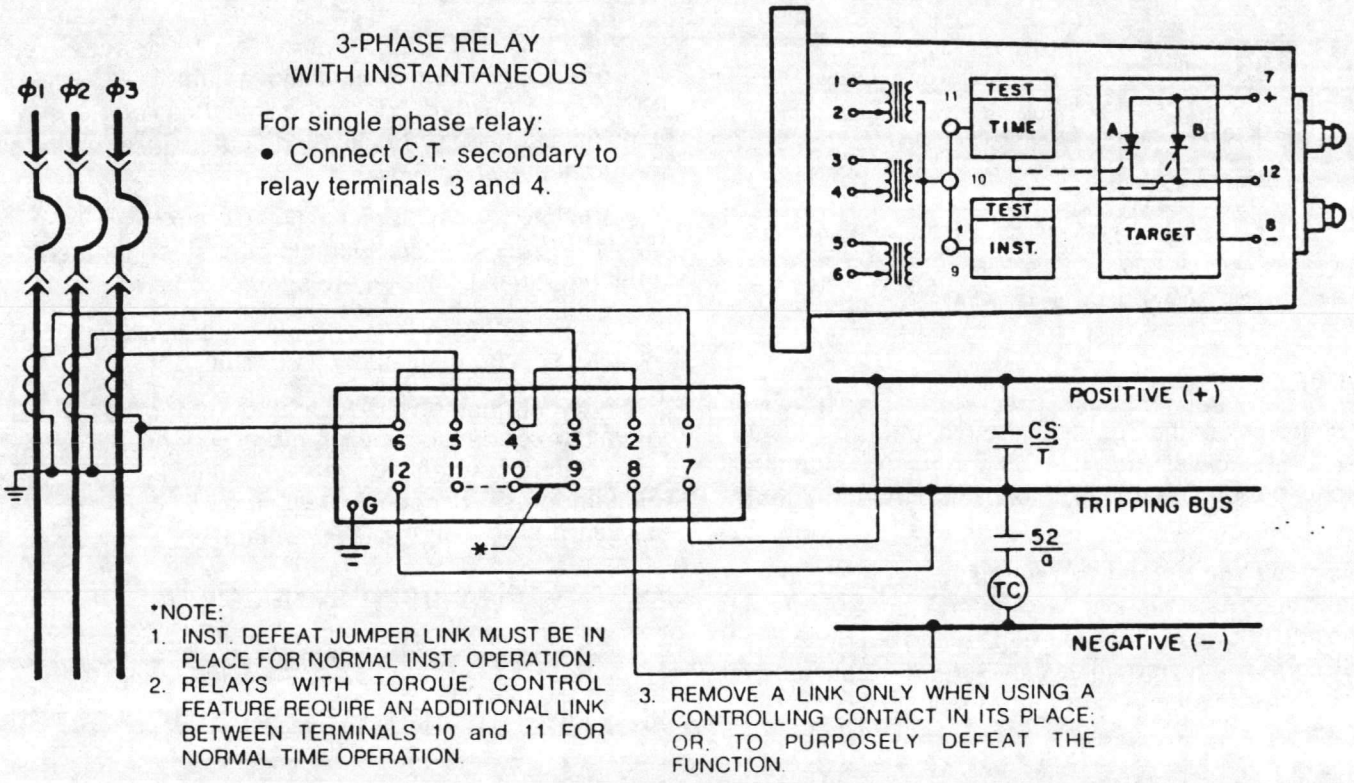


Fig. 1 — 3-Phase CIRCUIT-SHIELD Wiring Diagram

DRAWOUT SEMI-FLUSH MOUNTED RELAY

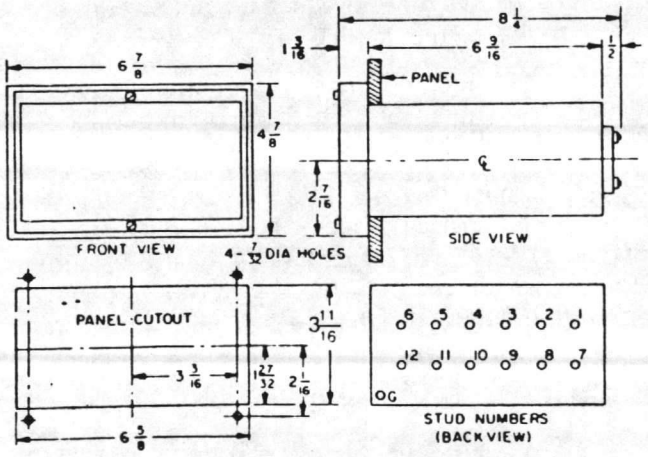
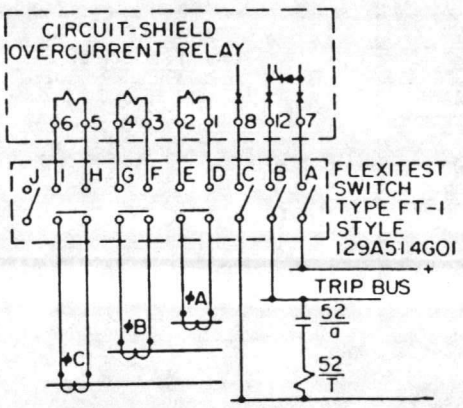


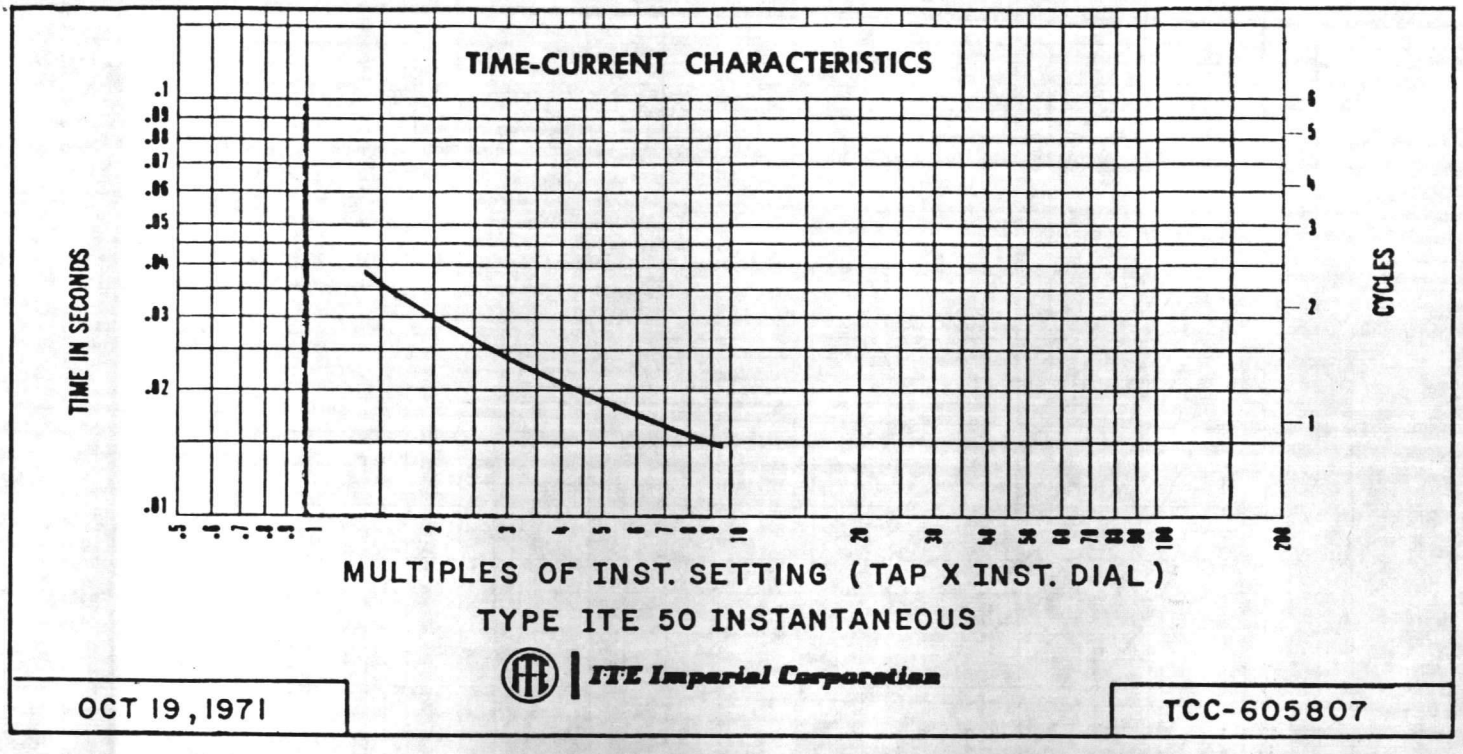
Fig. 2 — Overcurrent Relay Outline and Drilling

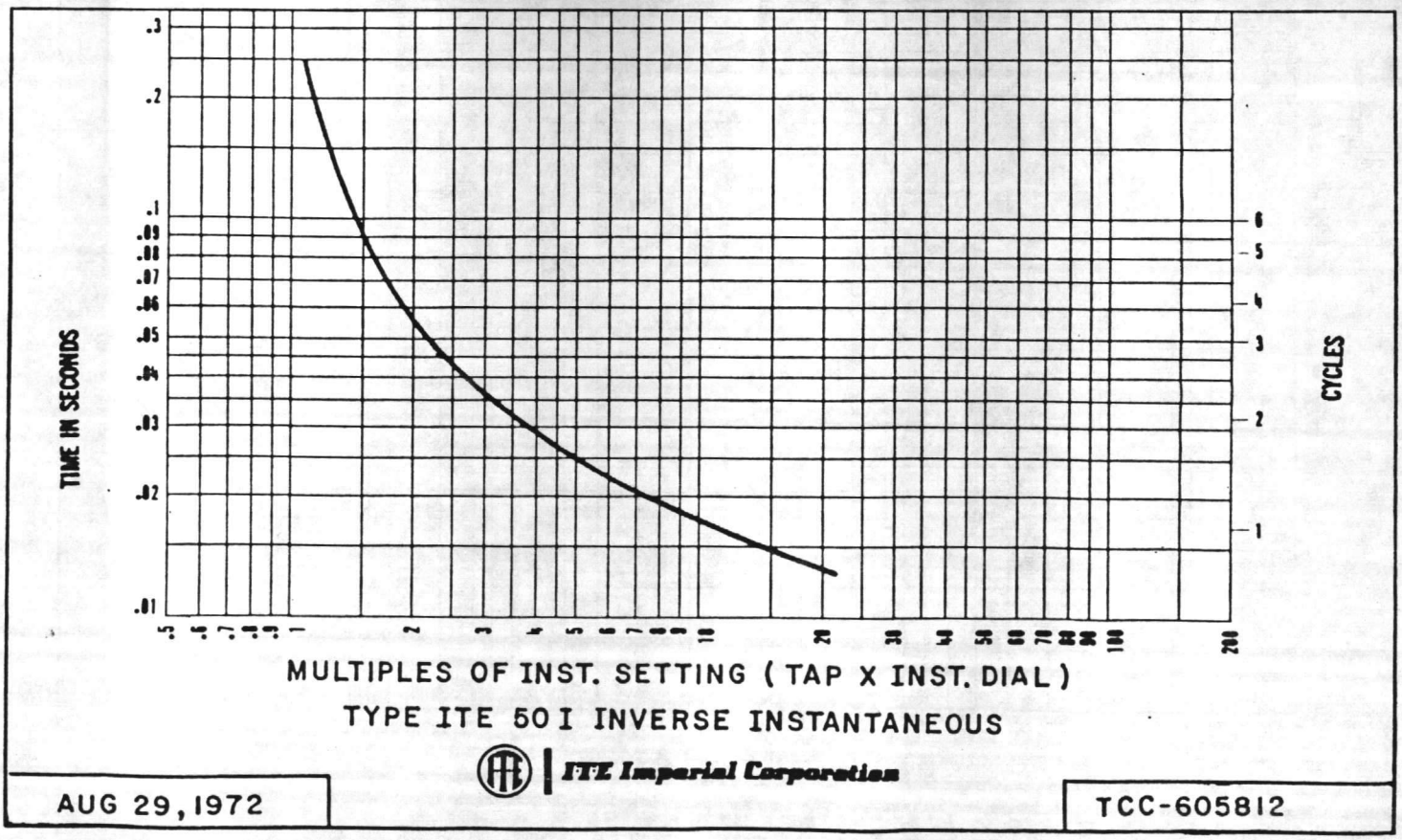


Suggested arrangement for drawout type test facilities to be used by those wishing to maintain their conventional test procedures when checking ITE's solid-state overcurrent relays.

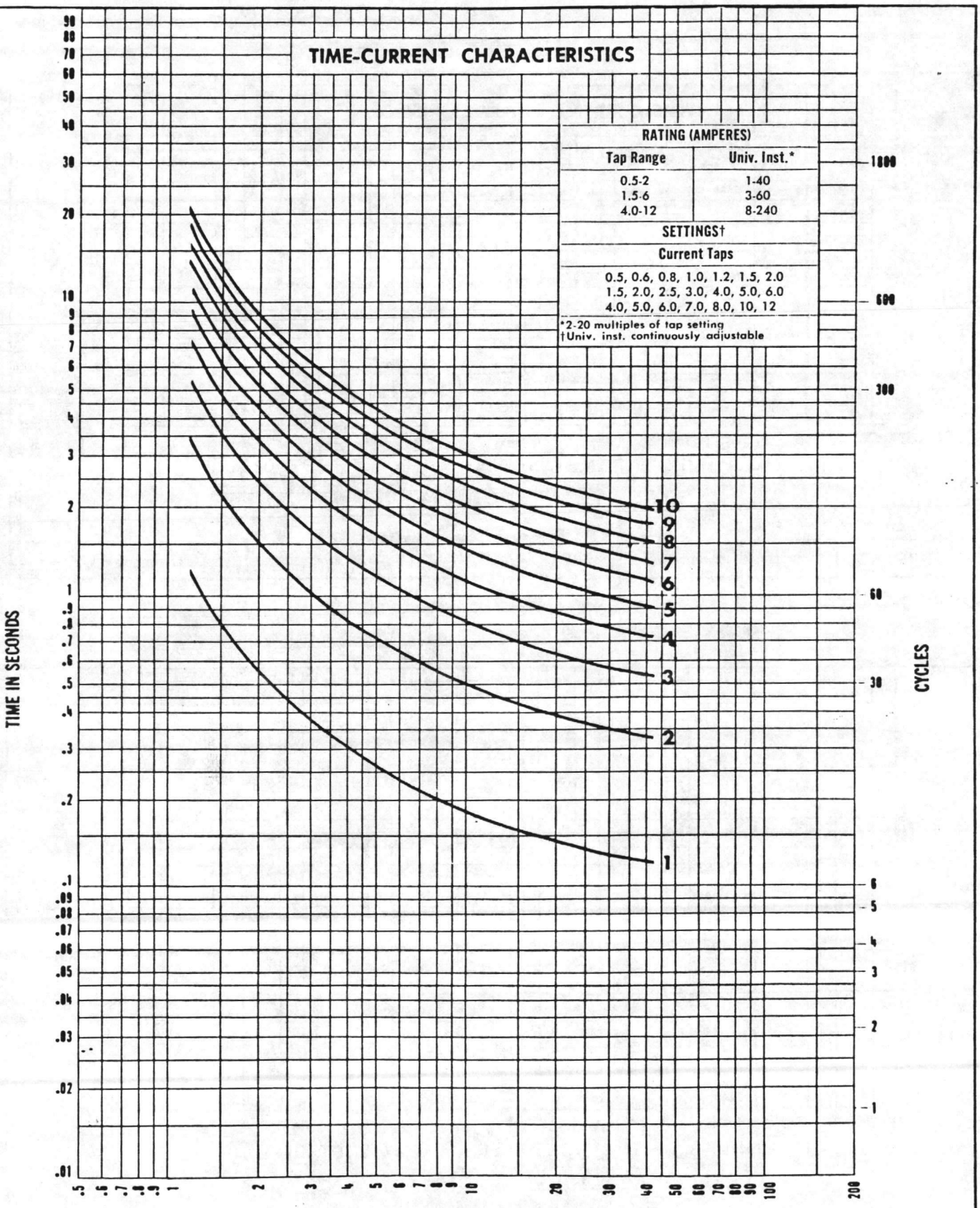
This sketch shows Westinghouse's Flexitest Switch. However, G.E., States, Meter Devices, or other types can be used.

Fig. 3 — CIRCUIT-SHIELD Connections to FT-1 Flexitest Test Switch


TIME-CURRENT CHARACTERISTICS
TIME IN SECONDS
CYCLES
MULTIPLES OF INST. SETTING (TAP X INST. DIAL)
TYPE ITE 50 INSTANTANEOUS
ITE Imperial Corporation
OCT 19, 1971
TCC-605807


TIME IN SECONDS
CYCLES
MULTIPLES OF INST. SETTING (TAP X INST. DIAL)
TYPE ITE 50 I INVERSE INSTANTANEOUS
ITE Imperial Corporation
AUG 29, 1972
TCC-605812

SOLID-STATE OVERCURRENT RELAYS

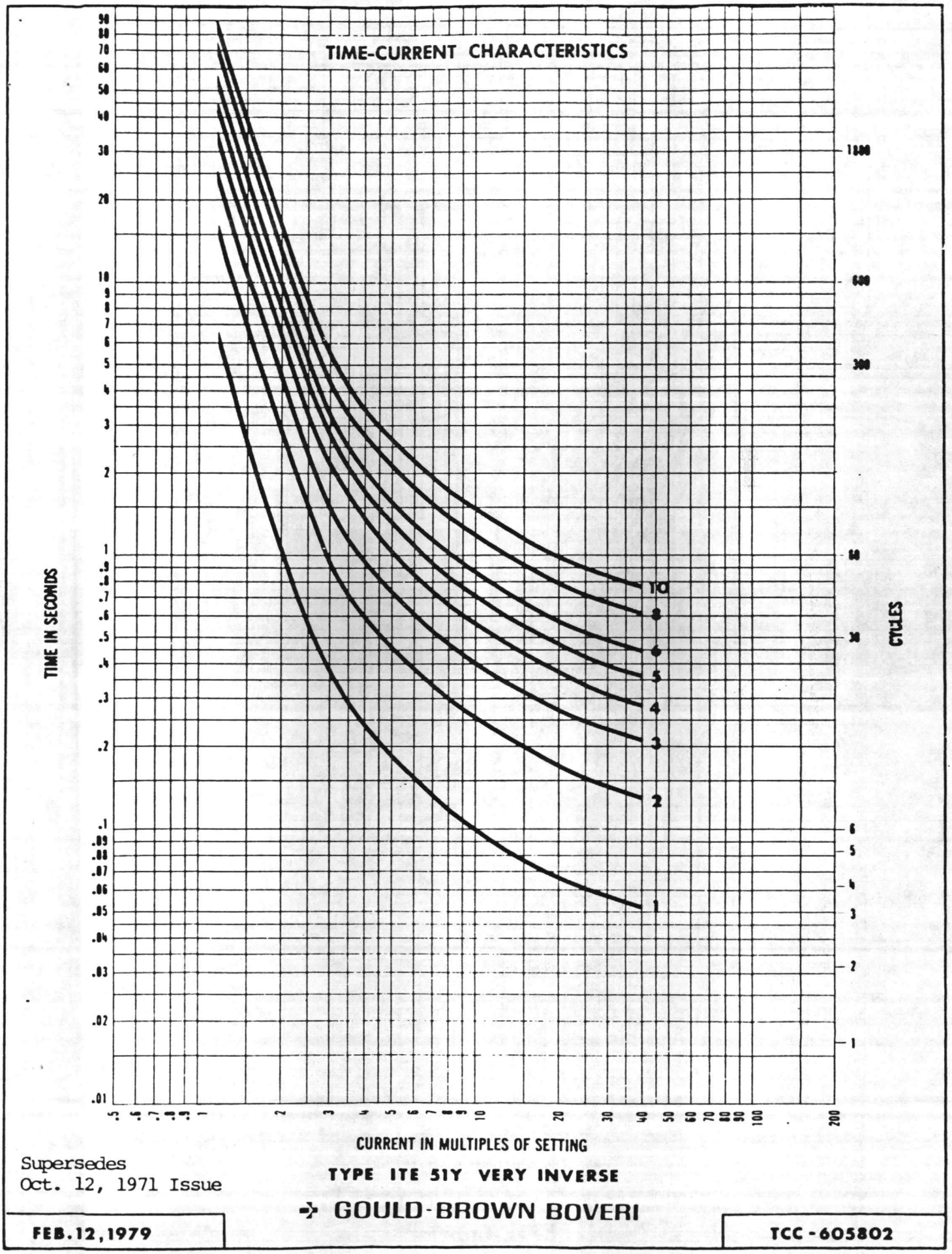


TYPE ITE 51I INVERSE

ITE Imperial CORPORATION

OCT. 12, 1971

TCC–605801

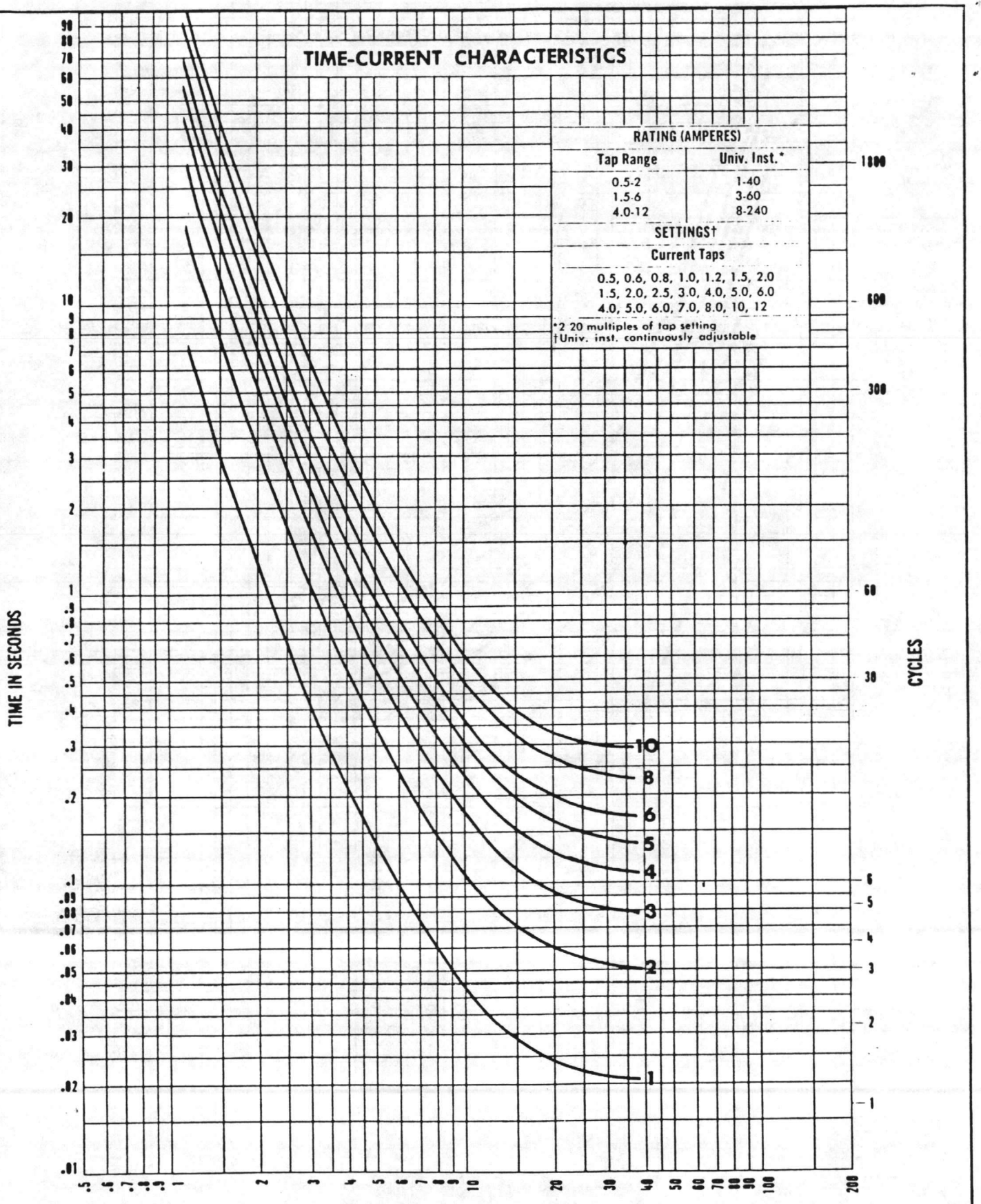


Supersedes
Oct. 12, 1971 Issue

TYPE ITE 51Y VERY INVERSE

GOULD-BROWN BOVERI

SOLID-STATE OVERCURRENT RELAYS

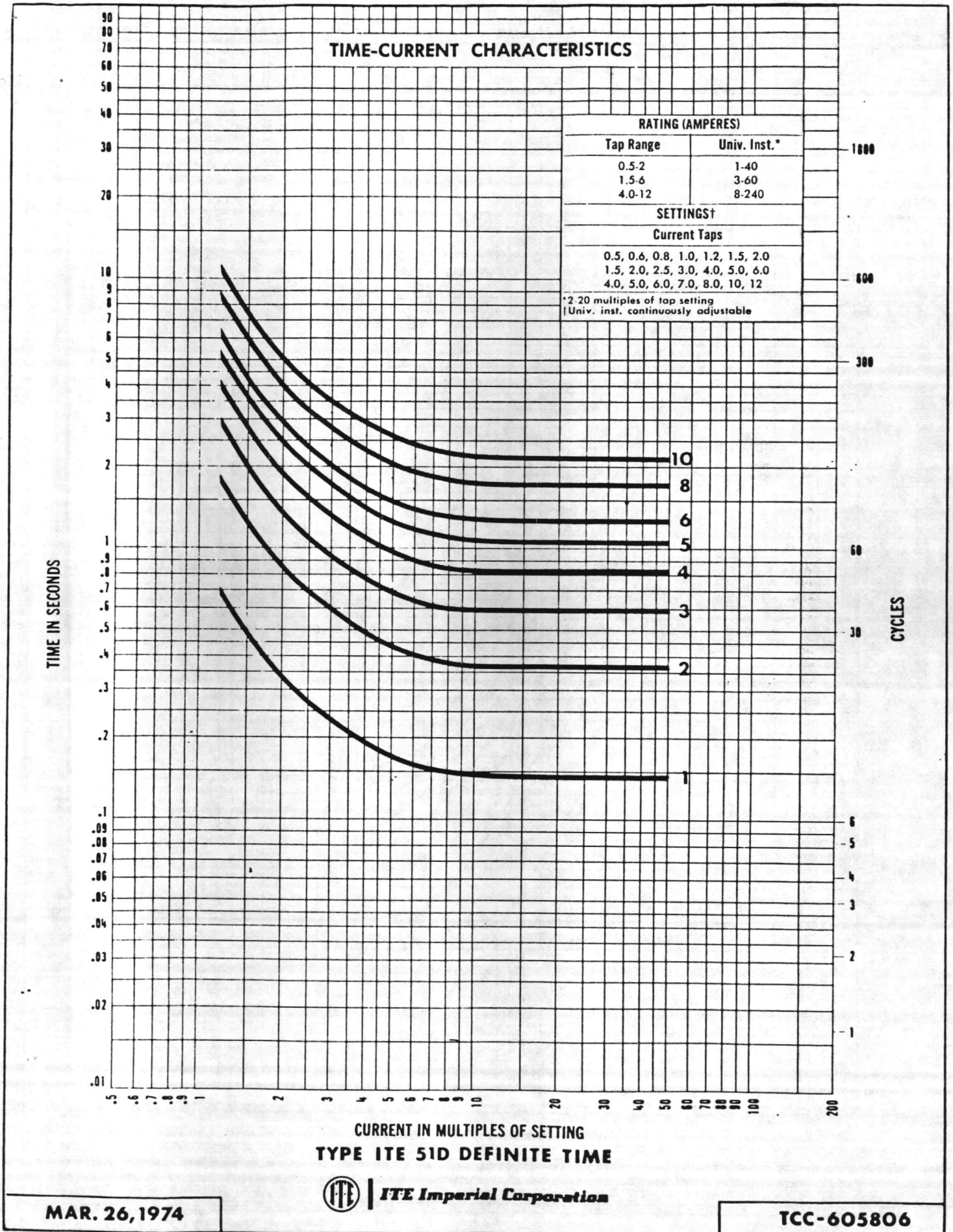


TYPE ITE 51E EXTREMELY INVERSE

ITE Imperial CORPORATION

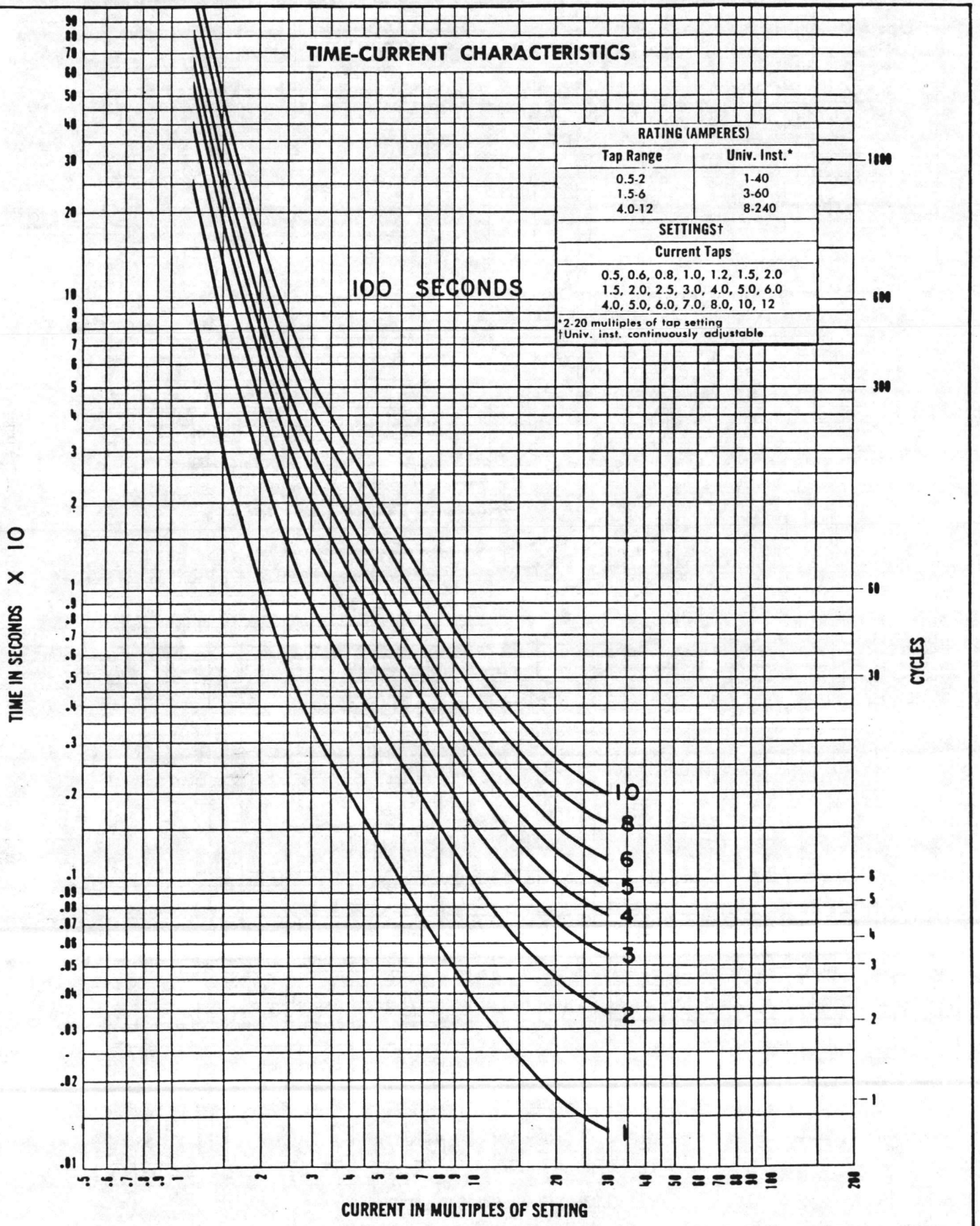
OCT.12,1971

TCC–605803



Supersedes curve dated 10/12/71

SOLID-STATE OVERCURRENT RELAYS



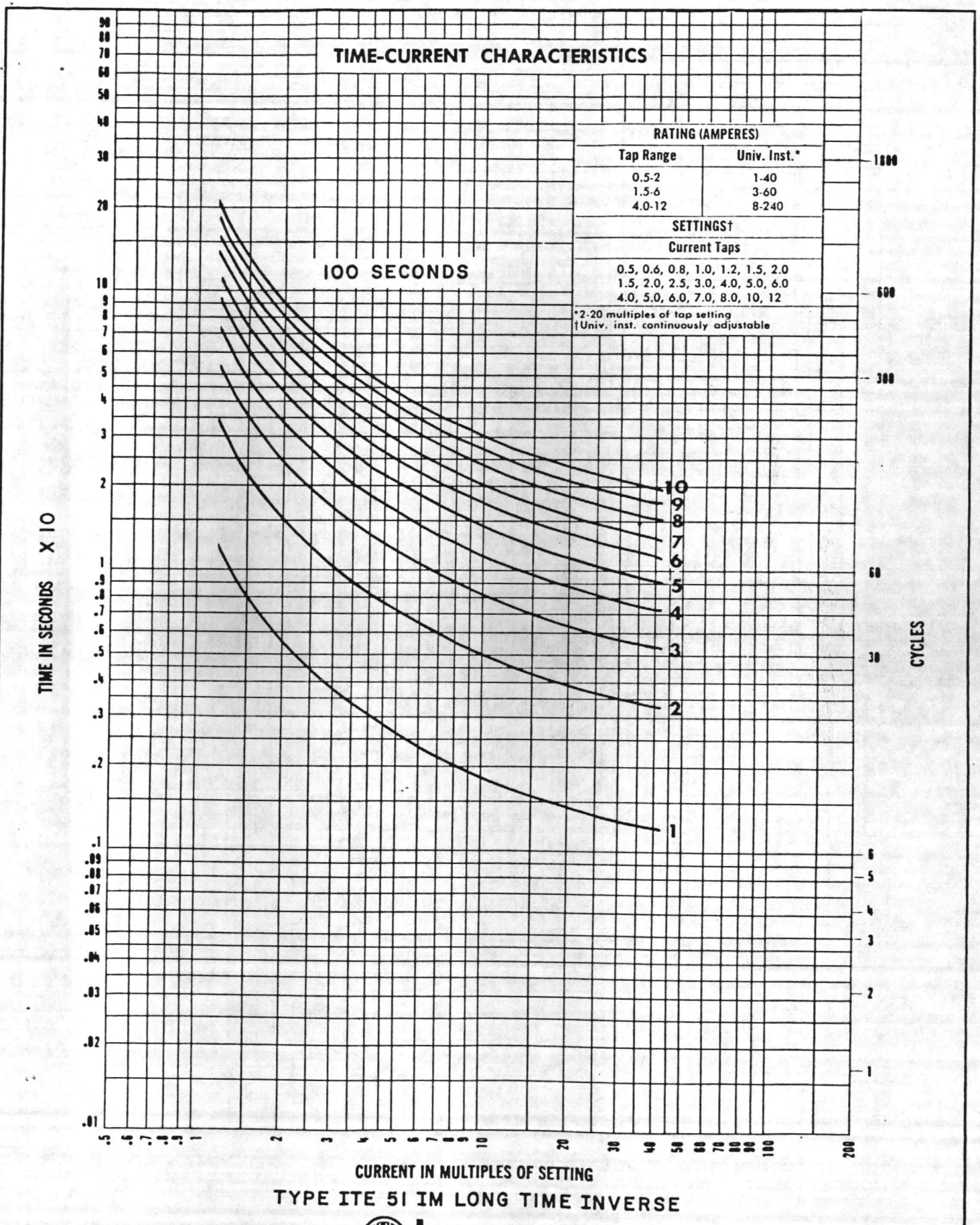
TYPE 51L LONG TIME

ITE Imperial Corporation

MAR. 9, 1973

605805

Supersedes curve dated 10/19/71

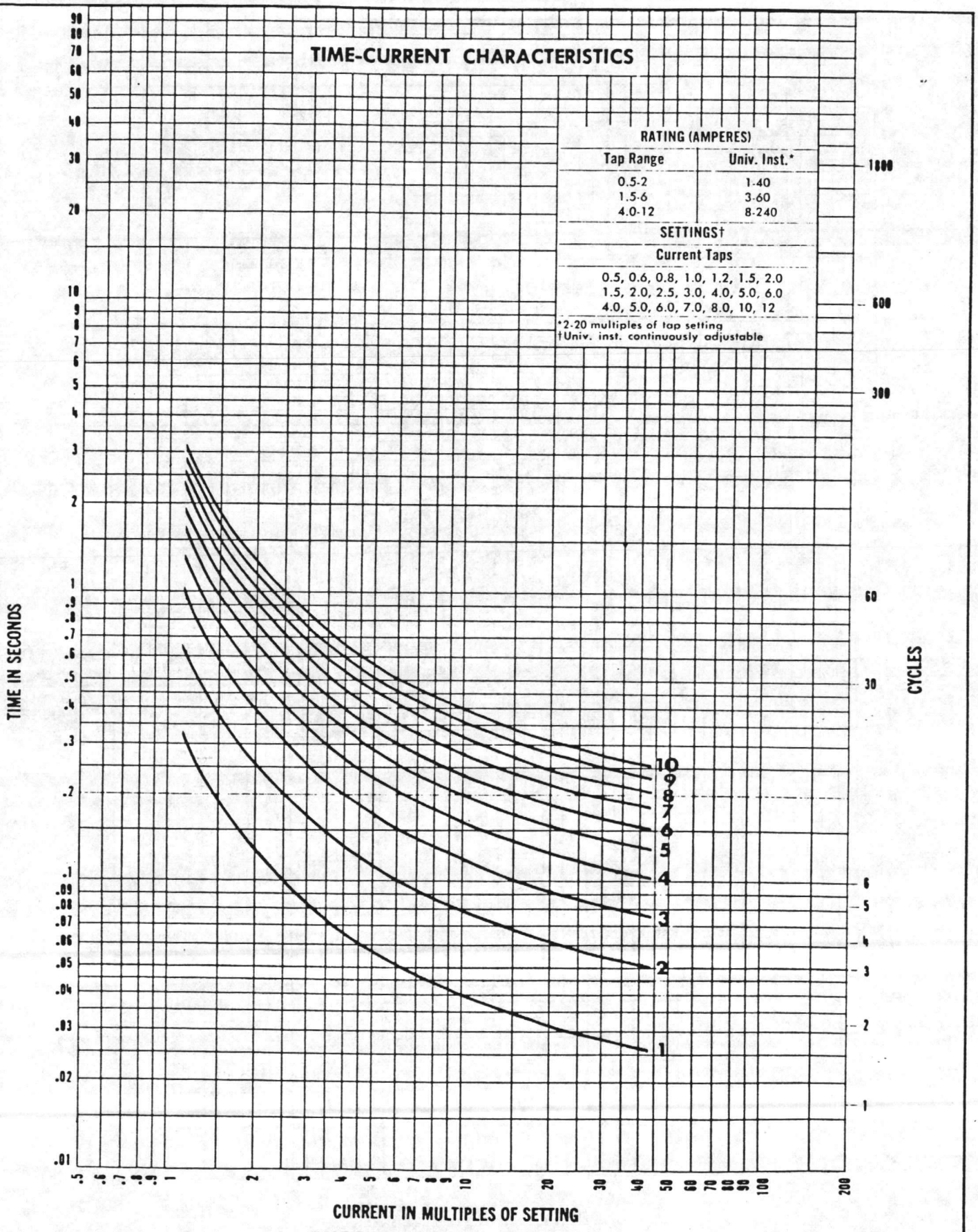


MAR 12, 1974

ITE Imperial CORPORATION

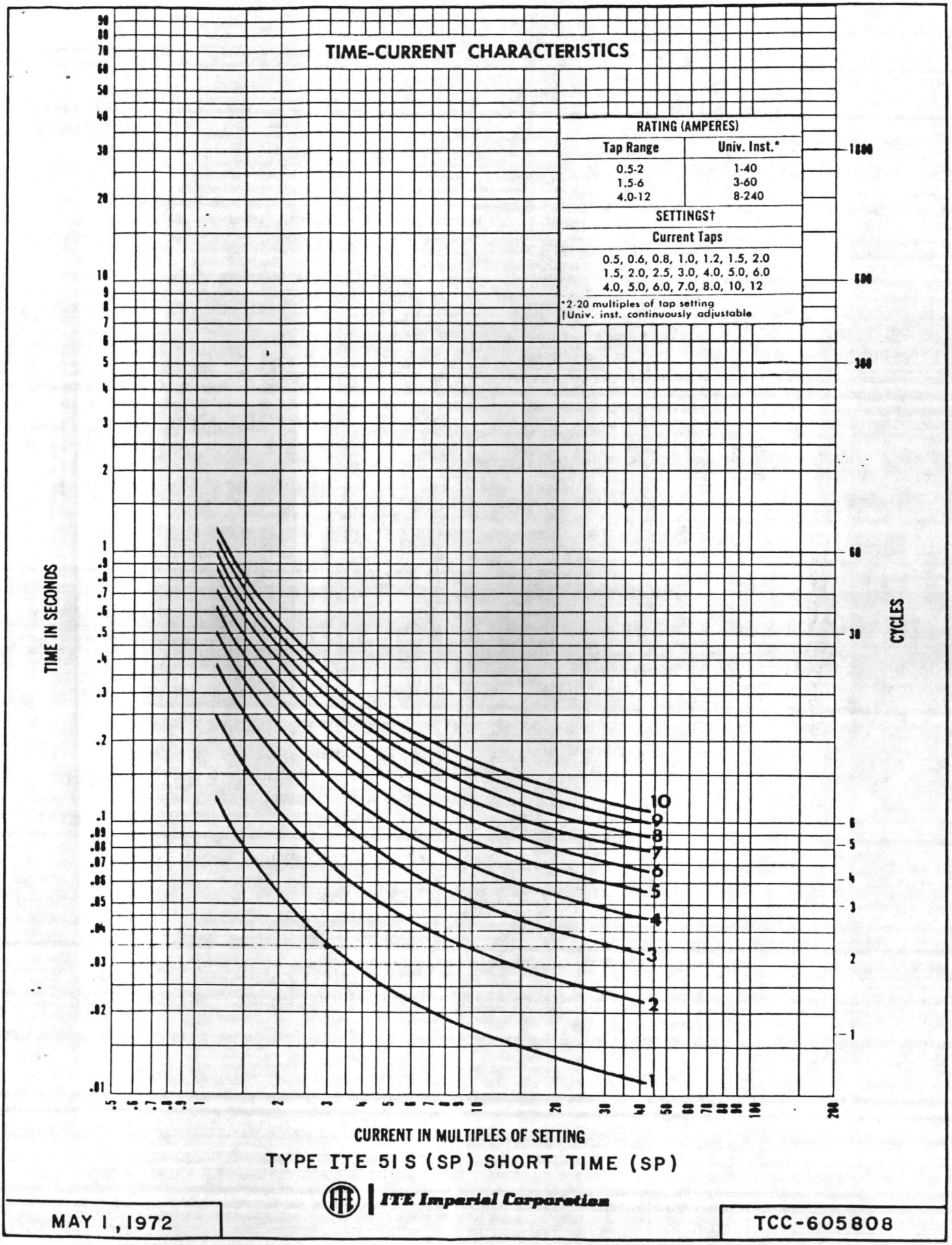
TCC-605813

SOLID-STATE OVERCURRENT RELAYS



TYPE ITE 51S SHORT TIME

ITE Imperial CORPORATION



TYPE ITE 51 S (SP) SHORT TIME (SP)

ITE Imperial Corporation

MAY 1, 1972

TCC-605808

CALIBRATION TESTING

1. MAINTENANCE AND RENEWAL PARTS

No maintenance is required on the CIRCUIT-SHIELD relay. Should the relay be damaged physically or electrically due to improper connections or applications, we recommend that a new relay be ordered from the factory. When ordering, state the type relay, catalog number, control voltage, and serial number.

By specifying the relay catalog number, a circuit description bulletin and schematic may be obtained from your ITE sales engineer should you desire to repair and recalibrate the relay.

2. HIGH POTENTIAL TESTS

Do not apply high voltage tests to solid-state relay circuits. If a control wiring insulation test is required, bond all terminals together and disconnect grounding wire before applying test voltage.

3. ACCEPTANCE TESTS

Follow calibration test procedure under paragraph 4. Check the following points: time dial 1, current 5 times pickup; time dial 10, current 10 times pickup; time dial 10, current 5 times pickup. Operating times should be within ±5% of the times shown on the time-current characteristic curve.

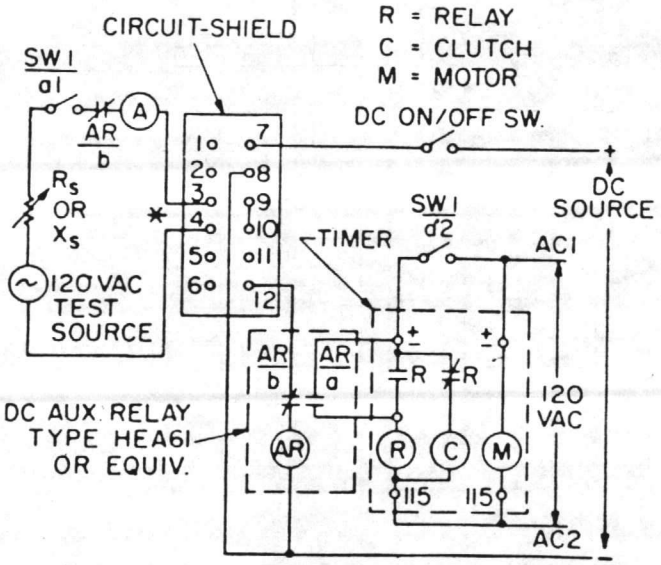


Fig. 4 — Calibration Test Circuit

4. CALIBRATION TESTS (Also see Appendix A)

Connect the CIRCUIT-SHIELD relay to the test source, proper DC control voltage (to match relay), and synchronous timer as shown in Figure 4. Also, set pickup tap to desired value.

TIME — Pickup

1) Set TIME dial to required value.
2) With DC source off, preset test current to 95% of pickup value.
3) With DC on, apply test current. No trip should occur.
4) With DC off, preset test current to 105% of pickup value.
5) With DC on, apply test current. The relay should trip and operate the TIME target. (Allow sufficient time) giving INST. target.
6) Reset target by pressing the RESET pushbutton.

TIME — Delay Curve

1) Set INST. dial to maximum position (20X).
2) Set TIME dial to required value, per time-current curves.
3) With DC off, preset test current to 300% of pickup value.
4) With DC on, apply test current. The relay should trip in a time within the tolerances shown on page 4.
5) Reset target by pressing the RESET pushbutton.

INST. — Pickup

1) Set INST. dial to required value.
2) With DC off, preset current to 90% of required value (TAP X INST. DIAL).
3) With DC on, apply test current. Relay should not trip on INST. (i.e. no INST. target indication).
4) With DC off, preset test current to 110% of required value.
5) With DC on, apply test current. Relay should trip giving INST. target.
6) Reset target by pressing the RESET pushbutton.

NOTE: If a rectifier is to be used as the DC source for testing, the filter capacitor should be at least 250 ufd.

***NOTE:** FOR 3-PHASE RELAYS, PHASES A & C CAN BE SIMILARLY TESTED BY ALTERNATELY CONNECTING THE TEST SOURCE TO 1—2 and 5—6.

NOTE: Auxiliary relays with coil resistances greater than 10 ohms/volt must have a parallel resistor added across the relay coil. Size resistor to draw 100 ma current from DC source

APPENDIX A

CIRCUIT-SHIELD TEST TABLES

NOTE: You need not use these tables if you desire to make the standard receiving calibration check described under calibration testing.

When testing protective relays with test sources of limited capacity the accuracy of test results is affected by the wave shape of the test current. Where extremely accurate calibration test are desired, the attached test Tables prepared under laboratory conditions with standard CIRCUIT-SHIELD relays can be used:

Table 1 — Resistance Testing
("STATES" resistance bank #33560.R)

Table 2 — Reactance Testing
("G.E." reactor, #6054975)

Table 3 — MULTI-AMP Unit (SR-51 test set)

Note that the test current wave distortion is more apparent at the low current tap setting (highest relay burden) and at high current multiples (lowest test source impedances).

CIRCUIT-SHIELD solid-state overcurrent relays have been designed with a low burden characteristic. This relay burden is such that the primary current transformer will not saturate at high fault current values if the CT is selected so that its saturation point is above one multiple of the relay pickup setting. This is accomplished by a specially designed input transformer in the relay which saturates at just above pickup current. In addition to improving the accuracy performance of the primary current transformer, this feature also effectively prevents internal solid-state components from being subjected to high currents and voltages under fault conditions.

CONSULT FACTORY FOR TEST CURRENT CORRECTIONS TO BE USED FOR TEST SETS NOT LISTED IN THIS APPENDIX.

TABLE 1
CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — RESISTANCE TESTING
120 VOLT SOURCE (FIXED)

(STATES #33560.R)

TEST CURRENT MULT.	0.5-2 AMP TAP RANGE							1.5-6 AMP TAP RANGE		4-12 AMP TAP RANGE						
	0.5	0.6	0.8	1.0	1.2	1.5	2.0	2.5	3	4	5	6	7	8	10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.02	1.22	1.62	2.02	2.42	3.02	4.02	5.02	6.02	8.02	10.00	12.00	14.00	16.00	20.00	24.00
3X	1.56	1.86	2.46	3.06	3.65	4.55	6.05	7.55	9.05	12.10	15.10	18.10	21.10	24.10	30.10	36.10
4X	2.12	2.51	3.31	4.11	4.91	6.11	8.11	10.10	12.10	16.10	20.10	24.10	28.10	32.11	40.10	48.10
5X	2.70	3.19	4.19	5.19	6.19	7.68	10.20	12.70	15.20	20.20	25.20	30.20	35.20	40.20	50.20	60.18
6X	3.30	3.89	5.09	6.28	7.48	9.28	12.30	15.30	18.30	24.30	30.30	36.30	42.30	48.30		
8X	4.57	5.36	6.94	8.53	10.10	12.50	16.50	20.50	24.50	32.50	40.50	48.50	56.50			
10X	5.95	6.92	8.88	10.90	12.90	15.80	20.80	25.80	30.80	40.81	50.80					
15X	9.94	11.30	14.20	17.10	20.00	24.50	31.90	39.40	46.90							
20X	14.90	16.50	20.10	23.90	27.80	33.70	43.60	53.50								

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

TABLE 2

CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — REACTANCE TESTING
120 VOLT SOURCE (ADJUSTABLE)

(G E REACTOR #6054975)

TEST CURRENT MULT.	0.5	0.6	X_S=24 Ω 0.8	1.0	1.2	1.5	2.0	X_S=12 Ω 2.5	3	4	5	X_S=6 Ω 6	7	8	X_S=3 Ω 10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.08	1.21	1.61	2.00	2.40	3.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00	24.00
3X	1.52	1.81	2.41	3.00	3.60	4.50	6.00	7.50	9.00	12.00	15.00	18.00	21.00	24.00	30.00	36.00
4X	2.05	2.41	3.20	4.00	4.80	6.00	8.00	10.00	12.00	16.00	20.00	24.00	28.00	32.00	40.00	48.00
5X	2.55	3.04	4.00	5.00	6.01	7.50	10.00	12.50	15.00	20.00	25.00	30.00	35.00	40.00	50.00	60.00
6X	3.06	3.64	4.90	6.00	7.20	9.05	12.05	15.00	18.00	24.00	30.25	36.00	42.00	48.00	60.00	72.00
8X	4.06	4.90	6.55	8.05	9.75	12.15	16.05	20.10	24.30	32.40	41.00	49.00	56.00	64.00	80.00	
10X	5.35	6.35	8.25	10.40	12.30	15.25	20.50	25.50	31.00	41.50	51.50	62.50	71.50	80.00		
15X	7.85	9.55	12.40	15.50	18.90	22.70	30.45	40.00	47.00	61.80	78.00					
20X	10.70	13.20	16.60	22.00	25.00	31.25	46.50	63.00	67.00						X_S=0.5 Ω	

0.5-2 AMP TAP RANGE
1.5-6 AMP TAP RANGE
4-12 AMP TAP RANGE

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

When using a tapped reactance in series with a variable voltage source to test CIRCUIT-SHIELD relays, the desired test current should be set using the largest possible reactance, as indicated in the chart above for a 120 Vac source.

TABLE 3

For specific test instructions using MULTI-AMP SR-51 Test Set see page 15.

CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — MULTI-AMP TEST SET

(MULTI-AMP SR-51)

80 VOLT TAP: use data to left of bold line.
40 VOLT TAP: use data to right of bold line.

TEST CURRENT MULT.	0.5	0.6	0.5-2 AMP TAP RANGE 0.8	1.0	1.2	1.5	2.0	1.5-6 AMP TAP RANGE 2.5	3	4	5	4-12 AMP TAP RANGE 6	7	8	10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.55	1.58	1.87	2.25	2.59	3.15	4.10	5.05	6.10	8.10	10.00	12.00	14.20	16.00	20.00	24.30
3X	3.35	3.34	3.49	3.85	4.29	5.01	6.40	7.80	9.40	12.30	15.30	18.30	21.30	24.30	30.20	36.50
4X	5.10	4.89	5.09	5.45	6.00	6.90	8.70	10.40	12.30	16.50	20.40	24.50	28.50	32.00	40.50	48.80
5X	6.78	6.50	6.60	7.00	7.70	8.81	11.00	13.30	16.00	20.80	25.50	30.80	35.60	41.20	51.00	62.00
6X	8.10	7.90	7.95	8.50	9.30	10.50	13.30	16.00	19.00	25.00	30.60	37.00	44.20	49.50	61.80	74.00
8X	10.80	10.40	10.60	11.30	12.40	14.30	17.80	21.80	25.20	33.00	41.50	51.50	59.50	65.50		
10X	13.30	12.90	13.30	14.00	15.60	18.00	22.30	27.00	31.00	40.90	55.00	65.00	75.00	82.00		
15X	18.80	18.70	18.60	20.50	22.50	25.00	32.00	39.00	52.00	65.00	79.00				40 VOLT TAP	
20X	24.00	24.30	24.00	26.00	29.50	32.50	42.00	61.00	70.00	85.00						

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

The SR-51, which operates from a 120 Vac source, uses a transformer with step down taps to produce a wide range of currents useful in general relay testing. Since the series impedance of the transformer provides a fixed source impedance, a variable autotransformer is used to adjust the level of input current. This fixed source impedance is in general not large enough compared to the non-linear relay impedance to guarantee sine wave test current.

TESTING WITH MULTI-AMP SR-51 TEST SET

EQUIPMENT NEEDED

1. MULTI-AMP MODEL SR-51 RELAY TEST SET and

2. Small AUXILIARY RELAY with DC coil to match CIRCUIT-SHIELD relay voltage rating and with a set of normally open contacts. Auxiliary relays with coil resistances greater than 10 ohms per volt must have a parallel resistor added across the relay coil.

TEST PROCEDURES

ALWAYS REFER TO MANUFACTURER'S LITERATURE BEFORE TESTING.

TYPE OF TESTS

Pickup — Timing Circuit
Time/Current Characteristics
Pickup — Instantaneous Circuit

SETUP OF CONTROLS BEFORE TEST

Control	Position
"Power ON" switch	OFF
"Timer Operation Selector" switch	Upper — "N.O. MOM" Lower — "CONT."
"Main Control"	Zero (counterclockwise)
"Aux. Power" switch	"INT."
"Voltmeter Range" switch	150
"Voltmeter Selector" switch	"DC"
"Aux. Selector" switch	"DC 150"
"Aux. Control"	Zero (counterclockwise)
"AC Range" switch	10A
"DC Range" switch	5A
"Main Ammeter Range" switch	So that desired test current will be read on upper 1/3 of meter scale.
"Voltage Relay Test" (DET) switch	Set "NORM"
"Output #1 - #2" switch	Output #1

PICKUP TEST — TIME CIRCUIT

1. Connect the Multi-Amp relay tester to a suitable source of power as indicated on the nameplate and ground. BE SURE THE MAIN SWITCH IS OFF. CHECK THE "POWER ON" LIGHT.

2. Connect relay input circuit (Relay Terminals 1-2, 3-4, or 5-6) to the right-hand common and the 80 volt tap of "Output #1" of test set.

3. Connect Relay Terminals 7-8 to "DC Output" binding posts of test set. NOTE: Relay Terminal 7 should be connected to positive (+). Reversed polarity can damage relay.

4. Connect output circuit of relay (Relay Terminals 8 and 12) to operating coil of the small DC auxiliary relay.

5. Connect normally open contacts of the DC auxiliary relay to the "Relay Contacts" binding posts of the test set.

6. Turn "Power ON" switch ON. "Power ON" light should glow.

7. Initiate unit by pressing and holding "Initiate" switch.

8. Rotate "Aux. Control" clockwise until DC voltage of relay under test is observed on voltmeter. Release "Initiate" switch.

9. Preset ammeter needle using "Pointer Preset" to ½ division below desired test current. Desired test current is relay tap value less 5%.

10. Set test current desired by jogging the "Initiate" switch and rotating "Main Control" (clockwise) to increase output until the ammeter needle quivers. Hold in "Initiate" switch and rotate the "Main Control" until test current is read on ammeter. Release "Initiate" switch.

11. Set "Timer Operation Selector" switch: Upper to "N.O. MAINT."; Lower to "TIMER".

12. Reset timer to zero with "Timer Reset" lever.

13. Initiate test set by pressing "Initiate" switch. Relay input circuit will "see" test current. Relay SHOULD NOT operate to de-energize test set under these conditions (allow 1-1½ minutes). De-energize test set by turning "Power ON" switch OFF.

14. Remove one lead from "DC Output" binding posts.

15. Turn "Power ON" switch ON: Reset "Timer Operation Selector" switch: Upper to "N.O. MOM."

16. Repeat Steps 9 through 12 above, except test current should be relay tap value +5%.

17. Replace DC lead that was removed in Step 14.

BE SURE TO MAKE TEST CURRENT CORRECTION PER TABLE 3 WHEN SETTING TEST CURRENT

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BROWN BOVERI

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18. Adjust "Time Operation Selector" switch: Upper to "N.O. MAINT."

19. Initiate test set by pressing "Initiate" switch. Relay input circuit will "see" test current and SHOULD operate to de-energize test set and stop timer (allow sufficient time). Relay time target should operate.

20. Turn test set OFF.

TIME DELAY TEST

1. Reset "Timer Operation Selector" switch: Upper to "N.O. Mom."

2. Repeat Steps 1 through 9 under "PICKUP TEST — TIME CIRCUIT," except the value of test current should be obtained from Table 3.

3. Remove one lead from "DC Output" binding post.

4. Initiate unit by pressing "Initiate" switch.

5. Set test current desired by jogging the "Initiate" switch and rotating "Main Control" (clockwise) to increase output until ammeter needle quivers. Hold in "Initiate" switch and rotate "Main Control" to make final current adjustment. Release "Initiate" switch.

6. Replace DC lead that was removed in Step 3 above.

7. Set "Timer Operation Selector" switch: Upper to "N.O. MAINT."; Lower to "TIMER".

8. Reset Timer to zero with "Timer Reset" lever.

9. Initiate unit by pressing "Initiate" switch. Timer will run and test current will be indicated on ammeter. The relay test set will automatically cut off and the timer will stop when relay operates to fire the SCR which energizes the DC auxiliary relay to close its contacts. Relay time target should show.

10. Note the relay under test must be energized with DC to reset relay target.

11. Turn-test set OFF.

PICKUP TEST — INSTANTANEOUS CIRCUIT

1. If test current will exceed 42 amperes, use 40 volt tap on test set "Output #1".

2. Jumper terminals 9 and 10 on relay.

3. Repeat Steps 1 through 8 under "PICKUP TEST — TIME CIRCUIT".

4. Preset ammeter needle using "Pointer Preset" to ½ division below desired test current. Desired test current is relay instantaneous setting less 10%. Obtain value of test current from Table 3.

5. Remove one lead from "DC Output" terminal.

6. Set "Timer Operation Selector" switch: Upper to "N.O. MOM."; Lower to "FAST TRIP".

7. Jog "Initiate" switch and rotate "Main Control" clockwise until test current is read on ammeter. Release "Initiate" switch.

8. Replace DC lead removed in Step 5 above.

9. Press and hold "Initiate" switch. Relay instantaneous circuit SHOULD NOT pick-up to stop timer (allow 0.30 second). Reset relay target.

10. Remove one lead from "DC Output" terminal.

11. Repeat Step 7, except that test current should be relay instantaneous setting +10%*. Obtain value of test current from Table 3.

12. Replace DC lead removed in Step 10.

13. Press and hold "Initiate" switch. Relay instantaneous circuit should pick-up, fire its SCR to energize the DC coil of auxiliary relay to stop timer. Relay instantaneous target should operate.

14. Release "Initiate" switch.
WARNING!!! CURRENT INDICATED ON AMMETER IS PRESENT IN RELAY CIRCUIT UNTIL "INITIATE" SWITCH IS RELEASED. Therefore, it is important to perform this test rapidly.

15. Turn test set OFF.

16. Record all test results.

***NOTE:** For 0.5-2 ampere tap range, the settings should be ±20% instead of ±10%.