ISOLATION TESTS FOR WESTINGHOUSE TYPE AR RELAYS USED IN AUXILIARY RELAY RACKS

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SUMMARY

WESTINGHOUSE TYPE AR RELAY ISOLATION TESTS

Electrical tests were performed on three Westinghouse type AR relays to demonstrate and document their coil-to-contact and contact-to-contact isolation capabilities. Voltages of 580VAC and 250VDC were applied in these tests to determine leakage path resistances. Acceptance for isolation was based on the criterion that the leakage path resistances for all tests be greater than 1 megohm. All three relays tested exhibited leakage path resistances exceeding the criterion by factors ranging from approximately 40 to 30,000, demonstrating that they are effective electrical isolation devices.

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1.0 OBJECTIVE

The objective of this test is to verify the isolation capability of the AR Relays used in the Auxiliary Relay Racks. Westinghouse type AR Relays have been used as isolation devices between 1E and non-1E circuits in the Protection System cabinets where the relays have been qualified for this use by virtue of cabinet qualification tests.

The Auxiliary Relay Racks (ARR) have historically provided a housing for AR type relays serving control grade circuits and, as such, were not qualified. When the ARR were installed at some plants, all external wiring connected to the train designated circuits were routed with legitimate Class 1E wiring. Consequently, all train designated wiring must be treated as associated circuitry as defined in Regulatory Guide 1.75 and IEEE Standard 384-1974. The question now arises as to whether the integrity of any Class 1E Systems are significantly degraded due to the association with train wiring from the relay racks.

2.0 EQUIPMENT TO BE TESTED

Testing is to be performed on the following relays built to drawing 765A624.

QUANTITY	NO. OF POLES	CATALOG NUMBER	STYLE
2	4	AR440AR	766A025G09
1	4	NAR880AL	751B297603

3.0 TEST REQUIREMENTS

3.1 General Requirements

The relays were tested at the Westinghouse Nuclear Services Integration Division (WNSID) ITTC facility in Monroeville, Pennsylvania. All required test equipment and manpower were provided by WNSID.

Engineering bench tests were conducted on Westinghouse type AR relays to verify the isolation capability of the relay. Three AR 440 relays (4 pole) were tested for isolation between contacts and coil and between contacts. Only 4 pole relays were tested, based on the assumption that the contacts added for the 8 pole relays are at greater distances from the coil than the contacts of the 4 pole relays and would not add to the credibility of the tests. (Four poles were removed from the 8 pole relay, NAR880AL, to obtain a third, 4 pole relay for the tests.)

3.2 Test Equipment

A detailed list of test equipment used for the isolation testing is included in the test log book. The list includes:

1. Megohmmeter
2. Digital Voltmeters
3. Digital Micro-ammeter
4. 580 VAC Power Source
5. 250 VDC Power Source
6. Wood Mounting Plate
7. Terminal Blocks
8. #12 and #16 AWG Type K wire, per specification MIL-W-16878.

3.3 Mounting Requirements

The equipment was mounted on a piece of 3/4" thick plywood (Figure 9.1) with dimensions large enough to accomodate the three relays to be tested and terminal blocks TB1, TB2 and TB3. The wiring from the relays to the terminal blocks was bundled together using tie wraps as shown in Figure 9.1.

3.4 Electrical Connections

Electrical connections to the equipment were made using spade lug terminals and connectors as required. Each piece of equipment shall be interconnected to its associated test equipment as indicated in Figures 9.2 thru 9.4. The interconnections and operation of each piece of equipment was the responsibility of WNSID personnel.

3.5 Responsibilities

Nuclear Services Integration Division was responsible for defining the electrical connections, electrical monitoring of the equipment under test, and test equipment calibration.

3.6 Monitoring Requirements

Applied Test voltages, leakage currents, induced voltages and values of resistances were measured and recorded when data was taken according to the test procedure. The accuracy of the recording instrumentation shall be ±1.0%.

4.0 TEST PROCEDURE

Testing was done at room temperature using both 580 VAC and 250 VDC to simulate faulted conditions and 1090 VDC to measure insulation resistances.

4.1 TEST 1

The test voltages were applied in turn (580 VAC first; 250 VDC second) between the contacts and coil with the leakage current and test voltages measured and recorded after one minute (Figure 9.2. The time of one minute allowed any transients in the system to decay.

4.2 TEST 2

The test voltages were applied in turn between contacts and ground and the induced coil voltage measured after one minute. The coil was loaded with a 1.3 ohm resistance (Figure 9.3). One minute after the test voltage was applied, the test voltages and leakage currents were measured and recorded. The 1.3 ohm resistor was selected to represent the source impedance of any supply connected to the coil.

4.3 TEST 3

The test voltages were applied in turn between adjacent contacts (Figure 9.4) and the leakage current measured after one minute. After one minute of the test voltage application, the test voltage and leakage current were measured and recorded.

4.4 INSULATION RESISTANCE TESTS

The insulation resistances between the relay coil-to-frame, coil-to-contacts, contacts-to-frame, and contact-to-contact were measured using a megometer before starting Tests 1, 2 and 3 and after completing them.

5.0 REQUIRED TEST DATA

The test data included, but is not limited to the following:

1. All test recordings, which were clearly identified and scaled.

2. A listing of all equipment used for the test.

3. All significant events (i.e., start of test, abnormal occurrences, etc.) were noted and clearly identified in a logbook (See Section 7.2).

4. A log and data sheet recording the completion of test steps defined in Section 4.0.

5. Photographs (see Section 7.3) of the test setup and equipment.

6.0 ACCEPTANCE CRITERION

If the leakage path resistance in all cases was greater than 1 megohm, the relays will have demonstrated the proper isolation exists between coil and contacts and between contacts. This criterion was derived from the applicable relay test procedures of EIA Standard RS-407-A using the highest test voltage of 580VAC and then applying a safety factor of approximately two to yield a stronger acceptance criterion.

7.0 DOCUMENTATION

7.1 The test results are given in Section 8.0 and includes the following information.

a. A listing of all instrumentation used to collect data including model number and serial number.
b. A summary of all data collected to satisfy this specification.

7.2 Log Book

The test log included the following:

a. Data and time of each test activity.
b. Signature of personnel making the entry and responsible test engineer.
c. Any deviation from this test specification to be signed by WNSID engineers.
d. An entry stating the completion of the test.
e. Photographs.

7.3 Photographs

All photographs are black and white, 8 x 10 inch glossy. Photographs were taken of the test setup with test equipment for each test configuration.

8.0 TEST RESULTS

The AR Relays were tested according to the overall isolation test plan as outlined in Section 2 through 7 for the Auxiliary Relay Racks AR Relays on November 8th and 26th.

The objective of this test was to verify the isolation capacity (>1 megohm) of the AR Relays used in the Auxiliary Relay Racks. The three AR relays tested (numbered one, two and three) were:

CONTROL RELAY NO.	MODEL NO.	STYLE
1	AR440AR	766A025G09
2	AR440AR	766A025G09
3	NAR880AR	751B297G03

The Number 3 Relay, NAR880AR had four contacts removed so that it was equivalent to the other AR440 relays. The relay contacts were normally open. The three relays were mounted and wired according to the test plan.

Visual inspection of the relays before testing did not disclose any obvious material deterioration.

EQUIPMENT LIST

MODEL	SERIAL NUMBER	CALIBRATE DATE
Fluke 8502A Digital Multimeter	2945038	5-21-84
Fluke 8502A Digital Multimeter	2775033	5-21-84
Fluke 8505A Digital Multimeter	3535009	8-16-84
Fluke 8024B Digital Multimeter	2930396	7-11-84
Hewlett-Packard Capacitance Meter	1207J06240	3-29-84
General Radio 1864 Megohmmeter	4260	11-4-83

Hewlett-Packard 6515A DC Power Supply	ISD2503	N/A*
AC Power Supply	N/A	N/A*

* Power supply voltages set and/or measured with the Fluke 8024B multimeter.

A preliminarry insulation resistance measurement was made on the relays with the General Radio megohmeter using a voltage of 1090VDC. The results are shown on data sheet one, Table 10.1. The insulation resistance for all tests (except No. 3 relay contact to Frame) was greater than 1000 megohms which greatly exceeded the acceptance criterion of 1 megohm.

The relays were then tested with 250VDC and 580VAC. The DC isolation resistances shown on data sheet two, Table 10.2, were greater than 59 megohms which exceeded the acceptance criterion. Therefore, DC isolation between contact and coil and between contacts was proven by the tests.

The AC impedance values were measured according to the test plan and the values are listed on data sheet three, Table 10.3. The test voltage used was 580VAC. All AC impedance values were greater than the acceptance criterion of 1 megohm.

The megohmometer was used to measure the insulation resistance after the test data was taken and the values are tabulated on data sheet four, Table 10.4. All values were greater than 1000 megohms.

In the test procedure the induced voltage in the coil and the resultant current flow were measured when the coil was shorted with a 1.3 ohm resistance and the test voltage was applied between the contacts and the frame. Results are tabulated on data sheet five, Table 10.5.

The induced coil voltage and the resultant current flow if the circuit is completed would not impair normal operation of the circuit.

In conclusion, since the acceptance criterion for the planned tests was exceeded, the AR Relay has been demonstrated to be an effective isolation device for use in the Auxiliary Relay racks.

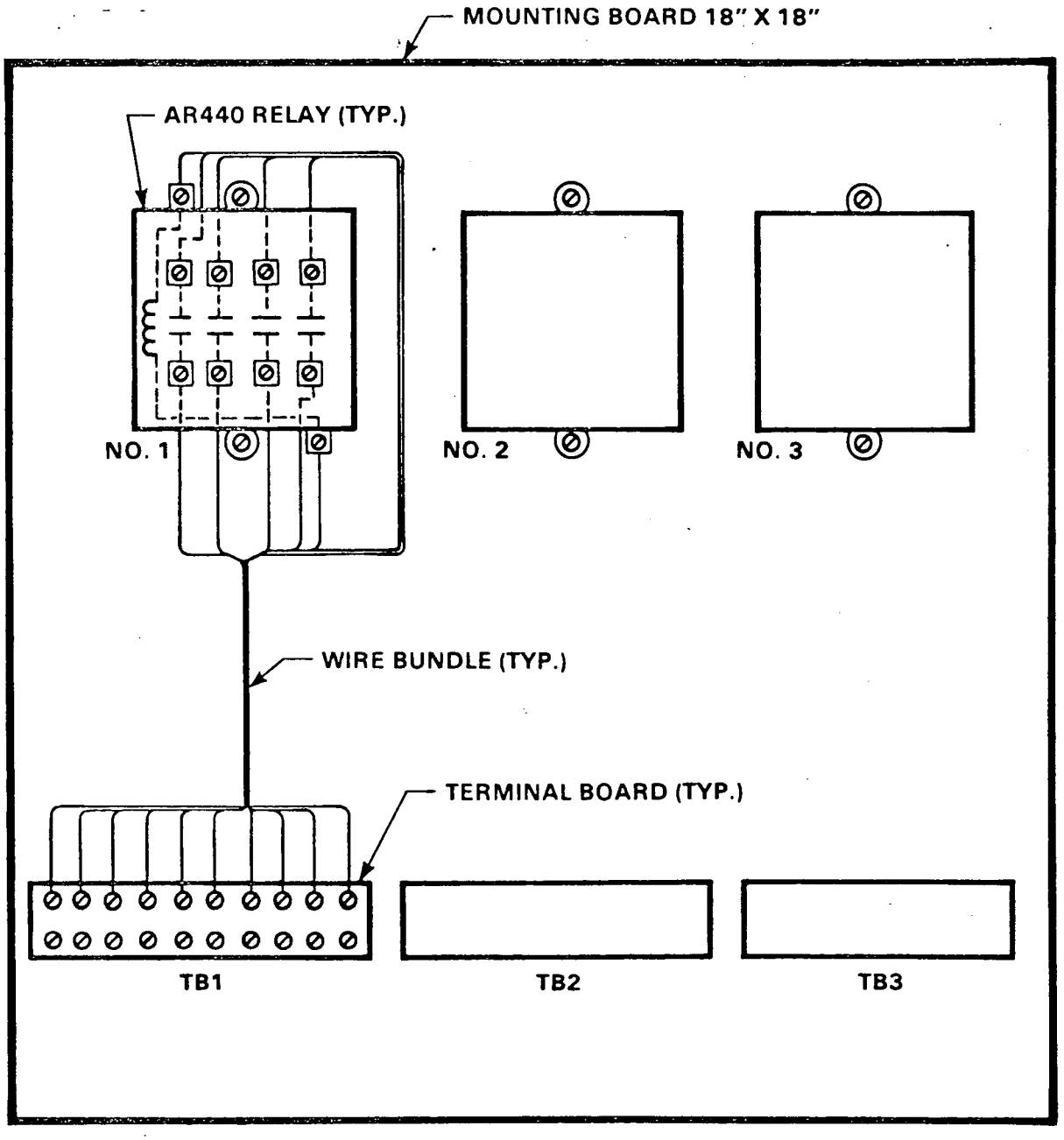

Figure 9.1 Equipment Mounting

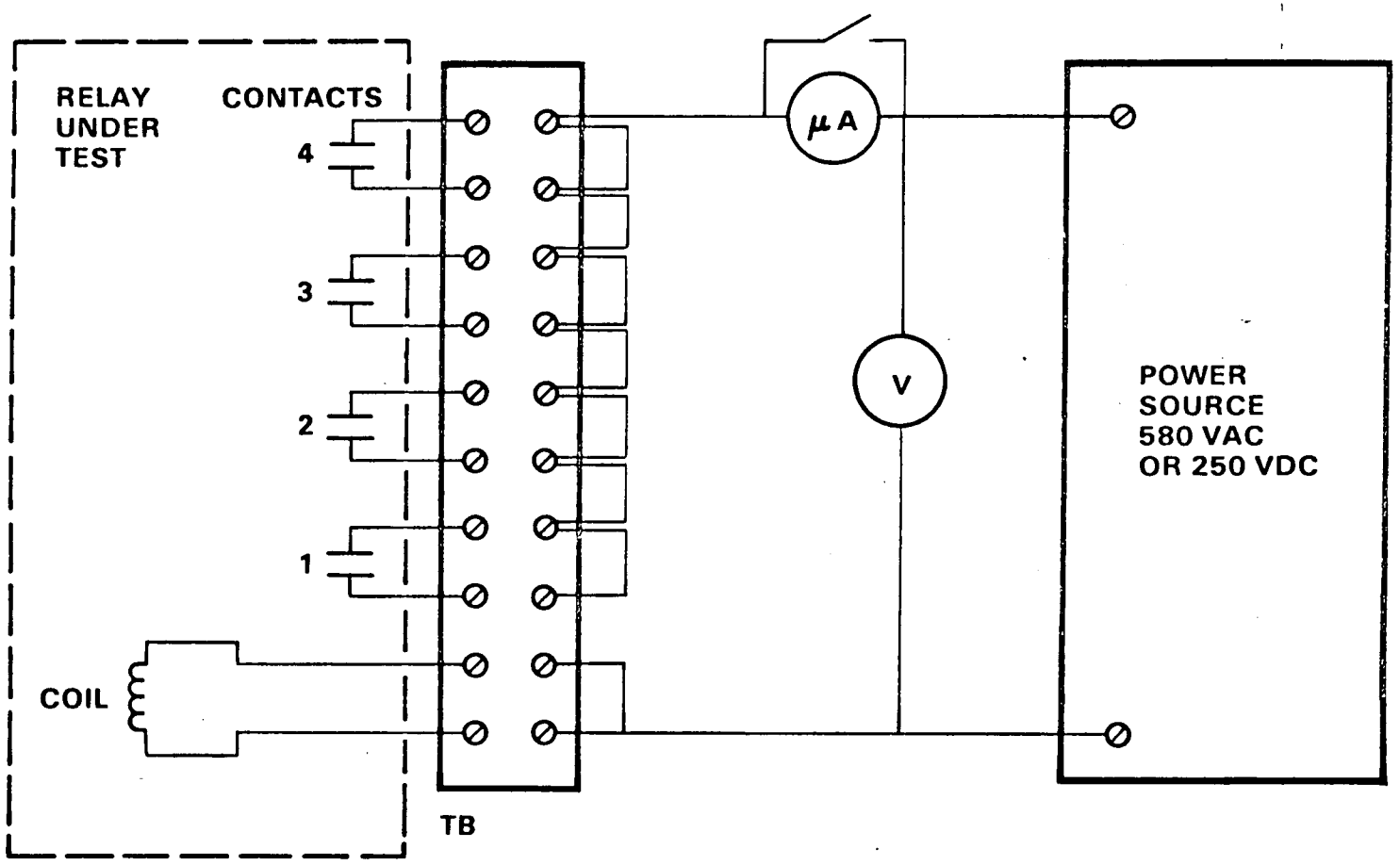

Figure 9.2. Coil-to-Contact Leakage Current

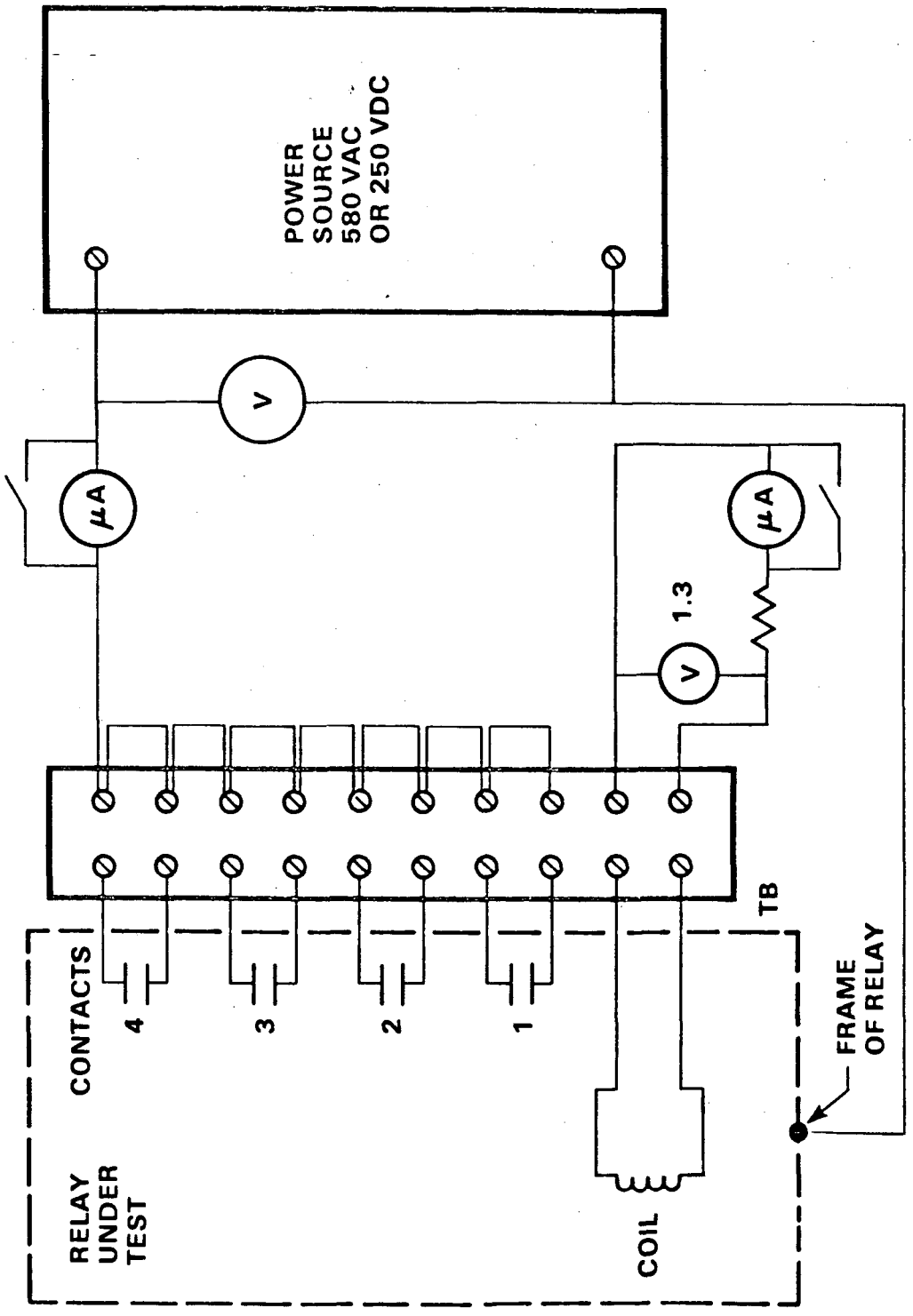

Figure 9.3. Induced Coil Voltage

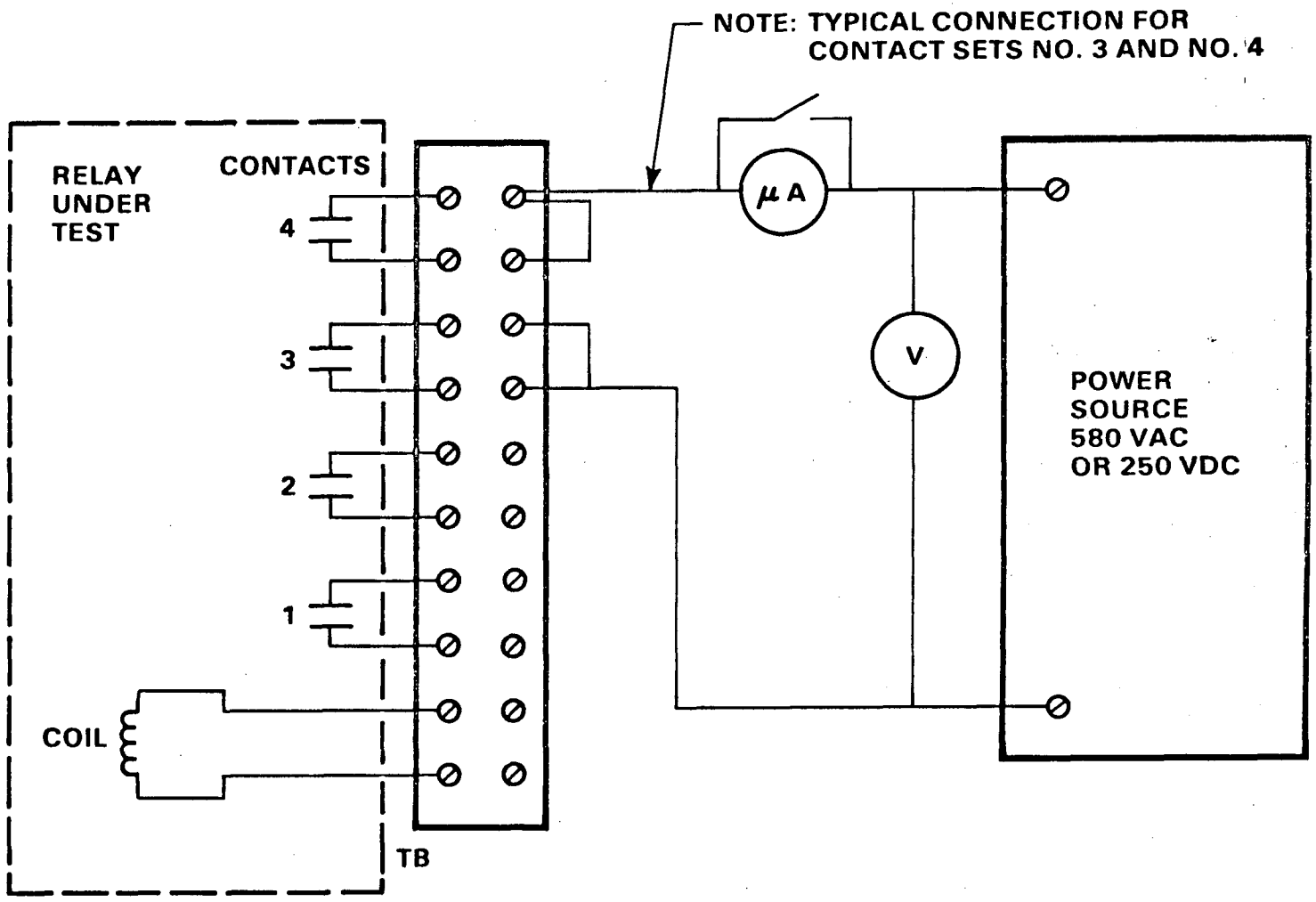

Figure 9.4. Leakage Current Between Contacts

TABLE 10.1

DATA SHEET ONE

INSULATION RESISTANCE

1090 VDC

Test values before relay testing in megohms, 11/8/84.

RELAY NO.	COIL TO FRAME	COIL TO CONTACT	CONTACTS TO FRAME	CONTACT TO CONTACT 1 to 2,3&4
1	4400	2400	1450	1300
2	3100	2400	1160	1300
3	2800	2200	900	1120

TABLE 10.2

DATA SHEET TWO

AR RELAY ISOLATION TEST

250 VDC

Insulation resistance in Megohms, 11/8/84.

RELAY NO.	TEST 1 COIL TO CONTACTS	TEST 2 CONTACT TO FRAME	TEST 3 CONTACT TO CONTACT 1&2	2&3	3&4
1	28,000	25,000	59.5	60.2	59.8
2	31,000	20,800	59.4	59.2	59.1
3	31,000	23,000	59.5	59.5	59.5

TEST 10.3

DATA SHEET THREE

AR RELAY ISOLATION TESTS

580 VAC

Impedance value in megohms, 11/26/84.

RELAY NO.	TEST 1 COIL TO CONTACTS	TEST 2 CONTACT TO FRAME	TEST 3 CONTACT TO CONTACT		
			1&1	2&3	3&4
1	53.7	175.75	45.96	46.80	49.2
2	50.04	189.54	41.84	45.24	45.21
3	66.74	331.43	39.19	53.7	57.26

TABLE 10.4

DATA SHEET FOUR

AR RELAY ISOLATION TESTS

INSULATION RESISTANCE

1090 VDC

Test values after relay testing in megohms, 11/8/84.

RELAY NO.	COIL TO FRAME	COIL TO CONTACTS	CONTACTS TO FRAME	CONTACT TO CONTACT 1 TO 2,3 & 4
1	4400	2200	2000	1500
2	3000	2300	1500	1260
3	2600	2100	1350	1080

TABLE 10.5

DATA SHEET FIVE

AR RELAY ISOLATION TESTS

580 VAC & 250 VDC

TEST 2, induced coil voltage and courrent, test voltages applied between contact and frame.

Coil loaded with a 1.3 ohm resistor; 250 VDC TEST 11/8/84, 580 VAC TEST, 11/26/84.

	580VAC		250VDC	
RELAY NO.	COIL VOLTAGE mV	COIL CURRENT mA	COIL VOLTAGE mV	COIL CURRENT mA
1	24	3.5	0.09	.773
2	25	3.35	0.086	.757
3	21	8.50	0.083	.761